



Rail Accident Investigation Branch

Rail Accident Report



Near miss at Llanbadarn Automatic Barrier Crossing (Locally Monitored), near Aberystwyth 21 October 2008

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

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Preface

- 1 The sole purpose of a Rail Accident Investigation Branch (RAIB) investigation is to prevent future accidents and incidents and improve railway safety.
- 2 The RAIB does not establish blame, liability or carry out prosecutions.

Definitions

- 3 All mileages in this report are measured from a datum of 31 miles 20 chains at the site of the former Buttington Junction, east of Welshpool. The zero datum point for this mileage was formerly situated at Whitchurch (Cambrian Junction) prior to line closures in the 1960's.
- 4 The Cambrian main line runs from Shrewsbury to Aberystwyth, via Welshpool, Newtown and Machynlleth. Trains heading towards Aberystwyth are running in the down direction and those towards Shrewsbury in the up direction.
- 5 All references in this report to the left or right are from the view of the driver in the direction of travel.
- 6 Appendices at the rear of this report contain the following:
 - abbreviations in Appendix A;
 - technical terms (shown in *italics* the first time they appear in the report) in Appendix B;
 - Key standards relevant to the incident in Appendix C; and
 - An RAIB Urgent Safety Advice issued on 24 November 2008 in Appendix D.

Summary of the Report

Key facts about the incident

- 7 At 11:13 hrs on Tuesday 21 October 2008 a passenger train ran across Llanbadarn level crossing, near Aberystwyth (Figure 1) while the barriers of the crossing were open to road traffic. A collision with a tanker lorry carrying liquefied petroleum gas was avoided by less than two metres.
- 8 No injuries resulted from the incident.

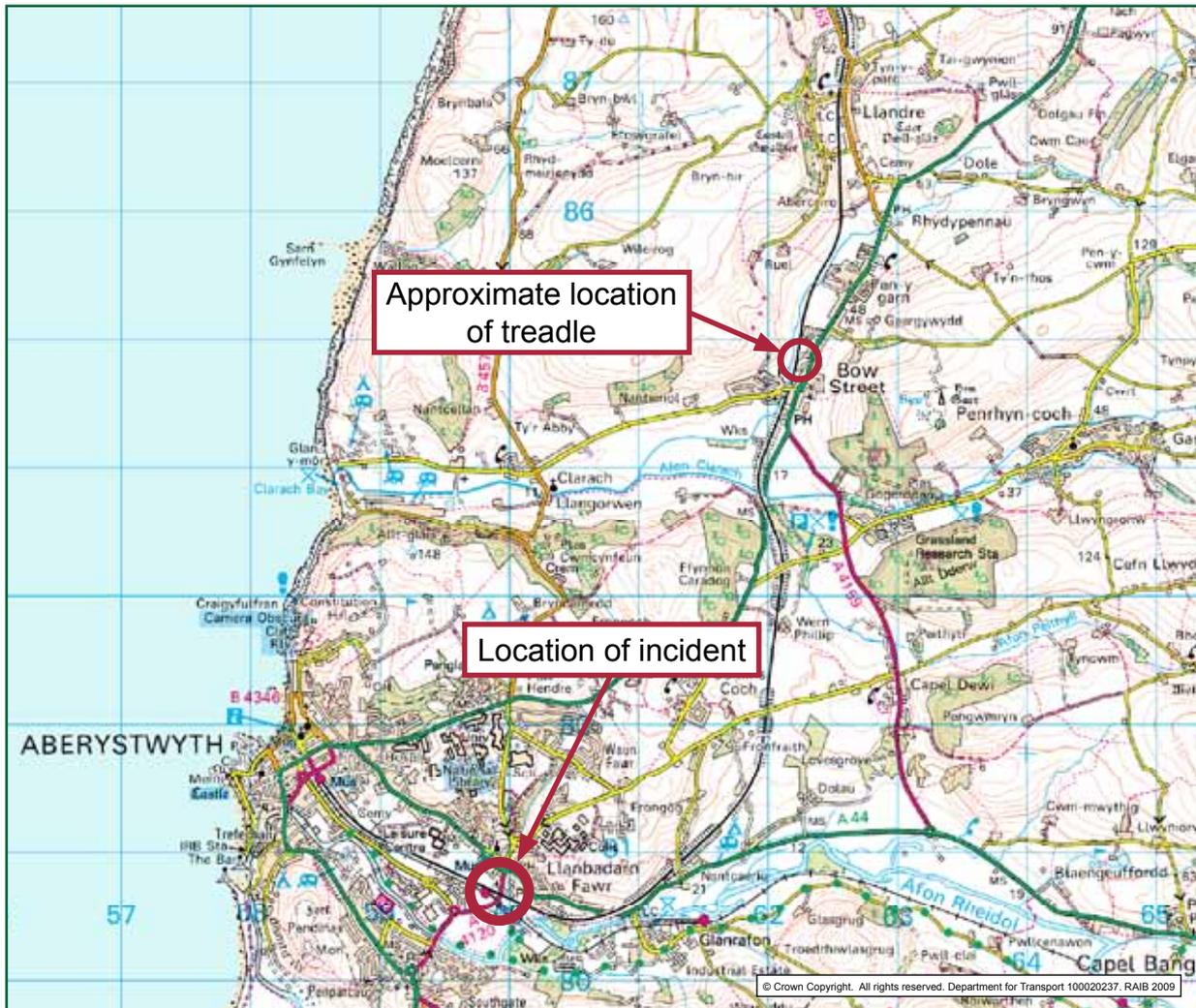


Figure 1: Extract from Ordnance Survey map showing location of incident and of treadle to initiate crossing operation

Immediate cause, causal and contributory factors, underlying causes

- 9 The immediate cause of the incident was that the driver of the train did not brake his train sufficiently early to stop before the crossing despite a flashing red aspect indicating that the crossing had not operated on the approach of his train.

- 10 Causal factors were that:
- the driver of the train did not apply the brakes of the train until 9.7 seconds after the train had passed the special speed restriction board for the crossing; and
 - the driver anticipated that the *driver's crossing indicator* would change from a flashing red aspect to a flashing white aspect after he had passed the special speed restriction board.
- 11 Possible other factors were:
- the driver may have been fatigued and distracted by the presence of two other drivers in the cab with him;
 - the settings of the driver's crossing indicators at two other locally monitored automatic crossings on the Cambrian lines, which showed a flashing red aspect after the driver had passed the special speed restriction board; and
 - the lack of explicit guidance to drivers about when to decide to apply brakes in module TW8 of the Rule Book.

Recommendations

- 12 Recommendations can be found in paragraph 157. They relate to the following areas:
- the design of the Llanbadarn level crossing;
 - modifications to other crossings on the Cambrian lines that display driver's crossing indicator aspects that may have affected the driver's performance at Llanbadarn, and to at least nine similar crossings on the rest of Network Rail;
 - Rule Book amendments, and briefing to drivers, about their duties on the approach to locally monitored level crossings; and
 - the maintenance of locally monitored level crossings on the Cambrian lines of Network Rail.

The Incident

Summary of the incident

- 13 At 11:13 hrs on Tuesday 21 October 2008 train 1J11, the 08:33 hrs from Birmingham to Aberystwyth, ran across Llanbadarn level crossing, near Aberystwyth, while the barriers of the crossing were open to road traffic. The train was braking heavily, and stopped on the crossing. A collision with a tanker lorry carrying liquefied petroleum gas was avoided by approximately two metres.

The parties involved

- 14 Network Rail owns and operates the main line infrastructure at Llanbadarn, and carries out maintenance of it, including the level crossing at Llanbadarn. It employs the maintenance staff involved in the incident.
- 15 The Vale of Rheidol Railway Ltd operates a heritage railway which has a level crossing at Llanbadarn across the same road as Network Rail (Figure 2). The maintenance of the controls for this crossing is carried out by Network Rail, as the two crossings are interlinked.

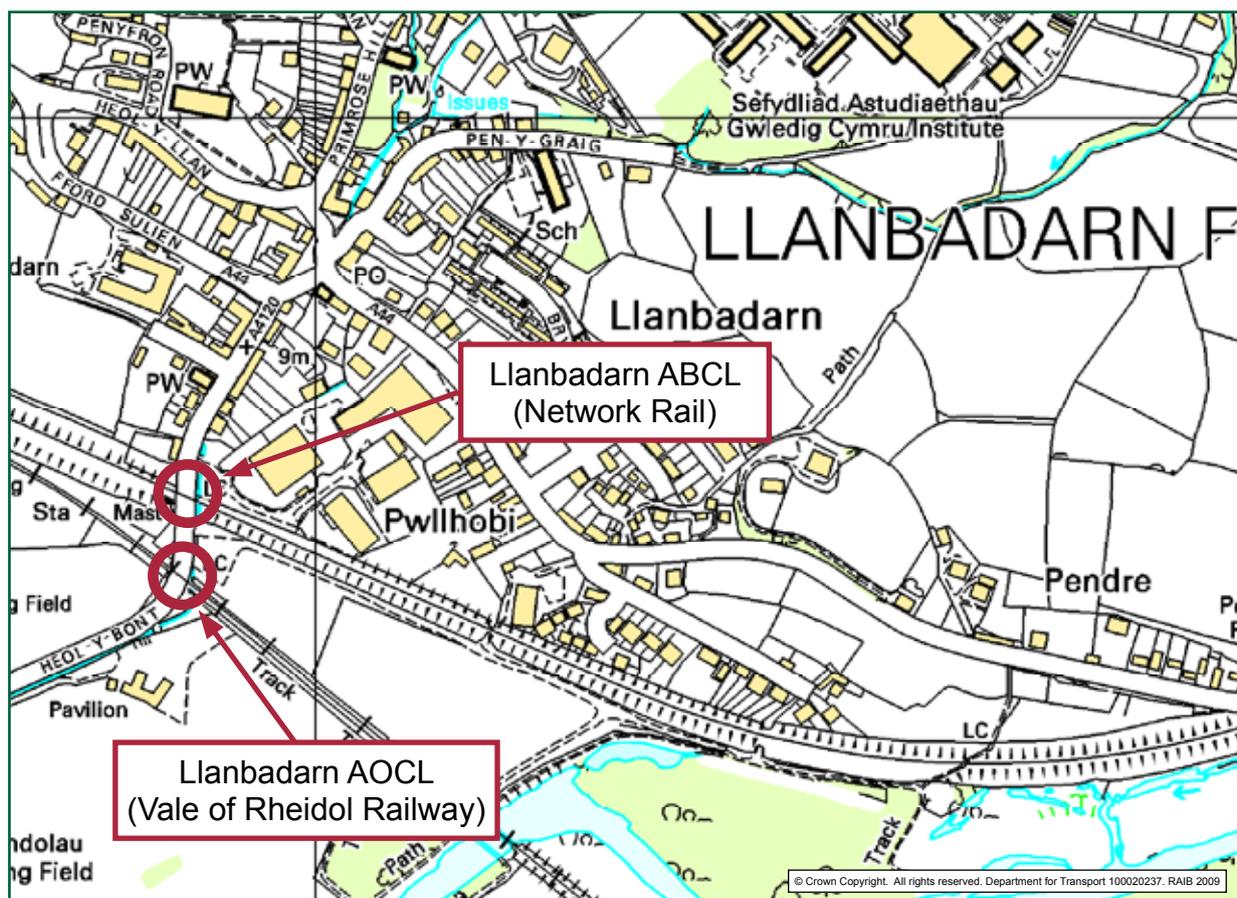


Figure 2: Extract from Ordnance Survey map showing location of level crossings at Llanbadarn

- 16 Arriva Trains Wales Ltd operates the passenger service between Shrewsbury and Aberystwyth, including train 1J11. It employs the driver of that train.
- 17 West Wales Gas is a supplier of liquefied petroleum gas, based in Llandysul. It is the owner of the lorry involved in the incident, and employs the driver of the lorry.
- 18 Network Rail, Arriva Trains Wales Ltd, the Vale of Rheidol Railway and West Wales Gas all freely co-operated with the investigation.

Location

- 19 The Llanbadarn level crossings are located where the two railways cross the A4120 approximately one and a half miles (two km) east of their terminal stations at Aberystwyth. There are two adjacent level crossings, some 50 to 60 metres apart. The more northerly crossing is on the Shrewsbury to Aberystwyth line of Network Rail, at 94 miles and 56 chains (Figure 3), and the southern level crossing is on the Vale of Rheidol Railway, 1 mile and 15 chains from Aberystwyth.



Figure 3: Llanbadarn ABCL looking south along A4120

- 20 The A4120 links the A44, entering Aberystwyth from the east, with the A487, which gives access to the south and south east of the town. It provides an effective by-pass to the centre of the town, and also gives access to an area of 'out of town' shopping and industrial premises that have been developed in recent years. The road traffic over the crossings is heavy, with both cars and lorries constantly crossing the railways during the working day.

- 21 The Network Rail line is on a falling gradient as it approaches Aberystwyth. This gradient is 1:75 from a summit at approximately 92 $\frac{3}{4}$ miles, flattening to 1:676 around the 94 $\frac{1}{2}$ mile post, approximately 16 chains, or 322 metres, to the east of Llanbadarn crossing (Figure 4).



Figure 4: Llanbadarn ABCL approach in the down direction

External circumstances

- 22 The weather at Llanbadarn at the time of the incident was generally sunny with a small amount of low cloud. There had been some rain (4.0 mm) in the previous 24 hours, and visibility was very good (estimated at up to 24 km). The sun was at an elevation of 25.77° and a bearing of 235 ° relative to the driver's vision, which is behind and to the left of his line of sight on the approach to the crossing. At this angle the sun could not have affected the driver's view of the crossing, and its associated signals.

Train(s)/rail equipment

Train

- 23 The train involved in the incident was a two carriage Class 158 diesel multiple unit. This was one of 182 such units, introduced into service from 1989 to 1992, and used on regional services, at speeds of up to 90 mph (140 km/h).

Signalling control

- 24 The Cambrian Lines of the Network Rail system run from Shrewsbury to Aberystwyth (the Cambrian Main Line), and from Dovey Junction to Pwllheli (the Cambrian Coast Line). They are controlled from a single signal box at Machynlleth, using a system known as Radio Electronic Token Block (RETB).
- 25 The RETB system requires each train driver to speak to a signaller at Machynlleth to request an electronic token before entering a section, to report the train's actual entry to the section, and to return the *electronic token* on leaving the section. Consequently the Machynlleth signallers are continually involved in *safety critical radio communication*.

Level crossings

- 26 The Network Rail Llanbadarn level crossing is an Automatic Barrier Crossing (Locally Monitored), commonly known as an ABCL. The adjacent Vale of Rheidol crossing is an Automatic Open Crossing (Locally Monitored), commonly known as an AOCL.
- 27 All automated level crossings over public roads are required to have a *Level Crossing Order*. In the case of the Llanbadarn crossings the current orders were issued in 1989, at the time that the Vale of Rheidol Railway was sold to private owners by British Rail. Further orders for both crossings were issued in 1992, covering matters relating to road markings, but the previous orders remain valid.
- 28 On the Cambrian Main Line there are three AOCL crossings and two ABCL crossings (including Llanbadarn). There are a further 11 locally monitored crossings on the Cambrian Coast Line, and a total of 177 such crossings on Network Rail as a whole. There are also several such crossings on heritage railways throughout the UK.
- 29 The philosophy underlying the design of both AOCL and ABCL crossings is to provide a less expensive crossing than the traditional type with gates or barriers, that is monitored by the driver of the approaching train. The designs were introduced in 1963 (AOCL) and 1988 (ABCL) respectively.
- 30 In 2006 there were 128 AOCLs on the Network Rail system, and 50 ABCLs. From 2000 to 2006 there was only one fatal accident at these crossings, at an AOCL in 2000. However, in both 2007 and 2008 there was a single fatal accident at an AOCL crossing. In each of these three accidents the road vehicle users lost their life, but there were no casualties on the train. There is no record of any recent fatal accident at an ABCL.
- 31 The *Railway Safety and Standards Board (RSSB)*'s risk analysis for 2008¹ shows that the risk associated with all ABCL crossings is 0.2 *fatalities and weighted injuries*² per annum, the third lowest figure for any type of crossing. When this value is normalised to account for the number of crossings of each type the annual risk for an ABCL is 3.7 per 1000 crossings, compared with an overall average of 1.8 for all level crossings on the Network Rail system, and figures of 3.5 for AOCLs, and 4.4 for automatic half barriers.

¹ RSSB Annual Safety Performance Report, 2008, available at www.rssb.co.uk

² The RSSB calculates the fatalities and weighted injuries index by adding the outcomes of a fatality being taken as 1, a major injury as 0.1, a reportable incident as 0.05 and all other physical injuries as 0.001.

32 Both AOCLs and ABCLs are signalled in the same way to an approaching train driver. After a train has left the crossing, and until the arrival of another train initiates its operation, the crossing is in its normal state. In this state an indicator, known as the driver's crossing indicator, shows a flashing red aspect³ to rail traffic (Figures 5 and 6), and there are no lights shown to road traffic. If, when a train approaches, the crossing has initiated correctly, and the highway flashing red lights have commenced to show to road traffic, and (in the case of an ABCL) the barriers have commenced to lower, then the driver's crossing indicator's flashing red aspect will switch off, and be replaced by a flashing white aspect. This flashing white aspect informs the driver that the crossing is functioning correctly. The speed of trains is limited across the crossing, and a speed restriction board is placed a set distance before the crossing. This board should be positioned so that a train running at the speed displayed on it can stop at the crossing if the driver's crossing indicator has not displayed a flashing white aspect by the time the front of the train passes the board. This board is referred to in Railway Safety Principles and Guidance⁴ as the special speed restriction board. An advanced warning board warns the driver that he is approaching the special speed restriction board.

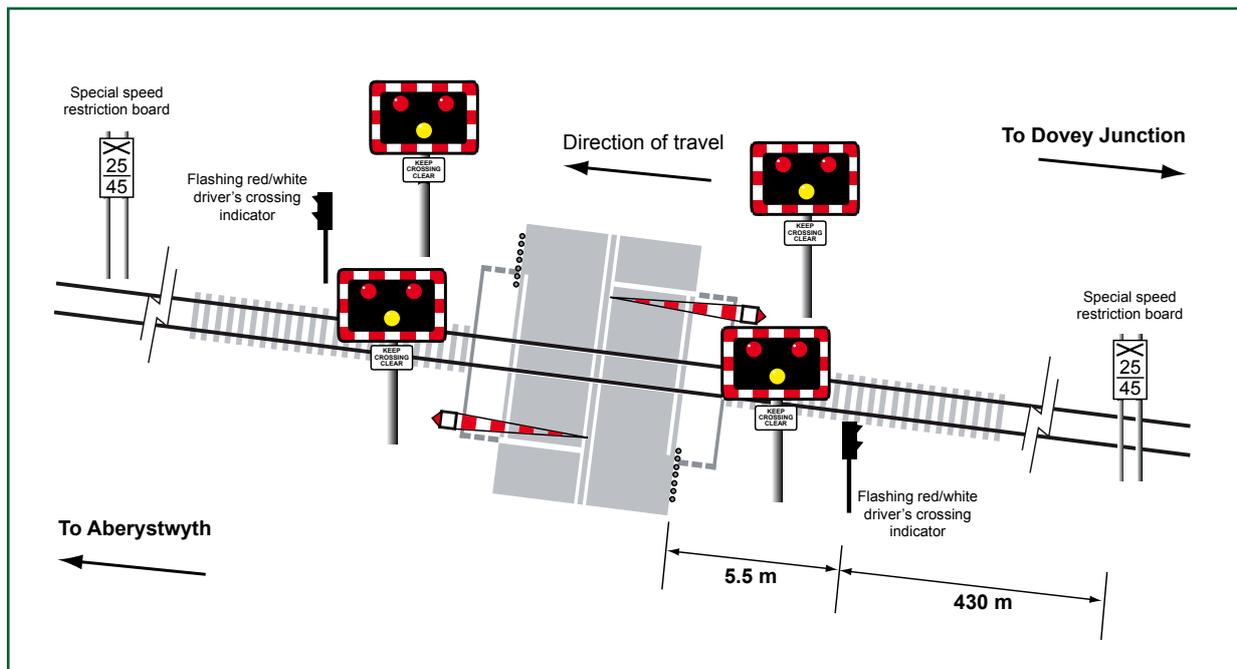


Figure 5: Schematic diagram of Llanbadarn ABCL

33 If the driver observes that there is a flashing white aspect at the driver's crossing indicator, and also that there is no road traffic on the railway at the crossing, he may drive his train across the crossing at the speed shown on the special speed restriction board. This speed may never exceed 55 mph (88 km/h). At Llanbadarn the speed for down passenger trains, as specified in the level crossing orders, is 45 mph (72 km/h).

³ Not all AOCL crossings are fitted with a flashing red aspect.

⁴ Railway Safety Principles and Guidance part 2E: Guidance on level crossings, produced by HSE in 1996 and now the responsibility of the Office of Rail Regulation (ORR). It is available at: <http://www.rail-reg.gov.uk/upload/pdf/rspg-2e-levxngs.pdf>.



Figure 6: Llanbadarn ABCL showing driver's crossing indicator (flashing red)

- 34 The two crossings at Llanbadarn both detect the approach of a train on their respective systems, but they are interlinked so that the activation of one crossing will prevent the activation of the other until the first train has passed. This is so that only one crossing can be closed to road traffic at any time, as the heavy road traffic could back up over the other crossing when one is shut.
- 35 The interlinking of the crossings is designed so that trains on Network Rail will have priority over those on the Vale of Rheidol Railway. To achieve this trains approaching from the Machynlleth direction on Network Rail are detected by a *treadle* at approximately 92 miles 10 chains, some 2 miles 46 chains (4.14 km) on the Machynlleth side of the crossing. The activation of this treadle initiates the crossing sequence by preventing the Vale of Rheidol crossing from operating, although it does not activate any lights or barriers at the Cambrian crossing until further detection of the approaching train has taken place when the train approaches the crossing. This further detection is by a treadle, located such that the flashing white aspect can be seen by a driver approaching the special speed restriction board. However, if this second treadle has not operated correctly, then the later sequences do not activate, and the crossing remains open to the highway, with the driver's crossing indicator exhibiting a flashing red aspect to approaching trains.
- 36 The Vale of Rheidol crossing is initialised by an approaching train, but only operates:
- when no train has initialised the Network Rail crossing; and
 - when the Vale of Rheidol train driver has depressed a plunger, after stopping his train.

37 The special speed restriction board for down trains at Llanbadarn is located 430 metres before the driver's crossing indicator (Figures 7 and 8), which, in turn, is located 5.5 metres before the crossing. Thus the board is approximately 436 metres before the crossing. The *driver's crossing indicator* can be seen by a driver 480 metres before it is reached, that is 50 metres before the train reaches the board.



Figure 7: The SSRB on the down approach to Llanbadarn ABCL

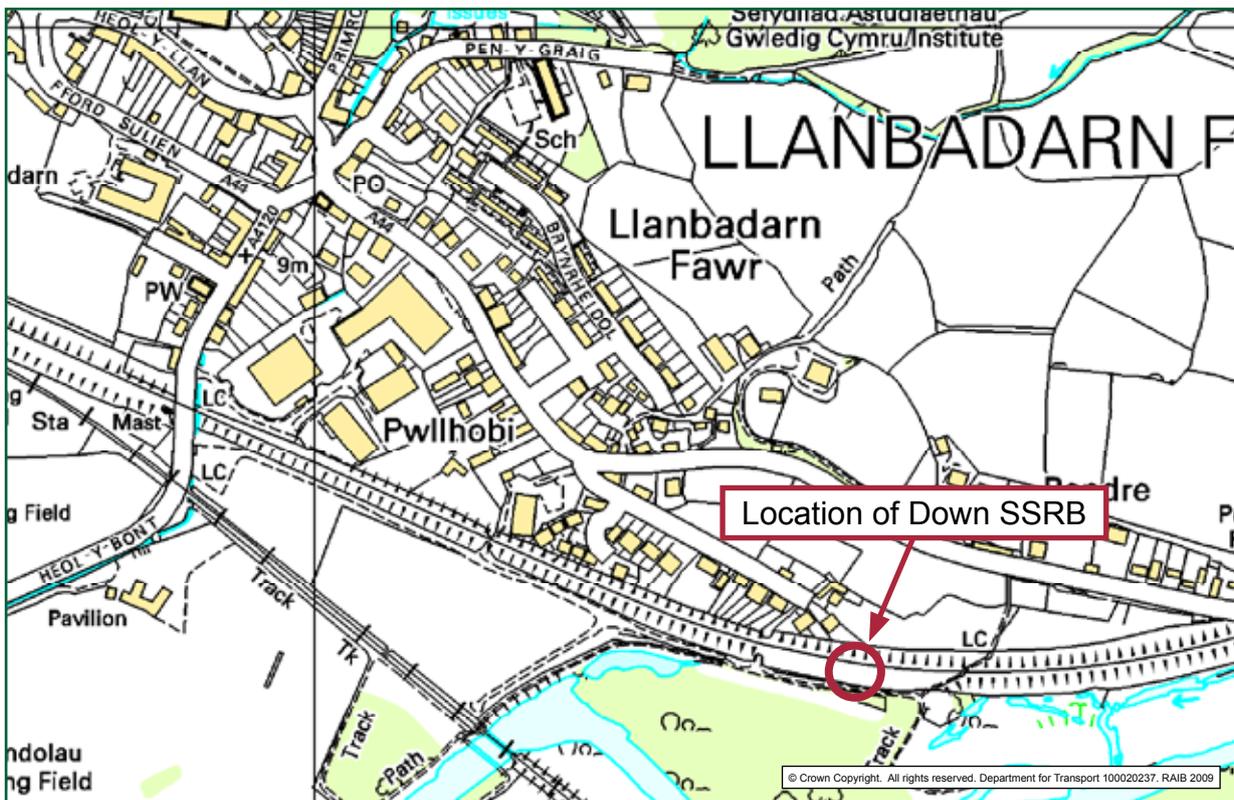


Figure 8: Extract from Ordnance Survey map showing location of the down special speed restriction board

Events preceding the incident

- 38 The driver of train 1J11 booked on duty at Crewe station, his home depot, at 06:07 hrs on 21 October. He then drove the 06:26 hrs train to Manchester, and the 07:30 hrs train from Manchester back to Crewe. He reported that there were problems with the public address system, and one of the compressors on the run to Manchester, but he was able to resolve them at Manchester Piccadilly station by tripping and re-setting the relevant auxiliary circuits. Otherwise the journeys were uneventful.
- 39 After being relieved at Crewe the driver travelled on as a passenger on the same train to Shrewsbury, arriving there at 08:52 hrs. He then had a short break, until the arrival of the 08:33 hrs from Birmingham New Street at Shrewsbury, running number 1J11, at 09:26 hrs.
- 40 The driver took over the controls of train 1J11, which departed from Shrewsbury on time at 09:28 hrs. The journey to Machynlleth was uneventful.
- 41 The driver was accompanied in the cab from Shrewsbury by two other drivers, employed by Serco, who were travelling to learn the route.
- 42 The driver of train 1J11 reports that neither of the Serco drivers distracted him from his duties during the journey.
- 43 During the morning of 21 October local signalling maintenance staff were working at Llanbadarn Network Rail crossing to carry out various regular tests on the crossing, due to be done at 13 weekly and annual intervals. These tests involved disconnecting the crossing, so that it would not operate if a train approached. However, the driver's crossing indicator would show a flashing red aspect at all times. The signalling maintenance team re-connected the crossing shortly before train 1J11 was due to arrive there. However, they did not do this until after the train had passed the treadle at 92 miles 10 chains.

Events during the incident

- 44 Train 1J11 had left Machynlleth at 10:49 hrs, still running on time. It was driven by the same driver who had driven from Shrewsbury, and he was still accompanied by the two Serco drivers.
- 45 The journey was uneventful until the approach to Llanbadarn crossing.
- 46 The Serco drivers have confirmed that they were not conversing with, or otherwise distracting, the driver of train 1J11 as it approached Llanbadarn.
- 47 As train 1J11 approached the crossing, the control equipment did not register its presence, and consequently the road lights did not illuminate, the barriers did not lower, road traffic continued to use the crossing, and the driver's crossing indicator continued to display a flashing red aspect to the approaching train driver.
- 48 According to the On Train Data Recorder (OTDR) the train was travelling at approximately 45 mph (72 km/h), the speed laid down for the crossing. The brakes were not applied until some seconds after passing the special speed restriction board, and the train did not stop before reaching the crossing.

49 The CCTV record from the train indicates that:

- Five cars crossed over the crossing at 4 (Figure 9), 11, 12, 12.2 and 20 seconds after the train passed the special speed restriction board.



Figure 9: CCTV image showing car crossing four seconds after train passed special speed restriction board

- A pedestrian was about to use the crossing, pushing an infant in a pushchair. He observed the approaching train, stopped his approach, and backed off the crossing. The pedestrian was at his nearest point to the crossing 22 seconds after the train passed the special speed restriction board, some 6.5 seconds before the train reached the crossing.
 - A lorry carrying a tank containing approximately two tonnes of liquefied petroleum gas was also approaching the crossing. It traversed the crossing immediately in front of the train, and cleared the path of the train 28 seconds after the train had passed the special speed restriction board, that is less than one second before the train reached the crossing (Figure 10). The driver of the lorry had accelerated to clear the crossing when he realised that the train was approaching him, and subsequent calculation indicates that at their closest approach the two vehicles were some two metres apart. The RAIB has calculated the speed of the train at this point as 12.5 mph (20 km/h).
- 50 The train continued to brake, and came to a halt with its leading cab beyond the crossing. The rear of the train remained on the crossing. The RAIB has calculated that the leading cab of the train came to a halt approximately 13 metres beyond the surface of the crossing.



Figure 10: CCTV images showing gas tanker crossing in front of train

Consequences of the incident

- 51 There were no casualties or injuries as a result of the incident, and no physical damage was caused.

Events following the incident

- 52 After it was clear that no collision had taken place the driver drew his train clear of the crossing to allow road traffic to recommence moving. After further discussion with the signaller at Machynlleth, and with Arriva Trains Wales the driver took the train forward the short distance to Aberystwyth, where he was relieved, and another driver was provided to return the train to Shrewsbury.
- 53 Both the train driver and the signalling maintenance team informed the Machynlleth signaller of the near miss.
- 54 The pedestrian reported the incident to Dyfed-Powys police, who in turn referred it to the British Transport Police. After an initial investigation they informed the Rail Accident Investigation Branch of the near miss.

The Investigation

Investigation process and sources of evidence

55 The following sources of evidence were used:

- witness statements;
- interviews with key personnel;
- CCTV evidence from the train;
- OTDR data from the train, and from trains involved in previous incidents;
- signal sighting tests on the special speed restriction board and the driver's crossing indicator review of the location;
- brake tests commissioned by the RAIB on Class 158 trains;
- observation of locally monitored level crossings on the Cambrian Main Line;
- operating logs from Machynlleth signal box and Llanbadarn crossing;
- operational documents concerning locally monitored level crossings, and Llanbadarn crossing;
- level crossing orders for both Llanbadarn crossings;
- report on weather at Llanbadarn on 21 October 2008; and
- records of hours worked of key staff.

Key Information

Requirements for AOCLs and ABCLs

Railway Safety Principles and Guidance

- 56 Guidance for level crossings in Great Britain is laid down in Railway Safety Principles and Guidance, Part 2, Section E, Level Crossings. This was published in 1996, but the principles for AOCLs and ABCLs are substantially unchanged from those in force in 1989, when the level crossing orders at Llanbadarn were issued.
- 57 Paragraphs 93 and 115 of this document specify the need for a special speed restriction board for ABCLs and AOCLs respectively. The special speed restriction board is to be located at the 'point from which the crossing speed begins.'
- 58 The document does not specify that the crossing, when operating correctly, should indicate a flashing white aspect to train drivers before they reach the special speed restriction board, only requiring in paragraph 89 (for an ABCL) that 'The indication to the train driver should only be displayed when the barriers have begun to descend and at least one of the intermittent red lights of each road traffic signal is lit, and the main power supply has not failed'. Paragraph 111 gives similar information for an AOCL.

Railway Group Standards

- 59 The rail industry's requirements are laid down in Railway Group Standard GIRT/7012, issue one, dated August 2004 'Requirements for level crossings'. Paragraph E3.4 of this standard gives the general requirements for a special speed restriction board. It states in particular:

'The crossing speed shall be determined for each approach to the crossing to ensure that an approaching train is able to decelerate from that speed and come to rest short of the crossing, from the point at which the driver's level crossing indicator can be seen and the crossing can be seen to be clear.'

Network Rail Standards

- 60 Network Rail's internal standards also specify requirements for locally monitored crossings. Standard NR/L2/OPS/100, Issue 2 of June 2008, 'Provision, Risk Assessment and Review of Level Crossings' states:
- 'Speed of trains to be limited so that drivers can stop short of the crossing from the point at which the crossing comes fully into view.'
- 61 Railtrack Line Code of Practice RT/E/C/11600, Part X, Issue 1, (which remains in force under Network Rail) gives design technical guidance for level crossing signalling and operational telecommunications. Section 8 deals with ABCLs, and the positioning of the special speed restriction board is dealt with in sub section 8.3. This gives a detailed process which determines firstly the location of the speed restriction board (at the maximum distance from which the entire crossing is clearly visible), and secondly the speed to be displayed (this must be ≥ 10 mph and ≤ 55 mph).

The Rule Book and locally monitored automatic crossings

- 62 Railway Group Standard GE/RT/8000, the Rule Book, includes module TW8, Level Crossings. Section 4 of module TW8 includes the duties of drivers at AOCL and ABCL crossings.
- 63 Paragraph 4.2 a, which deals with normal working of locally monitored crossings, tells the driver that:
- ‘On passing the speed restriction board, you must make sure that
 - o you can see that the crossing is clear; and
 - o the white light next to the crossing is flashing.’
- 64 Paragraph 4.2 b, which deals with when the crossing is not working normally, tells the driver that:
- ‘You must stop before reaching the crossing if:
 - o The white light next to the crossing is not flashing or, at an ABCL and some AOCLs, the red light is flashing.’
- 65 There is no explicit requirement in module TW8 to apply the brakes if a flashing red aspect is showing when passing the special speed restriction board.

Locally monitored automatic crossings on the Cambrian Main Line

- 66 There are five locally monitored level crossings on the Cambrian Main Line, three of the AOCL design, and two ABCLs, including the crossing at Llanbadarn. An RAIB inspector rode in the driver’s cab from Shrewsbury to Aberystwyth and return to observe the working of these crossings. His observations are summarised in Table 1 below.
- 67 In three of the ten approaches to the crossings the driver’s crossing indicator red flashing aspect did not change to white until after the front of the train had passed the special speed restriction board.

The driver

- 68 The driver of the train was employed by Arriva Trains Wales, and had been a train driver since 2002. His employers had changed as franchises altered during that period, but he had been based at Crewe throughout.
- 69 The driver had been involved in a *Category A Signal Passed at Danger* (SPAD) in 2002, and had over-run one station and failed to call at another during 2004.
- 70 The RAIB has reviewed the driver’s roster for the two weeks leading up to the incident, using the *Fatigue Index*. The resultant calculations give no indication that the driver would have been fatigued at the time of the incident, and the RAIB has found no other evidence that the driver may have been fatigued.
- 71 The driver stated that the two other drivers in the cab with him learning the route did not distract his attention from driving the train and observing the signals. However, Arriva Trains Wales’ policy, regularly briefed to its drivers, is that only one driver may be in a train cab for route-learning purposes.

Crossing	Mileage	Direction	Speed Restriction (pass. train)	Visibility of driver's crossing indicator at the special speed restriction board (SSRB)	Driver's crossing indicator flashing red aspect changes to flashing white
Forden AOCL	38m 20c	Down	55mph	Can see several seconds before reaching SSRB	Approx 10 metres after cab passes SSRB
		Up	45 mph	Can just see at SSRB	Before visible from train
Weig Lane AOCL	54m 26c	Down	35 mph	Can see several seconds before reaching SSRB	Immediately after cab passes SSRB. (Driver sees red at SSRB)
		Up	30 mph	Can see several seconds before reaching SSRB	Immediately after cab passes SSRB. (Driver sees red at SSRB)
Borth Capel Soar AOCL	87m 59c	Down	35 mph	Can see several seconds before reaching SSRB	Before visible from train
		Up	50 mph	Can just see at SSRB (Vegetation may obscure view in summer)	Before visible from train
Llandre ABCL	89m 58c	Down	45 mph	Can see several seconds reaching SSRB	Before visible from train
		Up	40 mph	Can see just before reaching SSRB	Just as cab passes SSRB. (Driver sees white at SSRB)
Llanbadarn ABCL	94m 56c	Down	45mph	Can see approx 20 metres before reaching SSRB	Before visible from train
		Up	40 mph	Can see several seconds before reaching SSRB	Several seconds before reaching SSRB

Table 1: Observations of the operation of AOCL and ABCLs on the Cambrian Main Line

- 72 The driver, on first seeing the crossing, observed the driver's crossing indicator showing a flashing red aspect. The driver stated that he had anticipated that the driver's crossing indicator would clear to a flashing white aspect, and hence he did not apply the brakes immediately after he passed the special speed restriction board.
- 73 The driver was tested for drugs and alcohol after the incident, in line with normal industry practice, and found to be clear for both.

- 74 The driver had not observed that Forden crossing's driver's crossing indicator did not clear to white until after he had passed the special speed restriction board, and could not recall any specific briefing on the working of locally monitored crossings.

The Serco drivers

- 75 Both the Serco drivers who were in the cab at the time of the accident stated that there was no conversation in the cab as they approached Llanbadarn. One was looking at his route maps on the far side of the cab from the driver. The other saw staff in high visibility clothing at the crossing, but did not realise that the train was proceeding towards a flashing red aspect until the driver made a comment to that effect, applied the brake and blew the horn; both Serco drivers then saw cars going over the crossing.

Drivers' understanding of locally monitored level crossings

- 76 Arriva Trains Wales drivers based at Crewe in *Link A* are qualified to drive the routes from there to Chester, Manchester and Cardiff, from Craven Arms to Llanwrtyd Wells, and from Shrewsbury to Aberystwyth. Only on these latter two lines are there locally monitored level crossings.
- 77 There were eighteen drivers in Link A in October 2008, and only two duties per day that went to Aberystwyth; consequently a driver would go there on average every eight or nine working days.
- 78 Arriva's driver managers at Crewe were aware of the fact that not all driver's crossing indicators cleared to a white flashing aspect before the driver passed the special speed restriction board, and were also aware of the contents of Rule Book module TW8.
- 79 The general view of those drivers and their managers questioned by the RAIB was that they would apply the brakes if a flashing red aspect continued after they had passed a special speed restriction board, but they did not have a specific point when they would do so. All knew that they had to stop by the driver's crossing indicator if a flashing red aspect continued, and most had developed an unofficial marker at Forden, by when they would apply the brakes if the white flashing aspect had not appeared.

The train

- 80 The Class 158 train was introduced into service by British Rail's Regional Railways in 1989. It was designed as a high speed unit for secondary inter-city routes, such as Cardiff to Manchester, and can operate at up to 90 mph (145 km/h).

- 81 The Class 158 was one of the first multiple unit trains to be fitted with disc brakes, which can be applied by a four position control. *Step* one is a gentle application, step two a normal stopping force, step three a full service application, and step four an emergency stop. The deceleration between step three and step four is, in practical terms, identical, as the same braking force is applied in each case.
- 82 The distance within which a train should stop after brakes are applied is specified in Railway Group Standard GM/RT2044, Braking System requirements and performance for Multiple Units (currently Issue Four of June 2001). Although this standard did not apply when the Class 158 was being designed and built, the original specification for braking performance was similar to that currently mandated for trains to operate over routes signalled in accordance with Appendix 3 of Railway Group Standard GK/RT0034, Lineside Signal Spacing. Class 158 braking performance is measured against curve A3 from Figure 3 of GM/RT2044, one of the curves that show the expected braking performance from different speeds for various types of train. This shows that a train travelling at 45 mph (72 km/h) should come to a stop in 253 metres after the brake is first applied (the distance travelled whilst brake pressure rises is included within the 253 metres).

The handling of the train

- 83 Evidence from the driver indicates that he anticipated that the driver's crossing indicator would change from a flashing red aspect to a flashing white aspect, but he could not recall where he applied the brakes relative to the special speed restriction board.
- 84 Analysis and reconciliation of the CCTV and OTDR records of the train (Figures 11 and 12, Table 2) shows that the sequence of events was as tabulated below. All times are given in seconds from the driver's cab passing the special speed restriction board.
- 85 The OTDR data from unit 158 831 initially appeared to show that the brake control was operated to step two 29 seconds before the train halted, and that deceleration commenced five seconds later. This would have indicated a braking performance substantially below that defined by the A3 *braking curve* in Railway Group Standard GM/RT2044. However, tests of the OTDR and accelerometer tests indicate that the OTDRs on unit 158 831, and other Arriva Trains Wales Class 158 units, are recording the deceleration of the train somewhat later than actually occurs. In the case of unit 158 831 this delay was an average of 3.5 seconds, and this has been allowed for in the calculations above. Analysis of the speed and deceleration of the unit by comparing the rate of progress using the CCTV record throughout the deceleration of the unit confirms these times. Allowing for this delay, the brakes were initially applied 24.5 seconds before the train came to a halt.
- 86 The train came to a halt 264 metres after the brakes were initially applied, a distance consistent with the values defined by braking curve A3, given the stepped way in which the brake was applied.
- 87 There is no evidence of any wheel slip from the OTDR record.

Time (Seconds)	Event	Distance driver's cab past special speed restriction board (metres)	Distance from drivers cab to crossing (metres)	Train Speed
-2.5	Driver can see driver's crossing indicator aspects	-50	486	44 mph (71 km/h)
0	Driver's cab passes special speed restriction board	0	436	44 mph (71 km/h)
3.8	First car passes over Llanbadarn crossing in front of train	75	361	44 mph (71 km/h)
N/A	Change in gradient from 1:75 to 1:675 falling	approx 114	approx 322	44 mph (71 km/h)
9.7	Driver applies brakes to step one, moving to step two approximately 0.75 seconds later,	190	246	44 mph (71 km/h)
11.1	Brakes commence to slow train	218	218	44 mph (71 km/h)
11.3	Driver increases brake application to step three	222	214	44 mph (71 km/h)
20.2	Driver moves brakes to emergency	364	72	27 mph (43 km/h)
22	Pedestrian at closest point of approach	385	51	24 mph (38 km/h)
27	Lorry enters CCTV vision	427	9	14.5 mph (23 km/h)
28	Lorry leaves CCTV vision	434	2	12.5 mph (20 km/h)
28.5	Train enters level crossing	436	0	12.5 mph (20 km/h)
34.2	Train comes to a halt	455	-19	0

Table 2: Time and distance relationship of train and level crossing during incident

88 The CCTV data shows that the time elapsed from the cab passing the special speed restriction board to the train coming to a halt was 34.16 seconds. Thus the driver did not apply the brakes until 9.7 seconds after the train passed the special speed restriction board.

The testing of Llanbadarn ABCL

89 The approach of the train did not activate the crossing operation sequence, and hence resulted in the flashing red aspect continuing. Although a continuing flashing red aspect can occur as a result of technical failure, or the operation of Vale of Rheidol trains, it is important to understand why the flashing red aspect continued in this instance, since if the crossing had operated correctly there would have been no incident.

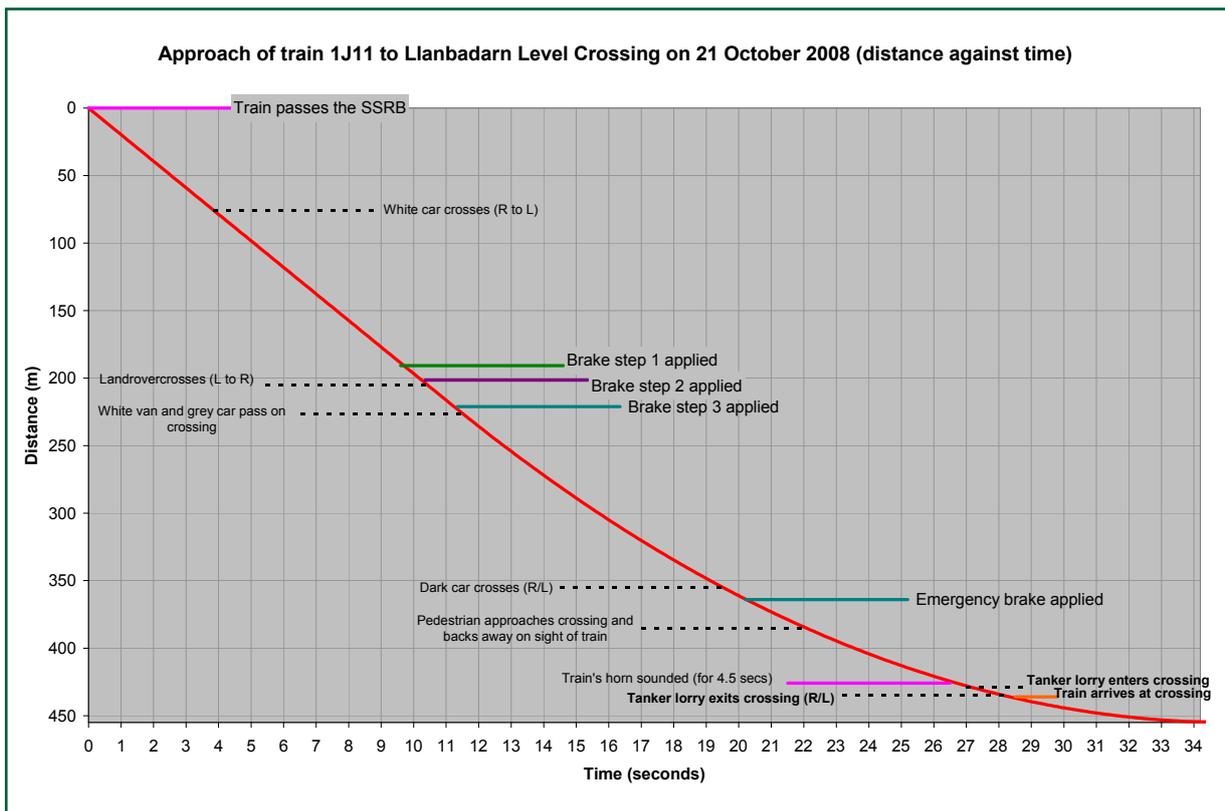


Figure 11: Distance / time plot of the deceleration of the train

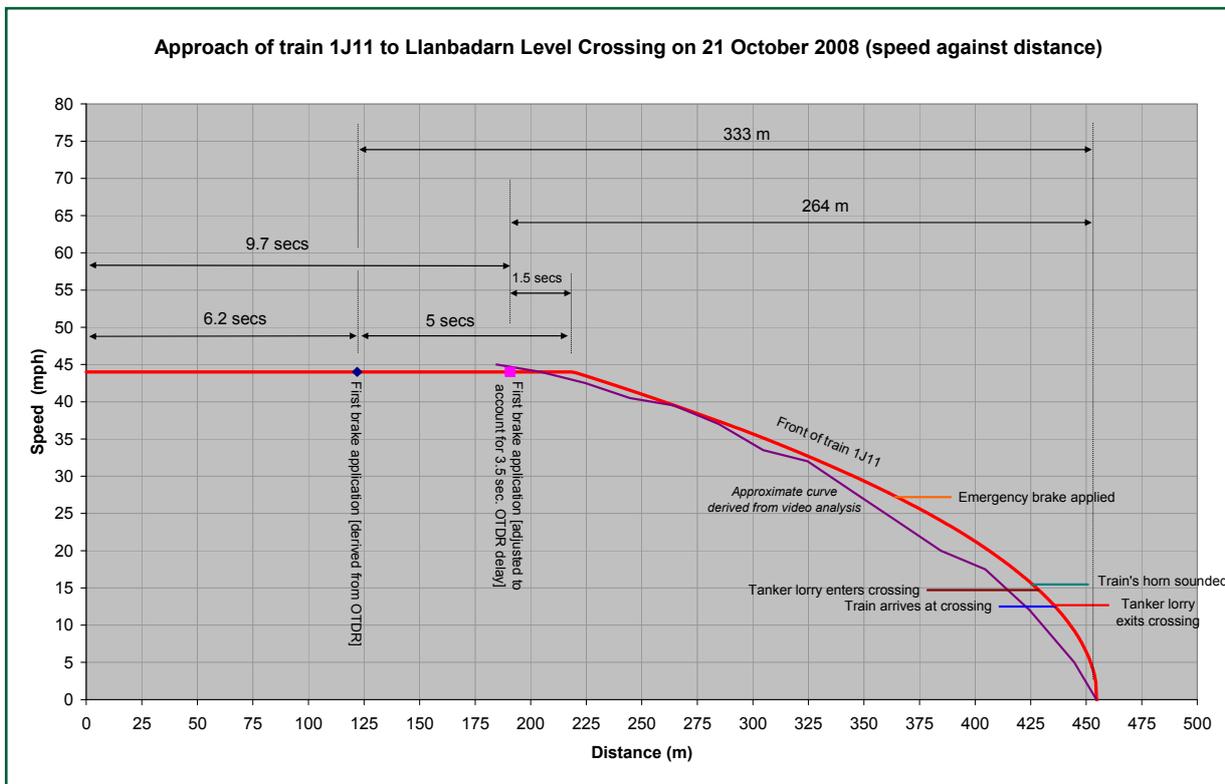


Figure 12: Speed / distance plot of the deceleration of the train

Maintenance and testing of level crossings

- 90 Level crossing maintenance and testing is carried out on Network Rail by signalling maintenance staff. Most crossings, including locally monitored ones, are subject to two levels of testing to ensure they function correctly; a routine test every thirteen weeks, and a more thorough annual test.

Documentary requirements

- 91 The requirements for testing of level crossings are spelt out in a series of documents known as the *Signalling Maintenance Specifications* (SMS). These are designed in filofax® format, so that technicians can carry them to site easily. There are separate pages available for most items of equipment, and the specification includes how to carry out a test, including the necessary safety precautions.
- 92 SMS Number RT/SMS/LC00 covers general issues for level crossings. In a sub section headed 'Level Crossing Annual Testing' it states:
- 'It is advisable in most cases that the full annual test is conducted under a possession of the level crossing and ideally and if possible a road closure.'
- 93 The testing of Llanbadarn crossing on 21 October 2008 included both thirteen week and annual tests, and was carried out with both the road and the railway open to traffic.
- 94 SMS Number RT/SMS/Test/071 specifies the ABCL Operational Sequence tests. It covers both thirteen weekly and annual tests. The first heading of this SMS is 'General', which immediately states:
- 'Liaise with the signaller before any tests are carried out.'
- 95 There is no record of any conversation between the signalling maintenance staff at Llanbadarn crossing on the morning of 21 October 2008 before the incident, other than a discussion about a problem with the Vale of Rheidol Railway AOCL.

Maintenance of locally monitored level crossings on the Cambrian lines

- 96 On the Cambrian Main Line to Aberystwyth there is only one train in each direction every two hours, whilst on the Cambrian Coast Line there are only nine trains in each direction during the entire day. The signallers at Machynlleth have their workload set by this level of traffic, the number of loops where tokens have to be exchanged, and the number of level crossings that have to be controlled, directly or in response to telephone calls. The combined effect of these is sufficient to produce a continuous workload for the signallers, although the amount of traffic at any one time is limited.
- 97 The radio system used by the signallers and train drivers is *open channel*, and signalling maintenance staff have access to the system to enable them to take *possession* of the line if they need to.
- 98 The large number of level crossings on the Cambrian lines means that there is a regular need to carry out thirteen weekly or annual tests on these crossings. A total of 32 crossings need such tests, which equates to an average of five tests a fortnight (assuming that the annual test coincides with a thirteen weekly test).

- 99 Witness and documentary evidence from both operational and maintenance functions of Network Rail shows that the tests on locally monitored crossings were being carried out without informing the signallers at Machynlleth. Tests on crossings that were monitored by the signallers were being correctly notified to the signaller.
- 100 Witness evidence is that the maintenance staff perceived that the signallers at Machynlleth were under pressure, because of the constant radio calls to control train movements, and thus their calls to arrange level crossing maintenance would not be welcomed by the signallers. As the maintenance staff had access to the radio system they were able to hear when trains entered or left block sections, and hence they believed that they could carry out their work around the infrequent train service without causing delay. As the crossings were protected by driver's crossing indicators, they felt that if a train did approach the train would stop when the driver saw the flashing red aspect.
- 101 Witness evidence indicates that this process has been followed by the maintenance staff for several years, and possibly since the introduction of RETB in 1988.

Events of 21 October 2008

- 102 The practice that had developed for work at Llanbadarn was to disconnect the crossing and start work after a train had left Aberystwyth and cleared the crossing. This would usually give a space of around an hour and a half to carry out work. When the next train requested the electronic token for the section from Dovey Junction to Aberystwyth, the team would cease work and re-connect the crossing. It is 13 miles from Dovey Junction to the strike-in treadle at 92 miles 10 chains (paragraph 35), so this practice allowed over a quarter of an hour to re-connect the crossing, an activity that only takes a couple of minutes.
- 103 On 21 October 2008 the signalling maintenance team from Machynlleth planned to carry out a thirteen week test on the Llanbadarn ABCL, and the Assistant Signalling Maintenance Engineer from Shrewsbury had decided to join them to carry out the annual test. The maintenance team arrived first, and commenced work on the thirteen weekly tests. At some stage in the work they found that the battery of their radio was flat.
- 104 Because of the flat radio battery the signalling maintenance staff were not warned when the train left Dovey Junction, and so they judged the time when they should re-connect the crossing functions. However, they reconnected the crossing after the train had passed the strike-in treadle, and hence when train 1J11 arrived at Llanbadarn it did not operate the crossing, resulting in the driver's crossing indicator displaying the flashing red aspect to the driver.
- 105 The radio charging station at Machynlleth is clearly visible, and has no history of working incorrectly. There is no evidence that the radio has failed before or since 21 October 2008.

Supervision and monitoring of crossing testing

- 106 The Assistant Signal Maintenance Engineer at Shrewsbury was aware of the working practice of listening to the radio without speaking to the signaller, to avoid interfering with traffic.

- 107 The Signalling and Telecommunications Maintenance Engineer at Shrewsbury stated that he was not aware of the practice. Network Rail standard NR/SP/SIG/10028 'Inspection and Surveillance of Signal Engineering Activities' requires the holder of this post to visit every site for which he is responsible over a two year period, and every team of staff at least annually. The Signalling and Telecommunications Maintenance Engineer had been in post for approximately three years at the time of the accident. He had visited each of his eleven teams at least once a year since his appointment, and had visited all the sites under his control at least once, and often twice, since his appointment. However, the Shrewsbury area includes a wide range of signalling assets, with 27 signal boxes and 70 level crossings for which he was responsible, and he had only visited locally monitored automatic crossings on the Cambrian lines during maintenance twice since his appointment. On both occasions he arrived during the work, and left before the end of it, and hence did not see whether or not the correct communications with Machynlleth signal box were taking place.
- 108 The Signalling and Telecommunications Maintenance Engineer had not checked signal box logs to see if the correct calls were being made to notify the signallers about work on the crossings. There is no specific requirement for him to do this.
- 109 The Signalling and Telecommunications Maintenance Engineer was aware that testing was taking place in contravention of the advice of RT/SMS/LC00 that testing should take place in a possession and with a road closure. He was of the opinion that, because of the low levels of rail traffic, and its predictable running times, working without possessions was acceptable. He had not applied for road closures, as he found them difficult to obtain.

Previous occurrences of a similar character

- 110 Since 2001 there have been three previous occasions recorded when a train ran through Llanbadarn level crossing in an uncontrolled manner⁵ when the barriers were not lowered, on 17 August 2001, 8 November 2005, and 24 April 2007. None resulted in any collision with a road vehicle, or any injury or damage. The 2005 incident involved an up train, and the other two down trains. In all cases the immediate cause of the crossing not having operated was the effect of a train crossing the Vale of Rheidol Railway AOCL, which meant that, in accordance with its design, the Network Rail crossing did not initialise. In all three cases the driver's crossing indicator correctly displayed a flashing red aspect to the oncoming train on Network Rail, but the driver did not stop the train in time. In 2001 the industry investigation concluded that the driver misjudged the braking because he had become distracted and lost concentration, possibly due to domestic problems. In the 2005 incident the industry investigation concluded that the driver did not stop by the flashing red aspect because he was distracted by the train conductor making announcements after the train had left Aberystwyth. In the 2007 incident the Arriva Trains Wales report concluded that the driver was late in reacting to the red flashing aspect not changing to white.

⁵ The Rule Book allows a train to go over the crossing with the barriers raised if the flashing red aspect has continued to show, the driver has stopped the train at the crossing, observed that there is no road traffic (or it has stopped), and then drives over the crossing at caution. In addition, at Llanbadarn ABCL the driver has to operate a plunger before he decides it is safe to travel over the crossing.

- 111 After its investigation into the 2007 incident, Arriva Trains Wales recommended that the speed of trains approaching Llanbadarn in the down direction should be reduced to 35 mph (56 km/h). The company took no formal steps to propose the necessary design change to Network Rail, but notices were posted at both Machynlleth and Crewe depots to instruct drivers to slow down to this speed.
- 112 The notice at Crewe depot was placed in the 'New Notice' case at Crewe, where it remained for three weeks, in accordance with the depot practice. Thereafter it was placed in the General Notice Case for a further five weeks, again in accordance with depot practice, after which it was removed.
- 113 The notice at Machynlleth remained on display.
- 114 As the proposed speed change had not been discussed with Network Rail there was no reminder to train crew at Crewe of the reduced speed. The driver of 1J11 on 21 October 2008 had been aware of the notice, but with it having been removed, and the speed restriction signs still showing 45 mph (72 km/h), he had reverted to driving at the higher speed.

Analysis

Identification of the immediate cause⁶

115 The immediate cause of the incident was that the driver of train 1J11 did not control his train sufficiently to stop before the crossing when a flashing red aspect was showing.

Identification of causal⁷ and contributory⁸ factors

The driving of the road tanker

116 There is no evidence that the road vehicle driver did anything that contributed to the incident in any way. His acceleration of the lorry may have prevented a collision from occurring.

The driving of the train

117 A causal factor to the incident was that the driver of train 1J11 did not apply his brakes until almost ten seconds after passing the special speed restriction board. During this time a car passed in front of him, and a second could clearly be seen rapidly approaching the crossing. Had he applied his brakes at the time he reached the special speed restriction board he would have been 190 metres further from the crossing throughout the braking sequence, and would have stopped some 171 metres before the crossing, and 165 metres before the driver's crossing indicator.

118 The 45 mph (72 km/h) speed limit did not contribute to the incident occurring, as the train, at this speed at the special speed restriction board, could have stopped a considerable distance before the crossing.

119 A further causal factor is that the driver anticipated the light changing to give a flashing white aspect after passing the special speed restriction board, as he stated. However, it is difficult to accept that this alone would prevent application of the brakes for nearly ten seconds, particularly when a car crossed the level crossing some four seconds after the train cab passed the special speed restriction board.

120 There are various factors that may have caused the driver not to apply the brakes of the train until nearly ten seconds after passing the special speed restriction board. These possible factors are listed below, but the RAIB is unable to say which, if any, may have actually existed.

121 The driver being fatigued (although there is no evidence for this), and distracted by the Serco drivers, are possible causal factors. However, it is legitimate, providing that a driver agrees, for one other driver to join him in the cab to learn the line, and in this case all three individuals are adamant that no conversation was taking place as the train approached Llanbadarn.

⁶ The condition, event or behaviour that directly resulted in the occurrence.

⁷ Any condition, event or behaviour that was necessary for the occurrence. Avoiding or eliminating any one of these factors would have prevented it happening.

⁸ Any condition, event or behaviour that affected or sustained the occurrence, or exacerbated the outcome. Eliminating one or more of these factors would not have prevented the occurrence but their presence made it more likely, or changed the outcome.

- 122 The driver being conditioned to expect a flashing red aspect to continue to display after the special speed restriction board is a possible causal factor. On three of the ten locally monitored automatic crossing approaches between Shrewsbury and Aberystwyth the driver's crossing indicator flashing aspect only changes from red to white after the driver has passed the special speed restriction board. As a result drivers, either consciously or subconsciously, may become used to passing special speed restriction boards and waiting for the flashing white light to appear. It is possible that the driver of train 1J11 may have been so conditioned by the other crossings, and this may have contributed to him waiting for some twelve seconds from when he could first see the flashing red aspect before he applied his brakes.
- 123 The special speed restriction board is the last positive indication of location to a driver before he reaches the driver's crossing indicator. As locally monitored crossings rarely fail, drivers are not used to having to respond to a flashing red aspect on a regular basis⁹. If a driver does not take action to control his speed at the special speed restriction board there is a risk that he will leave applying the brakes until it is too late, as happened in this incident.
- 124 The lack of explicit guidance about actions to be taken on passing the special speed restriction board in module TW8 of the Rule Book is a possible contributory factor. The various documents that define the working of a locally monitored automatic crossing are listed in paragraphs 56 to 65. Only in RT/E/C/11600, the signalling design code of practice, is it explicit that the braking distance for the train could be the same as the distance from the special speed restriction board to the driver's crossing indicator. It follows from this that if the driver's crossing indicator is showing a flashing red aspect when the driver reaches the special speed restriction board he must apply the brakes. Although module TW8 is clear that the driver must stop if the driver's crossing indicator does not show a flashing white aspect, it is not explicit that this aspect should be visible when the train passes the special speed restriction board. This means that drivers are given no instruction on when to commence braking and may therefore delay this action in anticipation of the aspect changing. A subsequent loss of concentration may then result in the train approaching the crossing too fast.

The train brakes

- 125 The Class 158 train is expected to perform as laid down in the A3 brake curve specified in GM/RT2044. Thus the train should stop by, at most, 253 metres from the driver applying the brakes in step 3 or the emergency position. The tests commissioned by the RAIB indicate that the performance of the brakes of 158 831 was consistent with this curve (paragraph 86), and did not contribute to the incident.

⁹ At Llanbadarn the effect of the Vale of Rheidol linkage may make the display of a flashing red aspect somewhat more common.

Other factors for consideration

The maintenance work on Llanbadarn Crossing

- 126 The crossing at Llanbadarn did not operate as it was designed to because of the activities of the maintenance team. Although this led to the driver approaching a flashing red aspect, this is a normal situation for a driver to face. However, if the driver's crossing indicator had not shown a flashing red aspect, the incident would not have happened.
- 127 The immediate reason for the activities of the maintenance team interfering with the normal operation of the crossing as a train approached was that the unofficial method of working that they had adopted had broken down, because their radio had a flat battery.
- 128 The requirements of the SMS to notify the signaller are clear and absolute. They were not followed by the signalling maintenance team. Had they been followed, then the signallers at Machynlleth would have either insisted that the disconnection be handed back before the train entered the section, or they would have informed the driver of the train that the crossing was being worked on, and that he should proceed at caution, expecting the driver's crossing indicator to display a flashing red aspect, and to stop before it. In either case the incident would probably have been avoided.
- 129 The Signalling and Telecommunications Manager at Shrewsbury was not aware that his staff were not working according to the SMS's requirements.
- 130 The assistant to the Signals and Telecommunications Manager regularly carried out annual tests of the crossings. Although he stated that he always called the signal box when he was carrying out maintenance testing, there is no record of any such call in a period of months prior to the incident. On 21 October 2008 he arrived at the crossing after work had commenced, and it is possible that this had happened before, but he effectively condoned the working practices by taking part in them.

Llanbadarn crossing

- 131 NR/SP/OPS/100 specifies that:

'The All Level Crossing Risk Model (ALCRM) shall be used to assess the risk at each crossing, to be supported as necessary by expert judgement or additional risk assessment processes where appropriate.'

- 132 The ALCRM is used to assess *Individual Risk* and *Collective Risk* at level crossings of all types. Based on the assessment of individual risk each crossing is assigned a letter between A (risk of death to a regular user once in 1000 years) and M (zero). The assessment of collective risk results in the assignment of a number from 1 (0.05 Fatalities and Weighted Injuries per annum) to 13 (zero). Crossings with a collective risk between 1 and 3 inclusive are required to have options for improvement considered within thirteen weeks of the assessment.
- 133 Llanbadarn crossing was assessed using the ALCRM in April 2007, with a confirmatory visit in October, and was rated as I4. Key risk factors identified were the large number of users, and the large number of heavy goods vehicles

- 134 The assessment notes did mention the interlinking with the Vale of Rheidol Railway, but did not identify that a consequence of this is that the likelihood of a flashing red aspect being displayed by the driver's crossing indicator is higher than on most, if not all, other such crossings in the UK.
- 135 The assessment notes recognised that there had been incidents caused by drivers' braking errors, and identified that this was a significant risk. However, this was not transferred into the assessment ranking, as the model does not allow for this.

Weig Lane level crossing

- 136 The signs provided as special speed restriction boards at Weig Lane crossing, near Caersws, are those specified as a Combined Whistle and Speed Board for an *Open Crossing*, and not a special speed restriction board for an AOCL.

The OTDR on Class 158 units

- 137 Unit 158 831 had a three and a half second delay in recording the deceleration of the unit by the OTDR (paragraph 85), and tests indicate that this may be typical for the OTDRs used in Arriva Trains Wales Ltd Class 158 fleet. However, this delay has no effect on the safe operation of this fleet of trains.

Conclusions

Immediate cause

138 The immediate cause of the incident was that the driver of the train 1J11 did not brake his train sufficiently early to stop before the crossing despite a flashing red aspect indicating that the crossing had not operated on the approach of his train (paragraph 115, Recommendation 1).

Causal factors

139 Causal factors were that:

- The driver of train 1J11 did not apply the brakes of the train until 9.7 seconds after the train had passed the special speed restriction board (paragraph 117).
- The driver anticipated that the driver's crossing indicator would change from a flashing red aspect to a flashing white aspect after he had passed the special speed restriction board (paragraph 119).

140 Possible causal factors were:

- The driver may have been fatigued, and distracted by the presence of two other drivers in the cab with him (paragraph 121).
- The existence of other ABCL crossings on the same route at which the flashing red aspect is normally displayed to the driver after his cab has passed the special speed restriction board. This may have conditioned the driver to expect the flashing red aspect to continue to be displayed after he had passed the special speed restriction board on the approach to Llanbadarn crossing (paragraph 122, Recommendation 2).

Contributory factors

141 A possible contributory factor was:

- the lack of explicit guidance to drivers about when to decide to apply brakes in module TW8 of the Rule Book (paragraph 124, Recommendations 3 and 4).

Additional observations¹⁰

142 The ABCL crossing at Llanbadarn was not operating as it should, because it was undergoing maintenance (paragraph 126).

143 The signalling maintenance staff used an unofficial method of working when maintaining locally monitored automatic level crossings on the Cambrian lines. This unofficial method of working broke down because of a flat battery in the radio the team were using (paragraph 128, Recommendation 8).

¹⁰ An element discovered as part of the investigation that did not have a direct or indirect effect on the outcome of the accident but does deserve scrutiny.

- 144 Network Rail's managers either were not aware of, or condoned, the working practices of signalling maintenance staff, which did not comply with the requirements of the SMS (paragraphs 129 and 130, Recommendation 8).
- 145 The ALCRM assessment did not allow for the increased likelihood, due to the interlinking with the Vale of Rheidol Railway, of a flashing red aspect on the driver's crossing indicator (paragraph 134, Recommendations 1 and 5).
- 146 There are incorrect signs provided at Weig Lane crossing in lieu of the special speed restriction boards (paragraph 136).
- 147 There was a three and a half second delay in the OTDR recording accelerations. (paragraph 137).

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

- 148 The RAIB issued an Urgent Safety Advice on 24 November 2008 regarding the driver's crossing indicators at Weig Lane and Forden crossings, and the risk of similar arrangements elsewhere on the Network.
- 149 Network Rail has reported that it subsequently assessed most locally monitored level crossings on its system, and found that at least nine of them, a white flashing aspect does not show at the driver's crossing indicator when the crossing is operating correctly, and the train has reached the special speed restriction board. At the time of publication of this report Network Rail has not decided what steps to take at these crossings (Recommendations 6 and 7).
- 150 Network Rail has instructed signalling maintenance staff at Shrewsbury and Machynlleth to contact the signal box in accordance with RT/SMS/Test/071; a review of logs at Machynlleth by the RAIB indicates that this is now happening on occasions, but not in all cases.
- 151 Following the ALCRM assessments (paragraph 133) Network Rail has studied the possibilities of closing the Llanbadarn crossing, or of converting it to a CCTV controlled crossing. The highway authority has stated that closure of the crossing is not an acceptable option, and Network Rail considers that the cost of carrying out a conversion is grossly disproportionate to the potential safety benefits identified, so no changes to the crossing are currently proposed.
- 152 Network Rail has installed an additional *Automatic Warning System* (AWS) permanent magnet on the down direction approach to Llanbadarn, to give an additional warning to drivers as they approach the crossing. If the warning is not acknowledged by the driver then the train's brakes will automatically be applied. The RAIB notes that use of an AWS magnet in such an installation is outside the normal use of such a device. Network Rail reports that it is now considering the removal of this magnet (Recommendation 1).
- 153 Network Rail is in the process of converting the Cambrian Lines to operate on the European Railway Traffic Management System (ERTMS). This will replace the present RETB system, and the radio / voice control of trains will cease at the same time. The present timescale for the introduction of ERTMS is late 2009. Llanbadarn crossing will remain as an ABCL under this system.
- 154 Arriva Trains Wales Ltd has suggested that Llanbadarn ABCL should be linked to the new control system, so that the brakes would automatically be applied on any train that was running too rapidly towards the crossing. Network Rail stated that this change could not be included in the initial ERTMS project, but are considering whether it can be included as a future, separate, project. Network Rail is also reviewing whether the interlink with the Vale of Rheidol crossing needs to be maintained (Recommendation 1).
- 155 Arriva Trains Wales has suspended the driver from driving trains as a precautionary measure.

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

156 Network Rail has authorised the conversion of Weig Lane crossing to a closed circuit television monitored crossing. This will be installed in February 2010, and will lead to the incorrect signs at the crossing being removed, and will also remove the driver's crossing indicator. For this reason no recommendations are made regarding these two matters.

Recommendations

157 The following safety recommendations are made¹¹:

Recommendations to address causal and contributory factors

- 1 Network Rail should complete its reviews of Llanbadarn ABCL and implement any actions that it deems reasonably practicable to improve the safety of the crossing (paragraphs 151 and 154).
- 2 Network Rail should amend the timings of Forden crossing so that it is possible for drivers to observe a flashing white aspect on the driver's crossing indicator when passing the special speed restriction board (paragraph 140).
- 3 The Rail Safety and Standards Board should make a proposal, in accordance with the Railway Group Standards Code, to amend paragraph 4.2 of module TW8 of the Rule Book so as to make explicit that a driver should start to control his speed at once if he observes a flashing red aspect when passing the special speed restriction board of a locally monitored automatic crossing (paragraph 141).
- 4 Arriva Trains Wales should review its training (and training material) for drivers who have to drive over locally monitored automatic crossings to make clear the meaning of the position of the special speed restriction board, and the need to control the speed of the train if the driver's crossing indicator is not showing a flashing white aspect when a driver passes it (paragraph 141).

continued

¹¹ 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 them to carry out their 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 167 to 171) can be found on RAIB's web site at www.raib.gov.uk.

Recommendations to address other matters observed during the investigation

- 5 Network Rail should review the ALCRM assessment for Llanbadarn ABCL to take into account the risk of a Vale of Rheidol Railway train causing a flashing red aspect of the driver's crossing indicator to display when a train arrives on the Network Rail line, and the short sighting time to the down direction special speed restriction board, and, if appropriate, take any actions identified as reasonably practicable (paragraph 145).
- 6 Network Rail should complete its assessment of the other locally monitored automatic crossings on its network (paragraph 149).
- 7 Network Rail should, if required in the light of Recommendation 6, amend crossing timings so that it is possible for drivers to observe the white flashing aspect on the driver's crossing indicator before they reach the special speed restriction board (paragraph 149).
- 8 Network Rail should implement monitoring of the compliance by signalling maintenance staff on the Cambrian Lines with the requirement in RT/SMS/Test/071 to contact the signaller before working on locally controlled automatic crossings, so as to be able to take steps to address any deficiencies identified (paragraph 150).

Appendices

Appendix A - Glossary of abbreviations and acronyms

ABCL	Automatic Barrier Crossing (Locally Monitored)
ALCRM	All Level Crossing Risk Model
AOCL	Automatic Open Crossing (Locally Monitored)
AWS	Automatic Warning System
ERTMS	European Rail Traffic Management System
OTDR	On Train Data Recorder
RETB	Radio Electronic Token Block
RSSB	Rail Safety and Standards Board
SMS	Signalling Maintenance Specifications
SPAD	Signal Passed At Danger

Appendix B - Glossary of terms

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

Automatic Warning System (AWS)	A fail-safe arrangement of permanent magnets and electro-magnets placed between the rails, that conveys information about a speed restriction or the aspect of the associated signal to the train driver.*
Braking curve	The graphical representation of the deceleration of a particular train when velocity is plotted against distance.*
Category 'A' Signal Passed at Danger	Any 'signal passed at danger' that occurs at a correctly displayed stop aspect due to driver error when sufficient time was available to bring the train to a stop at the signal.*
Chain	A unit of length equal to 66 feet or 22 yards (approximately 20117 mm). There are 80 Chains in one standard mile.*
Collective risk	The average risk to all people involved in the activity as a whole, measured as a frequency of a particular outcome (e.g. equivalent fatalities per annum).
Driver's crossing indicator	A signal provided on the approach to an Automatic Barrier Crossing, Locally Monitored, and an Automatic Open Crossing, Locally Monitored, to convey the status of the level crossing to the driver.*
Electronic token	The data message used by a Radio Electronic Token Block system to give permission for a train to enter a section of track. The system ensures that only one electronic token can be issued for any section of track at a time.
Fatalities and Weighted Injuries	A method of assessing risk used by the RSSB, based on different weightings depending on the predicted level of injury resulting from an incident.
Fatigue Index	<p>The Fatigue Index was developed by the Centre for Human Sciences at the Defence Evaluation and Research Agency (now known as QinetiQ). It was designed to assess the short-term daily fatigue and cumulative fatigue risks associated with shift work. The Fatigue Index is based on the five main factors known to have an impact on fatigue:</p> <ul style="list-style-type: none"> ● time of day; ● shift duration; ● rest periods; ● breaks within a shift; ● cumulative fatigue. <p>For each component a scoring system operates. *</p>
Individual risk	The risk to a specified individual, measured as a probability of death per unit of time or per activity (e.g. probability of death per annum for the person who is most exposed to a risk).

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.*
Link	The itinerary of a particular driver or traincrew.*
Open channel	A radio system where all parties holding a unit hear all communications on the channel in use.
Open Crossing	This type of crossing does not have road barriers or road traffic light signals and only road traffic signs are provided. Road users are required to give way at the crossings. Road users can see approaching trains in sufficient time for them to be able to cross the crossing or stop safely. Telephones for the use of the public are not required.
Possession	A period of time during which one or more tracks are blocked to trains to permit work to be safely carried out on or near the line.
Railway Group Standard	A document mandating the technical or operating standards required of a particular system, process or procedure to ensure that it interfaces correctly with other systems, process and procedures.*
Rail Safety and Standards Board	A company owned by the railway industry, whose objective is to co-ordinate the industry's work in achieving continuous improvement in the health and safety performance of the national railway network, and thus facilitate a reduction of risk to employees and passengers. The Rail Safety and Standards Board is responsible for the control of Railway Group Standards.
Safety critical radio communication	Any radio message given or received which may affect the safe operation of the railway.*
Signalling Maintenance Specifications	Documents provided by Network Rail for front line signalling maintenance staff to inform them of the requirements for different elements of their work.
Step (Brake)	The different positions on the driver's brake controller representing progressively greater brake demands.
Treadle	An electrical switch with an actuating lever operated by the wheel flanges of passing rail vehicles. They are used particularly to activate an automatic level crossing.*

Appendix C - Key standards current at the time

GE/RT8000/TW8	Rule Book section, Level crossings
GI/RT/7012, Issue 1	Requirements for Level Crossings
GK/RT0034, Issue 4, December 2000	Lineside signalling spacing
GM/RT2044, Issue 4, June 2001	Braking System requirements and performance for Multiple Units
HSE Railway Safety Principles Guidance, Part 2, Section E	Highest level safety requirements Safety and Guidance for Level Crossings
NR/L2/OPS/100, Issue 2, June 2008	Provision, Risk Assessment and Review of Level Crossings'
NR/SP/SIG/10028	Inspection and Surveillance of Signal Engineering Activities
RT/E/C/11600, Part X, Issue 1	Design Technical Guidance for level crossing signalling and operational telecommunications.
RT/SMS/LC00	General issues for level crossings
RT/SMS/Test/071	ABCL Operational Sequence tests

Appendix D - Urgent Safety Advice issued on 24 November 2008

RAIB SF-3.1.9.1
ISSUE : 2A

URGENT SAFETY ADVICE



1. INCIDENT DESCRIPTION			
LEAD INSPECTOR		CONTACT TEL. No.	
INCIDENT REPORT No	0324	DATE OF INCIDENT	21 October 2008
INCIDENT NAME	Llanbadarn		
TYPE OF INCIDENT	Near Miss		
INCIDENT DESCRIPTION	Train crossed Llanbadarn ABC(L) whilst the barriers were raised, narrowly missing a collision with a road tanker carrying LPG		
SUPPORTING REFERENCES			

2. URGENT SAFETY ADVICE	
USA DATE:	24 November 2008
TITLE:	AOC(L) and ABC(L) warning lights
SYSTEM / EQUIPMENT:	Red / White flashing lights that notify driver of the state of the crossing
SAFETY ISSUE DESCRIPTION:	Lights remaining red after train cab has passed Special Speed Restriction Board (SSRB)
CIRCUMSTANCES:	See above
CONSEQUENCES:	See above – near miss
REASONS FOR ISSUE:	<p>On 20 November 2008 an RAIB Inspector cab rode from Shrewsbury to Aberystwyth and return. There are five AOC(L) and ABC(L) crossings on this route, so a total of ten crossing approaches were observed.</p> <p>In three of the ten crossing approaches the red flashing light did not change to white until after the driver's cab had passed the SSRB, in one case by several metres. In each case the train was running at the speed set out on the SSRB. The RAIB's checks indicate that this sequence is a regular occurrence</p> <p>One of the purposes of an SSRB is to mark the point at which braking should commence if the flashing red light has not turned to white. In the circumstances observed, drivers may become acclimatised to red lights not changing to white by the time of reaching the SSRB, and thus the risk of over-running a crossing if it does not correctly operate are increased, with consequent possible risk of collision</p>
ADVICE:	<p>The RAIB wishes to draw the attention of Network Rail, Northern Ireland Railways, and Heritage Railways to the possible risks if the set timings of AOC(L) or ABC(L) crossing lights mean that the lights regularly do not change to white before a correctly driven driver's cab has passed the SSRB.</p> <p>The RAIB advises that Network Rail, Northern Ireland railways, and any heritage railway with an AOC(L) or ABC(L) should check the timings of all such crossings to identify if this feature is present, and, if so, should adjust sign positions (within the confines of level crossing orders) or crossing timings so that the flashing white light displays before the cab reaches the SSRB. If timings are adjusted then it will be necessary to consider the effect on road vehicle drivers, and whether the change might increase the risk of them disregarding the road signal lights.</p>

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