RAIB

Rail Accident Investigation Branch

Rail Accident Report

Fatal accident at Motts Lane level crossing, Witham, Essex
24 January 2013

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January 2014

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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Summary

At 17:37 hrs on 24 January 2013, a cyclist who was using the footpath and bridleway level crossing at Motts Lane, near Witham in Essex, was struck and fatally injured by a passenger train travelling at almost 100 miles per hour (160 kilometres per hour).

It was dark at the time. The red/green lights provided at the crossing to indicate the approach of trains were showing red, and the associated audible warning was sounding. The cyclist was unaware that the train was so close to the crossing, probably because it was difficult to pick out the train's headlight amongst the lights of Witham station, about 700 metres from the crossing.

The cyclist rode onto the crossing into the path of the train, although the lights were showing red. Although it is not possible to know why he did this, it may have been because he was used to seeing the lights at red for long periods before trains arrived at the crossing, and decided for himself whether it was safe to cross. The lights showed red for long periods because there were deficiencies in the design of the railway signalling system in the area, and it was not being used as it was designed to be.

The RAIB has made four recommendations, addressed to Network Rail, which cover:

- the review and reduction of long waiting times at automatic level crossings;
- the design and checking of software which is used for automatic route setting in signalling control centres;
- minimising the effect of local variations in the way trains are signalled that may affect the length of the periods during which red lights are displayed at level crossings; and
- modification of risk management processes for crossings with miniature stop lights to include allowance for the length of time that the red lights show.

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 and speeds 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 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

6 At about 17:37 hrs on Thursday 24 January 2013, train number 1P46, the 17:00 hrs service from London Liverpool Street to Norwich, struck a cyclist who was crossing the railway at Motts Lane level crossing, near Witham, Essex (figure 1).

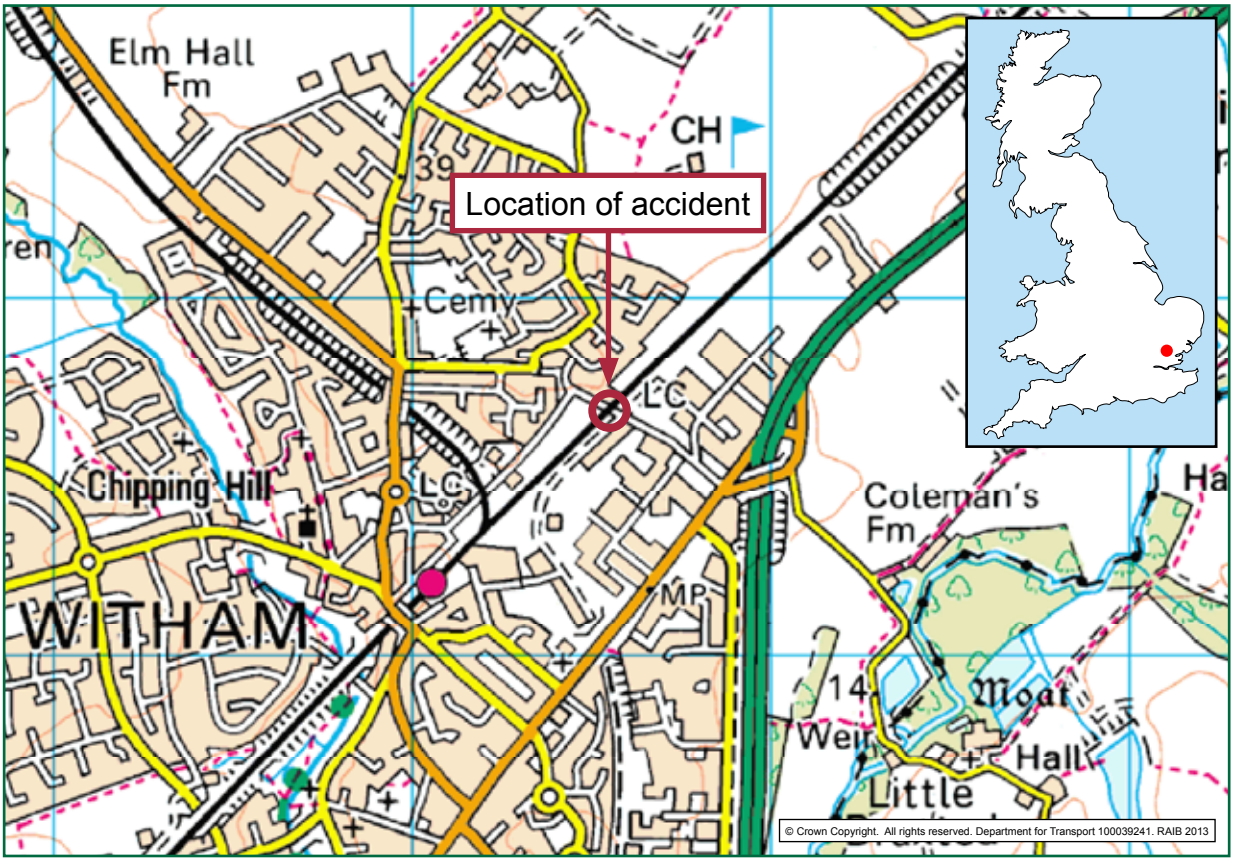

Figure 1: Extract from Ordnance Survey map showing the location of the accident

7 The cyclist was fatally injured.

Context

Location

8 Motts Lane level crossing is a *bridleway* crossing where Motts Lane, which is no longer a through route for vehicles, crosses the railway between Witham and Kelvedon stations. It is just over 39 miles from London (Liverpool Street), at a point where the double-track railway runs roughly south-west to north-east.

9 The crossing is on the north-eastern edge of the town of Witham. There is an industrial estate on the south-east side of the railway, and a residential area across the line to the north-west (figure 2). The crossing provides a route between these two, and there is evidence that it is much used (between 200 and 300 users per day) by people going to and from work (see paragraph 108).

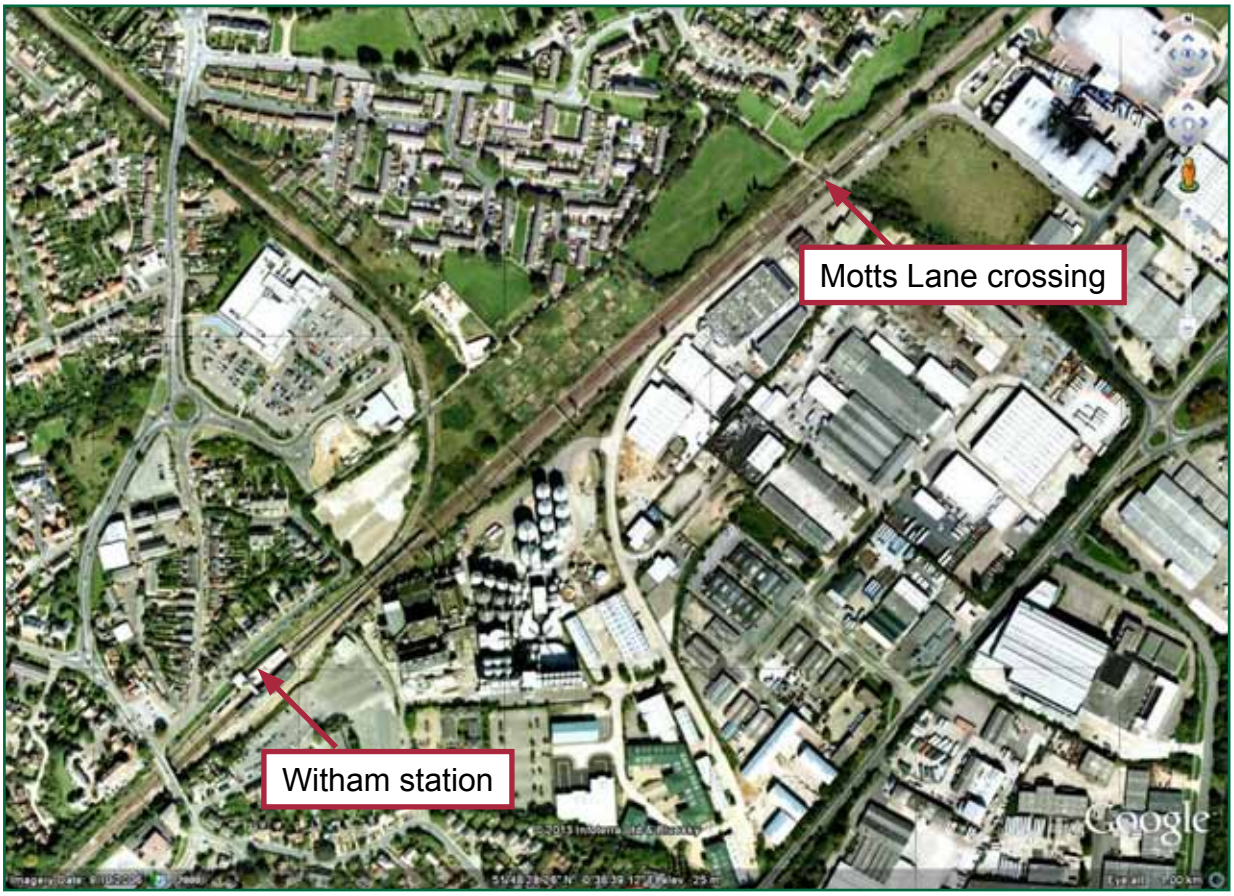

Figure 2: Witham station and Motts Lane crossing

10 The crossing is 770 yards (700 metres) north-east of Witham station. There are loop lines either side of the double-track main line, which extend from the station almost to the crossing. The permitted speed for trains on the main lines is 100 mph (160 km/h) in both directions. Trains going to and from the loops are required to travel at no more than 25 mph (40 km/h).

11 Signalling in the area is controlled from Liverpool Street *Integrated Electronic Control Centre* (IECC) in London. The crossing is equipped with red and green miniature stop lights (MSL), facing across the railway on both sides, which show green as long as there are no trains in the vicinity. A statutory *Level Crossing Order* issued by HM Railway Inspectorate (HMRI) (the safety regulator for the railway industry, at that time part of the Health & Safety Executive (HSE), but now within the Office of Rail Regulation (ORR)) in 1996 defines the arrangements and operating systems required at the crossing. These include a requirement that the lights should change to red at least 40 seconds before the arrival of the fastest train, and remain red until the train has passed. There is also a requirement that an audible alarm sounds while the lights are red, and that the tone of the audible alarm changes if a second train is to pass before the lights turn back to green. There are notices at the crossing advising users on the meaning of the lights (figure 3). The crossing is not provided with telephones.

Organisations involved

12 Network Rail owns, operates and maintains the railway infrastructure, and is the employer of the level crossing management team and other operations staff.

13 Abellio Greater Anglia Ltd, trading as Greater Anglia, operated train 1P46 and was the employer of the train driver.

14 Essex County Council is the highway authority for Motts Lane, and assisted Network Rail with its application to close the level crossing in 2012.

15 Network Rail, Greater Anglia and Essex County Council freely co-operated with the investigation.

Train involved

16 Train 1P46 was formed of nine coaches, propelled by a class 90 electric locomotive. The leading vehicle of the train was a driving van trailer (DVT), a non-powered vehicle which incorporates a driving cab and storage space, but has no passenger accommodation. Following the accident, the DVT was inspected by Greater Anglia, and the headlights were found to be working. The condition of the train was not a causal factor in the accident.

The crossing user

17 The deceased person was employed at a factory near the crossing, and was on his way to work for a night shift. He had been working there for about six years, and had used the crossing regularly during that period, travelling between his place of work and his home on the north side of Witham.

External circumstances

18 Thursday 24 January was cold but dry. At the time of the accident, soon after 17:30 hrs, it was dark, the temperature[1] was zero Celsius, and there was a light breeze (1.5 metres per second), from the north. The weather conditions are unlikely to have influenced the causes of the accident.

Events preceding the accident

19 Train 1P46 left Liverpool Street station in London on time at 17:00 hrs, and ran non-stop, covering the 39 miles (63 km) to Witham in 36 minutes, as timetabled.

20 The train approached Witham and, by operating *track circuits* and *treadles*, activated the automatic controls which initiated the warning light and audible alarms at Motts Lane crossing at 17:35:10[2] hrs. It was travelling at close to the line speed of 100 mph (160 km/h) as it passed through Witham station. The train arrived at the level crossing at 17:35:55 hrs.

[1] Weather information as recorded at Stansted airport, 15 miles (24 km) from the site of the accident.

[2] These timings are to the nearest five seconds, as recorded by the signalling system data logger at Liverpool Street IECC

Events during the accident

21 There were no witnesses to the cyclist's actions before the accident. The driver of the train reports that he caught a glimpse, in the headlights of the train, of a person on a bicycle coming from his left onto the line, as the train was closely approaching the crossing. The driver's evidence was that there was no time for him to sound the train's horn before it reached the crossing, and that the person appeared to look at the train, and attempted to cycle clear, but was not able to do so before being struck by the right-hand front corner of the leading vehicle of the train. He was thrown to the right, clear of the train's path.

Events following the accident

22 The train driver applied the emergency brake immediately on seeing the cyclist, and the train came to a stop about one mile (1.6 km) beyond the crossing. Emergency services and Network Rail staff attended quickly at Motts Lane, but the casualty was declared dead at the scene of the accident. The railway was re-opened at 18:33 hrs.

The investigation

Sources of evidence

23 The following sources of evidence were used:

- witness statements;
- the on-train data recorder from the train;
- site photographs and measurements;
- weather reports and observations at the site;
- the signalling data recorder at London Liverpool Street IECC;
- records relating to the signalling and level crossing controls in use at London Liverpool Street IECC;
- Network Rail's level crossing file;
- a review of previous reported occurrences at the crossing; and
- a review of previous RAIB investigations that had relevance to this accident.

Key facts and analysis

Background information

24 Motts Lane originally ran from the London – Colchester road north-west through open country. The level crossing dates from the opening of the Eastern Counties Railway in 1843, when a crossing keeper's house was provided at the north-east corner of the crossing. The land on both sides of the crossing was developed in the 1960s, with housing to the north-west and factories to the south-east. At that time the lane was a public road, and the crossing was operated by an on-site crossing keeper who opened and closed the gates and operated interlocked railway signals. In 1996 the road was closed to vehicles and the crossing became a bridleway (which also includes public footpath rights), with the gates worked by crossing users, and equipped with miniature stop lights. The authority for this change was given by the Railtrack Motts Lane Level Crossing Order 1996, which was issued by HMRI on 11 December 1996.

25 The railway is part of the main line from London to Norwich. The section through Witham was electrified on the 25kV overhead system in 1959. The present signalling, controlled from Liverpool Street IECC, dates from 1992. The railway is used by about 230 passenger trains and 35 freight trains each weekday. Passenger trains not stopping at Witham (3 per hour each way off-peak) usually pass the crossing at the line speed of 100 mph (160 km/h). Stopping passenger trains (3 per hour each way) and freight trains (which run at irregular intervals) run at lower speeds.

Signalling and level crossing protection

26 All lines are equipped with signalling to enable trains to run in both directions on them. Although this bi-directional signalling facility is not required for the normal timetabled operation of trains, it is used during engineering works and during periods of disruption to normal working.

27 The miniature stop lights are required by the Level Crossing Order to be automatically operated and arranged so that:

> '*the green lights remain illuminated until an approaching train reaches a position from which when travelling at its maximum permissible speed it will take not less than 40 seconds to arrive at the crossing at which position the red lights shall become illuminated, the audible warning shall begin and the green lights shall be extinguished. The red lights shall remain illuminated until the rear of the train has passed clear of the crossing.'*

28 The Order also requires that, if another train approaches the crossing while the red lights are showing:

> '*the red lights shall continue to remain illuminated and the audible warning shall continue to operate. As soon as one train reaches the crossing the warbling rate of the audible warning devices shall be increased.'*

29 After the first and any subsequent trains have passed so that it is possible for people to use the crossing again, the red lights go out, the green lights become illuminated and the audible warning stops.

30 The arrangements at the crossing, and in particular the requirement for a 40 second warning time, are based on the HMRI document 'Railway Safety Principles and Guidance part 2 section E: Guidance on Level Crossings' (RSPG 2E), published by HSE in 1996. Paragraph 254 of the HMRI document gives guidance on warning times at crossings equipped with miniature stop lights. A warning time of 40 seconds applies to bridleway crossings, and a time of 20 seconds to footpath crossings.

31 The operation of the lights at the crossing is part of the signalling system controlled from Liverpool Street IECC. The design of the crossing controls, including the requirement for a 40 second warning period, was implemented through *control tables*, which were prepared in the early 1990s. To try to achieve a consistent warning time, the control tables included 'stopping' and 'non-stopping' settings for trains travelling in the *down* direction, reflecting the difference in approach times for trains which stop at Witham and those which pass through at speed.

32 The crossing controls are designed so that the crossing is activated by down non-stopping trains as those trains pass a point 2095 yards (1917 metres) from the crossing, representing 42 seconds running time at a steady speed of 100 mph. For down stopping trains, the design calls for the signal at the end of Witham station platform three (L769) to be held at red by the signalling system as the train draws to a stop (figure 7). After 75 seconds, the crossing lights change from green to red. Ten seconds after that, signal L769 clears, and if the train immediately starts and accelerates towards the crossing at a rate of about 1.2 metres per second per second[3], it will reach the crossing about 44 seconds after the crossing lights changed.

33 Errors in the implementation of this design, and in the way the signalling system is operated, have caused variations in these warning times. This is discussed in paragraphs 63 to 73. There is much less variation in warning times for trains going towards London (up trains), because all of these are normally travelling at speed as they approach Motts Lane.

Description of the location

34 Motts Lane crosses the railway almost at right angles. Figure 4 shows the level crossing as it was at the time of the accident. The arrangements had been substantially unchanged since 1996, when the crossing was converted to a bridleway and the miniature stop lights were installed (paragraph 24).

35 It is not necessary for users to have a good view of approaching trains because the miniature stop lights provide information about whether it is safe to cross. However, the topography of the railway in the area means that users can supplement this information with their own observations, and the evidence that RAIB has seen suggests that this occurs regularly. The railway is straight for over two miles (3.2 km) in each direction from the crossing, and so anyone using it can see trains coming some time before they arrive, and in most cases well before the crossing lights and alarms are activated.

[3] This acceleration rate is based on the acceleration of a class 90 electric locomotive running light, observed during RAIB's investigation into the derailment at Bletchley Junction on 2 February 2012 (report 24/2012), which represents the maximum acceleration likely to be achieved by a train on the UK national network.

36 The view towards Witham station from the pedestrian approaches to the crossing is good. This is because the railway widens out immediately south-west of the crossing, and the overhead line equipment (OLE) is supported on 'portal' structures whose legs are set well back from the main lines (figure 5).

37 The view towards the north-east from both sides of the line is obstructed by OLE stanchions until a user has passed through the gate, but it is still possible to get a good view from both sides while standing in the gateway and remaining clear of the track (figure 6).

38 As specified in the Level Crossing Order, the miniature stop lights are supplemented by an audible alarm. When a second train is coming after the first has passed, and the interval between the two trains is insufficient for the crossing to be re-opened, the tone of this alarm changes to a higher frequency. However, the notices at the crossing do not explain the significance of this change in tone, and it is unlikely that many users know what it means[4].

39 The crossing is equipped with signs instructing people on the correct way to use it, as specified in the Order (figure 3).

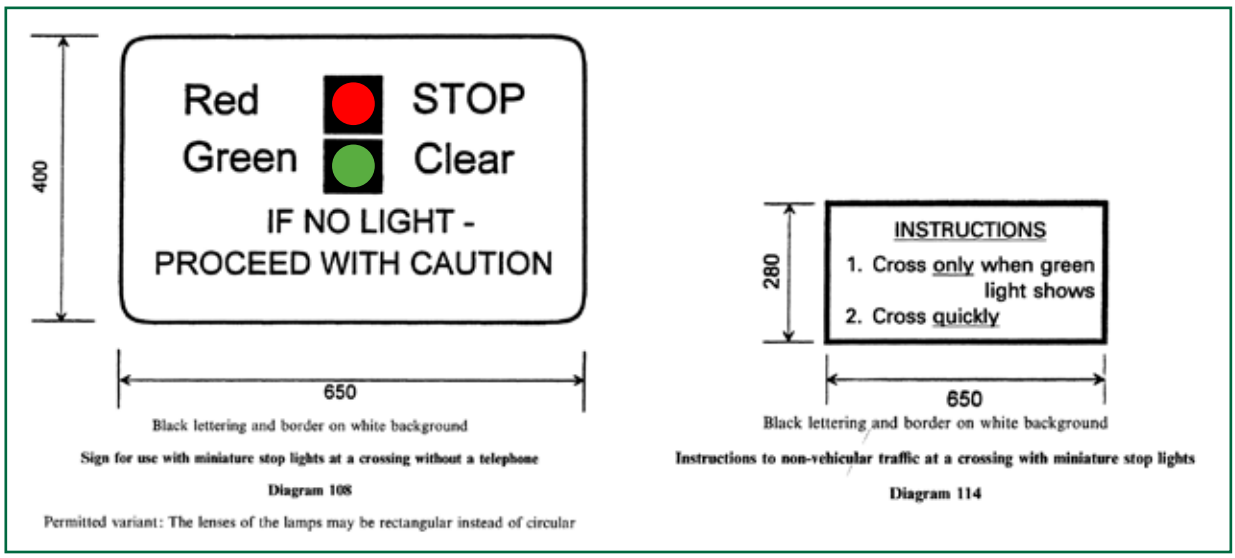

Figure 3: Instruction signs at MSL crossings, as used at Motts Lane (source: The Private Crossings (Signs and Barriers) Regulations 1996 (SI 1996 No. 1786))

40 Additional signs at the crossing give warnings about trespass, the possibility that trains may run in both directions on either line, the hazards of the OLE, and tell cyclists to dismount[5].

41 The crossing is some distance from the nearest main road and factory buildings, and there is little background noise.

[4] Paragraph 34 of The Highway Code, in the section 'Rules for Pedestrians' says 'You **MUST NOT** cross or pass a stop line when the red lights show, (including a red pedestrian figure). Also do not cross if an alarm is sounding or the barriers are being lowered. The tone of the alarm may change if another train is approaching.' There is no obligation on pedestrians to read the Highway Code.

[5] The notice on the gate relating to 'Restricted Access' had been placed there in error by Network Rail, and should have been positioned on the gate at the side of the crossing which gives maintenance staff access to the line side. This sign, and its counterpart on the other side of the line, were repositioned by Network Rail on the correct gates during the RAIB's period of observation at the crossing on the day after the accident.

Figure 4: Motts Lane crossing from the south-east, showing instruction signs

Figure 5: View from north-west (down) side of Motts Lane crossing, looking towards Witham station

Figure 6: View from north-west (down) side of Motts Lane crossing, looking towards Kelvedon station

Management of the crossing

42 Network Rail's requirements for the management of risk at level crossings are defined in its company standard NR/L2/OPS/100 'Provision, risk assessment and review of level crossings', and associated documents. The standards indicate that risk assessments at footpath and bridleway crossings should be carried out every three years, unless an accident or near-miss incident occurs (in which case a risk assessment should be carried out immediately afterwards).

43 Risk assessment is required to be carried out with the aid of the All Level Crossing Risk Model (ALCRM), a computer-based system for estimating risk, which was launched in 2007. Motts Lane crossing is in Network Rail's Anglia route, and risk assessments for it were done by staff from the level crossing team covering that route.

44 The ALCRM provides a prediction of risk which it classifies in the following ways:

- Individual risk of fatality (identified by a letter A (high) to M (low)), which relates to the annual risk of death for an individual using the crossing frequently (500 times per year).
- Collective risk (identified by a number 1 (high) to 13 (low)), which relates to the total risk at the crossing. This takes into account the overall risk of death and injury for crossing users, train crew and passengers. The value which ALCRM calculates for the collective risk is heavily influenced by the amount of traffic (trains and crossing users) at the crossing.

The use of ALCRM is supplemented by a qualitative assessment of local risks, if the predicted risk ranking is above a certain level. All the ALCRM risk calculations carried out at Motts Lane resulted in scores above the qualifying level.

45 A risk assessment using ALCRM was first carried out at Motts Lane in June 2007, and the model calculated the risk as C2, mainly because of the large number of crossing users. However, this survey greatly under-estimated the number of trains passing over the crossing, and used a figure of 54 instead of the actual weekday value of around 260. The next assessment, on the three-yearly cycle, in May 2010, used a lower value for the number of crossing users, but a more realistic (although now too high) number of trains. This produced a higher ranking of B1. A further assessment, in support of an application to replace the crossing by a bridge (paragraph 93), was carried out in September 2011 and produced a score of C1. By this time, the ALCRM algorithm had been re-calibrated to correct an error which was producing excessively high rankings for crossings equipped with MSLs. The crossing was put through the ALCRM process again in December 2012, and again scored C1. Details of the figures used in all the risk assessments are in appendix C.

46 Once an ALCRM risk calculation has been undertaken, Network Rail uses a web-based system known as the Level Crossing Risk Management Toolkit (LXRMTK)[6] to assist with the identification of possible risk mitigation measures, taking into account local factors. It provides a listing of options for consideration and indicative costs for each one. The principal factors that the instructions for using the toolkit say should be considered when assessing the potential benefits of a risk mitigation proposal are the effectiveness and longevity of risk reduction against the cost of the measure proposed.

47 The score calculated using the ALCRM is used to prioritise actions to reduce risk. Although Motts Lane crossing scored highly, plans to close it and replace it with a bridge were being considered from 2003 (paragraph 92) before the risk was quantified using the ALCRM process (from 2007 onwards).

Identification of the immediate cause[7]

48 **The cyclist moved onto the level crossing into the path of the approaching train.**

49 The train driver stated that a person on a bicycle came from the left side of the line as the train approached, looked towards the train, and then appeared to try to get across the line before the train reached the crossing.

50 The position of the cyclist and his bicycle following the accident is consistent with this account.

[6] The Level Crossing Risk Management Toolkit is managed by RSSB and is available to view at www.lxrmtk.com.

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

Identification of causal factors[8]

The actions of the cyclist

The red light and audible warnings

51 The cyclist disregarded the warnings given by the red light and audible alarm.

52 The signs at Motts Lane crossing tell users to stop when the red light shows, and to cross only when the green light shows (figures 3 and 4). However, the RAIB has obtained evidence from various sources (including observations by RAIB inspectors, members of the public, and assessments by railway staff) that users of the crossing at Motts Lane habitually disregard the warning given by the lights and audible alarm, and cross the line while these warnings are active. There are two probable reasons why people do this:

a. they are able to see that a train that is in sight is still some distance away, or is stationary (paragraph 35); and

b. they are aware that the warnings are likely to show for a significant length of time before a train arrives at the crossing.

53 The cyclist was a regular user of the crossing (paragraph 17), and may have become accustomed to looking for trains, rather than waiting for the green light, and may also have seen other people do the same.

54 The red lights were illuminated for long periods before the arrival of trains because:

- the crossing is designed to provide a minimum warning time of 40 seconds, which is much longer than almost all users require to cross the line (paragraph 56);
- the closure time was extended to at least 3.5 minutes by the use of the 'non-stopping' setting for down trains which were due to stop at Witham (paragraph 62); and
- the interaction of the signalling system and the *automatic route setting* (ARS) system extended the crossing closure time for stopping trains, even when the 'stopping' setting was selected by the signaller (paragraph 67).

55 It is also possible that the cyclist may not have seen the train, or seen it and misjudged its speed and position, or assumed that it was stationary. This possibility is discussed later at paragraph 84.

Length of warning time

56 The crossing is designed to provide a minimum warning time of 40 seconds, which is much longer than almost all users require to cross the line.

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

57 A person who uses the crossing regularly in daylight can see trains in the distance and standing at the station, and will become aware of how long it takes an approaching train to reach the crossing. They may well make a judgement that, although the train is in view, they have sufficient time to cross the line. They are likely to be alerted to the approach of a train by the red miniature stop light and audible alarm, and make a decision on whether to cross based on what they can see of the train. After dark, although it is not so easy to distinguish trains that are some way away, a user may be influenced by their experience during daylight, and attempt to make a similar decision. In these circumstances, they are less likely to be able to make a safe decision because of the difficulty of distinguishing a moving train from among the station lights[9]. It is possible that a user may not be conscious of this limitation. It is also the case that users will become accustomed to the fact that the crossing is always closed for a long time (at least 40 seconds), and this may influence their decision to cross before the train arrives.

58 Motts Lane crossing is classed as a bridleway, and as such the guidance in RSPG 2E stated that the minimum warning period should be 40 seconds, as compared with 20 seconds for a footpath crossing (paragraph 30). This additional warning time is intended to allow for the extra time which may be needed by horse riders to open the gates and get on and off the crossing. However, there is no evidence that the crossing is ever used by people with horses. It has not been possible to establish why the crossing was given bridleway status when it was downgraded from a road in 1996.

59 The crossing is 9.2 metres wide (the distance from each gate to 2 metres past the furthest rail, the point at which a user will be safely clear of the line). The time required for a pedestrian to traverse the crossing, at the speed of 1.2 metres per second given in the ORR guidance, is 7.6 seconds. This time is, by Network Rail company standard, increased by 50% to take account of vulnerable and encumbered users, such as those with bicycles, wheelchairs, mobility scooters or pushchairs, who are likely to take longer to cross. The total traverse time, on this basis, is 11.5 seconds. A warning time of 40 seconds is therefore greatly in excess of what is required, even considering the needs of vulnerable users.

60 The guidance in RSPG 2E has been superseded by the ORR document 'Level crossings: A guide for managers, designers and operators' (current version issued in December 2011). This says, at paragraph 2.272, in relation to crossings with miniature stop lights:

> '*The minimum warning period should be determined by risk assessment of crossing usage and be at least 5 seconds longer than the time required to cross.*'

This permits the crossing operator (Network Rail) to vary the warning time to a level based on assessment of the risks related to the actual users of the crossing. However, the warning periods at Motts Lane are subject to the requirements of the Level Crossing Order (paragraph 27). It is possible for the Order to be amended to vary the requirement for warning times, but this would require a request from Network Rail and the approval of ORR.

[9] The RAIB has previously commented on the difficulty of identifying and judging the movement of an approaching train in darkness, in the investigations into the fatal accidents at West Lodge crossing, Haltwhistle on 22 January 2008 (report 01/2009), and at Bayles & Wylies crossing, Bestwood on 22 November 2008 (report 32/2009) and 28 November 2012 (report 19/2013).

61 The risk associated with long warning times at crossings has been recognised by the railway industry, particularly in connection with vehicle drivers waiting at automatic half-barrier crossings, and is reflected in the LXRMTK and in the guidance issued by ORR[10] (see paragraph 82).

Signallers' use of the 'non-stopping' setting for stopping trains

62 **The closure time was extended by the use of the 'non-stopping' setting for trains which were due to stop at Witham, because signallers had not received any instructions about the operation of the crossing.**

63 Some signallers at Liverpool Street IECC were, according to evidence given to the RAIB, in the habit of using the 'non-stopping' setting (paragraph 31) for all down trains. Anecdotal evidence indicates that there were two reasons why they were doing this:

- The spacing of the signals through the Witham area (L761, L769 and L781 on the down main line, see figure 7) is less than standard, because of the layout of the various junctions, platforms, goods loops and the level crossing. Because of this condition (known as 'under-braking'), if signal L769 is at red for any reason, signal L761 is also maintained at red until an approaching train is close to it, and then clears to single yellow to ensure that the speed of the train has been reduced sufficiently to enable it to stop before reaching the next signal. This has the effect of delaying the train's arrival at the station. On some occasions, train drivers had requested a 'clear run' through the Witham area to help them regain time after a delay; they would be able to make a quicker approach to the platform if the signals through the station were clear and the train was not checked as described above.
- It is also the case that signallers said that they wished to avoid running a train towards a red signal when there was (from their perspective) no reason to do so, and thereby creating a situation in which a signal might be passed at danger (the use of the 'stopping' setting holds signal L769 at danger as the train approaches it (paragraph 32)).

There are no telephones for public use at the crossing, so no-one had ever contacted the IECC to query the length of time that the red light was illuminated.

64 For the period from 1996 until the accident in January 2013, the RAIB has found no evidence that signallers at Liverpool Street IECC were briefed or trained on the use of the 'stopping' setting. There is no evidence of any local instructions relating to it. There is also no evidence that local managers were aware of any safety implications (such as extended warning times) in respect of the level crossing that were associated with the use of the 'stopping' setting, or took any action to change the behaviour of the signallers.

[10] *Level crossings: A guide for managers, designers and operators* (ORR, December 2011) says at paragraph 2.77, in relation to automatic half-barrier crossings: 'The train should pass as soon after 27 seconds as possible. At least 95% of trains should arrive within 75 seconds and 50% within 50 seconds, once the closing sequence has begun.' Previous versions of the guidance, such as RSPG2E, were similar. This ORR guidance now appears as requirements in the Network Rail standard NR/L2/SIG/11201/ModX40 Issue 2, clauses 4.1.2 and 4.1.3.

65 The effect of using the 'non-stopping' setting was to start the crossing warning sequence when any train arrived at a point 2095 yards (1917 metres) before reaching the crossing. For a train timetabled to stop at Witham, the total of the running time from this point to the platform, the time spent standing in the station and the running time to reach the crossing is likely to be at least three and a half minutes, and often more than five minutes, depending on the time that the train waits at the station.

66 Following the accident on 24 January 2013, Network Rail instructed the signallers at Liverpool Street to use the appropriate setting for each train. This has reduced the period for which the crossing is closed, but only to between 1.5 and 3.5 minutes for a stopping train, for reasons explained in the next section.

The interface between the signalling and automatic route setting systems

67 **The interaction of the signalling system and the automatic route setting system extended the crossing closure time for stopping trains.**

68 The Witham workstation at Liverpool Street IECC is equipped with ARS. This software-based system operates the signalling system to run trains according to the timetable, and the workstation normally runs with ARS operating and the signaller observing the situation. When trains are running late, ARS decides on priorities, unless the signaller intervenes to over-ride it.

69 At Witham, the ARS is programmed to run stopping trains into the down platform with the signal at the platform end, L769, at danger (figure 7). When the train arrives at the platform (occupying track circuit LLY), ARS sets the route ahead, and the signal clears 11 seconds later. This has the effect of immediately changing the warning lights at Motts Lane from green to red, and starting the audible alarm ('closing' the crossing). If the route were set beyond L769 before the train occupied track circuit LLY, the 75 second delay would be applied (paragraph 32) and the crossing closure time would be shortened. However, the way that ARS has been programmed means that the crossing is closed at least 90 seconds before the train reaches it[11].

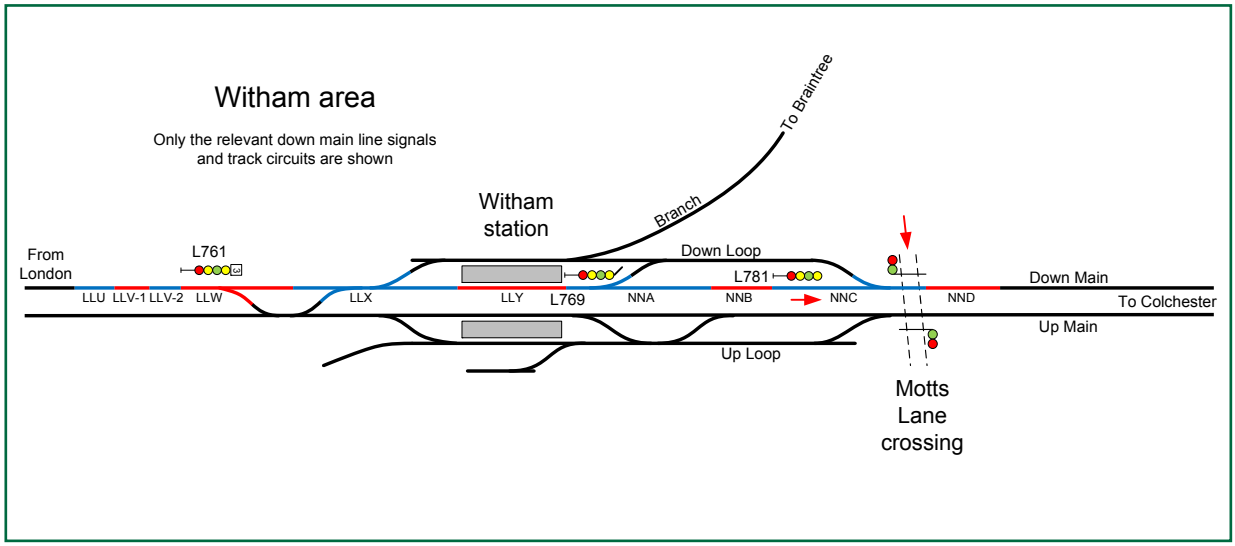

Figure 7: Signalling in the Witham area (only relevant down line signals and track circuits are shown)

[11] This is, in practice, the shortest time required for the train to call at the station, opening and closing doors to allow passengers to board and alight, then leave the station and cover the 700 metres to the level crossing at Motts Lane. This time is increased if the train is delayed in the platform for any reason.

70 This occurs because the ARS is setting the route forward from L769 after the train has arrived at Witham. Evidence indicates that this design was intended to avoid the excessive crossing closure time that could have resulted if the route was set earlier, but it overlooked the pre-existing 75 second delay built into the signalling system. To minimise the crossing closure time, the ARS should have been programmed to set the route forward from L769 when the stopping train occupied LLX track circuit, before reaching the platform (figure 7). This would have meant that when the train arrived at the platform, the crossing lights would stay at green for 75 seconds, and the crossing would then close, and signal L769 would clear, at a time when it is likely that the train would be ready to depart.

71 These effects are shown diagrammatically in figure 8. The operating sequence for the signalling system is detailed in appendix E.

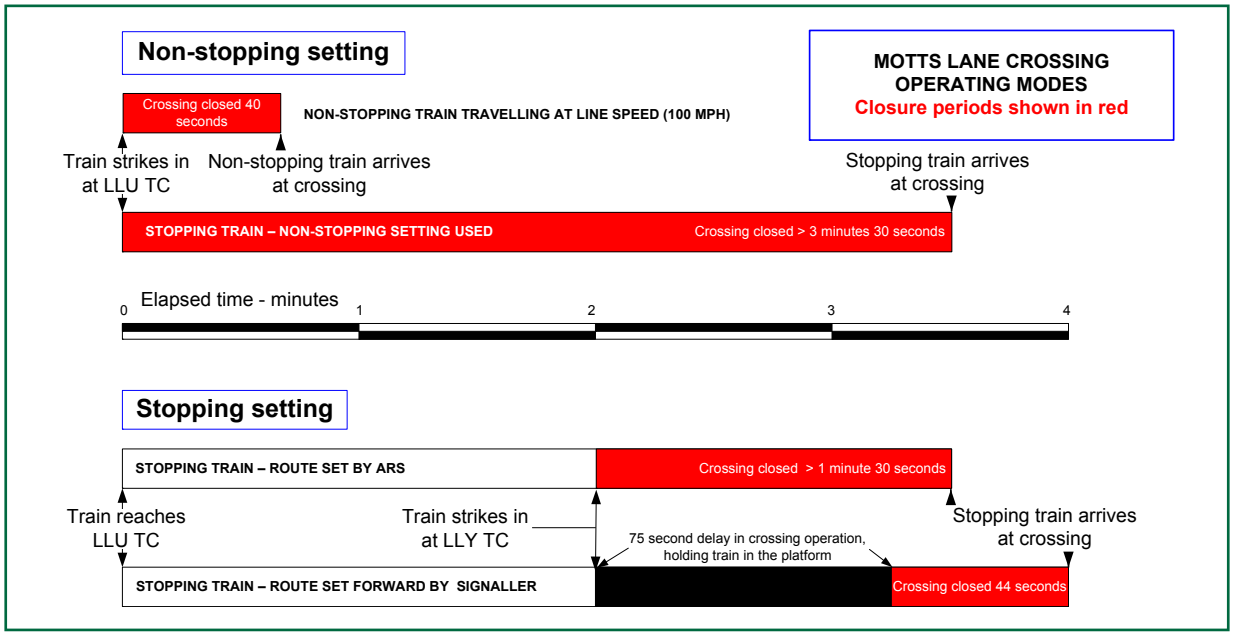

Figure 8: Motts Lane crossing operating modes, showing closure time

72 This possibility of this outcome arising from the interaction between ARS and the signalling system had not been identified by Network Rail before this accident occurred. The design, installation and commissioning of the signalling and ARS systems took place in the mid-1990s. At that time there was no standard way of applying data for MSL level crossings to the design of the *solid state interlocking* (SSI) used at Liverpool Street IECC. It appears that the designer of the ARS system applied a rule in programming the ARS system that was intended to delay the operation of the level crossing, without realising that the controls within the SSI already provided for such a delay. The result was the behaviour described in paragraph 69. At present, Network Rail is unable to say whether its current design protocols prevent such a situation occurring in new applications of ARS to existing or new signalling schemes.

73 It is possible that other level crossings may be similarly affected, either by this type of interaction between ARS and the signalling, or because the design of the signalling in a complex area makes it difficult to achieve a consistent closure time. At present, Network Rail does not assess the risk arising from long waiting times at automatic crossings. The RAIB has made Network Rail aware of this issue during the investigation.

Extent and effects of extended closure times

74 The factors described in paragraphs 58 to 73 meant that the crossing would be closed for extended periods of time, up to five minutes for a single train. The intensity of the train service through Witham further increases the incidence of long periods of closure, and makes it more probable that users will become intolerant of this, and cross when the red lights are showing.

75 The pattern of services through Witham includes stopping and non-stopping passenger trains. Because of the way the signalling system was being used (see paragraph 63), regular users of the crossing would often have encountered the lights at red when there was a train standing in the station, clearly visible from the crossing, and they could see that there were no other trains in the area.

76 There are seven trains each way in each hour off-peak. Three of these are non-stopping. The total time that the crossing is closed each hour is therefore about 14 minutes, or 23% of the time. During the morning and evening peaks, when most use is made of the crossing (by both trains and pedestrians), this figure rises. The RAIB observed traffic on a weekday evening between 17:00 hrs and 19:00 hrs, using observers in a position where they were unlikely to have influenced the behaviour of users. The total time that the crossing was closed before a train (or the last train in a group) arrived was 32 minutes 26 seconds, or 27% of the time.

77 Including the time taken for a train to pass the crossing and for the lights to change from red to green after the train had passed, the total closure time rises to 36 minutes 50 seconds, or 31% of the elapsed time.

78 During this period of observation 56 people used the crossing. The longest period that the crossing was closed was 4 minutes 39 seconds, while two trains passed. During that wait, four users crossed against the red light one minute and ten seconds after the start of the closure period, and a further three crossed immediately after the first train had passed, two minutes and six seconds after the start. These seven people were the only ones who were observed to cross against the red lights during the period that RAIB observed the crossing.

79 The shortest warning time given by the crossing during this period was 40 seconds, for a down non-stopping train.

80 Before the accident, when the signallers were using the 'non-stopping' setting for all down trains, the periods of closure would have been even longer (paragraph 65). In the morning and evening peak periods, between 07:00 hrs and 09:00 hrs and 17:00 hrs and 19:00 hrs, the crossing is likely to have been closed for a total of approximately 50 minutes, or 41 % of the time (the actual period will vary depending on the punctuality of the trains). The maximum closure time could have been about eight minutes, on two occasions in the evening peak, when two down stopping trains followed in succession. Diagrams showing the crossing closure in these periods are at appendix D.

81 Such long periods of closure are likely to make users intolerant. Research in North America[12] has shown that the number of pedestrians crossing roads against traffic signals increases significantly if waiting time is longer than 40 seconds. A previous study[13] in Europe found that 38% of pedestrians cross on red if waiting time is 40-60 seconds, and only 18% cross on red if waiting time is shorter than 30 seconds. In the UK, RSSB is currently sponsoring research into pedestrian behaviour at level crossings, and this is one of the aspects that is included in the study[14]. Extended waiting times may also influence motorists' behaviour at level crossings. At the time of writing this report, the RAIB is also investigating an accident involving a car that was driven round a barrier on an automatic half-barrier crossing at Athelney, Somerset on 21 March 2013, with fatal consequences for the driver of the car when it was struck by a train. On this occasion, the barriers had been down for a period of around three times longer than the normal time of 28 seconds.

82 The evidence of crossing misuse at Motts Lane described in paragraph 78, and from other sources seen by RAIB (including Network Rail records, and video evidence provided by members of the public), bears out these findings. There is a range of suggested options in the LXRMTK (paragraph 46) to deal with extended closure times. Relevant to the situation at Motts Lane are (factor 21) differential train speeds, (factor 53) closure, and (factor 72) install a bridge/underpass. Factor 21 says: *Ensuring that the approach speed of different types of train to a level crossing is the same provides a consistent warning time and consistent activation time of barriers / lights. This can be achieved by using differential speed restrictions for different types of train*. While this does not exactly mirror the situation at Motts Lane, it provides a hint that inconsistent warning times are undesirable and should be avoided where possible.

83 The extended warning times experienced by users of the crossing, produced by the combination of circumstances described in paragraphs 58 to 79, are probably a factor in the levels of misuse that have been experienced there. Despite this, the issue of differential warning times for stopping and non-stopping trains had not been identified by any of the Network Rail staff who had visited Motts Lane and gathered data relating to it. They believed that the signalling system and the crossing warning lights were functioning as they were designed to, and the RAIB found no evidence that any of the Network Rail staff measured the actual warning times at the crossing. At the time, there was nothing in the guidance issued to staff that highlighted this risk.

The cyclist's observation of the approaching train

84 **The cyclist may not have seen the train, or seen it and misjudged its speed and position, or assumed that it was stationary.**

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[12] *Effects of Pedestrian Signals on Safety, Operations and Pedestrian Behavior – Literature Review* (1982) published in *Transportation Research Record 847*, quoted in K G Baass, *Review of European and North American Practice of Pedestrian Signal Timing,* Roads and Transport Association of Canada, 1989.

[13] *Pedestrian friendly traffic lights in towns and villages – a short description,* Arbeitskreis Verkehr und Umwelt, Berlin (1987), quoted in Baass, op. cit.

[14] RSSB research project T984 'Research into the causes of pedestrian accidents at level crossings and potential solutions'.

85 The train driver's evidence indicates that the cyclist appeared on the crossing when the train was less than five seconds running time away, looked towards the train, and then appeared to try to get across before it arrived. From the cyclist's actions it appears that, if he had seen the train as he approached the crossing, he did not appreciate that it was moving towards him at high speed.

86 This is likely to be because of one or both of the following reasons:

- he may have misjudged the speed and position of the train because of the darkness (paragraph 57) and the almost head-on angle he was viewing the train at; or
- he may have assumed that the train was stationary (or moving only slowly) because he was accustomed to seeing trains call at the station.

87 The accident occurred after dark, in clear weather. In such conditions the view to the south-east from the approach to the level crossing on the down side is dominated, after dark, by the lights of Witham station (figure 9). The RAIB has observed in a previous investigation[15] that it can be difficult to distinguish a single headlight amongst a cluster of other lights when it is coming directly towards the viewer, ie its apparent position is not changing.

88 The RAIB observed trains approaching Motts Lane crossing after dark, from a position immediately outside the gate on the down side. It was difficult to pick out the headlights of a train from among the station lights until the train had passed through the station. It was also difficult to clearly identify that a train was moving towards the observer until it was less than five seconds running time from the crossing. Research into the human factors associated with this issue has been published and is referred to in a previous RAIB investigation into a fatal accident at a footpath crossing[16].

89 Had the cyclist briefly looked in the direction of the station, as he moved towards the crossing gate, it might not have been obvious that the headlight of train 1P46 was moving towards him. During the next few seconds he would have been occupied in opening the gate and getting the bicycle through it, and when he looked again towards the station, the train would have been close upon him.

90 In conclusion, it is possible that, if the cyclist glanced briefly towards the station, he either did not pick out the train among the station lights or, if he did, he assumed that the train he could see was stationary at the platform (figure 9).

[15] Investigation into a fatal accident at West Lodge crossing, Haltwhistle, on 22 January 2008, paragraphs 50 to 53 (RAIB report 01/2009).

[16] Fatal accident at Mexico footpath crossing (near Penzance), 3 October 2011, paragraph 68 and footnote 18 (RAIB report 10/2102).

Figure 9: View from the north-west (down) side of Motts Lane crossing towards Witham station, after dark

Replacement of the crossing

91 **Motts Lane crossing had not been closed and replaced by a bridge, despite long-standing plans to do so.**

92 The crossing at Motts Lane is heavily used, and has a history of observed misuse by pedestrians and cyclists (paragraph 52). A risk assessment carried out by Network Rail in 2003 recommended, for those reasons, that the crossing should be replaced by a bridge. At that time, Network Rail did not have a formal cost-benefit analysis process for the replacement of crossings. It has not been possible to establish why Motts Lane was not chosen as a priority for replacement, but it is likely that the funds allocated by Network Rail were very limited, there was no external funding available, and work on other crossings in the Anglia route took priority. These factors have been explored in the RAIB investigation into the fatal accident at Johnson's crossing, near Bishop's Stortford, on 28 January 2012 (report 27/2012, paragraphs 57 to 62).

93 In February 2009, Network Rail completed a further study which explored closure of the crossing, with provision of either a bridge or a subway to accommodate pedestrians, cyclists and horse riders. At that time, the cost of a bridge suitable for horse riders exceeded the funding available, and a subway would have been even more expensive. However, following consultation during 2010 with the local authorities (Braintree District Council and Essex County Council), a further study was commissioned to investigate the cost of providing a bridge suitable for cyclists and pedestrians only. Evidence indicates that Braintree District Council was prepared to allocate funding towards the construction of such a bridge.

94 Building a cycle/pedestrian bridge at Motts Lane implied extinguishment of the bridleway rights over the crossing, and the change in status of the route to a cycleway. It meant that Network Rail and the local authority considered that the bridleway status was no longer needed. At the time (and subsequently), there was no evidence of any actual use of the route over the crossing by horse riders. Network Rail and Essex County Council agreed that this was an appropriate approach, which would reduce the cost of the proposed bridge.

95 In early 2011 Network Rail completed this study, and a design for a bridge was drawn up. On 18 January 2011 Network Rail requested Essex County Council to apply to the Magistrates Court for an Order under section 116 of the Highways Act 1980 to remove public equestrian rights over the crossing, on the basis that these rights were no longer necessary. The County Council consulted various organisations on this proposal, and objections were received, which prevented the Order being made.

96 To progress the project further, and as safety was considered to be a factor, Essex County Council and Network Rail agreed that the Council should make a Rail Crossing Extinguishment Order under section 118A of the Highways Act 1980, which would have the effect of closing the crossing completely.

97 Network Rail made an application to Essex County Council for an Extinguishment Order on 17 November 2011. There were seven objections outstanding when the Council submitted the Order to the Secretary of State for Environment, Food and Rural Affairs for confirmation. Because of these objections, it was necessary for the Order to be considered by the Planning Inspectorate.

98 The Planning Inspector considered the proposed order, and, in a decision dated 24 August 2012, refused to confirm it. The project to replace the crossing with a bridge was then delayed while Network Rail considered what to do next. On 24 January 2013, while the matter was still being discussed, the accident to the cyclist occurred.

99 The planning inspector gave reasons for this decision, which included the following:

> *The Order, if confirmed, would result in the permanent closure of the crossing to all pedestrians and cyclists for a long time and perhaps indefinitely. Network Rail counter this by stating that they have no intention of closing the crossing to pedestrians and cyclists, other than when necessary to construct the bridge at some unidentified point in the future. This is in direct conflict with the statement in their application which provides that, assuming the Order is confirmed, appropriate steps would be taken to securely fence off the access to the crossing at each side, and signing would be erected in accordance with the requirements of the highway authority.*
>
> *Network Rail has indicated that it would accept a modification to the Order to show that it would not come into effect until the bridge has been built, but I do not consider that it is appropriate for me to introduce into the Order a significant alteration which has not been subject to consultation and which would, of its very nature, be vague and open-ended.*
>
> *Furthermore, if Network Rail is content to leave the crossing open until such time as it is necessary to close it for construction works, then it seems to me that it cannot be considered so unsafe as to warrant complete closure at this time.*
>
> *Thus, whilst I accept that there is an element of misuse of the crossing which presents a danger to all those involved, it is not so overwhelming as to negate the remainder of the use which is acceptably safe and adequately controlled.*
>
> *…the Order I am considering does not make any provision for an alternative crossing, by a bridge or otherwise, and the inconvenience to the public as a result of the intended stopping-up outweighs the issues of safety which have not been demonstrated to me to warrant the closure of the crossing entirely.*

100 The RAIB has concluded that the application to extinguish the bridleway rights did not succeed because the inspector considered that the application was defective, in that it proposed to extinguish a well-used right of way without a formal commitment to provide a replacement bridge, rather than because of any objections to the principle of replacing the crossing by a bridge.

101 Staff of Network Rail and Essex County Council had co-operated in preparing the application.

102 Following the accident, Network Rail decided to provide a bridleway bridge, and during 2013 it successfully applied for planning permission for a bridge from Braintree District Council. Network Rail has indicated that it proposes to apply for a temporary Traffic Regulation Order to close the route over the crossing once the bridge has been constructed (see paragraph 120), and at the same time to apply for a Rail Crossing Diversion Order to divert the route via the new bridge.

Time taken to address known risk factors at level crossings

103 In the last five years the RAIB has investigated a significant number of accidents that have occurred at level crossings where the need for improvements, or closure, had already been identified by Network Rail. These are summarised in appendix F. Given the number of such instances, the RAIB is currently examining Network Rail's past and current processes for the planning and implementation of improvement works at those level crossings where the need for further risk mitigation has been identified. This examination has the objective of identifying:

a. any factors which may extend the time taken to implement the measures for improvement that had been identified, or unreasonably impede the adoption of such measures; and

b. why suitable interim risk mitigation measures were not implemented, at crossings where the need for major improvement works has been identified.

The RAIB will publish the outcome of this examination of the factors influencing the time taken to address known risk factors at level crossings.

Discounted factors

104 The train driver's evidence indicates that at the moment the cyclist was struck he was moving briskly and was nearly clear of the train's path. He was on his way to work, and there is no evidence that he was doing anything other than using the crossing normally.

105 No earphones or headphones were recovered at the scene of the accident, and there is no evidence that the cyclist was distracted from the task of crossing the railway.

106 The cyclist was riding his bicycle over the crossing, despite the 'cyclists dismount' signs displayed on both sides. These signs, although of a recognised pattern[17], were not specified in the Level Crossing Order. They are frequently used at level crossings where railway staff have concluded that there is a hazard to cyclists from the gaps in the crossing surface where the rails run, and that it would be safer if cyclists wheeled their machines across. It is not clear that dismounting would have made any difference to the outcome in this case, as the cyclist was moving steadily over the crossing and did not fall.

Observations[18]

107 Motts Lane crossing is heavily used, but the figures that Network Rail compiled did not accurately reflect this.

108 The crossing at Motts Lane is heavily used by people going to and from the adjacent industrial area. Most of this usage is in the morning and evening peaks, between 07:00 hrs and 09:00 hrs, and 16:00 hrs and 18:00 hrs. However, accurate figures for the actual numbers involved do not appear to have been used by Network Rail in calculations of risk at the crossing. A summary of the various censuses carried out between 1999 and 2011 is in appendix C. All of them were carried out over short periods, between 40 minutes and two hours. From 2006 onwards, the assessors converted the figures obtained from the census into a daily usage by using a multiplier corresponding to 13.5 hours use per day, a figure which has been used for many years. Because the traffic at Motts Lane is concentrated into the morning and evening peaks, this type of census has resulted in significant over- or under-estimates of the actual usage, depending on whether the census took place in the peak or off-peak period.

109 When the RAIB first visited the crossing, on 25 January 2013, about 15 people used the crossing between 10:15 hrs and 12:30 hrs. During a further RAIB visit, on a weekday evening in September 2013, 56 people used the crossing between 17:00 hrs and 19:00 hrs. Based on this, and the actual figures recorded by Network Rail in the past censuses, the RAIB estimates that there are actually between 200 and 300 traverses of the crossing each day.

110 The inconsistent and inaccurate figures used by Network Rail for both the number of users and the number of trains do not appear to have affected the outcome of the processes put in place to close the crossing. However, in other circumstances this could have resulted in an inappropriate level of priority being given to mitigating the risk at the crossing.

111 The level crossing team in Network Rail's East Anglia route experienced difficulties with personnel and resources in the period from 2006 to 2009, and the resulting backlog affected the work of the team for some time afterwards. The situation is described in the RAIB's report into the collision at Sewage Works Lane level crossing, near Sudbury, on 17 August 2010 (report 14/2011). It is possible that the lack of records relating to decisions about the replacement of Motts Lane by a bridge is related to these events.

[17] Traffic Signs Regulations and General Directions 1994 (SI 1994 no 1519), diagram 966.

[18] 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.

Previous occurrences of a similar character

112 The RAIB has, since it became operational in 2005, investigated 15 previous accidents to pedestrians or cyclists at footpath and bridleway crossings. Of these, the following have factors, or resulted in recommendations, which are relevant to the accident at Motts Lane:

- At West Lodge user-worked crossing, near Haltwhistle, Northumberland, on 22 January 2008, a young person delivering coal was struck and killed by a freight train travelling at 49 mph (79 km/h). He was probably unaware of the approaching train because he did not recognise its headlights among those of vehicles on an adjacent road (RAIB report 01/2009).
- At Gipsy Lane, near Needham Market, Suffolk, on 24 August 2011, an elderly pedestrian was struck and killed by a train travelling at almost 100 mph (160 km/h). It is likely that the pedestrian misjudged the speed of the train as it approached. The accident occurred in daylight, and the crossing at Gipsy Lane was not equipped with lights. The RAIB recommended that the level crossing should be closed, but this has not yet been done (RAIB report 15/2012).
- At Johnson's footpath crossing, near Bishop's Stortford, on 28 January 2012, a young person was struck and killed by a train. The crossing was equipped with miniature stop lights and an audible alarm similar to those at Motts Lane crossing. The investigation concluded that the pedestrian may have been unaware of the warnings provided by the lights and audible alarm, or if she was aware, did not realise that a train was closely approaching. The crossing was subsequently closed and replaced by a bridge, which had been planned before the accident took place. The RAIB recommended action to improve the conspicuity of miniature stop light indications at pedestrian crossings (RAIB report 27/2012).
- At Bayles & Wylies footpath crossing, Bestwood, Nottingham, on 22 November 2008, a train struck and killed a woman and a 7-year-old child. At this crossing, a footpath crossed both a single railway track and a tram track. A tram, travelling in the same direction, had passed over the crossing about two seconds before the train. On 28 November 2012, at the same crossing, a young person was struck and killed by a tram travelling at 43 mph (70 km/h). Both of these accidents took place after dark. In the first case, the investigation concluded that, among other factors, the headlight of the train was relatively dim in relation to that of the tram, and may have made it difficult to see. In the second case the investigation concluded that the pedestrian did not respond to the warning horn sounded by the tram, and may have failed to distinguish the tram among the lights of a nearby tram stop. It is also possible that she was aware of the tram's approach, but misjudged the time available to cross in front of it.

Summary of conclusions

Immediate cause

113 The cyclist moved onto the level crossing into the path of the approaching train. (**paragraph 48**).

Causal factors

114 The causal factors were:

a. The cyclist disregarded the warnings given by the red light and audible alarm (**paragraph 51, no recommendation**).

b. The crossing had not been replaced by a bridge, despite previous plans to do so (**paragraph 91, see paragraphs 120 and 121**).

115 It is possible that the following factor was causal:

a. The cyclist may not have seen the train, or seen it and misjudged its speed and position, or assumed that it was stationary (**paragraph 84, no recommendation**).

116 It is possible that the cyclist disregarded the lights because he had become accustomed to seeing the red lights illuminated for long periods before the arrival of trains. The factors that contributed to these long periods were:

a. The crossing is designed to provide a minimum warning time of 40 seconds, which is much longer than almost all users require to cross the line (**paragraph 56, Recommendation 1**).

b. The closure time was extended by the use of the 'non-stopping' setting for trains which were due to stop at Witham, which occurred because the signallers had not received any instructions about the operation of the crossing (**paragraph 62, see paragraph 119 and Recommendation 2**).

c. The interaction of the signalling system and the automatic route setting system extended the crossing closure time for stopping trains (**paragraph 67, Recommendations 1, 3, and 4**).

Observations

117 Motts Lane crossing is heavily used, but the figures that Network Rail compiled did not accurately reflect this (**paragraph 107, see paragraph 118**).

Previous RAIB recommendations relevant to this investigation

118 The following recommendations were made by the RAIB as a result of previous investigations and address factors identified in this investigation. They are therefore not remade so as to avoid duplication:

Recommendation that is currently being implemented

Accident at Gipsy Lane footpath crossing, 24 August 2011, RAIB report 15/2012 published July 2012

Recommendation 2

Network Rail should have effective systems in place for accurate information gathering during data collection visits at level crossings. Any changes from previous data collected should be clearly understood and feedback given to the relevant person where data is incorrect. This includes data relating to … the number of crossing users where the quick census is undertaken.

The ORR reported in June 2013 that Network Rail had taken the following action in response to this recommendation:

- improved its data handling and consistency in the Anglia route; and
- appointed Level Crossing Managers with responsibility for all matters relating to crossings.

ORR is continuing to engage with Network Rail and will report further to RAIB.

Recommendation reported as implemented

Train passed over Lydney level crossing with crossing barriers raised, 23 March 2011, RAIB report 20/2011 published December 2011

Recommendation 1

Network Rail should modify procedures so that:

a. *routine reviews and updating of signal and crossing box instructions include verification, by engineering staff, that the instructions are compatible with the equipment provided;*

b. *there is clear guidance on the information to be contained in all box instructions;*

c. *training material is reviewed and updated as necessary, concurrently with the associated box instructions; and*

d. *reviews of box instructions and associated training material should be subject to checking, at least on a sample basis.*

ORR reported in December 2012 that this recommendation had been implemented by Network Rail.

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

119 Immediately after the accident, on 25 January 2013, Network Rail instructed the signallers at Liverpool Street IECC to use the appropriate stopping or non-stopping signalling setting for all trains passing through Witham. Although this will not fully resolve the issue of extended warning time (paragraph 116c), it has improved the situation as an interim measure until a bridge is provided (paragraph 121).

120 Network Rail has appointed staff to its Liability Negotiation team who have suitable legal qualifications, and has changed its internal guidance on level crossing closure processes to address the problems that were encountered with the initial application to extinguish the bridleway rights at Motts Lane (paragraph 114b).

121 Network Rail plans to close Motts Lane crossing and replace it with a bridleway bridge. Planning permission has been obtained and preliminary site works have begun, with the bridge due to be installed over the Christmas shutdown in December 2013 (paragraph 114b).

Recommendations

122 The following recommendations are made[19]:

1 *The intention of this recommendation is to reduce the risk created by long waiting times by taking action at other locations where this situation may exist.*

Network Rail should, as soon as possible, review all automatic level crossings (including AHB, ABCL, AOCL and MSL crossings) to identify locations where complex track and signalling layouts, nearby stations and/or railway operations may lead to the red road/pedestrian lights showing for an excessively long time. At each location that is identified, Network Rail should assess the risk from extended closure times, and take action to manage this risk as necessary (paragraph 116a).

2 *The intention of this recommendation is to reduce the risk that local signalling practices may lead to unnecessarily long waiting times at level crossings.*

Network Rail should determine, in the light of the risk that arose from the indiscriminate use of the non-stopping setting at Liverpool Street IECC, whether there are any other locations where local instructions/practices may be at risk of introducing unnecessarily long waiting times at automatic crossings, and take appropriate action to correct the situation (paragraph 116b).

3 *The intention of this recommendation is to reduce the risk that may be created by the interaction of ARS with the controls for level crossings, by reviewing the principles which define the design of such systems.*

Network Rail should review its processes for designing and implementing ARS where it interacts with level crossing controls, and amend or enhance them as necessary to produce assurance that the design will result in the crossing operating in accordance with relevant standards and guidance (paragraph 116c).

continued

[19] 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 intention of this recommendation is to improve the control of risk by establishing appropriate maximum times that red lights should show for, and taking the red light times into account at regular reviews of the safety of level crossings.*

Network Rail should establish, by carrying out research or otherwise, appropriate maximum time(s) for red lights to be designed to be shown at MSL crossings, and acceptable levels of variability for this time (taking into account factors such as the types of train, and stopping patterns), in view of the risk that users may become intolerant of extended waiting times. Taking account of the results of this work, it should modify its risk management processes for MSL crossings to include consideration of the length of time that the red lights show (paragraph 116c).

Appendices

Appendix A - Glossary of abbreviations and acronyms

ALCRM	All level crossing risk model
ARS	Automatic route setting
IECC	Integrated Electronic Control Centre
LXRMTK	Level crossing risk management toolkit
MSL	Miniature stop lights
OLE	Overhead line equipment
ORR	Office of Rail Regulation
RSPG	Railway Safety Principles and Guidance
SSI	Solid state interlocking

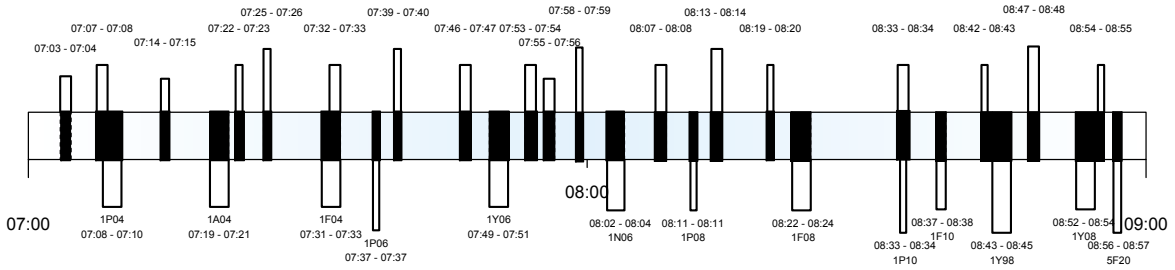
Appendix B - Glossary of terms

Automatic route setting	A system which uses software, with the current timetable programmed into it, to route trains through an interlocking area.
Bridleway	A bridleway allows use by people on foot, on horses, and on bicycles. This includes normal accompaniments such as pushchairs, wheelchairs and mobility scooters.
Control tables	Control tables are used in railway signal engineering to define the conditions required for signals to display a proceed aspect (ie other than red), and all the associated controls for points, level crossings and other equipment.
Down	The direction of trains travelling away from London.
Integrated Electronic Control Centre	A signal box controlling a very large area of railway in which signallers use visual display units to control the movement of points and associated signal aspects.
Level crossing Order	An order made under the Level Crossings Act 1983 specifying in detail the method of operation and control of a level crossing.
Solid state interlocking	A microprocessor based Signalling System using two-out-of-three voting to perform the train detection, Interlocking and control functions.
Track circuit	A track circuit is an electric or electronic device used to detect the absence of a train from a defined section of track, by using the rails as part of a circuit. A train passing over this section will short out the circuit, and thereby its position is identified by the signalling system.
Treadle	An electromechanical device, actuated by the wheel of a rail vehicle, used to indicate to the signalling system that a train has passed a certain point.

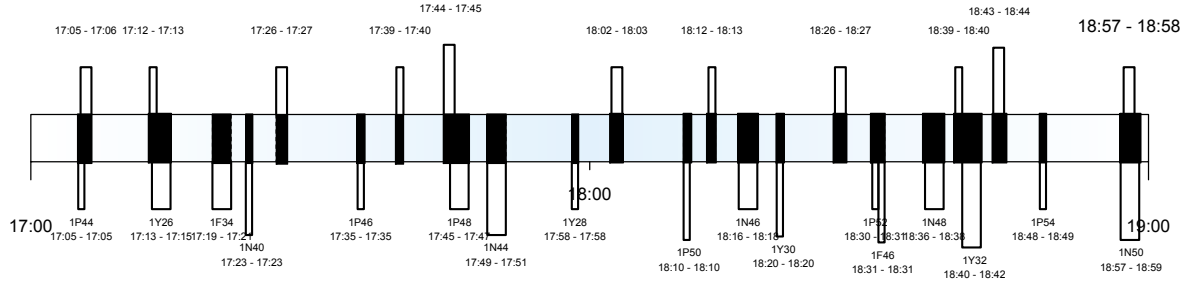
Appendix C - Summary of level crossing usage censuses and ALCRM results

Date	Census times	Users	Calculated daily use	Number of trains	Calculated risk ranking
09.06.1999	0730-0930	45			
03.12.2003	? (30 mins)	2			
14.04.2005	? (30 mins)	12			
01.12.2006	0930-1000	27	675		
15.06.2007	1215-1330	3	675 (data from 01.12.06 used)	54	C2
10.05.2010	1000-1100	7	95	306	B1
01.09.2011	0930-1010	35	668	277	C1
03.12.2012	0910-0940	12	668 (should be 324)	285	C1

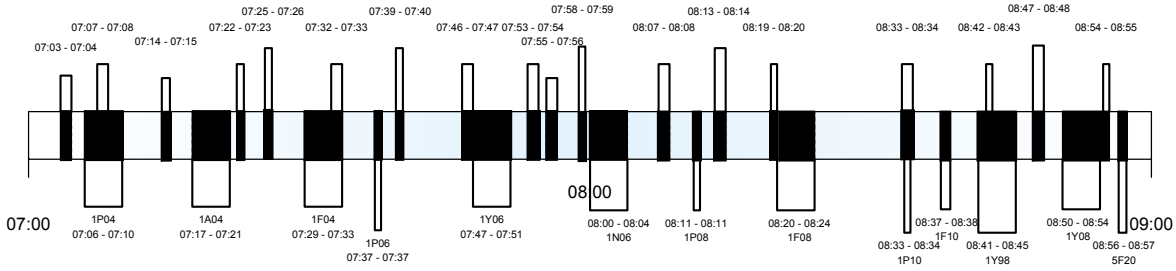
Appendix D - Level crossing closure periods



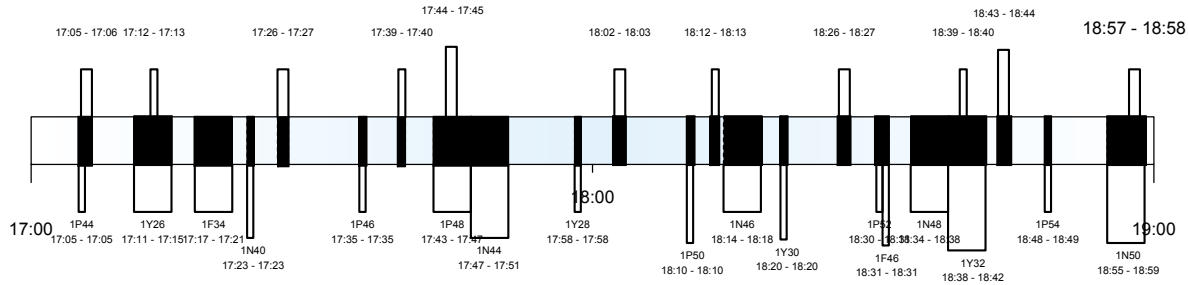
Motts Lane Crossing closure times – morning peak



Motts Lane Crossing closure times – evening peak



Motts Lane crossing closure periods – morning peak using non-stop setting



Motts Lane crossing closure periods – evening peak using non-stop setting

Appendix E - Operational sequences

Simulation of sequence for **stopping** trains using ARS-generated routes:

- Crossing lights at Green. 761B(M), 769B(M), 781A(M) routes Normal.
- ARS selected and 761B(M) route set. 761 aspect clears to Yellow.
- Train strikes in and occupies LLU track – crossing not called.
- Train proceeds through route and occupies LLY track.
- ARS selected (*1) and 769B(M) route set. Aspect clears to Yellow.
- ARS selected and 781A(M) route set.
- ***Crossing lights called to Red incorrectly, overriding 75 second timer for trains stopping at Witham Station.***
- 781 aspect clears to Yellow (or other appropriate proceed aspect depending on aspect sequence ahead) approximately 30 seconds later – this relates to signal regulation time of 33 seconds applied to 781 signal.

(*1) – ARS has crossing delay rule that requires LLY track occupied before setting 769B(M) route.

Simulation of sequence for **stopping** trains using Signaller-operated routes
(Routes set before LLY track occupied):

- Crossing lights at Green. 761B(M), 769B(M), 781A(M) routes Normal.
- Signaller sets 761B(M) route. 761 aspect clears to Yellow.
- Signaller sets 769B(M) and 781A(M) routes.
- 781 aspect clears to Yellow.
- Train strikes in and occupies LLU track – crossing not called.
- Train proceeds through route and occupies LLY track.
- **Crossing lights called to Red correctly, approximately 75 seconds after LLY track occupied.**
- 769 aspect clears to Double Yellow approximately 10 seconds after crossing called - this relates to signal regulation time of 11 seconds applied to 769 signal.

Appendix F - Summary of level crossing accidents where the need for improvements or closure had already been identified by Network Rail

Accident	Date of accident	RAIB report	Nature of risk factor	Improvement identified	When identified
Fatal accident at Moor Lane (footpath crossing)	16/04/08	27/2008	Slippery surface	Non-slip surface	Feb 2005
Fatal accident at West Lodge (user worked crossing)	22/01/08	01/2009	Poor sighting of trains	Whistle boards or improved signage	1991, 2005, 2007
Fatal accident at Johnson's (footpath crossing with miniature stop lights)	28/01/12	27/2012	High usage in urban environment	Closure	2000, 2007/8
Fatal accident at Beech Hill (automatic half-barrier crossing)	04/12/12	17/2013	Effect of sunlight on conspicuity of lights	Brighter lights (based on light emitting diode technology)	July 2011
Passenger injured at Thorne South (station pedestrian crossing)	08/01/13	Preliminary Examination	Second train, high usage at station	Closure	1993, 2007 and 2012
Fatal accident at Motts Lane (footpath crossing with miniature stop lights)	24/01/13	01/2014	High level of misuse, high usage in urban environment	Closure	2003, 2009
Fatal accident at Barratt's Lane (footpath crossing)	26/10/13	Ongoing	Poor sighting of trains	Closure	Nov 2011

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