RAIB

Rail Accident Investigation Branch

Rail Accident Report

Fatal accident at Grimston Lane footpath crossing, Suffolk
23 February 2016

Report 23/2016
November 2016

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.

Preface

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. 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.

The RAIB's findings are based on its own evaluation of the evidence that was available at the time of the investigation and are intended to explain what happened, and why, in a fair and unbiased manner.

Where the RAIB has described a factor as being linked to cause and the term is unqualified, this means that the RAIB has satisfied itself that the evidence supports both the presence of the factor and its direct relevance to the causation of the accident. However, where the RAIB is less confident about the existence of a factor, or its role in the causation of the accident, the RAIB will qualify its findings by use of the words 'probable' or 'possible', as appropriate. Where there is more than one potential explanation the RAIB may describe one factor as being 'more' or 'less' likely than the other.

In some cases factors are described as 'underlying'. Such factors are also relevant to the causation of the accident but are associated with the underlying management arrangements or organisational issues (such as working culture). Where necessary, the words 'probable' or 'possible' can also be used to qualify 'underlying factor'.

Use of the word 'probable' means that, although it is considered highly likely that the factor applied, some small element of uncertainty remains. Use of the word 'possible' means that, although there is some evidence that supports this factor, there remains a more significant degree of uncertainty.

An 'observation' is a safety issue discovered as part of the investigation that is not considered to be causal or underlying to the event being investigated, but does deserve scrutiny because of a perceived potential for safety learning.

The above terms are intended to assist readers' interpretation of the report, and to provide suitable explanations where uncertainty remains. The report should therefore be interpreted as the view of the RAIB, expressed with the sole purpose of improving railway safety.

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.

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Fatal accident at Grimston Lane footpath crossing, Suffolk, 23 February 2016

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Summary

At 12:19 hrs on Tuesday 23 February 2016, a pedestrian, Mr Stanley Sawyer, was struck and fatally injured by a train on Grimston Lane footpath level crossing in Trimley St Martin, Suffolk.

The train was travelling from Ipswich to Felixstowe. The driver sounded the train's warning horn soon after first seeing the pedestrian. The pedestrian raised his arm in apparent acknowledgment of the horn and continued to cross in front of the train.

It is not possible to be certain why the pedestrian started to cross the railway when he had insufficient time to do so. The RAIB has concluded that he was either unaware of the train at the time he decided to cross, or that he misjudged the time he needed.

He may have been unaware of the train because he did not look, possibly as a result of the skewed alignment of the crossing. On the other hand, it is possible that he was not in the best position to see the train when he made his decision to cross.

He may have misjudged the time he needed because he overestimated the time it would take for the train to arrive at the crossing, or he underestimated how long it would take him to cross.

The age and health of the pedestrian meant that he fell into the category of people considered, by Network Rail's guidance, to be 'vulnerable users'. Network Rail's assessment of the user group for the crossing did not identify the need to make an additional time allowance for vulnerable users at the crossing. However, as the sighting time for approaching trains was sufficient even if such an allowance had been made, this was not causal to the accident.

The RAIB has made two recommendations to Network Rail. One relates to the importance of understanding and managing the effects of skewed alignment on the use of level crossings. The second relates to reducing the risk to vulnerable level crossing users in an expedient manner, as it upgrades passive crossings.

Additionally, the RAIB identified a learning point relating to the implementation of findings from recent RSSB research into encouraging pedestrians to make better crossing decisions.

Introduction

Key definitions

1 Metric units are used in this report, except when it is normal railway practice to give speeds and locations in imperial units. Where appropriate the equivalent metric value is also given.

2 All mileages in the report are measured from a datum at Liverpool Street station, London.

3 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. Sources of evidence used in the investigation are listed in appendix C.

The accident

Summary of the accident

4 At 12:19 hrs on Tuesday 23 February 2016, passenger train 2R14[1], the 11:58 hrs service from Ipswich to Felixstowe, struck and fatally injured a pedestrian on Grimston Lane footpath crossing in Trimley St Martin, Suffolk (figure 1).

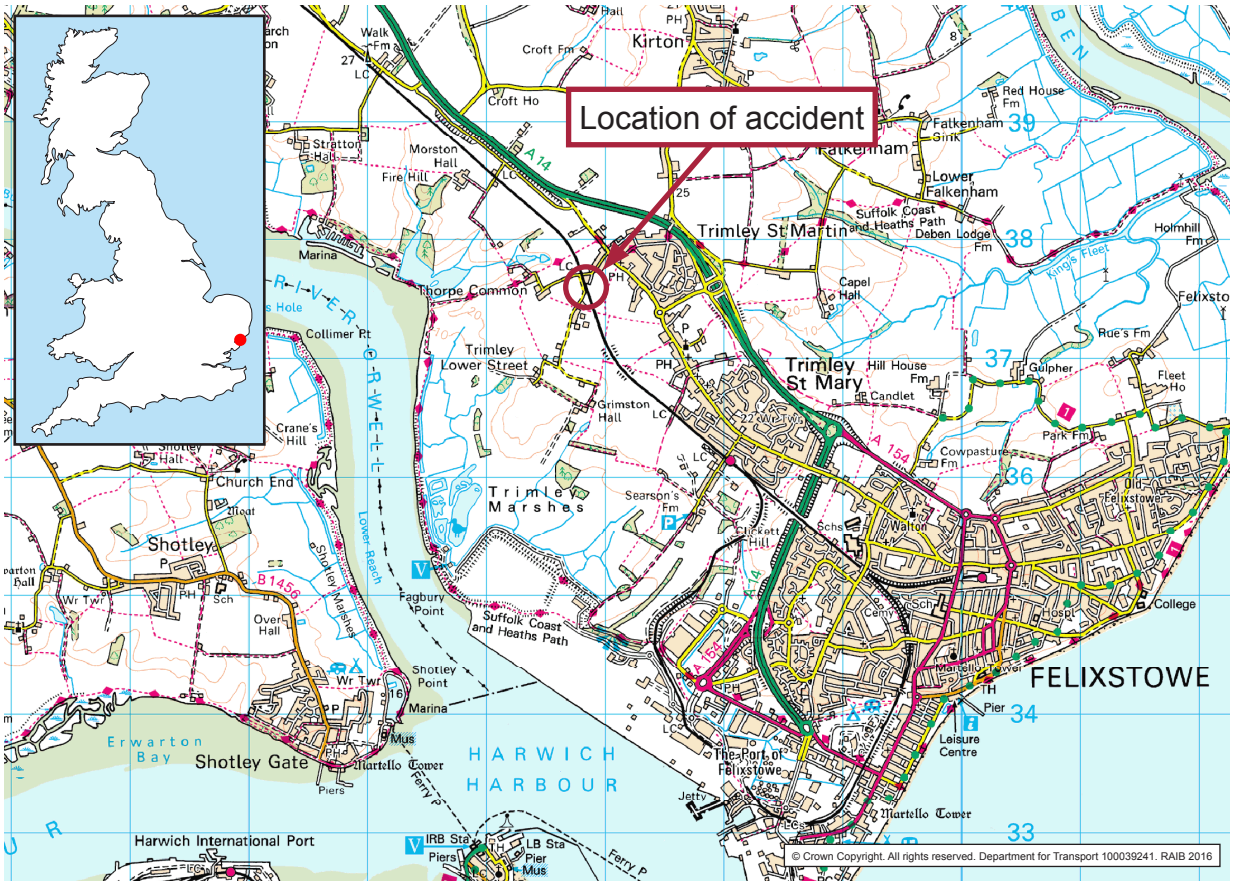

Figure 1: Extract from Ordnance Survey map showing location of accident

Context

Location

5 Grimston Lane footpath crossing is on the Felixstowe branch line, which runs approximately south-east from Westerfield Junction (72 miles 23 chains), in Ipswich, to Felixstowe Town station (84 miles 30 chains). The level crossing is located at 81 miles 48 chains between the intermediate stations of Derby Road (74 mile 67 chains) and Trimley (82 miles 64 chains). The branch line is single track, with a loop at Derby Road to allow trains to pass. Two junctions on the branch line serve container freight terminals in the Port of Felixstowe. Trains travel in the up direction towards Ipswich (via Westerfield Junction), and in the down direction towards Felixstowe Town and the port.

[1] An alphanumeric code, known as the 'train reporting number', is allocated to every train operating on Network Rail's infrastructure.

6 There are a number of other level crossings near Grimston Lane footpath crossing. In the up direction, Thorpe Lane public road level crossing, an *automatic half barrier crossing*, is 133 metres away, and another footpath crossing, Thorpe Grove, is 338 metres away. In the down direction, there are two footpath crossings. Trimley is 206 metres away and St Martin is 475 metres away. Further away are two *user worked crossings*, Gun Lane and Keeper's Lane. There are 14 level crossings altogether on the branch line.

7 A mixture of passenger and freight trains use the branch line; the majority being freight trains. In the vicinity of Grimston Lane there is a permanent speed restriction of 60 mph (97 km/h) for freight trains and 75 mph (121 km/h) for passenger trains. Signalling on the branch line is by *track circuit block*, controlled from Colchester signal box.

8 A number of schemes for converting sections of the branch line to double track have been considered over the last decade. This would increase the line's capacity to allow more freight trains to access the port. Some are still being considered, and may ultimately result in the closure of Grimston Lane footpath crossing. However, none had been implemented at the time of the accident.

9 Figures 2 and 3 show the layout of the railway and the location of nearby level crossings.

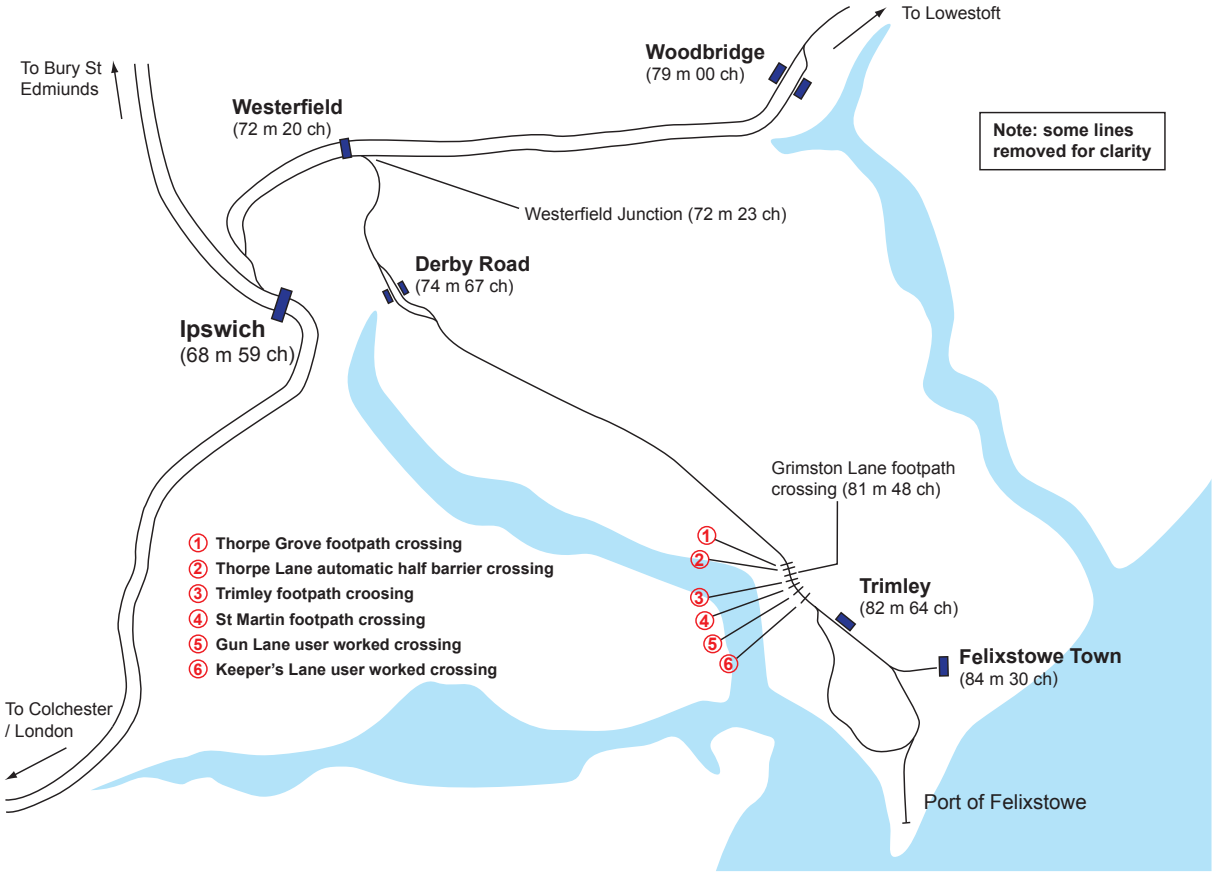

Figure 2: Layout of the railway

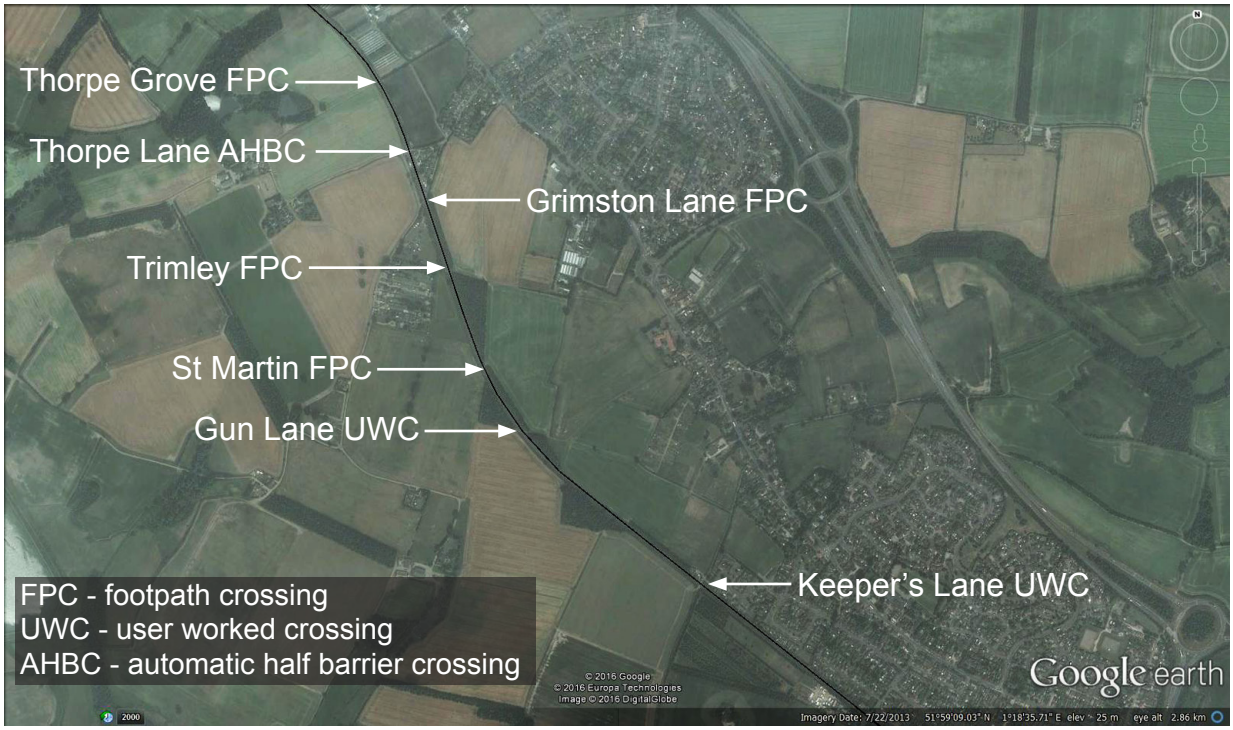

Figure 3: Location of the level crossings in the vicinity of Grimston Lane

Organisations involved

10 Network Rail owns, operates and maintains the railway infrastructure where the accident occurred as part of its Anglia Route. It also employed the staff responsible for gathering data about the crossing, and for assessing and managing its safe use.

11 Abellio Greater Anglia operated train 2R14 and employed its driver.

12 Network Rail and Abellio Greater Anglia freely co-operated with the investigation.

Train involved

13 Train 2R14 was formed of a single-car Class 153 *diesel multiple unit*, number 153309.

14 Photographs taken shortly after the accident show that, on the front of the train, the lights were working and there was no obvious degradation of the yellow-coloured areas provided to improve conspicuity (figure 4). Post-accident inspection and testing by Abellio Greater Anglia recorded nothing untoward with the brakes, warning horn operation, or the windscreen wiper and washer.

15 The RAIB found no evidence that the condition of the train, or the way it was driven, contributed to the cause of the accident.

Figure 4: Photograph of train 2R14 taken at 13:49 hrs on 23 February 2016 (image courtesy of Network Rail)

Level crossing

16 The original level crossings at Grimston Lane and Thorpe Lane were both road crossings and were constructed to allow continued highway access to agricultural land west of the village of Trimley St Martin. In 1959, permission[2] was granted to close the crossing at Grimston Lane to road vehicles and build a new link road so that vehicle users could access the part of Grimston Lane on the west side of the railway after first crossing at Thorpe Lane. Grimston Lane level crossing was to remain open to pedestrians.

17 Figure 5 shows the general layout of Grimston Lane footpath crossing at the time of the accident. The single line railway at this location runs approximately north to south in a relatively wide strip of railway land. Self-closing wooden wicket gates at the railway boundary provide access to an open lineside and broken-edged tarmac footpaths leading to a level timber *crossing deck*. The paths and the crossing deck broadly follow the original line of Grimston Lane, which crossed the railway on a skewed alignment. Inside the railway boundary, signs instruct users to stop, look and listen and beware of trains. The pedestrian was crossing the railway from the east. Figure 6 shows the key features when approaching in this direction.

18 The footpath over the level crossing is recorded on the local *definitive map* as a public right of way. It is designated as 'FP51 Trimley St Martin'.

[2] British Transport Commission Act 1959.

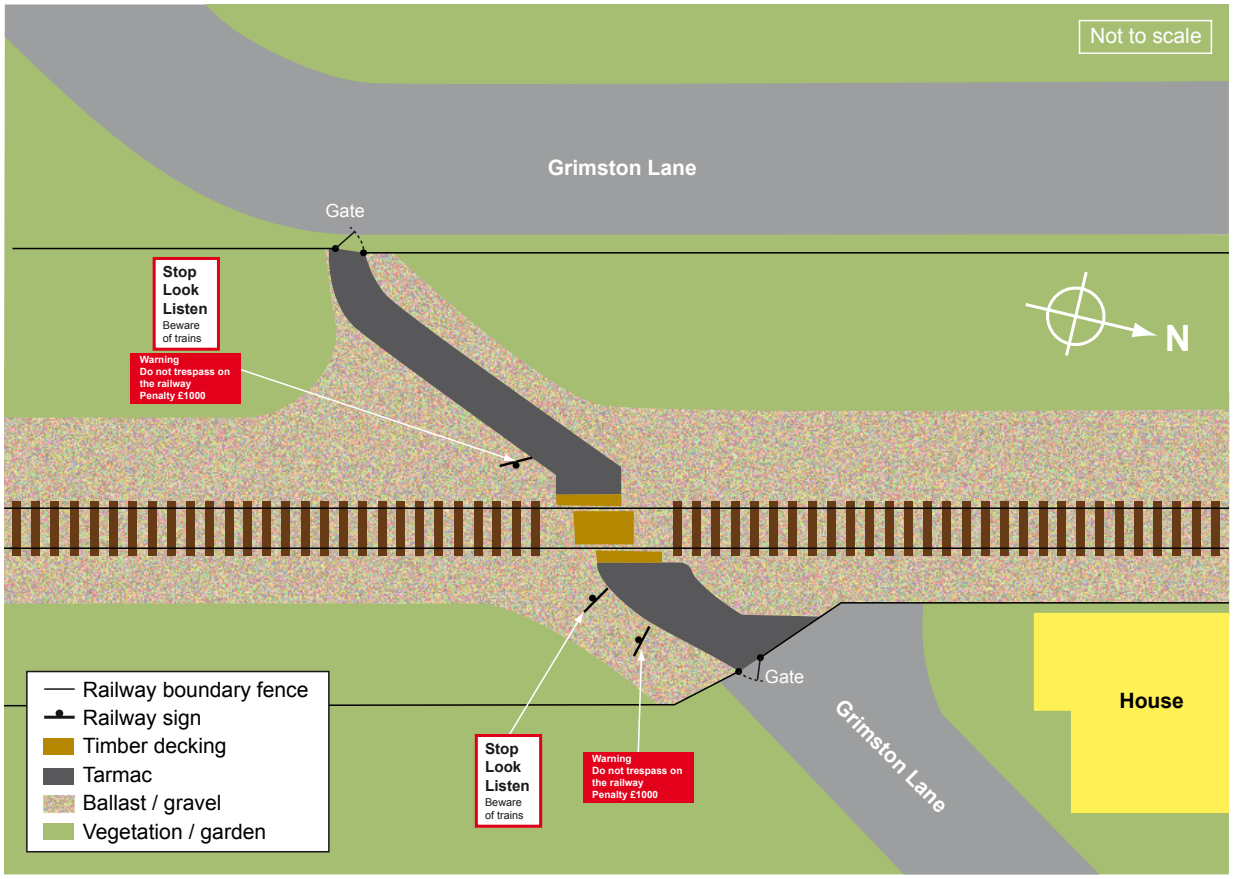

Figure 5: Layout of Grimston Lane footpath crossing

Figure 6: Key features of Grimston Lane footpath crossing when approaching from the east

The pedestrian

19 Mr Sawyer was aged 82. He was a local resident who enjoyed local walks and had been a regular user of Grimston Lane and other nearby footpath crossings for many years. He had no known significant distance vision impairment, although he had suffered some loss of hearing due to his exposure to noisy machinery when he had been at work.

20 Mr Sawyer had been diagnosed with dementia in July 2014, but this was considered mild by those who had regular contact with him. He was taking prescription drugs for the condition and continued to live independently.

21 Mr Sawyer was crossing the railway on his own. Although he sometimes used a walking stick, due to problems with his left leg following a motor cycle accident in the 1950s, he was not carrying a stick on the day of the accident.

External circumstances

22 It was daylight at the time of the accident; the sun was close to due south (facing the approaching train) and almost at its maximum altitude, 27.98°. The weather recorded at Wattisham airfield, 28 km away, was partly cloudy. This is consistent with photographs taken at the crossing shortly after the accident (figure 7). There was no fog or mist.

23 A local weather station in Trimley St Martin recorded an air temperature of 9.4°C and a north-north-westerly wind of 15 km/h. There had been no precipitation over the previous 12 hours.

24 The RAIB found no evidence that the above environmental factors contributed to the cause of the accident.

Figure 7: Photograph of the railway at Grimston Lane footpath crossing in the direction from which the train approached, taken at 13:36 hrs on 23 February 2016 (image courtesy of Network Rail)

The sequence of events

25 Train 2R14 departed from Ipswich on time at 11:58 hrs and, after being routed onto the Felixstowe Branch Line, made a scheduled stop at Derby Road. The driver was accompanied in the cab by a Network Rail supervisor who was examining the railway for track maintenance purposes. At approximately 12:07 hrs, the train running ahead, freight train 4L02, passed over Grimston Lane footpath crossing.

26 Train 2R14 departed Derby Road at 12:10 hrs and around nine minutes later started to round the curve on the approach to Thorpe Lane and Grimston Lane level crossings at 64 mph (103 km/h). At 12:19:11 hrs the train would have become visible to a pedestrian looking for trains as they approached Grimston Lane footpath crossing from the east side. It would have appeared from behind level crossing equipment and structures at Thorpe Lane automatic half barrier crossing.

27 At 12:19:16 hrs the driver sounded the train warning horn and then started to apply the emergency brake having seen the pedestrian walking over Grimston Lane footpath crossing from the left-hand (east) side. He and the supervisor both stated that the pedestrian appeared to acknowledge the horn by raising an arm, but then continued walking across. By this time the train was passing Thorpe Lane level crossing. Train 2R14 reached Grimston Lane footpath crossing around five seconds later, and the front right-hand corner struck the pedestrian shortly before he would have been clear.

28 The train stopped around 380 metres after the footpath crossing and the driver called the signaller at Colchester to report the accident. The emergency services were called and attended the scene. However, the pedestrian had been fatally injured.

Key facts and analysis

Background information

Footpath crossings

29 Footpath crossings are found where the railway crosses a path on which pedestrians have a right of way. On this type of level crossing, guidance provided by the Office of Rail and Road (ORR)[3] states that 'users are expected to use reasonable vigilance to satisfy themselves that no trains are approaching before they start to cross'. They are then expected to cross quickly while remaining alert.

30 Safe use of a footpath crossing depends on users having sufficient time to reach a position of safety on the opposite side of the railway. Therefore, the time from when the user first becomes aware of an approaching train until the time it arrives at the level crossing (the warning time) needs to be greater than the time required by users to cross (the traverse time[4]).

31 The warning time needs to account for the maximum permitted speed of trains approaching the crossing. Where the warning time is found to be insufficient, for instance because the distance at which approaching trains can first be seen (the sighting distance) is too short, additional means of warning may need to be considered. These have typically included *miniature stop lights*, audible warnings, such as a train driver's response to a whistle board (a lineside sign requiring approaching drivers to sound the train warning horn prior to the train coming into view) and telephones (for contacting the signaller or other railway control staff).

32 ORR's guidance refers to the need to 'take account of the mobility of likely users and the crossing surface' when determining the required traverse time.

33 It is not a fundamental requirement for the safe operation of level crossings such as Grimston Lane footpath crossing that train drivers should be aware of, and react to, the presence of pedestrians. Level crossings where users are expected to be vigilant and satisfy themselves that no trains are approaching before they start to cross are commonly referred to as passive crossings (that is, the crossing is not provided with equipment to warn users of approaching trains).

Routine level crossing management

34 Network Rail manages its responsibilities for the safety of footpath crossings in accordance with wider arrangements for the routine management of level crossings. Two key processes are involved:

- Level crossing risk assessment: regularly assessing the risks associated with collisions (and other incidents) on operational level crossings and identifying and implementing necessary control measures.
- Level crossing asset inspection and defect rectification: regularly inspecting operational level crossings, identifying defects and managing their rectification.

[3] Level Crossings: A guide for managers, designers and operators. Railway Safety Publication 7, December 2011.

[4] Also referred to as the crossing time.

Risk assessment

35 Network Rail's current process for level crossing risk assessment is described in procedure 5-16 of its *operations manual*, 'Risk assessing level crossings'[5], and referenced guidance documents. It includes:

- a periodic site visit to each level crossing to collect data relating to its condition, environment and use;
- using the collected data and the algorithms in Network Rail's *all level crossings risk model* (ALCRM) to quantitatively model the risk and calculate an *ALCRM risk score*;
- investigating different risk control options to make the crossing safer; Network Rail refers to this as optioneering, and it involves the use of quantitative (ALCRM risk score, and cost benefit analysis) and qualitative (for instance, expert judgement) assessment to identify and recommend level crossing improvements;
- completing a narrative risk assessment report describing the identified risks and their management, supporting information and the risk control options selected; and
- arrangements for managing and implementing selected risk control options.

36 The frequency of risk assessments largely depends on the crossing's ALCRM risk score; the higher the score the more frequent the risk assessment. Risk assessments are also required in the event of other triggers, for instance an accident, a near miss or a proposed operating or design change.

37 For footpath crossings, the risk assessment includes consideration of the sighting and speed of approaching trains (so the warning time can be evaluated), and of the traverse time. It also includes the need to complete a census of those using the crossing. This is relevant to the traverse time as Network Rail uses the information to help decide if an allowance needs be made to cater for users likely to take an extended time to cross. Network Rail refers to these (and those that might be at a greater risk of harm) as vulnerable users.

38 Network Rail provides guidance on managing the risks associated with vulnerable users. This states factors such as mobility limitations, visual impairment, cognitive ability and being encumbered (eg with dogs or cycles) as reasons for them being at greater risk. It lists seven potential groups: people with disabilities (physical and/or mental); young children (unaccompanied or in groups); elderly people; dog walkers; cyclists; people with push chairs, or carrying heavy bags or large objects; and non-English speakers.

39 The guidance states that, while not absolute, the decision for applying an extra time allowance for vulnerable users should be based on census data and should demonstrate that there is a 'higher than average number' of such users[6]. It further explains that it is 'reasonable to consider' that the allowance would always be applied if three in five users, or more, could be classed as vulnerable; and not typically applied if only one in five were. If two in five users are considered vulnerable, it states that a risk-based decision should be made. This criterion was developed in response to an RAIB recommendation (paragraph 98).

[5] Issue 3, published 6 December 2014 for compliance on 7 March 2015.

[6] Or that there is a strong alternative case to apply the allowance.

40 Network Rail's standard allowance for vulnerable users is to increase the calculated traverse time of a non-vulnerable user by 50%. While Network Rail had no record of the origin of the allowance, it advised that the value had been used for a number of years.

Asset inspection

41 Network Rail's current process for level crossing asset inspection is described in its standard NR/L2/SIG/19608, 'Level crossing asset inspection and implementation of minimum action codes'[7]. This requires that level crossings are inspected regularly with the aim of identifying defects and arranging rectification.

42 Inspections of footpath crossings mainly focus on the condition of the level crossing signage, fences, gates and walking surfaces. However, the inspections also include an assessment of the adequacy of the sighting and the need to remedy any deficiency, for instance clearing vegetation.

43 A table in NR/L2/SIG/19608 lists the action required for different types of defects and the timescale for rectification.

Organisational arrangements

44 In 2013, Network Rail introduced the new role of level crossing manager (LCM) on its Anglia Route as part of a nationwide initiative. There are currently 13 LCMs on the route, each with a number of allocated level crossings. They are organised into two teams, each reporting to a route level crossing manager (RLCM). The LCM responsible for the Grimston Lane footpath crossing reports to the RLCM for Great Eastern and Thameside.

45 Network Rail explained that one of the key motivations for introducing the LCM role was so that a single suitably-qualified specialist was regularly visiting the level crossings within an area and developing a detailed understanding of the issues to be managed[8].

46 Previously, specialist risk co-ordinators completed ALCRM risk assessments, using data collected on level crossing visits by mobile operations managers, and level crossing asset inspections were carried out by the local off-track maintenance teams. Now, all these tasks are carried out by the LCM, who then co-ordinates with the relevant maintenance team and investment authority regarding rectification and improvement work.

[7] Issue 7, published 27 May 2014 for compliance on 6 September 2014.

[8] Recommendation 5 of the RAIB's investigation of the level crossing accident at Sewage Works Lane, near Sudbury, Suffolk, 17 August 2010, relates to this change (RAIB report 14/2011).

Grimston Lane footpath crossing – routine management

Risk assessment

47 The last risk assessment, dated 15 April 2015, was the first to be completed as a narrative risk assessment (paragraph 35). It found that the sighting of up and down trains was compliant from both sides of the railway[9]. At the side from which the pedestrian was crossing, a sighting distance of 303 metres was recorded for down trains (the direction train 2R14 was travelling). This is equivalent to a warning time of 9 seconds, which is significantly more than the calculated traverse time, 5.1 seconds[10]. Furthermore, while the traverse distance on which the calculation was based did not fully account for a diagonal path that followed the skewed alignment of the crossing deck, the corresponding effect on traverse time was not found to be significant and would not result in the sighting becoming non-compliant[11].

48 Network Rail set up a motion-triggered camera at the crossing to undertake a six-day user census[12]. From this, it concluded that, on average, 17 pedestrians use the crossing each day and that there was not a high proportion of vulnerable users. As a result, the LCM did not extend the calculated traverse time. The RAIB reviewed the images from the camera and estimated that, based on definitions in Network Rail's guidance (paragraph 38), around two in five users could be considered vulnerable. This suggested that the decision was not incompatible with Network Rail's guidance (paragraph 39).

49 Four risk control options were evaluated as part of the supporting optioneering exercise:

- crossing closure and diversion to the nearby Thorpe Lane road level crossing;
- replacing the skewed timber crossing deck with a straight rubber crossing deck, and fencing the approach paths (from the wicket gates on the railway boundary)
- installing current standard miniature stop lights; and
- installing a new lower-cost version of miniature stop lights, known as *overlay miniature stop lights*.

All of these were considered to be long term improvements. Only crossing closure (and diversion) showed a numerical cost benefit. The LCM concluded in the narrative that, if this was not possible, the second option of straightening the crossing deck would 'remove bad habits of not crossing directly' (suggesting that he felt it would encourage users to cross by the shortest path).

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[9] In that they could be seen for longer than the calculated traverse time (paragraphs 30 and 31).

[10] The narrative report recorded a traverse time of 5.1 seconds and a traverse length of 5.8 metres. This is equivalent to a traverse speed of 1.13 m/s, and consistent with the walking speed typically used for normal able-bodied pedestrians.

[11] Crossing at an angle of 33° (paragraph 62) would extend the traverse distance used in the last risk assessment from 5.8 metres (footnote 10) to 6.7 metres. The corresponding increase in traverse time would only be marginal, 0.8 seconds.

[12] Between 14 April and 20 April 2015.

50 Network Rail's LCM explained that investment approval is required to progress a risk control option and that, at the time of the accident, none relating to Grimston Lane crossing had been tabled at the meeting that decides this. The LCM explained that routine risk assessments had shown that the sighting was sufficient and that there were other crossings that he felt were a higher priority. The risk assessment on 15 April 2015 gave Grimston Lane crossing an ALCRM risk score of C5[13]. Nearly 20% of footpath crossings on the Anglia Route have a risk score higher than this.

51 The RAIB obtained records of additional risk assessments of Grimston Lane footpath crossing dating back to October 1999. All of these recorded sighting distances that, on their own, yielded warning times compliant with ORR guidance (footnote 3) in that they exceeded the traverse time. No whistle boards or other additional means of warning were provided (paragraph 31). None of these risk assessments identified the need to make allowance for vulnerable users.

Asset inspection

52 The RAIB obtained level crossing asset inspection records for the two years prior to the accident. They showed inspections were being carried out in accordance with intervals prescribed in NR/L2/SIG/19608.

53 In an inspection on 27 January 2014, the LCM identified improvement work similar to the second risk control option evaluated in the last risk assessment (paragraph 49): replacing the skewed timber crossing deck with a straight rubber crossing deck, and installing fencing on the approach paths. The work was given a required completion of 28 July 2015. Network Rail advised that a number of similar work proposals had been raised for crossings in the area at the time and it was subsequently decided to re-prioritise the replacement work at Grimston Lane on the basis that the existing timber crossing deck was in a satisfactory condition. The proposed improvement work remained outstanding at the time of the accident.

54 None of the inspection records identified any adverse issues with the sighting at the crossing or other relevant concerns or defects. No other identified improvement work was outstanding at the time of the accident.

Identification of the immediate cause

55 **The pedestrian started to cross the railway at Grimston Lane footpath crossing when there was insufficient time for him to get to a position of safety on the opposite side before train 2R14 passed over.**

56 The witness evidence of both the driver and the track supervisor in the cab is that the pedestrian continued crossing after he had appeared to acknowledge the train warning horn, and that he very nearly managed to get clear of the path of the train before he was struck (paragraph 27).

[13] The ALCRM risk score is made up of two parts, a letter representing the individual risk and a number representing the collective risk. The individual risk is an estimate of the risk to a notional crossing user. The collective risk is an estimate of the total risk generated for all crossing users and the occupants of trains.

Identification of causal factors

57 It is probable that the accident occurred due to one of the following:

a. the pedestrian was unaware that train 2R14 was approaching when he decided to cross the railway (paragraph 59); or

b. the pedestrian misjudged the time he needed to cross the railway (paragraph 72).

Factors not considered as causal

58 The RAIB found nothing to indicate that the following occurred or played a part in the accident. As such it has concluded that:

- The pedestrian did not misjudge the speed of passenger train 2R14, thinking it was approaching at a similar speed to a freight train, which are more common. Train 2R14 was travelling towards the crossing at around 64 mph (103 km/h), which is not significantly higher than the speed at which freight trains were permitted to travel (paragraphs 7 and 26).
- The pedestrian did not become physically impeded as he crossed. The crossing deck was level and in good condition and he was not crossing with a walking stick (paragraph 21) that might have become trapped.
- There was no lack of instruction on how to use the crossing. Standard signage was provided at the crossing reminding users to be vigilant and aware of trains (paragraphs 17 and 29; and figures 5 and 6).
- It is unlikely that the pedestrian believed that he knew the traffic pattern well enough to not consider looking to see if a train was coming. Trains frequently pass over the crossing and, given the nature of freight traffic, at irregular intervals.
- There was no evidence that fog, mist or sunlight were likely to have affected the pedestrian's view of the approaching train (paragraphs 22 to 24).
- The pedestrian had no known significant distance vision impairment (paragraph 19) that may have explained him not noticing the approaching train.
- The pedestrian's hearing impairment (paragraph 19) did not affect his safe use of the crossing because he was not required to hear a warning from an approaching train (paragraph 51). Furthermore, the pedestrian's apparent acknowledgement suggests that he had heard the train warning horn (paragraph 27).
- Changes to the lineside equipment, structures or vegetation since the last risk assessment had not compromised the pedestrian's view of the approaching train. Figure 8 shows photographs of the view taken for the last risk assessment (on 20 April 2015) and the view after the accident (on 23 February 2016).

Figure 8: Photographs taken from the east side of the crossing, in the direction from which the train approached, on 20 April 2015, for the last level crossing risk assessment, and 23 February 2016, after the accident (images courtesy of Network Rail)

Awareness of the approaching train

59 **It is possible that the pedestrian was not aware of the approaching train when he decided to cross the railway.**

60 As no other warning systems were provided at Grimston Lane footpath crossing (paragraph 51), the pedestrian was relying on being able to see that no train was approaching when he decided to cross. It is possible that he did not see train 2R14 because either:

a. he did not look in the direction of the approaching train (paragraph 61), or

b. he was not at the best viewing position when he looked in the direction of the approaching train (paragraph 67).

Not looking

61 **It is possible that the skew of the crossing, or another reason, resulted in the pedestrian not looking in the direction of the approaching train.**

62 Photographs showing footprints and wear patterns on the crossing deck (figure 9) indicate that users routinely follow the general skewed alignment of the crossing deck (and the tarmac approach paths to and from it) and cross the railway on a diagonal path. The RAIB estimates that a typical path would be at 33° to the direction at right angles to the track, and orientated so that users crossing from the east side naturally tend to face away from trains approaching in the down direction.

Figure 9: Evidence of footprints and wear marks on the crossing deck (images courtesy of Network Rail)

63 The visual field is a measure of the ability to see objects on the left and the right when looking straight ahead. Researchers have found that this deteriorates with age, and for a male older than 80 years is around 140° overall[14]. Other research work[15] indicates that eye rotation only enables this to be increased by around 40°, to either the left or the right. This would mean that if the pedestrian had approached the crossing on a path that was skewed around 33° it is unlikely he would have seen the train without having to move his head, or turn his body (figure 10). Furthermore, researchers considering the effects of head rotation on safe road vehicle driving[16], found that many older drivers were severely restricted in their ability to turn their head. The oldest drivers (70 years and over) had lost around a third of movement. The loss was more evident in males.

64 The optioneering reported in the last routine risk assessment included consideration of removing the crossing skew by installing a 'new straightened rubber deck' with fenced approaches (paragraph 49). This would help direct users to a sighting location where they would be encouraged to face the railway perpendicular to the track, and be able to look equally easily in both directions. They would also be encouraged to cross perpendicular to the track, and would, therefore, be using the shortest traverse distance. Although Network Rail was actively considering the need for this improvement work as a result of other management initiatives (paragraph 53), and that the narrative risk assessment report drew an overall qualitative conclusion that the improvement would be worthwhile (paragraph 49), the supporting ALCRM analysis did not calculate a significant numerical safety cost benefit or an improved risk score (paragraph 83).

65 The pedestrian may have been discouraged from looking in the direction of train 2R14 for some other reason, such as if he had been distracted by something he had seen.

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[14] Road Safety Research Report No.37, 'Older pedestrians: a critical review of the literature', Department for Transport, June 2004.

[15] Starke, S, Cooke, N, Howes, A., Morar, N, and Baber, C. Visual sampling in a road traffic management control room task. Contemporary Ergonomics and Human Factors 2015.

[16] Isler, RB, Parsonson, BS and Hansson, GJ. Age related effects of restricted movements on the useful field of view of drivers. Accident Analysis and Prevention 1997.

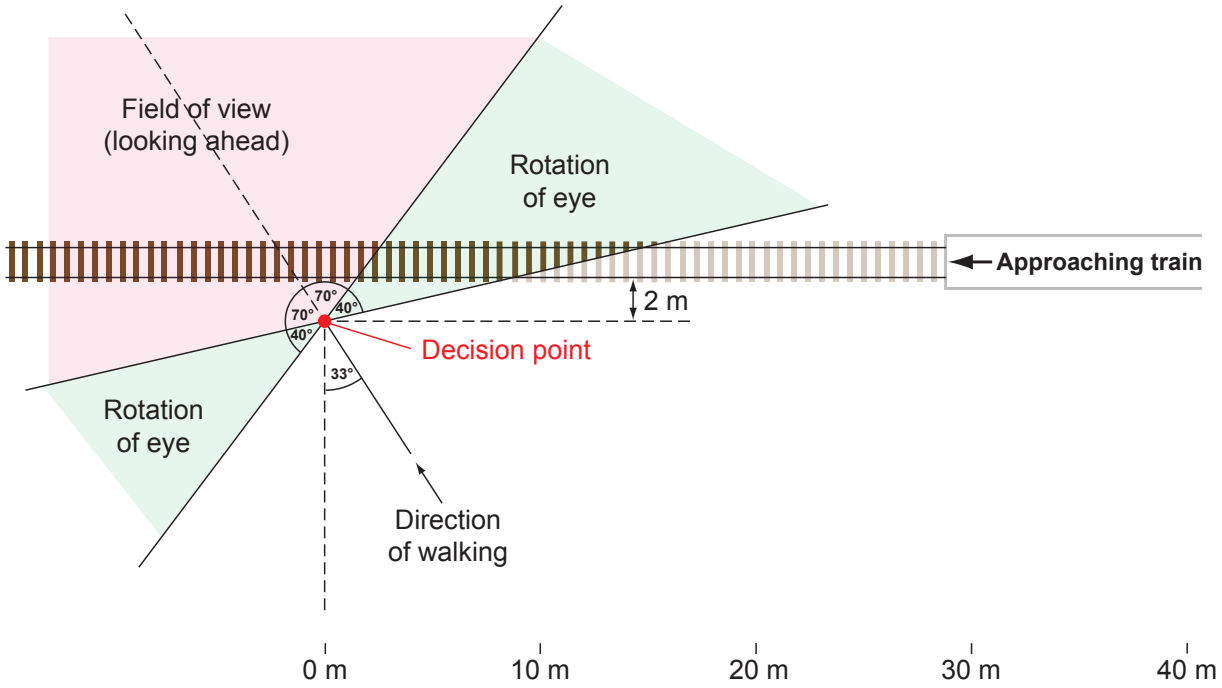

Figure 10: Estimated field of view at a decision point two metres from the track (paragraph 69) when crossing at a skew angle of 33° to the direction at right angles to the track

66 It is also possible that the pedestrian forgot or decided not to look. Eye-tracking measurements supporting research into pedestrian use of level crossings for RSSB[17] established that 16% of the users surveyed only looked for trains in one direction; 5% did not look at all[18]. Site observations supporting the same research found that 28% did not look at all, and 10% only looked when they were on, or near, the railway line, and, therefore, no longer in a position of safety.

Viewing position

67 **It is possible that when he made the decision to start to cross, the pedestrian was not at the best viewing position and the approaching train was obscured.**

68 Network Rail refers to the lineside location where a user looks and decides whether or not to cross as the decision point. In common with many other footpath crossings, the decision points at Grimston Lane crossing were not pre-defined and marked on the ground. Rather, they are positions that users select using their own judgement.

69 In its last level crossing risk assessment, Network Rail assessed the sighting distance and the traverse distance using a decision point two metres from the track[19]. This is the minimum distance permitted in ORR's guidance (paragraph 29) and the closest place to the track that is considered to be safe.

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

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

[19] Measured to the nearest running rail.

70 Trains approach Grimston Lane footpath crossing in the down direction on a right-hand curve (paragraph 26) and, on the east side of the crossing, nearby structures increasingly restrict a pedestrian's view of trains as the selected decision point moves further from the track. The RAIB made video recordings of down-direction trains approaching the crossing with cameras positioned at two metres (the decision point used in the last level crossing risk assessment) and three metres from the track. At two metres, close to the sign instructing users of the need to 'stop, look and listen' (paragraph 17), the train remains in view from when it appears, from behind level crossing equipment at Thorpe Lane, to when it reaches Grimston Lane. However, at three metres, it becomes obscured by a two-storey house shortly after appearing from behind the Thorpe Lane level crossing equipment; it only reappears when it is close to Grimston Lane footpath crossing (figure 11).

71 It is not possible to establish the pedestrian's exact location on the east side of the railway when he made the decision to cross. It is possible that he looked when he was further away from the track than the optimum two metres and, because it was temporarily hidden, he was unaware that train 2R14 was closely approaching.

Figure 11: Video images of an approaching down-direction passenger train recorded at two metres and three metres from the track, on the east side of Grimston Lane footpath crossing

Time needed to cross the railway

72 **It is possible that the pedestrian was aware that the train was approaching but he misjudged how much time he needed when he decided to cross the railway.**

73 The pedestrian often went for walks in and around Trimley St Martin and was a frequent user of the level crossings in the area (paragraph 19). Therefore, he may have seen train 2R14 and, based on previous experience, believed he had enough time to cross safely. This could have been because:

a. he misjudged how long the approaching train would take to reach the crossing (paragraph 74); and/or

b. he underestimated how long it would take him to cross the railway (paragraph 77).

Time for the train to arrive at the crossing

74 **It is possible that the pedestrian misjudged the time the approaching train would take to arrive at the crossing and, therefore, considered he had more time to cross the railway than he had.**

75 RSSB has sponsored research into behaviour at railway level crossings. This has found that, at user worked crossings, users are poor at judging the speed of trains, and increasingly underestimate speed as trains travel faster[20]. On lines similar to those at Grimston Lane footpath crossing[21], around 75% of users judged that trains were travelling slower than they were. A study for the *Health and Safety Executive*[22] on human factors issues at level crossings reported on the difficulty of estimating the speed of trains approaching almost head on.

76 The applicability of road research to railway footpath crossings needs to be carefully considered, particularly since train drivers, unlike road vehicle drivers, cannot be assumed to be able to take accommodating or evasive action (paragraph 33). However, the RAIB found evidence of studies of road crossing by older pedestrians (footnote 14) that are potentially relevant to the railway environment. This included simulation studies that found the following:

- they take longer to decide if a gap in road traffic is safe;
- they risked making inaccurate crossing judgements, and while generally more cautious, the adjustments they made did not always compensate fully for their slower walking speed;
- they are less able to simultaneously process distance and speed information and, as a result, preferred to cross in front of vehicles further away even if they were travelling at higher speeds; and
- they reported feeling their crossing decisions were safer than they really were.

[20] 'Determining the final decision point at user worked crossings', RSSB research project T269.

[21] Having permanent speed restrictions of between 60 and 80 mph.

[22] 'Level crossings, summary of findings and human factors issues', Health and Safety Executive research report 359.

Time to cross

77 It is possible that the pedestrian underestimated how long it would take him to cross over the railway.

78 Witness evidence from the driver of train 2R14 was that the pedestrian was crossing very slowly.

79 The RAIB analysed the information from the *on-train data recorder* (OTDR) to estimate the speed at which the pedestrian was crossing. With reference to figure 12, if the pedestrian had decided to cross just as (or just after) the driver had first seen him[23], and was located at a decision point two metres from the railway (paragraph 70), he would have been walking at a speed of no more than 0.7 m/s (scenario 1). However, if the pedestrian had decided to cross earlier, when he would not have seen an approaching train, but when train 2R14 was about to come into view, he would have been walking much more slowly, probably around 0.5 m/s (scenario 2). A review of studies into road crossing behaviour has observed that older pedestrians may not fully compensate for the decline in their walking speed (paragraph 76).

80 The pedestrian's reaction to the train warning horn (paragraph 27), suggests he was aware of the train at the time and either didn't feel the need, or was unable, to walk any faster.

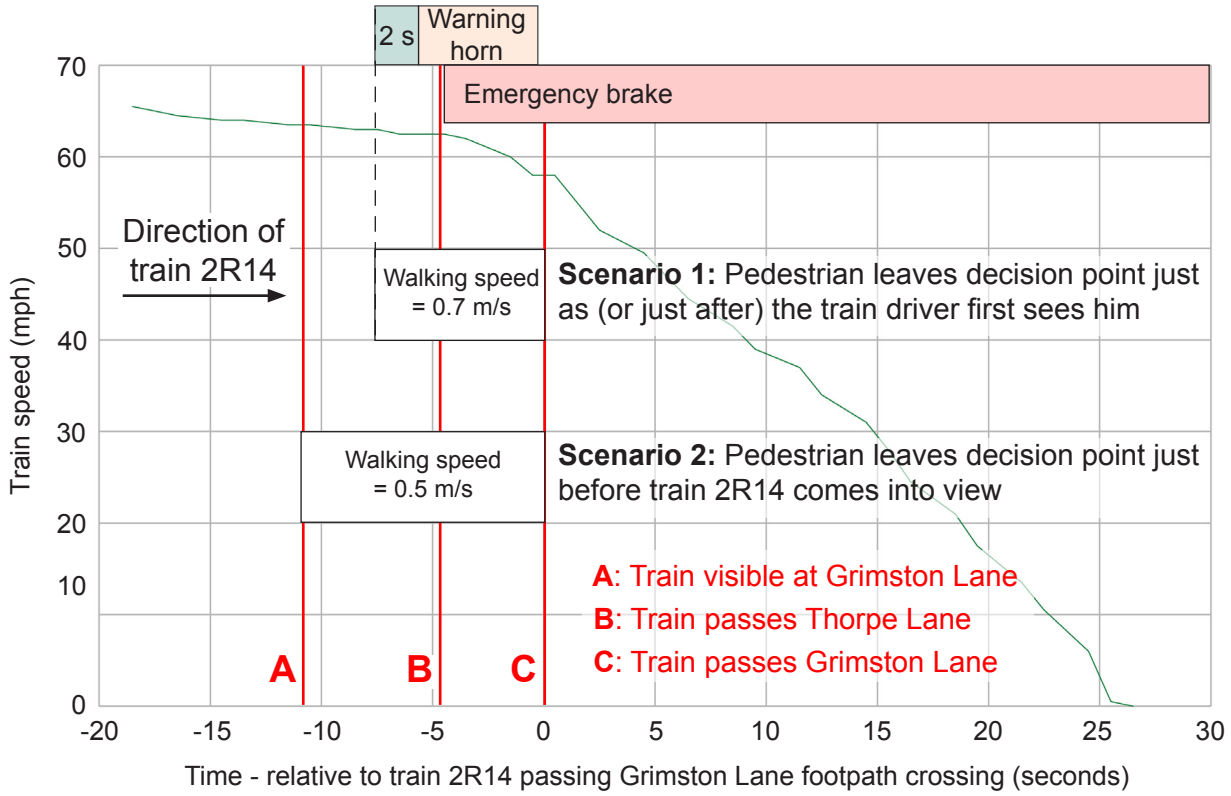

Figure 12: OTDR analysis showing the possible range of speeds at which the pedestrian was walking. Both scenarios assume: a) the decision point was two metres from the track; and b) the traverse path was aligned at 33° to the direction at right angles with the track

[23] The analysis is based on when the train warning horn was first sounded. It allows two seconds for the driver to notice the pedestrian, analyse and decide that the pedestrian was in danger, and then operate the control for the warning horn.

Identification of underlying factors

81 **It is possible that the quantitative assessment criteria and algorithms used to calculate risk at level crossings do not fully account for the degree to which skewed alignment affects the safety of passive crossings, where users need to be vigilant of approaching trains.**

82 The quantitative risk assessment work carried out in support of the last optioneering exercise found there was no significant safety benefit in straightening the crossing deck. If it had, it might have affected Network Rail's decision to improve the crossing.

83 Network Rail used ALCRM, its standard quantitative risk modelling tool, to assess the safety benefit of replacing the skewed timber crossing deck with a rubber crossing deck that was straight (paragraph 49). However, the tool, which is mainly sensitive to *traffic moment*, calculated that the ALCRM risk score would not be reduced (it remained at C5, paragraph 50) and that the investment cost would not be justified by the reduced risk (paragraph 64). While Network Rail's level crossing investment decisions do not depend solely on numerical risk model findings (paragraph 35), the criteria and algorithms used in the supporting tools may have a significant influence.

Observations

Allowance for vulnerable users

84 **The criteria and allowance that Network Rail currently uses for vulnerable users may not be suitably robust, particularly given the forecast rise in the elderly population.**

85 Network Rail's decision not to include an allowance for vulnerable users in its last routine risk assessment (and others before it) was compatible with its guidance (paragraph 48). However, the RAIB observes that applying Network Rail's standard 50% increase to the traverse time would not have resulted in it exceeding the warning time[24]. Therefore, the sighting at the crossing would have been assessed as adequate even if the allowance had been included.

86 Vulnerable users account for more than 60% of the fatalities at footpath and similar crossings reported to the RAIB; elderly users (over 70) made up 26% of the total. The *Office for National Statistics* reports that only 11% of the UK population is over 70. Furthermore, it forecasts that the elderly population in the UK will double over the next 25 years[25] suggesting there could be a progressive increase in the risk profile of this group of level crossing users.

[24] Including Network Rail's standard allowance for vulnerable users (paragraph 40), while additionally allowing for an extended traverse distance due to crossing at a skew angle of 33° (footnote 11), increases the traverse time to 8.9 seconds. This remains less than the warning time of 9 seconds (paragraph 47).

[25] The UK population of those aged 75 and over is forecast to increase from 5.2 million in 2014 to 9.9 million in 2039.

87 In practice, the RAIB found evidence that the pedestrian may have required more additional time than Network Rail's standard allowance. Applying the standard 50% time increase to the traverse speed used in the last risk assessment[26] gives an equivalent walking speed of 0.75 m/s. Depending on exactly when the pedestrian decided to cross, and where he was, it is unlikely that he was walking any faster than this, and was possibly walking as slowly as 0.5 m/s (paragraph 79).

88 A study in 2012 into the walking speed of older adults in the UK[27] found that the mean speed of males aged 80-84 was 0.8 m/s. The mean walking speed of females aged 80-84 was 0.7 m/s; it was only 0.5 m/s for females older than 85. The statistical variation[28] associated with these speed values means that a significant proportion of the elderly population have lower walking speeds.

89 Network Rail has clarified that its standard 50% increase in traverse time for vulnerable users is inclusive and is intended to cover any increased decision-making time as well as any reduction in walking speed.

Previous occurrences of a similar character

90 RSSB publishes an annual report on the safety performance of the mainline railway. In its 2015/16 publication[29] it reported that, excluding suicide, the overall risk of injury at level crossings is 11.4 *fatalities and weighted injuries* (FWI) per year. Most of this risk is to pedestrians, 62%, with pedestrian members of the public accounting for 57% and passenger pedestrians on station crossings accounting for the remaining 5%. Charts in the 2015/16 report record that the number of public pedestrian fatalities at level crossings can vary greatly from year to year. There had been three in 2015/16, eleven in 2014/15, eight in 2013/14 and nine in 2012/13.

91 Since October 2005, the RAIB has investigated 11 accidents involving pedestrians and cyclists at passive level crossings on the national network. Of these, four were on crossings with a skewed alignment; in each case, the skew orientated the user's view away from the approaching train. Two involved vulnerable users:

- an elderly female pedestrian was fatally injured on a station level crossing at Tackley station on 31 March 2008 (RAIB report 09/2009)[30];
- a female pedestrian was fatally injured on Moor Lane footpath crossing, Staines, on 16 April 2008 (RAIB report 27/2008);
- two pedestrians (a female and young child) were fatally injured on Bayles and Wylies footpath crossing, Bestwood, on 22 November 2008 (RAIB report 32/2009); and

[26] 1.13m/s, see footnote 10.

[27] Asher, L, Aresu, M, Falaschetti, E, Mindell, J. Most older pedestrians are unable to cross the road in time: a cross-sectional study. Age and Ageing 2012.

[28] The mean value for males aged 80-84 was associated with a standard deviation of 0.3 m/s.

[29] Annual Safety Performance Report 2015/16. RSSB, July 2016.

[30] The level crossing at Tackley was provided with both vehicle access gates and smaller wicket gates for pedestrian and bridleway users. The wicket gates were offset relative to each other. This meant that pedestrians were encouraged to follow a diagonal path over the crossing.

- a male cyclist was fatally injured on Kings Mill No.1 bridleway crossing, Mansfield, on 2 May 2012 (RAIB report 01/2013).

Vulnerable users were also involved in six of the seven remaining accidents (where the alignment of the crossing is unlikely to have played a part):

- an elderly male pedestrian was fatally injured on Barratt's Lane No.1 footpath crossing near Attenborough on 21 November 2005 (RAIB report 13/2006);
- a male cyclist was seriously injured on Scate Moor bridleway crossing between York and Harrogate on 8 January 2006 (RAIB report 06/2006);
- a female pedestrian, who was walking two dogs, was fatally injured at Fairfield footpath crossing, Bedwyn, on 6 May 2009 (RAIB report 08/2010);
- an elderly female pedestrian was fatally injured on Gipsy Lane footpath crossing, near Needham Market, on 24 August 2011 (RAIB report 15/2012);
- an elderly female pedestrian was fatally injured on Mexico footpath crossing, near Penzance, on 3 October 2011 (RAIB report 10/2012); and
- an elderly female pedestrian was fatally injured on Barratt's Lane No.2 footpath crossing, Attenborough, on 26 October 2013 (RAIB report 18/2014)

In the other remaining accident, a male pedestrian was fatally injured on a non-skewed user worked crossing at West Lodge, Haltwhistle, on 22 January 2008 (RAIB report 01/2009).

92 Network Rail has a record of a near miss incident at Grimston Lane footpath crossing on 29 December 2012[31]. It also involved the 2R14 Ipswich to Felixstowe passenger train service. Network Rail's records state the user was an elderly male; Abellio Greater Anglia's log records that the user was a 'dog walker'. Network Rail and Abellio Greater Anglia had no further details about what happened.

[31] There is witness evidence suggesting that the incident was not at Grimston Lane footpath crossing, but at a crossing nearby.

Summary of conclusions

Immediate cause

93 The pedestrian started to cross the railway at Grimston Lane footpath crossing when there was insufficient time for him to get to a position of safety on the opposite side before train 2R14 passed over (paragraph 55).

Causal factors

94 The accident was probably caused by either:

a. The pedestrian not being aware of the approaching train when he decided to cross the railway (paragraph 59); either because:

i. the skew of the crossing, or another reason, resulted in him not looking in the direction of the approaching train (paragraph 61, **Recommendation 1**); or

ii. he was not at the best viewing position when he made the decision to start to cross and the approaching train was obscured (paragraph 67, **Learning point 1**).

Or alternatively:

b. The pedestrian being aware that the train was approaching but misjudging how much time he needed when he decided to cross the railway (paragraph 72); because:

i. he misjudged the time the approaching train would take to arrive at the crossing and, therefore, considered he had more time to cross the railway than he had (paragraph 74, no recommendation); and/or

ii. he underestimated how long it would take him to cross the railway (paragraph 77, no recommendation).

Underlying factors

95 A possible underlying factor was that the assessment criteria and algorithms used by Network Rail to calculate the numerical risk at level crossings do not fully account for the degree to which skewed alignment affects the safety of passive crossings, where users need to be vigilant of approaching trains (paragraph 81, **Recommendation 1**).

Additional observations

96 Although not linked to the accident on 23 February 2016, the RAIB observes that:

a. The criteria and allowance that Network Rail currently uses for vulnerable users may not be suitably robust, particularly given the forecast rise in the elderly population (paragraph 84, **Recommendation 2**).

Previous RAIB recommendations relevant to this investigation

97 The following recommendation made by the RAIB has relevance to this investigation.

Accident at Gipsy Lane, RAIB report 15/2012, Recommendation 3

98 The first bullet point of Recommendation 3 in RAIB report 15/2012 related to the criteria Network Rail uses to decide when to make allowance for vulnerable users when assessing level crossings. The complete recommendation read as follows:

> *Recommendation 3*
>
> *Network Rail should develop its guidance for use by level crossing teams to include:*
>
> - *a clear definition of what constitutes a 'higher than usual' number of vulnerable users;*
> - *implementing risk-reduction measures at crossings that have deficient sighting or warning times; and*
> - *when speed restrictions must be imposed, what type of speed restriction is to be used (emergency, temporary or permanent) and the timescales for imposing speed restrictions.*

99 In its initial response to ORR in October 2012, Network Rail advised that it had engaged human factors specialists to look at what a 'higher than usual' number of vulnerable users constituted. In November 2013, it advised ORR that it was developing a 'long term vision' that would mean it moving away from having separate traverse times for vulnerable and non-vulnerable users. However, it proposed to develop interim guidance in the meantime to clarify what users are considered to be 'vulnerable users' and how to calculate when the proportion of them is 'statistically significant'. This was so that it could meet the requirement of the RAIB's recommendation.

100 In December 2013, Network Rail provided ORR with detail on the 'interim formula' it had developed for deciding when to include allowance for vulnerable users. It was essentially the same as that described in paragraph 39. ORR advised the RAIB that it was challenging Network Rail on the justification of the 'interim formula'.

101 Network Rail updated ORR in January 2014. Although it confirmed that it was still considering a common traverse time allowance (for vulnerable and non-vulnerable users), it had designed the interim guidance to help its level crossing managers decide when the traverse time needs to be increased because of 'high levels of usage' by vulnerable people.

102 In February 2014, Network Rail provided ORR with its 'closure statement' for the recommendation, together with a copy of the vulnerable user guidance it had developed. This is the guidance that was current at the time of the last level crossing risk assessment of Grimston Lane footpath crossing (paragraphs 38 and 48). ORR advised the RAIB in June 2014 that it was satisfied with the response to its challenge of the 'interim formula' and that Network Rail had implemented the recommendation.

103 Network Rail has separately advised the RAIB that it based its criteria for when to apply extra time for vulnerable users on professional judgement.

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

104 ORR wrote to Network Rail on 23 March 2016 and highlighted its concern that the skewed alignment of Grimston Lane footpath crossing may have contributed to the accident. It recognised that improvement schemes for the branch line may ultimately result in the closure of the crossing (paragraph 8). However, it asked Network Rail to identify interim improvements to give users the shortest traverse time and best visibility.

105 Network Rail has advised that it reviewed the sighting from Grimston Lane footpath crossing after the accident and removed vegetation and redundant lineside structures (in the vicinity of the nearby level crossing at Thorpe Lane) to improve the visibility of trains approaching in the down direction. It later advised that it has replaced the skewed timber crossing deck with a rubber crossing deck that is aligned perpendicular to the track, and has fenced the approach paths to it (figure 13).

Figure 13: New crossing deck and fenced approach paths at Grimston Lane footpath crossing (image courtesy of Network Rail)

106 Network Rail provided the RAIB with a copy of its recently-developed long-term national strategy for improving safety at level crossings. It is entitled 'Transforming Level Crossings'. The strategy makes a number of commitments relevant to footpath crossings, including that:

- by 2025, the decking on such crossings will be marked to highlight 'danger zones'; this corresponds with conclusions from RSSB research project T984 that found that marked danger zones, rather than designated decision points, may encourage users to decide to cross only when they are sufficiently confident no trains are approaching; and
- by 2039, all passive crossings will have automatic systems to warn users of approaching trains.

Recommendations and learning point

Recommendations

107 The following recommendations are made[32]:

1 *The intent of this recommendation is that the effect of skewed alignment on the safe use of passive crossings is fully understood and managed.*

Network Rail should (paragraphs 94a.i and 95):

i. identify the effects of skewed alignment at passive level crossings on user behaviour, including the sighting of approaching trains;

ii. review its processes and guidance for level crossing risk management, including the 'all level crossings risk management' tool (ALCRM), to determine whether the impact of skewed alignment is sufficiently taken into account; and

iii. make any necessary changes to its processes and the guidance and training given to its level crossing managers.

2 *Recognising Network Rail's commitment in its 'Transforming Level Crossings' document, to equip all existing passive crossings with automatic warnings by 2039, the intent of this recommendation is that the risk to vulnerable users at passive level crossings is reduced in an expedient manner during the interim*.

Network Rail should (paragraph 96a):

i. review its criteria for determining when it is appropriate to include an allowance for vulnerable users when calculating the required warning time at level crossings that are used by pedestrians; this review should take into account forecast demographic changes, in particular the ageing population;

ii. review the allowances made for vulnerable users to take into account good practice and research; and

iii. use the above to review levels of risk at existing passive level crossings to inform decisions to prioritise the crossings that are to be upgraded with the addition of automatic warning systems, or otherwise improved.

[32] 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 and Road 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.gov.uk/raib.

Learning point

108 The RAIB has identified the following learning point[33]:

1 The pedestrian may have looked for approaching trains before he reached the point at which he had the best safe view of them. This may have considerably reduced his sighting distance. RSSB research project T984 recognised that there are many factors that affect where a user of a passive level crossing makes a decision to cross the railway and that, in some cases, the concept of the decision point being at a single defined location is unrealistic. The adoption of findings from project T984, including the use of markings to highlight danger zones rather than designated decision points, may encourage users to make decisions when they have adequate information about approaching trains and, therefore, whether it is safe for them to cross (paragraph 94a.ii).

[33] 'Learning points' are intended to disseminate safety learning that is not covered by a recommendation. They are included in a report when the RAIB wishes to reinforce the importance of compliance with existing safety arrangements (where the RAIB has not identified management issues that justify a recommendation) and the consequences of failing to do so. They also record good practice and actions already taken by industry bodies that may have a wider application.

Appendices

Appendix A - Glossary of abbreviations and acronyms

ALCRM	All level crossings risk model
FWI	Fatalities and weighted injuries
LCM	Level crossing manager
ORR	Office of Rail and Road
OTDR	On-train data recorder
RLCM	Route level crossing manager

Appendix B - Glossary of terms

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

ALCRM risk score	The quantitative risk rating for a level crossing determined by ALCRM. The score is made up of two parts, a letter representing the individual risk and a number representing the collective risk. See also footnote 13.
All level crossings risk model	A model used by Network Rail to evaluate the risk at level crossings.*
Automatic half barrier crossing	An automatically-operated level crossing fitted with barriers that only extend over half of the road.
Crossing deck	That part of a level crossing that is walked on, ridden on or driven on by pedestrians, cyclists, equestrians or motorists.*
Definitive map	A map prepared by a surveying authority which is a legal record of the public rights of way.
Diesel multiple unit	A multiple unit train whose source of power is a diesel engine.*
Fatalities and weighted injuries	A concept used by the railway industry when recording safety performance or comparing risk: one fatality is deemed equivalent to ten major injuries, or to 200 minor injuries.*
Health and Safety Executive	A non-departmental public body responsible for the encouragement, regulation and enforcement of workplace health, safety and welfare, and for research into occupational risks.
Miniature stop lights	Miniature lights, most often red and green, used as the warning at certain types of level crossing.*
Office for National Statistics	Producer of official statistics about the UK's economy, society and population.
On-train data recorder	A data recorder fitted to a train that collects information about its performance and the status of systems on board, such as speed and brake control.
Operations manual	A document that contains mandatory procedures applicable to Network Rail operations and customer services functions.
Overlay miniature stop lights	A miniature stop lights arrangement that is operated by its own independent train detection system.
Track circuit block	The system of signalling the railway where safe operation of trains is achieved by allowing only one train at a time to occupy a section of track fitted with a track circuit (a track circuit is a device to detect the presence of a train).
Traffic moment	The number of trains passing a level crossing multiplied by the number of level crossing users in a given period.

User worked crossing	A level crossing where the user operates the barriers or gates. There is sometimes a telephone nearby so the user can contact the signaller.

Appendix C - Investigation details

The RAIB used the following sources of evidence in this investigation:

- information provided by witnesses;
- information about the deceased;
- information taken from the on-train data recorder (OTDR) on train 2R14 and the signalling data logger at Thorpe Lane level crossing;
- train radio voice recordings;
- site photographs, measurements and video recordings;
- information and documents provided by Network Rail and Abellio Greater Anglia;
- local weather reports and observations;
- industry research reports relating to the use of level crossings;
- scientific journals, and research reports and reviews;
- population information from the Office of National Statistics; and
- a review of related incidents and accidents that the RAIB has been notified of.

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

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