RAIB

Rail Accident Investigation Branch

Rail Accident Report

Near miss between a train and a level crossing user at Dock Lane, Melton, Suffolk 14 June 2016

Report 08/2017
May 2017

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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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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Near miss between a train and a level crossing user at Dock Lane, Melton, Suffolk 14 June 2016

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Summary

At about 13:25 hrs on Tuesday 14 June 2016, the passenger of a car that was waiting to cross the line was opening the gates at Dock Lane user worked crossing, in Melton, Suffolk, when a train passed over the crossing. The signaller at Saxmundham signal box had given permission for the car to cross the line after the car driver had contacted him using the telephone provided at the crossing.

The signaller knew the train's approximate location before the call and was aware of its proximity to Dock Lane user worked crossing. However, during the call he did not use this information to decide to refuse permission to cross. Immediately after the call, the signaller realised the error.

It is possible that the signaller gave an automatic response to the car driver, partly because of the familiar nature of the telephone call and partly because of mental fatigue resulting from the complexity of maintaining awareness of train locations with the limited information that was available to him. Also, because he had been provided with all the information he needed to handle such a call without asking for it, he did not take the lead in the conversation. Had he done so, it might have reduced the chance of such an error.

The signaller at Saxmundham signal box is responsible for managing a high number of crossing telephone calls. The volume was such that it was highly likely that he would eventually make an error that could lead to a near miss or an accident.

The RAIB has made four recommendations to Network Rail, addressing management of human error when assessing level crossing risk, assessment of the signaller's workload at Saxmundham, identification and assessment of other signalling locations with a high workload from level crossings, and the criteria for triggering assessment of workload demands on signallers.

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 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 incident

Summary of the incident

3 At about 13:25 hrs on Tuesday 14 June 2016, a train, reporting number 2D81, the 12:07 hrs service from Lowestoft to Ipswich, passed over Dock Lane *user worked crossing* (UWC) while the passenger of a car was opening the gates in preparation to cross. This level crossing is located at the east end of Dock Lane, in Melton, Suffolk (figures 1 and 2).

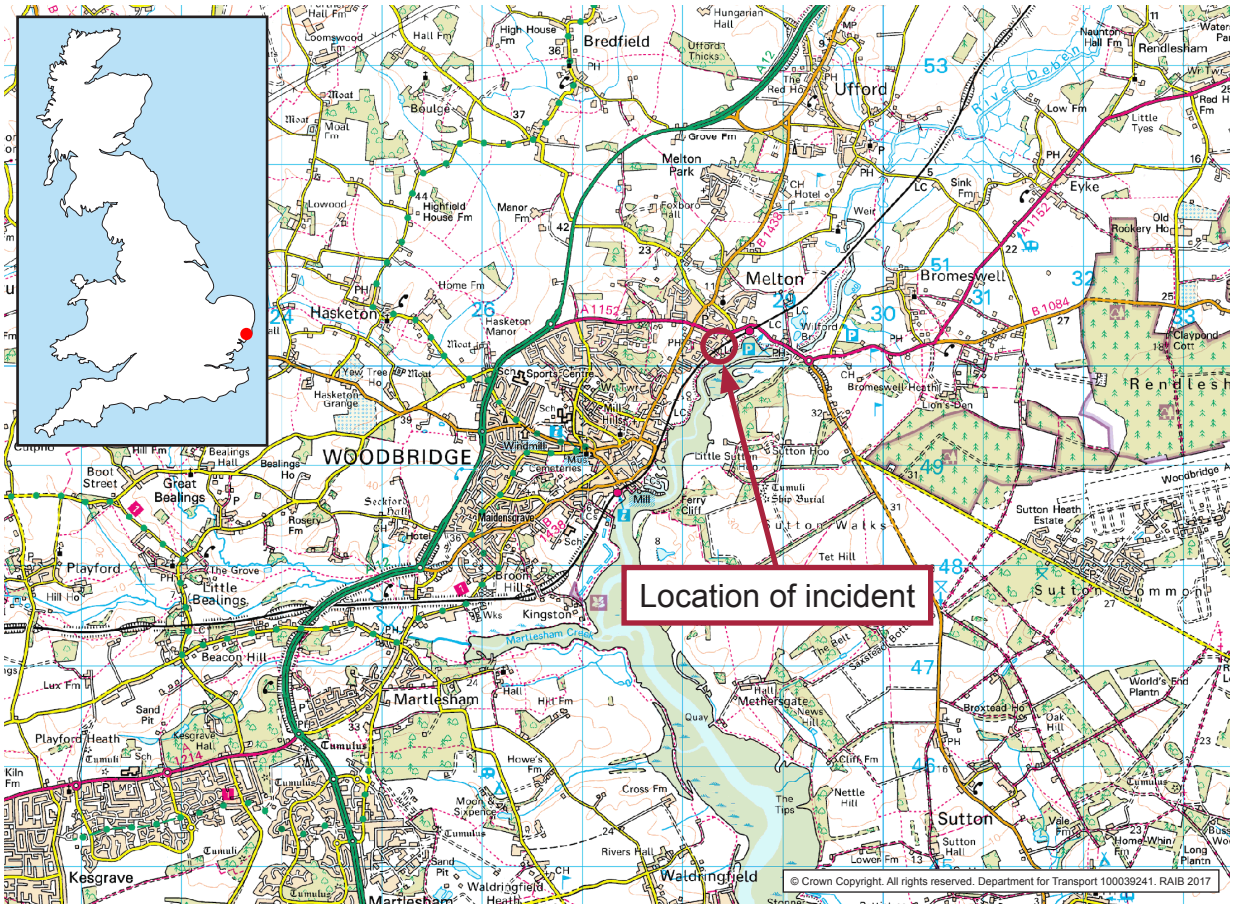

Figure 1: Extract from Ordnance Survey map showing location of incident

4 The car involved in the incident, carrying a driver and one passenger, approached the crossing from the east. The driver used the telephone at the crossing to get permission from the signaller to cross the line, and the passenger opened the gates.

5 The train was accelerating from a station stop at Melton. The RAIB has estimated that the train was travelling at between 30 mph (48 km/h) and 35 mph (56 km/h) when it passed over the crossing.

6 There was no collision with either the car passenger, or with the car, and the train did not slow down or stop. There were no injuries and there was no damage.

Context

Location

7 Dock Lane level crossing provides access to a boatyard and other facilities to the east, between the railway and the River Deben. The crossing is located at 80 miles 6 chains[1] on a single track section of the East Suffolk line between Woodbridge and Melton stations, on which there is generally an hourly passenger train service in each direction. The crossing is approximately 280 metres south-west of Melton station.

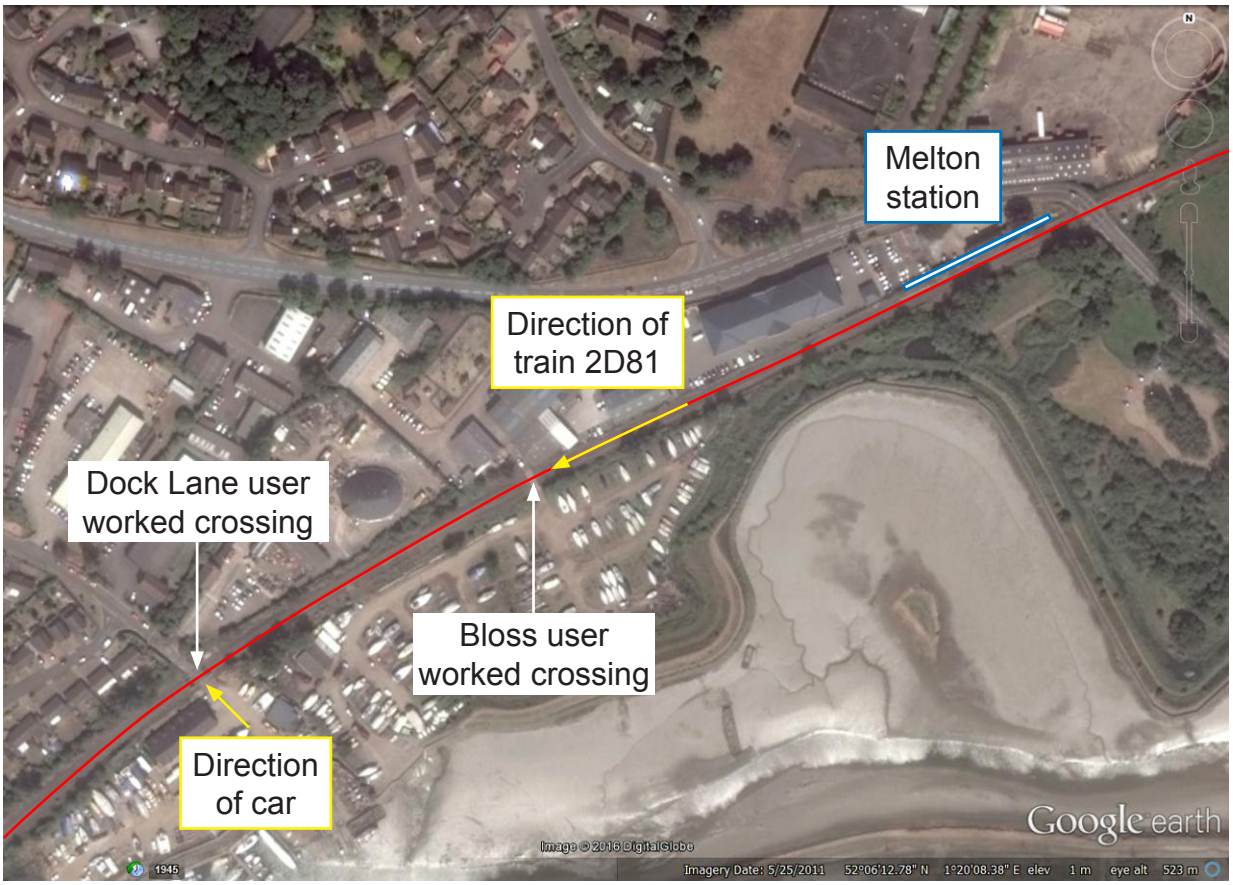

Figure 2: Detailed locations of crossings at Melton

8 Dock Lane is one of a number of user worked level crossings in the Woodbridge/ Melton area (figure 3). Another similar crossing, Bloss, is located between Melton station and Dock Lane. There are also a number of *automatic open crossings* that are fitted with both lights and half barriers.

Organisations involved

9 Network Rail owns and manages the infrastructure as part of its Anglia Route, employed the staff carrying out *risk assessments*, inspections and maintenance work on the level crossing, and employed the signaller.

10 Abellio Greater Anglia operated the passenger train service and employed the train driver.

[1] The mileage is measured from London Liverpool Street station; one chain is equal to 22 yards (approximately 20 metres).

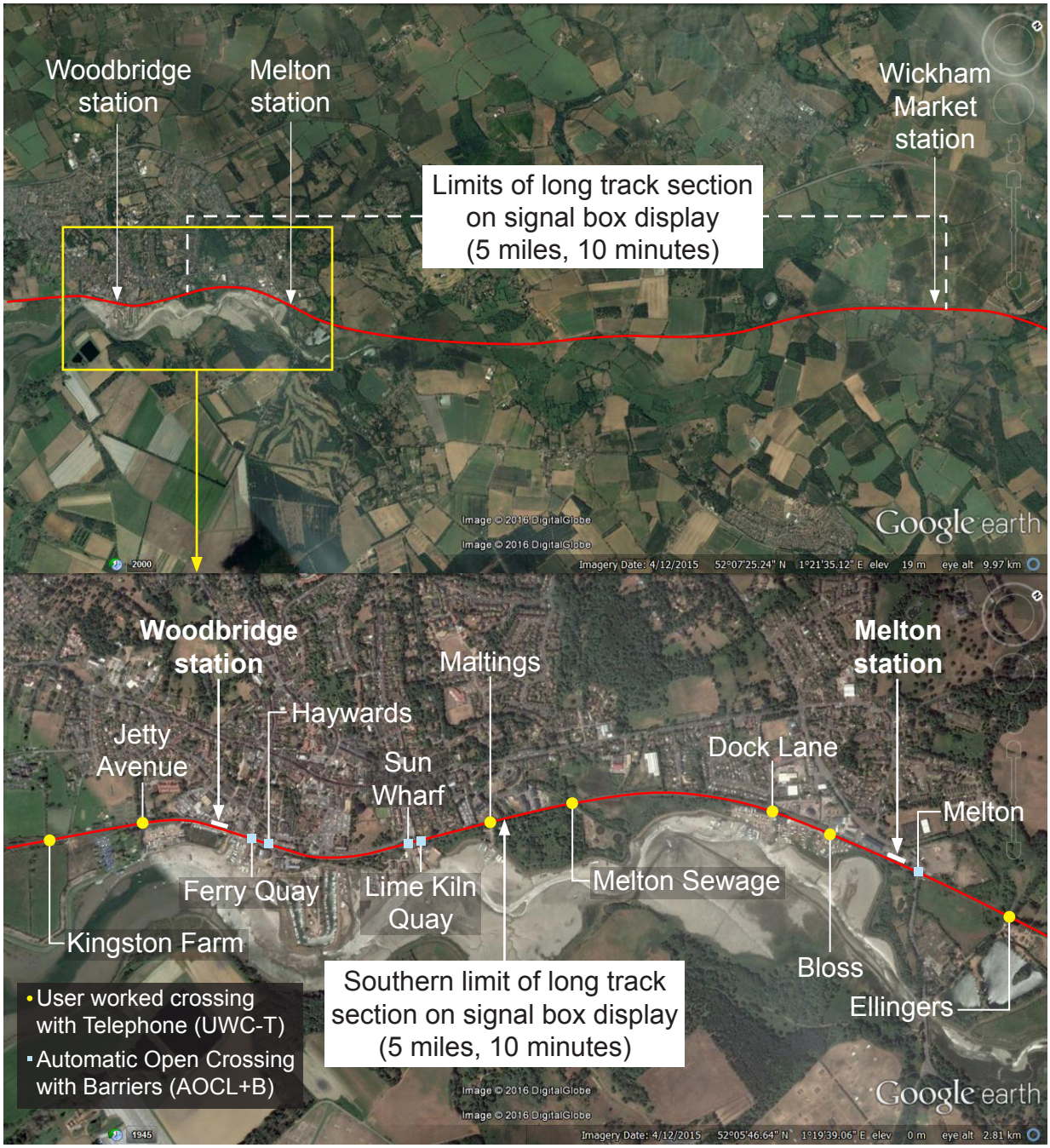

Figure 3: Level crossings in the Woodbridge/Melton vicinity

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

Train involved

12 The train was a two-car class 156 diesel multiple unit, number 156419. It was not fitted with forward facing closed-circuit television (CCTV). The condition of the train was not a factor in the incident.

Rail equipment/systems involved

13 The railway at this location comprises one non-electrified track. The speed limit for trains travelling in both directions is 55 mph (88 km/h), although passenger trains are unlikely to be travelling at this speed due to the proximity of Melton station, where they are all scheduled to stop.

14 Dock Lane level crossing is classified as a user worked crossing with telephones (UWC-T) and is intended for use by road vehicles belonging to, or having business with, a defined set of authorised users. The operator of the boatyard that the vehicle occupants had been visiting, was an authorised user. The UWC-T is fitted with a metal vehicle gate on each side of the railway which the road user is required to open and close on foot. There is a parallel footpath crossing, provided with a wooden pedestrian wicket gate adjacent to each vehicle gate (figure 4).

Figure 4: Dock Lane user worked crossing, viewed from river (east) side of railway

15 Telephones are provided at the crossing for vehicle users to contact the signaller to gain permission to cross, due to the insufficient sighting time of trains for vehicle users (paragraph 33). The signaller is located at Saxmundham signal box, which is approximately 10 miles (16 km) to the north-east of Dock Lane level crossing.

16 Saxmundham signal box controls trains on the line between Oulton Broad South, near Lowestoft, and Westerfield, near Ipswich, including those on the freight-only branch line to Sizewell. It has a bank of three display screens on which is displayed a schematic of the railway, showing signals, *track sections* and level crossings. A single signaller uses these screens to monitor the position of trains and to operate the signalling (figure 5). To the left of these screens is a *telephone concentrator* panel, which provides the signaller's interface with the telephones at all of the UWC-T crossings within the signal box's area. Each crossing has a combined button and lamp, which flashes when a user lifts the telephone to call the signaller. The signaller is able to answer the calls by pressing the appropriate button.

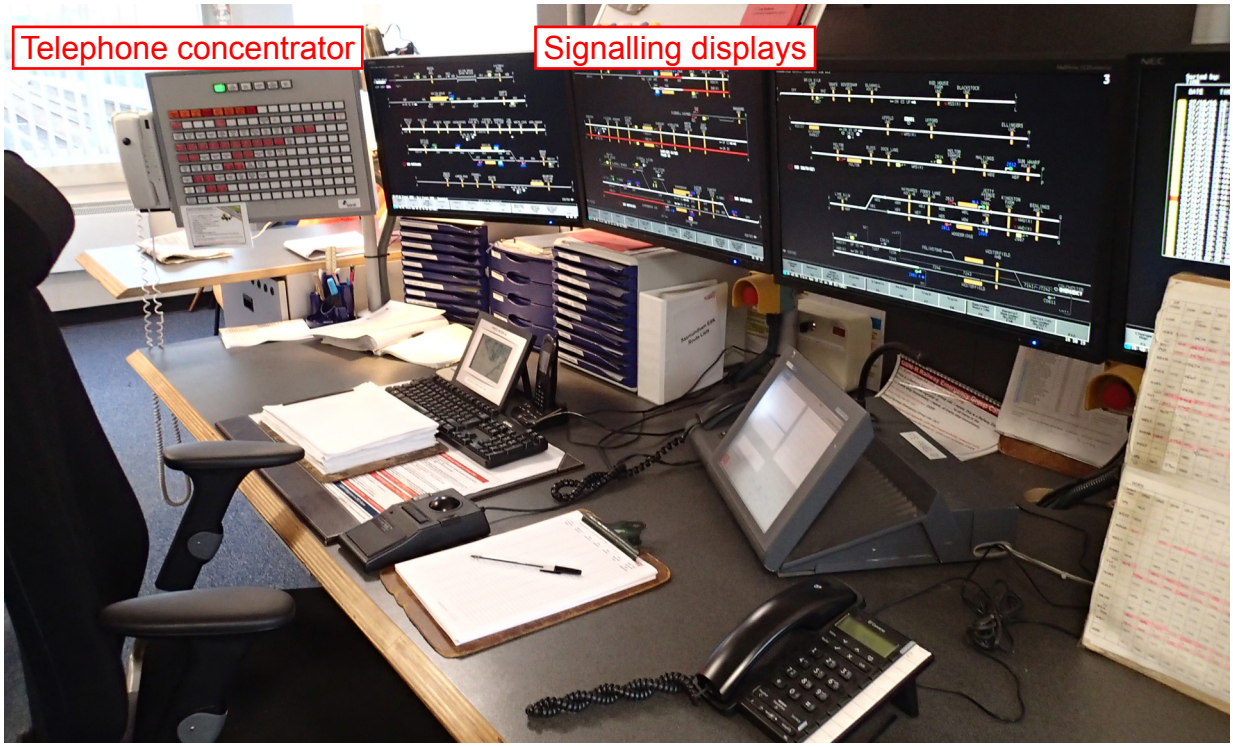

Figure 5: Saxmundham signal box

Staff involved

17 The signaller involved had worked for 22 years in that role, mainly in traditional *lever frame signal boxes*. He had started work at Saxmundham signal box around six months before the incident. This was the first signal box that he had worked at where the signalling was controlled using display screens. He had undergone training on this system, both using a simulator and at Saxmundham signal box. He had been recruited to fill a vacancy at Saxmundham signal box by the Network Rail *Local Operations Manager* (LOM) who was familiar with his competences. The LOM took an active part in the signaller's training, including visits to all of the level crossings controlled from Saxmundham signal box. There were no safety incidents on the signaller's record and he held the relevant, up to date competences to undertake his role at Saxmundham signal box.

18 The Network Rail Level Crossing Manager responsible for Dock Lane had been in that role for around two years. He was responsible for all the level crossings between Westerfield and Saxmundham, including those on the Sizewell branch. He lived locally to the area and was familiar with all of the crossings.

19 The train driver was unaware that there had been a reported near miss at the time. His actions played no part in the incident.

External circumstances

20 It was raining at the time the car driver and passenger were using the crossing. The passenger was wearing a hooded jacket that could have affected her view of the train and its audibility. However, vehicle users were not required to look for trains, having gained permission from the signaller to cross.

The sequence of events

Events preceding the incident

21 The signaller had started his shift at 06:40 hrs and had been involved in the routine signalling of trains and responding to UWC-T telephone calls. He had also dealt with a number of calls from both signalling and telecommunications staff and from level crossing maintenance staff, who had contacted the signaller to get permission to work on or near the line.

22 The signaller had dealt with 116 requests from UWC-T users to cross the line in the period from the start of his shift until the incident (almost seven hours). These requests had involved a total of 133 telephone calls from 17 different crossings, including instances when the signaller had asked the user to call him back. Of the crossing requests, 21 had taken place in the hour leading up to the incident, with the three most recent occurring 35 seconds, 81 seconds and 6 minutes before the incident call.

23 The signaller's last signalling action before the incident was setting the route for the train involved, 2D81, to leave Saxmundham, approximately 17.5 minutes earlier.

24 At 13:22:48 hrs, the signaller received a call from Bloss UWC-T requesting permission to cross the line with a lorry. During this call, the user told the signaller that he could see a train in Melton station. This was train 2D81. The signaller asked the user to wait, and to call him back when the train had passed. This call ended seven seconds before the near miss call.

Events during the incident

25 The vehicle involved stopped at the gates at Dock Lane, and the car driver got out to call the signaller while the passenger prepared to open the gates. At 13:23:23 hrs, the signaller answered a call from the car driver at Dock Lane UWC-T, who requested "Three rhino to go across – 72 seconds". The signaller repeated the message back to the caller and immediately gave permission to cross, stating "safe to cross". The driver got back into the car while the passenger started the process of opening the gates on both sides of the line.

26 During this call, train 2D81 left Melton station, heading towards Dock Lane. Eight seconds after putting the phone down, the signaller called the crossing telephone, having realised his error, but neither the car driver nor the passenger heard the telephone ring. Around this time the train approached Dock Lane crossing. The car driver heard the train coming and shouted a warning to the car passenger, who was about to cross the line to open the far side gate. She heard the warning and stopped short of the railway line before the train passed very close to her.

27 Having been unable to contact the user, the signaller immediately used the GSM-R[2] radio system to contact the driver of train 2D81. The train driver stated that he had seen someone at the crossing gates, but did not consider them to be in a position of danger, and so had not stopped his train.

[2] GSM-R is a radio system enabling voice and data communications between railway operational staff, including between signallers and train drivers.

Events following the incident

28 Reassured that the crossing user was safe, the signaller continued with his duties and set the route for both a northbound and a southbound train from Beccles.

29 At 13:25:15 hrs, the signaller received a call from the car driver to alert him to the fact that a train had just gone past. The signaller apologised for giving permission to cross. The caller said not to worry and that she wanted to let the signaller know where the train was, adding that 'the rhino are all safe'. The caller did not suggest that the car passenger had nearly been hit by the train.

30 The signaller then received a call from the user at Bloss UWC-T, who advised that he had crossed the line with the HGV and was clear. This was despite the signaller having asked him to call back after the train had passed and before crossing.

31 The signaller then continued with his duties until the end of his shift, and did not log or report the incident. The car passenger reported the near miss to Network Rail, by telephone, two days later, on 16 June 2016. The RAIB identified the near miss from Network Rail's daily log on 17 June 2016.

Key facts and analysis

Background information

User worked Crossings

32 User worked crossings are level crossings where railways intersect private roads, or roads which were originally private but have acquired public status since construction of the railway. Road users are required to operate gates or barriers when crossing the railway at such crossings. Where the road is private, use of the crossing is usually restricted to persons specified in the legislation authorising construction of the railway. These people are described as 'authorised users'.

33 Where a user is unable to see trains in sufficient time to be able to safely cross the line, other mitigation measures need to be provided. At Dock Lane, in common with many other UWCs, telephones are provided for vehicle users to contact the signaller, who has information about train locations, to obtain permission to cross the line. At this location, pedestrian users have sufficient sighting of trains to be able to cross safely and are not required to call the signaller.

34 At UWCs where there is no equipment to warn users of approaching trains, the 'safe to cross' decision lies with the user, based on the available sighting of trains. At UWCs equipped with *miniature stop lights* (MSLs) the user makes the decision to cross based on red/green lights that are operated automatically by approaching trains. However, at UWCs with telephones, the 'safe to cross' decision lies with the signaller, thus removing the responsibility of the user to check for trains.

35 Signallers are able to make decisions based on the information available to them about train positions, but the decision will always be subject to the possibility of *human error*.

Human Error

36 Human error is a possibility in all human actions and decisions, but needs to be particularly considered when a person, such as a signaller, is required to make safety-critical decisions.

37 *RSSB* research report T270 (Railway action reliability assessment user manual - A technique for the quantification of human error in the rail industry) suggests values for *Human Error Probability* (HEP) for different types of tasks. Task type R4 covers 'skill-based tasks (manual, visual or communication) when there is some opportunity for confusion'. This is a good description of the signaller's task of locating trains and deciding whether it is safe for UWC-T users to cross the line. A HEP of 0.003 is suggested for this type of task. As such, on average, approximately three in every thousand decisions made by a human undertaking such a task would be wrong.

38 The actual number of errors that might be made by signallers undertaking such tasks is dependent on the number of demands – ie the number of calls that they receive from telephone crossings. This, in turn, is affected by the number of crossings that they control and how busy each one is. Multiple busy crossings present more opportunities for signaller errors in a given period of time than a single quiet crossing, assuming that the error rate per demand remains constant.

39 A high number of demands can also increase the probability of the signaller making an error on each demand. The method used with RSSB research report T270 (paragraph 37) includes factors that can multiply the HEP value for the overall task type. Factors relating to task workload can increase the HEP value by up to six times, depending on the context. In other words, high workload could result in an error rate of nearly two in every hundred decisions.

Dock Lane UWC-T

40 Although the RAIB has been unable to determine when the telephones were fitted to Dock Lane UWC, it is known that they have been present since before 1998. Railtrack, the predecessor of Network Rail, had plans to fit MSLs to Dock Lane, and a number of other crossings, between 2002 and 2005. However, as a result of funding issues, Network Rail did not implement these plans (see paragraph 30 of RAIB report 15/2012).

41 In 2012/13, Network Rail fitted a trial installation of a system known as Wavetrain at Dock Lane UWC. This system was intended to allow the fitment of MSLs at crossings without the traditionally high cost associated with integrating them into the signalling system. Wavetrain was sound-based, using microphones attached to the rails to detect trains. However, reliability issues relating to train detection, particularly where crossings were close to stations, meant that the trial system was removed in 2013.

42 In 2015, Network Rail undertook a feasibility study to consider the closure of several level crossings in the Woodbridge area, including Dock Lane. These closures remain a long term intention at the time of publication of this report. In parallel with this, Network Rail has been pursuing development of a system where GPS transducers would be fitted to trains to provide the signaller with better information about train positions (paragraph 72). This system would not affect how the UWC-T crossings operated, but would potentially improve the signaller's ability to relate train locations to crossing requests. This system had not been fully developed at the time of the incident.

43 As a result, at the time of the incident the crossing remained a telephone operated crossing with the signaller making the 'safe to cross' decision.

Identification of the immediate cause

44 Having received permission to cross from the signaller, a member of the public was about to use the crossing when a train passed.

45 The car passenger started to open the crossing gates after the car driver had used the telephone to contact the signaller and gained permission to cross (paragraph 25). This was in accordance with the instructions for using the crossing.

46 However, the signaller had given the car driver permission to cross the railway while an approaching train was leaving Melton station, which was only 280 metres from Dock Lane crossing. The signaller had just been told by another user at Bloss crossing that the train was at Melton station (figure 2 and paragraph 24).

Identification of causal factors

47 It is likely that the signaller made the error due to a combination of the following causal factors:

a. It is possible that the signaller's thought process was diverted by the familiar and 'light-hearted' nature of the call, and that he gave an automatic response (paragraph 48).

b. There were numerous calls to the signallers operating Saxmundham signal box due to the large number of UWC-T crossings, with a cumulative high traffic load, controlled from there. This demand rate made the possibility of a signaller error more likely (paragraph 53).

c. It is possible that the signaller was mentally fatigued when the caller asked for permission to cross the line, due to the high mental demand involved in maintaining awareness of train positions in long track sections and relating these to the many UWC-T requests (paragraph 88).

Each of these factors is now considered in turn.

The signaller's response to the call

48 **It is possible that the signaller's thought process was diverted by the familiar and 'light-hearted' nature of the call, and that he gave an automatic response.**

49 The car driver was a frequent user of Dock Lane crossing, and was well known to the signallers. She was always good natured on the phone and always asked for 72 seconds to cross with some form of wild animal. Signallers recognised that her requests were light hearted and that she would be crossing with a vehicle and would require sufficient time to cross with it.

50 Signallers are trained to lead the communications with crossing users. This includes asking what type of vehicle (or animals) they wish to cross the line with and how much time they require. This allows the signaller to judge whether there is sufficient time for users to cross safely before the next train approaches the crossing. This user, in common with many other regular users, provided the signaller with information, without him having to ask for it (paragraph 25). Because the signaller was not leading the conversation, the amount of active interaction that he needed to make during the call was reduced and so the normal 'question and answer' thought process was bypassed.

51 The signaller repeated the information that the user had provided back to her, but did not ask for confirmation that this information was correct. Instead he immediately confirmed that the user was safe to cross, having forgotten that he had just been informed that a train was at Melton station (paragraph 24). The signaller recognised that he had made an error as soon as the call ended, and unsuccessfully tried to call the user at Dock Lane back before contacting the train driver (paragraph 27).

52 If the signaller had led the conversation and asked the user to verify the information that she had provided, it is possible that he would have maintained his awareness of the train's position relative to the crossing involved in the call.

Number of calls to the signaller

53 **There were numerous calls to the signallers operating Saxmundham signal box due to the large number of UWC-T crossings, with a cumulative high traffic load, controlled from there. This demand rate made the possibility of a signaller error more likely.**

54 The signaller at Saxmundham is responsible for the operation of 29 UWC-Ts. For most of the year there are between 100 and 300 requests to use these crossings each day. In 2016 the signallers recorded over 70,000 telephone requests to use UWC-Ts, which, when refusals and requests to call the signaller back are taken into account, amounts to over 80,000 telephone calls. This is equivalent to a signaller dealing with about 14 crossing user telephone calls per hour, when averaged over a 16 hour active period on every day of the year.

55 The signallers' call records show that signallers refuse approximately one in every six requests to cross, because a train is in the vicinity of the crossing and the user may not have sufficient time to cross safely. That means that signallers refuse permission to cross approximately 12,000 times a year.

56 Assuming that the possibility of a signaller making an error is in the order of three in every thousand demands (paragraph 37), then it is possible that the signallers at Saxmundham signal box could wrongly give permission to cross, somewhere in the order of 36 times per year. However, in the majority of these cases this would not result in an accident. This is partly because a signaller will refuse to allow a user to cross when unsure how much time there is, rather than only when knowing there is insufficient time. However, there will remain some risk of a signaller error leading to a near miss or accident.

57 The number of errors that signallers make is driven, to a significant degree, by the number of decisions that they have to make, and this in turn is determined by the number of users at telephone operated crossings that they control (paragraph 38). The number of errors can therefore be reduced by reducing the number of calls from users at telephone operated crossings. This could be achieved by upgrading to alternative crossing types with provision of active indication of the status of the railway to crossing users, thus removing the decision from the signaller.

58 At Saxmundham signal box, the majority of crossing requests are generated by a small number of heavily trafficked crossings. Approximately 50% of the calls come from the three crossings at Dock Lane, Bloss and Jetty Avenue, all of which are in the Woodbridge/Melton vicinity and are used to access boatyards and other properties on the river side of the railway (figure 3). The remainder of the calls are spread over the other 26 telephone operated crossings that are controlled from Saxmundham.

59 The other duties of signallers at Saxmundham, including that of signalling trains, make up a lower proportion of their workload than managing UWC-T telephone requests. The stretch of railway controlled by the signal box is relatively straightforward, consisting of a single route from Oulton Broad South to Westerfield, with a single freight branch to Sizewell that sees only infrequent trains. At any one time there are normally between two and four trains under the signaller's control, on a mixture of double and single track railway. The signaller needs to set a route for a train approximately every 15 minutes, on average.

60 The RAIB has not identified any evidence of distraction by signalling activities, other staff or personal issues that would have affected the signaller at the time of the incident.

61 The continuing high demand on the signaller from UWC-T calls was due to a combination of the following:

a. Assessments undertaken as part of the ongoing process for the management of risk at level crossings and signal boxes did not prioritise the need to change crossing types (paragraph 62);

b. The line upgrade in 2012 did not take the opportunity to change the crossing types (paragraph 76); and

c. Telephones had been added to Jetty Avenue level crossing (paragraph 83).

Each of these is now considered in turn.

Level crossing and signal box assessment

62 Network Rail's current process for assessment and management of risk at level crossings is described in procedure 5-16 of its operations manual, 'Risk assessing level crossings'[3]. 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 crossing 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* (CBA)) 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 considered; and
- arrangements for managing and implementing selected risk control options.

63 The frequency of risk assessments largely depends on the crossing's ALCRM risk score and additional assessments can be triggered by accidents, near misses or operational changes. The risk assessment includes consideration of the type of crossing, the sighting and speed of approaching trains, the traverse time, the number and type of users and the incident history. The risk assessment process is implemented by the level crossing manager, who is responsible for a number of level crossings. The last risk assessment of Dock Lane UWC-T was on 18 December 2015 and was still current at the time of the incident.

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

64 Although the ALCRM generic model of a telephone operated crossing includes some account of background human error rates, it does not take account of additional factors that can influence the generic rate for the signaller. One such factor is the complexity of the signaller's task in maintaining awareness of train locations, and this is of particular importance when crossings are associated with long track sections (paragraph 89). Another factor is the workload in the signal box that can arise from having control of a number of telephone operated level crossings.

65 The level crossing manager is required to liaise with operations staff, such as the signallers and their LOM as part of the ALCRM risk assessment process and this is prompted in the assessment checklist. However, the checklist does not identify what input is to be sought or how it should be used. Network Rail has stated that the level crossing manager is expected to record information from the operations staff as part of the narrative risk assessment and to use professional judgement to incorporate these when assessing the outputs of the ALCRM score and the CBA of any improvement options that are being considered for the crossing. This liaison is intended to identify factors that could compromise crossing safety, and the narrative risk assessment template highlights long signal sections and signal box ergonomics as potential risks.

66 When conducting the risk assessment that was carried out on 18 December 2015, the level crossing manager had recorded in the narrative risk assessment that the LOM had expressed concerns about the number of crossing calls being received by signallers at Saxmundham. However, the assessment conclusions were focused on crossing improvements that would target misuse, such as users not using the telephones to get permission to cross. They did not specifically target the LOM's concerns recorded in the narrative risk assessment and so did not prioritise any improvement measures that would address the volume of calls received.

67 Although the level crossing manager is responsible for several level crossings, the risk assessment process is carried out for each level crossing independently.

68 The signaller at Saxmundham is responsible for 29 telephone operated crossings, which are managed by two separate level crossing managers. Some factors, such as the volume and complexity of the signaller's workload, affect all of these crossings. These factors should be recorded separately in the assessments of each of the telephone operated crossings, but may only recognise the demands from the individual crossing rather than the total number of demands, which influences the actual risk of signaller error. Furthermore, potential improvements are assessed for each crossing separately, with the CBA assessing measures for each in isolation, thereby possibly under-estimating the true value of investment.

69 Network Rail stated that, although there is no documented requirement, it expects the level crossing manager(s) to be aware of these factors that span multiple crossings and to take them into account when optioneering improvements. The level crossing manager for Dock Lane stated that he understood that such factors were present. He was aware of the signaller workload issues at Saxmundham that affected multiple crossings, and had recorded them in the narrative part of his assessments.

70 Although he had considered the signaller workload issues, the level crossing manager was conscious that there was a long term proposal to close Dock Lane crossing (paragraph 42) and that possible measures to reduce the calls generated had a relatively low CBA result (paragraph 71b). As a result, optioneering for Dock Lane continued to be driven by the results of the ALCRM assessment, which does not take account of additional factors identified in the narrative element of the risk assessment.

71 The latest optioneering studies carried out for Dock Lane UWC-T concluded that:

a. remote unlocking of the gates by the signaller, to manage misuse by users not telephoning the signaller, had the best CBA result. The RAIB notes that this would not have addressed the number of calls the signaller has to deal with and, although it would have meant that the signaller had to undertake an additional task to allow users to cross, there is no evidence that this would have significantly reduced the likelihood of the signaller making an error.

b. provision of miniature stop lights to provide local indication of trains had the second best CBA result. The RAIB notes that this would have significantly reduced the signaller's call workload, and would do so even more if installed at other similarly trafficked crossings. However, the low cost technology to achieve this could not be used at Dock Lane because of the proximity of Melton station, and a more costly solution with a much lower CBA would be required. This was also seen to be a relatively short term measure until the crossing was closed. Such a system might have prevented the near miss.

72 In addition, the narrative risk assessment also refers to a GPS-based Train Approach Warning System that provides the signaller with better information about train locations. This was intended to be similar to a system developed for use on the Marks Tey to Sudbury line. Development of this system for use at Saxmundham signal box had been under discussion since September 2015. Network Rail considered that this project would address many of the concerns at all of the crossings in long track sections on the line controlled from Saxmundham. This would simplify the task of a signaller in locating trains in long track sections, but would not affect the numbers of calls received from crossings. Such a system could have reduced the mental fatigue of the signaller (paragraph 92).

73 Crossings are considered individually and the optioneering studies did not take account of the full impact of the total number of calls to the signaller nor the extent to which the risk at multiple crossings would be reduced by lowering the number of calls originating from them. For this reason, neither the highest CBA option, nor the technological option being pursued, addressed the issue of the number of calls that the signaller at Saxmundham was receiving. However, it would only have taken measures at three of the 29 telephone crossings controlled from Saxmundham (Dock Lane, Bloss and Jetty Avenue) to reduce the telephone call workload by about 50% (paragraph 58).

74 Separately from the level crossing assessment process, there is the opportunity for LOMs to identify any concerns when carrying out routine observation of signaller competence in the signal box. Any issues that are identified as part of these observations can be shared with the level crossing manager during his liaison as part of the level crossing assessment process (paragraph 65). This process resulted in the LOM concerns being recorded in the narrative risk assessment for Dock Lane (paragraph 66), but they were not addressed by the improvement options selected for further consideration.

75 Network Rail does not carry out routine assessment of signal box workload and ergonomics. However, such assessment is triggered when significant change is proposed. This process was carried out during the signalling upgrade in 2012 (paragraph 77), but the opportunity to change the crossing types was not taken at that time.

Line Upgrade in 2012

76 Until 2012, the signal box at Saxmundham operated a radio based signalling system, where trains were in radio contact with the signaller. The signaller sent electronic tokens to trains to authorise their movement between token exchange points, which were at the start and end of each section of single line controlled from Saxmundham. As a result of the withdrawal of the associated radio frequencies, the signalling was upgraded in 2012 to use conventional signals to control movements and a combination of track circuits and axle counters to determine train positions. At the same time a passing loop was reinstated at Beccles to allow the train frequency to be increased to hourly.

77 At this time, the signal box underwent an ergonomics assessment, as required by Network Rail standard NR/L2/ERG/24020 – 'Engineering assurance arrangements for ergonomics within design and development projects'. The intention was to manage the effects on health, safety and performance of the proposed changes to the equipment, its layout and the method of operation in the signal box.

78 Under the old radio signalling system, the signaller at Saxmundham controlled very long track sections, but was able to make continuous radio contact with train drivers, and so could ask for their locations when considering telephone requests from crossing users. The new signalling system, described in paragraphs 89 to 91, resulted in more visual information about train positions, and shorter track sections (although some of these still took 10 minutes for trains to traverse), but the signaller was no longer in continuous contact with train drivers. The effect of this was that the signaller had more visual information available on the screens. However, because it was insufficient to fully identify the positions of trains in long track sections, the mental task of maintaining awareness of train locations became more complex (paragraph 91).

79 The 2012 ergonomics assessment report (CCD/1075/REP/001/12 – 'East Suffolk Re-signalling work at Saxmundham Box: GRIP 4 Ergonomics') considered the workload on the signaller under the new signalling system. However, this workload assessment considered only the time that the signaller was observably occupied carrying out signalling or crossing related tasks, and not the time that the signaller would be maintaining his mental awareness of train positions. This recorded a time occupancy rate that peaked at about 16%, which the report concluded as being 'low and easily manageable by the signaller'. The report did not consider the extent and complexity of the work involved in the signaller maintaining awareness of train positions, particularly in long track sections.

80 No changes were made as a result of risk/ergonomics assessments to any of the telephone operated crossings within the area controlled by Saxmundham signal box during the line upgrade. However, the ergonomics assessment did recommend that the signaller's workload should be reassessed if earlier proposals to add more telephone operated crossings were pursued.

81 The ergonomics assessment identified that the new signalling display provided the signaller with more information about train positions than the radio signalling system had done, but highlighted that this was not the case for the remaining long track sections. It also acknowledged that if signallers did not allow users to cross at affected crossings while a train was in a long track section, then this could give rise to long waits and encourage misuse (paragraph 90). It recommended further work to mitigate this risk.

82 In response to this, Network Rail carried out a hazard identification exercise focused on preventing misuse at telephone operated crossings in long track sections. The outcome of this was to specifically authorise the Saxmundham signaller to contact train drivers using the GSM-R radio system to ask for their location. In normal circumstances signallers are only authorised to call moving trains in an emergency. At the time, this was considered to be a temporary measure, until better train position indicating technologies were available, or until Wavetrain miniature stop lights had been fitted to the affected crossings (paragraph 41). At the time of the incident, this risk mitigation measure was still in place.

Telephones at Jetty Avenue level crossing

83 Around the time that the signalling system was being upgraded, there were proposals to install telephones at the user worked crossing at Jetty Avenue, south of Woodbridge station (figure 3). At that time, the local Operations Risk Control Co-ordinator[4] for that crossing recorded that he had concerns about fitting telephones at Jetty Avenue because he was aware that the signaller at Saxmundham was 'already overstretched' in dealing with the large numbers of level crossing calls. However, telephones were seen as a temporary solution, because the Wavetrain miniature stop lights were proposed for installation at Jetty Avenue and at several other crossings. As a result, telephones were not installed there in 2012.

[4] At that time, the Operations Risk Control Co-ordinator undertook a similar role to that now undertaken by the Level Crossing Manager.

84 On 14 July 2013 a train collided with a car at Jetty Avenue UWC. This accident was investigated by the RAIB and is detailed in RAIB report 28/2014. Evidence obtained during that investigation indicated that telephones were subsequently installed at Jetty Avenue, on the instruction of the Route Safety Improvement Manager. The request for installation was made on 15 July 2013, the day after the accident.

85 Network Rail standard NR/L2/ERG/24020 – 'Engineering assurance arrangements for ergonomics within design and development projects' requires the ergonomic impact of changes to infrastructure, systems or equipment to be assessed. The level of assessment required depends on the nature and extent of the planned changes, and tables are provided to help categorise proposed work (NR/L2/ERG/24020/F003 - Project Classification Tables).

86 Reference P4 in Table 2 of the standard specifies 're-control or renewal of a level crossing to a location requiring additional remote operations' as being in Category 2, which requires the provisions of NR/L2/ERG/24020 to be applied. This means that an ergonomics assessment of the impact on the signaller's tasks and workload should have been undertaken when the telephones were added to Jetty Avenue level crossing. The need for this was also highlighted by the earlier ergonomics assessment of the signal box at Saxmundham in 2012 (paragraph 80). Network Rail has been unable to provide evidence that such an assessment was carried out.

87 Jetty Avenue is currently one of the three busiest crossings controlled by the Saxmundham signaller, and so accounts for a significant proportion of the signallers' workload arising from user worked crossing telephone calls.

Mental fatigue

88 **It is possible that the signaller was mentally fatigued when the caller asked for permission to cross the line, due to the high mental demand involved in maintaining awareness of train positions in long track sections and relating these to the many UWC-T requests.**

89 The signaller's displays at Saxmundham highlight which track sections are occupied by a train in red (figure 6). Some of these track sections are long and it can take the train considerable time to traverse them. As an example, the track section covering both Bloss and Dock Lane crossings (highlighted in figure 6) extends for a distance of approximately 5 miles (8 km) and includes both Wickham Market and Melton stations; trains take around 10 minutes to traverse it.

90 Although signallers at Saxmundham are able to tell when a train is occupying a track section, they are unable to observe a train's position within it. If a signaller was to refuse users permission to cross the line at crossings within, or near to the exit of, occupied long track sections, some users would have to wait for extended periods before getting permission to cross. This introduces the risk of impatient users either ignoring the refusal or not seeking permission to cross the line, and thus increasing the likelihood of accidents or near misses.

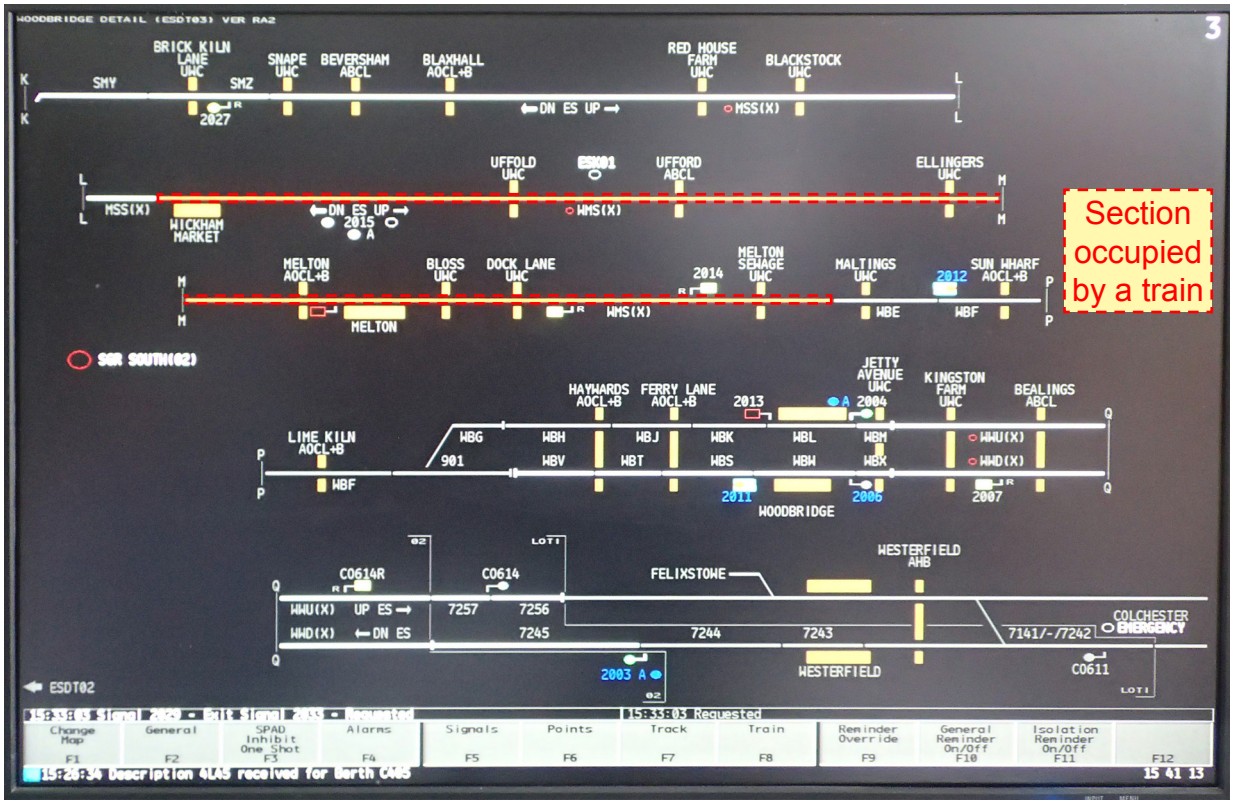

Figure 6: Saxmundham signalling display, showing long track section occupied by a train

91 The signallers at Saxmundham use a number of strategies to manage this risk. These strategies are based on observing when trains enter the long track sections and assessing when they are likely to be approaching the crossings. They use this information to reduce the waiting time for users. These strategies are not documented, but the signallers learn them 'on the job' when becoming familiar with operations at Saxmundham. Signallers at Saxmundham are also specifically authorised to use the railway GSM-R radio system to contact trains at any time if there is doubt about a train position in relation to a crossing user request (paragraph 82).

92 This continuous task of monitoring and maintaining awareness of train positions, and relating these to crossing requests, as they arise, requires a high level of concentration and is mentally demanding. This will result in a cumulative mental fatigue over the course of a signaller's shift. It is also possible that the large number of calls (paragraph 54) would have added to the level of mental fatigue.

93 A post-incident ergonomics assessment report (CCD/1541/REP/001/16 – 'Saxmundham Project Ergonomics Survey') was produced as part of a project to upgrade several automatic crossings in the Woodbridge area (paragraph 118). This report recorded a time occupancy of 49% on average, which was higher than that recorded in the similar survey in 2012 (paragraph 79), and peaked above 75% for 20 minutes of the two-hour survey. This exceeds the 75% limit considered by Network Rail to be the maximum that a signaller can cope with. The survey found that the most time consuming activities were associated with telephone calls from UWC-Ts. The report also emphasised that the time occupancy survey took place on a quiet day and that the figure would be much higher on busier days. The report stated that the 'number of level crossings and UWCs in this control area is substantial and drives the workload for this signal box. It is the unpredictable demand from the crossing requests that keeps the signaller occupied on the phone and with paperwork to record each call. The large number of UWCs under the signallers control presents an operational risk'.

94 The RAIB has reviewed the signaller's shift pattern against the guidance in the Health and Safety Executive's research report R446 'The development of a fatigue/risk index for shiftworkers'. This did not suggest that the signaller's level of fatigue, or the associated risk, is likely have been abnormally high at the time of the incident. In addition, there was no evidence to suggest that the signaller's level of sleepiness was high, or that the signaller had any related health or medication issues.

95 Although the signaller was unable to take any formal breaks during his eight hour shift, he was able to fit in personal needs breaks and to take food/drink between his routine duties, and had eaten about an hour before the incident.

Observations

96 **The signaller used the GSM-R radio system to call train 2D81 directly, rather than using the 'railway emergency call' function.**

97 The GSM-R radio system has a 'railway emergency call' facility whereby the signaller is able to send a message to all trains in an area, requiring them to stop. During the incident, the signaller instead chose to call the train driver directly, to tell him that he had incorrectly authorised the user to cross at Dock Lane. This direct call would have taken longer to alert the train driver than a railway emergency call. However, in this situation it is unlikely to have affected the outcome because the train was either very close to, or past, Dock Lane UWC-T when the call was made. However, if the train had been further from the crossing, it is possible that a railway emergency call could have allowed the train to have been brought to a stop before the crossing.

98 **The signaller did not report the incident.**

99 Railway group standard GE/RT8047 - 'Reporting of Safety Related Information' requires Network Rail to record defined safety related information in the industry's Safety Management Information System (SMIS). This includes 'incidents affecting, or with the potential to affect … the safety and health of persons, such as staff, passengers or public, on Network Rail managed infrastructure or at stations and related to … other signalling or handsignalling errors compromising safety'. In order to comply with this, Network Rail would require the signaller to report operational incidents such as this one.

100 The signaller did not report or record the incident. Having contacted the train driver, who advised that he had not perceived the incident as a near miss (paragraph 27), and spoken with the car driver, who was shocked and did not explicitly state that the train had nearly hit the car passenger (paragraph 29), the signaller continued with his duties. The signaller considered that he had dealt with the incident with no consequence for either the crossing user or for the train.

101 This suggests that there may be under-reporting of human error related incidents by signallers managing telephone operated crossings. As a result, the associated risks may not be fully accounted for when risk-assessing level crossings.

Previous occurrences of a similar character

102 The RAIB is aware of a number of other recent incidents where signallers have either not obtained or clarified the information provided by the crossing user or misjudged the location of the train. These have resulted in a signaller giving permission for a user to cross the railway with a train closely approaching the crossing. Some of these incidents could have resulted in a collision occurring had the signaller not realised their error and either called the user back or stopped the train. Other incidents have resulted in an accident or a near miss. Two of these accidents were the subject of separate investigations by the RAIB. These were at White House Farm crossing near Kings Lynn, Norfolk, on 25 September 2011 (RAIB report 06/2012) and at Hockham Road crossing near Thetford, Norfolk, on 10 April 2016 (RAIB report 04/2017). Another incident at Thorney Marsh Lane crossing at Castle Cary, Somerset has been published as a safety digest (Safety Digest 02/2017). Two incidents where a Saxmundham signaller erroneously gave a user permission to cross when a train was approaching a crossing also occurred at Maltings UWC-T on 22 November 2016 and at Dock Lane UWC-T on 3 April 2017.

Summary of conclusions

Immediate cause

103 Having received permission to cross from the signaller, a member of the public was about to use the crossing when a train passed (paragraph 44).

Causal factors

104 The causal factors were:

a. It is possible that the signaller's thought process was diverted by the familiar and 'light-hearted' nature of the call, and that he gave an automatic response (paragraph 48, **Learning point 1**).

b. There were numerous calls to the signallers operating Saxmundham signal box due to the large number of UWC-T crossings, with a cumulative high traffic load, controlled from there. This demand rate made the possibility of a signaller error more likely (paragraph 53, **Recommendations 2 and 3**). The high demand on the signaller from UWC-T calls continued due to a combination of the following:

   i. Assessments undertaken as part of the ongoing process for the management of risk at level crossings and signal boxes did not prioritise the need to change crossing types (paragraph 62, **Recommendation 1**).

   ii. The line upgrade in 2012 did not take the opportunity to change the crossing types (paragraph 76, **Recommendation 4**).

   iii. Telephones had been added to Jetty Avenue level crossing (paragraph 83, **Recommendation 4**).

c. It is possible that the signaller was mentally fatigued when the caller asked for permission to cross the line, due to the high mental demand involved in maintaining awareness of train positions in long track sections and relating these to the many UWC-T requests (paragraph 88, **Recommendation 2**).

Additional observations

105 Although not linked to the near miss on 14 June 2016, the RAIB observes that:

a. The signaller used the GSM-R radio system to call train 2D81 directly, rather than using the 'railway emergency call' function (paragraph 96, **Learning point 2**).

b. The signaller did not report the incident (paragraph 98, **Learning point 3**).

Previous RAIB recommendations relevant to this investigation

106 The following recommendations, which were made by the RAIB as a result of its previous investigations, and are currently being implemented, have relevance to this investigation.

Accident at Moreton-on-Lugg, RAIB report 04/2011, Recommendation 2

107 This recommendation (in RAIB report 04/2011) addressed management of human error by signallers. So as to avoid duplication, it is not remade in this report.

Recommendation 2

Network Rail should enhance its level crossing risk management process to include identification, assessment and management of the risk associated with:

- *human error by signallers and crossing keepers;*
- *operational arrangements, in particular with regard to the ability of operators to cope with interruptions, such as telephone calls, and other out-of-course events;*
- *equipment design, in particular where it is not compliant with latest design standards; and*
- *maintenance and inspection arrangements, particularly where these are used to identify and remedy any equipment functional and performance deficiency.*

The process should allow for sufficient liaison between the relevant engineering and operational departments.

When addressing risks identified by the implementation of the revised process, Network Rail should prioritise the implementation of required mitigation measures to level crossings where consequences of operator error are severe and not protected by engineered safeguards.

108 The Office of Rail and Road (ORR) has reported that Network Rail has taken the recommendation into consideration and is taking action to implement it. It notes that the introduction of the Narrative Risk Assessment to the level crossing assessment process addresses part of the recommendation.

109 The RAIB considers that this recommendation is relevant to the liaison between level crossing managers and operations personnel that is required to ensure that risks associated with signaller workload are managed effectively.

Accident at Hockham Road User worked Crossing, RAIB report 04/2017, Recommendation 1

110 This recommendation (in RAIB report 04/2017) addresses the availability of train location information for signallers, and signaller errors when managing telephone operated crossings. So as to avoid duplication, it is not remade in this report.

Recommendation 1

Network Rail should undertake a review of its measures for the protection of user worked crossings with the objective of identifying means of reducing the likelihood that an accident will be caused by signaller error. Options for consideration should include:

- *improved information for signallers (including consideration of ways of better enabling signallers to judge the time needed for a movement over a crossing and the time available before a train arrives at a level crossing);*
- *increased use of automatic warning systems;*
- *closure of UWCs or their replacement by automatic crossings.*

The review should also identify criteria for the prioritisation of improvements taking into account both risk and the opportunities presented by planned signalling upgrades. The findings of the review should be incorporated into Network Rail's level crossing strategy and the standards used to prepare specifications for new signalling schemes.

111 This recommendation had just been made at the time of publication of this report, and so the industry had not had time to identify its intended actions to address it.

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

112 After the incident, the signaller was rebriefed and discussed additional possible operating strategies with his manager before returning to duty.

113 The incident triggered Network Rail to review the risk assessment for Dock Lane crossing, which concluded that telephones were an appropriate risk mitigation measure for vehicle users of the crossing.

114 Network Rail has issued prompt cards to signallers operating telephone crossings. These cards detail the expected call communications protocol that the signaller should follow, and the information that they need to obtain from crossing users. This initiative was prompted by a number of previous crossing incidents, and not specifically by this incident.

115 Network Rail has identified that there are technical difficulties in using low cost miniature stop light systems at Dock Lane crossing, due to the proximity of Melton station. The inability of these systems to differentiate between stopping and non-stopping trains means that warning times at the crossing would be inconsistent.

116 Network Rail is pursuing procurement of a GPS Train Approach Warning System that provides the signaller with better train location information (paragraph 72).

117 Network Rail is developing long term proposals to close a number of user worked crossings in the Woodbridge area, including that at Dock Lane, and to provide replacement access via new link roads (paragraph 42).

118 As part of a separate project, Network Rail is progressing plans to convert a number of AOCL+B crossings in the Woodbridge area to be full barrier crossings with obstacle detection. This proposed change resulted in an additional ergonomics assessment of the signal box at Saxmundham, prompted by the concerns about the consequent increase in the signaller's already busy workload (paragraph 93). At the time of publication of this report, the project was still examining the measures that would be required to manage the signaller's workload.

119 Network Rail provided the RAIB with a copy of an internal document that describes its long term national strategy for level crossings ('Transforming Level Crossings - A long-term strategy to improve safety at level crossings'). This includes an intention to either close, or to provide additional mitigation measures (such as miniature stop lights) at all UWC-Ts by 2025. There is also an intention to eliminate the use of telephones at UWC-Ts in long track sections by the same date. Network Rail has indicated that its ability to meet the strategy intentions will be subject to funding and resourcing, and the availability of cost-effective technology.

Recommendations and learning points

Recommendations

120 The following recommendations are made[5]:

1 *The intent of this recommendation is to ensure that all elements of human error by signallers are accounted for when assessing the risks to users at telephone equipped level crossings and when considering options to reduce the level crossing risk.*

Network Rail should review, and revise as necessary, its risk management processes so that the risk of signallers making errors when controlling telephone operated level crossings is taken into account when identifying appropriate improvement options. This should include consideration of factors that affect:

- the probability of signallers making errors; and
- the number of crossing decisions that signallers are required to make.

Network Rail should also clearly identify who is responsible for assessing the risk associated with signallers making such errors (paragraph 104b.i).

[5] 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.

2 *The intent of this recommendation is to ensure that Network Rail fully understands the demand rate and work complexity for the signaller at Saxmundham signal box in dealing with telephone calls from user worked crossings, as well as other signalling activities.*

Network Rail should reassess the risks associated with the work demand on the signaller at Saxmundham signal box, using all the relevant assessment tools that it has available, to ensure that the number of permissions to cross given when it is not safe to cross is being managed to an acceptable level. This should include consideration of:

- the complexity of the tasks that the signaller needs to undertake;
- the number of user worked crossing calls that are dealt with by the signaller; and
- potential measures to reduce the number of user worked crossing calls that the signaller has to deal with.

It should produce a time-bound plan for implementation of any identified improvements (paragraphs 104b & 104c).

3 *The intent of this recommendation is to identify and assess any other signal boxes that manage high volumes of user worked crossing telephone calls, and reduce the associated risk, if necessary.*

Network Rail should identify signal boxes, and other locations, where signallers, or similar, are responsible for giving permission to cross at multiple high usage telephone crossings. It should reassess the risks associated with the work demand on the signallers at each such location, using all the relevant assessment tools that it has available, to understand whether the signaller's workload is being managed effectively. Where this is not the case, it should develop prioritised, time-bound plans for implementing any necessary improvements (paragraph 104b).

4 *The intent of this recommendation is to ensure that signallers' workload is maintained at acceptable levels.*

Network Rail should define criteria for when it is appropriate to either assess or re-assess the workload demands on signallers, and implement processes to ensure that the criteria are adhered to. Criteria for consideration could include, but not be restricted to:

- upgrades at the signal box;
- changes to the equipment controlled from the signal box;
- changes to usage;
- changes to the rates of incidents recorded;
- concerns identified during level crossing assessment;
- routine periodic assessment (paragraphs 104bii & 104biii).

Learning points

121 The RAIB has identified the following key learning points[6]:

1 When taking calls from level crossing users, it is important that signallers take the lead in the conversation and verify the information needed to make a safe decision (paragraph 104a).

2 When signallers need to stop a train in an emergency, it is important that the option of using the GSM-R radio system 'stop all trains' command is actively considered, as well as the option of contacting the train directly (paragraph 105a).

3 It is important that signallers report all near misses and operational errors, so that incident statistics are accurate and relevant safety learning can be properly targeted (paragraph 105b).

[6] '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
AOCL+B	Automatic open crossing (locally monitored) with barriers
CBA	Cost benefit analysis
CCTV	Closed-circuit television
GPS	Global positioning system
GSM-R	Global system for mobile communications – Railway
HEP	Human error probability
LOM	Local operations manager
MSL	Miniature stop lights
ORR	Office of Rail and Road
RAIB	Rail Accident Investigation Branch
SMIS	Safety management information system
UWC	User worked crossing
UWC-T	User worked crossing with telephone

Appendix B - Glossary of terms

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

Automatic open crossing	A level crossing protected by flashing lights that are triggered by approaching trains. Some of these have been fitted with supplementary half barriers.
Cost benefit analysis	A process for comparing the total costs of project options with the total benefits that they would provide, used to prioritise options.
Human error	The making of an error as an inevitable or natural result of being human.
Human error probability	The probability of a person making an error when undertaking a given task.
Lever frame signal boxes	A traditional style signal box where the signals and points are operated by manual levers.
Local operations manager	An individual who manages the day to day operation of a given area of Network Rail infrastructure, and has line management responsibility for operational staff, such as signallers.
Miniature stop lights	Small red and green lights mounted on a board adjacent to a user worked level crossing or footpath crossing. The lights are operated by the passage of trains. They are sometimes called miniature warning lights.
Risk assessment	A process of evaluating the potential risks that are involved in an activity or undertaking.
RSSB	A cross-industry organisation, formerly known as the Rail Safety and Standards Board, undertaking safety and standards related activities.
Telephone concentrator	A selector panel on the signaller's desk that allows a particular telephone call or line to be selected.
Track section	A length of track with fixed boundaries between which the train detection system provides information about its clear or occupied status.*
User worked crossing	A private level crossing, usually protected by outward opening farm type gates. Many are fitted with telephones which users crossing in a vehicle, or with animals, are required to use to obtain the permission of the signaller to cross. Some are fitted with red/green miniature stop lights.

Appendix C - Investigation details

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

- information provided by witnesses;
- level crossing documentation;
- signal box documentation;
- signalling and level crossing data recordings;
- site photographs and measurements;
- weather reports and observations at the site;
- a review of other similar reported incidents; and
- a review of previous RAIB investigations that had relevance to this accident.

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