Rail Accident Investigation Branch

Rail Accident Report

Collision at Black Horse Drove Crossing, near Littleport, Cambridgeshire 19 October 2005.

Department for Transport

Report 12/2006
July 2006

This investigation was carried out in accordance with:

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

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

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Contents

Introduction

1 The sole purpose of an investigation by the Rail Accident Investigation Branch (RAIB) is to prevent future accidents and incidents and improve railway safety.

2 The RAIB does not establish blame or liability, or carry out prosecutions.

3 Appendices at the rear of the report contain Glossaries explaining the following:

- acronyms and abbreviations are explained in the Glossary at Appendix A; and
- certain technical terms (shown in italics when they first appear in the body of this report) are explained in the Glossary at Appendix B.

Summary of report

Key facts about the accident

4 The accident occurred when a train travelling between Littleport and Downham Market collided with a tractor hauling a trailer over a user worked level crossing.

5 The accident took place at Black Horse Drove crossing in Cambridgeshire just after midday at 12:04 hrs on Wednesday 19 October 2005. Figure 1 shows an aerial view of the crossing and Figure 2 is a map of the area.

Figure 1: Aerial view of level crossing area

6 The train involved was 1T05, the 10:45 hrs from London King's Cross to King's Lynn, and consisted of a four car class 365 electric multiple unit. The train who was operated by West Anglia Great Northern Trains Ltd (WAGN). The driver of the train was employed by WAGN, had driven the train from London and was bound for King's Lynn.

7 The railway infrastructure manager was Network Rail, South East Territory. The line at this location is single track and the signalling system is single line *track circuit block*. The signalling is controlled from signal boxes at Littleport and Downham Market. A telephone is provided at the crossing which communicates with Downham Market signal box.

8 The tractor was on hire from Evergreen Tractors Ltd to Waldersey Farms Ltd. The tractor was being driven by a driver employed by Waldersey Farms Ltd. The tractor was taking potatoes from fields at Anchor Drove, near Brandon Creek to Cross Drains Farm at Black Horse Drove.

9 The accident led to the destruction of the tractor and the death of its driver. The leading vehicle of the train was damaged in the impact but the train did not derail. Only minor injuries were sustained by the train driver and a passenger. The trailer being pulled by the tractor was not on the level crossing at the moment of impact and was not damaged.

10 The ambulance service, Fire and Rescue Service and police attended the site along with representatives of the train operator and evacuated the passengers and crew from the train. The debris was cleared from the line and the train removed to the depot later that evening, allowing the line to reopen for the morning peak service the following day.

11 The level crossing equipment was tested and found to be in good order with the exception of the sounder units, which were permanently set on the lower volume 'night' setting. However, these sounders are only designed to be heard by pedestrians.

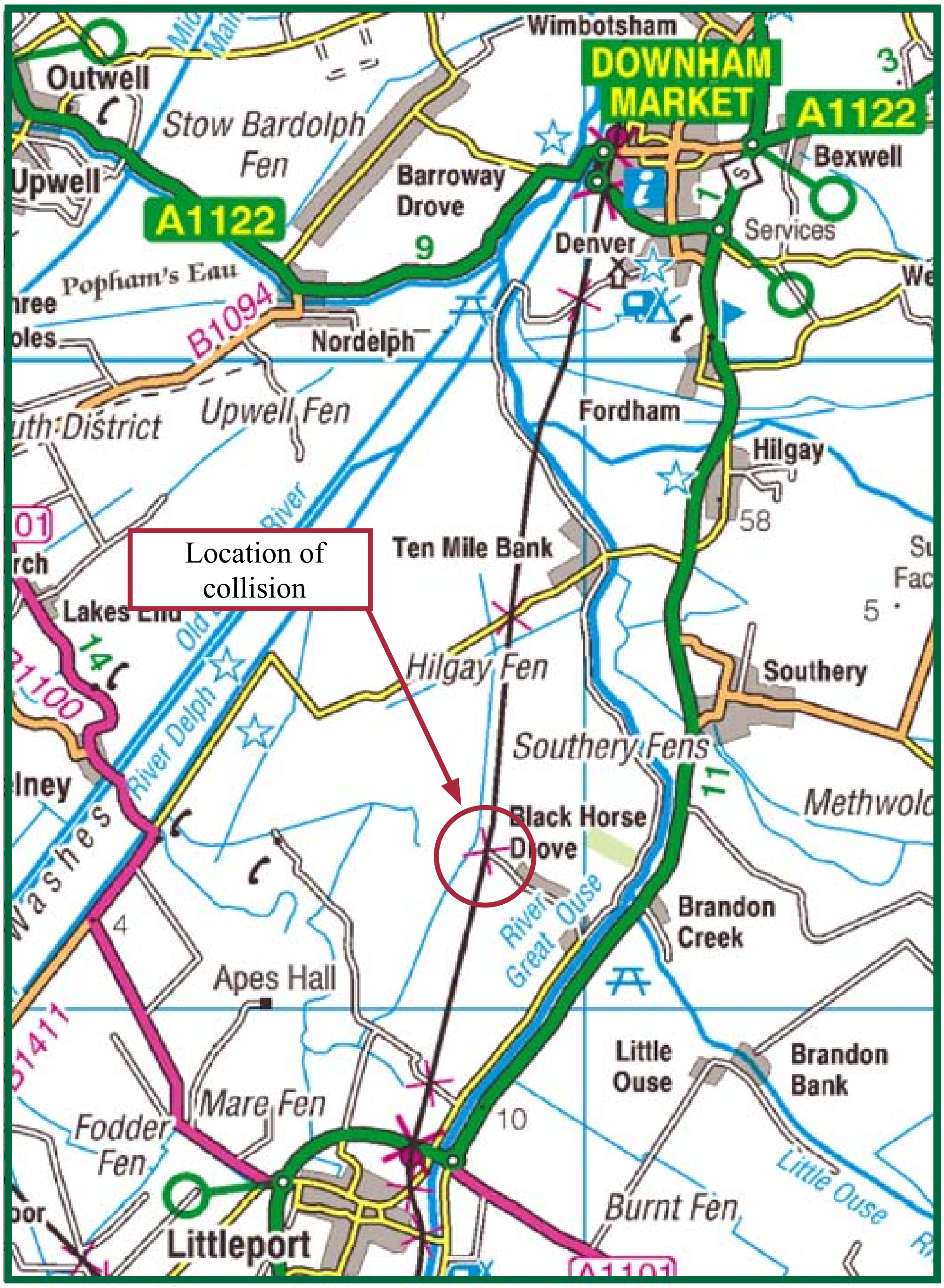

Figure 2: OS map extract showing location of accident

Immediate cause, contributory factors, underlying causes

12 The immediate cause of the accident was that the tractor driver started to cross the railway line despite the *miniature stop light* being red and with a train approaching at speed.

13 Causal factors were:-

- the possibility that the gates may have been left open prior to the tractor's arrival at the crossing, though this cannot be proved or disproved;
- the limited visibility of the line from the tractor due to a large bush at the lineside.

14 If the gates had been left open prior to the tractor's arrival at the crossing then an additional causal factor is that the tractor driver may have not noticed the miniature stop lights. Most road users very rarely encounter user worked crossings with miniature stop lights. If the gates were closed when the tractor arrived, this factor would be contributory, rather than causal, as the driver would have had to get out and operate the gates. Whilst doing this he would have to walk up to the miniature stop light and sign which gives instructions.

15 Underlying cause:-

The underlying cause was one of the following two alternatives. It is not possible to distinguish which of these was the cause on the evidence that is available.

- The tractor driver encountered the crossing with the gates already open and failed to notice the miniature stop light.
- The tractor driver, after correctly checking the light and opening the gates, was distracted. Depending on the position he had reached at the time of the distraction, he would have been either unable to see the light or he may have omitted to recheck the light.

Severity of consequences

16 The tractor driver was killed in the collision and his tractor destroyed.

17 The leading vehicle of the train suffered extensive damage to the front fairings but the cab structure withstood the impact without infringing the driver's survival space.

18 The passenger compartments in the train were not damaged, apart from the internal sliding doors to the first class section being dislodged from their tracks, causing them to jam in the closed position. Had the drivers cab been unavailable as an exit route, this would have hindered evacuation.

19 The train driver and one passenger sustained minor injuries.

Key conclusions

20 The accident was caused by the tractor driver either not noticing the red miniature stop light at the crossing or, for the reasons given in paragraph 15, choosing to ignore it and driving his tractor onto the railway.

21 Once the tractor had started to cross, there was nothing that the train driver could do to prevent the collision.

22 The crossing was used by the farm infrequently and the day of the accident was the first day that the crossing had been used in this particular harvesting operation. The tractor driver had received no specific instruction in the use of this crossing from his employer and was expected to obey the normal Highway Code rules. Although the Highway Code gives these instructions, most road users of user worked crossings very rarely encounter them with miniature stop lights, or refresh themselves on the contents of the Highway Code. The relevant section of the Highway Code is reproduced in Appendix E. The tractor driver had used this crossing many times in the past and was aware of the importance of closing the gates. However, he may not have been so familiar with the miniature stop lights.

23 Whilst not a requirement at a user worked crossing with miniature stop lights, the maintenance of clear *sight lines* by removal of lineside vegetation is a reasonably practicable measure that could have prevented this incident.

24 The safe working of user worked crossings is critically dependent on the gates remaining closed at all times following use. If crossing users do not immediately close the gates after crossing and another user approaches the crossing, there is nothing to draw their attention to the miniature stop lights and there is a risk of them seeing the road is clear and proceeding onto the crossing. It cannot be proved whether the gates were open or closed when the tractor approached.

Recommendations

25 Recommendations can be found at paragraph 157. They relate to the following areas:

- visibility of the line from user worked crossings;
- adequacy of signage at user worked crossings with miniature stop lights;
- maintenance of records of user worked crossings;
- communication of safety information to users of user worked crossings.

These recommendations are directed at infrastructure owners and maintainers (Network Rail), the Safety Authority (ORR/HMRI) and the Department for Transport.

The Accident

Description of the accident

26 The tractor drove up to the crossing gate line at least 11 seconds before the train reached the crossing. The train driver saw the tractor and sounded the horn. The tractor paused then continued onto the crossing. On seeing the tractor go onto the crossing, the train driver applied the brake when the train was 4 seconds from the crossing. According to its data recorder, the train was travelling at 92 mph (147 km/h prior) prior to braking and the brake had only just started to retard the train when the collision occurred.

27 The train collided with the tractor on the crossing at a speed of 90 mph (144 km/h). The tractor driver (tractor driver 1) was killed and the tractor destroyed.

28 The train was not derailed and came safely to a stand 647 m beyond the crossing. The train driver and one passenger suffered minor injuries.

The parties involved

29 The train was operated by WAGN and was being driven by one of their drivers as a driver-only operated train. On board the train were 32 passengers and two WAGN revenue control officers.

30 The tractor was owned by Evergreen Tractors Ltd and was on hire to Waldersey Farms Ltd who were using it to haul potatoes from the fields to a storage area at Cross Drains Farm. The tractor was being driven by a driver employed by Waldersey Farms.

31 The collision occurred on Network Rail infrastructure, on the Anglia Route in the South East Territory.

Location

32 The collision occurred at Black Horse Drove user worked crossing near Littleport in Cambridgeshire (grid reference TL586925). Black Horse Drove is on the Bethnal Green to King's Lynn line at mileage 79 miles 19 chains, measured from Liverpool Street. The *Engineer's Line Reference* is BGK. The crossing lies on the boundary between the counties of Cambridgeshire and Norfolk, but is just inside Cambridgeshire.

33 The surrounding countryside is flat fenland with isolated farms and houses. A minor road crosses the railway at Black Horse Drove, giving access to two farms and two houses on the west side of the line. The crossing is protected by steel tubular gates which are normally closed across the road and have to be operated by the road user.

34 The railway consists of a single track on a former double track formation and the line is electrified with 25 kV overhead equipment. The level of the railway on a low embankment means that the road approaches to the crossing slope up towards the line. The east side approach has a gradient of 1 in 17. The railway on the Littleport side of the crossing is straight and the railway on the Downham Market side of the crossing is on a shallow radius curve. The *linespeed* at the crossing is 90 mph (144 km/h) for *electric multiple unit* (EMU) trains and 75 mph (120 km/h) for others. Figure 3 shows a plan of the site and Figure 4 shows the east side road approach.

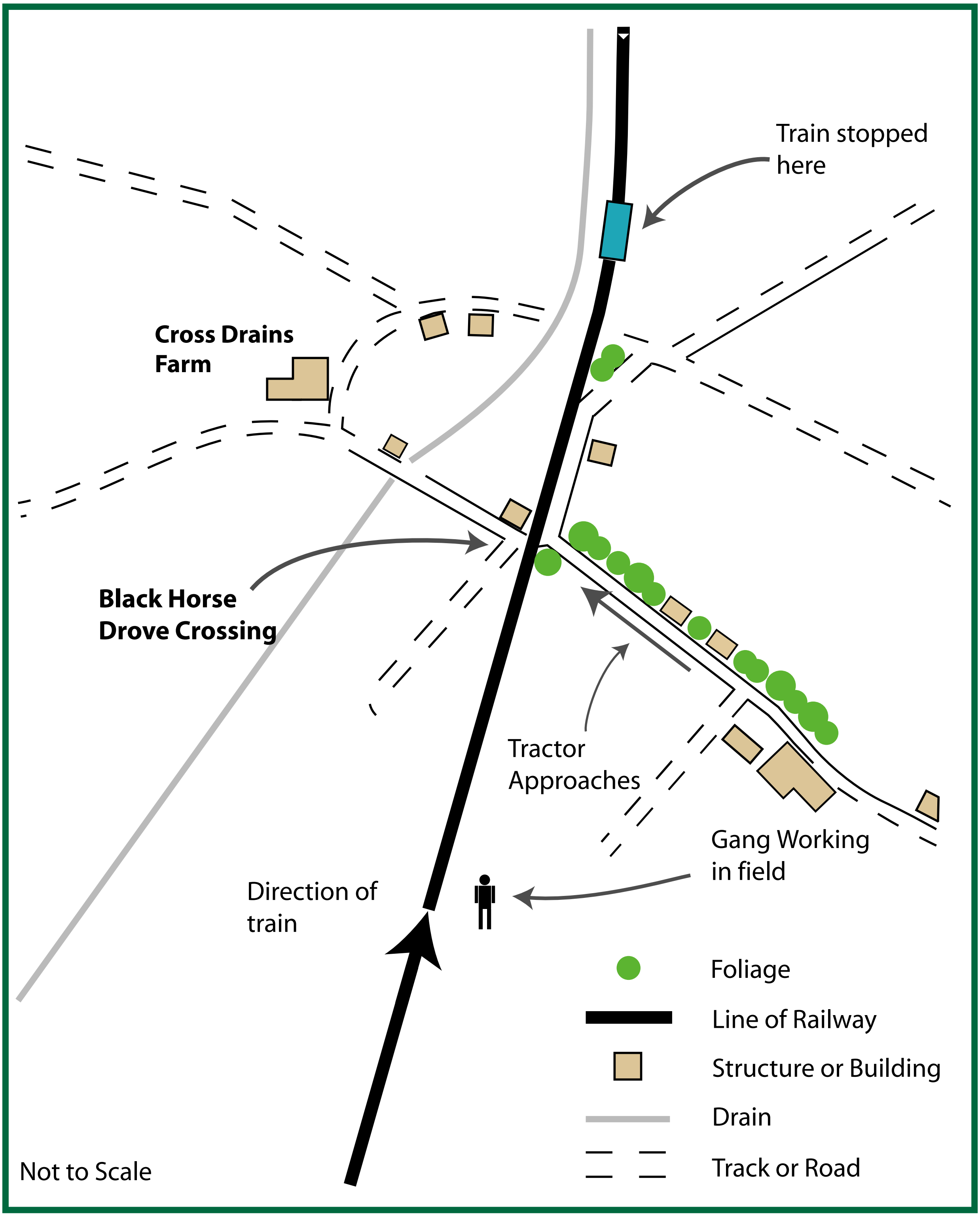

Figure 3: Plan of site

Figure 4: View of crossing approach from East side showing the stop line and gate line

35 Black Horse Drove is one of a number of crossings on the line between Littleport and Downham Market. The single track section of line between these places contains a total of 12 level crossings; 3 public road crossings with automatic half barriers (AHB) and 9 user worked crossings. Appendix D lists these crossings.

External circumstances

36 The weather on the day of the incident was changeable with dry sunny periods interspersed between heavy rain storms. At the time of the incident the weather was lightly overcast. Visibility was good.

Train(s)/rail equipment

37 The train was formed of a single 4-car electric multiple unit of class 365, number 365531. The vehicles making up the unit are aluminium bodied coaches which were built in 1995 by ABB Ltd at York.

38 The train was designed to 'crashworthy' principles defined by Group Standard GM/RT/2100 issue 2. These were developed following the Clapham Junction crash in 1988. This meant that the front of the train was fitted with *anti climb devices*, *collapse zones* and an *obstacle deflector* in front of the leading wheels. The vehicle body was constructed from welded aluminium extrusions and the cab structure, including energy absorbing elements, was fabricated from aluminium plates and sections. The cab front fairing was a glass reinforced plastic (GRP) unit fitted over the aluminium structure.

39 The train entered service in 1995 and the design of the cab, with its large windscreens, led to complaints from drivers about overheating. To overcome this problem, an air conditioning unit was fitted in front of the cab and covered over by an additional GRP fairing. This meant that the lower half of the cab front consisted of a double layer of GRP with a gap between the layers filled with air conditioning plant, pipes and cables.

40 The total weight of the train, including passengers, was approximately 153 tonnes and the leading vehicle weighed 41.7 tonnes.

The tractor

41 The tractor was a John Deere 6920 type delivered to its first owner on 28 April 2003. The tractor was fitted with a set of John Deere counterweights at the front and was towing a Richard Western ‘Suffolk rootcrop’ trailer. The tare weight of the tractor was 5.88 tonnes and the total weight, including an estimated amount of fuel, was 7 tonnes. The trailer was almost fully loaded with potatoes and its total weight was 16.5 tonnes. Figure 5 shows an identical tractor, but without the front counterweights fitted.

Figure 5: John Deere 6920 tractor

Events immediately preceding the accident

42 The train was proceeding from Littleport towards Downham Market and was running 7 minutes behind schedule after being held up earlier in its journey. The train stopped at Littleport station at 12:01 hrs. On departure, the train ran over the A10 level crossing and slowed for a 40 mph (64 km/h) speed restriction as it went onto the single track and through an *overhead line neutral section*. After passing this neutral section, the train accelerated to the linespeed of 90 mph (144 km/h). The data recorder (OTMR) on the train shows that the train was travelling at 92 mph (147 km/h).

43 The tractor driver killed in the accident, tractor driver 1, had started his journey from potato fields at Anchor Drove, 9 miles (14 km) away by road. His journey took him along a minor road to Brandon Creek then along the A10 main road to Littleport (Figure 2 shows a map of the area). Here he left the main road and took a minor road alongside the River Great Ouse to Black Horse Drove. He then went along the Black Horse Drove minor road up to the level crossing. He was heading for Cross Drains Farm, a short distance beyond the crossing. With a full load, the journey from field to farm would have taken about 45 minutes.

44 There were several tractors and trailers involved in the harvesting operation and they set off from the field at different times. The tractor in front of the one involved in the accident had been well ahead and had unloaded and returned before the accident tractor reached Black Horse Drove. The tractor following the incident tractor loaded up at the same time from a different harvester and both set off close together. The driver of the second tractor, tractor driver 2, stopped during the journey and was about half a mile behind tractor driver 1 at Black Horse Drove. A third tractor and trailer was following a few minutes behind the second.

45 A gang of fencing contractors from IMS Ltd was working for Network Rail repairing lineside fencing on the east side of the line, 600 m to the south of the crossing (Littleport direction). They had parked their vehicles beside the road at the crossing and walked through the fields to their worksite.

Events during the accident

46 Tractor driver 1 drove towards the level crossing and stopped. Witness evidence is contradictory here. The train driver states that the tractor drove up to the crossing and only paused for a second or so before driving onto the crossing. This implies the gates were already open when the tractor arrived. However, the last known person to use the crossing, a nearby resident, said that they had closed them only a few minutes before the collision and no-one else had used the crossing in the meantime.

47 A large elderberry bush partly obscured the tractor from the train and completely obscured the train from the tractor. The counterweight on the front of the tractor was seen protruding from behind the crossing gate line by the train driver. The train driver blew the horn but the tractor started to cross the line.

48 Evidence from the on-train monitoring recorder (OTMR) shows that the first blast of the warning horn started when the train was 425 m (10.4 sec) from the crossing and continued for 2.8 seconds. The horn was then blown for a second time starting 299 m (7.3 sec) from the crossing and continued for 2.6 seconds, then a 0.2 second gap followed by another 1 second blast of the horn. The horn finished when the train was 143 m (3.5 sec) from the crossing.

49 The train driver saw that the tractor driver was continuing onto the crossing. Realising a collision was imminent, he applied the brake in the *step 3 (full service)* position. The brake application started 151 m (3.7 sec) from the crossing and the *brake handle* reached step 3 at 119 m (2.9 sec) from the crossing. The train struck the tractor on the crossing at which moment the train speed was 90 mph (144 km/h). The position of the tractor relative to the train at the moment of impact is shown in Figure 6. The position was determined from the scrape mark left on the road surface by the trailer drawbar. This drawbar fell to the ground and the trailer ran back under gravity leaving a gouge in the road surface.

50 The relative orientation of the train and tractor are shown in Figures 6 and 7 in plan and elevation respectively. Figure 7 shows how the rear axle of the tractor was at the same height as the right side *anticlimber* on the train. This meant that the initial impact force was borne by the train on the members that were designed for this purpose. The skew of the level crossing meant that the initial impact was between the GRP fairing over the right side anticlimber and the back wheel tyre of the tractor. This impact would not have been severe and the anticlimber continued into the main structural core of the tractor, bursting the fuel tank. The main tractor units; chassis, gearbox and back axle, are all aligned at the height of the rear axle and were broken apart by the right side anticlimber.

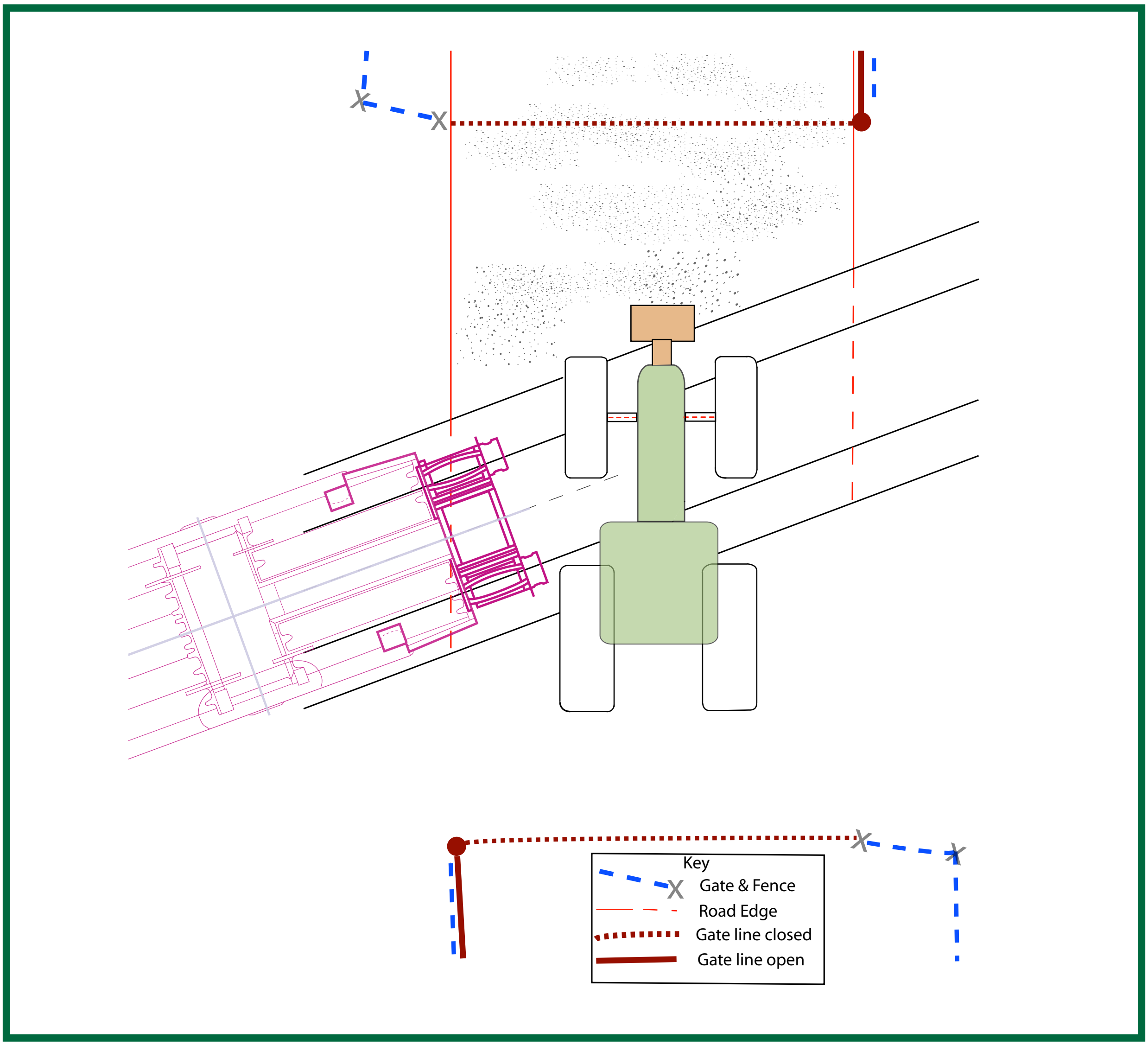

Figure 6: position of tractor and train just prior to impact (plan)

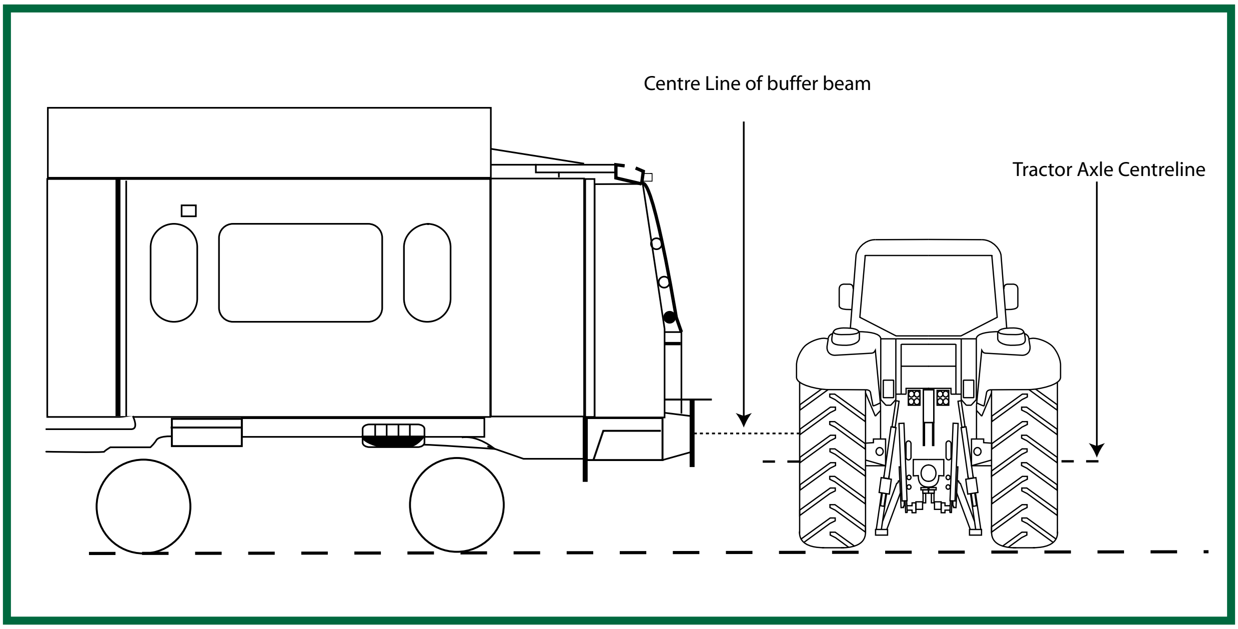

Figure 7: Position of tractor and train just prior to impact (elevation)

51 The impact pushed the tractor over raising the left side front wheel so that its axle end impacted with the train's left side anticlimber. The front axle was then wedged between the anticlimber and the timber surface of the crossing. The train pushed the axle across the timber surface leaving score marks (Figure 8) before the axle was thrown clear with the rest of the debris as the tractor broke up.

Figure 8: Gouge marks on crossing surface

52 Very early on in the collision, the coupling between tractor and trailer was broken though the drawhook connection to the trailer remained intact. The failure occurred where the drawhook assembly attaches to the tractor, this assembly remaining attached to the trailer (Figure 9). The trailer then rolled back down the slope clear of the line.

Figure 9: Trailer with part of the tractor drawbar still attached

Figure 10: Front of train showing impact marks from tractor cab

53 The top of the tractor cab impacted the GRP fairing of the train cab high up, breaking the train windscreen (Figure 10), though the glass remained in place. The rear section of the tractor was then pushed aside to the right of the train impacting heavily with the train driver's door and breaking the glass, which showered into the train cab.

Consequences of the accident

54 Tractor driver 1 was killed instantly in the collision. The train driver suffered a minor shoulder injury and was showered with broken glass but was not cut by it. One train passenger suffered a minor injury.

55 As would be expected, the leading vehicle in the train sustained the most damage, but the following vehicles also suffered superficial damage from tractor debris. This damage consisted of scratches and minor impacts to the exterior of the train on the right hand side and impact damage to some of the underfloor equipment. Figure 11 shows the damage to the front of the train.

Figure 11: Damage to front of train

56 The train front was built to comply with the *crashworthy principles* of GM/RT 2100 and so had anticlimbers in the position where a conventional train has buffers. The offside anticlimber struck the tractor at the front of the rear tyre then impacted on the plastic fuel tank. This caused the diesel fuel from the tractor to be ejected and the spray obscured the train from the view of some witnesses. Despite the presence of 25 kV overhead electrification, this fuel cloud did not ignite.

57 The relative height of the train's structural underframe members and the tractor's main masses meant that the centre of gravity of the large parts of the tractor aligned with the axis of the train underframe. The underframe was therefore able to resist the impact loading with the energy absorbing members deforming in the process. If the relative heights of the underframe and tractor were different, the consequences of the accident could have been much more serious for the train driver and passengers as the cab could have been severely damaged or the train derailed.

58 The front counterweight of the tractor broke free and projected at an angle to the left of the train into the (open) level crossing gate, damaging the gate. The weight then bounced off the gate and ended up in the road on the west side of the crossing.

59 The tractor debris trajectory was at a shallow angle to the railway line and to the right of the train. Very little debris was thrown to the left, apart from the counterweight. The main parts of the tractor, including the cab superstructure and instrument panel were thrown a distance of between 7 m and 25 m. Lighter debris, such as the engine cowling and air cleaner parts, were carried further in the train's slipstream and this debris was found between 30 m and 147 m from the impact.

60 The tractor engine was mounted on top of the main chassis member and this raised it above the level of the train's anticlimbers. The engine was struck by the front section of the cab where the two GRP skins are at their maximum separation and the collision imparted a considerable amount of energy to the engine. The engine was thrown a total distance of 171 m, ricocheting off a gate before coming to rest in reeds at the lineside. The engine was almost complete (Figure 12); the weight of a complete engine is 537 kg. The impact pushed the cab front inwards, causing a panel to dislodge from the driver's desk.

Figure 12: Tractor engine

61 The GRP cladding on the lower part of the front of the train was broken up and the electrical connection box at the coupler was destroyed. The anticlimbers suffered heavy impacts and their supporting structure was distorted. This supporting structure consists, in part, of curved plates behind the anticlimbers whose purpose is to absorb energy. These were distorted (Figure 13). The cab structure had shortened such that the left side anticlimber moved back by 22 mm and the right side anticlimber was pushed back a maximum of 382 mm, though it was rotated to the right side. This shortening of the cab structure was evident in the buckling of the floor plate (Figure 14).

Figure 13: Damage at left side of train

Figure 14: Buckled floor plate beneath train cab

62 The front coupling remained intact but the electrical connection box was destroyed. The coupler at the other end of the leading vehicle sustained a degree of shock loading which was sufficient to cause the *attachment bolts* to show signs of movement, though they did not fail.

63 The train was fitted with an obstacle deflector in front of the bogie. There were no marks on the deflector from impact with debris, so it did not play a part in this incident. Small debris had, however, got beneath the train as there was evidence of impacts with underfloor equipment.

64 The impact destroyed the electrical connections at the train coupler and led to the loss of several electrical signals including *door interlock* and *overhead line light*. The disturbance to the electrical system also caused the loss of the electrical signal on the *brake wires* which had the effect of applying the brake in the *emergency position*. The brake handle remained in step 3 throughout and was found in this position by the RAIB inspectors.

Events following the accident

65 The IMS Ltd COSS (Controller of Site Safety) saw the collision and raised the alarm with Littleport signal box at 12:04 hrs using his mobile phone, before the train had stopped moving. He asked for the emergency services to attend and for the overhead power supply to be isolated.

66 At 12:05 hrs, once the train had stopped, the train driver used his mobile phone to contact Littleport signal box. The train driver did not use the cab secure radio to raise the alarm as he saw that the receiver was hanging down and thought that the radio had been broken in the collision. He used his own mobile phone which he had pre-programmed with the phone numbers of many of the signal boxes on the line. He had the Littleport number but not the Downham Market one, so he called Littleport. However, the call failed after the driver had reported the collision and the signaller did not get all of the details. It was fortunate that the IMS COSS had already given full details.

67 The Littleport signaller sent the *emergency alarm signal* to both Downham Market and Cambridge signal boxes before placing a '999' call to the emergency services at 12.05 hrs. The level crossing location was given by the signaller to the emergency services control room as the full grid reference of the crossing. The signaller then called the Network Rail control room to report the incident and the IMS COSS to confirm the arrangements.

68 The driver of the tractor following the one involved in the incident (tractor driver 2) arrived at the crossing at the same time as a local resident (local resident 1). They went over to the tractor driver 1's body. It was evident that he was already dead. Local resident 2 attempted to raise the alarm by using the crossing telephone. When the IMS COSS arrived at the crossing he asked tractor driver 2 and local residents 1 and 2 to move away from the line and asked tractor driver 2 to move his tractor to allow access for the emergency services.

69 Some of the IMS staff ran down to the train to check on the condition of the driver and passengers. In addition to the driver, there were two other WAGN staff on the train and the IMS staff assisted the WAGN staff in checking on the condition of the passengers and driver. The first emergency services to arrive at the train were the Fire and Rescue Service.

70 A '999' call was received by Norfolk police from a train passenger at 12:05 hrs reporting that 'the train had crashed'.

71 At 12:06 hrs the Cambridgeshire ambulance service mobilised their nearest paramedic, who was in Littleport and he left for site in a 4x4 off-road vehicle. The ambulance service notified the Cambridgeshire Fire and Rescue Service and police, the notification being recorded by the police at 12:10 hrs. The Cambridgeshire police were also notified, at 12:14 hrs, by the Norfolk police. The air ambulance was also called to site.

72 The paramedic was the first person from the emergency services to arrive on site and the tractor driver was pronounced dead at 12:25 hrs.

73 Norfolk police were the first police to arrive, at 12:25 hrs, with Cambridgeshire police arriving shortly after and setting up the outer cordon at 12:37 hrs.

74 The emergency isolation of the overhead power supply, requested by the IMS COSS, was complete at 12:30 hrs. Network Rail staff arrived at 12:34 hrs and a Rail Incident Officer (RIO) was appointed at 12:35 hrs. Network Rail despatched staff to Littleport and Downham Market signal boxes at 12:57 hrs to secure evidence and to ensure the welfare of the signallers.

75 British Transport Police (BTP) received advice of the incident from WAGN control at 12:13 hrs. The first BTP officer was on site at 12:44 hrs. BTP set up an inner cordon and maintained this until the RAIB inspectors arrived at 15:54 hrs.

76 The passengers were attended to by WAGN revenue control officers who were on the train. They were quickly joined by members of the IMS Ltd fencing gang. The WAGN staff and IMS Staff went through the train checking whether any passengers were injured and they also checked the driver. There were no serious injuries and the WAGN staff gathered passenger's names and addresses.

77 The passengers were led off the train by Network Rail and WAGN staff and firemen, assisted by the IMS staff, and all were detrained by 13:50 hrs. They were led along the track 200 m to the disused Cold Harbour level crossing where a section of fence was removed to provide access off the lineside. From here they were then taken onto the road another 370 m back to Black Horse Drove crossing. They had to pass close by the scene of the accident, but there was no other access route from the train. Road transport was provided from there to take them back to Ely where they were met by WAGN customer services staff. They completed their journeys from Ely by taxi.

78 The driver was led off the train by the firemen who took him to the paramedic's vehicle in an adjacent field. He was then driven to the ambulance at the crossing.

The Investigation

Investigation process

79 The IMS COSS was the first member of railway staff to arrive at the crossing and he took control of the scene. He asked the people already on the site to leave the lineside and then used some of his staff to maintain the security of the crossing area until the emergency services arrived. At this time, there were local residents 1 and 2, tractor driver 2 and several workers from Cross Drains farm at the scene.

80 The Cambridgeshire police set up an outer cordon across the access road to the site and controlled access to the site until BTP arrived. BTP then set up the inner cordon at the level crossing. The evacuation route for the passengers did not involve them entering the inner cordon at the level crossing.

81 A *T3 possession* of the line from Littleport to Downham Market was taken at 15:25 hrs with *an isolation of the overhead power supply* to provide protection for the site.

82 BTP kept the site secure until the RAIB inspectors arrived. The train was released to the train operator at 17:02 hrs, with the proviso that the OTMR be downloaded in the RAIB's presence at the depot the following day; this was done. The site was released to Network Rail for recovery of the tractor debris to commence at 18:25 hrs. The RAIB team returned the following day to survey the crossing from the highway on both sides and to observe the *signal testing* being undertaken by Network Rail's contractor, Atkins Rail.

Sources of evidence

83 Access was freely given to Network Rail, WAGN, IMS and Waldersey Farms staff, data and records. Copies of HMRI correspondence on the crossing were also provided to the RAIB.

84 The accident was witnessed by the train driver and by the members of the IMS fencing gang. The train driver was watching the line ahead and was the only witness to see the tractor approach the crossing. The IMS staff were not looking towards the crossing at the time and their attention was drawn to the impending collision by the train driver blowing the horn and one of the IMS staff looking up. He then shouted to the others.

85 The moment of impact was also witnessed by the residents of a nearby house, local residents 1 and 2. Their attention was drawn to the crossing by hearing the train horn.

86 Tractor driver 2 did not see the impact or hear the train horn but saw the train slow down and stop.

87 The first people on site were local residents 1 and 2 from a nearby house and they were quickly joined by tractor driver 2. He raised the alarm with the farm manager and a group of farm workers ran to the site from Cross Drains farm.

88 The telephones at the signal boxes were not fitted with voice recorders and the evidence of communications to and from the signallers was obtained from the *train registers* of Littleport and Downham Market signal boxes.

89 The train was fitted with an OTMR and the data from this was obtained by the RAIB. The OTMR was downloaded at site but the analysis of the data on site could not confirm that the data had been successfully downloaded, due to a problem with the computer used for the analysis. The OTMR was downloaded again the following day after the train had returned to its depot at Hornsey.

90 Network Rail carries out two sets of level crossing inspections at user worked crossings with miniature stop lights. One set is carried out by the Network Rail signalling engineers and, at the time of the accident, was done annually. The other set of inspections is carried out monthly by the Network Rail operations staff. The operations staff inspection cycle also include a periodic risk assessment at maximum intervals of 3 years

91 The operations staff inspection and risk assessment is specified in Network Rail standards RT/LS/S/012 and RT/LS/P/026. These mandate the inspection of user worked crossings at intervals not longer than six monthly and user worked crossings with miniature stop lights at intervals not longer than monthly. In addition, the risk assessment must be reviewed at intervals not longer than 3 years. The method to be used for the risk assessment is given. These documents are operational documents and gave directions to operations staff in the management of the crossings.

92 The signalling engineers standard test, which is carried out annually, is mainly concerned with the signalling equipment at the crossing but it also includes checks that the crossing is in accordance with the Level Crossing Order, if one exists for the crossing. The signalling inspection of the crossing was specified in the Signal Maintenance Specification, RT/SMS.

93 The signalling inspection of this crossing, carried out on 3 June 2005 (to the Network Rail signalling maintenance specification RT/SMS, test plan LC47B), found nothing incorrect that could be rectified on the day but noted two defects for subsequent action. One was to repaint the road markings and the other noted that no section order (i.e. level crossing order) plans were available. The latter comment is interesting, as the crossing is not covered by a Level Crossing Order. Repainting of the road markings was the responsibility of the highway authority and this work had not been carried out at the time of the incident. The inspection included testing that the Yodalarms were working. The Yodalarms were controlled by a timer switch which changed the volume level to make the crossing quieter at night. The inspection included checking that this switch was operating correctly. However this timer switch had a life of 10 years and the one at the crossing had been installed in 1991. Network Rail had a code of practice, NR/GN/SIG/19008 'SIGTAN008 Sangamo/Schlumberger time switches used at level crossings' which recommended replacement of units over 10 years old. This unit had not been replaced.

94 The operating staff inspection of the crossing (to Network Rail Line Standard RT/LS/S/012) uses a standard form which is based on a 'tick box' approach where the inspector answers questions such as, 'Are the gates in good condition?' with a tick in the 'yes', 'no' or 'N/A' box. The form is designed for use with standard user worked crossings and includes features not present at every crossing. However, it does not contain a section on the level crossing sounder alarms as these are normally only fitted to public road crossings. The form design makes it cumbersome for the inspector to use as fixed or slowly changing information (eg legal status, grid reference, crossing dimensions) has to be entered, interspersed with condition information (eg crossing condition, are telephones working?). This leads the user of the form to 'pre-fill' the form with data which he perceives to be fixed before going to site. In this case, this had led to the inspection sheets not recording the current state of the crossing accurately. Specifically, the signage at the crossing is different to that recorded on the sheets and the traffic using the crossing is also different.

The sheets used for the most recent inspections at Black Horse Drove crossing are not the latest version of the form. There is a section entitled 'Unique Factors/Local Environment' on the form that might be used to record items such as the defective sounders, but this box is subtitled to imply that it is concerned only with possible changes of use of the crossing.

95 The HMRI correspondence includes letters from British Rail (BR) around the time that the line was electrified. These give details of the legal status of the crossing. The legal status of the level crossing is a *private occupation crossing* with public footpath rights. The railway was built under the powers obtained in the Lynn and Ely Railway Act 1845, which incorporated the Railway Clauses Consolidation Act 1845. A private road existed here to serve some farms and the railway provided a private occupation crossing.

96 Some time before 1910 the highway authority adopted the road up to the crossing and beyond as far as Scotland Farm, which was situated between the crossing and Cross Drains Farm. The railway company does not appear to have been consulted on this and the section of road between the railway fences remained private. The British Railways Board accepted that the crossing had acquired public footpath status and this was mentioned in a letter from the BR Property Board to the Regional Operations Manager, dated 27 February 1991. There are dedication notices on both sides of the crossing which state that under the Highways Act 1980, the crossing is not dedicated to the public except as a footpath.

97 The issue of whether the crossing is private or public for vehicular traffic is important because it affects the equipment that must be provided. BR wrote to HMRI in November 1991 to clarify HMRI's requirements for this crossing, as the presence of public roads both sides of a private crossing was unusual. BR were proposing to install miniature stop lights here as the line was being electrified and rail traffic would increase in volume and speed.

98 The guidance laid down by HMRI for private road level crossings is given in the Railway Safety Principles and Guidance (RSPG), part 2 section E. The RSPG were published in 1996 and, prior to this, the requirements for level crossings were published in a Department of Transport publication 'Railway Construction and Operation Requirements – Level Crossings' published in 1981. The requirements relevant to a user worked crossing with miniature stop lights are identical in these two documents. These recommendations apply to private road crossings where the user works the gates themselves (user worked crossings). This type of crossing is not permitted to be used on public roads. The RSPG recommendations permit the use of miniature stop lights at these crossings and detail the arrangements for siting them. The RSPG does not mention the use of audible warning devices (eg Yodalarms) at miniature stop light crossings.

99 BR and HMRI met on site on 12 November 1991 to discuss the requirements for this crossing, in view of the public road on both sides. The meeting minutes record that agreement was reached that miniature stop lights were an appropriate form of protection and listed some specific requirements. These mainly concerned signage but also included a requirement for the miniature stop lights to be supplemented by Yodalarms, one on each side of the line adjacent to the wicket gates. If the crossing had been treated as a public road crossing, the only types of crossing that the RSPG permits are the AHB and the *full barrier crossing.*

100 The crossing was inspected by HMRI on 20 January 1993 and the crossing arrangements, including the miniature stop lights and Yodalarms, were approved by HMRI in a letter to BR dated 26 February 1993.

Previous occurrences of a similar character

101 Statistics on the number of collisions between trains and road vehicles are compiled by HMRI and published in their annual reports. A summary of the incidents involving the various types of user worked crossings has been extracted in Figure 15. Many of these incidents at user worked crossings with miniature stop lights are reported to involve users ignoring the miniature stop lights.

Year	Crossing Type		
	User worked crossing with *miniature stop lights*	*User worked crossing* with telephone	Other *user worked crossings*
2000/1	0	4	2
2001/2	3	5	2
2002/3	1	2	9
2003/4	3#	3#	2#
2004*	1	5	3

Figure 15: Level crossing incidents 2000-2004

Source: HMRI Annual Reports

Notes:

* HMRI reported by financial year up to 2003/4 when they switched to calendar year. The figures given for 2004 are for 9 months only.

The 2003/4 report does not list incident totals, the figures here are for fatalities.

102 There are a total of 3,788 user worked crossings on the Network Rail network, plus several more on other railways in the UK. There have been several incidents where trains have collided with farm vehicles on user worked, and other crossings.

103 The only previous incidents on record at Black Horse Drove crossing were in 1960, when a train hit a small van, and in 1990 when a pick-up truck crossed the line in the path of a freight train, narrowly avoiding a collision.

104 However, nearby crossings have been the subjects of incidents, with a collision between a loco hauled passenger train and a sugar beet harvester at Pleasants crossing on 11 December 1984 and between a freight train and a tractor and plough at the same crossing on 25 November 1988. Pleasants crossing is one of the three user worked crossings in the area also fitted with miniature stop lights.

105 A near miss incident was reported at the nearby Poplar crossing on 25 July 2003, when a tractor crossed in front of a passenger train requiring the driver to make an emergency stop.

106 Accidents have occurred in other parts of the country involving collisions between trains and agricultural vehicles on user worked crossings. Most such accidents have not involved fatalities, but several have led to derailment of the train and injuries to the passengers, driver or farm worker.

Analysis

Identification of the immediate cause

107 At Network Rail's request, the level crossing equipment was subjected to a *wrong side failure investigation* and full *principles test* . This work was carried out by Atkins Rail and a copy of their report was supplied to the RAIB by Network Rail. The main findings of this report are that the miniature stop lights and the *track circuit*s that trigger them were working correctly but the Yodalarm warning sounders were not providing the specified volume level; they were quieter than they should have been. The Yodalarm sounder circuit is designed to reduce the volume of the sounders at night but the circuit had failed leaving the sounders permanently on the night setting. This failure was due to a battery failure, the battery appeared to have never been changed (Paragraph 93). The effective volume of the sounder on the side of the crossing that the tractor approached from was further reduced by it being mounted directly behind a fence timber. However, the use of audible warning devices at user worked crossings is not mandatory. Yodalarms are only designed to be heard by pedestrians. Their use at this crossing was requested by HMRI at the time the line was upgraded.

108 In addition to the annual technical check of the equipment by the signalling engineer, operations staff carried out monthly visual inspections. The last visual inspection of this crossing by Network Rail operations staff was carried out on 5 October 2005 and the one before that on 19 September 2005. Neither of these inspections showed any defects with the crossing equipment. The inspections did not check the volume of the sounders as the standard form does not require these to be checked, sounders not being part of the normal equipment for a crossing of this type. The inspection did not comment on the visibility of the line from the crossing as this is not required by the standard where miniature stop lights are provided. The presence of the elderberry bush obscuring the view towards Littleport was not noted. The standard and forms used for this inspection could be improved and this was commented on in paragraph 94.

109 The RAIB arranged a re-enactment of the tractor crossing the line. This was carried out on 15 December 2005 and consisted of taking an identical tractor with a loaded trailer over the crossing. It was not possible to obtain an exactly identical trailer and the one used in the re-enactment was 2.5 tonnes lighter. The lighter weight was compensated for by altering the weight distribution of the trailer load so that most of the weight was at the back of the trailer over the axle. This had the effect of reducing the trailer weight on the tractor drawbar, making it more likely that the tractor would slip. It was not possible to determine which gear the tractor was in after the incident but the gear lever was found in the 'D' range position. However, the 'C' and 'D' ranges are immediately adjacent and the lever may have been thrown from 'C' to 'D' in the collision. The tests were conducted with the tractor in both 'C' range and 'D' range gears. Tests were conducted with the tractor starting from the stop line, from a position where the counterweight was just visible from behind the gate line and with the tractor not stopping at the crossing at all, timings being measured in each case. Visibility from the tractor cab of the crossing miniature stop lights and the railway line was assessed. Sound level measurements were taken in and around the tractor with the crossing sounder operating. These tests were conducted in a protected green zone under T2-H protection. The results of these tests are summarised in Figure 16.

Test	Result
Cross without stopping in ‘C’ gear range	Time from stop line to completely clear = 13.3 sec
Cross without stopping in ‘D’ gear range	Time from stop line to completely clear = 9.2 sec
Tractor starting from gate line, ‘C’ gear range	Time from start to collision point = 10 sec Time from start to completely clear = 16 sec
Tractor starting from gate line, ‘D’ gear range	Time from start to collision point = 5 sec Time from start to completely clear = 15 sec
Tractor starting from stop line, driver gets out and works gates	Time taken to get out and work gates = 38 sec. Time to walk back to tractor, get in and start moving = 12 sec Time taken to cross = 16 sec Total time 1 min 6 sec
Sound level measurements with tractor on stop line (engine idling) and crossing sounder off	At crossing gates = 66.7 dB(A) In cab (door open) = 65.5 dB(A) In cab (door closed) = 60.5 dB(A) Beside tractor = 80 dB(A)
Sound level measurements with tractor on stop line (engine off) and crossing sounder on	At wicket gate = 67 dB(A) Beside tractor = 57 dB(A) In cab (door closed) = 48 dB(A)

Figure 16: Results of tests undertaken with an identical tractor

110 The train was taken to the Bombardier collision repair facility at Crewe and the bogies were removed from the leading vehicle. The RAIB examined the train there in order to assess how the *crashworthiness* features of the train had performed. Paragraphs 55 to 62 give the findings of this assessment.

Identification of causal and contributory factors

111 It is not possible to be certain of the reason(s) why the tractor driver considered it safe to drive onto the crossing and so alternative event chains have been postulated. Causal analysis of these event chains leads, however, to some common causal and contributory factors which apply whichever event chain is considered.

112 The lineside bushes obscured the view of the line from the point when the tractor approached the stop line to the point when the front of the tractor was just over the gate line. Figure 17 shows the view from the stop line towards Littleport. If the bushes had not been present, then the tractor driver would have had a clear view of the train approaching. However, the requirement to have a clear view of the line is not necessary if other means of warning of a train's approach are provided. Miniature stop lights provide this means of warning. Nevertheless, if the bush had not been present, the tractor driver could have easily seen the train approaching and so the presence of the bush has been considered as causal.

Figure 17: View towards left from stop line

113 The way in which the train driver saw the tractor approach the gate line suggests that the tractor driver was relying on his vision up and down the line, rather than using the miniature stop lights. A witness saw the tractor stopped at the gate line then pulling away. The tractor driver would have had to look out for himself at almost all of the other user worked crossings in the area. Even if this was the case though, the driver should still have been able to see the approaching train once he had crossed the gate line. However, the tractor driver knew that the trains passed to a regular timetable and, not knowing that the down train was running slightly late, may have expected the next train to approach from Downham Market. It is possible, but cannot be firmly established, that tractor driver 1 may therefore have spent more time looking in the opposite direction to that of the approaching train.

114 The Yodalarm sounders were operating at a slightly lower volume level than specified, being stuck on the 'night' setting, and this would have reduced the area over which they could be heard above the tractor engine. This may have contributed to the accident under scenario 2 (see paragraph 128). The miniature stop lights are the primary means of warning and the sounders are only intended to alert a pedestrian to the approach of a train while they are operating either set of road. Even if the sounders had been at full 'daytime' volume, they could not have been heard in the tractor cab above the engine noise.

115 The question of whether tractor driver 1 was distracted by something between the time of opening the gates and starting off in the tractor cannot be answered with certainty and this could have been contributory. It is not causal as the driver should still have checked the stop lights before driving off.

116 Tractor driver 1 had lived and worked in the area throughout his recent career and regularly used the crossings on this line. In almost all cases, the crossings he used were of the Automatic Half Barrier (AHB) type. He also used the user worked crossings fairly regularly as his job as a crop sprayer required him to access fields on both sides of the line during the spraying season. Most of the user worked crossings have gates but no miniature stop lights, only Black Horse Drove and Pleasants crossings have these lights. The day of the incident was the first day that Black Horse Drove crossing was being used for the harvesting operation underway. It cannot be said with certainty that he was treating the crossing as he would a user worked crossing without lights, but this corresponds with the evidence of some of the eye witnesses. If this is true, then the question of instruction in the use of such crossings arises. Witness evidence obtained by the RAIB stated that when discussing the use of the crossing, farm workers emphasised the need to close gates and tractor driver 1 had mentioned this on the morning of the incident to a colleague. There was no mention of observing the miniature stop lights.

117 The Highway Code contains instructions on the use of these crossings and the instructions are also displayed on the signs at the crossing. However, the signs at Black Horse Drove are adjacent to the pedestrian wicket gates and do not explicitly mention that the lights apply equally to pedestrians and vehicles. If the gates are left open, there is no warning to approaching road drivers to draw their attention to the need to obey the miniature stop lights. Authorised users of occupation crossings owe a duty of care to their visitors under the Occupiers' Liability Acts 1957 and 1984. Authorised users who are also employers also owe a duty to their employees under the Health and Safety at Work etc Act 1974. This means that authorised users are under an obligation to ensure that crossing users are instructed of the need to use the crossing correctly. There had been no communication from Network Rail to Waldersey Farms regarding this crossing and the farm manager did not realise that there was anything unusual about the crossing and did not consider that any specific briefing on its use was necessary.

118 Network Rail write to the authorised users of user worked crossings regularly to remind them of their obligation to use the crossings correctly. The interval between these reminders is two years. However, at the time of the incident, Network Rail policy did not include writing to authorised users of user worked crossings with miniature stop lights. RSPG, in a footnote to Figure 1, defines a user worked crossing with miniature stop lights as being a protected crossing. Network Rail's policy was to write only to authorised users of unprotected crossings. Waldersey Farms are an authorised user of Black Horse Drove crossing but are not recorded as authorised users of any other user worked crossings. Therefore they did not receive any communication from Network Rail regarding the correct method of use of this crossing.

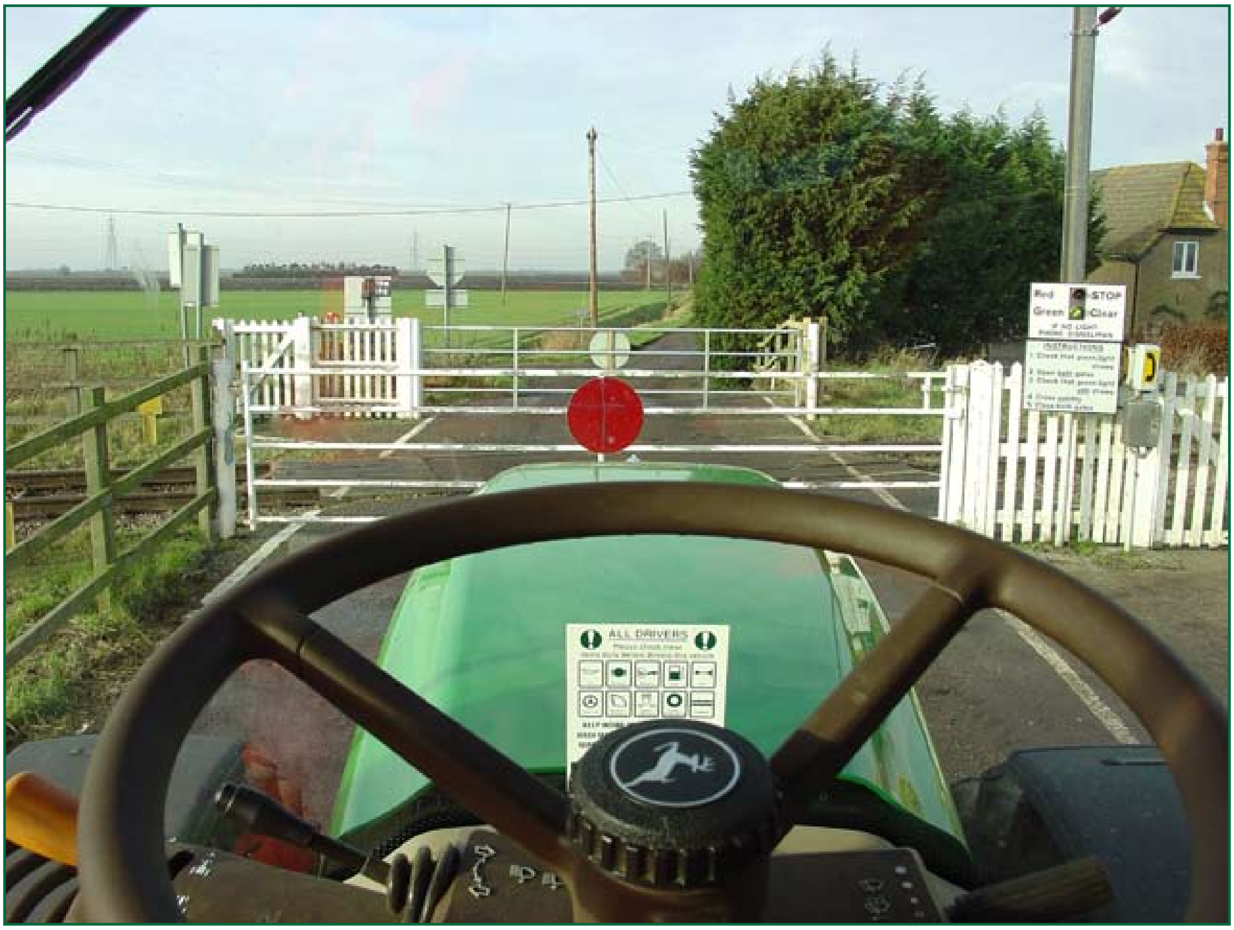

Figure 18: Level crossing from tractor parked on the stop line

119 The conspicuity of the miniature stop lights was considered and assessed by an RAIB Inspector sitting in the cab of the tractor on the stop line. Figure 18 shows the view of the crossing from the tractor cab. The board containing the miniature stop lights can be seen quite clearly, although the lights are not as large as conventional traffic lights. It was concluded that the conspicuity of the lights was not causal.

120 The question of whether the existing crossing is appropriate to the situation here or whether a public road crossing, eg AHB or full barrier crossing would be more appropriate was considered. The presence of a public road on both sides of the crossing usually means that members of the public drive vehicles over the crossing. In the case of Black Horse Drove crossing, however, the road on the west side only provides access to farms and houses and is not used by through traffic. The investigation found no evidence of use of the crossing by anyone other than authorised users or their agents (eg delivery drivers). In this case, therefore, a user worked crossing is appropriate.

121 It is not possible to be certain about whether the gates were open or closed as the tractor approached, as the witness evidence is contradictory on this point (Paragraph 46 refers). This leads to the development of two alternative event chains. These chains have some events in common.

Alternative 1 – gates left open

122 If the gates were already open when the tractor arrived at the crossing, tractor driver 1 could have remained in his cab. He would not have had to get out and open the gates. In this case, he could not have heard the sound of the Yodalarms in his well-insulated cab with the engine running. He would have had to rely only on the miniature stop lights. There were two vehicles parked close to the crossing on the same side of the road as the miniature stop lights. These would have obscured the view of the lights from an approaching tractor at a distance from the crossing. However, once the tractor reached the stop line the lights could have been clearly seen (see Figure 8). The Yodalarms are only designed to be heard by pedestrians and, even if they were at full volume, they could not have been heard in the tractor cab. Therefore the failure of the control circuit for the alarms is not a contributory factor.

123 The train driver saw the tractor draw up to the gate opening, which is beyond the marked stop line, and pause before going onto the crossing. Another witness also saw the tractor starting off from the gate line. This pause at the gate line is consistent with the tractor driver not looking at the miniature stop lights but trying instead to look up and down the line himself. The bush on the lineside would have provided a blind spot sufficient to hide the approaching train from view. The tractor driver would have been able to see around 100m (corresponding to 2.5 seconds of travel of the train) of clear track from behind the bush but would not have been able to see an adequate distance until the front of the tractor was over the gate line. He may also have been expecting the train to approach from the opposite direction.

124 The train driver saw the tractor approach the crossing and stop. Trains have absolute right of way at level crossings and the train driver did not perceive the tractor to be a threat until he noticed the tractor front counterweight was projecting forward beyond the gate line. When he saw this he sounded the horn. The OTMR shows that this was 10.4 seconds before the collision. The tractor paused briefly at the gate line, then moved on to the crossing. As soon as the train driver saw the tractor move on to the crossing, he applied the brake into step 3. The OTMR shows this was 3.7 seconds before the collision. In the reconstruction, the tractor was able to cover the distance from the gate line to the collision point in times varying from 4 seconds to 10 seconds, depending on the gear selected. This means that the time between the tractor starting on to the crossing and the driver applying the brake was between 0.3 seconds and 6.3 seconds. As the driver was looking at the tractor, it is likely that the reaction time was towards the lower end of this range. If the time had been the maximum 6.3 seconds and the driver had applied the brake straight in to the emergency position, the additional train speed reduction would have been about 16 mph (25 km/h), ie the collision would have occurred at 74 mph (118 km/h). This is still a high speed collision and the outcome would have been very similar. Once the tractor had reached the crossing, there was nothing the train driver could have done to avoid a collision. The collision occurred at 90 mph (144 km/h).

125 There are three possibilities for the reason why tractor driver 1 did not obey the stop light. It is not possible to determine with any certainty which of these three possibilities was the actual cause. The first possibility is that he may simply have not noticed the light. The parked vehicles would have obscured the light as he approached, but he had used this crossing in the past and will have known that the lights were there and could see them clearly from the stop line.

126 The second possibility is that he saw the red light but chose to ignore it. A user is more likely to do this if they perceive that the red light warning is given too long in advance of the passage of the train over the crossing. The warning time here is 45 seconds at the linespeed of 90 mph (144 km/h) for down trains and 53 seconds at linespeed for up trains. The timetable requires that trains run at linespeed over the crossing so most trains will have these warning times. The HMRI guidance states that the minimum warning time is 40 seconds for a user worked crossing with miniature stop lights, so the actual times are not greatly in excess of this.

127 The third possibility is that tractor driver 1 did not appreciate that the miniature stop lights applied to him in his tractor. The miniature stop lights and their associated signs were placed adjacent to the pedestrian wicket gates at the crossing and similar miniature stop light crossings for pedestrians were situated at some of the stations on this line. It is possible that tractor driver 1 may have thought that such lights only applied to pedestrians.

Alternative 2 – gates closed

128 If the gates were closed when the tractor arrived at the crossing, tractor driver 1 would have had to get out of the tractor to open the gates. Whilst doing this, he could have seen up and down the line and have also heard the yodalarms. This event chain has had two alternative possibilities within it. The ‘correct operation’ possibility assumes that the tractor driver was familiar with the crossing and followed the instructions. The ‘not familiar with crossing’ possibility assumes that the driver did not know that the lights and sounders applied to him.

129 In the ‘correct operation’ possibility, if the train *struck in* while he was opening the gates, he would have been aware of its approach. The crossing has a 44-second *strike in* for a down train at 92 mph (147 km/h). Tractor driver 1 therefore would have had 44 seconds in which to return to the tractor and drive over the crossing. In the reconstruction, this took 28 seconds, giving a 16-second margin. This time was measured to the point where the trailer was clear of the line. The train struck the tractor, however, and the time taken in the reconstruction for the tractor to reach the collision point was 17 seconds. If this event chain is to be believed, then it is necessary to have a delay of about 27 seconds (44 - 17) between tractor driver 1 moving out of hearing range of the sounders and starting to drive the tractor over the crossing. He would also have had to not notice that the red light was showing. There was no evidence that the driver was wearing ear defenders or had any hearing impediment. A mobile phone was found in the driver’s belongings and the wreckage of another mobile phone was found at the lineside. It is not known if the latter phone was actually involved in this incident. Checks were made with the mobile phone companies on these two phones and neither was used at the time of the incident, so he was not distracted by a phone call. He may have been distracted by another cause, but there is no conclusive evidence. Whatever the reason, it is necessary for there to have been a delay of around 27 seconds between him opening the gates and driving onto the track. Without this delay there would have been time to cross the line before the train arrived.

130 In the 'not familiar with crossing' possibility, it is assumed that the train triggers the crossing lights while the driver is opening the gates. This would have switched the miniature lights to red and started the sounders. The driver would not have seen the lights while opening the gates but would have heard the sounders. This event chain thread has to assume that he did not understand the meaning of the sounders and therefore ignored them. This seems unlikely as the driver was familiar with using AHB crossings which have the same sound. In addition to ignoring the sounders, he would have also had to ignore the red miniature stop light after returning to the tractor cab.

131 The lower than specified volume of the Yodalarm sounders may have been contributory in the case where the gates are closed when the tractor arrives, as the effect of the lower volume would have been to reduce the area over which the alarms could be heard above the tractor engine noise.

132 The safe method of use of user worked crossings relies on the previous user having closed the gates. If a user arrives to find the gates already open, they do not need to leave their vehicle before going onto the crossing and, unless they notice the miniature stop lights, they are likely to proceed straight onto the crossing. If the gates are closed when they arrive, they must get out and open them and, in doing so, can see the lights and hear the sounder if a train is approaching. The correct way of using one of these crossings involves the user opening both gates, driving over, then closing both gates behind them. This involves crossing the line a total of five times, four times on foot and once in their vehicle.

Severity of consequences

133 The train brakes were only applied in step 3 and the effect that this may have had on the outcome of the incident was considered. The driver started to apply the brake when the train was 151 m from the crossing. The handle had reached step 3 when the train was 119 m from the crossing. The brakes are applied to the wheel discs by air pressure and this pressure was still rising to the step 3 level when the impact occurred. The fact that the brake was only applied to step 3 and not the emergency position did not therefore affect the outcome of the incident. The destruction of the electrical connection box in the collision caused the brakes to go to the emergency position.

134 The OTMR shows that the train was travelling at 92 mph (147 km/h). The linespeed here is 90 mph (144 km/h) and the timetable requires the driver to drive the train at linespeed in order to keep time. As it would be very difficult to control a train precisely to linespeed, the Railway Group Standard (GO/RT3253) on checking the speed of trains allows a 3 mph (5 km/h) tolerance. The maximum expected speed of a train on a 90 mph (144 km/h) line would therefore be 93 mph (149 km/h) and the driver was driving the train within this speed limit. The effect of the additional 2 mph (3 km/h) on the warning time at the crossing is to reduce it from 45 seconds to 44 seconds, still in excess of the minimum allowable warning time of 40 seconds.

Response of others

135 The emergency services responded very quickly and a paramedic was despatched to site 2 minutes after the incident occurred. Unfortunately, the tractor driver was already dead when the paramedic reached him. The Pathologist's report states that the driver was killed instantly.

136 The Cambridgeshire Fire and Rescue Service and Norfolk Police arrived on scene within 20 minutes of the incident. The Norfolk police control room advised the Cambridgeshire police who arrived shortly after them and set up an outer cordon. British Transport Police officers arrived on site at 12:44 hrs and set up an inner cordon close to the crossing.

137 The passengers on the train were attended to by the police and Fire and Rescue Service who provided drinking water for them. A group of fencing workers were working on the railway fencing nearby at the time of incident and also assisted in the control of the site and the care and evacuation of the passengers.

138 The damage to the train did not prevent it being moved and, following the recovery operation and removal of damaged components, it was driven away to the depot from the other cab at reduced speed. The level crossing equipment was damaged but the essential parts were repaired by the following morning and handsignalling arrangements put in place to allow the morning peak service to run. The line was then closed between the peak hours to allow Network Rail's contractors to fully test the crossing equipment and complete repairs. A normal service was run throughout the following day.

139 The tractor debris and the undamaged trailer were taken away by Cambridgeshire Police recovery contractors for examination. A copy of the report by Cambridgeshire Police was provided to RAIB.

Other factors for consideration

140 The conspicuity of miniature stop lights has been studied by RSSB and it is understood that a new, larger, design of lamp based on LEDs is undergoing development and approval by HMRI. This would be an improvement on the present design and should be implemented as soon as possible (Recommendation 2).

141 The wider matter of protection of the line at user worked crossings is worthy of further consideration by RSSB, HMRI and the Department for Transport. The present system of gates and signs, supplemented by telephones and miniature stop lights in some cases, has remained unchanged for many years. There may be better solutions to the problem of road users' misuse of these crossings available now that could be implemented at acceptable cost. In particular, the appearance of the miniature light units is very different to conventional road traffic lights. Measures to draw the road user's attention to the presence of the lights is advisable (Recommendation 2).

142 The legal status of this crossing is a *private occupation crossing* with public footpath status. There are legal *dedication notices* to this effect at the crossing. However, the local highway authority has started to maintain the road on both sides of the crossing and records it as a public road on both sides. Crossings with miniature stop lights on public roads are no longer allowed by HMRI for new construction or for upgraded lines and this gave rise to the unusual situation at this crossing where HMRI specified that certain features be provided. This would be done, for a public road crossing, by means of a Level Crossing Order but an order was not made in this case. The Infrastructure Owner has changed twice during the course of railway privatisation and their records no longer record the details of HMRI's requirements. The regular inspections do not, therefore, check that these requirements are still being met. This factor, whilst not causal to the incident, is noted as an observation as a similar situation may exist elsewhere.

Conclusions

Immediate cause

143 The immediate cause of the incident was that the tractor driver either failed to notice that the red miniature stop light at the crossing was showing, or chose to ignore it, and drove his tractor onto the crossing.

Causal and contributory factors

144 The view of the line towards Littleport was obscured by vegetation. Whilst not a requirement at a user worked crossing with miniature stop lights, the maintenance of clear sight lines by removal of lineside vegetation is a reasonably practicable measure that could have prevented this accident (Recommendation 1).

145 The level crossing gates may have already been open when the tractor reached the crossing or the tractor driver may have opened them himself and then got distracted before restarting his tractor.

146 The tractor driver had received no specific instruction in the use of this crossing from his employer and was expected to obey the normal Highway Code rules. Although the Highway Code gives these instructions, most road users very rarely encounter user worked crossings with miniature stop lights (Recommendation 2).

147 User worked crossings with miniature stop lights are not common, according to RSSB statistics there are only 162 of them in existence nationally and only three in this area. Although the tractor driver had used this crossing previously, it is possible he may not have appreciated that the miniature stop lights apply equally to vehicle drivers and pedestrians.

Additional observations

148 The coincidence in the relative heights of the main tractor components and the train underframe, and the design of the train to sustain impacts with other trains, meant that the consequences of the accident were much less serious than could otherwise have been the case.

149 The train cab structure behaved as the designer intended with the energy absorbing members deforming in the manner they were designed to do. The structure absorbed about 0.3 MJ of energy in the collision.

150 The management of records relating to the crossing by British Rail/Railtrack/Network Rail was deficient and this meant that the HMRI's specific requirements for this crossing were not available to the site staff during inspection and maintenance (Recommendation 3).

151 The level crossing sounder was not producing the specified volume for daytime pedestrian use (it was set at the lower 'night time' volume).

152 The emergency response to the accident was effective and medical staff were on site with an Air Ambulance very quickly. In the event, there was nothing that they could do for the tractor driver, who was killed instantly.

153 The release of the site to traffic after recovery was done promptly, with traffic starting again the next morning, with special arrangements in place to protect the crossing until the remaining equipment was repaired. The line was subsequently closed later in the day by Network Rail for Atkins Rail to conduct a full Principles Test of the signalling equipment at the crossing and for repairs to be completed.

Actions already taken or in progress

154 The elderberry bush at the crossing has been cut down to provide a clear view of the line from the crossing.

155 Network Rail has changed its policy on writing to authorised users of user worked crossings every 2 years so that they also write to the users of crossings with miniature stop lights (previously they did not write to these users) to remind them of the correct way to use the crossing.

156 Network Rail are planning a major publicity campaign to raise road users' awareness of the risks of level crossings and the safe method of operation. It is planned to include targeting authorised users of user worked crossings.

Recommendations

157 Following an organisation's consideration of the recommendations below and decisions regarding implementation, then, that organisation will be responsible for establishing the necessary implementation priority and timescale taking into account their health and safety responsibilities and the safety risk profile and safety priorities within their organisation.

1. Notwithstanding the fact that alternative means of warning of a train's approach may be provided, Infrastructure Owners should have a system to manage lineside vegetation as far as reasonably practicable such that visibility of the line from user worked crossings is not obscured (paragraph 144).

2. ORR (HMRI) and the Department for Transport should evaluate whether highway signs at user worked crossing with miniature stop lights are appropriately designed and located to provide adequate information to unfamiliar or occasional users on how to operate the crossing safely. This evaluation should include consideration of the relative position of the signs that the road user must obey and remedial action should be taken as necessary. The introduction of new LED units should be progressed with this work (paragraphs 140 and 141).

3. Network Rail should instigate a robust means of recording the features required at each user worked crossing and ensure that these features are maintained in the same way as that Level Crossing Order provisions are (paragraph 150).

4. Infrastructure Owners where they do not already do so should implement a system to regularly write to all authorised users of user worked crossings, regardless of type, to draw their attention to the safe method of use of these crossings (paragraph 118).

   NB: Network Rail already have this in hand (paragraph 155).

Appendices

Glossary of abbreviations and acronyms — Appendix A

AHB	Automatic half barrier, a type of level crossing with barriers which are operated automatically by the trains.
AOCL	Automatic open crossing locally monitored, a type of level crossing without barriers where the train driver observes a light which shows that the road lights are working correctly. The train driver must also check that the crossing is physically clear of obstructions and control the speed of the train so that it can stop short of any obstruction.
COSS	Controller of site safety, the person in charge of setting up a safe system of work for staff working around a railway line.
DMU	Diesel multiple unit.
EMU	Electric multiple unit.
GRP	Glass reinforced plastic.
HST	High speed train, often referred to as an Intercity 125.
OTMR	On-train monitoring recorder, the 'black box' data recorder fitted to most trains.
RSPG	Railway Safety Principles and Guidance.
RSSB	Railway Safety and Standard Board.
SMS	Signal maintenance specification. A Network Rail document which details how to maintain signalling equipment.
WAGN	West Anglia and Great Northern Ltd, the train operating company.

Glossary of terms Appendix B

Anticlimber/Anti	A device fitted to the front of a train consisting of a plate with a serrated front face. A pair of these devices are fitted, one each side of the train, to provide a means of interlocking with the adjacent vehicle in a collision and prevent the vehicles overriding each other.
Authorised User	A term used in the railway industry to denote a person or body registered with the infrastructure owner as a user of an accommodation or occupation crossing.
Brake Wires	The electrical wires on a train through which the brakes are controlled.
Collapse Zones	Parts of the train's structure that are designed to deform in a controlled manner to absorb energy in a collision.
Crashworthy Principles /Crashworthiness	A design method that involves designing the train structure so that it is able to perform to a given standard during a collision. Group Standard GM/RT2100 defines the required standard.
Dedication Notices	Legal notices erected at crossings stating whether the crossing has been dedicated as a public right of way.
Door Interlock	An electrical signal on a train that shows that the doors are correctly closed.
Electrical Connection Box	Part of the coupling between trains that carries the electrical wires between the trains.
Emergency Alarm Signal	A code that is sent between signal boxes to report an emergency and stop all trains.
Emergency (brake) Position	The position on the brake control that applies the maximum possible braking effort. This is beyond the normal service brake position.
Engineer's Line Reference	An alphanumeric code used by railway engineers' to describe a section of railway between two places.
Exit Track Circuit	The track circuit that shows that a train has left the area.
Full Barrier Crossing	A type of level crossing which has barriers that cover the full width of the road.
(Protected) Green Zone	A system of working on a railway line where trains are stopped on that line whilst the work is carried out.
Isolation of the Overhead Power Supply	An arrangement whereby the power to the overhead electrification is switched off and earthed so that it is safe to approach it.
Level Crossing Order (also called Section Order)	A statement of the Safety Authority's requirements for a particular crossing
Linespeed	The maximum nominal speed that trains are allowed to travel over a section of line.

Miniature Stop Light(s)	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. These are sometimes called miniature warning lights.
Obstacle Deflector	An attachment provided beneath the front of the leading vehicle which is designed to prevent large objects on the track from going under the train and derailing it.
(Private) Occupation Crossing	A level crossing that is provided by the railway company to give access to private premises whose access road is cut by the construction of the railway.
Overhead Line Light	An indicator lamp to show the train driver that his train is in contact with a live power supply.
(Overhead Line) Neutral Section	A length of overhead wire that is not energised and provides a buffer between adjacent live sections. Trains lose power when passing through a neutral section.
Power/Brake Handle	A train control that operates the brake when moved in one direction and applies power when moved in the opposite direction.
Principles Test	A test of signalling equipment to confirm that it is correctly designed, installed and is working in accordance with fundamental signalling procedures.
Section Order	See level crossing order.
Sight Lines	Imaginary lines from the point where a crossing user stands beside the line towards the directions that trains approach from.
Signal Testing	A defined procedure for testing the correct operation of signalling equipment.
Step 3 (full service) Brake Position	On trains fitted with brakes with 3 steps, step 3 is the maximum braking that is normally used.
Strike In	The process whereby a train starts to activate the level crossing equipment.
Timeout	The feature of a level crossing control circuit that allows the crossing sounds/lights warning to stop after a certain time if the train has not been detected as having cleared the crossing. The timeout would only occur if the circuit detecting that the train has passed has failed.
Track Circuit	An electrical circuit through the rails used to detect the presence of a train.
Track Circuit Block	A type of signalling system where trains operate the signals by triggering electrical circuits in the rails.
Track Circuit Failure	The failure of a track circuit. These circuits are designed such that if they fail the circuit shows that the track is occupied by a train.

Glossary of terms

Train Register	A book that is kept at each signal box that records the movement of trains through that box's area.
T2-H Protection	A means of preventing trains from entering a section of line whilst minor work is carried out. The procedure involves handsignallers at the entrances to the section.
User Worked (Level) Crossing	A type of crossing where the road user has to operate the gates or barriers themselves.
Wrong Side Failure Investigation	A wrong side failure is when a piece of equipment fails resulting in a reduction in the level of protection. The Wrong Side Failure Investigation is a defined procedure for investigating this.
Yodalarm	A particular type of audible warning device used at level crossings to warn of trains approaching.

Key standards current at the time **Appendix C**

1. RT/LS/S/012, 'Inspection and Risk Assessment forms for User-worked, Footpath and Bridleway level crossings', Railtrack Company Procedure, Issue 3, June 2002.
2. RT/LS/P/026, 'Inspection and Risk Assessment Methodology for User-worked, Footpath and Bridleway level crossings', Railtrack Company Procedure, Issue 2, June 2002.
3. HS(G)153/6, 'Railway Safety Principles and Guidance, Part 2, Section E, Guidance on level crossings', HSE, 1996.
4. 'Railway Construction and Operation Requirements, Level Crossings', Department of Transport, 1981.
5. Statutory Instrument 1996 No. 1786, 'The Private Crossings (Signs and Barriers) Regulations 1996', 1996.
6. GM/RT2100, 'Structural Requirements for Railway Vehicles', Railway Group Standard.

Details of level crossing on the single line between Littleport and Downham Market

Appendix D

Crossing Name	Mileage (miles and chains)	Type	Features
Poplar Drove	76m 71c	User worked	
Willow Road	77m 16c	User worked	
New Road	77m 52c	User worked	
Peacocks (1)	78m 07c	User worked	
Peacocks (2)	78m 26c	User worked	
Black Horse Drove	79m 19c	User worked	*Miniature stop lights* and telephone
Hilgay	81m 39c	AHB	
Pleasants	81m 57c	User worked	*Miniature stop lights* and telephone
Concrete Road	82m 22c	User worked	Telephone
Martins	82m 48c	User worked	Telephone
Denver	84m 38c	AHB	
Downham By-pass	85m 64c	AHB	

User-operated gates or barriers
269: Some crossings have 'Stop' signs and small red and green lights. You **MUST NOT** cross when the red light is showing, only cross if the green light is on. If crossing with a vehicle, you should
• open the gates or barriers on both sides of the crossing • check that the green light is still on and cross quickly • close the gates or barriers when you are clear of the crossing. *Laws RTA 1988 sect 36 & TSRGD reg 10 & 52(2)*
270: If there are no lights, follow the procedure in Rule 269 above. Stop, look both ways and listen before you cross. If there is a railway telephone, always use it to contact the signal operator to make sure it is safe to cross. Inform the signal operator again when you are clear of the crossing.

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