



A Better,
Safer
Railway

Level crossing digest

Issue 4, January 2022 edition



Leading Health and Safety on Britain's Railways

Safertogether
Healthiertogether

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Foreword

Since railways began, there have been level crossings and a corresponding operational safety risk to passengers, staff, road users, and footpath users. The accidents, incidents, and near misses of the past have allowed us to identify mistakes, misjudgements and misunderstandings and learn from them—ultimately reducing the risks associated with the road-rail interface. However, as time passes, memories fade and those responsible for managing the risk may change. This can create gaps in our knowledge of why level crossings are designed and operate as they do, and can threaten to undermine the progress in risk reduction.

This digest aims to help plug these gaps through documenting and sharing lessons learnt in the past. It is intended for anyone with an interest in level crossing safety, both as a reminder or an introduction.

The industry is learning all the time, so this document will be updated as the further examples are identified.

Images

The following photographs appear courtesy of RAIB, and originally featured in their investigation reports:

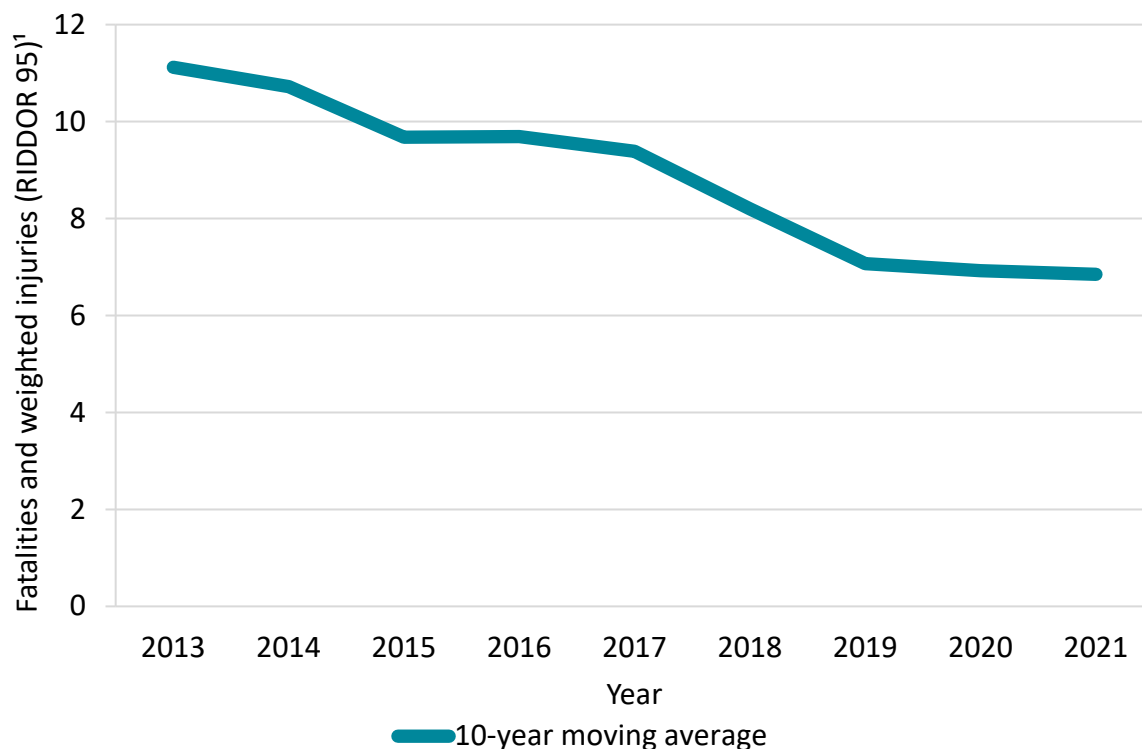
- Hixon p11 (Trinity Mirror / Mirrorpix / Alamy Stock Photo)
- Ufton Nervet p13 (Richard Austin / REX / Shutterstock)
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1 Statistical context

If you've read our [Annual Health and Safety Report](#), you'll doubtless know that Britain has one of the safest railway networks in Europe. You'll know too that most of the risk at level crossings 'arises from user behaviour'. You'll also know that Network Rail 'continues to make improvements in level crossing safety'. The chart¹ below shows how that resource, that work, is leading to improving levels of safety. This document shows how that journey began, how it progressed and how it continues to do so.



Source: SMIS and SIDB

¹ The weightings for fatalities and weighted injuries applied here are those that were aligned with the Reporting of Injuries, Diseases and Dangerous Occurrences Regulations 1995, rather than the current 2013 weightings. This is to allow consistent comparison across the period considered (2004-2021).

2 In the beginning

Level crossings link parts of the country severed by railways while keeping road² and rail users safe where one crosses the other 'on the flat'. That said, they actually predate the railway as we know it. The earliest examples existed where tramroads crossed the highway, while Tyneside's wooden wagonways—like the Whickham (1645) and Tanfield Moor (1772)—had gated crossing points. Originally, these gates were kept closed across the line and were in some cases used to protect animals crossing from field to field. In 1834, however, the Liverpool and Manchester Railway started to block the road during the day.

RSSB statistics show level crossing risk to comprise 6% of the total mainline system risk. Most of the risk is borne by members of the public, rather than railway users or staff, with most casualties occurring to road vehicle occupants and pedestrians.

Bells were provided to allow an attendant to open the way to passers-by.³ This clearly recognised the greater speeds—and stopping distances—of the train, a fundamental point about crossings that we carry forward today.

Another point we carry through to today is that users need to be warned of approaching trains. Indeed, it was a collision between a train and a farmer's cart at Bagworth in 1833 that probably led to the invention of the steam whistle.⁴

The [Highways Act of 1839](#) required level crossings on turnpikes and highways to have gates attended by 'good and proper persons', adding that said 'gates shall be kept constantly closed across the railway except during the time when carriages or engines passing along the railway shall have to cross such turnpike or other road'. The [Railway Regulation Act of 1842](#), however, noted that experience had shown it to be 'more conducive to safety' that such gates be kept closed across the road. This was duly enacted⁵, 'except during the time when horses, cattle, carts or carriages passing along such turnpike or other road shall have to cross such railway'.

Level crossing construction was generally allowed only if the inaugural Act clarified that the railway owner was obliged to replicate existing road access points. This is why most public level crossings have been in place since the 19th century—the boom time for rail construction. They are especially prevalent in flatter parts of Britain and where the expense of bridging or tunnelling was found to be too great for the line's original promoters.

Key points:

- Level crossings are meant to keep road and rail users safe where one crosses the other 'on the flat'.
- Safe use requires reliable technology and responsible behaviour.
- Crossings formed part of the Act that brought a railway into existence.

² And those using bridleways and footpaths.

³ *The Oxford Companion to British Railway History*, ed By Jack Simmons and Gordon Biddle, 3rd edn (Oxford: Oxford University Press, 2003), p. 261.

⁴ The modern equivalent of which is of course the train horn.

⁵ Unless the Board of Trade authorised otherwise.

3 Crossing types

There are two broad level crossing groups in use in Britain:

- **Active crossings**—the road vehicle or pedestrian is warned of an approaching train through closure of gates or barriers and/or by warning lights and/or alarms.
- **Passive crossings**—no warning of a train's approach is given, or the only warning is the use of the train horn. The onus is on the road vehicle user or pedestrian to determine whether it is safe to cross or not. Instructions for use are provided at each location, along with other appropriate signs.

These two groups are divided further in the table shown below – see [here](#) for the full set of definitions:

Crossing type			Number	
Passive	UWC-T	User-worked crossing with telephone	1576	
	UWC	User-worked crossing	384	
	OC	Open crossing	41	
	FP	Footpath crossing	1855	
	SBC	Station Barrow Crossing	86	
Active	Manual	MCG	Manually controlled gate	109
		MCB	Manually controlled barrier	169
		MCB-OD	Manually controlled barrier with obstacle detection	118
		MCB-CCTV	MCB monitored by closed-circuit television	438
	Automatic	AHB	Automatic half-barrier	411
		AFBCL	Automatic full barrier crossing locally monitored	3
		ABCL	Automatic half barrier crossing locally monitored	61
		AOCL+B	Automatic open crossing locally monitored with barrier	63
		AOCL/R	Automatic open crossing locally or remotely monitored	23
		UWC-MSL	User-worked crossing with miniature stop lights	177
		FP-MSL	Footpath crossing with miniature stop lights	77
		SBC-WL	Station Barrow Crossings with lights	18
Total			5609	

Source: Network Rail (ALCRM), May 2021

No new automatic open crossings are likely to be created and there are very few open crossings on public roads. Following recent research, Network Rail has developed a concept new for Britain, but used widely in Germany, Italy and Japan: full barrier crossings controlled by obstacle detectors (MCB-OD and AFBCL).⁶ Work has also started on developing a new type of crossing, using an overlay extra barrier solution for **automatic half barrier** (AHB) crossings. This is the **automatic full barrier locally monitored** (AFBCL), of which there are three on the network at the time of writing (September 2020).

⁶ RSSB research report T522, [Research into obstacle detection at level crossings](#)

3.1 Open crossings

These are located on minor roads with little road or rail traffic. They provide road traffic signs but do not have barriers or road traffic light signals. At the crossings, road users are required to give way to trains, so it's important that they are able to see approaching trains with enough time to cross or stop safely. Open crossings have approach warning signs for train drivers, who have a duty to stop their train if the crossing is not clear and must sound the train horn in the daytime. Additionally, appropriate permanent speed restrictions will be in place, trains being required to approach the crossing at a 'steady speed', typically 10 mph (16 km/h). These are the only 'passive' crossings normally in use on public roads.

3.2 Staffed crossings

As noted above, gates across the railway, physically controlled by hand, wheel or other mechanism, are the traditional type of road crossing in Britain. By 1960, there were some 2,500 of them. In most cases, especially in recent years, they have been interlocked with railway signals. However, due to a lengthy gate closure time, they aren't suitable for busy roads that cross busy lines.

By 1960, permission had been obtained to replace gates with lifting barriers controlled locally by electric or hydraulic operation. In some cases, motorised boom gates or barriers were provided, although these are increasingly rare nowadays.

There is no fundamental difference between staffed barriers and staffed gates (though the former can usually be operated more quickly than the latter).

The 1970s saw the development of technology which allowed activities to be observed remotely via a camera located at the crossing. These interfaces have a number of features which have, collectively, made them a popular choice when existing crossing equipment has required an upgraded or replacement. For example:

- The road is completely closed to traffic, providing complete separation.
- Existing staff at each location can be replaced by fewer staff at a central location, with supervision of several crossings by one person being possible (or combined with signalling tasks).
- Rail traffic is not impeded unduly, but controlled by signals until the crossing is closed and checked.
- Train speeds of up to 125 mph (200 km/h) can be permitted.

That said, equipment costs (especially cabling) can be considerable, and only a limited number of crossings can be grouped together because of signaller workload concerns. Furthermore, the time that a crossing is closed to the road can be significantly longer (as much as three or four minutes for a single train movement) compared to [automatic half-barrier crossings](#) (which are usually closed for less than a minute).

3.3 Automatic crossings

Under the [Railways Clauses Consolidation Act of 1845](#), the railway was legally obliged to maintain attendance at all public level crossings. However, it proved to be expensive—and increasingly difficult—particularly after World War II, when near full employment made it hard for British Railways (BR) to find staff for what was a responsible, but poorly paid and often dull job.

Furthermore, by 1955, there were over three million cars on British roads, and the number was rising. Many crossings took time to operate, caused heavy delays and offered insufficient protection for such an increase in usage. Clearly the situation was only going to get worse. Something had to be done, and the answer seemed to lie on the Continent.

The Railway Inspectorate (RI)—along with representatives from BR and the Ministry of Transport—reviewed European automatic level crossings in detail the following year.⁷ The group's findings led to the creation of the attendant-free AHB. This type of crossing allows barriers to block oncoming traffic (leaving the exits clear for trapped occupants), and has a closing sequence activated by an approaching train via a treadle attached to the rail.

Though there was some opposition to these 'Continental crossings', which many feared were not safe, the first AHB came into use at Spath, near Utttoxeter, on 5 February 1961.⁸

By the end of 1967, there were 207, with plans for many more. Then came an accident that highlighted the shortcomings of both the design itself, and the way it had been introduced.

Key points:

- Increasing car use and post-war recruitment problems exacerbated the need for automation.
- The first AHB came into use in 1961.

Resident crossing keepers (RCKs) at crossings which were not block posts and might not have protecting signals, and at which the gates were normally closed to the road, had to work 24 hours a day and only had 12 hours off a week. Usually there would not be any night road traffic, but if a local resident liked to be out late and the local farmer had to be up early, there might not be much of a gap.

Resident keepers were often women. If they went out, older children could be left to operate the equipment. At East Shalford (near Guildford), the RCK was the local ganger's wife. The wife became ill and her younger sister came to look after her. When she later died, the sister was employed to operate the crossing, which had the advantage that the ganger did not lose his home. However, following a fatal accident after she had persuaded the signaller to give her permission to open the gates despite there being a train on each line in the section, the station manager was then informed by the police that she was under-age for such a responsible position.

Hixon and Lockington

6 January 1968 and, its police escort already across, a colossal road transporter carrying a 120-ton transformer was crawling carefully over [Hixon](#) AHB in Staffordshire. At around 12:30 pm, the red lights started to flash, and the barriers began to lower. The vehicle driver had failed to phone the signalman; the vehicle failed to get clear. It was struck by an express train at around 75 mph. Eleven

⁷ See [Level crossing protection: report by officers of the Ministry of Transport and Civil Aviation and of the British Transport Commission](#) (HMSO, 1957) – known as the McMullen Report.

⁸ Spath AHB ceased to exist when the Utttoxeter–Leek line was closed in 1965.

people were killed, 120 yards of track were damaged, and the overhead power lines were brought down.

Realising that the RI's involvement in the AHB's development compromised its independence, the government chose to hold a Court of Inquiry under the [Regulation of Railways Act 1871](#), appointing Mr E B Gibbens QC as chair. In the first such inquiry since Tay Bridge⁹, the Court found that the haulage company had failed to inform BR that it intended to take the transporter over the crossing, which in turn prevented BR from taking appropriate precautions.

The report highlighted poor communications between railway and police, and railway and haulier, about telephoning the signaller when large, slow-moving vehicles were being routed. It also cited inadequate signs and poor police training as part of the causal chain. However, the report found the 'origin of the accident' to be 'the failure of officers of both the Ministry and British Railways in collaboration to appreciate the measures necessary to deal with a hazard of which they were aware'.

A book published in 2018 also refers to the 'arrogance' of the (then) RI in its belief that telephones should not be supplied at AHBs at all, lest their use interfere with the operation of the (then) newly electrified 'high-speed' West Coast Main Line. This belief was not shared by BR, and demonstrates the difficulties that can arise when many different bodies are involved in the management of change (particularly in the introduction of new technologies).¹⁰ Such unclear accountabilities were further resolved with the demise of the approval of new works legislation in 2006.



⁹ On 28 December 1879, the central 'high girder' section of the Tay Bridge collapsed, taking a mail train with it and claiming 75 lives.

¹⁰ See Richard Westwood, *The Hixon Railway Disaster* (Pen and Sword, 2018).

The Hixon inquiry found that 'level crossings protected by automatic half barriers are a valuable answer to the needs of modern transport and [...] are reasonably safe'.¹¹ Despite this, the management failings the inquiry unearthed led it to recommend additional safety measures, whose cost stalled the automation policy severely. Indeed, although better signage and warning lights (known as 'wigwags') were introduced from 1969, little progress would be made until 1977, when another working party visited Europe¹² and agreed to relax the recommendation requirements.¹³ This made it slightly easier to create AHB crossings, of which there are now around 430 in use on lines where the speed of trains is 100 mph (160 km/h) or less.¹⁴

The working party's findings also endorsed an automatic crossing that had warning lights, but no barriers. These are known as **automatic 'open' crossings locally monitored** (AOCL); 44 were in use by 1986. Though cheap to install and maintain, they depend wholly on the road user seeing and obeying the red flashing warning lights.¹⁵ The dangers of open crossings were demonstrated at [Lockington](#) on 26 July that same year, when eight rail passengers and a boy travelling in a van were killed when the van driver missed the lights and drove into the path of a train. In response, [a review – led by Professor P F Stott](#) – was published during 1987.

The Lockington crossing was an AOCL—an **automatic open crossing remotely monitored**. An AOCL is equipped with road traffic signals and audible warnings only: there are no barriers. It is operated automatically by approaching trains. Telephones are provided for the public to contact the signaller in an emergency.

The Stott report concluded that no more AOCLs should be installed and that those already in place should be converted to AOCLs or AHBs. As it happened, a new kind of level crossing—the **automatic barrier crossing, locally monitored** (ABCL)—was introduced. The first ABCL to be commissioned was at Beccles on the East Suffolk Line in 1988.

The ABCL is essentially an AOCL equipped with half barriers. From the point of view of road users, it appears the same as an AHB. The difference is that train drivers must ensure the crossing is clear before passing over it. The maximum permitted speed for trains is no more than 55 mph.

¹¹ *Report of the Public Inquiry into the Accident at Hixon Level Crossing*, HMSO July 1968, and *ibid*.

¹² French level crossings usually have a single red light on a circle backboard, bells and automatic half barriers. When activated, the red light flashes, the bells ring, and the barriers close. Those with more than one track have a sign saying "un train peut en cacher un autre" (one train can hide another train).

¹³ See [Report on level crossing protection, including visits to the Netherlands, French, West German and Swiss railways by officers of the Department of Transport and the British Railways Board](#) ('Townsend-Rose Report') (HMSO, 1978).

¹⁴ Where an AHB is to be installed on a railway line with low train speeds (or where train speeds can be reduced without adversely affecting the service) a variant of the design is permitted. Here, the operation of the crossing equipment is proved by the operation of a white light facing the train driver, who has to be able to stop the train at the crossing if required. There are only a limited number of locations where this approach is practical. Fifty-nine of these crossings have been installed since the late 1980s.

¹⁵ The warning sequence at an AOCL is initiated by the approach of a train, which will normally have to stop short of the crossing unless the driver is sure that the warning devices are operating, and the crossing is clear. Telephones for road users are not normally supplied, but signs giving details of the supervising point are provided for emergency contact. The accident at [Halkirk](#) in 2009 hastened plans to add barriers to AOCLs (thus turning them into AOCL+Bs).

Only one AOCR now remains on GB rail, at Rosarie in the Scottish Highlands, which remains because special site circumstances have made its replacement very difficult.

Key points:

- Automation introduces new types of risk.
- Automation heightens the need for emergency communications between road users and the railway.

4 Themes

The previous sections showed how level crossings came into existence, and how they were shaped during the twentieth century. The remainder of this document will delve into some of the themes that have emerged from level crossing accidents, not all of which relate to user behaviour, despite the emphasis shown in the figures.

4.1 Crossing design

Ufton, Berkshire, 2004



No level crossing can be absolutely safe, but all are intended to be safe if used correctly. Sometimes, however, the way new designs are introduced can lead to problems. This was evident at Hixon. In the years following Lockington, the most serious level crossing collision occurred at Ufton AHB on 6 November 2004.

That afternoon, a car had been deliberately driven onto the crossing by a suicidal motorist. It was struck by a High Speed Train (HST), which resulted in the leading wheelset of the train derailing. Normally, it would have braked to a stand, but less than 100 metres ahead was a set of points leading to a loop. The derailed wheelset started to turn towards this loop, causing the train's leading vehicles to overturn. Seven people—including the car driver and train driver—were killed.

Following [RSSB's report](#) into the accident, the industry's [level crossing risk assessment process](#) (All Level Crossing Risk Model (ALCRM)), was enhanced to include the consideration of post-collision potential at each level crossing.

As a result of Ufton, RSSB also launched research into obstacle detection, which recommended the adoption of technologies that would enable their use.¹⁶ In 2012, an MCB in Filey, North Yorkshire,

¹⁶ RSSB research report T522, [Research into obstacle detection at level crossings](#)

was fitted with Light Detection and Ranging (LIDAR)¹⁷ equipment, radar and cameras to detect blockages by vehicles.¹⁸

These crossings are becoming common on some lines, like the East Coastway and Peterborough–Lincoln routes. The systems have also been trialed with the new ‘S60’ barriers, which are similar to those found in America, and which use electrics as opposed to hydraulics. The crossings are triggered automatically via a treadle or track circuit, although the signaller still has the facility to operate them manually. As well as providing a practical safe alternative to CCTV crossings, they provide a major enabler for the creation of Network Rail’s Rail Operating Centres (ROCs) and its wider signalling control strategy. If CCTV monitoring stations had to be transferred to these ROCs in large numbers, their size and footprints would have had to be substantially increased, with more signalling staff.

Key points:

- Pointwork situated near crossings can increase the risk from post-collision derailment.
- Obstacle detection is a vital tool to help combat the problem of vehicles on crossings.

West Lodge, Haltwhistle, 2008

On 22 January 2008, a freight train struck and killed a person using [West Lodge UWC](#) to deliver coal on foot.

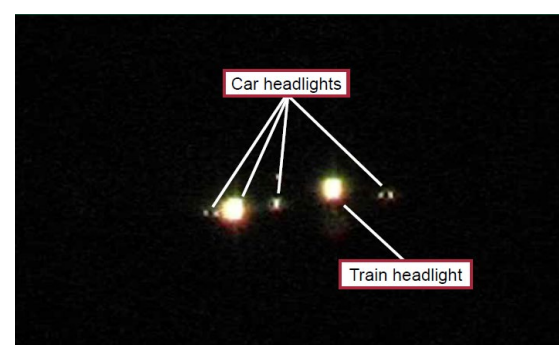
Shortly after 17:00, a delivery driver parked his vehicle across the approach to West Lodge. The two coalmen then carried a sack of coal each over the crossing. The driver made out the delivery paperwork at his vehicle while his colleague delivered a third sack and walked back towards the lorry. At this time, the train was on the approach.



At 17:13, the train driver confirmed seeing a person appear from trackside vegetation to his left. Despite the driver having sounded the warning horn immediately and continuously, the person continued to walk the few steps from the crossing onto the line.

The Rail Accident Investigation Branch (RAIB) said the user had been unaware of the approaching train, possibly because the sighting distance and warning time were less than required at the West Lodge side of the crossing.

The fact the user was not required to contact the signaller also had an effect. Furthermore, he would be unlikely to recognise a train’s headlights among those of road vehicles until it was within a second or two of the crossing (see photo, right). Traffic noise



darkness

¹⁷ At least initially, LIDAR was found to be susceptible to snow and horse manure. The equipment was first fitted to Everton crossing on the East Coast Main Line. However, it was later moved to Filey, the site of its first successful use.

¹⁸ Lasers and reflectors can also be used to scan the crossing and see if it is blocked.

and wind would have impaired his ability to hear clearly and would have masked the sounds of the approaching train. Similarly, the train driver could not sound the warning horn earlier than he did, because he did not see the person until the train was close to the crossing.

RAIB also said it was ‘feasible that the person was unaware of the approaching train because he was unaware that he was on the track at the time of the accident’. The warning signs were not at the decision point and he may not have discerned them (and the track) from their surroundings in darkness.

For RAIB, the underlying factor was that Network Rail’s management systems did not acknowledge the findings of local inspections and assessments. As a result, it did not act to reduce the identified risks. Furthermore, Network Rail’s methods of level crossing inspection and assessment did not consider foreseeable environmental conditions that resulted in users being unable to recognise a train’s headlights among those of road vehicles, and its sounds masked by traffic noise and wind.

Key point: the crossing type should be appropriate to the local environment and patterns of use in all conditions.

Oakwood Farm, Knaresborough, 2015

On 14 May 2015, a passenger train collided with a tractor at [Oakwood Farm UWC](#), near Knaresborough. The train, which was travelling at 65 mph, did not derail, but the impact caused the front of the tractor to become detached from its cab. The tractor driver suffered minor injuries; the train driver was treated for shock. In different circumstances, the consequences could have been much worse.



The tractor driver began crossing the railway after the illuminated warning at the crossing started to display a red light. This was probably because he was unfamiliar with the crossing’s operation, it being one of a small number in the country fitted with power-operated gate opening (POGO), which is designed to reduce the number of traverses a UWC vehicle user has to take and increase the desired behaviour of closing the gates behind them.

RAIB reported that the tractor driver probably did not recheck the warning lights after first stopping on the approach to press a button to open the gates. This button had not originally been intended to open the gates (it should only have been capable of being used to close them). It was situated at such a distance from the crossing that the time it took for the tractor driver to stop, open the gates and drive on to the crossing was greater than the time between the warning light turning red and the arrival of the train.

There was no sign at the button to warn the driver to recheck the warning light before going over the crossing, and the warning light was not conspicuous among the many signs present. The risks at Oakwood Farm were not adequately mitigated, and the process for the introduction of the bespoke gate operating equipment was not adequately managed.

A similar incident occurred at [Frogmal Farm UWC](#) on 23 October 2017. In this case, a van driver was delivering a parcel to a property on the far side of the crossing. He initially went to an incorrect address, where he was given directions which involved traversing the interfaces. Being unfamiliar with UWCs, the van driver did not notice the telephone and pressed the button to operate the gates. They opened, and so he returned to his van to drive across the crossing, believing it was safe to cross.

Retention of records relating to the acceptance of the POGO equipment did not sufficiently demonstrate the basis on which decisions were made during the history of the trials. Furthermore, it was not in accordance with the company standard.¹⁹

The tractor driver pleaded guilty to endangering safety on the railway. After the accident, Network Rail and the authorised user further discussed legal responsibilities for invited crossing users and how risks could be better managed. A briefing pack now helps the authorised user to brief visitors. In addition, other options for this closure were considered, the crossing signs were reviewed, and the POGO equipment replaced.

Key points:

- Processes for accepting new equipment and technology must be robust.
- Sufficient records must be kept to allow informed decisions to be made.

Stainforth Road AHB, Doncaster, 2018

On 11 January 2018, a car collided with the rear-most wagon of a stationary freight train at [Stainforth Road AHB](#). The crossing's warning equipment was not operating and its half-barriers were raised when the car approached. The car driver suffered only scratches and bruises, but their vehicle was damaged beyond repair.

The train was at a stand because its brakes had been applied by the locomotive's vigilance device. This occurred because its driver did not respond to the device's audible alarm in the time period permitted, probably due to the high level of ambient noise in the cab. The car driver was not alerted to the presence of the train by the crossing's warning devices because the design of the level crossing's control circuits had permitted it to re-open to road traffic while it was still occupied by the train. The car driver did not see the wagon with enough time to take effective avoiding action, given her speed of approach. This was because the train's side was unlit and unreflective and also because there was no ambient light near the crossing.

The crossing's control circuits dated back to its original installation in 1974. They had not been modified to incorporate later features which prove that trains are clear of a crossing before it re-opens. This was because a retrospective modification of this type was not mandated by relevant standards and guidance. And because, for other reasons, the crossing's circuits had not required modification during the life of the crossing. The crossing had not been renewed or replaced prior to the accident, because Network Rail had assessed it as still having useful working life left. The level crossing risk assessment process used by Network Rail did not identify and address the risk of the original design of control circuit remaining in service without it having later design features intended to improve safety.

Key points:

- Equipment needs to be updated in line with later improvements.
- Risk assessments need to take all factors affecting safety into account.

¹⁹ [NR/L2/RSE/100/05](#) (Product introduction and change).

4.2 Train speed

Variations in train speeds can lull crossing users into thinking they have more time to cross than may actually be the case. Problems can arise on mixed traffic lines, where fast expresses and slower freight services share the same line of route, or on routes where trains either stop or don't stop at nearby stations. The latter is likely to have been exemplified on 5 October 2016.

Alice Holt footpath crossing, Hampshire

At 16:20 that afternoon, a mobility scooter user was killed when their vehicle was struck by a train at [Alice Holt footpath crossing](#) in Bentley, Hampshire.

Users of Alice Holt crossing are required to look and listen for approaching trains before deciding whether it is safe to cross the line. It is uncertain why the user decided to cross when it was unsafe to do so, as CCTV images suggest he had previously crossed in a safe manner. It is probable that the user did not see the train or misjudged when it would arrive at the crossing, perhaps due to sun glare, when deciding to cross. It may also have been the case that he incorrectly believed it would stop at Bentley station (just before reaching the crossing), as most trains did.

4.3 Another train coming

When [AHBs were first introduced](#) to Britain's railway, they were provided with audible warnings (originally bells, later replaced by solid state devices), with trains sounding whistles or horns continuously on approach. Both audible warnings were intended for the benefit of pedestrians. In the event of two trains passing during a single crossing activation, the bells were sounded until the barriers lowered, and two whistles were sounded (one from each train as they passed the relevant whistle board).

A review of the audible warnings in 1978 suggested that, with the move to solid state devices, the audible warnings provided at the crossing would suffice and recommended that the associated whistle boards be removed. The review also recommended that the audible warning should emit 'a more urgent tone' when the mini-Another Train Coming lamp was activated, although at the time of the review it was unclear how this was to be achieved.

A further review of audible warnings at these crossings in 1983²⁰ led to a recommendation that those provided at AHBs should be like those provided at AOCLs, which operate continuously until a train has passed, and change tone if a second one is on its way. This change was made to AHBs during renewals. But it was not a guarantee of success...

Elsenham, Cambridgeshire, 2005

On 3 December 2005, a train struck and killed two teenage girls on the pedestrian crossing at Elsenham. The crossing is next to a manually operated road level crossing, between the staggered platforms at the station. Although red lights were flashing and a klaxon was sounding to herald the arrival of another train, it is likely the girls thought they applied to the train they wanted to catch, which was just pulling in.

The curvature of the line is such that there are only three seconds' visibility of an approaching non-stop train in the other direction. Previous risk assessments (2002) had identified the potential

²⁰ See [Pedestrian safety at public road level crossings](#) (HMSO, 1983).

dangers and recommended installing crossing gates that lock automatically as trains approach. This, however, was not acted upon.

In 2012, Network Rail was prosecuted for breaching health and safety law and fined £1m in relation to the accident, since which it has fitted locking gates and erected a footbridge across the line.

As [RAIB noted in its report on station crossings in general, including this accident](#), RSSB had published a research project to investigate methods of warning level crossing users of the approach of a second train.²¹ The research found that ATC accidents tended to involve pedestrians, rather than vehicles, with the majority of victims being teenagers. Accidents also tended to occur at AHB and miniature stop light (MSL) crossings. It made the point that the annualised risk from accidents involving a second train at AHBs and MSLs was around 0.25 Fatalities and Weighted Injuries (FWI) a year. Provision of new warnings would reduce, but not eliminate, the risk associated with ATC, principally because users can still violate the warning regardless of its clarity. As such, the achievable safety benefit would be *less than* 0.25 FWI per year.

The risk from ATC is recognised in other countries; some have already implemented ATC-specific warnings. In general, there are three main types: static signs, dynamic signs and audible warnings, which can be used individually or in combination, though different approaches have been taken in different countries. Some are specifically targeted towards pedestrian users (such as in Australia and USA), others are more general (Canada and Japan). However, there is no hard evidence as to the safety benefits of the different ATC warnings.

The research also showed that the arrival of more than one train is a difficult concept to convey simply, as it cannot be certain when the user arrived at the crossing, or what the user can see and has understood of the situation. The challenge is to provide a warning that is perfectly clear and not open to misinterpretation in any way (as this could result in an increase in risk).

The effectiveness of any warning system is dependent on several factors, like the warning's ability to get a user's attention and how well users recognise it. The effectiveness of the warning is also dependent on certain crossing characteristics. In some cases, the way in which the signalling works would mean that ATC warnings would not activate for certain trains, or at all. This could mislead users.

Analysis showed that it may be reasonably practicable to fit ATC at the 14 stations that have MSL crossings and that it is worth exploring these locations more. No other strategy that was considered could be justified on the grounds of cost-benefit analysis. However, since the research was undertaken the majority of these crossings have been closed—reducing the risk yet further.

Crossing immediately behind one train, unwittingly into the path of a second on the other line, is a common factor in fatalities on passive crossings too.

Key points:

- Most ATC-related incidents involve teenage pedestrians.
- The arrival of more than one train is a difficult concept to convey simply.

²¹ RSSB research report T652, [Examining the benefits of 'another train coming' warnings at level crossings](#). See also T332, [Understanding the risk at station and barrow crossings](#).

4.4 Risk assessment

The All Level Crossing Risk Model (ALCRM) was rolled out across Network Rail in 2007, and has subsequently been populated with a great deal of data. The current version represents the culmination of nearly eighteen years' research, modelling, calibration, upgrades, and related activities. A need was identified to capture the history of the model's development since the first version was designed in the mid-1990s. A 'history' document was duly published early in 2008, but has since been updated to include more recent developments. The ALCRM configuration management team has access to an 'Enhanced Specification', which provides references for all variables and algorithms, with narrative sections that provide explanations of the main steps in the algorithms.

In August 2014, Network Rail introduced narrative risk assessment (NRA) as a measure to improve its assessments of level crossing safety. NRA has both the quantitative output from ALCRM and the professional judgement of level crossing manager providing a balanced and thorough assessment of risk for each level crossing on the network. NRAs enable Network Rail to make informed decisions about the safety of its level crossings and help target investment wisely. They tell the 'story' of risk at each site and enable Network Rail to demonstrate compliance with the [Management of Health and Safety at Work Regulations 1999](#), Reg 3.

A new version of ALCRM went live in April 2021. It includes many risk algorithm enhancements, which will enable greater resolution of crossing level risk distribution and inform better decision making.

Key point: A report documenting the history of level crossing risk assessment (from 1993) may be found [on RSSB's SPARK website](#).

4.5 User type

Most level crossing risk (95%) relates to the behaviour of those using it. There are recorded cases of cars trying to race trains, people running after dogs in front of trains, and even instances of satellite navigation systems guiding car drivers to turn onto the railway instead of keeping to the road.

Grimston Lane, Suffolk, 2016

A case in point may have occurred at around 12:25 on 23 February 2016, when a pedestrian was struck and killed by a train on [Grimston Lane footpath crossing](#). RAIB said the user was not aware of the approaching train when he decided to cross, either because the skew of the crossing resulted in him not looking in the direction of the train, or because he was not at the best viewing position when he made the decision to start to cross and the approaching train was obscured.

As a result, RAIB highlighted this learning point:

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

crossing surfaces at a large number of locations to highlight danger zones as recommended by the research.

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

Key points:

- The effects of skewed alignment at passive level crossings on user behaviour, including the sighting of approaching trains, must be identified.
- Guiding users to the correct decision point helps reduce risk.

4.5.1 Heavy goods vehicles

One area of concern involves heavy goods vehicles (HGVs). A case in point occurred on 14 May 1998, when a passenger train struck a petrol tanker at Sutton Forest AHB. There were no reported injuries, and no spillages. A fire that broke out in the cab of the lorry was soon brought under control. The lorry driver claimed that the brakes had failed as the vehicle approached the crossing, and that the barrier came down between the cab and the trailer as it began to traverse.

This incident was largely a mechanical matter, but RAIB reported on an incident in 2019 that involved the driver of a lorry, and the handsignaller of the same occupying a 'bubble' that included their own work but not that of the railway.

Mucking, Essex, 2019

Shortly before noon on 13 March 2019, a passenger train passed over [Mucking AHB](#) a few seconds after a partially loaded concrete delivery lorry had reversed clear as part of a manoeuvre to enter an adjacent Network Rail construction site. The lorry driver was following handsignals from a railway worker and drove onto the crossing after it had been automatically activated by the approaching train and the red stop lights had begun flashing. A lowering crossing barrier came down on the lorry and was manually lifted by site staff, before the lorry reversed off the crossing.

RAIB said the incident occurred because staff involved in the work planning, and staff on site, did not recognise and manage risk associated with working near level crossings. As a result, one of its four learning points read as follows:

Irrespective of any signals provided by banksmen or other people, drivers of road vehicles must always comply with all Highway Code requirements relating to the use of level crossings. All vehicle drivers must obey the flashing red stop lights.

More recently (October 2021), there have been reported cases of crossing failures caused by collisions between HGVs and barriers or lights, further examples of barriers lowering between cabs and loads and HGV drivers ignoring red lights and warning signs. There is concern that the need for more delivery drivers, due to a shortage at the time of writing, will result in a less-experienced user group, which may lead to an increase in incidents.

Key point: Heavy goods vehicle operation remains an area of concern.

4.5.2 Horses

Network Rail's advice to riders is to dismount, stop and call the signaller when [using level crossings](#). However, The British Horse Society's advice is that horses should be *ridden* across level crossings, as the rider has more aids to control their mount. The problem is that a led horse can easily jerk the reins free and put the person—and others—in danger.

However, the Society recognises that, in some instances, dismounting and leading may be the only way to use the crossing. It advises that, if the rider does choose to dismount and lead, they must exercise extra care and use a trackside telephone if one is available.

Key point: The British Horse Society's level crossing guidance may be found [on its website](#).

4.6 Distraction

4.6.1 Dogs

After concern was raised over the frequency at which dogs were involved in level crossing incidents, the Safety Risk Model was modified. Version 6 (SRMv6) set out to separate risk precursors specific to risks involving dogs. For example, such as a dog pulling an owner on a lead into the path of a train, or as a source of distraction.

Fairfield, Wiltshire, 2009

At about 17:30 on 6 May 2009, a passenger train struck a pedestrian on Fairfield footpath crossing, near Little Bedwyn in Wiltshire. The pedestrian, who was crossing from the north-west side of the railway, was fatally injured. [RAIB's report](#) noted that, 'although there is no direct evidence [...], the pedestrian may have been distracted when making her decision to cross the line by the presence of her dogs'. It also noted there may have been sighting issues at the interface and that the absence of whistle boards may have been a factor.

Another possible contributory factor was the absence of an adequate [risk assessment](#). Network Rail was prosecuted under Section 3 of Health & Safety at Work Etc Act 1974, pleaded guilty and was fined around £300,000.

RAIB also considered an underlying factor to be the [difficulty in closing the crossing](#), and its availability to members of the public as a footpath. Following the accident, the footpath over the crossing was temporarily closed by Wiltshire County Council and the gates were padlocked by Network Rail. In 2010, following local consultation, Network Rail gave special authorisation for whistle boards to be provided more than 400 metres away in both directions on the approaches. A site inspection by the then Office of Rail Regulation (ORR)²² on 15 March 2010 found that the crossing had been re-opened, and that the whistle boards appeared to be having the desired effect.

RSSB did some further research with Network Rail: [T936: Enhancing the accuracy and functionality of the All Level Crossing Risk Model](#).

Key point: A [user guide for dog walkers](#) has been developed in association with the Dogs Trust.

²² Later the Office of Rail and Road.

4.6.2 Mobile phones and devices

There can be no doubt that mobile phones have revolutionised how we communicate with each other. Indeed, they've become so vital to modern life that few of us would want to leave home without the means to chat 'on the go', listen to music, watch videos or surf the net.

Within a safety critical environment like the railway, it's not always safe to yield to the natural reflex to answer a phone or reply to a text, in fact, it can be fatal, as was illustrated all-too-clearly in the USA on 12 September 2008, when a Metrolink commuter service passed a protecting signal at danger and collided head-on with a freight train in [Chatsworth, California](#). Twenty-five people lost their lives, including the Metrolink driver himself. On the day of the accident, he had sent and received several text messages while on duty, the last of which occurred just 22 seconds before the collision.

Mobile devices can be a distraction for level crossing users, a number of near misses have been recorded involving (often) young people. To combat this, Network Rail and the British Transport Police (BTP) have used [geo-targeting at a number of level crossings](#) where phone distraction has been flagged as high-risk. The system is designed to alert young people using their phones near level crossings to put them away.

As mobile technology becomes ever more integrated with our daily lives, the risks caused by their distractions increases. Distraction or disorientation while using headphones is also a common factor in fatalities on Britain's passive level crossings. In America, the prominent 'One ear out' campaign was borne from the tragic death of a young woman using earbuds.

4.7 Signalling error

Although the daily incident logs show instances of pedestrians being trapped between gates or barriers at CCTV crossings – usually because of sighting issues – to date no fatalities have occurred from this cause. Often, those trapped have chosen to enter the crossing after the signal sequence has started. Indeed, it is rare for a signaller to make a mistake that leads to a loss of life. Over time, with lessons learnt, not only has our understanding of keeping trains a safe distance apart improved, but so has the technology designed to help us do it.

Occasionally, however, there can be instances when controls break down, and when 'the holes in the cheese slices' align.²³

²³ Professor James Reason modelled a company or industry's defence mechanisms against failure as a series of barriers, which he represented by slices of Swiss cheese. The holes in the slices signify weaknesses in parts of the system. When all of the holes in each of the slices align, it creates a 'trajectory of opportunity', so that a hazard can pass through all the holes in all the defences, leading to a failure – or accident., or accident. See (for example) James Reason, *Managing the Risks of Organizational Accidents* (Ashgate Publishing Ltd, 2002).

Moreton-on-Lugg, Hereford, 2010

Such was the case on 16 January 2010, when a collision occurred between a passenger train and two cars on the level crossing at [Moreton-on-Lugg](#), near Hereford. A passenger in one of the cars was killed.

The signaller raised the barriers in error when the train was too close to be able to stop before reaching the crossing. He'd just been involved in a telephone call from another crossing (about the movement of sheep to a field in an area where this did not normally happen), which interrupted his normal task of monitoring the passage of the train. As a result, he believed that the train had already gone.



There was no safeguard in the signalling system to prevent this from happening. There was no plan to fit such a safeguard, and no industry requirement to consider the safety benefits of one.

RAIB noted that, as well as being put off by the telephone call, the signaller probably also lost his normal cues, because he was not standing in the optimal position in the box to monitor the situation, and also felt a degree of pressure to re-open the barriers at Moreton-on-Lugg.

RAIB also suggested that, while an engineered safeguard was provided in the form of interlocked signals, this was not enough to prevent a signaller mistakenly replacing the protecting signal and then raising the barriers when a train was near. At the time, there was no government requirement for approach locking, an engineered safeguard that provides this protection, when the crossing was converted to manual barrier operation in the mid-1970s. Although there have been a number of other incidents involving errors made by signallers and level crossing keepers in recent years, Network Rail had neither fitted it nor undertaken a formal risk assessment to quantify the safety benefit.

RAIB noted that a 'possible underlying factor was the lack of regular liaison between Network Rail's operational risk team and signalling engineers'. This 'made it less likely that the risk associated with signaller error, and the potential mitigation, would be considered'.

Based on two recommendations from its own formal investigation into the incident, Network Rail planned to undertake reviews of:

- improvements to interlocking arrangements to mitigate the risk of operator error at MCB level crossings in semaphore signal areas
- the effectiveness of the follow up of employees who score low on confidence in online tests.

A working group was set up to implement the first recommendation, and work was done to determine the status of engineering safeguards fitted to other level crossings. The review was later expanded to cover all level crossings with interlocked protecting signals (not only in semaphore signal areas like Moreton-on-Lugg).

At the time of the review the group identified that including Moreton-on-Lugg, there were 54 MCB level crossings without approach locking, or with only partial protection. Network Rail has since established a means of prioritising the risk at the identified interfaces and a programme of site visits to review the potential engineering and operational control measures.

Network Rail has also reported that it is undertaking a review of its level crossing risk management process, which will include how the risk of signaller error should be taken into consideration.

In addition, RAIB recommended:

- Identifying level crossings operated by railway staff where a single human error could result in the road being opened to the railway when a train is approaching.
- Enhancing level crossing risk management processes.
- Developing and implementing criteria for when it is necessary to formally assess the need to bring existing signalling and level crossing assets in line with latest design standards; and a process to record the findings of such assessments.
- Assessing the risk associated with the use of TRUST, and similar information systems, by signallers when undertaking safety critical activities, and implement appropriate mitigation measures.

The Narrative Risk Assessments now used for every level crossing and enhanced engineering criteria have addressed many of these issues. Progress in modifying some of the similar but low risk crossings has been slowed due to deferred renewal schemes during CP5²⁴ but all Network Rail Routes retain the accountability for finalising the action.

Hockham Road, Norfolk, 2016

At 12:30 on Sunday 10 April 2016 a Norwich–Cambridge service collided with a tractor and trailer at [Hockham Road level crossing](#). The tractor driver was seriously injured; the train driver and several passengers received minor injuries. The tractor was destroyed, and the train was badly damaged.



Hockham Road crossing, which is on a private road near Thetford, also carries a public footpath. Vehicle users must open and close the gates themselves and, at the time of the accident, had to use the telephone to obtain permission from a signaller at Cambridge before crossing.

The tractor driver was given permission to traverse, and had got half-way across when his vehicle was struck by the train, which was travelling at 84 mph.

The trailer separated from the tractor and struck the side of the unit several times, breaking windows and puncturing the outer body, before coming to rest at the lineside. The cab of the train was severely deformed by the impact, and the driver's door had broken away.

RAIB determined that the signaller had given the tractor driver permission to cross when there was insufficient time to do so before the arrival of the train. This was because the signaller had lost his awareness of the position of the train because his levels of concentration may have lapsed due to a combination of fatigue and a lack of engagement with the signalling task. His competence to operate the workstation safely and effectively had also not been adequately monitored.

The 'EBI Gate 200' system that had been installed at the crossing in 2012—intended to display green or red lights to warn crossing users whether it was safe to cross—was not working at the time of the accident. It had been decommissioned by Network Rail while the design was modified to improve

²⁴ Network Rail control period covering 2015-2019.

the safety integrity of the system. This meant users had to telephone the signaller for permission to cross. RAIB found that Network Rail had not come to a clear understanding with the manufacturer of the system about how the equipment met the required safety integrity level. Having assessed the risks during a routine design modification, they had decided to turn off the system while improvements were made.

An underlying factor was that the arrangements in Cambridge signal box for managing fatigue among signalling staff were inadequate. Furthermore, Network Rail did not adequately define the minimum experience requirements necessary for signallers to maintain their competence to work safely and effectively on the Thetford workstation.

Trenos footpath crossing, South Wales, 2017

On 1 June 2017, a pedestrian was killed at [Trenos footpath crossing](#), near Llanharan in South Wales. The pedestrian walked onto the interface and did not move even when the driver of an approaching train repeatedly sounded the horn and applied the emergency brake.

Around 20 minutes before, another train had stopped at Trenos when its driver saw the same person walking slowly over the crossing. The guard on this service had a short conversation with her and, concerned about her state of mind, asked his driver to contact the signaller by radio. The call was made. The call was answered by a signaller at Cardiff, who relayed the message to a signaller at Port Talbot, the latter being responsible for the Trenos area. As a result, the signaller was asked to stop trains at signals before the crossing and instruct drivers to proceed at caution when approaching.

Whatever the person's reasons for remaining on the crossing, RAIB noted that the accident could have been avoided. Specifically, if the signaller's display screen hadn't been based on out-of-date and misleading information. As a result, the train involved in the incident was not cautioned correctly and thus approached the crossing at speed. RAIB also added that the Port Talbot signaller's decision making may have been influenced by fatigue.

Key points:

- Signalling display screens need to reflect the reality of the railway at all times.
- Signaller fatigue and error can arise from low as well as excessive workload, lifestyle and nutrition.

Worlingham UWC, Suffolk, 2020

On 8 June 2020, the driver of a passenger train applied the emergency brake after observing a vehicle towing a trailer cross [Worlingham UWC](#). The train was about 350 metres from the crossing and was travelling at 55 mph, equivalent to 14 seconds' running time. A second road vehicle was about to drive across behind the first, but reversed away as the train approached. No collision occurred and there were no reported injuries.

In the ten minutes before giving permission to the driver of the road vehicle at Worlingham crossing at 13:17, the signaller had taken six telephone calls from other UWCs; two of these had been after the departure of the incident train from Oulton Broad South four minutes before. The signaller did not realise how much time had passed since this move occurred.

In May 2020, Network Rail had introduced additional axle counters to subdivide some of the long signal sections controlled by Saxmundham. A table provided to the signallers as part of the project indicated that permission should not be given for Worlingham crossing to be used after a train approaching from Oulton Broad South had occupied a specific axle counter section. The signaller

involved in the incident had not been trained in the use of this additional information provided on the display, or the associated table. Had he been trained and assessed as competent, it is possible that he would have chosen not to give permission for the use of the crossing when the incident train was as close as it was.

A national programme of workload assessments to assess task-demand on signallers from crossing requests at UWCs had only recently been carried out in response to the near miss at [Dock Lane on 14 June 2016](#). Recommendation 3²⁵ of that report required (*inter alia*) the development of action plans to reduce signaller task-demand for locations with high volumes of crossing requests from UWC-T crossings. In the case of Saxmundham, the project to introduce additional axle counters was one such agreed improvement action:

“The provision of improved train position information to assist the signaller with decision making when giving permission to cross at UWCs should reduce the cognitive demand on the signaller resulting from the complexity of maintaining awareness of train locations using the limited information available.”

Key point:

- Signallers must be briefed when changes are made to safety related information that affects them.
- Signallers should not rely on a perception of elapsed time when making safety critical decisions, as this can be affected by distractions.
- There should be continued management focus on reducing the risk from signaller errors at user-worked crossings.

4.8 Sighting

Often, if the railway is at fault in a level crossing accident, the issues centre on sighting at the crossing. In some cases, vegetation obscures, signage is inadequate, or the sun shines low (which is pleasantly poetic, but not much use for safety).

4.8.1 Vegetation

Bratts Blackhouse, Suffolk, 2006

On 22 May 2006, a freight train conveying a discharged nuclear flask from Willesden Brent Yard to Sizewell struck a road vehicle on [Bratts Blackhouse No 1 UWC](#). There were no reported injuries, but both train and vehicle sustained minor damage.

RAIB found the immediate cause of the accident to be that motorist did not stop at the designated Stop Board and drove directly into the path of the approaching train without checking the line first.

²⁵ Recommendation 3 says: ‘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.’

Causal to the event was the gates at the crossing had been left open for some time and could not be closed. This was due to overgrown vegetation, the inadequate maintenance of the gates and the non-implementation of the findings of previous crossing inspections.²⁶

At Bratts Blackhouse No 1 UWC, there is insufficient warning time to safely cross unless a driver stops (and looks), with the bonnet of the car within 2.5 metres of the track (ie at the final decision point). This problem had been exacerbated by the inadequate control of vegetation in proximity to sightlines. Network Rail later removed several large trees on the north side between 30-60 metres from the crossing.

Key point: Vegetation can pose risks at level crossings and must be routinely cut back.

4.8.2 Signage

The [Hixon](#) inquiry highlighted inadequate signage as being in the causal chain of that most tragic of accidents. However, it has been a causal factor in many other cases.

Halkirk, Caithness, 2009

At 14:09 on Tuesday 29 September 2009, a passenger train struck a car on [Halkirk AOCL](#) in Caithness. The car's three occupants were killed.

RAIB's report on the accident commented (*inter alia*) on the conspicuity of the road traffic signals, which were less than optimal. In particular, reference was made to their faded backboards (see photo), which would have given rise to 'a greater susceptibility to glare in a road vehicle driver with sub-standard eyesight' (as was the case in this incident).

Network Rail's investigation also found that [low sun](#), which was positioned behind the car driver and shining towards the crossing at the time of the accident, may have affected the car driver's view of the signals and signs as his vehicle approached the interface.

As a result, Network Rail fitted LED road traffic light signals, including new backboards and chequered surrounds, at Halkirk AOCL. When flashing, these are more conspicuous to an approaching road user than the 50-Watt halogen lamps previously used.

The accident also hastened plans to add barriers to AOCLs (thus turning them into AOCL+Bs).

Network Rail also established road-rail partnerships with local authorities in many parts of the country, including the Highland Council. These partnerships provide a forum in which matters concerning the road-rail interface may be discussed and the progress of improvement measures may be monitored.



The red and white background to the level crossing wigwag seen in the photo above dates back to the Stott report, which refers to a need 'to increase the conspicuity and visual impact of both the crossing itself and the signal head'. Stott suggested 'that the back board of the signal head be somewhat increased in size and its conspicuity increased by the additions of a prominent border (say of red and white chequers) whilst some of the associated signs (visual clutter) be removed'. Prior to this, the backboard had a purely white border.

The wigwag signals are covered by the [Traffic Signs Regulations and General Directions](#) (TSRGD) and are used at level crossings, swing or lifting bridges, tunnels, airfields and in the vicinity of premises regularly used by fire, police, or ambulance service vehicles. TSRGD also stipulates the need for retroreflecting material.

²⁶ Note that the road vehicle driver did not look for approaching trains because he had never encountered a train at the crossing before.

Sewage Works Lane, Suffolk, 2010



At around 17:35 on 17 August 2010, a passenger train collided with a loaded 44-tonne articulated road tanker on [Sewage Works Lane UWC](#) (a private railway crossing), near Sudbury in Suffolk. The collision caused the train to derail. Several passengers and the conductor were injured; four passengers and the train driver were seriously injured.

RAIB found that the driver of the road tanker did not use the telephone provided before driving onto the crossing, although it was a requirement to do so.

The company employing the road tanker driver had not been briefed by Anglian Water (to whom they were contracted) on how staff should use the crossing safely. Among other causes, however, was the fact that the signs at Sewage Works Lane UWC presented information to road users in an unclear manner. Nevertheless, the lorry driver, did know what he should do and had used the telephone on previous occasions. He was prosecuted for his failings in this instance.

As a result of this and other incidents, RSSB commissioned research into signs at private railway crossings, some of which Network Rail has implemented (see [T983](#), *Research into signs at private level crossings*).

4.8.3 Low sun

Beech Hill, Doncaster, 2012

At 12:31 on Tuesday 4 December 2012 a collision occurred between a passenger train and a car at [Beech Hill AHB](#), near Finningley. One of the occupants of the car, a young child, was seriously injured and later died in hospital.

The crossing's data logger showed that the crossing had been operating normally at the time of the accident, the barriers being down as the car approached.

However, the car driver said she did not see that the wigwags were flashing as she approached and only noticed the lights and barriers when she was very close to the interface. The weather was sunny at the time of the collision, but there had been rain showers earlier and the road surface was wet, leading to glare from the low winter sun.

RAIB took the wigwag units and arranged for testing in an optical laboratory. It was found that they were fitted with 36-watt lamps and an obsolete design of red lens unit. Their light output was measured to be well below the specification for lights of this type.

Network Rail used the learning from Beech Hill to modify almost 500 level crossings, eradicating 1960s 36-watt filament bulb lights from its level crossings nationwide.

Key points:

- Level crossing risk assessments should take sunlight into account.
- As new technology becomes available, determining what is a reasonably practicable control measure has to keep pace.

4.9 Adhesion

Exeter St David's, Devon, 2010

At around 19:25 on 4 January 2010, a passenger train from Barnstaple struck the rear of another train waiting in the same platform at [Exeter St David's](#). Six passengers and three members of staff were injured. RAIB listed one of the causal factors of the incident as being low adhesion. Although it was a frosty day, swab samples taken also identified that 'high levels of chlorine were present' on the train's leading wheels, the rails within the platform area and the rails at the nearby Red Cow level crossing.

The report noted that '[a] possible source of chlorine was from corrosion of the rails, due to their reaction with the salt used by local authorities to treat road surfaces'. The road on the approach to Red Cow crossing had been treated with road salt shortly before the arrival of the incident train.

As statistical analysis showed no correlation between gritting in the area and reports of low adhesion from train drivers, RAIB concluded that it was 'unlikely that road salt drawn onto the level crossing and along the railway caused low adhesion on the evening of 4 January 2010'.

But of course, low adhesion at level crossings isn't only a problem for rail traffic, it can be a very real problem for road traffic too. A tragic case in point came when a car driver was killed at South Drove crossing, Lincolnshire, in January 2009. The car had been involved in a rear-end collision with a van, but the slippery conditions caused it to become stuck on the interface as a train approached.

RSSB was asked to consider researching the balance of risk between local highway authorities gritting roads approaching or actually on the railway at level crossings.²⁷ However, analysis of all the data suggested that there was no direct evidence of this. Indeed, failure to grit level crossings created a bigger risk for road users than rail and was not to be encouraged.

Key point: Preventing the gritting of roads at level crossings increases the risk for road users, but does not necessarily reduce the risk to rail.

²⁷ R461, *Research into treating snow and ice on public road level crossings*.

4.10 Whistle boards and night time quiet period

Mexico footpath crossing, Cornwall, 2011

At around 15:50 on 3 October 2011, a pedestrian was struck and killed by a train on [Mexico footpath crossing](#), near Penzance.

On approaching the crossing round a curve, the train driver saw a person standing to the side of the line and sounded the warning horn. However, the pedestrian then tried to cross, and was struck and killed instantaneously.

Although RAIB could not be certain why the pedestrian tried to cross, it considers that she either misjudged [the speed of the approaching train](#) or misjudged her position in relation to it. She probably saw the train too late to make a reasoned judgement about whether or not she should cross.

The driver had also sounded the train's horn as required by a whistle board when the train was approximately 15-16 seconds from the crossing, and out of sight. If the pedestrian had heard and responded to the sounding of the horn at this stage, it's likely that she would not have passed through the gate and onto the crossing until the train had passed. RAIB considers that the sounding of the horn when the train was 15-16 seconds from the crossing did not serve its function of warning the crossing user of the approaching train for one of these reasons:

- the sound of the horn was inaudible to her
- she heard a horn being sounded, but did not distinguish it as coming from a train
- she did not register that the train horn was sounded, because she was only approaching the crossing at this time and not yet focused on crossing the railway.

After the accident, Network Rail applied to Cornwall Council to have the crossing closed, diverting users to the nearby Long Rock CCTV crossing, where they would be fully protected from the railway by barriers.

In December 2016, Network Rail reduced the 'night time quiet period' (NTQP) from 23:00-07:00 to 23:59-06:00, as evidence had shown that there was now greater crossing use during this bracket than expected.

Key point: It is important that drivers sound train horns when passing whistle boards rather than at some distance on the approach to them. This will ensure that the likelihood of the horn being heard at the crossing is maximised.

4.11 Blocking back

The first AHB crossing was introduced at Spath, near Uttoxeter, on 5 February 1961. Initially, a crossing keeper was retained to oversee operations, but by the July of that year, British Railways was keen to withdraw attendance as the new equipment was working well.

Indeed, the Ministry of Transport was close to granting permission when word reached them of a problem, namely seasonal traffic peaks at the interface, brought about by its close proximity to Alton Towers. With a T-junction a mere 100 yards beyond, traffic blocking back over the crossing was inevitable—even back then.

The Ministry thus required the railway to maintain attendance and report how many times this problem was arising. It was reported in September that no further occurrences had occurred. As a result, the Railway Inspectorate consented to attendance being withdrawn on 26 September 1961, while stipulating that signs be erected that read ‘Do Not Stop On The Crossing’.

Yellow boxes are now common for AHBs and frequently feature at MCBs. Some crossings have active signs warning drivers when there is a blocking back risk, while MCB-ODs have sensors to stop barriers auto lowering on stationary traffic (both implemented at Harlescott, among others).

Key point: Blocking back continues to pose risks that need to be closely monitored.

4.12 Wrong side failures

Norwich Road AHB, New Rackheath, Norfolk, 2019

On Sunday 24 November 2019, the barriers at [Norwich Road level crossing](#), near New Rackheath, Norfolk, lifted as a Class 755-formed Norwich–Sheringham service was approaching. Two road vehicles crossed the railway in front of the train, which reached the crossing less than half a second after the second road vehicle was clear.

RAIB found that there was contamination of the railhead in the area caused by leaf-fall and atmospheric conditions. This contamination had not been removed because there were no railhead treatment trains on the Norwich–Sheringham line at weekends.

There was a narrow running band on the railhead, because most of the rolling stock (Class 755) on the Norwich–Sheringham line was new and had wheel profiles in similar condition. This left the wheel-rail interface vulnerable to a poor electrical contact in the event of contamination and caused the level crossing equipment to misinterpret the position of the train. Consequently, it opened the crossing to road traffic while the incident train was closely approaching.

Furthermore, processes intended to update trial installations of equipment did not recognise and correct the shortcomings at Norwich Road crossing.

As a result of the incident, Network Rail reset the ‘loss of shunt’ (LOS) timers on all its HXP3²⁸ systems to 99 seconds, the maximum available on this equipment. This should guard against barriers rising before a train arrives at a crossing if the predictor incorrectly assesses its position.

All HXP3 predictor crossings were also fitted with pairs of reinforcement treadles at the equivalent of the strike-in point, the point at which the minimum warning time for the road user is achieved with the fastest train. The treadles will force the crossing sequence to start if the predictor has not registered the train while it was running between the limit of approach and the treadles. If the HXP3 predictor has registered the train before it reaches the treadles but not started the sequence due to the train’s speed, the treadles will have no effect.

On the rolling stock side of the equation, the automatic sander operation on all Stadler manufactured Greater Anglia trains (Class 755 and 745 units) has had the delay removed. The frequency and pressure of scrubber block applications has also been increased on Class 745s and 755s. These blocks, which are similar to small tread brakes, are intended to improve traction by cleaning the treads of the driven wheels. Although it is not the design intent of the scrubber blocks,

²⁸ HXP3 uses audio frequency track circuits to detect an approaching train, and the rate of change of the inductance of the rails is used to determine its speed and hence calculate the trigger moment to provide a constant warning time for each train.

it is possible that their increased usage will provide some improvement to the wheel-rail electrical contact.

Network Rail is currently developing remote condition monitoring systems for signalling and level crossing equipment. This should result in data on the real-time performance of level crossings becoming available to maintenance staff and investigators, should they need it.

Key point: The management of change needs to consider both rolling stock and infrastructure, especially the latter in degraded conditions.

4.13 Right side failures

Not all problematic failures are wrong side, however. At Athelney in 2013, for example, a right side failure occurred which was to have fatal consequences.

Athelney AHB, Taunton, Somerset, 2013

At about 06:23 on 21 March 2013, a car drove around the barriers of [Athelney AHB](#), near Taunton in Somerset. This took the car into the path of a train which was approaching the crossing at high speed. The driver of the car was killed in the resulting collision.

The motorist drove around the barriers without waiting for a train to pass and the barriers to re-open. The level crossing was closed to road traffic for between 75 and 103 seconds before the arrival of the train, because of earlier engineering work that had affected its automatic operation. This was notably longer than the normal 29 seconds. The motorist may have therefore believed that the crossing had failed with the barriers in the closed position, or that the approaching train had been delayed. He did not contact the signaller by the crossing's telephone for advice before he drove around the barriers.

After the accident, Network Rail's Western Route fitted directional strike-in treadles to the eight AHBs within its area that have independent treadle and track circuit operation to reduce the likelihood of extended barrier time closure.

Key points:

- Sometimes the holes in James Reason's Swiss cheese slices²³ can be small, yet still allow a 'trajectory of opportunity' to get through.
- People develop a mental model of how to use a level crossing from their prior experience of using crossings, instructions or by observing the behaviour of other users. While the mental model may work in normal operations, in degraded conditions it can be fatally flawed.

5 Crossing closure

There is no simple or easy procedure for closing such a crossing, which – as they are public rights of way – requires widespread public consensus. For example, an installation at Willesborough in Kent took several attempts at closure in the 1980s and 1990s before it was agreed that a bridge would be provided.²⁹ In fact, clauses in several private parliamentary bills were required over several years until the move was approved.³⁰

It should be noted that level crossings create benefits to society and road users, as well as risk to users and passengers—and cost to the railway.³¹ The number of crossings has, however, been reduced over the last 50-60 years. There are three main reasons for this:

The railway first tried closing Buriton footpath crossing (Hampshire) in 1896. Various attempts were later made, but closure only came in January 2017, following a Public Inquiry.

- the reduction in the size of the rail network and the closure of many branch lines (mainly as a result of Beeching's 1963 report, [The Reshaping of British Railways](#))
- the increase in train speeds from the first introduction of HSTs in 1976 and from the many related resignalling/track realignment schemes
- more recently, Network Rail's level crossing closure programme.

Key points:

- Closing a crossing requires widespread agreement, where they are public rights of way.
- Most public crossing closures over the last 50-60 years have been down to line closures, and increases in train speeds. Increases in train speeds can increase the likelihood and consequence of accidents at level crossings.

²⁹ This was required as the line was to form part of the upgraded route to the Channel Tunnel.

³⁰ The process, and comparison with that applying in several other countries, was reviewed in RSSB's research report T528, [Attitudes to, processes and funding for, crossing closures in other countries](#).

³¹ Michael Woods, RSSB, *The Economics of Level Crossings*. Paper to Ninth International Level Crossing Safety and Trespass Prevention Symposium, Montréal, Canada, September 2006.

6 Changing level crossing user behaviour

Through its crossing closure programme spanning CP4 and CP5³², Network Rail has closed around 1200 level crossings. However, closures are now becoming increasingly difficult to achieve. As a result, Network Rail is focusing on level crossing risk reduction, which includes continuing to close crossings, increasing use of technology, and educational campaigns to influence user behaviour. This work has been undertaken under the auspices of the CP4 Level Crossing Improvement Programme, the CP5 Level Crossing Prioritised Technology Programme and Network Rail Safety Campaigns.

6.1 Changing behaviour using technology

Learning both from incidents and RSSB research, Network Rail has developed new technology which works to influence how users interact with level crossings. Such technology includes proactive warning systems and enforcement technology.

Warning Systems and Supplementary Audible Warning Devices

In 2015, Network Rail began to introduce the CovTec Supplementary Audible Warning Device (SAWD), an overlay train detection system that broadcasts the sound of a train horn at whistle board-protected crossings. They supplement, rather than replace, whistle boards, but reduce the risk from train horns not being heard.

Overlay Miniature Stop Lights

Network Rail developed overlay miniature stop light systems (OMSL), installation beginning in 2017 at footpath, bridleway³³ and user-worked crossings. Installations have been prioritised at crossings in long signal sections, where the equipment can reduce long waiting times, and where sighting is poor. OMSLs provide a significant cost reduction when compared to a conventional integrated MSL. This means Network Rail is able to install more of them across the railway.

Enforcement Technology and Mobile Safety Vehicles

In partnership with BTP, a fleet of mobile safety vehicles, equipped with automatic number plate recognition technology and video surveillance equipment, are deployed to deter deliberate misuse and catch offenders. While some offenders are prosecuted, others are offered an education programme to improve safety.

Red Light Safety Equipment

In 2015, Red Light Safety Equipment (RLSE) started to be installed at public highway level crossings. The equipment recorded its first offence in the May of that year. By 2017/18, 33 crossings had been fitted; a total of 2343 cases were brought that year. The crossing with the most recorded offences was White Hart Lane, with 776 cases.

³² Network Rail control periods covering 2009-2014 and 2015-2019 respectively.

³³ Bridleway crossings are those designed for use by horse riders and cyclists as well as pedestrians, but not vehicles.

RLSE is fully automated and unattended. It captures evidence of road vehicles failing to stop at level crossing red lights. The cameras' primary purpose is to reduce the risk from collision with a train. They act as a deterrent, dissuading motorists from driving dangerously.

6.2 Education

Education and awareness Campaigns

Safety awareness campaigns remain an important tool in cascading safety communication messages to the public. Network Rail continues to work collaboratively with partners such as the National Farmers Union (NFU), trade groups, Drinkaware, BTP and more broadly with rail industry colleagues through the International Level Crossing Awareness Day ([ILCAD](#)) community. Campaigns target at-risk groups, such as those most prone to errors, lapses or deliberate misuse. Each campaign delivers key safety messages to coincide with risk and seasonal trends, keeping information fresh and engaging.

Examples of such campaigns include:

- [Stay Safe with Thomas](#)
- [Beware the bubble](#)
- [Switched On!](#)

Driver education

BTP manages education courses that have been successful in raising awareness and reducing the likelihood of repeat offences for drivers caught breaking the law at level crossings.

7 Legislation and standards

As we saw earlier, the original railway Act of Parliament specified how the railway was to cross other ways (for example roads and footpaths), either by bridge or on the level. Where the crossing was on the level, the arrangements for protecting the users, both railway and highway, were specified.

Since initial construction, use of the roads and railway has changed considerably, as has the cost of and delay caused by level crossings. From the 1950s level crossings have also been modernised to permit remote or automatic operation with lifting barriers and/or road traffic signals.

To encourage railway operators to change the protective arrangement specified in the original Act, a legal process was introduced to empower the Secretary of State for Transport to make statutory orders specifying the new or updated arrangements at individual crossings to which the public has access. This is currently authorised through provisions in the [Level Crossings Act 1983](#). It is managed by the ORR, normally initiated by the operator of a level crossing, and requires consultation with the local traffic authority. A level crossing order provides for the protection of those using a level crossing and may place duties on both the crossing operator and local traffic authority. It may also make such provision as the Secretary of State considers necessary for the safety or convenience of crossing users.

Requirements for the road/rail interface at level crossings were primarily set by Railway Inspectorate (RI) and published in [Railway Construction and Operation Requirements: Level Crossings](#) (1981). In particular, these included the timings of the warning lights before the barriers start to descend and the minimum time before a train can arrive at the crossing.

The 1981 requirements superseded level crossing requirements in the earlier *Railway Construction and Operation Requirements for Passenger Lines and Recommendations for Goods Lines*, published by the Ministry of Transport, together with a number of supplementary publications detailed in the introduction to the 1981 requirements.

The 1981 requirements largely implemented the recommendations in the [1978 'Townsend-Rose' report](#). They were replaced in 1996 by *Railway Safety Principles and Guidance (RSPG); part 2 section E Guidance on Level Crossings*, published by the Health and Safety Executive (of which the HMRI was a part at that time). Responsibility for the HMRI and for this guidance document was subsequently transferred to the ORR. This was in turn replaced by [Level crossings: a guide for managers, designers and operators](#), published by the ORR in December 2011.

Although, since 1996, the design parameters have been published as 'guidance' rather than 'requirements', upgrading or modification of a level crossing on a public road requires an amendment to the Level Crossing Order if the new protection arrangements will not comply with the current one.

The introduction to the 1996 guidance stated:

'3 Application of this guidance should provide a sufficient level of safety for approval to be given by the Inspectorate, provided that it has been demonstrated that the use of the guidance is wholly applicable to the level crossing.'

'4 If this is not the case, then the Inspectorate will wish to be satisfied that due consideration has been given to implementing the safety principles in the Part 1 document Railway safety principles and guidance in a way that ensures that all intolerable risks have been eliminated and that all remaining risks have been reduced to be as low as reasonably practicable (known as ALARP).'

Failure to comply with a level crossing order is a criminal offence. Under [the following year's Level Crossing Regulations](#), failure to comply also allowed the ORR to issue an Improvement Notice if it

considers the arrangements at a crossing unsatisfactory and feels the infrastructure manager has not made or proposed suitable improvements, asking for an order to change the type of protection.³⁴

Railway Group Standard on GE/RT7012, *Requirements for Level Crossings*, was published in August 2004. This incorporated requirements for the road /rail interface, which were based on the guidance in RSPG part 2 section E, with some more specific requirements on how they were to be implemented. There was an earlier set of Level Crossing Principles documents produced internally by British Rail, which are mentioned along with other superseded documents in the introduction to GE/RT7012, but these were not formally issued as Railway Group Standards.

GE/RT7012 was withdrawn in 2010 and replaced by GKRT0192 *Level Crossing Interface Requirements*. GKRT0192 is limited in coverage to the interface between railway infrastructure and trains. The presentation of the crossing to the road user is no longer within the scope of Railway Group Standards, and therefore the requirements relating to the road/rail interface were withdrawn. The design of the road/rail interface is now the responsibility of the infrastructure manager, who in most cases is Network Rail; standards relating to the road/rail interface are therefore issued by Network Rail, and further developments since then have been entirely handled by them, although as stated before the basic principles of protection including timing sequences are set out in the ORR's guidance.

In 2021, the ORR updated its guidance for level crossings. The new [Principles for managing level crossing safety](#) encourages thinking about the how level crossings are actually used and how level crossing design can influence this. It also fosters a collaborative approach to reduce and eliminate risk, as also demonstrated in the breadth of level crossing community representatives involved in the guidance's successful consultation.

7.1 The role of RAIB

According to its website, *The RAIB must by law investigate all rail accidents involving a derailment or collision which result in, or could result in:*

- *The death of at least one person;*
- *Serious injury to five or more people; or*
- *Extensive damage to rolling stock, the infra-structure or the environment.*

*The RAIB may also investigate other incidents which have implications for railway safety, including those which under slightly different circumstances may have led to an accident.*³⁵

The RAIB will not investigate:

- Worker accidents/incidents with the exception of those involving train movements;
- Accidents/incidents involving trespassers or suicides; or
- Accidents/incidents where there are no likely safety lessons to be learned.

³⁴ Note the ORR acts under an agency agreement with the Department for Transport (DfT); if the ORR requires a crossing operator to apply for a Level Crossing Order then the issuing of the Order passes to the DfT on behalf of the Secretary of State.

³⁵ See http://www.raib.gov.uk/about_us/index.cfm#a5 (and *ibid*).

Regarding trespass, it is now normal to consider both the risk of trespass and the potential consequences (such as from contact with adjacent electrified infrastructure or pointwork in level crossing design).³⁶ Where trespass risk indicates, anti-trespass guards are fitted either side of the crossing to deter people straying from the right of way.

7.2 Public rights of way

Network Rail was worked with the Association of Directors of Environment, Economy, Planning & Transport – Rights of Way Managers’ Group (ADEPT), and the Institute of Public Rights of Way and Access Management (IPROW) to develop a Memorandum of Understanding (MoU). The aim of the MoU is to promote level crossing safety and improve working practices between Network Rail and Local Highway Authorities (LHAs) where Public Rights of Way (PRoW) use level crossings in England and Wales.

The MoU is not intended to be legally binding, but aims to encourage clearer communication and build collaborative relationships between Network Rail and LHAs when changes are proposed to a level crossing which affects a PRoW.

Key points: Collaboration with stakeholders is important to bring about change, the full MoU may be found [here](#).

³⁶ This stems from the ‘Herrington’ fatality, which occurred on 7 June 1965 at Mitcham. It involved six-year-old boy, who had been playing on the railway line after gaining access through a hole in the boundary fence, which was in bad repair. He was electrocuted on the live third rail. In *Herrington v British Railways Board* [1972], the House of Lords ruled that, as the British Railways Board (as occupiers) was aware of previous trespasses but had failed to maintain the integrity of the boundary fence, it was liable for injuries to the child. The House of Lords held that the occupier of the railway premises owed a duty of common humanity to said child. Until this case, no duty of care was owed to trespassers.

8 Research and development

Starting in 2001, RSSB managed and published a number of research reports related to level crossings and other road-rail interface issues such as bridge strikes, mainly focussed on improving safety at the interface. The responsibility for new research has now passed to Network Rail, which has a number of research activities completed and in progress. Such research is conducted in nine main areas:

- Understanding the risk at level crossings to enable prioritisation of remedial actions.
- Identifying and sharing good practice in Britain and overseas to facilitate the adoption of appropriate solutions.
- Identifying new technical and operational solutions to prevent errors and misuse of crossings.
- Understanding the costs of level crossings and the benefits of adopting alternatives to optimise societal benefits.
- Working in collaboration with highway and planning authorities to design out safety risk and reduce the overall cost to society.
- Understanding the needs of vulnerable users at level crossings to facilitate social inclusion.
- Review and overhaul of the legislative framework for level crossings to identify legal requirements and consolidate disparate regulations.
- Research into bridge strikes and vehicle incursions.
- Research to support inquiry recommendations, government and regulatory policies, proposed and new legislation.

This table lists the research projects published on level crossings during the last decade:

Project No.	Title	Published
T000	<i>User worked and footpath level crossing research</i>	2002
T028	<i>Development of a universal level crossing risk tool</i>	2007
T032	<i>Trials of median strips / lane separators at level crossings</i>	2007
T105	<i>Wayside horns at level crossings</i>	2003
T232	<i>Improving level crossing information systems</i>	2004
T269	<i>Human factors risk at user worked crossings</i>	2004
T332	<i>Understanding the risk at station and barrow crossings</i>	2005
T333	<i>Evaluating best practice deterrence and enforcement mechanisms at level crossings</i>	2007
T334	<i>Reducing the risk to motorists traversing user worked crossings on foot</i>	2009
T335	<i>Improving road user and pedestrian behaviour at level crossings</i>	2008
T336	<i>Modelling the economics of level crossing closures and conversions</i>	2007
T364	<i>The cost of level crossings - an international benchmarking exercise</i>	2006
T521	<i>Developing enhanced consequence algorithms for level crossing risk models</i>	2006
T522	<i>Obstacle detection at level crossings</i>	2006
T524	<i>Use by other railways of risk models and risk assessments for level crossings</i>	2007

Project No.	Title	Published
T527	<i>Analysis of research ideas from recent international level crossing conferences</i>	2007
T528	<i>Attitudes to, processes and funding for, crossing closures in other countries</i>	2006
T561	<i>Evaluating safety benefits from miniature warning lights at level crossings</i>	2007
T650	<i>Improving safety and accessibility at level crossings for disabled pedestrians</i>	2011
T652	<i>Examining the benefits of 'another train coming' warnings at level crossings</i>	2008
T653	<i>Safer European level crossing assessments and technology (SELCAT)</i>	2009
T668	<i>Research into the safety benefits provided by train horns at level crossings</i>	2009
T680	<i>Mapping the extent of the train horn noise problem</i>	2006
T681	<i>Understanding the problems that train horn noise causes to neighbours</i>	2006
T707	<i>Analysing the potential of vehicle activated signs at public road level crossings</i>	2011
T719	<i>Monitoring motorists' behaviour at level crossing median strip trial sites</i>	2009
T729	<i>Further work on obstacle detection at level crossings</i>	2010
T730	<i>Understanding human factors and developing risk reduction solutions for pedestrian crossings at railway stations</i>	2009
T737	<i>Documenting the All Level Crossing Risk Model</i>	2010
T738	<i>Trialling the national roll out of the level crossing cost model</i>	2010
T756	<i>Research into traffic signs and signals at level crossings</i>	2014
T818	<i>Optimising public communication with signallers in emergencies at level crossings</i>	2009
T821	<i>Further work on miniature warning lights at user worked crossings</i>	2010
T854	<i>Reducing the number and impact of vehicle strikes on railway underline bridges</i>	2012
T863	<i>Updating the Level Crossing Risk Management Toolkit</i>	2010
T907	<i>A guide to RSSB research in Road Rail Interface Safety</i>	2011
T936	<i>Enhancing the accuracy and functionality of the All Level Crossing Risk Model (ALCRM)</i>	2017
T983	<i>Research into signs at private level crossings</i>	2015
T984	<i>Research into the causes of pedestrian accidents at level crossings and potential solutions</i>	2014
T1006	<i>Enhancing the accuracy and functionality of the AXIAT level crossing tool</i>	2006
T1007	<i>Research into positioning railway signals on the approach to level crossings</i>	2016
T1053	<i>Updating the Level Crossing Risk Management Toolkit</i>	2015
T1205	<i>Relationship between train horn test measurements and perceived sound levels on the track</i>	2021

Appendix: Level crossing types

Active crossings: Manual



Manually controlled gate (MCG): This crossing is equipped with gates, which are manually operated by a signaller or crossing keeper either before the protecting signal can be cleared, or with the permission of the signaller or signalling system. At the majority of these crossings, the normal position of the gates is open to road traffic, but on some quiet roads the gates are maintained 'closed to the road' and opened when required if no train is approaching.

Manually controlled barrier (MCB): MCB crossings are equipped with full barriers, which extend across the whole width of the roadway, and are operated by a signaller or crossing keeper before the protecting signal can be cleared. Road traffic signals and audible warnings for pedestrians are interlocked into the signalling system.



Manually controlled barrier protected by closed circuit television (MCB-CCTV): Similar to MCB crossings, except that a closed circuit television (CCTV) is used to monitor and control the crossing from a remote location.

Manually controlled barrier with obstacle detection (MCB-OD): MCB-OD are full barrier crossings equipped with an obstacle detection system as a means of detecting obstacles on the crossing prior to signalling train movements. The obstacle detection system comprises of RADAR and scanning laser obstacle detectors. The lowering sequence is instigated automatically upon detection of an approaching train. MCB-ODs are equipped with road traffic lights and audible alarms. The barriers, road traffic signals and audible warnings for pedestrians are interlocked with the signalling system. The signaller typically does not



participate in operation of the crossing and does not have a view of it. Indications on the state of the crossing warning lights, barriers and obstacle detection system are provided to the signaller and the barriers can be lowered and raised manually if required.



Train Man Operated, Manual Gates (TMOG):

On small branch lines, these crossings are common as they require no monitoring by any signallers, and simply have to be observed by the train driver as being closed. The guard will manually close the gates or push a button close to the crossing that activates it, and once lowered the train can cross safely. These appear to be MCG/MCB type crossings to the road driver, but have a much shorter closing time (with the drawback of the train having to stop completely to activate the crossing).

Active crossings: Automatic

Automatic half-barrier (AHB): AHB crossings are equipped with barriers that only extend across the nearside of the road (so that the exit is left clear if the crossing commences operation when a vehicle is on it). Road traffic signals and audible warnings are activated a set time before the operation of the barriers, which are activated automatically by approaching trains. The barriers rise automatically when the train has passed, unless another train is approaching. Telephones are provided for the public to contact the signaller in case of an emergency or to ensure it is safe to cross in a long or slow vehicle. These crossings can only be installed where the permissible speed of trains does not exceed 100mph.



Automatic barrier crossing locally monitored (ABCL):

As far as the road user is concerned, this crossing looks identical to an AHB crossing. The difference is that train drivers must ensure that the crossing is clear before passing over it. Train speed is limited to 55mph or less.

Automatic open crossing remotely monitored (AOCR): The AOCR is equipped with road traffic signals and audible warnings only: there are no barriers. It is operated automatically by approaching trains. Telephones are provided for the public to contact the signaller in an emergency. Only one crossing of this type remains on the mainline railway, at Rosarie in the Scottish Highlands.

Automatic open crossing locally monitored (AOCL): Like the AOCR, this crossing is equipped with road traffic signals and audible warnings only and is operated automatically by approaching trains. A physical difference apparent to the user is that no telephone is provided. An indication is provided to the train drivers to show that the crossing is working correctly, they must ensure that the crossing is clear before passing over it and train speed is limited to 55mph or less. If a second train is approaching, the lights continue to flash after the passage of the first train, an additional signal lights up, and the tone of the audible warning changes.



Automatic open crossing locally monitored with barriers (AOCL+B): AOCL+B is a simple half barrier overlay to previously commissioned AOCL crossings. They look and function as if they are ABCLs.

Automatic full barrier crossing locally monitored (AFBCL): The AFBCL is equipped with full barriers which extend across the whole width of the roadway and a light detection and ranging (LIDAR) detection system. Like the ABCL, train drivers must observe the white light and ensure that the crossing is clear before passing over it. Train speed is limited to 55mph or less.



User-worked crossing with miniature warning lights (UWC-MWL): This crossing has gates or full lifting barriers, which the user must operate prior to crossing. Red/green miniature warning lights, operated by the approach of trains, inform the user whether it is safe to cross.

Passive crossings

User-worked crossing (UWC): This crossing has gates or, occasionally, full lifting barriers, which the user must operate prior to crossing. The user is responsible for ensuring that it is safe to cross; hence there must be adequate visibility of approaching trains. Once clear, the user is required to close the gate or barriers. These crossings are often found in rural areas, for example providing access between a farm and fields. They often have an identified user, some of whom keep the crossing gates padlocked to prevent unauthorised access.



User-worked crossing with telephone (UWC-T):

These are similar to the standard user-worked crossing, but a telephone is provided. In some circumstances (for example when crossing with livestock or vehicles) the user must contact the signaller for permission to cross, and report back when they are clear of the track. They are provided where visibility of approaching trains is limited, or the user needs to cross over the railway on a regular basis.

Open crossing (OC): At open crossings, which are sited when the road is quiet and train speeds are low, the interface between road and rail is completely open. Signs warn road users to give way to trains. Road users must therefore have an adequate view of approaching trains. The maximum permissible speed over the crossing is 10mph or the train is required to stop at a stop board before proceeding over.



Footpath crossing: These are designed primarily for pedestrians and usually include stiles or wicket gates to restrict access. The crossing user is responsible for making sure that it is safe to cross before doing so. In cases where sufficient sighting time is not available, the railway may provide a whistle board, instructing drivers to sound the horn to warn of their train's approach, or miniature warning lights. A variant is the bridleway crossing, which is usually on a public right of way, although some are private and restricted to authorised users. Some footpath crossings are in stations and these can be protected by a white light (which goes out when a train is approaching) and are generally only used by railway staff.

About RSSB

RSSB provides research, analysis, and insight to help the industry work together to deliver a better, safer railway.

As a membership-based rail industry body, RSSB includes train and freight operating companies, infrastructure managers, contractors, rolling stock leasing companies and suppliers, and our work involves partnerships with academia and other railways across the world.

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