NR17

Transforming Level Crossings

2015 - 2040

A vision-led long-term strategy to improve safety at level crossings on Great Britain's railways

Contents

Level Crossing Safety Strategy 2015 - 2040

1. Executive summary

This document outlines Network Rail's long-term strategy to improve level crossing safety in Great Britain. It is a vision-led safety strategy, designed to work towards eliminating accidental fatalities at level crossings. The strategy provides the details of the work Network Rail will undertake to improve level crossing safety for the benefit of crossing users, train crew and rail passengers alike.

Key elements of the Level Crossing Safety Strategy include:

- Continued focus on targeted level crossing closures
- Working to a time-bound framework for making all passive crossings 'active', providing clear warnings of approaching trains and replacing telephones and whistle boards to reduce the likelihood of human error
- Prioritising the elimination of passive crossings on high speed lines and at stations
- Improving underfoot conditions and signage, including marking of danger zones to raise user knowledge and situational awareness – reducing opportunities for human error
- Developing and rolling out automatic full barrier crossings with obstacle detection to help reduce pedestrian errors and deliberate road vehicle user violations on the network
- Prioritising the removal of AHBs near to stations and schools
- Continuing the use of red light safety cameras at public road level crossings, to reduce deliberate violations by road vehicle users
- Ensuring that the whole organisation takes account of the strategy in what they do, not just the level crossing community
- Working collaboratively with other functional areas of the business and taking opportunities for innovation, for example through technology within a digital railway

The strategy details the work that needs to be done between now and the end of CP9[1] (March 2039), allowing Network Rail to plan long-term across a number of funding periods.

2. Background

Level crossings represent one of the biggest public safety risks on the railway. They account for 8%[2] of total system risk on the British rail network. Network Rail's All Level Crossing Risk Model (ALCRM) calculates 12 Fatalities and Weighted Injuries (FWI) across all types of crossings nationally. The risk at unprotected footpaths and user worked level crossings accounts for over half of this.

[1] *CP or Control Period (Network Rail receives its funding allocations in 5 yearly blocks or Control Periods)*
[2] *As measured by Rail Safety & Standards Board (RSSB); source Safety Risk Model (SRM) v8.1*

Level crossings are the main interface between the rail and the road networks. Due to the nature of the UK road and rail network, both types of infrastructure are extremely congested in parts of the country, which increases the challenge of managing level crossings. There are in the region of 6,000 active-open level crossings across the network, ranging from passive crossings with simplest risk controls, through to public road crossings with active risk controls.

Closing level crossings will always be the most preferable and best solution to manage safety. However, it is not possible to close all level crossings on the network. A broad range of interventions and initiatives are needed to address long-term issues at crossings which remain open. The scale of work involved is significant and will take several control periods to complete. Incorporating all of the interventions and initiatives into a single, risk based Level Crossing Safety Strategy and implementation plan, informs the rail industry of the resources and timescales needed to comprehensively improve level crossing safety across the network. The Level Crossing Safety Strategy has a large focus on reducing risk at passive level crossings[3]. This is a targeted approach that will improve safety through the provision of active systems to warn users of approaching trains and through infrastructure improvements such as demarcation of the danger zone[4]. The strategy also focuses on other areas of level crossing safety involving other types of level crossings; notably, as part of our vision for reducing risk, there is an emphasis on motorist safety at public road crossings.

In the area of level crossing safety, Network Rail has moved forward a long way between 2011 and 2017. Through the Level Crossing Safety Improvement Programme the company has improved its organisational capability by introducing over 100 Level Crossing Managers (LCM) and Route Level Crossing Managers (RLCM). These key personnel are dedicated to the safety and risk management of the level crossing estate. These positions have also helped to clarify roles and responsibilities, resolving the previously fragmented structure. Network Rail has also improved its processes around level crossing risk assessment and asset inspection and has worked hard to resolve data and system integration problems. Over the last two years the business has embedded these changes and we are now seeing these improvements successfully reflected in the risk management of our level crossings.

Level Crossing Managers

Mobile apps have replaced paper based systems for risk assessment and asset inspections of level crossings

[3]Footpath and private vehicle crossings which require users to make safe decisions to traverse based on sighting alone or interface with Signallers using telephones (where provided)

[4]RSSB research paper T984 recommendation relating to the identification of 'unsafe areas' or danger zones at passive crossings

In parallel to investing in people, the Level Crossing Safety Improvement Programme has worked to reduce risk through a number of physical works projects. These include:

i. the closure programme (over 1000 level crossings closed since 2010);

ii. sighting improvement project (over 1100 passive level crossings had sighting improved);

iii. barrier-overlay installed at a proportion of automatic open crossings on the network including those high risk locations;

iv. barrier-inhibition retro-fitted to manual crossings with no approach locking;

v. a fleet of new BTP-staffed MSVs introduced around the country;

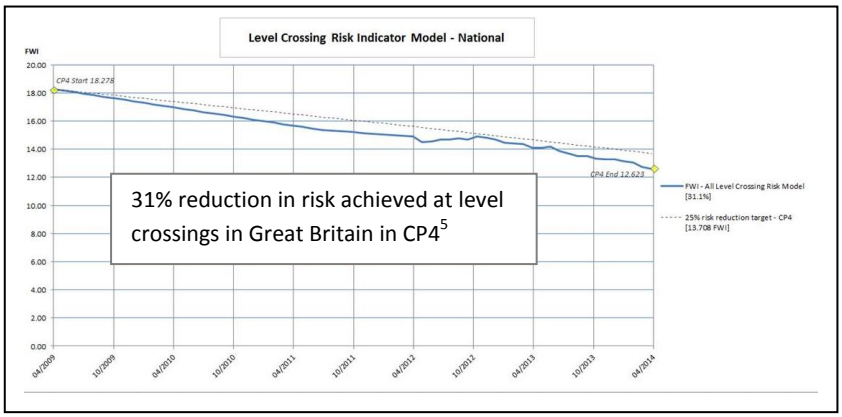
vi. 36w filament bulb road traffic light signals replaced with brighter LED heads (at almost 500 public road crossings);

vii. new spoken audible warnings installed at a number of sites to inform users when a second train is approaching; and

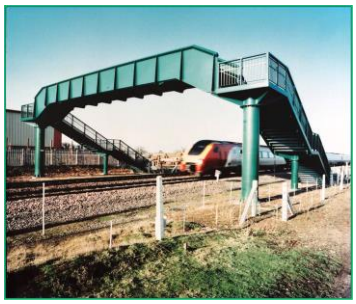
viii. power operated gate openers (POGO) installed at some private vehicle crossings to reduce the number of traverses a vehicle user makes on foot and also to reduce the likelihood of gates being deliberately left open; and

ix. a new full barrier signal protected level crossing type, which uses obstacle detection technology, has been introduced on the rail network.

These combined initiatives helped to reduce level crossing risk by 31% in CP4[5]; reflecting a safety investment of c.£132m.



LED conversion programme of road traffic light signals at c.500 assets and eradication of 36w filament bulbs from the network



Over 1000 level crossings closed

Barrier overlay installed at a significant proportion of automatic open crossings across

MSV fleet introduced to support improved user awareness & behaviour

[5]*CP4: 1st April 2009 to 31st March 2014*

For CP5[6], the Office of Rail and Road (ORR) allocated a ring-fenced fund of £99m which must be invested for maximum risk reduction during the control period. This programme is largely targeting closure of higher risk passive level crossings; although some of the money will be used for other innovative risk reduction schemes. Critically, the fund cannot be used to pay for basic legal compliance measures, for which Network Rail is otherwise funded.

Great Britain can demonstrate a very good safety record at level crossings in comparison to the rest of Europe, indeed ours is one of the best level crossing safety records of any major rail network in the world. Just one accident with multiple fatalities could, however, significantly change this.

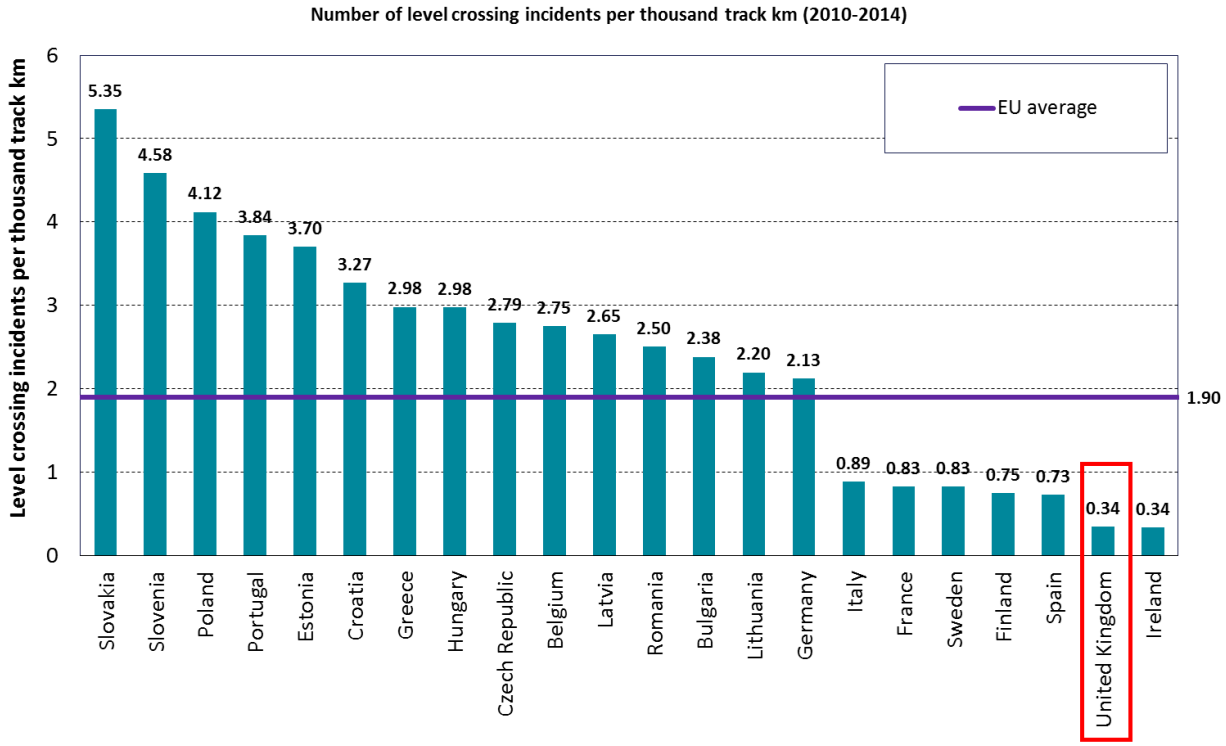


Figure 1
Level crossing incident rate across Europe per thousand track kilometres[7] 2010 - 2014

Commentators have extrapolated these figures to conclude that Britain has the safest level crossings in the world. The good record is assisted by factors such as:

i. relatively few level crossings compared to other major rail networks; and

ii. public awareness of rail/level crossing safety is generally high.

Both factors have benefitted from previous and current Network Rail focus.

[6] *CP5: 1st April 2015 to 31st March 2019*
[7] *Source: Eurostat Data – extracted August 2015*

Despite recent improvements in level crossing safety, there are still many issues to address, particularly with passive level crossings. Network Rail will adopt a long-term vision-led strategy for level crossings to permanently address the legacy issues and to design out foreseeable risks of the future.

3. Our vision, objectives and approach

*"Our vision is for **no accidents at level crossings**."*

To achieve this vision Network Rail will commit to a more comprehensive approach to level crossing risk management than has previously been employed.

Our strategic objectives

Our Level Crossing Safety Strategy is underpinned by a number of vision-led strategic objectives. These are:

- Eliminate fatalities at level crossings
- Eliminate accidents at level crossings
- Reduce safety risk to the public, passengers and the workforce
- Reduce business and reputational risk

Our mission

To achieve our safety vision for level crossings, we will move away from reactive management of emerging single issues in isolation, in favour of a targeted strategic plan to improve safety. This transition benefits all and will help to avoid a management culture of constant fire-fighting, waste, duplication of effort and sub-optimal solutions not aligned to a wider business strategy. In adopting a prioritised and targeted plan which is truly holistic and proactive in its approach, we will seek to:

- resolve all existing level crossing issues through a holistic, risk-based implementation strategy, and;
- take cognisance of societal needs into the mid-21st Century, together with available technology to develop the next generation of level crossings, and;
- take account of Network Rail's wider Group Strategy and sustainability plans.

We will invest in additional risk controls at level crossings across the network in order to tackle the range of legacy issues that remain currently. It is anticipated that allocated funding, resource and deliverability challenges and technology constraints will combine to make the implementation complex and a long-term objective. The vision-led safety strategy is accordingly estimated to last into CP9 or beyond.

Our vision-led commitments

Implementation of the Level Crossing Safety Strategy will deliver the following milestones:

- We will develop a safety-led technology strategy for level crossings which will consistently review emerging technology and seek to integrate level crossing operations with on-board train technology
- We will work with local authorities, government and communities to sensitively close level crossings where there is an alternative and practicable diversionary route available
- **By 2019** we will have an asset management plan for every level crossing on the network
- **By 2019** all whistle boarded crossings with known use during the night-time quiet period will be equipped with train detection/warning systems
- **By 2020** a new approved Automatic Full Barrier crossing design with obstacle detection will be available
- **By 2024** all road traffic light signals will be of LED type design; eradicating filament bulb signal heads from the network
- **By 2025** there will be no user worked crossings in long sections on the network which rely on telephones as the primary means of protection
- **By 2025** all whistle boards will have either been replaced or will be supported by automatic user-based warning systems
- **By 2030** telephones will not be the primary means of protection at any of our user worked crossings
- **By 2030** all footpath crossings will have a decked surface which indicates the 'danger zone'
- **By 2035** all Automatic Open and Half Barrier level crossings will have been replaced with full barrier crossings
- **By 2039** all existing passive crossings will be equipped with automatic user-based warning systems

4. Relative risk profile

At the beginning of CP5 there were 6,291 level crossings in use on the rail network[8]. The chart below illustrates the relative numbers of passive, automatic and fully protected level crossings.

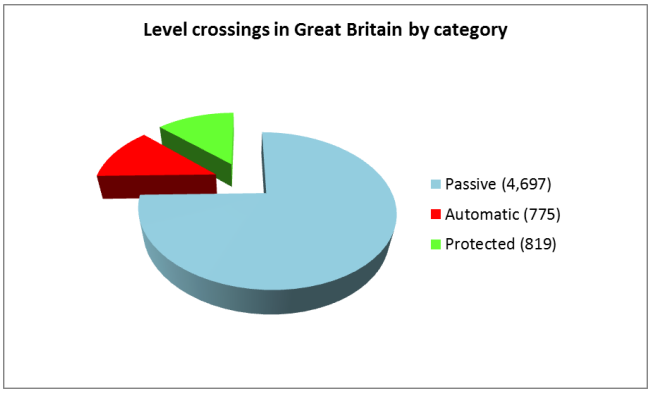


Figure 2

[8]*Source – All Level Crossing Risk Model (ALCRM), August 2015*

Passive crossings

The vast majority of the level crossing estate is classed as 'passive' level crossing types. Passive crossings are so called because they do not provide users with warning or protection from approaching trains. The primary method of operation for passive crossings is through users observing whether it is safe to cross. For this method of operation there needs to be enough sighting distance available to provide users with adequate time to cross and this is based on the railway line speed. If vehicles use the crossing then the traverse time is increased by factors such as vehicle length, use of trailers etc. Where pedestrians use the crossing the traverse time is affected by use by vulnerable users or those with mobility impairments. Passive crossing types include: footpaths, station crossings, bridleways, user worked crossings and user worked crossings with telephones.

Automatic crossings

At automatic level crossings, trains are detected automatically through track circuits or treadles which initiate a warning at the crossing. The majority of automatic crossings provide both an audible and a visual warning for pedestrian and road vehicle users. Warnings will typically consist of audible alarms, road traffic light signals and half barriers at crossings on public roads and audible alarms and stop lights at footpath or private vehicle crossings (UWCs). Most automatic crossings on public roads have half barriers. Whilst they offer some protection and provide an exit route for road vehicles and pedestrians, they also conversely present an opening or opportunity for deliberate misuse/risk taking behaviour. Automatic crossing types include: automatic half barrier crossings (AHBs), automatic barrier crossings locally monitored (ABCLs), automatic open crossings locally monitored (AOCLs) and footpath or UWCs with miniature stop lights (MSLs).

Protected crossings

The final category is fully protected crossings. These have the most comprehensive levels of protection. These crossings tend to be situated on public roads and they include crossing types such as: obstacle detection (MCB OD), those supervised/operated by CCTV (MCB CCTV), manually operated with barriers (MCB), or manually operated with gates (MCG). Protection typically includes: full barriers or gates which completely close-off the road approaches from the railway, a mechanism to confirm that there are no obstacles on the railway (including RADAR/LIDAR technology or visual check by a Signaller/Crossing Keeper on site or using CCTV), railway signals which are only cleared for trains to proceed once it is confirmed that the crossing is clear, visual warnings for road vehicle drivers in the form of road traffic light signals (and barriers) and audible warnings for pedestrians.

Road risk is also a factor at level crossings with, for example, risks from the surface condition at automatic crossings or direct vehicle impact where crossing operators manually close gates.

Table 1 below provides a breakdown[9] of the crossing numbers in more detail along with the total risk in Fatalities and Weighted Injuries (FWI) for each core crossing type.

[9]*Source – ALCRM, August 2015*	**Crossing core type**	**Number of level crossings on the network**	**FWI** (as calculated by ALCRM)
Passive level crossings	UWC/Bridleway (with telephone)	1717	1.1
	Footpath/bridleway/station	2246	2.8
	UWC	686	0.4
	Open crossing	48	0.1
Automatic level crossings	AHB	443	4.0
	ABCL/AOCL+B	119	0.4
	AOCL/R	39	0.6
	MSL	174	0.6
Protected level crossings	MCB CCTV	425	2.2
	MCB OD	55	0.1
	MCB	185	0.6
	MCG/Train Crew Operated	154	0.1
Total		**6291**	**13**

The following chart[9] compares each crossing type as a percentage of the overall estate (shown in blue) against risk as the respective percentage of level crossing system risk (shown in red).

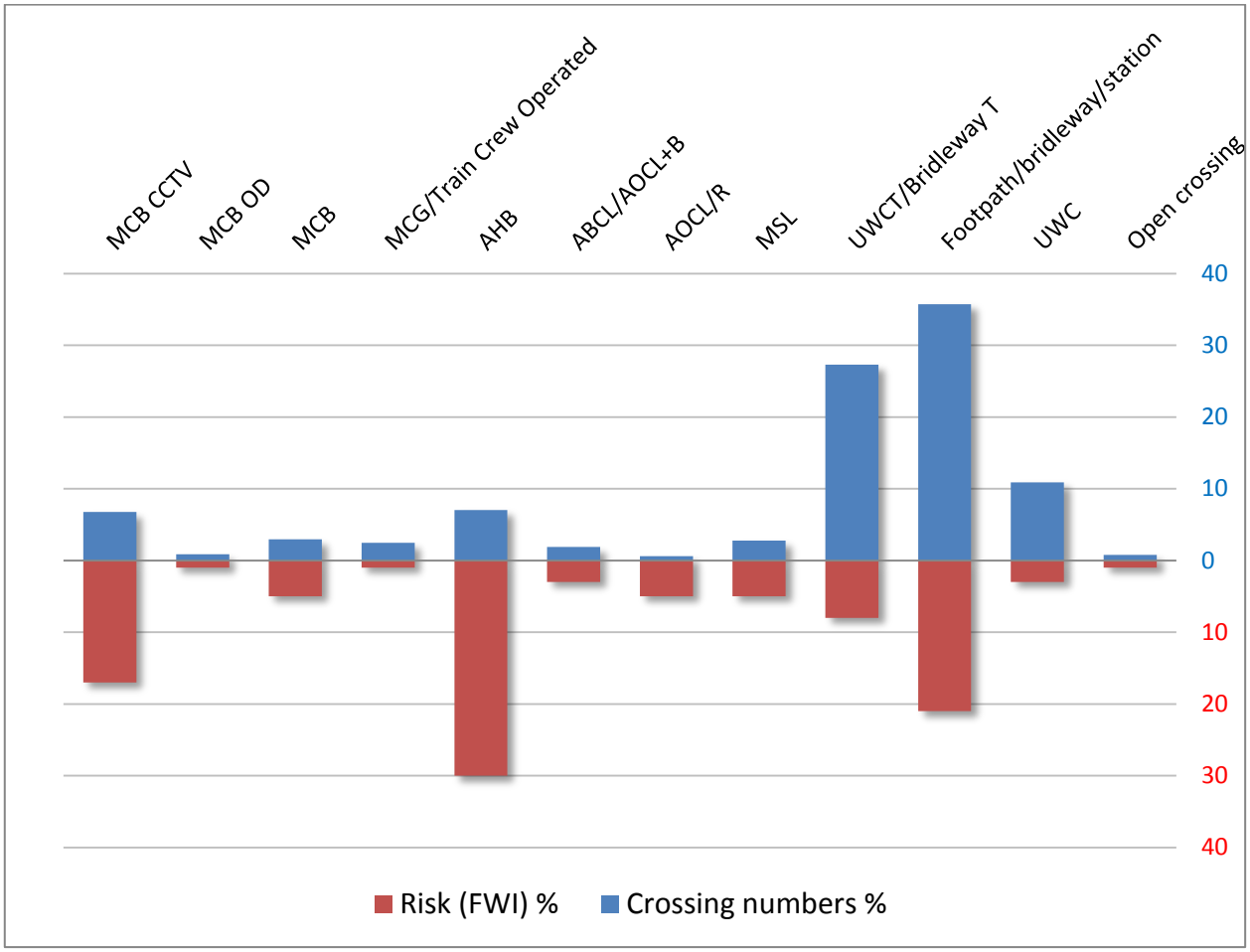


Figure 3
Level crossing types and risk properties expressed as % of the total estate

[9]*Source – ALCRM, August 2015*

Figure 3 illustrates the spread of risk in relation to the types of crossings which make up the level crossing estate. Relative to the proportion of AHBs in relation to the total number of level crossings on the network, risk is high across these crossing types. This is to be expected due to their design type and known residual risks as discussed above. The factors that make up risk vary from crossing to crossing however, and whilst a good indicator, caution is required in drawing too many conclusions from the data. Elements of risk are associated with the method of operation; other elements of risk simply reflect local conditions and user/train moment. At automatic half barrier crossings the risks can be significantly reduced by improving/upgrading the level crossings (treatable risk). Similarly at footpath, bridleway and user worked crossings the risk can be reduced by implementing additional controls. At fully protected crossings such as MCB CCTV and MCB OD crossings, the risk cannot easily be reduced any further.

5. Passive level crossings

Closures

Footpath crossings account for the largest share of the level crossing estate, but a lower proportion of the risk in relative terms. The risk at passive crossings is not distributed evenly across the estate and the majority of the FWI risk resides at those locations with the highest usage and the greatest number of train services; i.e. those crossings with the greatest 'traffic moment.' For that element of the level crossing portfolio, the only effective control is closure. We are not able to simply stop running train services and equally we cannot prevent users from enjoying their legal rights of way over the railway at these crossing locations. Closure via bridging, underpass or diversion is the only viable option in managing risk holistically. Closures have been central to the CP4 and CP5 Level Crossing Risk Reduction Programmes and have significantly contributed to reducing risk and improving safety across the network. Closures will continue in CP6 and beyond as funded business-as-usual activity.

Sighting

Sighting for footpaths, bridleways and user worked crossings can be limited by factors such as lineside equipment, structures and track curvature. Network Rail has a duty of care to provide users with enough time to traverse a level crossing safety. Where the obstruction cannot be resolved, the main options available are:

a) install a train warning system, or

b) install telephones to the Signaller such that they are required to advise users if it is safe to cross, or

c) install whistle boards, or

d) apply line speed restrictions on train services.

In addition:

- Around 1,600 passive level crossings are fitted with whistle boards. Whistle boards have been an accepted mitigation for poor sighting for many years. However they have increasingly been recognised as a mitigation which may be susceptible to elements which can reduce their effectiveness. Whistle boards place the onus onto the train driver to sound a warning which can lead to either no warning being sounded or inconsistent warning times (based on whether the train driver sounds the horn on approach to the board, at the board or beyond the board). Whistle boards do not account for locations affected by ambient noise, users with hearing difficulties, or those using mobile communications or personal stereos. Furthermore, since 2008, train horns are not used during set hours known as the night time quiet period (NTQP). The NTQP hours were adjusted in 2016 to better reflect the times people use such crossings. The current NTQP hours are between: 23:59 and 06.00; an adjustment from 23:00 to 07:00 hours.

- Circa 1,600 crossings are fitted with telephones as mitigation for poor sighting, primarily at vehicular user worked crossings. Telephones have significant weaknesses as a risk control in that:
    - they are dependent on users consistently and reliably using the telephones. It is known that users regularly fail to use telephones to obtain permission to cross;
    - rely on the controlling Signaller being able to identify the location of any trains in relation to the crossing in order to advise the users if they can cross. This is not possible on lines with long signal sections; and
    - there can be miscommunication and failure to reach a clear understanding which can lead to incidents and accidents.
- Although over 1,100 level crossings had their sighting distances improved in 2010-2011, some level crossing remain where restrictions exist and the sighting is poor. This includes user worked crossings where the sighting for vehicular users is affected by the boundary fence-line, gates and gate posts and other third party structures such as bridges and property. These issues are compounded by the fact that crossings can be used by various vehicle types or modes of transport from large plant/agricultural vehicles to small cars. Agricultural vehicles are also increasing in size.

Passive level crossings rely on users making their own judgement about whether it is safe to cross, which in turn increases human factor based risks (see Section 10). To address all of the above, Network Rail will seek to replace or supplement whistle boards and telephones with automatic train detection/warning systems over a phased programme. Similarly, crossings with poor or insufficient sighting will also be fitted with automatic train detection/warning systems; a step on our journey toward our long-term goal and the elimination of passive crossings from the network. Our vision: ***The ultimate aim is to provide automatic train detection/warning systems at every passive level crossing.*** There would be an FWI benefit of c.2.52 FWI per year if all passive crossings were fitted with automatic warning systems (figure calculated from ALCRM modelling).

The main drivers behind the long-term programme will be improved safety – especially preventing major injuries and accidental fatalities. Additional benefits include better legal compliance, avoided prosecutions and enforcement action, reputational benefits and performance benefits (TSRs removed or avoided).

Note: *Eradication of passive crossings on high speed lines should be a priority as line speeds and train services continue to increase and trains continue to become quieter. Passive crossings on high speed lines should be either closed or fitted with train detection/warning systems. High line speed should be considered as being those above 100mph. Station crossings also present a significant risk and should also be a priority target.*

Marking danger zones, improving underfoot conditions and signage, and designing for accessibility

RSSB research has demonstrated that pedestrians do not understand that the mandatory 'Stop, Look, Listen, Beware of Trains' signs mark the decision point where they should stand and look in both directions for trains before crossing. The research indicates that a more effective measure would be to mark the danger zone with yellow coloured decking over the width of the crossing and up to two to three metres from the nearest running rail. This would involve installing new yellow decking at

c.3,000 footpath and station crossings along with guide fencing and improved signage. It is also likely that further work in this area will be needed to address risk at vehicular user worked crossings as a result of re-assessing decision points.

Network Rail will take account of user needs at passive level crossings and, where required, will seek to improve accessibility.

6. Automatic level crossings

Development of Automatic Full Barrier (AFB) crossings

As reflected in Figure 3 above, the relative risk at AHB crossings is disproportionately high. Even with audible and visual warnings provided at automatic crossings, some pedestrian and road vehicle users ignore the warnings, pass the lights and weave around the barriers. A new design of automatic full barrier crossing (incorporating obstacle detection) will be developed to improve safety – especially where AHB crossings are situated near to stations or other areas where pedestrian numbers or urgency incentivise deliberate misuse.

It is desirable to retain the reduced barrier down-time afforded by automatic crossings. Reduced barrier down-time may lessen risk-taking behaviour and also avoids the greater costs associated with railway signal protected crossings. An automatic full barrier crossing will improve safety by preventing pedestrians from walking unchecked onto the crossing on the 'off side' and also prevent motorists from weaving around the barriers later in the sequence when the train is closest to the crossing. There is an estimated benefit of 2.15 FWI per year if all automatic half barrier/automatic open crossings were converted to an automatic full barrier type solution.

Improve conspicuity of road traffic light signals (RTLs)

There has already been a campaign to eradicate all 36w filament bulb road traffic light signals from the network through a programme that converted them to brighter LED lamps. The scope of this programme did not include 50w halogen lamps, which are brighter than 36w lamps, but not as bright as LEDs. Furthermore, the flashing LED lamps are more conspicuous because they have an instant 'rise and fall' compared to filament or halogen lamps. Network Rail will install LED road traffic lights at all public road level crossings and thus eradicate filament bulb RTLs from the network.

Audible warnings

There are some automatic level crossings on the network which are fitted with miniature stop light (MSL) train detection systems that provide a visual warning only. Network Rail will identify these crossings and develop a plan to install audible warning devices at these locations. Furthermore, 87 AHB level crossings are equipped with audible warning devices which conform to a previous design standard meaning that the warnings cease to sound when the half barriers reach the lowered position. Whilst these assets are compliant, they will be brought up to current design standards whereby the audible warnings continue until the end of the completed sequence; i.e. after the train has passed clear and the barriers have raised.

Red Light Safety Equipment (RLSE)

Network Rail has worked with technology suppliers and the Home Office to develop Home Office Type Approved (HOTA) digital red light enforcement cameras. We have also worked with the British Transport Police (BTP) and Staffordshire Police to develop a back office facility to process prosecutions. Finally the BTP have helped to develop a bespoke red light education and awareness course to prevent repeat offences. Network Rail will determine the effectiveness of the RLSE cameras through a benchmarking exercise at a number of level crossing trial sites in order to quantify the achievable risk reduction. This will be used as part of the business case for rolling out fixed RLSE cameras at the highest risk automatic crossings.

Furthermore, RLSE equipped level crossings are qualitatively recognised as being capable of instilling improved user behaviour. It should therefore be considered good practice for RLSE to be an integral part of public road level crossing renewals in the future.

Note: *The revenue generated from fines goes direct to the Department for Transport (DfT). The rail industry will continue to explore, with the DfT, whether roll out of RLSE cameras could be carried out as a DfT self-funding scheme.*

Mobile Safety Vehicles (MSVs)

Network Rail has worked with the BTP and technology suppliers to establish a fleet of fifteen mobile safety vehicles which are equipped with Automatic Number Plate Recognition (ANPR) cameras and are operated by BTP staff. These vehicles are at the front line of enforcement of level crossing safety. They are highly visual and provide a mechanism for reactive response to level crossings experiencing emerging deliberate misuse. They are also effective mechanisms for promoting safety awareness at events and shows, and as part of dedicated safety days such as ILCAD (International Level Crossing Awareness Day).

Network Rail will explore opportunities and business appetite to allow for a full fleet renewal during CP6 and, if agreeable, again during CP8. It is possible therefore that a fleet of mobile safety vehicles will be in operation until the end of CP9.

Automatic Half Barrier crossings (AHB)

AHBs will not be renewed 'like for like' as AHBs where they are adjacent to stations, in sight of stations and/or near to schools.

Automatic Open Level Crossings (AOCLs)

Network Rail will fit barriers to remaining AOCLs on the network. When renewing existing AOCL or AOCL+B assets, they should be renewed as automatic barrier crossings locally monitored (ABCLs) as a minimum.

7. Protected level crossings

Development of new generation of Primary Obstacle Detection

Currently LIDAR is used to supplement Honeywell RADAR systems at obstacle detection (OD) crossings. The LIDAR provides the capability to detect pedestrians very close to barriers or prone on the crossing surface. Lower LIDAR necessitates expensive crossing profiling work and other failure modes. Therefore each OD installation is subject to site specific assessment to decide whether LIDAR is required. Network Rail will identify an improved Primary Obstacle Detection system that will negate the need for expensive re-profiling work or other secondary obstacle detection equipment.

State of the art technology

Some protected (and automatic) level crossings use older technology and were installed prior to current designs becoming a mandated requirement. Some also use equipment that does not reflect the current state of the art technology. This includes some manual full barrier and gated level crossings that do not have full signal interlocking or approach locking. It also includes some AHB crossings that have audible alarms which cease earlier in the sequence as discussed earlier. Network Rail will upgrade affected crossings to meet modern design specifications.

Figure 4 illustrates the targeted vision-led implementation plan for primary schemes. Delivery of the plan in accordance with the timescale shown is dependent on many variables; these include funding, resource and availability of technology.

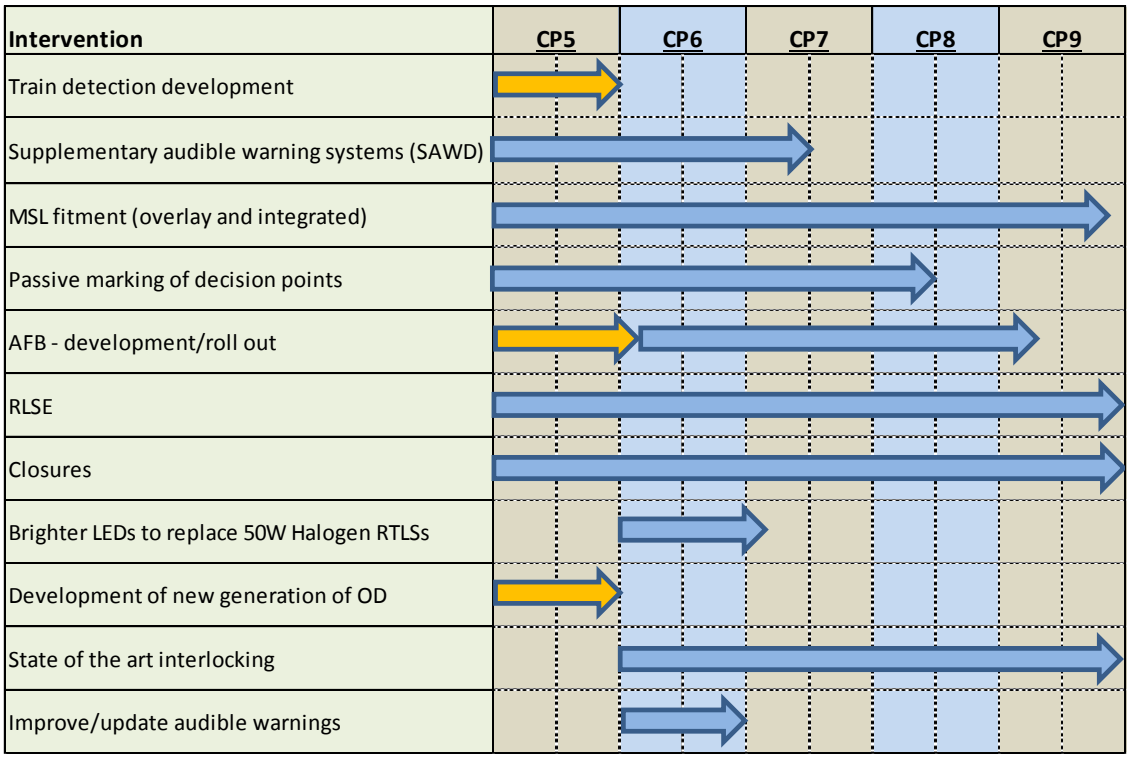


Figure 4

Vision-led implementation timescales

8. Designing for safety

Adopting a strategy which tackles legacy issues within a consolidated plan will significantly improve level crossing safety in the UK. It will also reinforce our reputation as world leaders in level crossing safety and will be welcomed by key stakeholders including the ORR and RAIB.

Safety risk is, however, an ever-changing landscape. If we focus only on addressing known legacy issues, it is likely that new and emerging risks will materialise during the lifetime of the implementation plan; either following accidents or incidents, through new stakeholder concerns or through changes in user behaviour. This is foreseeable and will result in a fresh set of safety concerns to address in the future. To move to a truly proactive strategy we need to critically evaluate existing level crossing designs using hazard identification and FMEA techniques, based on current progressive thinking regards level crossing safety. We need to predict foreseeable accident types of the future and incorporate additional preventative controls and mitigations into the design of new crossing types.

There are four key areas to explore in order to design out level crossing risk. These are discussed in the table below.

Note: *RV = road vehicle, RTA = road traffic accident, SPAD = signal passed at danger, DCI = Drivers crossing indicator, OTP = on-track plant, RRV = road-rail vehicle*

User mistake or error including slips and lapses	RV fails to observe level crossing RV driver turns onto railway Environmental factors RV on level crossing due to RTA Blocking back Grounding Second train coming RV failed on level crossing Error due to gates left open Error due to poor sighting Pedestrian nips in front of train Distraction
Deliberate misuse/violations	RV Driver Suicide RV Driver deliberate action RV deliberately placed on level crossing
Level crossing asset failure or defect	Lights/barriers fail to operate Failure to detect approaching train Slip trip fall due to defect
Irregular working by operator e.g. Signaller	Signaller/crossing keeper error Railway staff error in local control SPAD at protecting signal/stop board/DCI Train driver error – over-speeding Train driver error Operator error OTP/RRV

The Level Crossing Strategy and future level crossing design will take account of other key railway group strategy initiatives which include modernisation of the railway infrastructure through Digital Railway/ERTMS. This will include adapting crossing design to utilise possible opportunities for better train location capability, obstacle detection and communication between the level crossing and approaching trains regarding crossing status.

Note: *All future schemes, whether stand-alone or major enhancement schemes, will incorporate the principles of the Level Crossing Safety Strategy within their scope of works. For example, refrain from installing telephones as primary risk controls at passive crossings and avoid renewing AHBs as 'like for like' assets where they are adjacent to stations, in sight of stations and/or near to schools.*

9. Risk management

Network Rail has significantly improved the way risk is managed at level crossings over recent years. Dedicated Level Crossing Managers (LCMs) and Route Level Crossing Managers (RLCMs) have been introduced to bring together a number of level crossing related activities under a single role. Key activities of the role include risk assessment and asset inspection, first line defect rectification and stakeholder liaison.

Improved training, guidance and risk assessment methodology has been introduced. The All Level Crossing Risk Model (ALCRM) has also been developed and improved in support of enhanced risk management. Going forward, Network Rail will continue to utilise dedicated level crossing specialists in sufficient number to manage level crossing risk. Network Rail shall continue to invest in developing and improving risk management systems including the ALCRM. Site specific risk assessments will continue and will be underpinned by the Narrative Risk Assessment (NRA) process, ensuring a balanced quantitative and qualitative approach is assured. These site specific risk assessments will take the Level Crossing Safety Strategy into account when identifying appropriate risk controls and mitigations.

Note: *Network Rail will also continue the roll out of extended census gathering as part of risk assessment improvements, using mobile camera technology and third party census providers as core activity. This enhanced intelligence can provide invaluable information about how level crossings are used, who uses them, when they are used and helps target controls and prioritise improvements.*

10. Influencing user behaviour

Much of the level crossing strategy is about employing engineering controls to eliminate risk where possible or to reduce risk where elimination is not possible. User behaviour is the biggest contributory factor to level crossing risk. Some of the causes relate to an error on the part of the user and others relate to deliberate acts and violations.

The following Generic Error Model illustrates how switching occurs between the different types of information processing in tasks.

Figure 5
Human failure – Generic error model

Education and awareness campaigns will continue as ongoing 'business as usual' activity so as to reduce knowledge based errors. These safety campaigns will include both national media and/or targeted localised campaigns aimed at educating users about crossing safety.

There are other elements of the Level Crossing Safety Strategy which are also specifically aimed at influencing user behaviour, such as enforcement (in section 6) and marking danger zones, improving underfoot conditions and signage (in section 5).

11. Implementing the strategy

The development and implementation of a comprehensive, vision-led level crossing safety strategy provides many benefits for the rail industry in targeting improved level crossing safety.

It serves to highlight the various level crossing safety issues that exist and the respective work-streams that are required to address them. Therefore, it acts as a holistic problem statement for level crossings as an asset type and draws attention to the funding, resource and deliverability challenges that lie ahead. It also allows us to place single level crossing safety issues into wider context; an approach which is essential in order to collate all of the various work-streams in a structured, ordered way so that they can be prioritised according to safety risk.

The safety strategy is able to inform Network Rail, the wider rail industry, DfT and the Office of Rail and Road (ORR) about the level of resources needed to address the various level crossing safety issues. It allows us to quantify how much funding is then needed over a number of control periods to deliver the safety vision.

This strategy also incorporates deliverability and the achievable pace of change; allowing Network Rail to define key milestones in comprehensively transforming level crossing safety.

Finally, the safety strategy forms a reference point for all subsequent future decisions about level crossing investment, new or emerging initiatives and the impact of re-prioritisation.

All elements of Network Rail that have responsibilities for, or interface with level crossing operation, maintenance and renewal, must be aware of the Level Crossing Safety Strategy. It must be incorporated into technical standards and be reflected in the remits and scope for future renewals and enhancement schemes. Furthermore, the Level Crossing Safety Strategy should be used to inform and underpin funding in future control periods at both route and national levels.

12. Strategy review, tracking and governance

Implementation of the safety strategy will be subject to continuous review and evaluation. In delivering this ambitious safety vision, specific focus will be needed in relation to:

a) Delivery against the implementation plan; taking account of elements such as:
   - Financial authority and funding
   - Availability of technology and approved status
   - Supplier capability
   - Resource and logistics – implementation or delivery

b) Changes to the strategy content or the priory of remaining work-streams by taking account of elements such as:
   - point a) above;
   - new and emerging risks or hazards
   - changes in user behaviour or crossing use

Delivery against the implementation plan will be monitored through a Programme Board Governance Group. The group Chair will be the Senior Responsible Owner and all Routes will report progress through this group.

Ongoing review of whether the implementation plan work-streams remain current and have the correct prioritisation shall be undertaken through regular internal review by Network Rail, liaison meetings with the ORR and at the cross industry Level Crossing Strategy Group.

Appendix A

Fundamental principles of level crossing safety at Network Rail

Priorities

Network Rail's main priority is to continually improve the way we identify, manage and remove risk at level crossings so as to improve safety for all. This requires a cross-functional approach which includes the need for strong processes, decision-making and continuous technical improvement.

Effective risk assessment and management

A suite of existing tools support the risk management process and assist with decision making to improve safety and remove risk. We will continue to refine and use risk assessment tools and methodologies to identify our highest risk crossings on the network.

We will continue to invest in our Level Crossing Managers; those who undertake risk assessment of our level crossings and who manage their day to day safety. We will carry on building their expertise in risk assessment techniques and continue to share good practice across the business.

The Level Crossing Managers are at the heart of delivering effective risk assessments and making safe decisions. We will ensure they remain at the core of all risk based decisions; whether day-to-day risk management or longer-term decisions and future options.

Legislation and enforcement

We will continue to review level crossing legislation and support change where this helps clarify accountabilities and responsibilities regarding the management and closure of level crossings. We will continue to support the Law Commission's review of level crossing legislation and lobby for the proposals to be heard in Parliament.

There are opportunities to streamline level crossing legislation and this is crucial to successful delivery of our safety strategy. As a world leader in level crossing safety, we will lead this discussion with the ORR and other stakeholders.

We will roll out greater capability to support enforcement across the network, tackling both road vehicle and pedestrian violations at level crossings.

Leadership

We will continue to build on our achievements as world leaders in level crossing safety. We will share our good practice with our rail industry colleagues from around the globe. We will also conduct regular worldwide benchmarking exercises to ensure that we are delivering the best possible, fit-for-purpose solutions at level crossings in Great Britain.

We will embed level crossing safety awareness across the business and suitably equip those who are responsible for working on or who interface with level crossings; so that we have the best people working on our highest risk public interfacing asset.

Investment and technology

We will work collaboratively to invest more funding at passive level crossings. We will work to replace whistle boards with technology at level crossings with sighting restrictions.

It is imperative that solutions which employ technology are fit for purpose and are appropriate for the safety risks that they manage. We will administer this through better product acceptance and technical review processes. We will do this transparently and efficiently.

We will look for alternatives to automatic half barrier crossings rather than routinely upgrading to a full barrier solution which may not be appropriate for the local infrastructure.

Key to this element of the strategy is the need to continuously review emerging technology. We will not restrict ourselves in looking only for railway solutions; we will also look to other industries to help solve our problems.

We will negotiate with our regulators to optimise the funding available to improve level crossing safety. In return, we will optimise risk reduction, dealing with complex level crossings, as well as those with viable alternative routes nearby.

Asset condition and information

We will improve the information we currently hold on level crossings to enrich our intelligence and better drive holistic decision making. We will review our asset reliability and challenge suppliers on their performance.

We will seek to provide greater clarity and clearer accountabilities* around asset ownership. In addition, we will work to provide greater standardisation of level crossing types.

Note: **Level crossings are unique in that they are not considered to be a 'single asset' with a single asset owner; they interface with many functions of the business. This has the potential to generate confusion or inconsistencies in how level crossings are managed. Enhanced clarity relating to ownership responsibility and asset management process is essential to success.*

We will not be able to close all level crossings and so it is crucial that we have the best possible processes established to deal with managing the condition of the asset. We will do this through identifying ring-fenced funding for level crossing maintenance throughout the business. We will prioritise components based on safety and identify 'gold-plated' components so as to improve reliability and safety.

Level crossing maintenance will be delivered in the most efficient way. Good planning is crucial to this and we will help maintenance teams optimise their resources. We will reduce the number of temporary closures of level crossings following asset failure. An agreed renewals programme for both passive and controlled crossings is required.

Personal responsibility and education

It is crucial that we all recognise that level crossing safety is everyone's business. We will continue to run targeted education campaigns for external stakeholders and users of our level crossings. We will continue to help our people manage level crossings better through improved knowledge, equipment and IT solutions.