TRANSPORT AND WORKS ACT 1992

TRANPORT AND WORKS (INQUIRIES PROCEDURE) RULES 2004

THE NETWORK RAIL (ESSEX AND OTHERS LEVEL CROSSING REDUCTION) ORDER

PROOF OF EVIDENCE

-OF-

MARK BRUNNEN

Document Reference	NR27/1

1. Introduction

1.1. My name is Mark Brunnen. I am employed by Network Rail as the Head of Level Crossings within the Safety, Technical and Engineering (STE) directorate, a position that I have held since June 2016.

1.2. I joined Network Rail's General Management Graduate Scheme in October 2007, and have since progressed through a number of roles within the organisation including:

- Development Manager (forming and planning Track Renewal work banks),
- Scheme Project Manager (junction renewals on the West Coast Main Line),
- Commercial Scheme Sponsor (which covered a wide range of projects across various Network Rail departments: Level Crossings / Capacity Planning / Innovation etc.), and
- Head of Level Crossing Closures and Asset Improvement.

1.3. I hold qualifications in:

- Mechanical Design, Materials and Manufacture – BEng (Hons) – University of Nottingham.
- APMP Complete Project Management - Association of Project Management: Practitioner.

1.4. As Head of Level Crossings, my responsibilities include:

- Accountability for setting and directing Network Rail's level crossing safety risk management strategy and vision in line with corporate objectives.
- Leading a team of professional experts in level crossing safety risk management.
- Maintaining Network Rail's level crossing safety standards and guidance documents;
- Acting as the primary interface for matters of policy, governance and assurance with the ORR, RAIB, DfT and other UK and European bodies, including co-ordinating Network Rail's response to safety recommendations;
- Sponsoring the development of new technologies and products to reduce risk at level crossings.

2. Scope of Evidence

2.1. I have prepared this Proof of Evidence in support of Network Rail's application for the Network Rail (Essex and Others Level Crossing Reduction) Order.

2.2. The purpose of the Order is to rationalise the number of level crossings in the Counties of Essex and Hertfordshire, the Unitary Authority areas of Thurrock and Southend-on-Sea, and the London Borough of Havering. The proposals include the acquisition and use of land in connection with these changes, the construction of works, the extinguishment of existing public and private rights of way across the track, and the creation of alternative rights of way by grade separation.

2.3. The strategic case for seeking this order (and rationalising at-grade crossing points of the railway) is threefold:

- Operational efficiency of the Network.
- Safety of both rail users and those interacting with railway by reason of Public and Private rights across the operational railway.
- Efficient use of public funds in accordance with "Managing Public Money".

2.4. The operational efficiency of the Network will be addressed principally in the evidence of Eliane Algaard, Director Route Safety and Asset Management for the Anglia Route.

2.5. My proof of evidence addresses Network Rail's statutory obligations under key health and safety law, the overarching framework for rail regulation, and Network Rail's Operating Licence Conditions for safety and efficiency; it also addresses Network Rail's national strategy for managing risk at level crossings, collectively covering the following topics:

3) Level Crossings: an overview

4) Network Rail's regulated functions

- Network Rail's Operating Licence and statutory objectives
- The Licence

5) Wider Context

- Secretary of State's Policy
- Rail Safety Directive
- Regulatory Policy and Guidance
- Network Rail Safety Guidance

- Operational Expenditure and “Managing public money”
- Network Rail Company Standards
- Rail Safety and Standards Board (RSSB) research programme

6) Network Rail’s Level Crossing Policy and Strategy

7) Level Crossing Risk

8) Level Crossing Risk Management

- All Level Crossing Risk Model (ALCRM)
- Qualitative risk assessment
- Narrative risk assessment

9) Human Behaviour and Risk Control Selection

- Vulnerable Users and User Encumbrance
- Failing to check for trains
- User gender and age
- User familiarity
- Stop, Look and Listen (SLL) sign
- Gates
- Crossing surface – slips and trips

10) Level Crossing Sighting

- Whistle boards
- Sighting distance
- Long sighting distance
- Reduction in line speed

11) Passing trains

12) Deliberate Misuse and Trespass

13) Rail Accident Investigation Branch: Level Crossing Fatalities

14) Witness Declaration

3. Level crossings: an overview

3.1. Network Rail owns and operates the rail infrastructure of Great Britain. It is responsible for its safe operation, the efficient maintenance, repair and renewal of track, signalling, electrical control equipment, stations, maintenance depots, bridges, viaducts, tunnels, culverts, walls, fencing, drainage, level crossings and connections into privately owned freight terminals. It also has a duty to enhance and improve the railway network in operational terms.

3.2. Network Rail is responsible for approximately 6,000 level crossings. A level crossing is an intersection where a railway line crosses a road or path on the level, as opposed to one crossing over or under the other using a bridge or tunnel.

3.3. There are many different types of level crossings: some of Network Rail's crossings operate with modern automatic barriers, some with barriers remotely controlled by a Signaller, and others with a more traditional operation. Whatever the type, they generally originate from the very earliest days of building the railway.

3.4. The need for defined crossings first arose when the railway consisted of horses drawing cartloads of heavy minerals on wooden rails to stop them sinking into the mud. Gates were provided on these primitive railways to stop animals straying onto the line when being herded across.

3.5. The advent of the modern railway and steam locomotives in the 1830s made level crossings much more commonplace and different types of crossings were developed, many of which are still with us today. The 'occupation crossing' was provided where the railway crossed a private road and the 'accommodation crossing' was provided where a new line split a piece of private land in two. At these private crossings, the user was responsible for its safe use - both for their own safety and that of the railway. Where the railway crossed public footpaths the paths were provided with crossing stiles, and public highways were fitted with gates. Arrangements for determining when it was safe to cross, the provision of gates and stiles, as well as penalties for misuse, were determined by each Act of Parliament authorising the railway to be built.

3.6. From 1839 the Government introduced safety measures as well as standardisation for public level crossings. Where rail and public road crossed, the railway company had to provide gates that were kept closed across the road and operated by 'good and proper persons' to let road users pass. However in certain areas, particularly in the growing towns and cities, this was neither safe nor efficient and in 1842 the Board of Trade was given powers to authorise the gates being closed across the

railway in certain areas. Over time - particularly after the introduction of motor vehicles - it became usual for the gates to always be closed across the railway giving the road the right of passage until a train was due.

3.7. As both rail and road traffic grew, the point at which they intersected became more of a problem for the authorities. Technology enabled some level crossing gates to be interlocked with signalling which increased safety and reduced the need for separate crossing keepers. Where the supervision of a crossing was not linked to a signal box, the Railway Clauses Act 1863 required the railway companies to build accommodation for a permanent crossing keeper. However it also gave the Board of Trade powers to order a railway company to take the road either under or over the railway, rather than putting in a level crossing. Doing this voluntarily removed the ongoing requirement to provide accommodation and a salary; the railway companies quickly caught on and after 1863 new railway lines had relatively few level crossings.

3.8. Few changes were applied to level crossings or their interfaces for the next 100 years; after World War II the nationalised railway embraced modernisation but little attention was initially paid to level crossings. While the closure of lines reduced the overall numbers of crossings, the increasing use of road transport and the need to reduce the cost of running the railway put the issue of supervised gated level crossings on the Ministry of Transport's agenda. They looked to the Continent where unsupervised automatic barriers had been used for a number of years. These crossings were linked to the local signal box by telephone and the half barriers - where only the approach side of the road is blocked - were lowered and raised when a passing train operated a treadle or track circuit on the line. Flashing road traffic signals and bells alerted road users to an approaching train. Automatic barriers were first introduced in 1961; this change in crossing equipment made a major impact on the operating ethos of the railway as while the duty to control the risk at a level crossing remained with the railway, it now placed responsibility for the safe use of a public crossing on the road user. Then as now, the railway engaged in major publicity and educational campaigns to highlight the safe use of level crossings.

3.9. Whilst the railway has continued to modernise and society has evolved, many level crossings (particularly passive crossings, as explained in Section 7.3) have not. We are left with a level crossings legacy that remains today and an interface at odds with the cultural safety expectation of today's society. This is brought into focus by the design of modern railway lines built in this country over recent years, for example High Speed 1 between the Channel Tunnel in Kent and London St.

Pancras International Station. Such lines purposefully do not feature any level crossings.

3.10. Trains which were once less frequent, slower and louder have been replaced by rolling stock which is significantly faster and quieter than predecessors. Once infrequent road traffic has also increased and continues to rise.

3.11. Pedestrian level crossing users are increasingly more likely to succumb to distraction through text messaging, social media, phone calls or the wearing of headphones than peers of years ago and, as a consequence, are more likely to be distracted when using level crossings.

4. Network Rail regulated functions

Network Rail's Operating Licence and Statutory Objectives

4.1. Network Rail is a regulated statutory undertaker. The statutory framework for regulating the railways in Great Britain is comprised of: The Railways Act 1993 (as amended), The Transport Act 2000, The Railways and Transport Safety Act 2003 and the Railways Act 2005. The 1993 Act established the Rail Regulator under the Strategic Rail Authority. The Rail Regulator was superseded by the Office of Rail and Road (ORR) in 2004.

4.2. The ORR is now the body principally responsible (together with the Secretary of State and Scottish Ministers) for the regulation of the railway industry in Great Britain. In so far as is relevant to this inquiry, the ORR is the Health and Safety regulator for the rail industry and of Network Rail in its operation of the railway.

4.3. The ORR and the Secretary of State must have due regard to the protection of the interests of users of rail services, to promote the use, efficiency and economy on the parts of persons providing rail services and to impose on operators of railway services the restrictions that are consistent with the performance of their functions.

4.4. The activities of Network Rail are regulated by the ORR and by the Secretary of State under the 1993 Act by virtue of its Network Licence dated 1 April 2014 (as modified) (*"the Licence"*)[1]. The Licence, granted under section 8 of the 1993 Act, authorises Network Rail to operate the railway network.

4.5. The Licence includes conditions under which Network Rail *must* operate (see: *Part III - Conditions*). No discretionary entitlement to depart from the Licence or its imposed conditions is conferred. As the operator and owner of the national rail infrastructure, Network Rail has a key role to play in railway safety and improving railway performance and efficiency. The Licence is a primary instrument through which ORR holds Network Rail to account, and Network Rail must comply with it in all respects.

4.6. As this evidence and that of other witnesses will demonstrate, it is evident that a public or private right of way scheduled over an operational line of railway can give rise to:

[1] Network Licence granted to Network Rail Infrastructure Limited: http://orr.gov.uk/__data/assets/pdf_file/0012/3063/netwrk_licence.pdf

i) Highly specific safety risk, and

ii) Operational inefficiency.

4.7. Sections 4 and 117 of the 1993 Act provide:

In terms of railway operational efficiency:

"4 – General duties of the Secretary of State and [the Office of Rail Regulation].

(1) [The Office of Rail and Road] [shall] have a duty to exercise the functions assigned or transferred to [it] under or by virtue of this Part…in the manner which [it] considers best calculated—
(zb) to promote improvements in railway service performance;

(a) otherwise to protect the interests of users of railway services;

(b) to promote the use of the railway network in Great Britain for the carriage of passengers and goods, and the development of that railway network, to the greatest extent that [it] considers economically practicable…"

In terms of railway safety:

"117 Safety of railways and other guided transport systems.

(1) Part 1 of the Health and Safety at Work etc. Act 1974 ("the 1974 Act") shall have effect as if the provisions mentioned in subsection (4) below (which relate to the proper construction and safe operation of certain transport systems, and of the vehicles used on those systems, and the protection of railway employees or the general public from personal injury and other risks arising therefrom):

(a) were existing statutory provisions, within the meaning of that Part; and

(b) in the case of the enactments mentioned in paragraphs (a) to (m) of that subsection, were specified in the third column of Schedule 1 to that Act.

(2) If to any extent they would not do so apart from this subsection, the general purposes of Part 1 of the 1974 Act shall include:

(a) securing the proper construction and safe operation of transport systems to which this section applies, and of any locomotives, rolling stock or other vehicles used, or to be used, on those systems; and

(b) protecting the public (whether passengers or not) from personal injury and other risks arising from the construction and operation of transport systems to which this section applies…"

The Licence

4.8. Part A1 (Network management) under Part III of the Licence sets out Network Rail's responsibilities for maintaining, renewing, replacing and developing, improving and enhancing the rail network. This includes the responsibility for managing safety on the network which extends to overseeing safety matters relating to its staff, contractors, train and station operators; those who come onto railway land or property, either as a private individual or a member of the public. The use of any level crossing is necessarily encompassed within this global responsibility.

4.9. Paragraph A1 states:

"1 Network management

Purpose

1.1 The purpose is to secure:

(a) the operation and maintenance of the network;

(b) the renewal and replacement of the network; and

(c) the improvement, enhancement and development of the network,

in each case in accordance with best practice and in a timely, efficient and economical manner so as to satisfy the reasonable requirements of persons providing services relating to railways and funders, including potential providers or potential funders, in respect of:

(i) the quality and capability of the network; and

(ii) the facilitation of railway service performance in respect of services for the carriage of passengers and goods by railway operating on the network.

General duty

1.2 The licence holder shall achieve the purpose in condition 1.1 to the greatest extent reasonably practicable having regard to all relevant circumstances including the ability of the licence holder to finance its licensed activities.

Specific obligations

1.3 The following obligations in this condition are without prejudice to the generality of the general duty in condition 1.2 and compliance with those obligations shall not be regarded as exhausting that general duty.

In fulfilling each of those obligations, the licence holder shall at all times comply with the general duty in condition 1.2."

4.10. The specific obligations (in complying with the general duty) are:

(a) Planning (*paragraphs 1.4 – 1.9*): to plan over the short, medium and long term to meet reasonably foreseeable future demand for railway services, consulting persons providing services relating to railways and funders to facilitate effective industry-wide planning. As part of this, to prepare plans, strategies and documents to the ORR on a network-wide basis and at a suitably disaggregated level of detail.

(b) Delivery Plan (*1.10 – 1.13*): to prepare and publish a delivery plan to enable providers of services relating to railways and potential providers to plan their businesses and funders and potential funders of railway services to plan their future financial and service requirements in each case with a reasonable degree of assurance.

(c) Long term planning process (*1.14 -1.17*): to establish and maintain long term plans to promote the effective and efficient use and development of the capacity available on the network, consistent with funding available or which becomes available during the planning period.

(d) Capacity allocation (*1.18*): to co-operate with potential providers or funders to identify ways in which their reasonable requirements regarding allocation of capacity on the network could be satisfied.

(e) Asset Management (*1.19 – 1.22*): to develop and apply policies and criteria regarding maintenance, renewal, replacement, improvement, enhancement and development of relevant assets to demonstrate compliance with the general duty and to maintain appropriate and accurate information about the relevant assets, including their condition, capability and capacity.

(f) Timetable planning (*1.23*): to run an efficient and effective process, reflecting best practice for establishing a timetable and any changes to it and, where necessary and appropriate, initiate changes to relevant industry processes to enable those providing railway services and other relevant persons to plan their businesses with a reasonable degree of assurance and to meet their obligations to railway users.

4.11. Hence, Network Rail is under a duty (that is ultimately regulated and enforceable by ORR) to operate the rail network efficiently and safely, so far as is reasonably practical, and having due regard to all relevant circumstances, as well as to satisfy more generally the core needs of train operators and of rail users. In so doing, Network Rail contributes towards the successful development of the Government's integrated transport policy.

5. Wider context

Secretary of State's policy

5.1. The National Policy Statement (NPS) for National Networks (December 2014) contains the Government's policy for decisions on development consent orders. However, it may be a material consideration for other decision-making.

5.2. In summarising the need for rail network development, the Networks NPS states:

> *"2.2 There is a critical need to improve the national networks to address… crowding on the railways to provide safe, expeditious and resilient networks that better support social and economic activity; and to provide a transport network that is capable of stimulating and supporting economic growth…*
>
> *2.9 Broader environment, safety and accessibility goals will also generate requirements for development. In particular, development will be needed to address safety problems, enhance the environment or enhance accessibility for non-motorised users. In their current state, without development, the national networks will act as a constraint to sustainable economic growth, quality of life and wider environmental objectives.*
>
> *2.10 The Government has therefore concluded that at a strategic level there is a compelling need for development of the national networks – both as individual networks and as an integrated system.*
>
> *…*
>
> *2.29 In the context of the Government's vision for the transport system as a driver of economic growth and social development, the railway must:*
> - *offer a safe and reliable route to work;*
> - *facilitate increases in both business and leisure travel;*
> - *support regional and local public transport to connect communities with public services, with workplaces and with each other, and*
> - *provide for the transport of freight across the country, and to and from ports, in order to help meet environmental goals and improve quality of life."*

5.3. It is clear from the above that a safe and efficient rail network is required by national policy.

5.4. In respect of safety matters, the Networks NPS provides:

> *"3.12 It is the Government's policy, supported by legislation, to ensure that the risks of passenger and workforce accidents are reduced so far as reasonably practicable. Rail schemes should take account of this and seek to further improve safety where the opportunity exists and where there is value for money in doing so by focussing domestic efforts on the achievement of the European Common Safety Targets."*

Rail Safety Directive

5.5. The EU Rail Safety Directive (Directive 2004/49/EC) seeks to further improve the safety of rail systems throughout Europe, where reasonably practicable to do so (Recital (4)). It requires that all those operating the railway system should bear the full responsibility for the safety of the system (Recital (5)). Specifically, article 4(1) provides that *"Member States shall ensure that railway safety is generally maintained and, where reasonably practicable, continuously improved"*. Annex I to the Directive lays down *"common safety indicators"* for assessing whether safety targets are met. As well as accident data, *"indicators relating to technical safety of infrastructure and its implementation"* are included. One such indicator is the *"number of level crossings (total and per line kilometre)"*.

Regulatory Policy and Guidance

5.6. Network Rail works closely with our Regulator, the Office of Rail and Road (ORR) on matters of level crossing efficiency and safety. The ORR's "Strategy for regulation of health and safety risks – 4: Level crossings" (see: *The Network Rail (Essex and Others Crossing Reduction) Order Statement of Case, Folder 2, NR14*) states:

> *"In particular, we want to:*
>
> *Encourage crossing closure and ensure that all risk assessments consider this first, in line with the principles of prevention, prioritising those crossings that present the highest risk:"*

And:

> *"6. The removal of crossings is always the first option to be considered in a risk control strategy by the duty holder, in line with the general principles of prevention (Management of Health and Safety at Work regulations 1999 Schedule 1) in European and UK law. The closure of level crossings requires*

attention to many factors, including the practicalities of replacing them with bridges or underpasses, the legal arrangements for closing rights of way, the need to minimise the possible transfer of risk to other crossings, and the possibility of importing new dangers such as increasing the likelihood of trespass."

5.7. The ORR offers guidance to railway infrastructure owners on the safe management, operation, modification and use of level crossings in Great Britain. This guidance is documented in the "Level Crossings: A Guide for Managers, Designers and Operators (RSP7)" publication[2], which offers level crossing risk management advice and direction. Consistent with the ORR's Strategy for regulation of health and safety risks, RSP7 supports the Health & Safety Executive's hierarchy of risk control selection for managing hazards and risks, with 'eradication/elimination' being the preferred and safest option. Network Rail endorses and adheres to its recommendations and content wherever possible.

5.8. In October 2013, the ORR published the "Periodic Review 2013: Final determination of Network Rail's outputs and funding for 2014-19" (PR13)[3]. This determination set Network Rail's funding and the outputs the ORR expects the company to deliver during the five years from 2014-15 to 2018-19 (control period 5, or CP5). It set goals towards meeting the challenges and opportunities facing the rail industry as a whole: a safe railway, raising standards for customers, improving efficiency, and sustaining growth.

5.9. PR13 describes the requirement for Network Rail to "maximise the reduction in risks of accidents at level crossings", specifically through the delivery of level crossing closures and safety enhancements. Referring to the regulated outputs for CP5, PR13 notes:

"35. Network Rail must continue to meet its legal safety obligations, improving safety where reasonably practicable. This determination makes specific provision to address significant safety risks. There will be extra funding to reduce the risk at level crossings, for example by enabling the closure of more crossings."

[2] Level Crossings: A guide for managers, designers and operators, Railway Safety Publication 7, (RSP7) (December 2011): http://orr.gov.uk/__data/assets/pdf_file/0016/2158/level_crossings_guidance.pdf

[3] Periodic Review 2013: Final determination of Network Rail's outputs and funding for 2014-19, (PR13), (October 2013): http://orr.gov.uk/__data/assets/pdf_file/0011/452/pr13-final-determination.pdf

…

"Chapter 11: Health and Safety.

> *Network Rail is required to deliver projects (including level crossing closures), to maximise the reduction in risk of accidents at level crossings…"*

Network Rail Safety Guidance

5.10. Safety is at the heart of Network Rail's national strategy for the operation of the railway network.

5.11. Network Rail has a legal duty and responsibility under the Health and Safety at Work Act 1974, for the health, safety and welfare of its employees and for protecting others against risks to health or safety in connection with their undertaking.

5.12. Network Rail also has a legal duty and responsibility under the Management of Health and Safety at Work Regulations 1999, of which Section 3 specifically focuses on the requirement for suitable and sufficient assessment of risks to the health and safety of employees and others in connection with their undertaking.

5.13. In the case of level crossings, Network Rail has a duty of care toward the safety of the public who use them, (irrespective of whether they comply with any cautionary signage, if it can be said that the authority as a whole is aware of the likelihood of such behaviour). This duty of care extends to train passengers, train staff and other railway employees who travel in trains over them.

5.14. In the above context, operational safety is an obvious, principal consideration. Network Rail has a high legal duty and responsibility to maintain operational safety. This point has been summarised by Network Rail's Chief Executive Officer:

> *"Safe behaviour is a requirement for working for Network Rail. We will relentlessly strive to find new ways to keep ourselves, colleagues, passengers and the public safe. We will design, construct, inspect, operate and maintain the railway to keep everyone safe."*[4]

Operational Expenditure and Managing Public Money

[4] Network Rail Safety Vision Statement, Mark Carne, Chief Executive, March 2014

5.15. As a Government funded organisation, Network Rail has a direct requirement to adhere to "*Managing public money*"[5]. Network Rail was re-classified as an arms-length Government body in September 2014. Accordingly, Network Rail must ensure that it manages public money responsibly, which includes adhering to the principles, rules, guidance and advice set out by Government. For example, these include:

(a) the principles featured in 1.1.1 and Box 1.1:

> *"Box 1.1: standards expected of all public services:*
>
> *honesty; impartiality; openness; accountability; accuracy; fairness; integrity; transparency; objectivity; reliability;*
>
> *carried out in the spirit of, as well as to the letter of, the law in the public interest, to high ethical standards, achieving value for money."*

(b) the final sentence of 1.1.3 which reads:

> *"Public services should carry on their businesses and account for their stewardship of public resources in ways appropriate to their duties and context and conducive to efficiency."*

(c) Annex A4.15 Asset Management: public sector bodies are required to have an asset management strategy.

> *"A4.15.2: Each organisation needs to have a clear grasp of:*
>
> *i. the content of its current assets base;*
> *ii. the assets it needs to deliver efficient, cost effective public services;*
> *iii. what this means for asset acquisition, use, maintenance, renewal, upgrade and disposal;*
> *iv. whether any gains could be achieved by working with other public sector organisations;*
> *v. how use of assets fits within the corporate plan"*
>
> *…*

[5] Managing public money, HM Treasury, (July 2013, with annexes revised as at August 2015): http://www.civilservant.org.uk/library/2015_Managing_Public_Money.pdf

"A4.15.8: Assets should be managed like other parts of organisation's business, with up to date and reliable information systems to provide feedback on performance, efficiency and value for money. The organisation is expected to:

15) view value for money from the asset from the perspective of the whole Exchequer, taking account of opportunities to work with other public sector organisations to minimise the government's overall required asset base;

16) manage the assets in a way which aims to optimise cost sustainability through their effective lives;

17) use commercial terms for the delivery and support of assets;

18) incorporate adequate flexibility to cope with the organisation's future change programme."

5.16. When spending public money Network Rail needs to satisfy itself that any spend is justified. Network Rail operates within defined budgets, each covering a five year control period. Any money that is used unnecessarily or inefficiently directly impacts our ability to deliver other important improvements elsewhere across the network. Unjustified expenditure is therefore not acceptable.

Network Rail Company Standards

5.17. Network Rail has its own company standards governing the asset management and risk management of level crossings. These standards enable Network Rail to meet its legal and moral obligations and they also underpin the health and safety management of the level crossing estate.

5.18. There are two key standards that govern the risk assessment process for level crossings:

- A high level document that sets out Network Rail's requirements for having a robust and consistent process for assessing risk and determining the safety requirements for existing or new level crossings.
- A detailed, process-specific document, which sets out the frequency of routine risk assessments, defines non-routine risk assessment triggers and details the complete assessment process. It is the standard that Level Crossing Managers work to under the normal course of their duties. The requirements of this standard provide the compliance and assurance framework for the risk management of level crossings.

Rail Safety and Standards Board (RSSB) Research Programme

5.19. RSSB's Research Programme T984 'Research into the causes of pedestrian accidents at level crossings and potential solutions' published in July 2014 (T984)[6] was a wide-ranging review of the causes of pedestrian accidents at level crossings. This research was undertaken on behalf of the rail industry group which collectively funds RSSB.

5.20. T984's findings included the following:

- There is a strong link between the occurrence of pedestrian accidents, the number of pedestrians using a crossing and the number of trains which travel over the crossing
- The numbers of accidents increase with the age of the pedestrian
- The use of Network Rail's current risk assessment approach using the ALCRM is robust; and
- The move to including narrative risk assessment (which went live in mid-2014) is supported as, in addition to the ALCRM quantitative risk assessment, it takes into consideration characteristics of users, trains, layout, equipment and environment.

[6] Research into the causes of pedestrian accidents at level crossings and potential solutions, RSSB, (July 2014): https://www.rssb.co.uk/pages/research-catalogue/t984.aspx

6. Network Rail Level Crossing Policy and Strategy

6.1. Network Rail is committed to reducing risk at level crossings where reasonably practicable. In support of this, Network Rail has a policy for managing level crossing risk.[7] The policy contains sixteen principles and commitments, centred around:

- Risk management; limiting/reducing the number of active open level crossings, continuing on-going risk reduction, risk based prioritisation of efforts, carrying out inspection and maintenance activities, on-going risk assessment regime, support for public education and awareness of level crossing safety.
- Research and development; commitment to request and participate in research to reduce level crossing risk, also to investigate and introduce new technology.
- Co-operation with stakeholders; support the British Transport Police (BTP) and the ORR to enforce adherence to level crossing and road traffic legislation, forming partnerships with other organisations such as local authorities/highway authorities.
- Learning and taking action; Network Rail will learn from others, from accidents, incidents and recommendations, and take action as considered necessary.
- Only in exceptional circumstances shall we permit new crossings to be introduced onto the network.

6.2. It is therefore Network Rail policy to seek to eliminate traverses across the railway at grade, wherever possible. The reduction of the number of level crossings on the network is an important strategic priority, consistent with the regulatory duties described above.

6.3. During Control Period 4 (CP4) (2009–2014), Network Rail reduced risk at level crossings by 31%, reflecting a safety investment of £132m. This was achieved through a combination of crossing closures and the provision of accompanying diversionary routes or bridges, and a series of asset improvement schemes. Over 800 crossings were closed on the level; more than 1,100 level crossings benefited from improved sighting; approximately 500 crossings were fitted with LED road

[7] *Level Crossing Policy (July 2011), Our Approach to Managing Level Crossing Safety : see Appendices NR27/2 Tab 1*

traffic lights improving on the brightness previously offered by 36W filament bulbs; a fleet of Mobile Safety Vehicles (MSVs) were introduced for operation by the British Transport Police to discourage and record offences at level crossings; barriers were installed at over 60 level crossings that had previously been open crossings; new technology was introduced at a number of sites to better inform users when a second train is approaching the crossing in quick succession to the first; Power Operated Gate Openers (POGO) were installed at approximately 80 private vehicle crossings to reduce the number of traverses a user needs to makes on foot when crossing with a vehicle and to reduce the likelihood of gates being deliberately left open; a new automated crossing type was introduced to the network featuring obstacle detection technology.

6.4. Additionally, during CP4, Network Rail improved its organisational capability by introducing over 100 dedicated Level Crossing Managers (LCMs) and Route Level Crossing Managers (RLCMs). These key personnel are dedicated to the safety and risk management of the level crossing estate. Their introduction has helped to clarify roles and responsibilities and to resolve a previously fragmented level crossing management structure. Network Rail has also worked to improve processes around level crossing risk assessment and asset inspection, resulting in a more integrated and consistent approach to risk management.

6.5. In response to the requirements set out by the ORR's Final Determination (PR13), Network Rail is seeking to achieve a further 25% reduction in risk at level crossings during Control Period 5 (CP5) (2014–2019), including through the closure of level crossings (and extinguishment of rights, diversion or bridging).

6.6. 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.

6.7. 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:

a) relatively few level crossings compared to other major rail networks; and

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

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

6.9. Despite recent improvements in level crossing safety, there are still many issues to address, particularly with passive level crossings (see paragraph 7.3). Network Rail

is adopting a long-term vision-led strategy for level crossings to permanently address the legacy issues and to design out foreseeable risks of the future.

6.10. Our vision is for there to be 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.

6.11. Transforming Level Crossings 2015–2040 (see: *The Network Rail (Essex and Others Crossing Reduction) Order Statement of Case, Folder 2, NR17*) – Network Rail's level crossing safety strategy – is underpinned by a number of 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

6.12. 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 unaligned to a wider business strategy. In adopting a prioritised and targeted plan which is both 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.

6.13. 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 Control Period 9 (2040) or beyond.

7. Level Crossing Risk

7.1. There are approximately 6,000 level crossings in operation across Network Rail's infrastructure and, of these, approximately 1,500 are on public vehicular roads. The remainder are where public footpaths, bridleways and private roads/track cross the railway.

7.2. The layout, configuration and use of level crossings vary from location to location, so each one is essentially unique. Collectively, level crossings form the largest contributor to train accident risk on the railway network.

7.3. Level crossings offer an accessible interface between the railway and surrounding land, giving rise to an increased potential for user behaviour to affect train operations. They have differing levels of protection and can be split into two broad groups:

- Active crossings: where the user is warned of the approach of a train through the locking of gates and/or closure of barriers and/or road traffic light signals and/or alarms. Depending on the type of active crossing, these warnings may be activated automatically by an approaching train, or manually by a Crossing Keeper or Signaller.
- Passive crossings: where no warning of train approach is given other than by the train driver who may use the train horn. The onus is on the crossing user to determine whether it is safe to cross the line. Instruction for proper use must be provided at each location, along with other appropriate signage.

7.4. Active crossings are typically more suitable than passive crossings for use by those who are less able to detect the approach of a train audibly or visually. Crossings with full barriers across the road provide a physical block to those who may not be able to detect warnings. However, there remain several factors that can cause accessibility problems at active level crossings:

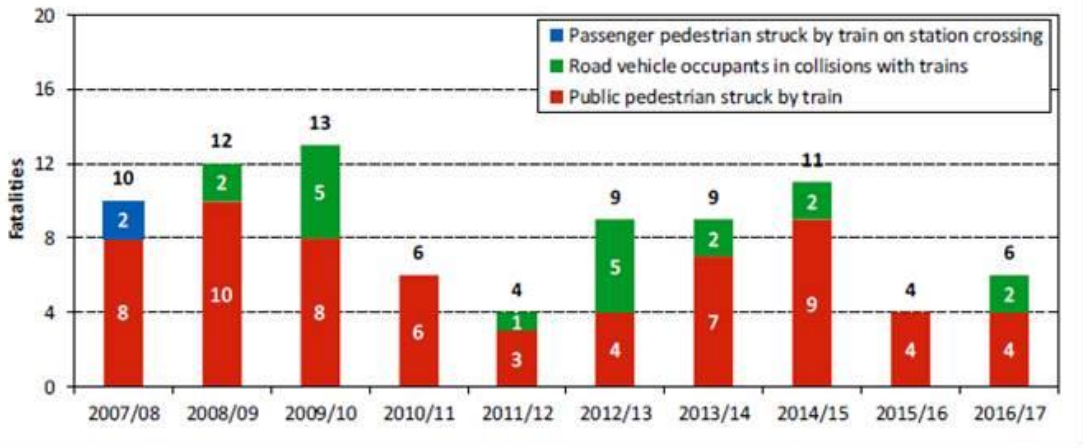
- It is not possible to have a kerb that segregates the footway from the carriageway. Only a white line is possible.
- If the visual and audible warning starts, users may panic.
- On curves, the outer rail is raised above the inner rail, to account for the differential between the rail wheels. This means that a level crossing cannot be flat if it is located on a significant curve, resulting in a potential tripping hazard.

- Pedestrians may be struck by descending barriers, especially if they have not heard or seen the warning of their descent.
- At half-barrier crossings, pedestrians might approach the railway on the right-hand side of the road where there is no barrier, although they would still have the benefit of visual and audible warnings.
- Some pedestrians move too slowly to reach the other side of the level crossing before the barrier has descended. If warning times at level crossings are extended to accommodate slower-moving users, misuse by other users may increase by reason of their impatience, (see Paragraphs 9.6 and 9.7).
- It is not generally possible to grit level crossings of their approaches to combat snow or ice, even if the surrounding highway network is gritted. This is because of the likelihood of track signalling systems failing, and the corrosion that can result to rails.

7.5. Passive crossings for road vehicles are generally used in rural areas and are known as User Worked Crossings (UWCs). These crossings tend to be on private roads, for example to provide access to a farm, or between a farm and fields. In general, UWCs tend to be comparatively high risk relative to the volume of traffic passing over them.

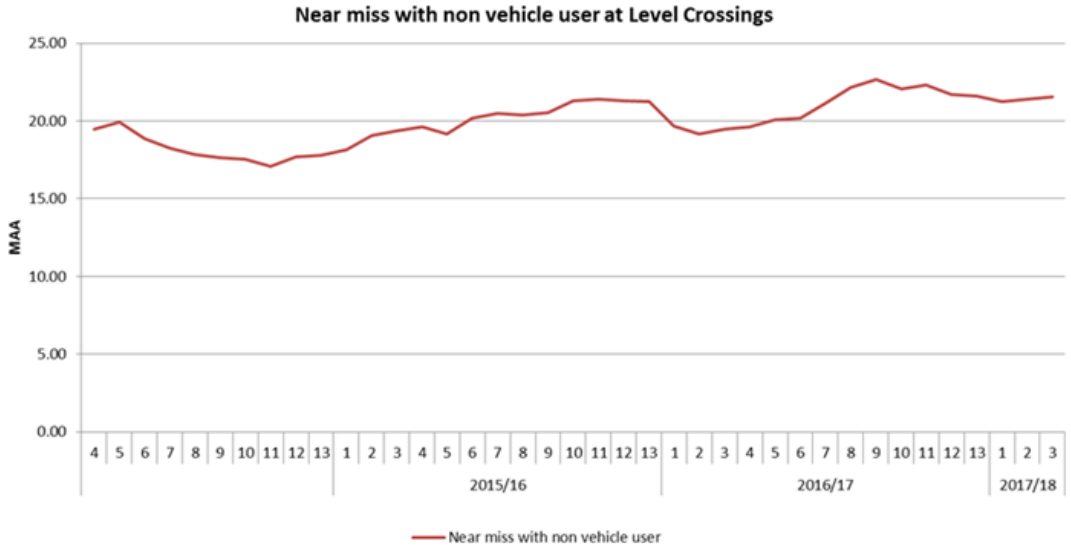
7.6. Passive crossings that are not designed for vehicles are commonly referred to as Footpath Crossings (FP). Access to the railway is provided via wicket gate, kissing gate or stile. Such features constitute a barrier to access for some users. Stiles can theoretically be replaced by wicket gates to improve accessibility. However, this may lead to a level crossing being used by slower-moving users, for whom there may be insufficient warning or an approaching train, (see Sections 9 and 10). Footpath crossings can be found in urban and rural areas; some are located at stations whilst others may have associated bridleway rights. Where the railway is in a cutting or on an embankment, steps are provided to facilitate passage. Replacement of lineside steps with ramps is often not practical owing to constraints of space.

7.7. Over the past 10 years Rail Standards Safety Board (RSSB) records that 77% of all accidental level crossing fatalities have involved pedestrian users, with the remaining 23% made up of vehicular users (drivers and passengers). The number of pedestrians and cyclists killed and injured at level crossings was as follows:



Source: Rail Safety and Standards Board, Annual Safety Performance Report – A railway guide to safety trends on GB railways 2016/17.

7.8. Over the past 5 years there has been an average of 253 near misses with non-vehicular users reported per year, (or 19.46 per 28-day period). This, of course, does not take account of those near misses that have not been reported. The number of near misses with non-vehicular users (by period) over the last 3 years is presented below, and shows a gradually worsening trend.



Source: Rail Safety and Standards Board, Annual Safety Performance Report – A railway guide to safety trends on GB railways 2016/17.

7.9. It is widely acknowledged that removing 'at grade' railway crossings is both the most effective way of reducing risk at level crossings, and the only way to eliminate the risk completely. Network Rail always reviews the opportunity to remove a level crossing from the network whenever significant renewal or enhancement work is required. This is consistent with the General Principles of

Prevention, set out in Schedule 1 of the Management of Health and Safety at Work Regulations 1999**,** and in particular, the following:

(a) avoiding risks;

(c) combating the risks at source;

(f) replacing the dangerous by the non-dangerous or the less dangerous

8. Level Crossing Risk Management

All Level Crossing Risk Model

8.1. The All Level Crossing Risk Model (ALCRM) is a comprehensive and complex risk calculation model used to assess quantitative risk at level crossings consistently and accurately.

8.2. Risk assessment of level crossings in Great Britain originated in 1993 when British Railways Board began a programme of research. ALCRM's development was based on this extensive research and the subsequent risk assessment approaches that had been adopted since the early 1990s.

8.3. First introduced in 2007, ALCRM was developed through a collaborative partnership between Rail Safety & Standards Board (RSSB), Network Rail and Arthur D Little (ADL). It is recognised by the ORR as *the* level crossing risk ranking tool for all level crossings under Network Rail's management and is acknowledged to provide a good overview of risk priorities.

8.4. ALCRM's main purpose is to support Network Rail's management of level crossing risk by providing a consistent methodology for assessing the safety risks to crossing users, train passengers and train staff at level crossings on Network Rail controlled infrastructure.

8.5. ALCRM is a quantitative risk model that also incorporates qualitative commentary to document decision making and record observations relevant to the safety risk management of level crossing assets. ALCRM not only enables risk to be calculated and measured, it also helps to calculate the effect of risk control solutions by modelling the benefits as revised scenarios.

8.6. ALCRM's calculated levels of risk are used as one part of Network Rail's overall risk management process, informing Network Rail of the relative risks of different level crossings and supporting, in conjunction with structured expert judgement, business decisions on crossing upgrades and closures.

8.7. ALCRM has been calibrated (i.e. setup to be representative of real-world levels of risk) using data from the rail industry's Safety Management Information System (SMIS) and from the RSSB's Safety Risk Model (SRM). SMIS is a repository database used by Railway Group members to record details of all safety related events which occur on Network Rail managed infrastructure. In relation to level crossings, SMIS is searchable to identify safety events such as accidents and incidents

(including near miss events). It records detailed information related to these events including: date, time, location, level crossing type and a narrative of the incident itself. The SRM uses the incident data (or precursors) from the safety events within SMIS to calculate the actual levels of risk for each type of level crossing. These baseline risk levels, found against each core crossing type in ALCRM, underpin the calculations of the risk model. SRM calculated risk is used by the rail industry as a measure of system risk on the network; of which level crossings are but one element.

8.8. ALCRM can be updated to incorporate findings from latest research, account for the changing risk profile (recalibration) or accommodate other business needs.

8.9. ALCRM uses the same principles for modelling risk at each type of crossing. In particular, the consequences associated with level crossing accidents are largely independent of crossing type. However, there are key differences in the way that each type of crossing is modelled regarding the frequency of accidents, from both a railway and user perspective, which give rise to different levels of risk. ALCRM has been designed to account for these differences, looking specifically at the causes of accidents that could occur at different types of crossing. For example, at user worked crossings, users are responsible for complying with the instructions for use and for making their own decision on when it is safe to cross. Accidents may therefore be caused by inadvertent failure of the user to correctly stop, look and listen for trains. In contrast, at manually controlled crossings the user is prevented from entering the crossing by barriers which are lowered across the road and so it is unlikely that a user will enter onto the crossing when a train is approaching unless they disregard the protection and climb the barriers. These differences are reflected in the calculations for each crossing type, which summarise in a logical way all the different causes of accidents.

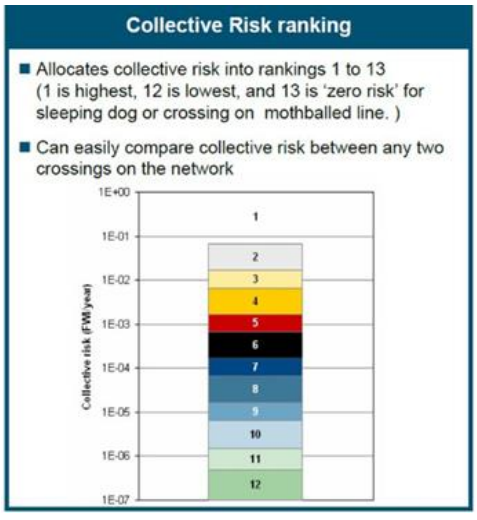
8.10. To calculate the level of risk for each level crossing, ALCRM requires specific information about each asset. Information is gathered from existing records held by Network Rail on the crossing, using sources of intelligence, stakeholder engagement and, most importantly, from a site visit during which the presence of a defined set of observable crossing features is recorded. The features to look for during the site visit are listed in site visit pro forma, and include aspects such as crossing orientation, user census, and the visibility of the crossing on approach roads/paths.

8.11. Once the mandatory inputs are entered into ALCRM, Network Rail can use the model to process the data that has been entered and return results, or calculated

risk, for the particular crossing that is being assessed. ALCRM determines level crossing risk using the same basic principles as for any risk assessment; namely hazard identification, frequency and consequence assessment leading to a calculation of risk. These calculations are fundamental to the way in which crossing risk is calculated, as risk varies according to the particular characteristics of the crossing, the people using the crossing and the railway features such as number of trains and train speed.

8.12. ALCRM reports two measures of risk; collective risk and individual risk of fatality.

8.13. Collective risk is a measure of the total harm, or safety loss, and is expressed in terms of Fatalities and Weighted Injuries (FWI) per year. FWI is a measure that accounts for fatalities and injuries. For example the value 1 represents: 1 fatality or 10 major injuries or 200 minor RIDDOR[8] injuries or 1000 minor non-RIDDOR injuries per year. Collective risk is reported by ALCRM in a simplified form referred to as a 'Collective risk number' ranked from '1 to 13' ('1' representing the highest risk and '13' representing nil risk). This is independent of crossing type, so crossings that are relatively busy with lower degrees of protection will receive the highest rankings and conversely lightly used crossings that have high levels of protection will receive rankings towards the lower end.

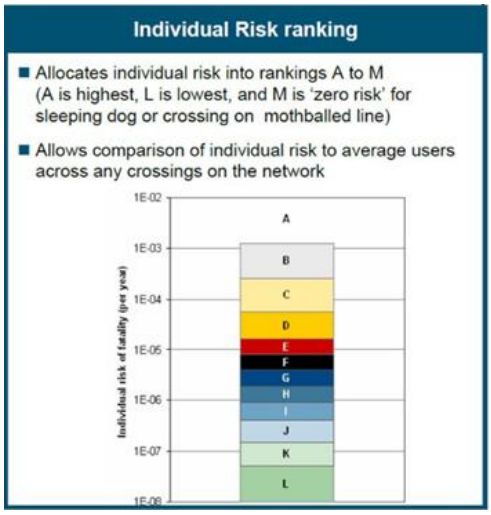


Collective Risk Ranking	Predicted FWIs per year	Predicted FWIs per year
1	Theoretically infinite	Greater than 5.00E-02
2	5.00E-02	1.00E-02
3	1.00E-02	5.00E-03
4	5.00E-03	1.00E-03
5	1.00E-03	5.00E-04
6	5.00E-04	1.00E-04
7	1.00E-04	5.00E-05
8	5.00E-05	1.00E-05
9	1.00E-05	5.00E-06
10	5.00E-06	1.00E-06
11	1.00E-06	5.00E-07
12	Less than 5.00E-07	Greater than 0
13	0	0

8.14. The risk to a regular crossing user is presented as individual risk of fatality per year. This calculation shows the level of risk a single typical user is exposed to per year of use at a level crossing based on 500 traverses. ALCRM calculates this risk as the 'probability of fatality' and unlike the collective risk, is not expressed as an

[8] Reporting of Injuries, Diseases and Dangerous Occurrences Regulations (2013)

FWI. Individual risk is expressed in the simplified form of an 'Individual risk letter' ranked from 'A to M' ('A' representing the highest risk and 'M' representing nil risk). This is independent of crossing use; the probability of fatality to each user (i.e. individual risk) does not increase with number of users. Crossings with higher degrees of protection (such as Manually Controlled Barriers (MCB)) will be grouped around the lower end (towards 'L'), with less well protected crossings (such as User Worked Crossings (UWC)) grouped around the higher end (towards 'A').



Individual Risk Ranking	Upper Number	Lower Number	Upper Value Scientific Notation	Lower Value Scientific Notation
A	1 in 1	Greater than 1 in 1,000	1	1.00E-03
B	1 in 1,000	1 in 5,000	1.00E-03	2.00E-04
C	1 in 5,000	1 in 25,000	2.00E-04	4.00E-05
D	1 in 25,000	1 in 125,000	4.00E-05	8.00E-06
E	1 in 125,000	1 in 250,000	8.00E-06	4.00E-06
F	1 in 250,000	1 in 500,000	4.00E-06	2.00E-06
G	1 in 500,000	1 in 1,000,000	2.00E-06	1.00E-06
H	1 in 1,000,000	1 in 2,000,000	1.00E-06	5.00E-07
I	1 in 2,000,000	1 in 4,000,000	5.00E-07	2.50E-07
J	1 in 4,000,000	1 in 10,000,000	2.50E-07	1.00E-07
K	1 in 10,000,000	1 in 20,000,000	1.00E-07	5.00E-08
L	Less than 1 in 20,000,000	Greater than 0	5.00E-08	Greater than 0
M	0	0	0	0

8.15. ALCRM also highlights the pre-defined key risks which contribute toward the overall calculated level of risk (where applicable). Known as key risk drivers, these include hazards such as sun glare, low sighting time or frequent trains.

8.16. The calculated outputs of ALCRM, in conjunction with expert structured judgement, enable Network Rail to better identify the hazards and risks present at each of its level crossings. ALCRM also enables proposed risk control solutions to be modelled as scenarios. This option enables a comparison to be made with the current risk assessment and facilitates an understanding of how changes or improvements translate 'quantitatively' as a benefit or risk reduction. In this way, ALCRM can inform decision-making about investment or safety expenditure, so that Network Rail delivers the greatest degree of public safety for every pound spent.

8.17. Inevitably, with a finite resource, money spent on safety improvements in one location will lead to some reduction in the money spent elsewhere. Our aim is always to secure the greatest public safety return for any investment that we make. That is why we take such care in each case to proceed with an entirely logical, evidence-based and consistent approach.

Qualitative Assessment

8.18. Alongside its quantitative assessment, Network Rail also incorporates a qualitative (structured expert judgement) approach to assessing risk at level crossings. This helps to deliver a rounded and balanced analysis of risk.

8.19. The ORR are supportive of this approach, noting in a letter from Ian Prosser (Director of Railway Safety, ORR) to Network Rail, dated 18 April 2012, that:

> *"…although ALCRM can provide a good overview of risk priorities, the routes will also know where the priorities lie, based on their local knowledge, and you should consider letting their knowledge feed into the prioritisation process."*

8.20. Qualitative risk assessment, or structured expert judgement, is applied by the risk assessor throughout the risk assessment process for each level crossing.

8.21. Information to support structured judgement is derived through the collation of evidence during each site visit, by applying local knowledge, using smart intelligent sources such as the internet and mapping services, through stakeholder engagement and analysis of previous assessments and accident/incident data.

Narrative Risk Assessment

8.22. In August 2014, Network Rail introduced the Narrative Risk Assessment (NRA), which takes both the quantitative calculated risk recorded in ALCRM, and the qualitative commentary, enabling the risk assessor to reach and document balanced decision making of the risks and risk controls required. The NRA enhances the processes and importance of qualitative structured expert judgement and presents the findings in an accessible format.

8.23. The NRA helps Network Rail meet the requirements of the Management of Health and Safety at Work Regulations 1999, Section 3, and is fully consistent with, and supportive of, the key business vision of a balanced assessment of risk.

Clarification

8.24. Whilst Network Rail uses ALCRM to model level crossing risk as part of our Health and Safety and Asset Management duties, and it is a useful indicator of crossing risk, it has not been used to select or prioritise crossings for inclusion in this Order. In other words, the inclusion of a crossing is not determined by its ALCRM score in isolation or relative to other crossings in the vicinity.

9. Human Behaviour and Risk Control Selection

9.1. Research into human behaviour at level crossings shows that people do not always behave predictably when using level crossings. People's willingness to wait for trains or to adhere to instructions, alarms and/or crossing equipment, can be influenced by such things as:

- distractions,
- time pressures,
- over-familiarity with a crossing or timetable, etc.

9.2. Research indicates, and incidents show, that people do not always look at signage or crossing equipment and can fail to look for trains before crossing.

9.3. Risk control solutions should be appropriate for managing the hazards and risks identified. Not all solutions are appropriate for all locations and risk could increase if an inappropriate risk control is chosen. Therefore a site specific assessment of suitability is part of the selection process.

9.4. The protection arrangements which are appropriate at level crossings will vary, depending upon the crossing location and the factors considered include the nature of the right of way (public or private), the type and frequency of use such as by vehicles, pedestrians, horse riders and farm animals, the proximity to road junctions, and the nature of railway traffic.

9.5. Where level crossings are being renewed or upgraded, Network Rail is required to make every reasonable effort to improve the crossing and reduce risk to both crossing and railway users. Certain types of level crossing design, particularly automatic types, whilst fit for purpose when road and rail traffic densities were lower, have been found to be prone to deliberate misuse or accidental user human error. This may lead to potentially serious, if not deadly, consequences when collisions occur. Given the high cost of installing level crossings and the requirement for a long service life (25 years), it is important that the most suitable crossing for the site-specific risks will be selected.

Vulnerable users and user encumbrance

9.6. The ORR's RSP7, (see: Paragraph 5.7), states:

- Users are expected to use reasonable vigilance to satisfy themselves that no trains are approaching before they start to cross the line. They should cross

quickly and remain alert while crossing. Users should have sufficient time from first seeing, or being warned of an approaching train, to cross safely [paragraph 138].

- A speed of 1.2 m/s should be used where the surface is at or near to rail level and 1m/s where the surface is at the standard profile of the ballast. The calculated time in traversing the crossing should be increased to take account of foreseeable circumstances such as impaired mobility of users, numbers of prams and bicycles or where there is a slope or step up from the decision point [paragraph 148].

9.7. Level crossings can cause difficulties for people who move slowly, and are not suitable for users who are unable to see or hear approaching trains or warning devices, as necessary at each crossing. This may mean that some users with a disability avoid routes with level crossings, or use them at increased risk over those without such disabilities.

9.8. Network Rail uses a risk-based process to establish the minimum warning time required at each crossing. This takes cognisance of the proportion of vulnerable users identified by our crossing censuses, research into the crossing environment and surrounding infrastructure, and the condition of the level crossing itself. Where appropriate, the crossing time is increased by 50% to account for vulnerable users. Guidance to help reach this structured expert judgement was developed in 2013 and forms part of the Level Crossing Managers' toolkit.

9.9. 'Vulnerable Users' are characterised as those who are unable to use the level crossing quickly and effectively, and are not fully aware of the dangers at a level crossing.

9.10. The term "vulnerable user" does not relate exclusively to disabled or elderly people with impaired mobility.

9.11. Young children, and older children in groups should be viewed as "vulnerable" because they do not have a mature perception of the risks. Furthermore, fully able bodied people can become "vulnerable" because they are "encumbered". An encumbered user is someone who is crossing with something that reduces their agility and/or can cause distraction.

9.12. Encumbered users include those with pushbikes (pushing them or riding), those who are carrying objects (for example, heavy bags or equipment) and those with

dogs, either on or off the lead. It is notable that in 17% of train strikes, the pedestrian was walking a dog.

9.13. From observation, users with pushchairs and bicycles sometimes have difficulty in opening and closing a crossing gate. In some cases, where the gate is located within 3m of the running rails, the longer forward footprint of these users can mean that they are in a position of danger before checking to see if it is safe to cross.

9.14. Many pedestrians also now wear vision-obscuring clothing (hoodies) and/or earphones, or are distracted using mobile phones whilst they cross, and just do not see or hear an approaching train until it is too late.

Failing to check for trains

9.15. Studies undertaken by RSSB as part of their T984 research programme ('Research into the causes of pedestrian accidents at level crossings and potential solutions') used eye tracking devices to ascertain that a small but significant number of users (around 5%) fail to check for trains in either direction. A further 16% only looked in only one direction anywhere on the approach or traverse.

9.16. These statistics confirm that over 20% of pedestrians crossing an operational railway line inadvertently place themselves in harm's way, presumably relying on peripheral vision, hearing or an expectation that no train is coming.

9.17. When the causes of train strikes with pedestrians are examined (by both Network Rail and the Rail Accident Investigation Branch) a large proportion are attributed to 'fails to stop/look/listen', suggesting that no other cause could be found other than a failure of the user to take reasonable care.

9.18. By way of example, on 8th June 2014, at a level crossing between Oxford and Banbury, which has miniature stop lights to warn pedestrians of an approaching train, a young man out walking his dog failed to respond to the audible alarm and lights which were warning of an approaching passenger train and started to cross the railway in front of the train.

9.19. The photo below is a still from the train's forward facing camera. It shows the train almost on the crossing with the young man and his dog just in front of it. It is evident from the photograph that the pedestrian has not seen the train, which was travelling at high speed, at that moment in time.

Still photograph taken from forward-facing camera mounted in a passenger train

9.20. In this case, at the last possible second the young man realised the train was there; fortunately, he was between the tracks (where the dog is pictured) when the train passed over the crossing. His dog was killed.

User gender and age

9.21. Male pedestrians dominate accidents at level crossings, associated with 70% of all train strikes. This would suggest male pedestrians are more at risk at level crossings than female pedestrians. Furthermore, the risk of being struck by a train increases steadily with age for adult users of both sexes.

User familiarity

9.22. Interviews with level crossing users suggest that users who live or work in close proximity to a crossing can become familiar with the crossing attributes and procedures required for crossing (e.g. Miniature Stop Light (MSL) activation durations). Their behaviour can become habitual, resulting in a failure to look for unexpected information, leaving them susceptible to errors of judgment. However, the same is true of unfamiliar users who can fail to cross safely due to knowledge-based errors about correct operation.

9.23. Differences in behaviour have been noted between familiar and unfamiliar Users. For example, T984's (see: paragraph 5.19) use of eye tracker data has revealed that first time users were less likely to look at the stop, look, and listen (SLL) sign than more frequent users. This might relate to their requirement for processing the complex crossing environment for the first time, whereas more frequent users are able to prioritise and are likely to look at all signs at a crossing (perhaps

suggesting that signs help users to recognise that they are at a level crossing, even if their content is not read).

9.24. Regular users were more likely than infrequent users to perceive crossing risk as low and could therefore be more likely to commit a violation of safe crossing procedure. This is supported by research investigating vehicle driver behaviour at crossings which revealed that 53% of red light runners (at a range of testing locations) used the crossing at least once a day[9].

Stop, Look and Listen (SLL) Sign

9.25. The most prominent crossing feature at passive level crossings is typically the SLL sign, which provides a warning (and sometimes the only warning) to the user that they are approaching a level crossing. It provides an indication of where the user might be best placed to observe an approaching train and, if read, gives instructions on how to cross safely.

9.26. Observations have indicated that SLL signs are not commonly viewed by users, and there is little evidence that users who do observe this sign are more likely to look for trains. Users looking at the SLL sign are, on average, very marginally more likely to subsequently look for trains. It can therefore only be concluded that the sign is having at best, a weak positive influence on encouraging users to take care to look for trains.

Gates

9.27. Gates are a second prominent feature commonly found at passive crossings. Well positioned, a gate can serve to cause the user to pause on approach to the crossing, which may increase the chance that the user then has time to look for a train. Gates also act as a barrier for those crossing with small children or dogs not on a lead.

9.28. There are several potential drawbacks associated with the use of gates:

- Gates can be difficult to use in high winds (especially if encumbered).
- Users with 'large footprints' such as those with bikes / pushchairs / horses have historically rarely been taken into account in gate positioning relative to

[9] HSE Contract Research Report No. 98/1996

the line, and as such it can be difficult to exit the tracks unimpeded, or make a decision to cross in a position of safety.

- At locations with interlocked gates some users, such as wheelchair users and those with pushchairs, are unable to use these gates as the locking mechanism prevents them opening fully. As such, they are forced to use the vehicle gates, potentially placing them at greater risk from accidents with a road vehicle.

9.29. Therefore, whilst gates are generally a good design principle, they may complicate safe crossing use in certain specific circumstances.

Crossing Surface – Slips and Trips

9.30. Slips and trips are a recurrent theme reported as the cause of users being struck by trains; there are numerous mentions of this hazard within the various sources of industry data compiled on accidents. For example 14% of train strikes at level crossings have been attributed to slips, trips or becoming snagged on the crossing. The crossing surface can therefore be regarded as having a key influence on risk. Slips and trips are particularly prominent for Footpath crossings, where the pedestrian crossing surface is the most variable of all crossing types.

10. Level Crossing Sighting

Whistle Boards

10.1. At passive level crossings, users are reliant on their own senses to detect an approaching train, as instructed by the "Stop. Look. Listen." sign. Those with impaired vision may be unable to see approaching trains; this can lead to the wrong decision being made to cross, which could prove fatal.

10.2. Sighting distances along the track can be limited by factors such as lineside equipment, structures, and track curvature. Network Rail has a duty to provide users with sufficient time to traverse a level crossing safely.

10.3. Whistle boards are a legacy risk mitigation which instructs Train Drivers to sound the train horn where sighting of approaching trains is limited at a level crossing. Their presence does not eradicate all risk. They provide an audible warning to pedestrians using the level crossing but: effectiveness can be reduced by ambient noise, weather conditions, distraction, wearing headphones, using mobile devices etc.; the warning time offered can be inconsistent; both train drivers and crossing users are susceptible to human error.

10.4. Train Drivers do not sound their horn at whistle boards during the Night Time Quiet Period (NTQP) between midnight and 06:00 hrs, except in emergency circumstances when someone is seen on or near the line. This arrangement is in place as a means of balancing the competing demands for level crossing safety and minimal noise intrusion into the lives of our lineside neighbours.

10.5. Whistle Boards must be positioned on both approaches to the level crossing at the distance required for the fastest train permissible, so that the audible warning gives users no less than the minimum time required to cross the railway in safety. On a standard two-track railway line with 100 mph line speed, the whistle boards must be positioned 435m in advance of the crossing. This gives users the necessary time to cross (approximately 9 seconds). Whistle Boards should not be positioned further than this from the crossing because the warning risks becoming lost to ambient noise. For this reason 100 mph is the maximum line speed that can be accommodated by whistle board protection. Therefore, any lines with footpath crossings have a maximum speed constraint.

10.6. Trains are not restricted to just one type on any particular line. Services can include high speed express trains, slower and more frequently stopping local commuter trains, freight trains, unscheduled movement of empty rolling stock,

and engineering trains. This can lead to considerable variance between trains in terms of speed and acceleration/deceleration characteristics.

10.7. By sounding the horn at the whistle board, an approaching train travelling at approximately half the maximum permitted line speed will give a crossing user twice the minimum amount of warning time before arriving at the crossing. The unpredictability and inconsistency of this extended warning time can lead to accidental errors of judgement and impatience of the user.

Sighting distance

10.8. A person's judgment of speed is intuitive and often based on daily experience of road vehicles. This can give a highly inaccurate perception of the speed of an approaching train, which are travelling in an environment without many of the usual markers which help us to evaluate speed and distance (e.g. buildings, road marking, other cars and pedestrians etc.).

10.9. The nature of the railways is such that trains take a substantial distance to stop, even at low speeds. The expected braking distances for road vehicles are of a different order to the considerably longer distance required for trains (which can be at 300 times heavier than the average family car, and which are subject to the reduced friction achievable between metal wheels and a metal rail).

10.10. According to the Highway Code a typical braking distance (excluding thinking time) for a car travelling at 70 mph is 75 metres; the braking distance of a local passenger train travelling at 70 mph is approx. 730 metres. At 50 mph, a car's braking distance is 38 metres; a local passenger train takes 380 metres. By the time a train driver is close enough to see something unsafe at a level crossing, the train is typically too close to be able to stop short of the crossing.

10.11. The time available for a crossing user to see an approaching train and to cross safely is therefore dependent on the speed of the train and the variance of time it takes for a train to reach the crossing when first seen. This can confuse pedestrians and lull crossing users into a false sense of security.

10.12. Sighting distances are not always consistent throughout the year. Whilst ALCRM models clear weather conditions only, in practice sighting distance can vary according to local weather conditions and vegetation growth. It is typically within Network Rail's power to manage vegetation but the weather is obviously outwith our control.

10.13. Crossings suffering from poor sighting distances may be fitted with whistle boards. It is a DfT requirement that if whistle boards are required then they must be positioned in both directions of travel as trains approach the level crossing. With the instruction for train drivers to sound their horns at whistle boards between 06:00 and 00:00 hrs it is not uncommon for Network Rail to receive complaints of noise pollution, especially relating to noise in the early morning and late at night when many residents are trying to sleep. These complaints have, in some instances, led to Noise Abatement Orders (e.g. Abbotts FP level crossing, (E56)) and Environmental Protection investigations (e.g. Padget FP level crossing (E41)).

10.14. New technology is being introduced to try and address the unsociable impact of whistle boards, but current options to give an audible warning locally at a passive crossing can only be used to supplement the whistle boards rather than to replace them.

Long sighting distance

10.15. Whilst short sighting distances may provide insufficient warning time for a crossing user to traverse the railway safely using a vision alone, there are also known risks associated with long sighting distances. Human factors research shows that people find it difficult to contextualise the speed of large objects. A long sighting distance, and therefore an excessive warning time, can have a detrimental impact on risk because people are susceptible to underestimating train speeds. This can result in people making a decision to cross at the wrong time.

10.16. Users often think they have longer to cross than they actually have. They may commit themselves to crossing, when seeing or hearing a train a considerable distance away, believing it is travelling at a slow speed. They then realise the train is travelling much faster than first thought, meaning they have minimal or insufficient time to get clear. This is the scenario which we believe was the cause of a recent fatality at Grimston Lane Footpath Crossing where an elderly gentleman and regular user of that crossing acknowledged the train's horn but continued to cross with the misapprehension he had sufficient time.

Reduction in line speed

10.17. A reduction in the line speed will provide users with additional visual warning time of approaching trains and may improve safety. However, as with long sighting

distances, too much warning time can sometimes be detrimental to crossing safety.

10.18. Reducing the line speed also goes against operational efficiency and conflicts with the intention of Network Rail's Licence conditions; the expectation in government funding of Network Rail is that line speeds should increase to reduce passenger journey times, not be permanently reduced.

10.19. Additionally, slowing a train at a level crossing can have a knock-on effect on the efficiency of the network. Each train runs in its allocated time slot according to the railway's working timetable and all train movements are meticulously planned to run without causing undue delay to other services. Where a train runs late due to incident or temporary speed restriction, it can have a knock-on effect across the network, causing other trains to be delayed too. This is especially common when train services of different speed and stopping patterns share the use of a line, and when lines merge at junctions around the network. Each delayed train can then further compound the situation, causing delays across the network. Level crossings therefore impose constraints on the operational efficiency and capacity of the railway network at odds with the general duty and requirements of the Licence conditions.

11. Passing Trains

11.1. As stated earlier, some pedestrians do not stop, look or listen for approaching trains when crossing the railway. Other users look, but direct the majority of their focus in just one direction and assume that the crossing is clear when the train approaching from that direction has passed. They overlook the possibility that a second train may train may also be approaching from the other direction.

11.2. Trains can pass each other in the vicinity of level crossings. This can give rise to one train temporarily obscuring another train travelling in the opposite direction, leading to pedestrians stepping out after a first train has passed and walking directly into the path of an approaching train from the opposite direction which they have not seen (or heard). This is what happened in the situation depicted below. The photographs were taken from two trains as they passed over the crossing at 70mph, (the photograph on the left was taken from the rear of the first train after it had passed the crossing, and the photograph on the right was taken from the front of the second train, travelling in the opposite direction to the first). Video footage of this incident is available to view on Network Rail's website.[10]

11.3. Some freight trains can be over 200 metres in length and can easily hide shorter commuter trains, of perhaps just 45 metres in length, for some considerable time. Even short commuter trains near to the pedestrian have the potential to 'hide' trains on the opposite line approaching the crossing, as per the images above.

11.4. In his Order Decision relating to Alphington Public Footpath level crossing (near Exeter), the Inspector noted (OD, at paragraph 15) that:

> *"I consider first the current situation, noting that for any sensible and fully mobile adult following the injunction to stop, look and listen, Alphington crossing would present a very low risk of harm – it is reasonably safe. Not all*

[10] See film 7 – Train driver's view: https://www.networkrail.co.uk/9-times-people-risked-lives-level-crossings/

adults, however, and perhaps fewer children, are fully mobile and sensible, and their safety as users of the crossing must be considered as well. I note here that while I was looking at the crossing, a high speed train went past on the down line, having correctly whistled at the whistle board just south of the Clapperbrook Lane East Bridge. After it had passed to the south of the crossing, on a gentle left hand curve, it obscured the view of an approaching train on the up line, and completely masked the sound of its whistle, so that the train on the up line only came into view, with no apparent audible warning, when it was roughly 300 metres from the crossing. This situation cannot happen very often, but I consider it potentially hazardous."

12. Deliberate Misuse and Trespass

12.1. Detailed covert censuses at Public Footpath level crossings have demonstrated a trend in the behaviours of youths in some locations, notably congregating at level crossings, often in urban areas. It is human nature to gather at known sites which offer interest, and which are away from the main thoroughfare, especially where teenagers are bored and there are limited activities in the locality to engage in. Video footage of such behaviour is available to view on Network Rail's website for illustrative purposes.[11]

12.2. Of great concern to Network Rail, this behaviour introduces a high element of deliberate trespass by youths, which is a criminal activity, as well as putting the individuals at serious risk of an incident involving a train.

12.3. Network Rail has a significant amount of photographic evidence of youths alone or in groups, openly standing on level crossings, sitting on the deck, walk up and down the rails, or chasing each other, as well as playing 'chicken' with approaching trains (i.e. running out in front of approaching trains at the last minute). The photographs below, and the entries contained within Appendices NR27/2 Tab 2, serve to illustrate these findings.






12.4. Network Rail has a duty of care towards trespass and without a realistic ability to police all high risk level crossings on a regular and ongoing basis, such deliberate misuse will persist. Consequently, the risk of an incident and injury will remain.

[11] See films 4 and 6 - : https://www.networkrail.co.uk/9-times-people-risked-lives-level-crossings/

12.5. Where a trespasser on the railway is reported by a passing train driver, all other trains in the local area are immediately put at 'caution' until the trespasser has vacated or been removed from the railway. Trains 'at caution' are subject to severe speed restrictions as they pass the site, thus delaying the train and the service, which can have knock-on effects elsewhere on the network. There is a real cost to minutes delay of each train, which Network Rail is contractually required to pay to the train operator as well as the cost of any call-out to remove trespassers from the line

12.6. The only real alternative, where use of the crossing has been proven to be light, and where there is no demonstrable need to retain it (because of alternative routes), is to divert the rights away from the railway and to close the level crossing.

13. Rail Accident Investigation Branch: Level Crossing Fatalities

13.1. Despite a sustained country-wide campaign by Network Rail to educate people of the dangers of crossing the railway, there have been many unnecessary, accidental fatalities to pedestrians at level crossings in Britain.

13.2. Unfortunately, the level of deliberate misuse and user human error occurring at level crossings still remains unacceptably high. Network Rail has evidence that shows a clear relationship between the numbers of near-miss events at level crossings and the number of accidents where a train collides with a vehicle or pedestrian. The more near-miss events that happen at a level crossing the more likely a serious accident is to happen. Therefore, removing crossings at grade represents the best option to improve safety.

13.3. The Rail Accident Investigation Branch (RAIB) has investigated 17 fatal incidents involving pedestrians, and a further 13 involving motor vehicles, at level crossings on Britain's main line railways since it became operational in October 2005. Additionally, in the last five years there have been 42 serious incidents and fatalities at level crossings that have not been the subject of a RAIB investigation, (see: Appendices NR27/2 Tab 2).

14. Witness declaration

I hereby declare as follows:

(i) This proof of evidence includes all facts which I regard as being relevant to the opinions that I have expressed and that the Inquiry's attention has been drawn to any matter which would affect the validity of that opinion.

(ii) I believe the facts that I have stated in this proof of evidence are true and that the opinions expressed are correct.

(iii) I understand my duty to the Inquiry to help it with matters within my expertise and I have complied with that duty.

Signed:

Mark Brunnen
Head of Level Crossings
September 2017