Mechanics Transport Communications
Academic journal
ISSN 1312-3823
issue 3, 2007
Introductory article № 3
http://www.mtc-aj.com

PUBLIC ROAD LEVEL CROSSINGS IN GREAT BRITAIN

Michael WOODS
michael.woods@rssb.co.uk
www.rssb.co.uk

Head of Operations Research, Rail Safety and Standards Board
Address: Central House, Upper Woburn Place,
London WC1H 0HY

LEVEL CROSSINGS DON'T RUN THE RISK

1 Background

There are some 1500 public road level crossings in Great Britain representing about 20% of the total number of level crossings on the national rail network [Reference 1]. This paper examines this group of crossings, why the numbers have been reduced in the last fifty years, how control systems have evolved to manage risk and keep road and rail traffic moving, and what initiatives, including research, have been deployed to improve safety and efficiency. Planned future developments are then previewed. Further papers covering the two other main groups of crossings – user worked or private road crossings, and footpath crossings – are planned for the future.

The public road group of crossings is significant in terms of the overall risk it represents because any collision between a road vehicle and a train has the potential not only of injuring or killing the road vehicle occupants but can lead to a train derailment and, potentially, injuries and fatalities to train passengers and staff. The most significant such accidents since 1967 have been:

- Hixon 1968 11 on-train fatalities
- Lockington 1986 8 on-train fatalities
- Ufton Nervet 2004 6 on-train fatalities

This type of accident, although rare, is more likely to occur at public roads than at private roads (where the traffic levels are generally much lower) and not significantly at footpaths where there is little risk to a train or its occupants unless a vehicle is placed onto the railway. To complete the picture, a fourth group of locations, the railway away from level crossings, can lead to train-vehicle accidents, such as the Great Heck accident in 2001, when there were ten on-train fatalities

2 History

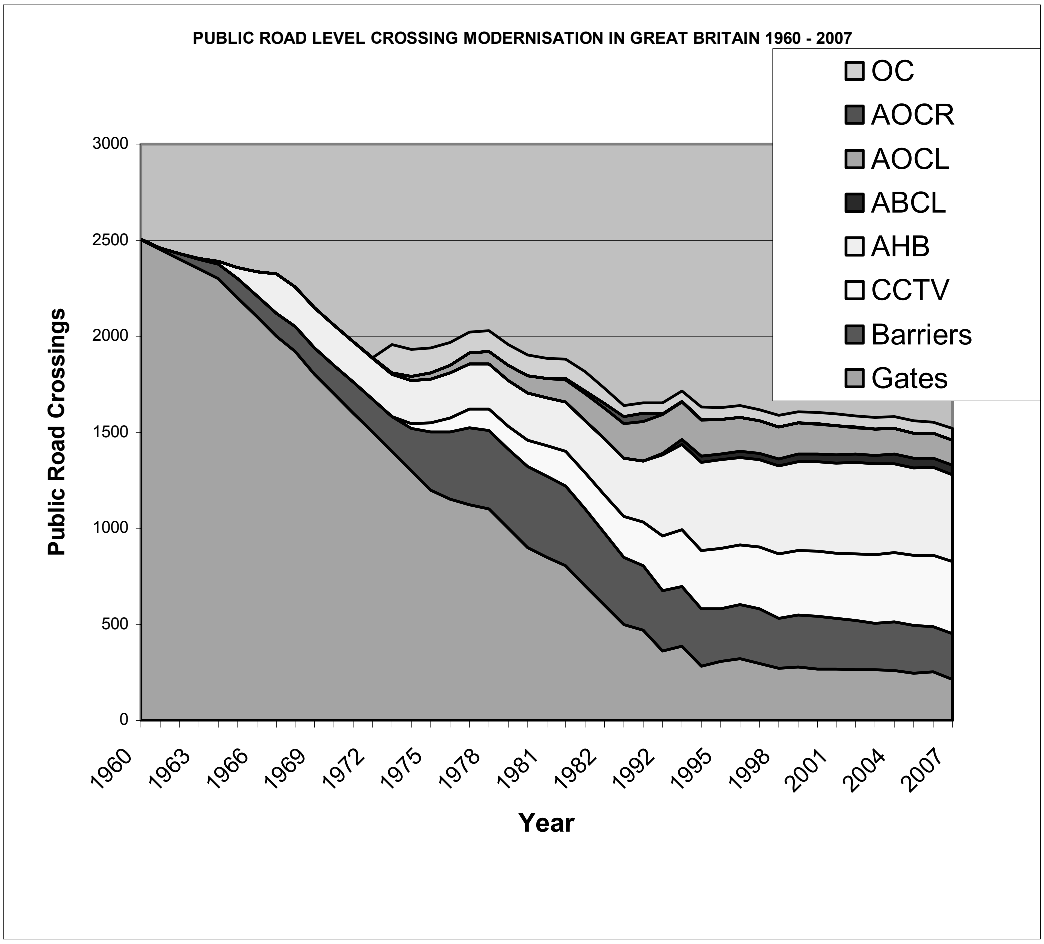
Most public road level crossings have been in existence since the original railways were built, principally in the nineteenth century. They are especially prevalent in flatter parts of Britain, such as Eastern England, and where the expense of bridging or going under the track was found not to be affordable by the original promoters of the railway lines. Railway construction was generally allowed only if parliamentary powers, usually in the form of a specific Act of Parliament, were obtained and the relevant Act required the railway to replicate road access which usually existed before the railway was planned. There is no simple or easy procedure for closing such a crossing, which requires widespread public consensus. As an example, a crossing east of Ashford in Kent, at Willesborough, took several attempts at closure in the 1980s and 1990s in conjunction with upgrading the line to the Channel Tunnel before agreement on the provision of a bridge was reached. Clauses in several private parliamentary

bills were required over several years until the closure was approved. The process, and comparisons to that applying in several other countries, was reviewed in a research report produced for Rail Safety and Standards Board (RSSB) [Reference 2].
It should be noted that level crossings create benefits to society and road users as well as risk and cost to the railway [Reference 3]. The number of road crossings has, however, been reduced over the last fifty years for two main reasons:

- The reduction in the size of the rail network and the closure of many branch lines in, mainly, the 1960s as part of the Beeching Plan.
- The increase in train speeds from the first introduction of high speed trains in 1976 and from the many related resignalling schemes

The number of such crossings routinely closed specifically in order to improve safety is thought to be small, although detailed records are not readily available.

Comprehensive figures giving the number of road level crossings by type are readily available from 1992 as they have been supplied by British Rail / Railtrack / Network Rail to Her Majesty's Railway Inspectorate (HMRI) for inclusion in annual reports. Earlier figures are available at specific points when the numbers were included in government or railway reports. Intermediate dates have been extrapolated and the trend can be seen in the following graph (see below for explanation of acronyms):



3 Crossing types

There are, broadly, eight types of crossing in use on the highway network, as follows, with the numbers as reported at the end of 2006:

- 213 Manned Crossings with Gates (MG)
- 238 Manned Crossings with Barriers (MCB)
- 377 Manned Crossings controlled by Closed Circuit Television (CCTV)

- 451 Automatic Half Barrier Crossings (AHB)
- 50 Automatic Half Barrier Crossings Locally Monitored (ABCL)
- 128 Automatic Open Crossings Locally Monitored (AOCL)
- 1 Automatic Open Crossing Remotely Monitored (AOCR)
- 63 Open Crossings (OC)

These types can be aligned to the new classification [Reference 4] being proposed by the European Rail Agency (ERA) as under:

LEVEL CROSSING (LC)

A. ACTIVE LC

A.1 Automatic protection/warning

A.1.1 road side protection (barriers, gates)	AHB; ABCL
A.1.2 road side warning (optical, acoustic, physical)	AOCL; AOCR
A.1.3 road side protection and warning	

A.2 Manual protection/warning

A.2.1 road side protection (barriers, gates)	MG; MCB; CCTV
A.2.2 road side warning (optical, acoustic, physical)	
A.2.3 road side protection and warning	

The reason why there are a number of types of public road crossings is that there has been a gradual process where new technologies have become available and particular circumstances have needed addressing. The majority of crossings are of five types – the original manned gates (14%); manned barriers (16%); CCTV (25%) and AHB/ABCL (33%). No new automatic open crossings (8%) are likely to be created and there are very few open crossings on public roads (4%). Following recent RSSB research [Reference 5] Network Rail is developing a new concept of an automatic full barrier controlled by obstacle detector (AFB) – see below.

Manned gates (MG)

Gates across the railway, physically controlled by hand, wheel or other mechanism, have been the normal type of road crossing in Great Britain and there were some 2500 of these by 1960. They were normally (but not always) kept closed across the railway and opened to block the road when a train was due. In most cases, especially in recent years, they are interlocked with railway signals. The controller, or crossing keeper, is usually located in a cabin or crossing box adjacent to the level crossing and in many cases this has also served as a signal box or block post. Various additional controls, such as fixed red lights (originally, oil lamps) and bells or other audible warnings, can be provided. Closure time to road users can be lengthy and thus these crossings are not really suitable for busy roads, especially where there is a frequent rail service. However, the nature of the crossing, where a physical gate fully segregates road users from the railway lines, produces a high level of safety although there is a small potential for human error by railway staff.

Photo - author

Manned crossing barriers (MCB)
By 1960 permission had been obtained to replace gates with lifting barriers which can be controlled locally by electrical or hydraulic operation. In some cases motorised boom gates or barriers were provided although these are increasingly rare. There is no fundamental difference between manned barriers and manned gates although the barriers can usually be operated more quickly than gates.

Photo - author

Manned Crossings controlled by Closed Circuit Television (CCTV)
By the early 1970s, technology had developed which allowed the activities at a level crossing to be observed remotely via a camera located at the crossing on a monitor in a remote building, either at a crossing box or a signal box / signalling centre. When a train approaches, the staff member activates the flashing light / audible warning system and observes road traffic on the monitor. When road traffic has stopped and is otherwise clear of the crossing, the entry barriers are lowered and then, if the crossing remains clear, the exit barriers come down. Once the barriers are proved to be down the railway signals are cleared for the approach of the train and, once it has passed, the barriers automatically rise (unless a second train has struck in). These crossings have a number of features which taken together have made them a popular choice when existing crossing equipment needed upgrading or replacement:

- The road is completely closed to traffic providing complete separation
- Existing staff at each location can be replaced, by fewer staff at a central location, with supervision of up to four crossings by one person being possible (or combined with signalling tasks)
- The movement of trains is facilitated and delays avoided
- Train speeds of up to 125 mph (200 km/h) are permitted

However
- Equipment costs, especially cabling, can be considerable
- Only a limited number of crossings can be grouped together because of workload factors
- The time that a crossing is closed to road is generally significantly longer than where an automatic half barrier crossing is provided and can be as much as three or four minutes for a single train movement

Photo - author

Automatic half barrier crossings (AHB)
In the late 1950s, crossings with a half barrier which close only the approach side of a crossing to the road and which are controlled by the movement of trains had become widespread and investigations were undertaken by HMRI and British Rail [Reference 6] to see if they could be safely adopted in Britain. There were three main drivers for this change:

- The enormous growth in road traffic and the serious delays caused by the operation of traditional gated crossings
- The increases in wages and the need for shift working which increased the cost of manning crossings at the time to some £3,000 per year
- The difficulty of recruiting staff to man crossings, a situation which was temporarily eased by the closure of railway lines under the Beeching Plan

Automatic full barriers, in use in France, were also examined but the potential for a road vehicle to be trapped was a major cause for concern. Without technologies which were then not available (although known about in principle), such as obstacle detection by radar, a crossing of this type was felt to be unsafe. After several accidents in France these crossings were withdrawn.

AHBs were introduced on a trial basis in the 1960s and by the time of the Hixon accident in 1968, 207 were in use. The accident occurred when a Manchester – Euston express train hit a heavy transporter lorry carrying an electrical transformer.

The inquiry [Reference 7] found that

- … level crossings protected by automatic half barriers are a valuable answer to the needs of modern transport and .. are reasonably safe
- … their safety can be improved by certain modifications
- … some dangers may involve the possible derailment of a high speed train, with the consequent loss of many lives, while other dangers do not
- The more substantial dangers to be eliminated are those created by crawling and stalling vehicles, by the negligent and the criminal. Of those only the stalled vehicle cannot be provided against except at the highest cost.
- There is a clear choice to be made between full protection for the automatic crossings by means of presence detectors allied with railway signals, and a lesser degree of protection which will minimise, but not eliminate, all risks.
- Though full protection with complete closure of the crossing would eliminate all risks so far as humanly possible, it would do so at such great cost … that conversion of level crossings to automatic operation would cease. Almost all benefits to road traffic would also be lost, for there are more slow trains than fast, and the average times of closure of the road would be much the same as in the case of manned crossings.
- ..the risks attendant on the abnormal slow-moving vehicle, and the negligent or the criminal driver (the ‘zig-zagger’) can be satisfactorily dealt with, and indeed, almost erased by other methods, the only case for demanding full protection would be in case a vehicle .. should stall on the crossing.

A number of modifications to AHB design and signage were proposed and the programme of conversion resumed after a gap of some four years. A further review [Reference 8] was published in 1978 and other changes were approved, which made it slightly easier to create AHB crossings. There are now over 450 of these crossings, in use on railway lines where the speed of trains is 100 mph (160 km/h) or less. Closure time is typically around a minute for one train and conversion of an AHB to a CCTV crossing can therefore have a detrimental effect on road traffic flows and the overall capacity of the highway network, especially when there is a frequent train service.

Photo - author

Automatic Half Barrier Crossings Locally Monitored (ABCL)

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

Photo – Network Rail

Automatic Open Crossing Remotely Monitored (AOCR)

In essence, an AOCR is an AHB without the barriers, and road traffic is controlled by the exhibition of flashing lights and audible warnings. Between 1982 and 1986 a total of 44 of these crossings were installed but in 1986 a train from Bridlington to Hull hit a van on an AOCR at Lockington, and eight passengers died and 37 were seriously injured. Two reports were published on this accident [References 9, 10] and on the Automatic Open Crossing types generally. The AOCR crossing type has now been almost totally eliminated with the exception of one which remains in Scotland due to special site circumstances.

Photo - author

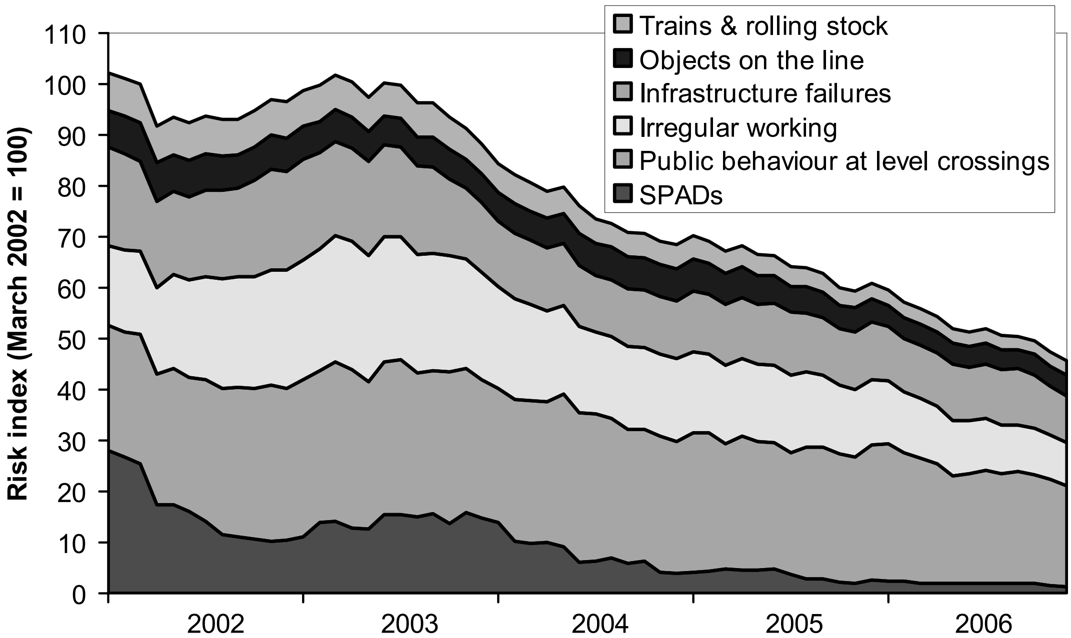
Open Crossings (OC)

These crossings are provided on minor roads with little road traffic where there is a low level of railway traffic also. These do not have barriers or road traffic light signals and only road traffic signs are provided. Road users are required to give way to trains at the crossings – they should be able to see approaching trains in sufficient time to cross the railway or stop safely. Train drivers must stop their train if the crossing is not clear and they must sound the train horn in the day time. There will be an appropriate permanent speed restriction for trains which are required to approach the crossing at a 'steady speed', typically at 10 mph (16 km/h). These are the only 'passive' crossings normally in use on public roads – see ERA diagram above.

Photo – Marcus Beard

4 Current initiatives

Overall risk from all causes on the national rail network is being managed actively and most accident categories and precursors are showing a positive reducing trend. This can be illustrated by the following chart using information from the RSSB precursor indicator model.



The trend for level crossing accidents caused by public behaviour is not improving significantly and this affects the three categories of crossing previous described:

- Public roads
- Private roads
- Footpaths, etc

In recent years the approaches used to tackle these types of risk, especially those resulting from public error or violations, have been described as the 'three Es', namely:

- Engineering
- Education
- Enforcement

The industry has worked together and with representatives of the road sector, within a body called the National Level Crossing Safety Group (NLCSG), facilitated by RSSB, to identify initiatives which can lead to reduced risk at level crossings and to specify research which may help in any way. This paper will conclude by examining several related initiatives which are designed to produce a better improving trend for all crossings, including public roads.

Development of risk models

A recently published research project by RSSB [Reference 11] extended the application and functionality of an existing risk model for automatic level crossings to all level crossings on the national rail network. The new model, the All Level Crossings Risk Model (ALCRM), improves Network Rail's ability to manage the risk to crossing users, passengers and rail staff by targeting those crossings with the highest risk for remedial measures. Complex algorithms have been created and located in a web-browser software environment. This allows local Network Rail level crossing practitioners to enter data for their crossings and establish the risk for each. They can also carry out scenario planning or produce inputs into a cost benefit analysis to assess the benefits of different enhancements.

A further RSSB research study [Reference 12] examined the use of risk models world-wide. The research compared other British, and overseas, models to establish whether they can augment or improve the ALCRM. The research showed that the ALCRM is a sophisticated model and is fit for purpose for the environment within which it is used. It also produced seven ideas for developing the ALCRM further and these are being considered by RSSB and Network Rail as appropriate.

Development of web-based assessment tools

As part of a parallel RSSB research project [Reference 13], a website www.lxrmtk.com has been created to allow level crossing risk practitioners working for Network Rail to conduct 'what if' analyses of various human behaviours to understand what remedial actions could be required at specific locations. This research, which is nearly complete, is designed as part of a wider tool-kit available to help implement cost-effective changes which do not require major crossing upgrades, infrastructure works, or crossing closures although it is designed to be used in conjunction with ALCRM and wider risk management processes. Fundamental to the research is the recognition that some 95% of the risk at level crossings in Great Britain is due to human error and violation rather than 'railway' causes.

Setting up of road / rail partnerships

The traditional approach to level crossing risk sees it as a 'railway problem' with little involvement from road authorities except where problems have occurred. Over the last four years representatives of the Driving Standards Agency and the CSS (formerly known as the County Surveyors' Society) have become active members of NLCSG and great progress has been made with amendments to the Highway Code and driving test procedures. The latest initiative is to set up local road / rail partnerships where all those involved in managing risk at level crossings in, typically, a county area, can work together to identify and prioritise activities, based on the three Es of engineering, enforcement and education. This has become a good example of the 'fourth E' – engagement – and will be rolled out over the country after a trial in Lincolnshire, West Sussex, North Yorkshire and Dorset. Twenty partnerships are now in place and others being set up include one to cover the Highlands of Scotland.

Creation of an economic cost model

A further research project [Reference 14] was designed to produce a model that aggregated the various road and rail whole-life costs of a public road crossing, giving an initial but robust indication as to whether there could be a sound business case for closure and provision of an alternative means of crossing the railway. The research determined all the relevant costs of level crossings, assessed the costs of alternatives, constructed the model, conducted proving trials, studied the sensitivities of the model's output to values of key input parameters, and produced guidance notes for users of the model. The model is now being populated on a trial basis, via some of the new road / rail partnerships to see if there is a case for incremental studies or a large national effort to identify the crossings with the greatest potential for abolition.

New planning processes in Network Rail

In support of its Level Crossing Strategy, Network Rail has already centralised the design process for level crossing replacements and enhancements and is drawing up a national programme, based on the expected dates when crossing equipment at each location will become due for renewal. The next stage is the setting up of a Level Crossing National Specialist Team which, among other activities, will create a single plan for all these crossings in plenty of time to identify which ones could be closed, going through the planning process in sufficient time to allow this to happen. The new organisation went 'live' in October 2007. The options for each crossing will be:

- Closure
- Enhancement
- Replacement on a like-for-like basis

Network Rail's advertising initiative 'Don't Run the Risk'

This campaign, now in its second year, has used a combination of TV, radio, press, leaflet and computer media to get over to target audiences the danger of running red lights or disobeying traffic signs at level crossings. Details can be found at www.networkrail.co.uk/aspx/2292.aspx.

The latest batch of information is a 'viral' campaign aimed at young road users and this can be found at www.myspace.com/watchrush

Use of obstacle detection at automatic full barrier crossings

A further piece of RSSB research mentioned above, [Reference 5] examined the options of using obstacle detection systems based on technologies such as radar to improve safety at level crossings. Obstacle detectors at level crossings are already used (in Germany and Italy and are on trial elsewhere) to detect obstructions capable of causing significant damage to a train, or to assist the signaller in charge of a closed-circuit television (CCTV)-controlled crossing to know that the crossing is clear before the barriers are closed. In order to avoid unacceptably high levels of safe-side (false) trips, such a system has to be sensitive enough to distinguish a significant threat to a train such as a car, from an insignificant threat like a shopping basket or a fox. The opportunities and challenges posed by these detectors need to be fully understood if they are to be used successfully in a cost-effective way in Britain. The project investigated the technicalities, logistics, cost and safety benefits of the most promising potential solutions for AHBs and for CCTV crossings, and made several recommendations, which are being assessed for implementation by Network Rail.

SELCAT

Network Rail and RSSB are consortium members in the Safer Level Crossing Appraisal and Technology project, which is an EU-funded sixth framework co-ordination action project due to report in 2008 [Reference 15]. The research has examined existing research, is currently evaluating existing and new technologies, and is now beginning to review risk modelling techniques in use or available to help manage risk at level crossings in Europe and for partner nations (which comprise China, India, Japan, Morocco and Russia).

5 Conclusions

The number of public road crossings in Great Britain has declined significantly over the past fifty years but they still provide important communication links for road users. At the same time they are a cause of road congestion and contribute to the overall safety risk on the railway. Other railway risks are, relatively and absolutely, declining and thus the level crossing element, which continues to be stable, is a cause for concern, especially as accidents at road intersections can lead to collisions with trains and harm to train occupants. A number of crossing types and configurations are in use and a new type – the automatic full barrier crossing with obstacle detection – is being developed, as are a number of other systems and initiatives sponsored by Network Rail underpinned by research managed by RSSB and supported by the National Level Crossing Safety Group. Plans for the future include the wider holistic use of the various tools and techniques which have been created, a stronger focused working relationship between the road and rail sectors, and the implementation of processes which will facilitate the closure of crossings, rather than their retention, whenever this is achievable.

References

[1] Source – Network Rail. Note that the figures quoted exclude level crossings on London Underground, metro systems, private and heritage railways and Northern Ireland Railways.

[2] RSSB research report T528 'Attitudes to, processes and funding for, crossing closures in other countries' www.rssb.co.uk/Proj_popup.asp?TNumber=528&Parent=80&Ord=

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

[4] European Rail Agency Draft paper 'Definitions of Common Safety Indicators on Level Crossings, January 2007.

[5] RSSB research report T522 'Research into obstacle detection at level crossings' www.rssb.co.uk/Proj_popup.asp?TNumber=522&Parent=80&Ord=

[6] Report into Automatically and Remotely Controlled Level Crossings, HMSO, March 1957 ('McMullen Report').

[7] Report of the Public Inquiry into the Accident at Hixon Level Crossing, HMSO July 1968 ('Hixon Report').

[8] Report into Level Crossing Protection (DoT / BR), HMSO May 1978 ('Townsend-Rose Report').

[9] Report on the Collision and subsequent Derailment … at Lockington Level Crossing, HMSO, August 1987 ('Lockington Report').

[10] Automatic Level Crossings A Review of Safety, HMSO, July 1987 ('Stott Report').

[11] RSSB research report T028 'Development of a universal level crossing risk tool'www.rssb.co.uk/Proj_popup.asp?TNumber=028&Parent=80&Ord=

[12] RSSB research report T524 'Use by other railways of risk models and risk assessments for level crossings' www.rssb.co.uk/Proj_popup.asp?TNumber=524&Parent=80&Ord

[13] RSSB research report T335 'Improving road user and pedestrian behaviour at level crossings'www.rssb.co.uk/Proj_popup.asp?TNumber=335&Parent=80&Ord=

[14] RSSB research report T336 'Modelling the economics of level crossing closures and conversions' www.rssb.co.uk/Proj_popup.asp?TNumber=336&Parent=80&Ord=

[15] EU-funded project SELCAT: www.levelcrossing.net/