RAIB
Rail Accident Investigation Branch

Rail Accident Report

Investigation into station pedestrian crossings (including pedestrian gates at highway level crossings); with reference to the fatal accident at Elsenham station on 3 December 2005

Department for Transport

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This investigation was carried out in accordance with:

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

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Introduction

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

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

3 Access was freely given by Network Rail and Rail Safety and Standards Board (RSSB) to their data and records for the purposes of this investigation.

4 Appendices at the rear of this report contain Glossaries explaining the following:

- acronyms and abbreviations are explained in the glossary at Appendix A; and
- certain technical terms (shown in *italics* the first time they appear in the report) are explained in the glossary at Appendix B.

5 Reference documentation is listed at Appendix H and indicated in the main body of the report by reference numbers contained in square brackets.

Summary of the report

Purpose of the investigation

6 This investigation was initiated following a fatal accident at Elsenham station on 3 December 2005. The remit can be summarised as follows:

- to identify the number and distribution of *station pedestrian crossing*s in the UK (including pedestrian gates associated with highway crossings);
- to investigate the safety issues associated with crossings of this type;
- to make general recommendations for the improvement of safety at station pedestrian crossings;
- to investigate the circumstances of the accident at Elsenham; and
- to make specific recommendations for the improvement of safety at Elsenham.

Definitions and scope

7 For the purpose of this investigation a station pedestrian crossing is defined as follows:

'a pedestrian level crossing which forms part of a public access route to/from a platform at a railway station that is designed to be used without escort or supervision by railway staff'.

8 This investigation considers all crossings on the national network that fall within the above definition. Station pedestrian crossings on heritage lines and tramways are excluded from the scope of this report because they differ significantly in the way they are operated and the risks arising. On heritage lines speeds are generally limited to 25 mph (40 km/h). Trams are generally driven on *line of sight* and often operate in a street environment.

9 The risk associated with pedestrian crossings that can only be used by the public when escorted or supervised by railway staff is outside the scope of this investigation.

The numbers and distribution of station pedestrian crossings

10 Network Rail has provided data on the numbers and distribution of station pedestrian crossings. This has been used by the RAIB to derive some estimates of the number and types of station pedestrian crossings. These estimates are presented below:

Station pedestrian crossings with gates that are locked on the approach of a train	13
Station pedestrian crossings with unlocked gates and miniature stop lights	2
Station pedestrian crossings with unlocked gates (no miniature stop lights)	15
Ungated station pedestrian crossings with miniature stop lights	17
Ungated station pedestrian crossings with no miniature stop lights	50
Total station pedestrian crossings in the UK	**97**

11 In addition there are estimated to be another 23 pedestrian crossings associated with highway level crossings that are used to access a station platform although not classified by Network Rail as a station pedestrian crossing.

Risk issues

12 The RAIB has carried out an analysis of the risks at station pedestrian crossings. The conclusions arising from this analysis are summarised as follows:

- The overall levels of *individual risk* that have been identified are sufficiently high to justify the production of a detailed risk assessment for each station pedestrian crossing in order to identify any crossings at which the level of risk to the most exposed user is intolerable. In those cases where an individual risk is found to be intolerable immediate actions should be taken to reduce the risk to a level that is tolerable.
- The overall risk to society (collective risk) posed by station pedestrian crossings is unlikely to justify the expenditure needed to support the upgrading of the safety measures across the entire network. However, the levels of risk identified during this investigation are sufficient to justify the development of a long term programme for the upgrading of station pedestrian crossings at those locations where it is reasonably practicable to do so. Such a programme should start with those at which the risks are judged to be the highest.

13 Prior to 2003 the railway industry had managed the risks at *footpath crossings* by means of regular inspections to check the condition of equipment and to confirm compliance with standards and legislation. During this period no distinction was made between station pedestrian crossings and other types of footpath crossings.

14 In recent years Network Rail and RSSB have been working closely together to develop new level crossing risk management tools. In early 2005 a new risk scoring procedure was developed as an aid to risk assessments at station pedestrian crossings. In parallel, Network Rail has been working to develop a comprehensive risk assessment tool, the All Level Crossing Risk Model (ALCRM). This is planned to encompass all types of footpath crossings, including those at stations.

The responsibilities of crossing users and providers

15 It is estimated that 96% of risk at level crossings arises due to the actions of users. However, there is no clear data on the proportion of accidents that arise due to the deliberate misuse of crossings as opposed to those arising due to errors and lapses.

16 In the context of station pedestrian crossings, users have an obligation to take care and to follow any instructions. Providers of crossings have an obligation to take reasonably practicable steps to reduce the risk that users will be harmed as a consequence of an error or lapse. Such steps should take into account the likely population of users. Additional measures (e.g. audible alarms) may sometimes be required where the population includes vulnerable persons such as unaccompanied minors, the elderly and the disabled.

Design and management issues

Her Majesty's Railway Inspectorate (HMRI) guidance

17 High level guidance on the design and operation of level crossings is provided in an HMRI document entitled 'Railway Safety Principles and Guidance' (RSPG). This guidance does not apply retrospectively to level crossings that were installed, or last modified, prior to the publication of RSPG in 1996. This is because its scope is limited to the design and operating concept for new or modified crossings.

18 However, it is apparent that certain guidance is poorly worded and in need of revision. Recent technological advances and enhanced understanding of human factors have still to be incorporated. RSPG gives little clear guidance on managing the risks that are specific to station pedestrian crossings.

19 The RSPG document has not been updated since it was first issued in 1996.

Fixed signage

20 In general, the meaning of the information on fixed signage at station pedestrian crossings is clear. In some cases there is no advice given to users concerning the risk from a second train.

21 At station pedestrian crossings equipped with *miniature stop lights* where there is no telephone, the wording of the sign that is currently mandated suggests that the crossings can continue to be used safely when there is no light showing. This is not often the case since miniature stop lights are generally installed at those locations where the *sighting time* is shorter than the time taken to cross in safety.

Fencing

22 At some station pedestrian crossings, the angle of the approach to the track can discourage users from looking before stepping onto the track and/or can lessen the visual impact of the stop lights. Where the physical layout of the crossing permits, it this risk can be effectively mitigated by the installation of fencing to direct passengers to approach the track at right angles with a head-on view of the miniature stop lights and/or signage.

Locking of gates

23 Implementation of locking at existing gates is likely to introduce some new risks. These include the following:

- inability of the signaller or crossing keeper to close the gate in good time;
- trapping of persons inside gates (although this can be mitigated by the provision of a safety zone between the track and the gate);
- accidents resulting from the unreliability of the locking/unlocking mechanism; and
- increasing the levels of abuse (e.g. persons climbing the closed gates).

24 At manned locations, the above risks can be controlled if the locking of the station pedestrian gate is linked to the signalling (i.e. the signals cannot be cleared until the pedestrian gates are proved to be locked shut). However, this solution will introduce additional delays to users since the gates will need to be closed sufficiently early to avoid approaching trains from encountering a restrictive signal aspect. These delays can give rise to trespass including climbing of the gate. For this reason this option may sometimes necessitate the construction of a footbridge or subway.

Miniature stop lights

25 The meaning of miniature stop lights (MSL) is well understood by the majority of users. However, given the potential for distraction at station pedestrian crossings there is a particular need to ensure that the attention of users is drawn to the lights. At most stations this need is exacerbated by the absence of gates to mark the approach to the track. These factors necessitate that the lights are conspicuous and well positioned.

26 The reliable operation of the lights is vital at those locations where elapsed time between the user's first sight of an approaching train and its arrival at the crossing is shorter than the time taken to cross.

27 Network Rail's decision to upgrade all miniature stop lights to a new design based on the use of light emitting diode (LED) technology will ensure an improvement in both the conspicuity and reliability of the lights.

Another train coming warning (visual)

28 When two trains are approaching a station pedestrian crossing at the same time; there is a chance that passengers will cross before or immediately after the first train has passed without realising that a second train is coming. It is possible that this risk could be mitigated by providing a specific visual indication when a second train is approaching. Further research is required to assess the effectiveness of a visual second train coming warning.

Audible alarms

29 Research by the railway industry has established that there is a good awareness of the meaning of audible alarms. However, the same research indicates that few users are likely to understand the meaning of a second tone if this is used to warn of the approach of a second train.

30 There is evidence that voice messages are a more effective way of warning users of a specific hazard, such as the approach of a second train.

Access for disabled and mobility impaired persons

31 The railway industry perceives that the cost of eliminating station pedestrian crossings has risen due to the requirement to preserve existing step free access routes.

32 The provision of ramps and lifts to enable access via a new footbridge or subway is unlikely to prove cost-effective at most locations and may not fully address the needs of disabled and mobility impaired users.

33 Where footbridges or subways are proposed as a replacement for a station pedestrian crossing that is adjacent to a *vehicular crossing*, the retention of the pedestrian crossing for use by passengers, including mobility impaired persons, is often a viable option but can only be achieved in limited circumstances (where there are staff to operate the crossing).

Minimising use of station pedestrian crossings

34 At a number of locations, additional use of the station pedestrian crossing is generated by the need to cross the line to use passenger facilities (such as the booking office).

Education of users

35 The education of station pedestrian crossing users should have particular focus on the communities located around the highest risk station pedestrian crossings.

36 Policing initiatives (supported by Closed Circuit Television (CCTV) installations where appropriate) will help to deter misuse. For such initiatives to be effective there is a need for close liaison between the British Transport Police (BTP), Network Rail and the local train operator(s).

The accident at Elsenham on 3 December 2005

The key facts of the accident

37 At 10:40 hrs on 3 December 2005, two young girls were struck by a fast moving train on the station pedestrian crossing at Elsenham station in Essex. Both girls were killed.

38 Immediately prior to the accident the two girls had purchased tickets from the booking office on the east side of the line (the *Up* platform) and were in the process of walking to the opposite platform to catch the 10:41 hrs service to Cambridge.

39 The station pedestrian crossing was fitted with miniature stop lights and an audible alarm to warn passengers of the approach of trains.

40 A map of the locality is to be found at Figure 1.

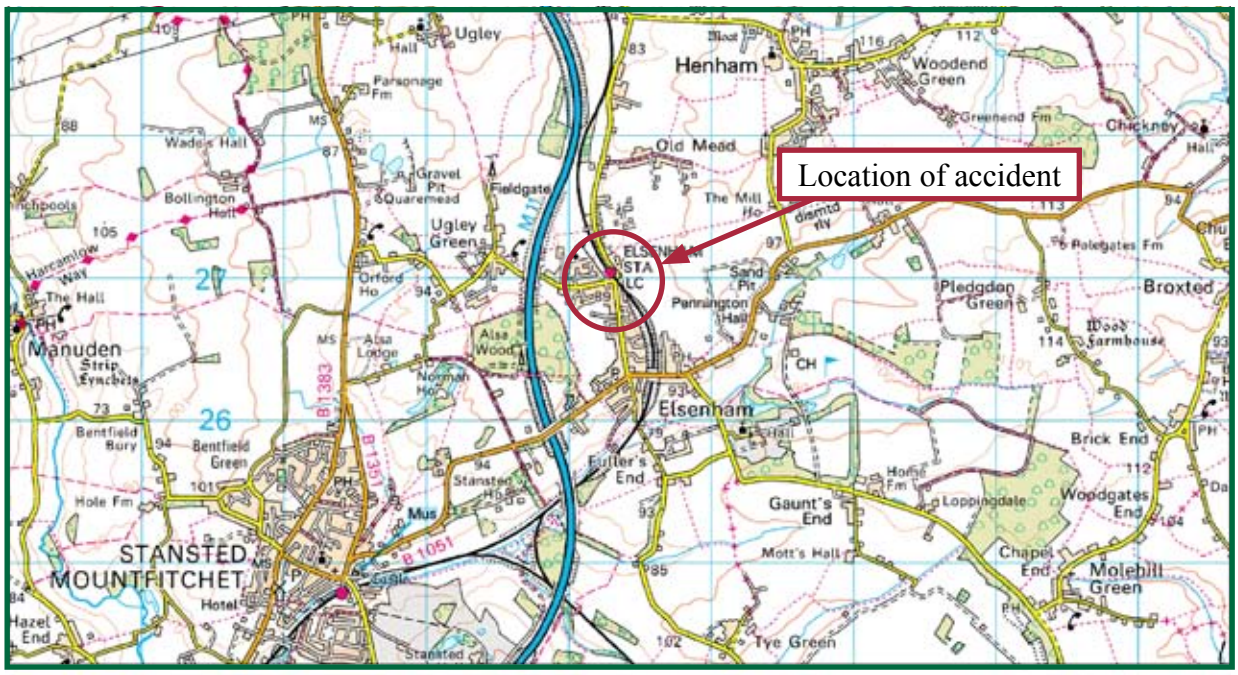

Figure 1: Map showing location of Elsenham

Findings

41 Elsenham station pedestrian crossing has been the site of two fatal accidents. The first, in 1989, resulted in one death. The second, on 3 December 2005, resulted in the death of two teenage girls.

42 There are a number of factors contributing to risk at the Elsenham station pedestrian crossing. These include the following:

- The line has traffic levels of up to 9 trains per hour in the peak.
- The trains that pass through are a mixture of stopping and fast trains.
- The booking office and ticket machines are located on platform 1. Many passengers travelling from platform 2 must therefore cross the line twice to buy their ticket.
- Elsenham has a significant number of users who are of school age.
- The station pedestrian crossing at Elsenham is used by 60 - 90 persons per peak hour. This is well above the average for station pedestrian crossings.

- The angle of the crossing is skewed (this means that intending users of the crossing must turn or look over their right shoulder in order to observe the approach of a train on the track nearest to them).
- The elapsed time between a train being sighted and it reaching the crossing is very short (about three seconds).

43 The last of the above risk factors is mitigated by the provision of miniature stop lights.

44 As part of this investigation the RAIB has assessed a range of significant risk factors at station pedestrian crossings throughout the UK. This assessment has indicated that the risks at Elsenham are likely to be amongst the highest at any station pedestrian crossing on the UK mainline network, and therefore deserving of particular attention.

45 Network Rail's own assessment of risk[1] using its semi-quantative scoring system shows Elsenham to have the third highest risk at any station pedestrian crossing on the UK network (this excludes crossings that can only be used by passengers when escorted by railway staff). Network Rail's scoring for Elsenham did not include any allowance for special local factors at Elsenham such as the number of school aged users.

Causal factors relevant to the accident at Elsenham on 3 December 2005

46 The immediate cause of the accident was the two teenage girls stepping into the path of an approaching train, despite the continued display of a red light and the sounding of an audible alarm.

47 It is likely that the accident occurred due to the girls' focus of attention on a train to Cambridge (the *Down* train) and the consequent failure to perceive the risk from trains in the opposite direction. This focus of attention on the Down train to the exclusion of Up trains was likely to have been created by a strong motivation to catch their intended train combined with an erroneous belief that the audible alarm related only to the train that was passing ahead of them.

48 The investigation has considered the degree to which the girls' state of mind may have contributed to the accident. It is concluded that it is not possible to draw a clear link between their likely state of mind and their subsequent error.

49 The following factors contributed to the occurrence of the accident:

- the design of the crossing at Elsenham did not physically prevent users from opening the gate and walking onto the line when a train was approaching; and
- the warning signs and systems at the crossing did not deter the girls from stepping into the path of the second train.

50 In addition to the above, it is possible that the presence of a ticket machine on the Down platform would have avoided the need for the girls to cross the line.

Recommendations

51 Following this investigation and in light of the findings the RAIB has made eight general recommendations with the purpose of improving safety at station pedestrian crossings.

52 In addition, the RAIB has made two recommendations that are specific to the station pedestrian crossing at Elsenham.

53 All recommendations are to be found at paragraph 407.

[1] Incorporating the revised assessment at Elsenham carried out on the 05 December 2005

The design and management of pedestrian level crossings at stations

54 The investigation reviews safety issues associated with pedestrian level crossings at stations. The following sections define the various types of crossings at stations in the UK, identifies their numbers and distribution, before considering the design, operations, risk and specific safety issues.

Types of pedestrian level crossings at stations

55 Various types of pedestrian level crossing are to be found at stations in the UK:

- crossings not available for use by the public unless escorted by railway staff (‘*staff crossings’*, often known as *‘barrow crossings’*);
- crossings available for use by the public without staff escort (‘station pedestrian crossings’);
  - station pedestrian crossings equipped with gates that are locked by the signaller or crossing keeper on the approach of trains (for the purpose of this report designated SPC-GL);
  - station pedestrian crossings equipped with unlocked gates on both sides of the track and miniature stop lights (for the purpose of this report designated SPC-GMSL);
  - station pedestrian crossings equipped with unlocked gates on both sides of the track (for the purpose of this report designated SPC-G);
  - ungated station pedestrian crossings equipped with miniature stop lights (for the purpose of this report designated SPC-MSL);
  - station pedestrian crossings with no gates or miniature stop lights (for the purpose of this report designated SPC-Open);
  - vehicular level crossings with pedestrian gates, adjacent to stations, that form a public right of way as well as the means of access to a platform (for the purpose of this report designated LC (Stn)).

56 Each is described in the following paragraphs.

Crossings not available for use by the public unless escorted by railway staff (‘staff crossings’)

57 Many stations are provided with a simple foot crossing for use by railway staff or by members of the public when escorted by railway staff. Such crossings are often provided with no special warning equipment other than fixed signs on each side. In other cases they are provided with a ‘white’ indicator light which is illuminated when no trains are approaching (see Figure 2). Some staff crossings are equipped with gates that are locked to prevent unauthorised use.

58 It is considered that the usage and risks associated with staff crossings at stations are significantly dissimilar to those at other types of pedestrian level crossing. For this reason this type of crossing is excluded from the scope of this investigation.

Figure 2: Typical example of a barrow crossing (Slough)

Crossings available for use by the public without staff escort ('station pedestrian crossings')

59 For the purpose of this report a 'station pedestrian crossing' is defined as follows:

'a pedestrian level crossing which forms part of a public access route to/from a platform at a railway station that is designed to be used without escort or supervision by railway staff'

60 Crossings of this type can be further categorised by reference to the layout and type of facilities provided at each. This sub-categorisation is described below.

Station pedestrian crossings equipped with gates that are locked by the signaller or crossing keeper on the approach of trains (for the purpose of this report designated SPC-GL)

61 These crossings are provided with a locking mechanism that is operated by the signaller or crossing keeper on the approach of trains. In all such cases the signaller is required to observe that pedestrians are clear of the crossing before the gate is locked using a remote button or lever located in the signal box (see Figure 3 for typical example).

62 Where provided, such locking devices are not interlocked with the signals. This means that the signaller is not required to lock the gate before he/she is able to clear the signals for a train to pass.

63 In the majority of such cases the locking is performed by means of mechanical linkage (e.g. cables or rods). In some cases this mechanical arrangement has been replaced with an electrically operated mechanism.

64 Of the above, the majority are also deemed a public right of way (i.e. the SPC-GL forms a continuation of a public footpath, pavement or is used by pedestrians walking along the public highway). In many cases the SPC-GL is adjacent to a vehicular level crossing.

Figure 3: Example of SPC-GL (Foxton)

Figure 4: Example of SPC-GMSL (Elsenham)

Station pedestrian crossings equipped with unlocked gates on both sides of the track and miniature stop lights (for the purpose of this report designated SPC-GMSL)

65 These crossings are provided with simple pedestrian gates (known as wicket gates) on each side of the track and miniature stop lights. See Figure 4 for a typical example.

66 The pedestrian gates are designed to swing closed after use, are unlocked, and have no latching mechanism.

67 The miniature stop lights are of the same design as used at numerous footpath crossings in the UK. They comprise red and green lights, mounted on a white sign that are linked to the operation of the train detection system such that a red light will be illuminated when one or more trains are approaching. At all other times the green light will be illuminated to indicate to users that the crossing can be used safely.

68 The safety of persons using this type of crossing relies on the user observing the lights and then acting in accordance with the instructions that are displayed.

69 Both the crossings of this type also form part of a public right of way across the railway line. The crossing at Elsenham is of this type and in addition is adjacent to a vehicular level crossing.

Station pedestrian crossings equipped with unlocked gates on both sides of the track (for the purpose of this report designated SPC-G)

70 These crossings are provided with simple pedestrian gates on each side of the track. These gates are designed to swing closed after use, are unlocked, and have no latching mechanism (see Figure 5 for an example).

71 Many of these pedestrian gates are located immediately adjacent to the barriers or gates of a vehicular level crossing. Side pedestrian gates of this type are often referred to as 'wicket gates' and are common in parts of the UK. Their traditional purpose was to enable members of the public to cross the line when the main vehicular gates were closed to the highway. This was seen as necessary since the vehicular gates were often closed to the highway for the majority of the time (as was the norm before the advent of the motor car). In today's environment, the vehicular gates or barriers are often open to the highway in order to facilitate the free flow of road traffic. Nevertheless, the pedestrian gates provide an alternative route for pedestrians, clear of road traffic. Furthermore, these gates can be safely used for some time after the vehicular gates have been closed for the passage of a train or trains.

72 The safety of persons using this type of crossing relies on the user seeing the approach of the trains and then waiting for the trains to pass before passing through the gate. At some crossings of this type, the elapsed time between the approaching train coming into view and its arrival at the crossing (the 'sighting time') is shorter than the time taken to cross in safety. At such locations *whistle boards* are often provided. These instruct drivers to sound their horn to provide an audible warning of the train's approach.

73 Of the above, a proportion are also deemed public rights of way (i.e. the SPC-G forms a continuation of a public footpath, pavement or is used by pedestrians walking along the public highway).

Figure 5: Example of SPC-G (Gomsall)

Ungated station pedestrian crossings equipped with miniature stop lights (for the purpose of this report designated SPC-MSL)

74 These crossings are provided with miniature stop lights to indicate to members of the public when it is safe to cross. See Figure 6 for a typical example.

Figure 6: Example of SPC-MSL (Woodlesford)

75 As with SPC-GMSL crossings the miniature stop lights are of the same design as deployed at numerous footpath crossings in the UK. Again they comprise red and green lights, mounted on a white sign that are linked to the operation of the train detection system such that a red light will be illuminated when one or more trains are approaching. At all other times the green light will be illuminated to indicate to users that the crossing can be used safely.

76 The safety of persons using this type of crossing relies on the user observing the lights and then acting in accordance with the instructions that are displayed.

77 A SPC-MSL crossing will not normally form part of a public right of way across the railway line.

Station pedestrian crossings with no gates or miniature stop lights (for the purpose of this report designated SPC-Open)

78 These crossings are provided with no special facilities other than a level walking surface and warning signs on both sides of the tracks. See Figure 7 for a typical example.

Figure 7: Example of SPC-Open (Ham Street)

79 The safety of persons using this type of crossing relies on the user seeing the approach of the trains and then waiting for the trains to pass before stepping onto the crossing. At some crossings of this type the elapsed time between the approaching train coming into view and its arrival at the crossing (the 'sighting time') is shorter than the time taken to cross in safety. At such locations whistle boards are often provided. These instruct drivers to sound their horn to provide an audible warning of the train's approach.

80 Of the above, a small number are also deemed public rights of way (i.e. the SPC-Open forms a continuation of a public footpath, pavement or is used by pedestrians walking along the public highway). In such a case there is usually a stile or gate located at the boundary of the railway property.

Vehicular level crossings with pedestrian gates, in proximity to stations, that form the means of access to a platform (for the purpose of this report designated LC (Stn))

81 It is estimated[2] that there are 23 pedestrian gates at vehicular crossings that are the means of access to a station platform yet are not classified by Network Rail as station pedestrian crossings. An example is at Fiskerton (see Figure 8).

82 About 40% of station pedestrian crossings of this type have gates that are fitted with locking mechanisms similar to those described in paragraphs 61 to 64.

Figure 8: Level crossing at Fiskerton

Distribution of station pedestrian crossings

National rail network

83 Network Rail was requested to provide a listing of all *station pedestrian level crossings* on their network for the purpose of this investigation. This data revealed a lack of consistency in the definitions that were adopted, the inclusion of some staff crossings and a number of inaccuracies. However, it proved possible to use the data to identify the distribution of various types of station pedestrian crossing. This distribution is shown in Table 1 and Figure 9.

84 Table 1 indicates that the distribution of station pedestrian crossings is far from uniform. The majority of such crossings (58%) are located in the eastern part of the country (Network Rail's London North Eastern and Anglia routes). The remainder are mainly located in the West Country, Wales and western parts of the Midlands. By contrast only 3% of the total number are located to the south of the River Thames.

[2] The information provided by Network Rail did not cover this type of crossing. For this reason it was necessary to estimate the total number based on an analysis of data obtained for highway crossings with pedestrian gates

Type of crossing (see also Figure 9)	**Distribution (by Network Rail 'route')**								
	Scotland	LNE	Anglia	Kent	Sussex	Wessex	Western	LNW	**Total for type**
SPC-GL		5	6					2	**13**
SPC-GMSL			1			1			**2**
SPC-G		5	1			1		8	**15**
SPC-MSL		8	5				1	3	**17**
SPC-Open		18	7	1			8	16	**50**
All of the above	**0**	**36**	**20**	**1**	**0**	**2**	**9**	**29**	**97**
LC (Stn) with lockable gates		*6*	*3*				*1*		***10***
LC (Stn) without lockable gates		*12*					*1*		***13***
Staff crossings	It has not been possible to establish the exact distribution of staff crossings from the data provided by Network Rail. However, the total is believed to be in excess of 100 [Ref. Appendix H, 1]								

Abbreviations

SPC-GL	Station pedestrian crossings equipped with gates that are locked by the signaller or crossing keeper on the approach of the trains
SPC-GMSL	Station pedestrian crossings equipped with unlocked gates and miniature stop lights on both sides of the track
SPC-G	Station pedestrian crossings equipped with unlocked gates on both sides of the track
SPC-MSL	Ungated station pedestrian crossings equipped with miniature stop lights
SPC-Open	Station pedestrian crossings with no gates or miniature stop lights
LC (Stn)	Vehicular level crossings with pedestrian gates, in proximity to stations, that form the means of access to a platform

Table 1: Distribution of station pedestrian crossings on Network Rail routes

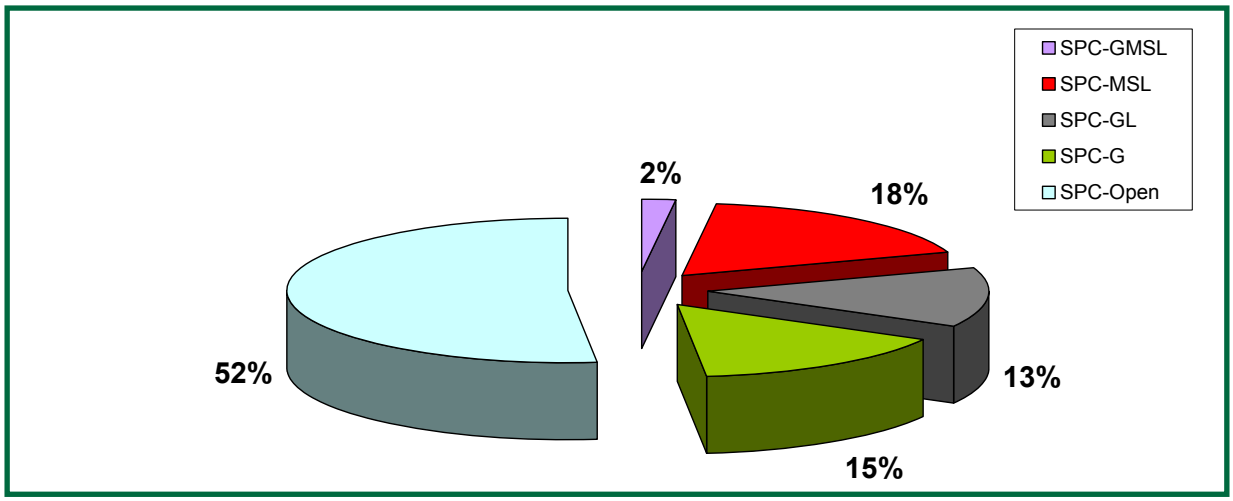

Figure 9: Pie chart types of station pedestrian crossing as a proportion of the total (see Table 1)

85 The map at Figure 10 shows even more vividly the uneven spread of station pedestrian crossings and distinct clusters in the following areas:

- East Anglia and Lincolnshire;
- Yorkshire;
- Cumbrian Coast;
- North part of the Welsh Marches.

86 Other parts of the country have a very low population of crossings of this type. These include:

- London and the South-east;
- Midlands;
- Sheffield and Manchester;
- Scotland.

87 The main factors giving rise to this uneven spread are as follows:

Historical factors

- Different standards for crossing design were adopted in the construction of the different railway routes.
- Since nationalisation the various parts of the network adopted different policies with regard to station pedestrian crossings. In particular, the Kent, Sussex and Wessex routes (the area covered by the former Southern region of British Rail) adopted a long term policy to abolish station pedestrian crossings in favour of footbridges. This policy reflected a general concern to eliminate potential routes of access in areas of *third rail electrification*. The only station pedestrian crossings that have been identified in the area of the former Southern Region are all located on non-electrified routes.

Geographical factors

- Level crossings of all types are more prevalent in areas of flat terrain.
- Level crossings were often built in areas of low population since the anticipated levels of road traffic were insufficient to justify the construction of bridges. In some such areas the population has since grown significantly since the level crossing was constructed (e.g. at Elsenham).

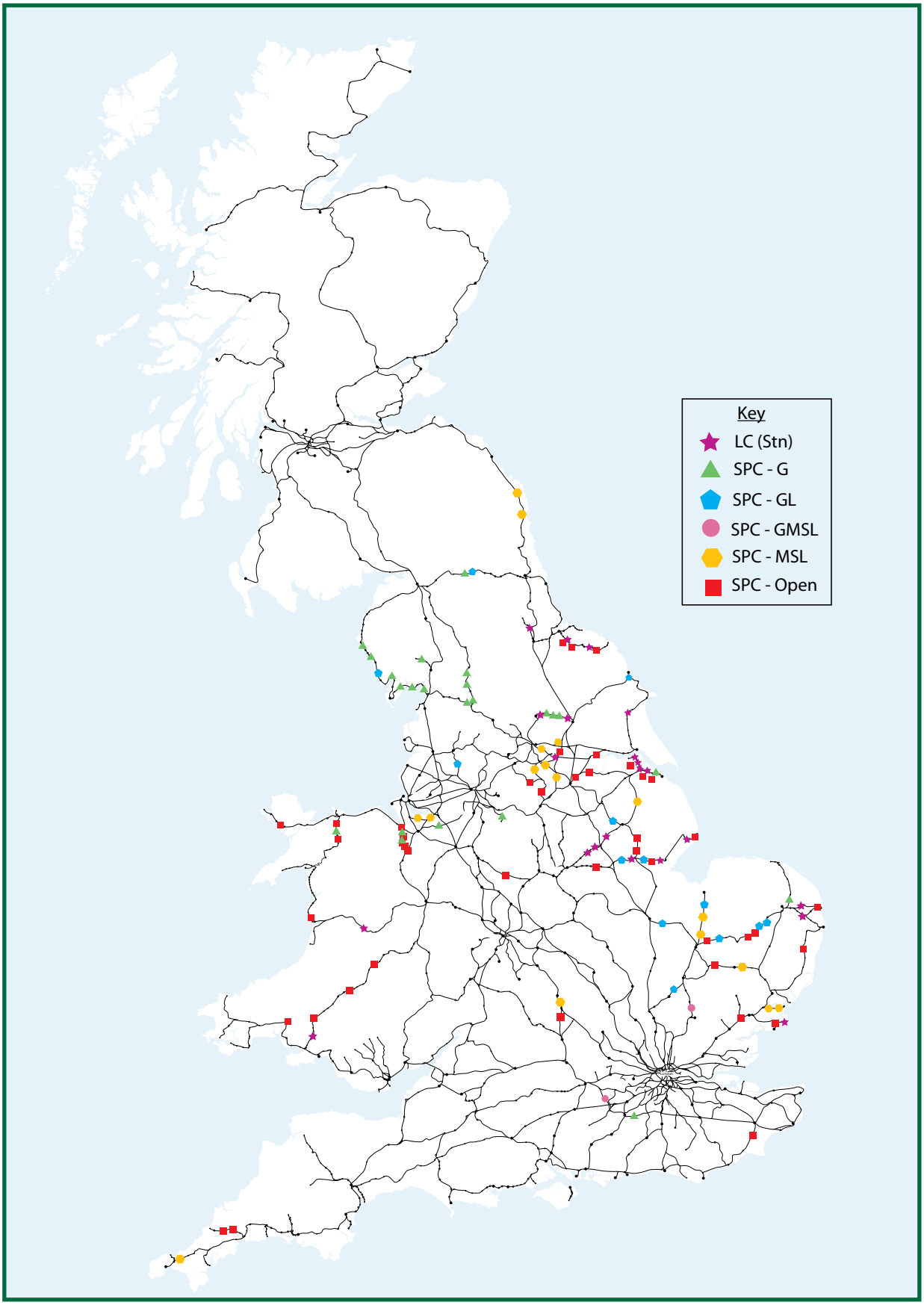

Figure 10: Distribution of station pedestrian crossings in England, Wales and Scotland

Legislation, standards and guidance relevant to station pedestrian crossings

Relevant legislation

88 Many pedestrian crossings at stations that form an intrinsic part of public vehicular level crossings (e.g. pedestrian gates adjacent to level crossing gates or barriers) are subject to Statutory Orders that govern the design and operation of public vehicular level crossings (Ref.: Level Crossings Act 1983 and Level Crossings Regulations 1997).

89 The majority of station pedestrian crossings are described as 'footpath crossings'. As such they are not subject to Statutory Orders.

90 There is no legislation that is specific to the design and operation of station pedestrian crossings. However, various requirements can be derived by reference to a range of more general legislation. This is described in the following paragraphs.

91 The general provisions of the Health and Safety at Work etc Act 1974 apply to the managers of station pedestrian crossings (i.e. Network Rail). In particular, Section 3 of this Act imposes an obligation to ensure the safety of persons affected by an undertaking so far as is reasonably practicable. In the context of station pedestrian crossings this implies that the manager has an obligation to assess risks to all users (i.e. pedestrians and persons in trains) and to put suitable safety measures or arrangements in place to manage these risks down to a level that is As Low As Reasonably Practicable (ALARP).

92 The Railways (Safety Case) Regulations 2000 (RSCR) imposed on railway operators and infrastructure managers a legal obligation to operate in accordance with a railway safety case that had been reviewed and accepted by HMRI. This safety case document was required to record the safety management systems that were in place. These were required to include a process for the assessment of risks and a record of the measures to control these risks to ALARP.

93 Until April 2006, the manager of a station pedestrian crossing proposing to make a material change to the design of the crossing, or the mode of operation, was required to obtain approval from HMRI in accordance with the Railways and Other Transport Systems (Approval of Works Plant and Equipment) Regulations 1994. To do this the manager was required to demonstrate to HMRI that the proposed changes were safe and compliant with relevant legislation and industry standards (relevant standards are outlined at paragraphs 108 to 114).

94 When considering an application for approval of an altered station pedestrian crossing, HMRI checked that the design and mode of operation was compliant with the safety principles laid down in Part A of its RSPG document. HMRI also judged the acceptability of the design by reference to the guidance contained in Part B of the RSPG. More details of the RSPG are outlined at paragraphs 100 to 107.

95 Significant alterations to station pedestrian crossings that form part of a vehicular crossing are subject to a Statutory Order made under appropriate level crossing legislation (Ref. Level Crossings Act 1983 and Level Crossings Regulations 1997).

96 The manager of a station level crossing is responsible for ensuring that the condition of the crossing is, and remains, consistent with relevant requirement of the following legislation:

The Railway Clauses Consolidation Act of 1845

This defines the requirement for gates or stiles at the railway boundary.

Private Crossings (Signs and Barriers) Regulations 1994

These regulations describe some of the signage to be provided at footpath crossings. They also allow for the provision of miniature stop lights.

Traffic Signs Regulations and General Directions 2002

Parts of this legislation may also apply if a station pedestrian crossing forms part of a public vehicular crossing.

97 An existing station pedestrian crossing is not subject to approval by HMRI. However, there are a number of circumstances in which a HMRI inspector would have powers to inspect the condition and operation of such a crossing. These are as follows:

- as part of a targeted inspection;
- upon observing an issue of health and safety concern;
- as part of a check of compliance with a railway safety case;
- following an accident or incident if the inspector has reason to suspect a breach of health and safety legislation;
- prior to April 2006, as part of an inspection carried out in connection with the approval of a material change to the crossing facilities or mode of operation; and
- as part of an assessment associated with a level crossing order.

Changes to legislation from 10 April 2006

98 From 10 April 2006 a new set of regulations, the Railways and Other Guided Transport Systems (Safety) Regulations 2006 (ROGS), came in to force. These regulations, subject to transitional provisions, replace:

- the Railway Safety Case Regulations; and
- the Railways and Other Transport Systems (Approval of Works Plant and Equipment) Regulations 1994.

99 The new regulations impose some amended requirements on railway undertakings and infrastructure managers. Those that are relevant to the design and operation of station pedestrian crossings are summarised below:

- to develop and submit for HMRI acceptance a safety management system as a condition for the issue of a safety certificate;
- if the new or altered equipment is both novel to the duty holder and is like to give rise to a new risk, or significant increase in risk, there is a requirement to put in place a process for a written safety validation of any safety related changes to the design or method of operation of railway infrastructure and equipment by an independent competent body (this includes changes to level crossing equipment and modes of operation).

HMRI's Railway Safety Principles and Guidance

100 HMRI has historically played an important role in the regulation of the design and operation of level crossings.

101 HMRI has published safety principles and guidance to the railway industry on the design and operation of railway systems in a document entitled Railway Safety Principles and Guidance, issued in 1996[3]. Information relevant to level crossings is provided in Part 2, Section E of the RSPG document.

102 However, the above guidance does not apply retrospectively to level crossings that were installed, or last modified, prior to the publication of RSPG in 1996. This is because its scope is limited to the design and operating concept for new or modified crossings.

103 In the introduction to the above document, HMRI have stated that the correct application of the guidance should provide a sufficient level of safety for approval to be given by the Inspectorate. For this reason the industry has generally sought to comply with the guidance in order to ease the process of obtaining approval from HMRI.

104 The RSPG has effectively become a 'standard' to which the industry has generally sought to comply when designing and commissioning new or altered works. This is evidenced by the many references to the RSPG contained in Railway Group Standards (RGS) and Network Rail Company Standards.

105 It is therefore considered that the RSPG has played an important role in the development of level crossing design. For this reason the investigation has reviewed the guidance as it relates to station pedestrian crossings.

106 The Office of Rail Regulation (ORR) has confirmed that it is to continue to develop and maintain those parts of the RSPG that relate to level crossings.

107 A summary of the guidance relevant to station level crossings is contained in Appendix D.

Railway Group Standards and Guidance

108 RGS defines the mandatory high level safety requirements to be complied with by all members of the Railway Group. Two Group Standards that were both applicable on the 3 December 2005 are worthy of particular attention. These are as follows:

- Provision, risk assessment and review of level crossings (GI/RT 7011) - this was withdrawn in October 2006.
- Requirements for level crossings (GI/RT 7012) - this is still in force.

109 Compliance with Railway Group Standards is mandatory on all members of the Railway Group.

110 With each of the above is an associated Guidance Note. These are as follows:

- Guidance on the Provision, Risk Assessment and Review of Level Crossings (GI/GN 7611) - this was withdrawn in October 2006.
- Miscellaneous Guidance on Level Crossings (GI/GN 7612).

[3] Prior to the publication of this document HMRI issued its guidance in the form of a Department of Transport publication (colloquially known as the 'Blue Book').

111 Guidance Notes do not contain mandatory requirements but are intended as guidance on the way in which the mandatory requirements of the associated Group Standard can be met.

112 Appendix E summarises the provisions of the above documents that are relevant to station pedestrian crossings.

113 The withdrawal of RGS GI/RT 7011 (and the associated Guidance Note) in October 2006 was carried out as part of an ongoing standards review process. As part of this process it was decided that the content of this standard was only applicable to Network Rail and imposed no obligations on any other member of the Railway Group. For this reason it was decided that this standard did not qualify as a RGS and that the issues covered in the standard should be covered within Network Rail's own Company Standards.

114 RSSB have advised that there is a chance that RGS GI/RT 7012 may also be withdrawn following the application of the same process.

Ownership, supervision and maintenance of station pedestrian crossings

115 Station pedestrian crossings on the national network are owned by Network Rail. As the owner, Network Rail is responsible for the installation, inspection, maintenance and renewals of the crossings. It is also responsible for ensuring that station pedestrian crossings remain fit for purpose as circumstances change.

116 All of the station pedestrian crossings that are the subject of this investigation are adjacent to stations that are leased from the owner of the freehold, Network Rail. In all cases the organisation leasing the station is the local passenger train operator.

117 The management responsibilities at stations that are leased from Network Rail are defined in the operative draft of the *Stations Code* (dated June 2005). This draft clearly defines the contractual responsibilities for the provision, care and up-keep of pedestrian crossings that can only be used by the public when escorted by railway staff (i.e. staff crossings). However, it provides no clear indication as to the contractual framework for those crossings that can be freely used by members of the public (i.e. station pedestrian crossings).

Risk management at station pedestrian crossings

118 In October 2002 Railway Group Standard GI/RT 7011 was issued. This Group Standard mandated that a valid risk assessment be carried out on all station level crossings (this includes those crossings referred to in this report as 'station pedestrian crossings') by February 2004.

119 By late 2003 it became apparent that the above target would not be met. For this reason a temporary non-compliance was issued by the RSSB and a revised programme was established for completion by October 2005

120 Prior to October 2005 the railway industry had no risk assessment process that was specific to station pedestrian crossings. Instead procedures had specified that the condition of footpath crossings should be checked on a regular basis. This approach was based on a series of checks against a list of requirements derived from RGS, the RSPG, and relevant legislation. This covered items such as *warning times*, the condition of the crossing surface and the condition of signage. The objective of this process was to verify that crossing remained fit for purpose (allowing for changes in usage), was in good condition and remained compliant with standards, guidance and the law.

121 In March 2005, Network Rail revised its Operations Manual to include an improved semi-quantitative assessment of *collective risk* at station pedestrian crossings that was capable of being performed by trained level crossing risk managers to meet the intent of RGS GI/RT 7011. Risk assessments of station pedestrian level crossings were commenced in March 2005 with the objective of completion by October 2005.

122 The new risk assessment procedure is based on a weighted scoring system in which the assessor is required to answer a series of questions by choosing a response from a short list. The response selected determines a score for the question. The scores available to the assessor reflect the relative importance of the risk factor being assessed (i.e. it is weighted according to risk). This weighting was based on an assessment of the relative importance of different risk generating factors derived from previous risk analyses performed by Network Rail.

123 The factors assessed as part of this risk assessment are as follows (the maximum score available for each factor is shown in brackets):

- unauthorised use (12);
- number of users (12);
- number of trains (16);
- number of non-stop trains (6);
- train speed (4);
- number of lines crossed (3);
- warning time (12);
- probability of stepping out from behind a train into the path of another (6);
- environmental noise (2);
- use by vulnerable, distracted or encumbered users (5);
- weather conditions (1);
- visibility (e.g. fog) (2);
- track cant (1); and
- other local factors[4](4).

[4] According to the Network Rail Operations Manual, local factors may include:

- Variable warning times;
- Other train routes nearby;
- Uneven passenger use.

124 At the end of the assessment all of the scores are totalled to give an overall score up to a maximum of 86. The actions taken following the assessment would be determined by the total score as follows:

- if the score is greater than 55, steps should be taken to reduce the risk;
- if the score is between 35 and 55, then measures to reduce the risk should be considered; and
- if the score is less than 35, no action is required.

125 This semi-quantitative approach was designed to deliver a systematic review of risk factors, to inform decision making. As such it was designed to meet the intent of RGS GI/RT 7011 in advance of the development of a more sophisticated risk assessment tool and has never been claimed to provide an absolute measure of risk.

126 In parallel with the above, Network Rail has been developing a computer based risk model that takes into account all of the key risk factors. Generic level crossing risk data and local risk factors are input into this model in order to provide a prediction of risk at individual locations. When fully implemented it will deliver a quantitative measure of the individual risk to which users of crossings will be exposed (i.e. an estimate of risk of death per annum as opposed to the risk score generated by the previous semi-quantitative approach). This All Level Crossing Risk Model is a development of a similar model encompassing automatic vehicular crossings that has been in use since 1995.

127 The intention is that the ALCRM will be deployed as a tool for the assessment of risks at station pedestrian crossings by the end of 2006.

General analysis

The control of risks at station pedestrian crossings

Risk factors at station pedestrian crossings

128 Until the issue of a new RGS, GI/RT 7011, in October 2002 there was limited systematic analysis of risk at individual station pedestrian crossings. Since then there have been two developments. These were the publication of a new risk assessment procedure for station pedestrian crossings in March 2005 and the publication of an RSSB research report in October 2005 [Ref. Appendix H, 1].

129 The objective of the RSSB research report was to identify, describe and evaluate some of the safety management issues associated with station pedestrian crossings. It also included the output of an exercise designed to identify any special risks arising at station pedestrian crossings on the UK railway network.

130 RAIB has carried out its own review of the particular hazards that apply at station pedestrian crossings. The purpose of this review was to assess the extent to which the risks at this type of crossing are likely to differ from a typical footpath crossing. Information was derived from the RSSB research report [Ref. Appendix H, 1] and has been supplemented with insights gained during this investigation. The output of this review is to be found at Appendix F.

131 The list at Appendix F indicates a significant number of risks that are specific to station pedestrian crossings or are likely to be increased by the proximity of the station.

Commentary on the distribution of station pedestrian crossings

132 Figure 10 shows that the distribution of station pedestrian crossings on the UK mainland is uneven. The reasons for this are discussed at paragraph 87.

133 The uneven spread of station pedestrian crossings suggests that any measures to familiarise the users of these crossings should be concentrated on the distinct geographical areas in which these crossings are most likely to be found.

134 There are no evident significant differences in the way in which the Network Rail territories are managing the risks associated with station pedestrian crossings.

The distribution of risk factors at station pedestrian crossings

135 At the time of this investigation Network Rail was in process of completing its risk assessments of pedestrian crossings at stations in the UK. The data obtained from these assessments was reviewed by the RAIB but proved insufficient to carry out an assessment of the risk distribution across station pedestrian crossings. The reasons for this are as follows:

- 23 station pedestrian crossings (out of a total of 97) identified by the RAIB are missing from the Network rail data; and
- the consistency of the scoring by Network Rail has yet to be validated.

136 Given the above RAIB elected to carry out an independent review of the relationship between crossing type and the factors likely to generate risk ('*inherent risk factors*') using the base data already obtained from Network Rail (paragraph 83). This review was based on an assessment of those inherent risk factors that could be evaluated by desk research. The inherent risk factors evaluated for each crossing were:

- train speeds;
- number of trains during the busiest hour;
- the number of non-stop trains; and
- the number of persons using the crossing.

137 Although the above list (the 'selected inherent risk factors') is very short, and excludes local factors such as sighting time[5] and history of misuse, it is sufficient to give an approximate indication of the inherent risk at each station pedestrian crossing.

138 Using data relative to each of the selected inherent risk factors the RAIB has scored the risk at each of the 97 crossings. This was done using a similar scoring system as adopted by Network Rail in its station pedestrian crossing risk assessments (paragraph 121). In this way it was possible to generate an indicative risk score for every known station pedestrian crossing. In turn this has allowed the ranking of crossings by the risk score. Figure 11 shows the total numbers of station pedestrian crossings against the indicative risk score.

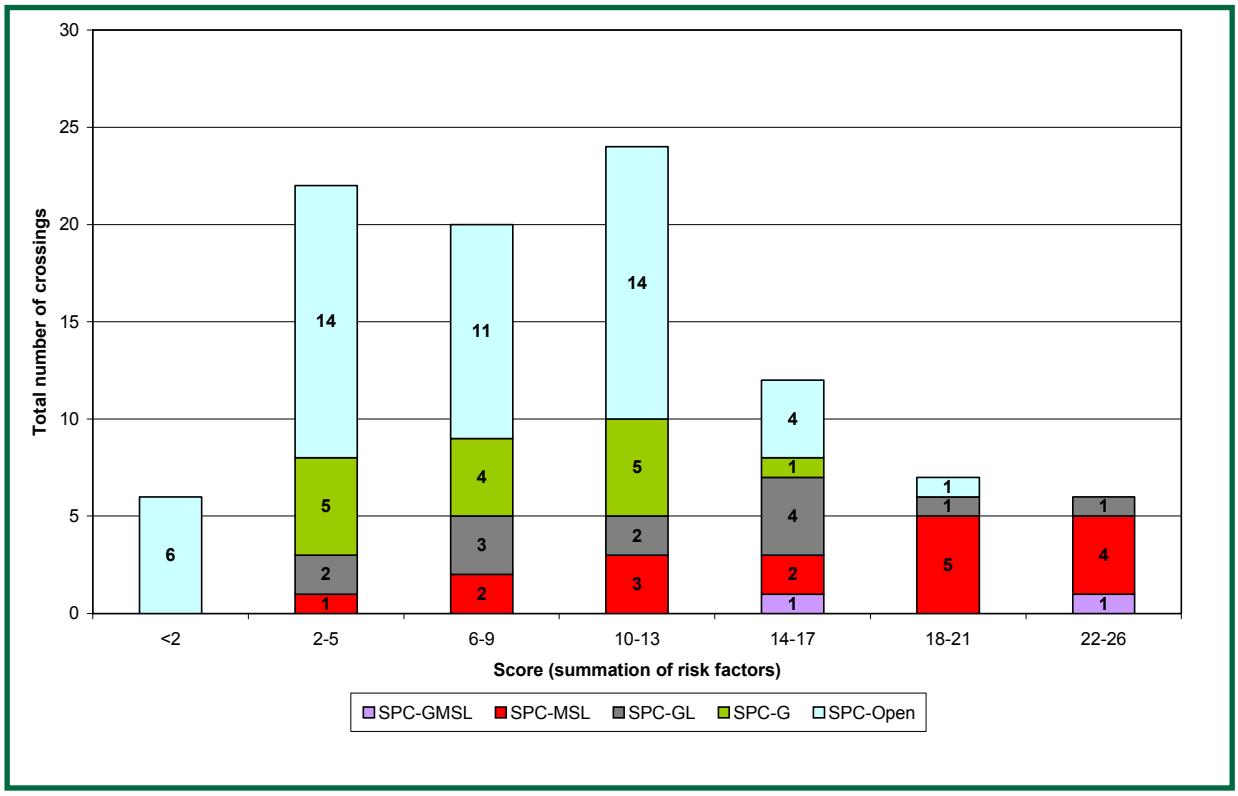

Figure 11: Graph showing total numbers of crossings, by type, against the indicative risk score

[5] The omission of sighting time from this analysis is not considered significant. This is because Railway Group Standards mandate the sounding of horns or the provision of miniature stop lights in all cases where the sighting time is shorter than the time taken to cross in safety. Furthermore, it was not possible to evaluate the safety impact of miniature stop lights. This is because they are usually used to compensate for a lack of adequate sighting and there is no methodology that would allow for a comparison of the risk at a crossing with adequate sighting as opposed to a MSL crossing with inadequate sighting. The key factor is not the presence of MSLs but the adequacy of the warning time. For the purpose of the analysis carried out by RAIB it was assumed that in all cases the warning time was in compliance with the current standards.

Type of crossing	No.	*Passenger journeys per annum (average for crossing type)*	*Maximum line speed (average for crossing type)*	*Number of trains per peak hour (average for crossing type)*	*Number of non-stop trains per peak hour (average for crossing type)*	*Inherent risk score (average for crossing type)*
SPC-GMSL	**2**	138953	70	6.7	3.0	16.4
SPC-MSL	**17**	60478	69	5.3	2.5	22.5
SPC-GL	**13**	40559	68	3.4	1.5	12.0
SPC-G	**15**	15705	52	2.7	0.8	7.8
SPC-Open	**50**	28277	46	2.4	0.9	7.9

Table 2: Average values of selected inherent risk factors at various types of station pedestrian crossing

139 Table 2 shows all of the inherent risk factors that were considered as part of this investigation. For each inherent risk factor, and for each crossing type, an average value has been calculated from the data obtained during this investigation.

140 The ranking of station pedestrian crossings by the inherent risk factors is only indicative. The analysis was limited by the data available and the accuracy of the data provided and it has not been possible to take into account local factors such as the history of misuse. For this reason this exercise does not compute absolute levels of individual and collective risk (these are discussed at paragraphs 197 to 215).

141 Table 2 gives a broad overview of the spread of risk factors across the entire population of crossings permitting a comparison of risk by crossing type.

142 Using Figure 11 and Table 2 it is possible to derive some conclusions about the way in which crossing type is currently related to the severity of hazard. These conclusions are as follows:

- Station pedestrian crossings fitted with miniature stop lights are generally located at stations where the inherent risks are greater.
- Open station pedestrian crossings are very common. However, they are generally limited to those stations where train speeds are below 75 mph (121 km/h) and/or the number of users is low.
- The distribution of station pedestrian crossings with gates is also generally limited to those stations where train speeds are below 75 mph (121 km/h) and/or the number of users is low.
- There is no clear correlation between the provision of locks at station pedestrian crossings and the severity of hazard. This lack of correlation may be linked to the fact that pedestrian gate locks have tended to survive on lesser used lines where mechanical signal boxes are still in use.

143 It is anticipated that Network Rail's introduction of more quantified risk assessments (paragraph 126) will provide a common tool for assessing the need for upgrading of station pedestrian crossings giving rise, in the long term, to a clearer correlation between risk and design of crossings.

Commentary on the design of station pedestrian crossings

144 The following paragraphs consider the different aspects of design and operational policy. In some cases reference is made to existing research. Much of this research relates to other types of crossings, in particular *User Worked Crossings* and footpath crossings. Conclusions are drawn from the research when it is considered to be applicable to the circumstances at station pedestrian crossing. In all cases there is a need for additional research, trials and tests. These requirements are reflected in **Recommendations 4 and 5**.

Layout and fencing

145 An issue associated with the layout of station pedestrian crossings is the angle at which intending users approach the crossing. To maximise the chances of the users responding correctly to the crossings, the best approach route is at right angles to the track for some distance before the crossing is reached [Ref. Appendix H, 5]. A right angled approach has the following benefits:

- the user is more likely to look in both directions before crossing;
- the user is less likely to step out onto the nearest track with their back to oncoming rail traffic; and
- the user's eye is more likely to be drawn to any associated signage or miniature stop lights located at the entrance to the crossing.

146 In practice very few station pedestrian crossings are consistent with the above ideal. In many cases the crossing is located at the base of the platform ramp and there are no barriers in place to direct the flow of passengers to approach at right angles. In some such cases any associated signage or miniature stop lights are placed so that they are facing users as they walk down the ramp. This means that the user is required to turn away from the sign/lights in their final approach to the crossing.

147 Space will sometimes allow for the provision of fencing to direct users to approach the crossing at a safer angle and to prevent them from stepping out onto the nearest track with their back to oncoming rail traffic (**Recommendations 4 and 5**). However, this is not always possible due to a lack of space on the platform ramp and environs.

148 An example of enhanced fencing at a station pedestrian crossing is found at Gomshall (see Figure 12). This was installed following a fatal accident in 2004.

149 In some cases the risk of deliberate misuse can be tackled by the provision of higher fencing or by making it more difficult to climb.

150 Another factor determining the layout of a station pedestrian crossing is the presence of a vehicular crossing. In some examples the pedestrians accessing a platform at the station are required to walk through the pedestrian gates at the vehicular crossing. However, this arrangement is only generally found at manually worked gated crossings. Current standards and RSPG preclude the provision of pedestrian gates at barrier crossings. When manually worked gated crossings are upgraded to barriers the route for pedestrians is diverted under the main barrier and no separate pedestrian gate is provided. In these circumstances passengers requiring to catch a train must wait for the vehicular crossing to open before they can cross the track.

Figure 12: Fencing installed at Gomshall to direct passengers

Figure 13: Pedestrian foot crossing at a station integrated with vehicular barriers (Roydon)

151 Upgrading of vehicular crossings has therefore sometimes led to the abolition of a separate pedestrian route that gives access to the platform, improving safety but interrupting the flow of passengers when the vehicular crossing has been closed for the passage of one or more trains (see Figure 13). In some cases the provision of a footbridge or subway may therefore be required to minimise the inconvenience caused to passengers due to long wait times.

Signage

152 The signage to be used at station pedestrian crossings is defined in regulations, railway standards and RSPG (paragraphs 88 to 114). In general, the wording as prescribed by these sources is clear in meaning and legible [Ref. Appendix H, 2]. However, in some cases a range of different signs have been mounted on the approach to the crossing. Whilst each individual sign is clear in meaning the combination of signage has the potential to be confusing.

153 An example of multiple signs on the approach to a station pedestrian crossing is to be seen at Farnborough North (see Figure 14).

Figure 14 Multiple signs at a SPC-GMSL (Farnborough North)

154 A particular issue is the absence of a warning on most of the signs found at station pedestrian crossings that another train may come after the passage of a first[6]. This absence is significant since the industry has recognised the importance of the 'second train coming risk' at pedestrian crossings [Ref. Appendix H, 13].

[6] This is not a requirement of RSPG

Whistle boards

155 Currently, HMRI RSPG and railway standards mandate the consideration of whistle boards on the approach to level crossings when the following conditions apply:

- the warning time is shorter than the time taken for users to traverse the crossing; and
- there are no miniature stop lights.

156 In the above conditions whistle boards may be proposed as a means of providing the warning of a train's approach.

157 In recent years the railway industry has adopted a policy of limiting the provision and use of whistle boards in response to growing public concern about the environmental impact of train horns. This concern has been exacerbated by the increased audibility of the horns provided on modern trains.

158 During the investigation HMRI have expressed the view that the use of whistle boards in order to warn of the approach of trains does not always represent an adequate means of warning users of the approach of a train.

159 There is limited value in the train horn being sounded if an audible yodel alarm is in operation.

Pedestrian gates

160 Pedestrian gates are a legal requirement (by virtue of the Railway Clauses Consolidation Act of 1845) where the station pedestrian crossing forms a part of a public right of way across the railway. Their original purpose was to mark the boundary of the railway and to prevent animals straying onto the line rather than to protect pedestrian crossing users.

161 There is no clear evidence that the existence of an unlocked gate improves the safety of station pedestrian crossing users. However, it does have the advantage of physically marking a clear decision point to the user thereby acting as a reminder of the risks. It is therefore possible the behaviour of users may be modified by the presence of a gate [Ref. Appendix H, 5]. On the other hand, the opening of a gate can cause a distraction on the final approach to the crossing. This distraction can be severe if a user has difficulty getting through the gate (e.g. the user is disabled or is pushing a child's push chair).

162 There are advantages and disadvantages associated with gates and crossings. However, there is currently insufficient evidence to assess the overall safety impact of providing such a gate at station pedestrian crossings. Additional research in this area should be considered (**Recommendations 4 and 5**).

163 Pedestrian gates are found at locations other than station pedestrian crossings. In particular they are found at many vehicular crossings alongside the main gates (in this context they are often referred to as 'wicket gates'). In many instances pedestrian gates at highway level crossings are fitted with remotely operated locks or miniature stop lights. A review of the distribution and types of pedestrian gates at highway level crossings is to be found at Appendix C.

Locking arrangements

164 As described at paragraphs 61 to 64, there are a number of station pedestrian crossings that are equipped with gates that can be locked by the signaller or crossing keeper on the approach of a train. None of these are interlocked with the signalling (i.e. the operation of the lock is not linked to the clearing of signals). This means that in all cases the onus is on the signaller/crossing keeper to check that the foot crossing is clear and the gates are locked in good time for the passage of the train.

165 A range of options for the deployment of locks on the gates of station pedestrian crossings are described below:

a) *Increase the number of station pedestrian crossings fitted with locks that are operated by the signaller/crossing keeper on the approach of trains.*

With this option the onus is on the signaller to observe that the crossing is clear and then operate the lock in good time. This arrangement is considered by the RAIB to be safe in those locations where the flow of pedestrian traffic is low and the signaller/ crossing keeper is not subject to distraction.

Some of the issues associated with the operation of lockable gates are illustrated by the example of the station pedestrian crossing at Foxton, Cambridgeshire. At this location the crossing keeper has an instruction to lock the gate on the pedestrian gates as soon as the associated road barriers are closed[7]. Whilst this minimises the risk that the crossing keeper will forget his duty to lock the gate it means that the pedestrian gates are closed for almost as long as the road barriers.

In general, it is considered that this arrangement is likely to prove an unsafe option if one or more of the following conditions applies:

- the crossing is subject to heavy pedestrian use;
- the signaller/crossing keeper has a heavy workload or is subject to frequent calls on his/her time for other purposes; and
- the crossing keeper is subject to direct contact with the public when making the decision to lock the gate.

b) *Install locks that are interlocked with the signalling system (i.e. the gate must be proved to be closed before the protecting railway signals can be cleared).*

This option can only be applied where there is some means of verifying that the crossing is clear before the gates are locked. This is easily achieved at manned locations or where the crossing is remotely monitored via CCTV. However, this option will introduce additional delays to users since the gates will need to be closed sufficiently early to avoid approaching trains from encountering a restrictive signal aspect. This would result in the pedestrian gate being locked some 3 to 4 minutes in advance of the train arriving. If another train were scheduled to pass this time interval could increase to as much as 6 minutes. In those cases where station pedestrian crossings are adjacent to a vehicular crossing, the pedestrian gates would be locked shut for as long as the road barrier or gate.

[7] Foxton is a rare example of pedestrian gates associated with a barrier crossing.

c) *Locks that apply automatically when the train reaches a certain point on the approach to the crossing.*

This option would result in pedestrian gates remaining unlocked until the train was some 25 seconds away from the crossing[8]. It also removes the onus from the signaller/ crossing keeper to remember to lock the gates in time. However, there are a number of issues. These are as follows:

- A means must be found to prevent users from becoming trapped after the gates have been locked. This implies a mechanism which would allow the gate to be unlocked from the side closest to the line whilst remaining locked to users on the side remote from the line. Such a mechanism should have a high reliability and should be designed to fail in a safe manner[9]. The consequences of trapping persons on the crossing can be alleviated by providing a safe standing area on either side.
- Groups will become separated as they pass through the gate. This could lead to inappropriate behaviour, distress and misuse of the crossing.
- If the crossings are heavily used there is a high chance that the gate would be open at the time the locking mechanism is activated. In such a circumstance it might then remain open to permit a succession of passengers pass through.

No automatic gate at a pedestrian crossing has been installed on the UK railway network to date.

Miniature stop lights (also known as miniature warning lights (MWL))

166 Miniature stop lights have been in wide use on the UK railway network for more than 40 years. Initially, they were deployed at User Worked Crossings to act as a warning device for persons opening gates or user worked barriers. When used in this context they are usually mounted on the side of the track from which the users approach, in close proximity to instructions on the use of the crossing.

167 In the case of User Worked Crossings the user should encounter a closed and latched gate, or barrier, and is therefore given an opportunity to notice the lights and read the associated signage.

168 In contrast, most station pedestrian crossings are provided with no gates. Where gates are provided these are unlocked and unlatched and therefore pose little obstacle to the user (latched gates are not permitted for fear of impeding the exit of users from the crossing). The absence of latched gates and barriers means that the passage of users is not interrupted on the approach to the crossing. For this reason there is an additional need for the lights, and the associated signage, at ungated station pedestrian crossings to be conspicuous (i.e. it is vitally important that the user notices the lights and understands their meaning).

[8] This timing is based on the assumption that the warning time will be the same as currently mandated for miniature stop lights plus 5 seconds to allow the locking mechanism to operate.

[9] This risk can be mitigated, but not alleviated, if a suitable area is provided on each side for persons to stand clear of the track if the gate on the far side is locked.

169 Some means of improving the conspicuity of stop lights at station pedestrian crossings are outlined below:

a) *Increase the size and intensity of the lights*

Larger and brighter lights will have a greater chance of attracting the attention of users. With modern technology it is now feasible to install larger luminares with high levels of brightness yet modest power consumption. The railway industry has already identified the desirability of improving the size and luminosity of the miniature stop lights [Ref. Appendix H, 2 and 6]. An improved design based on the use of LEDs has been developed and is being deployed at a number of locations. One such example is at Bolton-on-Dearne station (see Figure 15) (**Recommendations 4 and 5**).

Figure 15: Modern pedestrian stop lights at Bolton-on-Dearne station

It is understood by RAIB that it is the intention of Network Rail to implement this improved design at footpath and station pedestrian crossings across the network.

b) *Change the shape of the lights*

This option has been the subject of railway industry research [Ref. Appendix H, 2]. No evidence was found that changing the shape of the lights would significantly affect the behaviour of users.

c) *Place the signage and miniature stop lights on the far side of the crossing from an approaching user and facing inwards towards the railway*

The RSPG recommends the adoption of this measure at footpath crossings. The advantage of placing the miniature stop lights on the far side of the track as suggested by RSPG is that the display remains visible to the user at all times (even when the user is standing between the decision point and the track). However, there are a number of disadvantages. These are as follows:

- the display may be too distant for sight impaired users;
- the display will be blocked by the presence of a train; and
- there is a risk from confusion if the display turns from green to red when users are traversing the crossing (this risk has yet to be evaluated by human factors research).

Given the above concerns, HMRI have stated that they do not take actions to encourage the adoption of this particular guidance. HMRI has recognised the need to change the existing guidance on this design issue (**Recommendation 4**).

d) *'Back to back' lights*

A further option is to place miniature stop lights on both sides of the track. This would maximise the chance of the users noting the status of the stop lights. In this configuration the indication displayed on the far side would simply repeat the indication displayed to the user on the near side. This option does not address the possible risk from confusion if the display turns from green to red when users are traversing the crossing (**Recommendation 4**).

e) *Introduce flashing lights*

This option was considered as part of research carried out by RSSB into user behaviour at pedestrian crossings [Ref. Appendix H, 2]. It was concluded that flashing lights would bring no significant benefits.

Commentary on safety issues associated with the failure of miniature stop lights

170 At station pedestrian crossings equipped with miniature stop lights, and a telephone, users are instructed to use the telephone in the event of a light failure.

171 At station pedestrian crossings equipped with miniature stop lights, but no telephone, there is a need to instruct users on the actions to take when the lights have failed. Currently, the prescribed wording of the signs associated with the miniature stop lights at stations with no telephone advises users to 'proceed with caution' when no light shows. This is considered to be inappropriate advice to users at those locations where the warning times are less than the crossing time.

172 Many such signs still bear the previously mandated wording 'if no light – beware'. This is considered to be a more acceptable wording than that mandated today.

173 Options for dealing with this risk are summarised below:

- installation of a telephone in order that users can contact the signaller or other railway staff to report the failure;
- remote detection of light failure;
- at manned locations, an instruction to inform the crossing keeper or signaller;
- taking steps to significantly improve the inherent reliability of the lights (e.g. by installing LED type lights);
- a revision of the wording on signs at unmanned locations with no telephones to advise inform users that it is dangerous to use the crossing when no light is showing; and
- advice to use an alternative route (where appropriate).

174 At manned locations (e.g. at Elsenham) staff are required to report any failure of the miniature stop lights as soon as it occurs.

175 Once a failure is reported Network Rail needs to put in place written instructions on the risk control measures to be put in place. Dependent on the risks at the station, these measures may include the provision of a temporary crossing keeper or the slowing of trains.

176 Although it is foreseeable that the failure of miniature stop lights at a station pedestrian crossing could be hazardous, to date there is no record of such an occurrence resulting in death or serious injury to a user.

Visual warnings of 'another train coming'

177 One of the hazards associated with the use of station pedestrian crossings is the arrival of a second train shortly after the first has passed. In such cases there is always a possibility that the user will assume that the red lights displayed relates only to the first train and will therefore step out onto the crossing as soon as it has passed. At station pedestrian crossings the risk of this occurring is likely to be greater if the users are intending to catch the first train.

178 There is also a risk that users will assume that the failure of the miniature stop lights to switch from red to green as soon as the first train has passed is due to tardiness in response of the system rather than the approach of the second train.

179 Data derived from observations of users [Ref. Appendix H, 6] shows that a small number will stand beside the miniature stop lights when waiting for the first train to clear the crossing. This means that they are too far forward to observe the status of the lights once the first train has passed clear.

180 The current arrangements at station pedestrian crossings make no provision to display a specific warning that another train is coming after the passage of the first. Furthermore, the standard fixed signage at most locations makes no mention of this risk (paragraph 154).

181 The collective risk arising from 'another train coming' is highest when the following factors are combined:

- a large number of trains pass over the crossing;
- a large proportion of the trains do not stop;
- a large number of users; and
- short sighting times.

182 At such locations the provision of an active warning that a second train is approaching should be considered. This would require the development of a simple illuminated display of the type similar to that provided at a small number of vehicular automatic open crossings (locally monitored) on double track railways. Such a sign would display a simple warning message once the approach of a second train was detected (**Recommendations 4 and 5**). The positioning of such an active display would be critical. If it was located on the opposite side of the track it would be blocked from view during the passage of a train. Conversely an active display located on the side of the track closest to the intending user may be of no value if the user was standing forward of the sign (paragraph 179).

183 RSSB has already initiated a research project on the improvement of second train warnings at automatic crossings (Ref. RSSB research project T652).

Audible alarms

184 It is not a requirement of RSPG that station pedestrian crossings be provided with an audible alarm to warn of the approach of trains. However, at a number of crossings this has been done in order to enhance the warning given to users (e.g. Elsenham and Woodlesford).

185 Where provided, audible alarms generate a sound that is both distinctive and strident. Most users are likely to clearly understand the meaning of the warning [Ref. Appendix H, 2, 6, 15]. It is concluded that the use of audible alarms will benefit the safety of users. For this reason Network Rail is already investigating the feasibility of extending the use of audible alarms at user worked and footpath level crossings as a supplement to existing miniature stop lights or as an alternative to their installation.

186 Audible alarms can also be installed as a warning device for the protection of persons who may have difficulty seeing the visual display.

187 A problem associated with the increased use of audible alarms is that objections may be raised by local residents on the grounds of environmental disturbance.

188 RSPG and RGS and require the provision of a two tone audible alarm system at automatic vehicular crossings on two track railways. This system sounds two different tones of alarm. The first tone is used to warn that the barriers are closing. It continues to sound whilst the barriers are closed and the train is approaching. The second tone, distinct from the first, sounds (as the first train reaches the crossing) if another train is coming.

189 This two tone alarm has not been installed on any station pedestrian crossings to date.

190 There is research data [Ref. Appendix H, 2, 6] to show that the provision of a two-tone alarm at station pedestrian crossings is unlikely to significantly change the behaviour of users. When questioned, 95% users of crossings were unable to describe the meaning of the second tone.

191 Other industries (e.g. the aeronautical industry) have recognised that the human voice can be used to broadcast alarm messages [Ref. Appendix H, 14]. The advantage of using the human voice is that a specific safety message can be broadcast. Furthermore, this analysis has shown that individuals will tend to respond more readily to an authoritative voice than they will to a 'warble' type alarm.

192 The benefits of voice messages are maximised if the message is very simple and short.

193 The above analysis [Ref. Appendix H, 14] is related to the broadcasting of messages to trained aircrew in a controlled cabin type environment. However, it has yet to be demonstrated that such a solution will work effectively with members of the public in the environment of a railway station (**Recommendations 4 and 5**).

194 Two potential problems associated with the use of a voice message have been identified. These are as follows:

- not all users will understand a message broadcast in English; and
- the voice message may give rise to noise disturbance.

195 A further option for enhancing the impact of an audible alarm (warble or voice) would be to link it to the opening of a pedestrian gate [Ref. Appendix H, 5]. This would ensure that the alarm/message was broadcast when both of the following conditions applied:

- a train is coming (or another train is coming); and
- the gate is in the open position.

196 In this way the user would receive a clear warning in direct response to an action they have taken (i.e. a warning would be broadcast if they opened the gate, or held the gate open when a train was approaching). However, any person already on the crossing at the time the approach of a train is detected would not have the benefit of the warning message.

Commentary on the risk profile of station pedestrian crossings

197 The risk associated with station pedestrian crossings can be categorised under the following headings:

- individual risk - the risk to a specified individual, measured as a probability of death per unit of time or per activity (e.g. probability of death per annum for the person who is most exposed to a risk); and
- collective risk - the average risk to all people involved in the activity as a whole, measured as a frequency of a particular outcome (e.g. equivalent fatalities per annum).

Individual risk

198 An assessment of individual risk must be used to determine whether the risk is tolerable against specific defined criteria. This is done by selecting the person who is most exposed to the risk, calculating the risk to which the person is exposed and then comparing the level of risk with tolerability criteria defined by the Health & Safety Executive (HSE) (and accepted widely, including by the railway industry).

199 The criteria for tolerability of individual risk adopted by the railway industry (based on HSE guidance) are summarised in Table 3.

200 The RAIB has used the data collected on station pedestrian crossings as part of this investigation to estimate the individual risk to users in Britain. For the purpose of this exercise two populations have been considered. These are as follows:

- the regular rail user - assumed to use a station pedestrian crossing 250 times per annum;
- a member of public using a public right of way across a station pedestrian crossing on a frequent basis for reasons other than catching trains - assumed to use a station pedestrian crossing 500 times per annum (this value is consistent with the value proposed for 'most exposed users' in RGS guidance document, GI/GN 7611).

Individual risk, (probability of death per annum)	
$\geq 1.0E^{-04}$ (1 in $\leq$10,000 years)	Risk is intolerable and must be reduced (e.g. the station pedestrian crossing should be closed or safety enhancements made).
$1.0E^{-04}$ to $1.0E^{-06}$ (1 in 10,000 to 1 in 1,000,000 years)	Risk is considered to be tolerable but improvements should be implemented when it is reasonably practicable to do so. Included within the assessment of reasonable practicability should be a comparison of the benefits of the improvement against the costs (and other disbenefits as appropriate) arising.
$\leq 1.0E^{-6}$ (1 in $\geq$1,000,000 years)	The risk is considered to be broadly acceptable. No further action to control this risk is considered to be necessary, but risk levels must be kept under review
$1.0E^{-6}$ (1 in 1,000,000 years)	This is the risk target for new level crossings of all types.

Table 3: Summary of risk criteria for users of station pedestrian crossings (passengers and members of the public)

201 Certain key data have been used to derive the estimate of risk. This is summarised below:

- total number of occasions on which station pedestrian crossings have been used in the last 15 years (estimated to be about 40.71 million); and
- total number of fatalities to have been recorded in the last 15 years (a total of four[10]).

202 The total number of occasions on which station pedestrian crossings have been used in the last 15 years was based on a summation of the total number of passenger journeys to and from the stations in the list of 97 station pedestrian crossings (see Table 1). This summation was adjusted by a factor of 0.6 to take into account the fact that passengers do not always use the crossing and an allowance was made for the growth in passenger numbers over the last 15 years. Further allowances were made for the number of users other than rail passengers and for passengers who did not purchase a ticket.

203 The total number of fatalities was taken from RSSB data. It includes the two fatalities that occurred in a single accident at Elsenham on 3 December 2005.

204 The above data can be used to estimate the average risk to individuals at station pedestrian crossings. However, it is considered highly unlikely that risk will be distributed evenly across all station pedestrian crossings. For this reason estimates of risk have been made for those crossings at which the risk is judged to be higher than the average. Two cases have been considered:

- station pedestrian crossings at which the risk is twice the average; and
- station pedestrian crossings at which the risk is five times the average (consistent with the multiplier adopted by Arthur D Little [Ref. Appendix H, 1]).

[10] RSSB data (includes fatalities at Chorley, Gomshall and the recent fatalities at Elsenham).

205 Using the above 'base-case' data and assumptions, the risk to the different types of user defined in paragraph 200 at station pedestrian crossings in Britain is shown in Table 4.

206 Since the estimation of individual risk will be heavily dependant on the values for the number of foot transits and the total number of fatalities it was decided to carry out a simple sensitivity analysis. This was based on two alternative scenarios:

- an analysis based on twice the number of crossings transits (sensitivity 1); and
- an analysis based on the number of fatalities in the 15 years prior to the accident at Elsenham on 3 December 2005 (sensitivity 2).

207 The 'base-case' values in Table 4 indicate that the individual risk to the most exposed user of the highest risk crossings may be close to an intolerable level (Table 3).

208 The values derived from both sensitivity analyses generally show levels of individual risk that are at a level that is defined as tolerable according to HSE's criteria (Table 3). However, the level of risk to the most exposed user at high risk crossings is sufficient to give cause for concern.

209 The overall levels of risk reported above are sufficient to justify an urgent assessment of risk at individual station pedestrian crossing in order to identify those crossings at which the levels of risk are shown to be intolerable or very close to the upper limit of tolerability. In those cases where the risks are found to be intolerable immediate actions should be taken to reduce the risk to a level that is tolerable. In all cases UK health and safety law requires the user to assess whether it is reasonably practicable to implement additional safety measures.

Collective risk

210 Using the historical data it has collected, the RSSB has estimated the collective risk associated with all crossings at stations to be an average of 0.207 equivalent fatalities[11] per annum. This figure will be revised upwards in the next version of their risk model to take into account the accident that occurred at Elsenham on 3 December 2005. If there are no more serious accidents during 2006 this inclusion will increase the value of the predicted collective risk to around 0.3 equivalent fatalities per annum.

211 The above source data has been normalised so that it can be compared to other types of level crossing. This has been achieved for each type of crossing by dividing the number of such crossings by the number of equivalent fatalities that occurred on each crossing type per year. This data is presented in Table 5.

212 The figures in Table 5 explain the reason why the railway industry has focused attention on Automatic Half Barriers (AHB) and Automatic Open Crossing (Locally Monitored) (AOCL) type crossings in recent years. Accidents at vehicular crossings also pose a significant risk to the railway train, as was witnessed following the collision between a train and a car at Ufton Nervet in November 2004.

213 The figures in Table 5 also show that level crossings at stations generate significant levels of collective risk, which is markedly greater than that associated with footpath crossings.

[11] Equivalent fatalities encompass fatalities, major injuries and minor injuries. Fatalities are considered to be one equivalent fatality, major injuries are considered to be 0.1 equivalent fatalities and minor injuries are considered to be 0.005 equivalent fatalities. In order to obtain the figure quoted, the RSSB has taken into account accidents that have occurred in the period 1994-2004. These include fatalities at Chorley and Gomshall. No allowance has been made for any accidents that may have occurred at station pedestrian crossings that are not currently so classified by Network Rail. For this reason the analysis performed by RAIB based on the above RSSB data can be viewed as conservative.

Type of user	Number of foot transits	Level of risk at crossing	**BASE CASE** Calculation of individual risk based on the data post the fatality at Elsenham on the 3 December 2005 (4 fatalities + 40.71 million transits over 15 years)		**SENSITIVITY 1** Calculation of individual risk based on the data post the fatality at Elsenham on 3 December 2005 (4 fatalities + 81.42 million transits over 15 years)		**SENSITIVITY 2** Calculation of individual risk based on the number of fatalities prior to the accident at Elsenham on 3 December 2005 (2 fatalities + 40.71 million transits over 15 years)	
			Estimated individual risk (probability of death per annum)	*Average return period (years)*	*Estimated individual risk (probability of death per annum)*	*Average return period (years)*	*Estimated individual risk (probability of death per annum)*	*Average return period (years)*
Regular rail user	250	Risk at crossing is the same as the national average	**2.46E-05**	**1 in 40705**	1.23E-05	1 in 81410	1.23E-05	1 in 81410
		Risk at crossing is twice national average	**4.91E-05**	**1 in 20353**	2.46E-05	1 in 40705	2.46E-05	1 in 40705
		Risk at crossing is five times the national average	**1.23E-04**	**1 in 8141**	6.14E-05	1 in 16282	6.14E-05	1 in 16282
Member of public using crossing as means to cross railway	500	Risk at crossing is the same as the national average	**4.91E-05**	**1 in 20353**	2.46E-05	1 in 40705	2.46E-05	1 in 40705
		Risk at crossing is twice national average	**9.83E-05**	**1 in 10176**	4.91E-05	1 in 20353	4.91E-05	1 in 20353
		Risk at crossing is five times the national average	**2.46E-04**	**1 in 4071**	1.23E-04	1 in 8141	1.23E-04	1 in 8141

Table 4: Indicative estimates of individual risk at station pedestrian crossings

Crossing type	No. of crossings	Equivalent fatalities/1000 crossings/year
AHB	456	6.01
AOCL	128	4.53
All types of station and barrow crossings	181	1.38 (before the two fatalities at Elsenham) 2.76 (after the two fatalities at Elsenham)
User worked crossings (with MSL)	129	1.85
Manned gates and manually controlled barriers	861	1.30
Footpath crossings	2593	1.14
User worked crossings with telephones	1668	0.75
User worked crossings	1551	0.71
AHB, Locally Monitored	49	0.32
Open Crossings	58	0.09

Table 5: Estimates of collective risk for different crossing types (RSSB data)

Reasonable practicability

214 UK law (the Health and Safety at Work etc Act 1974) requires that the risk to persons affected by an undertaking be controlled 'so far as is reasonably practicable'. HSE guidance states that this requirement is met by reducing risks to a level that is 'as low as reasonably practicable' (ALARP). There is no absolute legal definition of ALARP since it is considered to be a matter of opinion articulated by the Courts based on their perception of society's views. Guidance on reducing risk to a level that is ALARP is published by the Health and Safety Executive.

215 The management processes employed by individual companies within the railway industry (duty holders) are designed to meet their legal responsibility to control risk to a level that is ALARP. For a railway system to be compliant with the ALARP principle it must be shown that the risk to any individual is at least tolerable (paragraph 198). Once this can be demonstrated, an argument in support of not taking a measure because it is not reasonably practicable will usually make reference to the following:

- a demonstration that the costs of any improvement to safety would be grossly disproportionate to the overall benefits;
- the measures currently in place comply with standards and 'good industry practice'; and
- a demonstration that suitable control measures are in place to address foreseeable hazards.

216 In its 2005 report for the RSSB [Ref. Appendix H, 1], the safety consultancy Arthur D Little calculated the following:

- an expenditure of £232,000 per annum could be justified each year to avert 0.17 equivalent fatalities (two fatalities averaged over 12 years, the figures current at the time the analysis was done) across the entire population of station and staff crossings (this assumed a 'Value of Preventing a Fatality' (VPF) of £1.36 million[12] in line with the guidance to industry at that time);
- the above value equated to only £1,200 per crossing per annum (or a spend of approximately £30,000 on an installation that would remain in place for 25 years);
- if it was assumed that 20% of the station and staff crossings generated the majority of the risk the justifiable spend on each of these high risk crossings would rise to £150,000 on measures that would remain in place for 25 years.

217 Using figures obtained for this investigation the above calculation has been revised by taking into account the higher collective risk values following the accident at Elsenham. Furthermore, the previous Arthur D Little calculation has been extended to include an estimate of the *Net Present Worth* of safety investments using current industry values for discounting and VPF.

218 An input to the RAIB's revised calculations is the predicted collective risk at each crossing. This has been derived as follows:

i) The collective risk generated by all station pedestrian crossings and staff crossings on the national network is 0.3 equivalent fatalities per annum (paragraph 210). There are estimated to be 97 station pedestrian crossings and around 100 staff crossings on the national network.

j) A working assumption that 75% of the total collective risk is spread across the 97 station pedestrian crossings has been adopted. This assumption takes into account the very low levels of usage of staff crossings and the requirement for passengers to be escorted or supervised by staff.

k) Given the above, the collective risk across the 97 station pedestrian crossings on the national network is taken to be (0.3 x 0.75) = 0.225 equivalent fatalities per annum.

219 It is clear from the summation of inherent risk factors described at paragraphs 130 to 140 that the levels of risk at station pedestrian crossings are varied in their severity. It is therefore reasonable to assume that some station pedestrian crossings will present risk that is greater than the average. For this reason the indicative cost benefit analysis prepared by the RAIB has considered three levels of risk. These are as follows:

- risk at the crossing is the same as the average across the national network;
- risk at the crossing is twice national average; and
- risk at the crossing is five times national average (consistent with the multiplier adopted by Arthur D Little when assessing the risk at high risk locations [Ref. Appendix H, 1]).

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[12] When undertaking costs benefit analysis, in line with other industries such as nuclear and offshore oil, the railway industry converts the injuries and fatalities saved by a specific investment into a monetary value. For 2006, this value is £1.5 million per fatality or equivalent fatality [Ref Appendix H, 19]. This figure should inform but not determine the amount of money that the industry is prepared to spend to avoid a fatality or equivalent fatality. This figure is not intended to place a value on a specific life.

The figures obtained from a computation of costs and benefits are the starting point for duty holders when considering whether a safety investment should be made; the output from the cost benefit analysis does not comprise but can be used to inform decision-making.

220 On the basis of the risk analysis carried out to date it is considered probable that the collective risk at the highest risk locations will be between two and five times the average. However, the exact difference between the average and the highest risk crossings can only be assessed once all crossings have been the subject of a detailed quantified risk assessment.

221 The results of the indicative cost benefit analysis performed by the RAIB are presented in Table 6.

222 The results in Table 6 show that in cost benefit terms alone, the predicted levels of risk at certain higher risk crossings may be sufficient to justify levels of expenditure of between £128,800 and £322,100 provided the risk is almost entirely averted by the safety investment that has been made. However, the overall risk generated by station pedestrian crossings across the national railway network is not sufficient to justify an extensive programme of upgrading existing crossings across the entire network in the short term (**Recommendation 2**).

223 A cost benefit analysis of the type described above is designed to provide guidance to managers when planning safety improvements. It is only an input to a decision on whether to make the improvement. Even if the cost of the improvement significantly exceeds the benefit, managers will consider other factors before making a final decision. Those factors will include the tolerability of the risk to the most exposed user, the overall level of confidence that can be invested in the cost benefit analysis and the wider commercial and ethical responsibilities of the company. They can also factor in any non-safety benefits that may arise from a safety improvement.

Scenario	**Input assumption**	**Expenditure justified by cost benefit analysis** *(assuming that all risk is eliminated)* *£k*
Total expenditure for all station pedestrian crossings on the national network (per annum)		337.5
Expenditure at an individual station pedestrian crossing (on measures that will remain in place for at least 25 years)	Risk at the crossing is the same as the national average	64.4
	Risk at the crossing is twice the national average	128.8
	Risk at the crossing is five times the national average	322.1

Table 6: Results of indicative cost benefit analysis for safety improvements at station pedestrian crossings (excluding barrow crossings)

Access for persons with impaired mobility

224 A significant number of station pedestrian crossings are not suitable for use by mobility impaired persons unless escorted by staff. For example, at a number of locations the walking surface is uneven or the crossing is narrow thereby creating the hazard of a wheelchair or walking aid falling from the walkway.

225 At most station pedestrian crossings any delay to persons traversing the crossing is dangerous since the warning time can be as short as 20 seconds.

226 The Disability Discrimination Act 1995 (DDA) imposes requirements on service providers to enable access to their services for disabled persons. A failure to provide suitable access, or actions that reduce the level of access, can lead to a legal challenge.

227 In the course of this investigation members of the railway industry have argued that the introduction of the DDA has made it more difficult to close crossings at stations. This is because these crossings often form a part of a step free route to and from the platforms. There is a perception that any footbridges built to replace station pedestrian crossings will need to be provided with disabled access ramps or lifts thereby greatly adding to the cost of the structure.

228 In addition to cost, there are other disbenefits to the provision of ramps at a new footbridge. These are as follows:

- To meet the Department for Transport (DfT) guidance on gradients [Ref. Appendix H, 16], the ramps are required to measure more than 100 m in length in order for the bridge to pass over the railway (in areas of overhead electrification this length will be extended by the need to pass over the *overhead line equipment*, a vertical rise of 4.5 m). This takes up increased space and may be considered unsightly which can lead to problems obtaining planning permission. The height of the bridge and hence the length of the ramps will be greater if the line it is passing over is electrified.
- Ramps are not favoured by some mobility impaired persons. They are difficult to use for the majority of unescorted wheelchair users and can be difficult for many other mobility impaired people to tackle.
- Ramps can be hazardous in ice and snow.
- Ramps are attractive to youngsters as a place to ride bicycles and skateboards.

229 There are disbenefits to the provision of lifts:

- reliability and safety issues limit their use to stations that are staffed (or to which a response can be sent quickly);
- lifts are vulnerable to vandalism; and
- there can be problems obtaining planning permission.

230 In the past, UK railway organisations have sometimes adopted a 'hybrid' solution by replacing the crossing with a stepped footbridge but retaining the former pedestrian crossing for use by disabled persons and passengers with heavy luggage. In such cases signage is provided forbidding use by passengers, or there is a locked gate that can be opened by railway staff. An example of this hybrid solution is to be found at Templecombe (see Figure 16).

231 The above solution is suited to those locations that are staffed during traffic hours. In practise this means those locations that are in proximity to a station or signal/crossing box. Most stations with pedestrian crossings are in fact unstaffed.

Figure 16: Pedestrian foot crossing retained for use by disabled passengers under the supervision of railway staff (Templecombe)

232 The retention of station pedestrian crossings for use by disabled persons is not considered to be feasible at those locations where there are no staff or CCTV monitoring.

The role of HMRI and the RSPG

233 HMRI has published guidance on the design and operation of level crossings in a document entitled RSPG. The purpose of the RSPG is described in paragraph 101.

234 Although the status of the guidance contained in the RSPG document is advisory it has acquired the status of a standard to which the industry has sought to comply in order to obtain approval of new or altered works. This has secured a reasonable level of consistency in the design of level crossings throughout the UK.

235 Various issues relevant to station pedestrian crossings have been highlighted by the RAIB review of the RSPG. These are summarised below (for details see Appendix D):

a) To date, HMRI have not considered station pedestrian crossings to be a distinct category of level crossing. This suggests that HMRI have considered that their guidance on footpath crossings is sufficient to address the particular risks at stations.

b) The RSPG stresses the need for users of level crossings to exercise vigilance in the use of level crossings. HMRI refers to case law that supports the contention that it is reasonable for railway companies to argue that users are responsible for their own safety[13] when crossing the railway.

c) The RSPG states that the access to all footpath crossings should be controlled by gates or stiles. Two thirds of station pedestrian crossings are not so fitted (although in some cases there is a gate at the entrance to the station to mark the railway boundary).

[13] Hendrie v Caledonian Rly Co (1909) S.C. 776

d) The RSPG does not propose the use of miniature stop lights at high risk locations. Instead, it **permits** their use in certain circumstances and gives guidance on their application.

e) The RSPG is generally non-specific about the use of audible alarms at footpath crossings. The only specific mention is in relation to use of the crossing by partially sighted and blind persons.

f) The RSPG stresses that any miniature stop lights at footpath crossings should be placed on the far side of the crossing from an approaching user and face inwards towards the railway. However, during discussions with HMRI it became apparent that HMRI has not always taken action to encourage compliance with this clause of RSPG when approving new works. In fact, miniature stop lights at station pedestrian crossings are not usually located on the far side of the track.

g) The RSPG makes no mention of active warnings at station pedestrian crossings to alert users as to the approach of a second train. In contrast the provision of a two-tone audible alarm for this purpose is recommended for the safety of pedestrians at AOCL crossings on double track railways.

h) The RSPG states that where pedestrian gates are provided across the footway at gated crossings operated by railway staff, they should be lockable. HMRI have explained that this is not intended to require that gates should be locked at crossings where miniature stop lights are provided.

236 It is evident from the above that the current guidance is in need of review to ensure that the guidance given is still appropriate to address the particular hazards associated with station pedestrian crossings and to resolve existing areas of uncertainty. This point is already acknowledged by HMRI who have confirmed that they will continue to develop and maintain those parts of the RSPG that are relevant to level crossings (**Recommendation 4**).

237 Many existing station pedestrian crossings are inconsistent with HMRI guidance in the RSPG. In many cases this is because they were installed, or last modified, prior to the publication of the RSPG in 1996. As stated previously in this report, it was never intended that the requirements of the RSPG be applied retrospectively to existing crossings.

Industry standards

238 In general the requirements of the RGS are consistent with the RSPG. However, RGS GI/RT 7012 requires that any miniature stop lights be located on the side of the track nearest to the approaching user in contradiction to the guidance provided by HMRI in the RSPG. HMRI and Network Rail have explained that this difference has arisen because the standard has already taken HMRI's revised views into account whereas the RSPG has yet to be updated. (**Recommendation 4**)

239 The above standard does not require that audible alarms be considered at station pedestrian crossings. Despite this a number of audible alarms have been installed at a number of high risk station pedestrian crossings.

Industry research

240 In July 2005 the RSSB issued a report entitled 'Understanding the risks at station and barrow crossings' (T332). This report has been reviewed and its findings taken into account during the investigation. The key recommendations are summarised below (the current status of each of shown in square brackets, thus [ ]):

- a review of the current status of staff and station crossings [ongoing activity];
- ORR to facilitate a review of the treatment of station and staff crossings in the Stations Code [ORR formally requested to undertake this activity];
- update the records in the station specific annexes to the Stations Code [ORR formally requested to undertake this activity];
- to develop a protocol to define roles and responsibilities in respect of pedestrian crossings at stations [ORR formally requested to undertake this activity];
- develop a means to balance accessibility needs against cost [recommendation rejected by Network Rail];
- decision making to consider all alternatives, including emerging technologies [Network Rail has recognised the need for a review of guidance and standards relevant to station pedestrian crossings]; and
- holistic assessments of risk should be conducted [ongoing activity using ALCRM].

241 Other than the above report there has been limited specific research on station pedestrian crossings. However, the findings of the following research reports are relevant to an understanding of the issues at station pedestrian crossings:

- T000 user worked and footpath level crossing research;
- T028 development of a universal level crossing risk model (in progress);
- T105 wayside horns at level crossings;
- T269 human factors risk at User Worked Crossings.

The responsibilities of crossing users and providers

242 It is an established principle that users of railway level crossings are required to take reasonable care when crossing. This principle was first established in the case of Hendrie v Caledonian Railway Co (1909) and reinforced, in the context of pedestrian safety at road level crossings, by the findings of the parliamentary committee chaired by Sally Oppenheim MP in 1983 [Ref. Appendix H, 17].

243 A working party has been established by the *National Level Crossing Safety Group* (NLCSG) to carry out a high level review of level crossing safety issues [Ref. Appendix H, 18]. This working party has reviewed information submitted by Network Rail and the RSSB. This indicated that 96% of the risk generated by level crossings involves misuse/ abuse of crossings by motorists or pedestrians, the main issues being:

- failure to obey road traffic lights;
- vehicles weaving around barriers;
- vehicles colliding with barriers and equipment; and
- pedestrians ignoring warning signs.

244 Instances of crossing misuse can be sub-divided into two main categories:

- violations (deliberate misuse); and
- errors/lapses (unintentional misuse).

245 It is not clear from the work of the NLCSG what the percentage of accidents is that have resulted from an error or lapse as opposed to those associated with deliberate violation and risk taking.

246 UK law requires that the provider of a crossing take all reasonably practicable steps to ensure users are not exposed to unacceptable risk. This should include consideration of the consequences of unintended misuse of crossings by users (i.e. mistakes). In practical terms this means that the provider of a level crossing should provide users with the equipment and information to enable them to use the crossing in safety and to protect them from the consequences of error or misjudgement, where these are foreseeable and it is reasonably practicable to do so. Additional measures to address human error may sometimes be required where the population includes vulnerable persons such as unaccompanied minors, the elderly and the disabled.

Enforcement

247 BTP have confirmed that they have an active policy to enforce the correct use of level crossings. This includes station pedestrian crossings. At the time of the accident at Elsenham on 3 December 2005 they had no specific policy relative to station pedestrian crossings.

248 BTP have confirmed that they are sometimes notified of incidents of misuse at station pedestrian crossings and will respond if they believe there is a realistic chance of identifying the perpetrator (paragraph 360).

249 Persons found to be deliberately misusing level crossings are either prosecuted or cautioned (Criminal Justice procedures for dealing with juveniles vary slightly). All offenders whether adult or juvenile, are likely to be dealt with for the offence of 'trespass'. However where there are aggravating circumstances or for more serious matters the offences of 'obstructing a train' or 'endangering the safety of persons on the railway' would be considered. All the above offences fall under one of three pieces of legislation:

- **Section 55 British Transport Commission Act 1949**. This Act deals with the general offence of trespass on railway lines or property in dangerous proximity to such lines or electrical apparatus. The proviso for this offence to be proved in Court is for a legible notice to be clearly exhibited at the nearest railway station warning persons against trespass. Current railway standards require this to be done at all platform ends.
- **Section 35 or 36 of the Malicious Damage Act 1861** covering the obstruction of a train or engine on the railway.
- **Sections 33 or 34 of the Offences Against The Person Act 1861** covering an act or omission that endangers the safety of persons on the railway.

250 Prosecutions under the Offences Against The Person Act 1861 can only be applied if it can be shown that the trespasser endangered persons travelling on the railway. Furthermore, where no fence or barrier is circumvented, it may be difficult to establish that trespass has occurred.

251 The main focus of police enforcement actions is the prosecution of road users who have misused an automatic crossing. This is understandable given the potential for a catastrophic train accident. However, they have also prosecuted or cautioned many trespassers who have climbed or passed round barriers.

Review of potential improved safety measures

252 As part of this investigation an overall review of potential safety improvements has been performed based on the analysis contained in this report. The results of this review are presented at Appendix G. The conclusions derived from this analysis are reflected at paragraphs 367 to 387.

The accident at Elsenham

Summary of the accident

253 At 10:40 hrs on 3 December 2005 two young girls were struck by a fast moving train on the station pedestrian crossing at Elsenham station in Essex. Both girls were killed.

254 Immediately prior to the accident the two girls had purchased tickets from the booking office on the east side of the line (the Up platform) and were in the process of walking to the opposite platform to catch the 10:41 hrs service to Cambridge.

255 The station pedestrian crossing was fitted with miniature stop lights and an audible alarm to warn passengers of the approach of trains.

256 Figure 1 shows a map of the locality. Figure 17 shows a sketch plan of the station and the crossings.

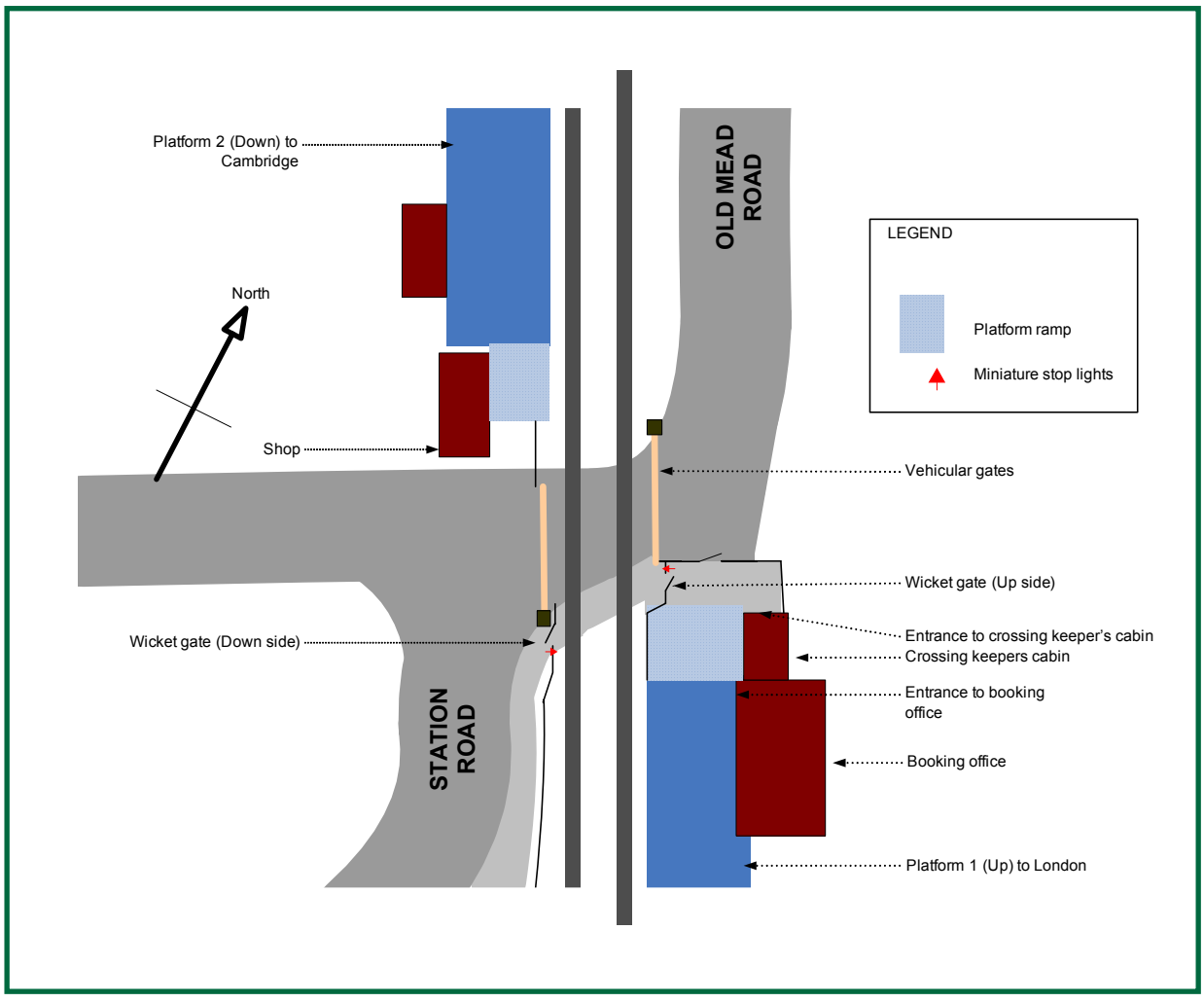


Figure 17: Sketch plan of Elsenham station

Description of the railway line, Elsenham station and the train service

257 Elsenham station is located on the route between London Liverpool Street and Cambridge. It is 35½ miles (58.6 km) by rail from London Liverpool Street and 20¼ miles (36.7 km) from Cambridge. The railway line through Elsenham comprises two tracks. The westernmost track is used by trains towards Cambridge (designated the Down line) and the easternmost track is used by trains towards London (designated the Up line).

258 The railway line through Elsenham is signalled from a signalling centre in Cambridge. The signals in this area are of the industry standard *colour light* type. Trains are detected by conventional *track circuit*s.

259 The permitted speed of trains through Elsenham is 70 mph (115 km/h) in both directions.

260 Due to a combination of track curvature and topography, the distances that can be seen along the track from either gate of the station pedestrian crossing are limited. These distances (the *sighting distances*), and the associated time for which the trains are in view before reaching the crossing (the sighting times) are shown at Table 7.

261 Elsenham station comprises two platforms. The westernmost platform (platform 2, Down direction) serves the track used by trains towards Cambridge while the easternmost platform (platform 1, Up direction) serves the track used by trains towards London.

262 Figure 17 is a sketch of the station layout at Elsenham. The two platforms are not opposite each other but are instead staggered. Platform 2 is located further to the north than Platform 1 and the two platforms are separated by a public highway. This road crosses the railway by means of a level crossing. Since there is no bridge or subway, any passenger who requires to walk from one platform to another must cross both tracks using the pedestrian crossing and then cross the public highway.

263 The only booking office on the station is located at the north end of Platform 1. The door of this booking office is only 3 m from the top of the ramp and 6 m from the station pedestrian crossing.

264 Affixed to the wall outside the booking office is a ticket machine, a machine to issue 'permits to travel' and information boards.

265 Platform 2 has no special facilities other than a simple waiting room and some information boards.

266 Trains which stop at Elsenham are exclusively operated by London Eastern Railway Ltd (trading as 'one Railway'). For the majority of the day there is one stopping train per hour in each direction. During the commuter hours this increases to two trains per hour. All 'one railway' services are operated by electrically powered multiple unit trains.

267 A number of non-stop trains also operate through the station. Some of these non-stop trains are to or from Stansted Airport and are operated by Central Trains. All of these services are operated by diesel powered multiple units. In addition, the occasion freight train operates through the station during the off-peak period.

268 During the busiest hour (06:57 hrs to 07:57 hrs) there are total of 9 trains per hour that pass through Elsenham (4 Down trains and 5 Up trains). Of these, 3 trains stop and the remainder are non-stop.

269 In the year prior to the accident around 170 000 passenger journeys started or ended at Elsenham (usage of the station has been steadily declining over recent years). This equates to an estimated 132 000 foot passages over the crossing per annum with a peak usage of 60 - 90 persons per hour (this allows for those persons using the crossing to visit the booking office). In addition, there are a small number of local persons who are not rail passengers but nevertheless use the pedestrian crossing in preference to the adjacent vehicular crossing. From observation, the number of such users is estimated to be less than 10% of the total (the crossing does not form part of a main thoroughfare). These persons are authorised to use this crossing since it is deemed to be a public right of way.

270 The station pedestrian crossing is heavily used by school children and students en-route to/from schools and colleges in Newport, Cambridge, Stansted Mountfitchet and Bishop's Stortford.

Description of the crossings at Elsenham

271 There are two, legally separate, level crossings at Elsenham station. The first of these is the vehicular crossing that separates the two platforms. This crossing carries Old Mead Road across the railway. The crossing is equipped with manually operated wooden gates onto which are fitted red reflective discs.

272 The above gates are opened and closed by the Network Rail crossing keeper. The crossing keeper's duties when closing the gates across the highway can be summarised as follows:

- The crossing keeper awaits notification that a train is approaching. This is provided by a bell that is automatically sounded in sufficient time for the vehicular gates to be closed, and the protecting signal cleared, without delay to the approaching trains.
- Once notified by the bell the crossing keeper stops road traffic and closes the gates to the highway (thereby opening them to the railway).
- Once the gates are closed and locked the crossing keeper is able to remove two keys from the gate mechanism. These are placed into a control panel which releases the railway signals to either side of the crossing (until this is done the railway signals to each side cannot be cleared).

273 The crossing keeper is provided with a small building located to the immediate east of the station pedestrian crossing. This building is provided as shelter and to house the control panel that is described above.

274 When open to the highway the vehicular crossing provides little clearance for pedestrians to walk safely, however, an alternative route is provided via a pedestrian crossing located on the south side of the southernmost gate. Access to this pedestrian crossing is via a pedestrian gate on each side of the crossing.

275 The pedestrian crossing is also used as the means of access for members of the public between the platforms. For this reason it is classified as a station pedestrian crossing despite the fact that it also forms part of a public right of way across the railway.

276 At the time of the accident, the crossing keeper had no formal responsibilities for the safe operation of the station pedestrian crossing at Elsenham. His 'special instructions' for the operation of Elsenham level crossing made no mention of the adjacent pedestrian crossing.

277 The station pedestrian crossing is equipped with wooden, self-closing, unlatched and unlocked pedestrian gates. According to the design assumptions recommended by the RSPG the time allowed for pedestrians to cross the track at this location is 10 seconds.

278 The foot crossing at Elsenham does not cross the track at right angles. Instead the angle of approach is skewed (see Figures 17 and 18). This means that intending users of the crossing must turn or look over their right shoulder in order to observe the approach of a train on the track nearest to them.

279 The times for which the trains are in view before reaching the station pedestrian crossing (the sighting times) are shown in Table 7. For trains in both directions the sighting times are less than the 10 seconds crossing allowance. For this reason the crossing is provided with the following equipment:

- miniature stop lights and associated signage; and
- a one tone audible alarm.

280 The red indication of the miniature stop lights and the associated audible alarm are activated by treadles on either side of the crossing. This gives a warning time of slightly over 20 seconds on the approach of non-stop trains (this is in line with the requirements of the RSPG and RGS GI/RT 7012).

281 More detail on the above features is to be found at paragraphs 319 to 339.

Position of user	**Direction of train**	**Sighting distance**	**Sighting time** (for trains travelling at 70 mph)
At gate on upside (platform 1)	up (towards London)	93 m	3.0 seconds
At gate on upside (platform 1)	down (towards Cambridge)	292 m	9.3 seconds
At gate on *downside*	up (towards London)	109 m	3.5 seconds
At gate on downside	down (towards Cambridge)	252 m	8.1 seconds

Table 7: Sighting times and distances at Elsenham station pedestrian crossing

The casualties

282 The two girls who were killed in this accident were aged 14 and 13. They were planning to travel together to do some shopping in Cambridge.

The parties involved

283 The railway lines, signalling, electrification system and level crossings at Elsenham are owned and operated by the infrastructure manager, Network Rail. The crossing keeper and the signaller (located at Cambridge Signalling Centre) are both employed by Network Rail.

284 The maintenance and any renewals of the equipment at the vehicular and pedestrian crossings at Elsenham is also the responsibility of Network Rail.

285 The staffing, operation and day-to-day maintenance of the station platforms, buildings and equipment are the responsibility of the station operator, 'one railway'. This company is the operator of all train services that are scheduled to stop at Elsenham.

286 The booking office is staffed and managed by 'one railway'.

287 As described at paragraph 267 some non-stopping trains through the station are operated by 'Central Trains' which operates a regular service to and from Stansted Airport.

288 Both 'one railway' and 'Central Trains' are owned by the National Express Group.

The train involved in the accident

289 Train 1L07, operated by 'Central Trains', was formed of a two car Class 158 diesel multiple unit. This unit, 158856 was inspected after the accident and the train was found to be in good working order. In particular the brakes and horn were found to be working according to their design specification.

The sequence of events

290 The sequence of events during the ten minutes prior to the accident has been reconstructed from the best evidence available and is presented at Table 8. This evidence has been derived from the following sources:

- the on train monitoring and recording equipment;
- the signalling system data logger;
- the ticket machine records; and
- the recollections of the witnesses.

TIME hrs:mins:secs	EVENT
10:32 (estimate)	The two girls arrive at Elsenham Booking Office (intending to catch the 10.41 hrs train).
10:32 – 10:38	Delays occur at the booking office due to other transactions and the girls' indecision about what tickets to buy.
10:34	Train 1L07 leaves Audley End station (6 miles north of Elsenham), 2 minutes late.
10:35	The bell rings to warn the crossing keeper that train 2H14 is approaching. He starts to close the gates of the vehicular crossing.
10:37	The gates of the vehicular crossing are now closed and signals cleared for the approach of 2H14 and 1L07.
10:39	Two half price tickets sold to the girls. One of the girls pays for both tickets. The girls appeared happy and excited. The girls remain at booking office and talk about sorting the money between them.
10:39:24	2H14 'strikes in' (i.e. the train is detected by signalling equipment causing the crossing yodel alarm to operate and miniature stop lights to display red signal).
	Girls ask booking clerk if the yodel is for their train. She replies that they should ask the crossing keeper.
10:39:51	Driver of 1L07 sounds train horn.
10:39:52	1L07 'strikes in'.
10:40	The girls are seen to have opened the pedestrian gate and are standing between the gate posts and at a point between the gate and the track. They appear happy but not agitated.
10:40:00	The trainee driver in cab of 2H14 signals to the girls to wait
10:40:02	The front end of 2H14 arrives at the crossing.
	Girls observed 'at the gate'
10:40:14	The back of 2H14 clears crossing. Driver of 1L07 sees two girls on the crossing.
10:40:15	The speed of 1L07 is 65.3 mph. 1L07 emergency brake is applied. 1L07 hits the 2 girls.

Table 8: Reconstruction of events using best available evidence

Consequences of the accident

291 The two girls were struck by train 1L07 and were killed.

292 A number of witnesses have also suffered considerable trauma as a direct consequence of their close proximity to these events.

Analysis related to the accident at Elsenham

History and previous incidents

293 The pedestrian gates were installed at some time between 1967 and 1984 (the exact year is unknown).

294 It is known that the miniature stop lights were installed in late 1983/early 1984 as part of the electrification and resignalling works. This installation had been the subject of provisional approval by HMRI under Section 41(1) and 41(2) of the Road and Rail Traffic Act 1933 and was brought into service prior to HMRI final inspection and approval. There is no evidence that the final HMRI inspection was ever undertaken.

295 On 20 November 1989 an elderly intending passenger was struck and killed by a train whilst passing from the Downside of the station towards the Upside via the station pedestrian crossing. The investigation into the accident concluded that this person had crossed whilst a red light was showing.

296 Following this accident HMRI made a number of recommendations for improvements at Elsenham. These included changes to the layout of fencing, signage and the miniature stop lights. A yodel alarm was recommended with the addition of a two tone device of the type installed at automatic crossings in order to warn users of the approach of a second train.

297 The above recommendations were implemented by British Rail with the exception that the yodel alarm fitted did not incorporate the two-tone 'another train coming' facility.

298 Since 1989 the crossing has been subject to frequent misuse. It has become commonplace for crossing users to cross the line whilst the red light is showing and the yodel is sounding. This is evidenced by an analysis of the 11 occurrence books that were obtained following the accident on 3 December 2005. These covered the period from 10 April 1999 to 6 December 2005. The data relating to this period is summarised as follows:

- There were a total of 303 recorded instances of misuse.
- Of the above; 140 involved adult males; 44 adult females; 61 male children; and 26 female children. The remainder involved a mixed group or the gender was not identified in the record.
- More than 90% of instances that were recorded in the occurrence books involved persons who started to cross after the lights had switched to red.

299 Some crossing keepers were far more likely to record misuse than others. It can therefore be deduced that the occurrence books are an incomplete record of the level of crossing misuse at Elsenham.

300 One crossing keeper has reported that on four occasions in the two years prior to the accident he was subjected to verbal abuse when he attempted to point out the dangers of misusing the crossing.

301 The investigation has revealed that there was no systematic management process to monitor and review the levels of misuse at Elsenham level crossing. In particular there was no process to ensure that relevant entries in the occurrence book were entered into the railway industry's Safety Management Information System (SMIS). Nevertheless, the Network Rail territory, Anglia, had been aware of the level of misuse at Elsenham and had identified it as a crossing for review. No timescale was established for this review to be completed.

The actions of those involved

302 The actions of the key persons involved in the accident at Elsenham are discussed below.

The actions of the driver of train 1L07

303 The train data recorder shows that the driver of 1L07 sounded his horn at the whistle board on the approach to Elsenham, 24 seconds before the impact.

304 The driver of 1L07 has stated that he saw the girls on the crossing a split second before the impact. It is likely that they came into view from behind the concrete post that supports the northernmost vehicular gate.

305 Witnesses have stated that the girls ran into the path of the train. It is therefore likely that the driver of 1L07 had only 1 or 2 seconds warning of the presence of the girls. Despite this short warning the emergency brake was applied at about the same time the girls were struck.

306 Given these circumstances there was nothing that the driver of 1L07 could have done additionally to avoid the collision with the girls.

307 After the accident the driver brought his train to a stand in proximity to the next signal and contacted the signaller in order to arrange for protection of the line.

308 The driver of 1L07 was routinely tested for drugs and alcohol in accordance with the RGS. The test was clear.

The actions of the crossing keeper

309 The crossing keeper has stated that at the time of the accident he was standing at the door of his cabin waiting the passage of the Down and Up trains. He thought that the girls were intending to catch the Down train. He recalled seeing the girls open the gate and pass through into the path of the Up train, 1L07. He has stated that they did this without warning and contrary to his expectations.

310 It is relevant to note that the crossing keeper has no formal responsibilities or duties for the safe operation of the station pedestrian crossing at Elsenham. His special instructions for the operation of Elsenham level crossing made no mention of the adjacent pedestrian crossing.

311 It is the view of the RAIB that safety value would be added if the crossing keeper were to be responsible for recording all cases of misuse and for helping with the education of users on the safe use of the crossing. However, it is considered that the crossing keepers' duties should not include the direct supervision of the station pedestrian crossing unless a facility is provided for the locking of the gates.

The actions of the girls

312 It is likely that during the 20 seconds before the accident the girls' attention was focused on train 2H14, the train to Cambridge. During much of this period they were standing beside or just beyond the miniature stop light display. They would have continued to hear the 'warble' alarm at the crossing but it is possible they assumed it applied only to train 2H14.

313 The timings provided at Table 8, and the recollection of witnesses, indicate that the girls held the gate open whilst train 2H14 was passing and then ran out onto the crossing as its rear cab passed in front of them.

314 The most likely explanation for the behaviour of the girls is that their strong motivation to catch the train to Cambridge, and a high degree of distraction, made them temporarily unaware of the risks posed by the Up line. In addition, it is likely that the girls assumed that the audible alarm they could hear related only to the train that was passing ahead of them.

315 Motivation and distraction are behavioural traits commonly associated with accident causation. In particular, they are often linked to road accidents involving teenagers and children [Ref. Appendix H, 5, 10, 11 and 12].

316 The problem of level crossing users disregarding the second train to arrive at a vehicular level crossing has been identified by Network Rail as a significant contributor to risk. It is therefore clear that the accident at Elsenham is not unprecedented but instead can be seen as a typical example of human error at a level crossing.

317 The investigation also has considered the girls' state of mind and how this may have contributed to the actions taken. Witnesses have stated that the girls appeared happy and excited when they were in the booking office. On arrival at the gate the girls appeared happy. A witness with a close view of the gate on platform 1 said the girls stood at the gate for some time but did not appear agitated.

318 Given the above, it is not possible to state with any degree of certainty how the girls' general demeanour and state of mind contributed to their subsequent error.

The design, condition and functioning of the station pedestrian crossing

319 Following the accident Network Rail tested the equipment at the crossing. This was performed by qualified testers and covered the following:

- train detection and interface with the *active systems* at the station pedestrian crossing;
- operation of the miniature stop lights; and
- operation of the 'yodel' alarm.

320 All systems were found to have worked in accordance with the design. These tests included a measurement of the time between the activation of the warning devices at the crossing and the arrival of a fast train. In the Up direction this time was just over 20 seconds which is consistent with the requirements of RGS and RSPG.

321 The correct operation of the railway systems at the station pedestrian crossing was confirmed by the witnesses to the accident.

Signage

322 The signage at Elsenham did not make reference to the possibility of a second train. Such warnings are routinely provided at automatic vehicular crossings on double track railways. Since one of the girls was a regular user of the crossing, it is possible that the inclusion of such a message would have made her more aware of this risk on the day of the accident (**Recommendation 6**).

323 The signage is not ideally placed to be viewed and read by a person approaching from Platform 1 (see Figure 18). However, in order to open the gate the intending user of the crossing must stand immediately in front of the sign and at that point the user is likely to notice its content and significance.

Figure 18: View of crossing signage and miniature stop lights on approach to Upside pedestrian gate from platform 1

Sight lines

324 As described at paragraph 279 the sighting times at Elsenham station pedestrian crossing are too short to allow sufficient warning of a trains approach. For this reason miniature stop lights and an audible alarm are provided. However, RAIB observations at crossings, and RSSB research [Ref. Appendix H, 2], indicate that some users will look for the approach of a train, and others will glance up before stepping onto the crossing, even when these types of equipment are provided. It is therefore relevant to consider the sight lines at Elsenham.

325 Any person standing on the 'safe' side of the Upside gate will see the approach of a fast train about 3 seconds before it arrives at the crossing. The sight lines are likely to be reduced still further for any person standing between the gate posts with the gate held open. In this case the sight line is interrupted by the large concrete post that supports the northernmost vehicular crossing gate.

326 The nature of the sightlines can be seen by reference to Figures 19 to 20.

327 In the case of the accident at Elsenham there is evidence the two girls were standing at the gate as train 2H14 passed. There is also evidence that they started to move through the gate as the rear of train 2H14 passed clear. It is therefore possible that the concrete post referred to at paragraph 325 momentarily interrupted their sight line.

Figure 19: Sightline from a point adjacent to the miniature stop lights

Figure 20: Sightline from a point just inside the Upside pedestrian gate

Miniature stop lights

328 The Upside miniature stop lights at Elsenham are shown in Figure 21. They are similar in design to those shown in the RSPG (see Appendix D) and are typical of those installed at footpath and User Worked Crossings throughout the UK. However, the position of the lights, on the side nearest to the approach of users, is inconsistent with the current wording of the RSPG. This document states that the miniature stop lights at footpath crossings should be located on the side furthest from the approach of the intending user, facing towards the track (an example of miniature stop lights in this position is shown at Figure 22).

329 Although the design if the crossing is different to that shown in the RSPG it was compliant with HMRI requirements at the time of installation. Since the requirements of the RSPG are not retrospective there was no obligation on Network Rail to change the design.

330 Had the miniature stop lights been located on the other side of the track, as per the existing RSPG requirements, they would have been obscured by the passage of the Down train and invisible to the girls until the back of the train had passed clear. For this reason it is concluded that had the lights been located on the far side it is unlikely that the accident would have been avoided.

Figure 21: Upside miniature stop lights at Elsenham

331 In order to open the gate the intending user of the crossing must stand immediately in front of the miniature stop lights and therefore is likely to note the display. It is therefore considered that the positioning of the miniature stop lights relative to the gate was appropriate to the location. It is unlikely that the positioning of the miniature stop lights was causal or contributory to the accident.

Figure 22: Photograph showing a station pedestrian crossing with miniature stop lights on the far side of the track (in line with current HMRI guidance)

Audible warning devices

332 Audible warnings are not required by railway standards for station pedestrian crossings, however, an audible warning device (yodel) has been installed at Elsenham. The yodel device is an effective means of making the user aware that there is a hazard. It is widely recognised as indicating danger but is not an effective means of relaying specific safety information (such as the approach of another train).

333 In the case of Elsenham, following a fatal accident in 1989, HMRI had recommended the installation of a two-tone audible warning of the type used on some automatic vehicular crossings to warn of the approach of a second train. For reasons that remain unclear, the two tone yodel device was never installed at Elsenham.

334 Human factor studies and user surveys have revealed that the majority of users do not understand that the second tone indicates that a second train is approaching. Since this second tone is rarely understood it is likely to be of limited value to the majority of users [Ref. Appendix H, 2, 5, 6]. However, in the case of the accident at Elsenham one of the girls had been a regular user of the crossing for 15 months. It is therefore possible that she would have become aware of the significance of the second tone had it been installed.

335 Voice alarms, have the capability of broadcasting a simple safety message more effectively than any 'yodel' type alarm device (paragraph 191). However, it has yet to be demonstrated that such a solution will work effectively with members of the public in the environment of a railway station. Further research in this area should take into account the interest of the hearing impaired and non-English speakers.

336 In the case of the accident at Elsenham it is considered that the broadcast of a distinct second alarm or the transmission of a spoken message, possibly linked to the opening of the gate, may have prevented the two girls from proceeding into the path of the second train. However, research into such a device and its effectiveness in modifying the behaviour of users is needed.

Locking

337 The RSPG state that where pedestrian gates are provided across the footway at a gated vehicular crossing operated by railway staff they should be lockable. Taken at face value this would require that the station pedestrian crossing at Elsenham be provided with lockable gates to be secured by the crossing keeper on the approach of trains. However, HMRI have since explained, that this guidance was not meant to apply to locations fitted with miniature stop lights.

338 The options for locking the gates on station pedestrian crossings are discussed at paragraph 165.

339 In the context of Elsenham the installation of locks on the gates would pose a number of problems. These are summarised as follows:

- In order for the station pedestrian crossing to operate in a safe manner it will be necessary for the locking of the gates to be detected before the railway signals are cleared (paragraph 165). In practical terms this means that the pedestrian gates should be closed just before, or after, the vehicular gates. This would effectively close the foot crossing for up to 4 minutes prior to the arrival of trains (longer if there are a number of trains approaching the crossing). This delay could inconvenience passengers and encourage deliberate misuse unless an alternative means of crossing the line were provided (The general issues associated with the locking of gates at station pedestrian crossings are discussed at paragraphs 164 and 165).
- An alternative design of gate that would lock automatically when the train was approaching would be less inconvenient but would pose some other safety issues (these are listed at paragraph 165c).

Provision of a footbridge

340 The RAIB investigation has included an assessment of the technical feasibility of a footbridge. This assessment has concluded that the construction of a stepped footbridge across the railway from platform 1 to Station Road at Elsenham would pose no significant engineering difficulties. In concept such a footbridge would be similar to those found at many other stations on the London Liverpool Street to Cambridge route.

341 A footbridge linking the platforms directly would be difficult to construct due to the staggered platform arrangement at Elsenham.

342 Construction of a footbridge with access ramps, or lifts, is unlikely to be viable given much higher construction costs and the potential environmental impact. However, the need for such facilities can be avoided if the existing station pedestrian crossing is retained for use when the vehicular crossing gates are closed across the railway.

343 Passengers will prefer to use a level crossing route as opposed to climbing the stairs on a footbridge. At Elsenham this would generate the risk that users will be diverted onto the narrow vehicular crossing where they would be exposed to the risk of being struck by road vehicles. This risk can be mitigated by retaining the foot crossing for use when the vehicular gates are open to the highway or by extending the width of the vehicular crossing to include a safe walking route.

The management of risks

344 Prior to April 2005 the railway industry had no specific risk assessment process to cover station pedestrian crossings. Instead procedures had specified that the condition of footpath crossings should be checked on a regular basis (for details see paragraph 120).

345 Paragraph 121 describes the development of a national policy to carry out a risk assessment on all level crossings in line with Railway Group Standard GI/RT7011. This policy gave rise to the development of a simple risk scoring system, for use by trained assessors, which was tailored for the particular characteristics of station pedestrian crossings.

346 On 14 April 2005 the new risk scoring system was deployed at Elsenham. The assessment was carried out by a trained assessor from Network Rail. The score obtained was 28.

347 On 5 December 2005, the Monday after the accident, Network Rail decided to repeat the earlier assessment. This time the score was 47.

348 Using the assessment criteria adopted by Network Rail on 14 April, a score of 28 equates to a level of risk at which no action is required to improve safety. On the other hand a score of 47 is a score that requires the need for additional risk control measures to be considered in line with Railway Group Standard GI/RT 7011 (see Appendix I for details).

349 The differences obtained were explained by incorrect scores under the following headings:

- frequency of misuse;
- frequency of use;
- number of trains; and
- probability of stepping out from behind a train.

350 None of the above factors had changed significantly between April and December 2005.

351 Network Rail's revised risk score for Elsenham, at 47, is the third highest they have recorded for any station pedestrian crossing on the national network. The two higher scores are for Downham Market (53) and Crowle (48) stations.

352 The revised score for Elsenham took no account for the additional local factors at Elsenham. Nor was an allowance made for the cant of the track.

353 The scoring system is not a sophisticated tool for the measurement of risk and certain of the assessment criteria are dependant on the judgement of the assessor. For this reason it was envisaged to be a temporary solution to the requirement for risk assessments at station pedestrian crossings prior to development of a more sophisticated quantified risk assessment tool designed to cover every type of level crossing, the ALCRM (paragraph 126). Work on this model is currently in progress.

354 The experience at Elsenham has demonstrated the importance of ensuring that persons tasked with carrying out risk assessments on site have the necessary competency, and the need for a process to check the validity of risk assessments that are undertaken (**Recommendation 3**).

355 There was no process for Network Rail and the station operator to jointly review the risks associated with the station pedestrian crossing (**Recommendation 2**).

356 The RAIB has assessed various inherent risk factors at station pedestrian crossings throughout the UK (paragraphs 137 to 138). This has enabled the comparison of inherent risk factors at Elsenham with the average risk at each type of station pedestrian crossing in the UK (see Table 9) and the production of an indicative listing of all station pedestrian crossings ranked according to the severity of the inherent risk factors.

357 The risk scoring shown in Table 9 makes no allowance for local factors at each crossing (this can only be done following detailed risk assessments at each location). However, in the case of Elsenham it is known that there a range of local factors that are likely to increase the level of risk. It is therefore unlikely that the inclusion of local factors for each individual station pedestrian crossing would significantly change the ranking shown in Table 9.

Type of crossing	No.	*Passenger journeys per annum (average for crossing type)*	*Maximum line speed (average for crossing type)*	*Number of trains per peak hour (average for crossing type)*	*Number of non-stop trains per peak hour (average for crossing type)*	*Inherent risk score (average for crossing type)*
Elsenham	**1**	***170000***	***70***	***8.0***	***5.0***	***28.0***
SPC-GMSL	**2**	138953	70	6.7	3.0	16.4
SPC-MSL	**17**	60478	69	5.3	2.5	22.5
SPC-GL	**13**	40559	68	3.4	1.5	12.0
SPC-G	**15**	15705	52	2.7	0.8	7.8
SPC-Open	**50**	28277	46	2.4	0.9	7.9

Table 9: Average values of selected inherent risk factors at various types of station pedestrian crossing (compared to Elsenham)

358 The analyses performed by the RAIB indicate that the inherent risk factors at Elsenham are amongst the highest at station pedestrian crossings on the UK mainline network, and therefore deserving of particular attention.

Other issues

359 The absence of a facility on the Downside of the station for the purchase of tickets was a factor in this accident. The girls might not have needed to cross over the line had there been a facility on the platform to purchase tickets. Alternatively, the provision of a facility to purchase tickets on the train for passengers whilst travelling on Down trains from Elsenham would avoid the need for some passengers to cross the line twice in order to buy a ticket.

360 Evidence indicates that the BTP had no special concerns about Elsenham prior to the accident. However, their records show that in the year prior to the accident three instances of misuse were reported to the BTP. All were logged but in none of the cases did the BTP respond since it was judged that it would be very difficult to detect the perpetrator in the absence of CCTV images.

Conclusions

General findings

Risk management

361 The overall levels of individual risk that have been identified are sufficiently high to justify the production of a detailed risk assessment for each station pedestrian crossing in order to identify any crossings at which the level of risk to the most exposed user is intolerable. In those cases where individual risk is found to be intolerable immediate actions should be taken to reduce the risk to a level that is tolerable (**Recommendation 2**).

362 The overall risk to society posed by station pedestrian crossings is unlikely to justify the expenditure needed to support the upgrading of the safety measures across the entire network. However, the overall level of risk identified by the RAIB is sufficient to justify the development of a long term programme for the upgrading of station pedestrian crossings at those locations where it is reasonably practicable to do so. Such a programme should start with those at which the risks are judged to be the highest (**Recommendation 2**).

363 Despite the above the highest levels of collective risk are generated by automatic vehicular crossings. This is due to the potential for a catastrophic outcome, such as the derailment of a train. The above programme of upgrades to the facilities at high risk station pedestrian crossings should not be permitted to deflect attention from the ongoing safety management of automatic vehicular crossings.

364 In order to manage the particular risks associated with foot crossings at stations it is necessary for Network Rail to adopt consistent definitions and terminology across its network. It is also important that all foot crossings that are used to access a station platform are included in the list (this will include many that were formerly classified as User Worked or Footpath Crossings). In all cases Network Rail should distinguish between staff crossings and those that are available for use by members of the public (paragraph 83 and **Recommendation 1**).

HMRI guidance and railway standards

365 The RSPG gives insufficient guidance on managing the risks that are specific to station pedestrian crossings.

366 The RSPG was last issued in 1996. Since that time the document has not been updated to incorporate human factors issues nor has it been revised to reflect the current views of HMRI inspectors on important safety matters (e.g. the location of miniature stop lights) (**Recommendation 4**).

Fixed signage

367 In general, the meaning of the information on fixed signage at station pedestrian crossings is clear. However,in some cases there is no advice given to users concerning the risk from a second train (paragraph 154 and **Recommendation 6**).

368 At station pedestrian crossings equipped with miniature stop lights where there is no telephone the wording of the sign that is currently mandated suggests that the crossings can continue to be used safely when there is no light showing. This is not often the case since miniature stop lights are generally installed at those locations where the sighting time is shorter than the time taken to cross in safety.

Fencing

369 At some station pedestrian crossings, the angle of the approach to the track can discourage users from looking before stepping onto the track and/or can lessen the visual impact of the stop lights. Where the physical layout of the crossing permits it this risk can be effectively mitigated by the installation of fencing to direct passengers to approach the track at right angles with a head-on view of the miniature stop lights and/or signage (paragraph 147, **Recommendations 4 and 5**).

Locking of gates

370 Thirteen per cent of station pedestrian crossings are provided with gates that can be locked by the signaller or crossing keeper on the approach of train. This safety measure can work effectively and safely at station pedestrian crossings provided the pedestrian traffic is not too high and provided the signaller or crossing keeper is able to do this reliably.

371 Implementation of locking at existing gates is likely to introduce some new risks. These include the following:

- inability of the signaller or crossing keeper to close the gate in good time;
- trapping of persons inside gates (although this can be mitigated by the provision of a safety zone between the track and the gate);
- accidents resulting from the unreliability of the locking/unlocking mechanism; and
- increasing the levels of abuse (persons climbing the closed gates).

372 At manned locations, the above risks can be controlled if the locking of the station pedestrian gate is linked to the signalling (i.e. the signals cannot be cleared until the pedestrian gates are proved to be locked shut). However, this solution will introduce additional delays to users since the gates will need to be closed sufficiently early to avoid approaching trains from encountering a restrictive signal aspect. These delays can give rise to trespass including climbing of the gate. For this reason this option may sometimes necessitate the construction of a footbridge or subway.

Miniature stop lights

373 The meaning of miniature stop lights is well understood by the majority of users. However, given the potential for distraction at station pedestrian crossings there is a particular need to ensure that the attention of users is drawn to the lights. At most stations this need is exacerbated by the absence of gates to mark the approach to the track. These factors necessitate that the lights are conspicuous and well positioned.

374 The reliable operation of the lights is vital at those locations where elapsed time between the user's first sight of an approaching train and its arrival at the crossing is shorter than the time taken to cross.

375 Network Rail's decision to upgrade all miniature stop lights to a new design based on the use of light emitting diode (LED) technology will ensure an improvement in both the conspicuity and reliability of the lights (paragraph 169, **Recommendations 4 and 5**).

Another train coming warning

376 When two trains are approaching a station pedestrian crossing at the same time there is a chance that passengers will cross before or immediately after the first train has passed clear without realising that a second train is coming. It is possible that this risk could be mitigated by providing a specific visual indication or audible alarm when a second train is approaching. Further research is required to assess the effectiveness of a visual second train coming warning (paragraph 182, **Recommendations 4 and 5**).

Audible alarms

377 There is a good awareness of the meaning of audible alarms [Ref. Appendix H, 6]. However, few users are likely to understand the meaning of a second tone if this is used to warn of the approach of a second train.

378 There is evidence that voice messages are a more effective way of warning users of a specific hazard, such as the approach of a second train (paragraph 191, **Recommendations 4 and 5**). However, the effectiveness of this design option should be the subject of trials in order to verify its effectiveness in the UK railway environment.

Access for disabled and mobility impaired persons

379 The railway industry perceives that the cost of eliminating station pedestrian crossings has risen due to the requirement to preserve existing step free access routes.

380 The provision of ramps and lifts to enable access via a new footbridge or subway is unlikely to prove cost-effective at most locations and may not fully address the needs of disabled and mobility impaired users.

381 Where footbridges or subways are proposed as a replacement for a station pedestrian crossing that is adjacent to a vehicular crossing the retention of the pedestrian crossing for use by passengers, including mobility impaired persons, is can be a viable option but can only be achieved in limited circumstances (where there are staff to operate the crossing).

Minimising the use of station pedestrian crossings

382 At a small number of locations additional use of the station pedestrian crossing is generated by the need to cross the line to use passenger facilities (such as the booking office) (paragraph 359, **Recommendation 8**).

The responsibilities of crossing users and providers

383 The estimated risk at 96% of risk at level crossings arises due to the actions of users [Ref. Appendix H, 18]. However, there is no clear data on the proportion of accidents that arise due to the deliberate misuse of crossings as opposed to those arising due to errors and lapses.

384 In the context of station pedestrian crossings users have an obligation to take care and to follow any instructions. Providers of crossings have an obligation to take reasonably practicable steps to reduce the risk that users will be harmed as a consequence of an error or lapse. Such steps should take into account the likely population of users. Additional measures (e.g. audible alarms) may sometimes be required where the population includes vulnerable persons such as unaccompanied minors, the elderly and the disabled.

Education of users

385 The education of station pedestrian crossing users should be focused on the communities located around the highest risk station pedestrian crossings.

386 At Woodlesford, near Leeds, Northern Trains have been issuing leaflets to passengers to advise them of the hazards. This approach is commended.

387 Policing initiatives (supported by CCTV installations where appropriate) will help to deter misuse. For such initiatives to be effective there is a need for close liaison between the BTP, Network Rail and the local train operator(s) (paragraph 247).

Findings specific to the station pedestrian crossing at Elsenham

388 Elsenham station pedestrian crossing has been the site of two fatal accidents. The first, in 1989, resulted in one death. The second, on 3 December 2005, resulted in the death of two teenage girls.

389 There are a number factors contributing to risk at Elsenham station pedestrian crossing. These include the following:

- The line has traffic levels of up to 9 trains per hour in the peak.
- The trains that pass through are a mixture of stopping and fast trains.
- The booking office and ticket machines are located on platform 1. Many passengers travelling from platform 2 must therefore cross the line twice to buy their ticket.
- Elsenham has a significant number of users who are of school age.
- The station pedestrian crossing at Elsenham is used by 60 - 90 persons per peak hour. This is well above the average for station pedestrian crossings.
- The angle of the crossing is skewed (this means that intending users of the crossing must turn or look over their right shoulder in order to observe the approach of a train on the track nearest to them).
- The elapsed time between a train being sighted and it reaching the crossing is very short (about three seconds).

390 The last of the above risk factors is mitigated by the provision of miniature stop lights. These are provided on the side of the track nearest to an intending user. This positioning is inconsistent with the current guidance contained in the RSPG. However, this inconsistency does not have any bearing on the accident that occurred.

391 The risk assessment carried out at Elsenham by Network Rail in April 2005 was incorrect and was not the subject of consultation with the station operator. The resulting assessment of the risks posed to users at Elsenham was therefore substantially flawed (paragraph 348, **Recommendation 3**).

392 According to the analysis preformed by the RAIB as part of this investigation, the inherent risk factors at Elsenham are amongst the highest at any station pedestrian crossing on the UK mainline network, and therefore deserving of special attention (paragraph 358).

393 Network Rail's own assessment of risk[14] using its semi-quantative scoring system shows Elsenham to have the third highest risk at any station pedestrian crossing on the UK network.

394 The crossing keeper had no formal responsibilities for the safe operation of the station pedestrian crossing at Elsenham. Furthermore, the investigation has revealed that there was no systematic management process to monitor and review the levels of misuse at Elsenham level crossing. In particular there was no process to ensure that relevant entries in the occurrence book were entered into the railway industry's Safety Management Information System (SMIS).

[14] Incorporating the revised assessment at Elsenham carried out on the 05 December 2005

Causal factors relevant to the accident at Elsenham on 3 December 2005

395 The immediate cause of the accident was the two teenage girls stepping into the path of an approaching train despite the continued display of a red light and the sounding of an audible alarm.

396 It is likely that the accident occurred due to the girls' focus of attention on a train to Cambridge (the Down train) and the consequent failure to perceive the risk from trains in the opposite direction. This focus of attention on the Down train to the exclusion of Up trains was likely to have been created by a strong motivation to catch their intended train combined with an erroneous belief that the audible alarm related only to the train that was passing ahead of them.

397 The investigation has considered the degree to which the girls' state of mind may have contributed to the accident (paragraph 317). It is concluded that it is not possible to draw a clear link between their likely state of mind and their subsequent error.

398 The following factors contributed to the occurrence of the accident:

- the design of the crossing at Elsenham did not physically prevent users from opening the gate and walking onto the line when a train was approaching; and
- the warning signs and systems at the crossing did not deter the girls from stepping into the path of the second train (paragraph 376, **Recommendations 4 and 5**).

399 In addition to the above, it is possible that the presence of a ticket machine on the Down platform would have avoided the need for the girls to cross the line.

Actions already taken or in progress, relevant to this report

400 Since the accident at Elsenham, Network Rail has completed its risk scoring of station pedestrian crossings on the UK network. This shows that the risk score at Elsenham is the third highest for any station pedestrian crossing.

401 Network Rail has already commenced the development of the ALCRM. This is planned for implementation in late 2006. When fully implemented it will provide a tool for the quantified assessment of risk at station pedestrian crossings. As such it will complement the risk scoring methodology that is already in place. To date the ALCRM does not incorporate local factors such as the use of stations by school children and other vulnerable groups.

402 The RSSB Formal Inquiry report following the accident at Elsenham makes a number of recommendations. The most important of these are summarised below (the current status of each is summarised in square brackets, thus [ ]):

- Review of the RSPG to incorporate existing knowledge on human factors and to deliver compatible systems for all types of level crossing [this review is to be undertaken by HMRI in consultation with RSSB and Network Rail].
- Risk assessments to be carried out at all station pedestrian crossings with miniature stop lights to identify reasonably practicable safety system controls. The purpose of this is to identify any additional reasonably practicable options for improving safety at these crossings [ongoing].
- Initiate with ORR a review of station access conditions [ongoing].
- Consult with community leaders at Elsenham to establish their views on the current levels of misuse and the balance to be struck between convenience and safety [one such meeting has already taken place].
- Consider permanent installation of video surveillance equipment [an installation is already in place].
- Arrange publicity and education on the safe use of station pedestrian crossings [this has commenced].
- Review options for installing ticket facilities on the Downside of the station ['one Railway' have installed a ticket machine on the Down platform].
- Ensure that safety related events recorded in the signalling keepers' book at Elsenham are reviewed and entered into SMIS [arrangements in place].
- Ensure that risk assessment procedures take into account local factors that motivate misuse [ongoing].
- Revise the duties of the crossing keeper at Elsenham to include a general responsibility for the safety of passengers and the public using the station pedestrian crossing [complete].

403 Network Rail has accepted all of the above recommendations and has commenced their implementation. In particular, video surveillance equipment has been installed at Elsenham specifically monitoring the station pedestrian crossing.

404 The Network Rail National Railway Crime Education scheme is in existence. An initiative to educate the users of the crossing at Elsenham has been launched. This is to be extended to include other station pedestrian crossings. To support this, a public information leaflet has been prepared outlining the risks at station pedestrian crossings with miniature stop lights and to inform users of the correct behaviour.

405 During the drafting of this investigation report, and subsequent to informal consultation on the recommendations, Network Rail announced to the press that it intended to alter the method of working by locking the pedestrian gates at the same time as the vehicular gates are closed to the highway. It has also announced that it intends to construct a footbridge for use when the pedestrian gates are closed. These proposals are consistent with RAIB's **Recommendations 9 and 10**.

406 RSSB has initiated a research programme to investigate methods of warning level crossing users of the approach of a second train (Ref. research project T652). (**Recommendation 5**).

Recommendations

407 The following safety recommendations are made:[15]

General recommendations to address safety matters observed during the investigation

Development of a risk based strategy for the management of risk at station pedestrian crossings

1 Network Rail to establish standard definitions and terminology to cover the various types of foot crossings at stations and to prepare a validated list of all station pedestrian crossings on its network (paragraph 364).

2 Network Rail in consultation with Station Operators to ensure that a suitable quantified risk assessment is conducted for each station pedestrian crossing. In conjunction with these risk assessments Network Rail should develop and implement a programme to address each of the following:

- the upgrading of all station pedestrian crossings at which the individual risk to the most exposed user is assessed as being above the upper limit of tolerability (paragraph 361); and
- the implementation of improved safety measures, where shown to be necessary, commensurate with the level of risk at each station pedestrian crossing (paragraph 362).

Any risk assessments undertaken in furtherance of this recommendation should take into account local factors such as the number of school aged children and elderly persons using the crossings.

3 Network Rail to review its management system to ensure the competence of the persons carrying out risk assessments at station pedestrian crossings (paragraph 391).

Design standards and guidance

4 ORR, in consultation with Network Rail and DfT, to undertake a comprehensive review of existing guidance relating to the design of station pedestrian crossings. This should include a review of current technologies and the modern understanding of human factors. This review should include each of the following:

a. Use of fencing to direct passengers to approach the crossing by the route that best enables them to observe the approach of trains whilst drawing their attention to any associated signs or stop lights (paragraph 369).

continued

[15] Responsibilities in respect of these recommendations are set out in the Railways (Accident Investigation and Reporting) Regulations 2005 and the accompanying guidance notes, which can be found on RAIB's web site at www.raib.gov.uk

b. An assessment of the safety benefits and disbenefits of providing pedestrian gates on the final approach to station pedestrian crossings (paragraph 162).

c. Research into the technical feasibility and safety benefit of providing an additional set of stop lights on the far side of the crossing from an approaching user to repeat the indication of the lights on the near side ('back-to-back' lights) (paragraph 169).

d. Research into the most effective means of providing users with an active warning to alert them of the approach of a second train. This should encompass research into the effectiveness of visual displays and/or voice messages as a means of alerting users (paragraph 376).

5 Network Rail, to carry out the necessary research, tests and trials to inform a review its own designs and operating policies for station pedestrian crossings and as an input to the review of guidance to be undertaken by ORR in line with **Recommendation 4**.

6 Network Rail to seek approval from ORR(HMRI) for the installation of fixed signage at station pedestrian crossings that cross more than one running line to remind users of the risk from a second train (paragraph 367).

7 Network Rail to expedite its programme for the installation of LED stop lights at all station pedestrian crossings that are currently equipped with miniature stop lights and to revise its Company Standards accordingly (paragraph 375).

8 Station operators to identify those locations where intending passengers are required to use a station pedestrian crossing in order to use the station facilities (e.g. booking offices, ticket machines, waiting rooms or toilets). In all such locations train operators should, where it is reasonably practicable to do so, install suitable facilities (e.g. another ticket issuing machine) to reduce the need for passengers to cross the line (paragraph 382).

Recommendations to address causal and contributory factors at Elsenham

9 Network Rail, in consultation with the station operator and representatives of the local community, to adjust the operation of the station pedestrian crossing by requiring that the pedestrian gates be locked in the closed position before signals can be cleared for the approach of trains (paragraphs 372, 392 & 398).

10 If necessary for the avoidance of delays, and subsequent misuse by intending passengers, a stepped footbridge should be constructed to provide an alternative route (mobility impaired users will be able to use the existing crossing in safety at all times when the gates are open to the highway) (paragraph 372).

Appendices

Glossary of abbreviations and acronyms — Appendix A

AHB	Automatic Half Barriers
ALARP	As Low As Reasonably Practicable
ALCRM	All Level Crossing Risk Model
AOCL	Automatic Open Crossings, Locally monitored
BTP	British Transport Police
CCTV	Closed Circuit Television
DDA	Disability Discrimination Act
DfT	Department for Transport
HMRI / ORR(HMRI)	Her Majesty's Railway Inspectorate (formerly part of HSE, now part of ORR)
HSE	Health & Safety Executive
LC (Stn)	Vehicular level crossings with wicket gates, in proximity to stations, that form the means of access to a platform
MSL	Miniature Stop Lights
MWL	Miniature Warning Lights
ORR	Office of Rail Regulation
ORR(HMRI)	See HMRI
RAIB	Rail Accident Investigation Branch
RGS	Railway Group Standard(s)
ROGS	Railways and Other Guided Transport Systems (Safety) Regulations 2006
RSCR	The Railways (Safety Case) Regulations 2000
RSPG	Railway Safety Principals and Guidance
RSSB	Rail Safety and Standards Board
SMIS	Safety Management Information System
SPC-G	Station pedestrian crossings equipped with unlocked gates on both sides of the track
SPC-GL	Station pedestrian crossings equipped with gates that are locked by the signaller or crossing keeper on the approach of the trains
SPC-GMSL	Station pedestrian crossings equipped with unlocked gates and miniature stop lights on both sides of the track

SPC-MSL	Ungated station pedestrian crossings equipped with miniature stop lights
SPC-Open	Station pedestrian crossings with no gates or miniature stop lights
VPF	Value of Preventing a Fatality

Glossary of terms — Appendix B

Active systems	Systems that display or sound a warning on the approach of a train.
Barrow crossing	(see 'Staff crossing')
Catenary wires	Overhead wires which support the contact wire.
Collective risk	The average risk to all people involved in the activity as a whole, measured as a frequency of a particular outcome (e.g. *equivalent fatalities* per annum).
Colour light type (of signals)	A signal displaying an indication by means of coloured lights.
Down (at Elsenham)	The direction towards Cambridge.
Downside (platform)	The platform serving Down trains (Cambridge bound).
Footpath crossing	A pedestrian level crossing which forms part of a public right of way across the railway.
Individual risk	The risk to a specified individual, measured as a probability of death per unit of time or per activity (e.g. probability of death per annum for the person who is most exposed to a risk).
Inherent risk factor	Factors likely to generate risk.
Line of sight (tramways)	A method of operation in which the separation of trams is dependant on the driver seeing the tram ahead and regulating his/her speed so as to avoid a collision.
Line speed	The speed at which trains are authorised to travel.
Miniature Stop Lights (MSL)	Small red and green lights indicating when it is safe or unsafe to proceed across a vehicular or footpath level crossing.
National Level Crossing Safety Group	A group set up on the initiative of RSSB, HMRI and Network Rail. The role of the group is to encourage closer relations between the organisations involved in level crossing safety and to enable the widest possible consideration of safety issues including those associated with user behaviour.
Net Present Worth	A standard term used to describe the real value of an investment in a long term project.
Overhead line equipment	The equipment suspended over the railway for supplying electricity to electric trains.
Sighting distance	The distance from the crossing that an approaching train is first clearly visible to the user.
Sighting time	The elapsed time between the user's first sight of an approaching train and its arrival at the crossing.
Staff crossing (Barrow crossing)	Crossings not available for use by the public unless escorted by railway staff, sometimes referred to as 'barrow crossings'.

Station Code	Code defining the contractual responsibilities of all parties at stations (an ORR document).
Station pedestrian crossing	For the purpose of this report this defined as a pedestrian level crossing which forms part of a public access route to/from a platform at a railway station that is designed to be used without escort or supervision by railway staff.
Station pedestrian level crossing	A collective term for all types of pedestrian crossings found at stations (includes all station pedestrian crossings and staff crossings).
Third rail electrification	A form of railway electrification in which traction power is supplied to trains by means of a conductor rail located parallel to the running rail.
Track circuit	An electrical device using rails in an electric circuit, which detects the absence of trains on a defined section of line.
Up (at Elsenham)	The direction towards London Liverpool Street.
Upside (platform)	The platform serving Up trains (London bound).
User Worked Crossings	A level crossing, where the user operates the crossing gates or barriers themselves.
Vehicular crossing	Level crossing designed for the transit of road vehicles.
Warning time	The time between the first warning of a train's approach and its arrival at the crossing.
Whistle boards	Line side sign instructing drivers to sound their horn.

Distribution and types of pedestrian gates at highway level crossings (other than at stations)

Appendix C

Type of crossing	**Distribution (by geographical 'route')**								
	Scotland	LNE	Anglia	Kent	Sussex	Wessex	Western	LNW	**Total for type**
Gates with miniature stop lights	5	19	14			3	13		**54**
Gates that can be locked on the approach of a train		21	7			1	2	1	**32**
Gates with no lights or locks		160	41	10	7	15	4	1	**238**

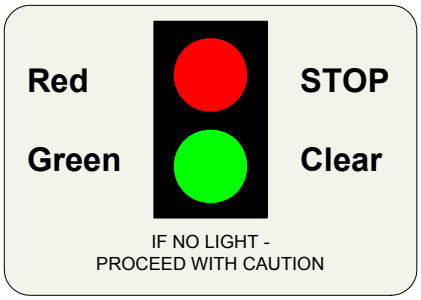
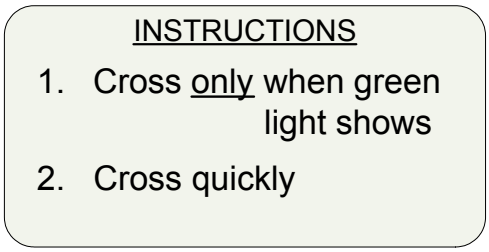
Summary of HMRI principles and guidance relevant to station pedestrian crossings — Appendix D

Shown below are extracts from the RSPG as relevant to station pedestrian crossings. The following requirements are not mandatory but are often used by HMRI as a basis for assessment when approving new or modified crossings.

Clause	Summary	RAIB Comment
11	Assessment of suitability of type of level crossings to be carried out whenever: a. circumstances at the crossing are to change; b. circumstances at the crossing are found to have altered; c. after a period of between 2 and 4 years.	
21	There are two types of non-vehicular crossing; a. footpath crossing; b. bridleway crossing. There is no separate category for station pedestrian crossings	
22	Footpath crossings are only considered suitable if the following conditions apply: a. train speeds should not exceed 160km/h; b. no more than two tracks over the crossing; c. the 'warning time' should be greater than the time required by users to traverse the crossing unless additional protection is provided; d. where miniature stop lights are provided, the notice given of the approach of a train should be at least 5 seconds longer than the time taken to traverse the crossing.	
147 148	When assessing the speed at which users will traverse the crossing, allowance should be made for the mobility of likely users and the crossing surface. A value of 1.2 m/s should be used where the crossing surface is level with the top of the rail.	
138	Users are expected to use reasonable vigilance	

[15] The time taken for users to traverse the distance between the decision points at each end of the

Clause	Summary	RAIB Comment
139	Footpath crossings should be equipped with a stile or self-closing pedestrian gate on both sides of the railway	Station pedestrian crossings are classified as footpath crossings. However, only 32 per cent of such crossings have gates.
142	Provision of a sign at the decision point on both sides of the crossing to explain how to use the crossing safely	
153	Miniature stop lights may be provided where: a. the crossing is the only access to houses; b. train speeds are in excess of 140km/h; c. the provision of whistle boards is considered to be inappropriate.	
154	An audible alarm may be provided if the crossing is regularly used by unaccompanied partially sighted or blind people	
194	An even, unobstructed walking surface to be provided on crossing	
197	A non-slip surface is to be provided	
199	The crossing surface should be made up to rail level if: a. the crossing is in proximity to houses and factories etc.; b. any of the approaches are metalled; c. there is regular or heavy use.	
207	Width of the foot crossing should be no less than 1m	
210	Foot crossing should be at right angles to the railway line	
216	Pedestrian gates should be at least 1m wide	
217	Pedestrian gates should be self closing. Latches which might prevent the gates being opened quickly should not be used Where pedestrian gates are provided across the footway at gated crossings operated by railway staff, they should be lockable.	As written this clause implies that all pedestrian gates associated with manned gated vehicular crossings should be lockable. HMRI and Network Rail have stated that it was never the intention that this be applied to crossings fitted with miniature stop lights.

Clause	Summary	RAIB Comment
246 247	Miniature stop lights consist of red and green lights mounted on a specified sign (see the Figure below)  The sign shown in the Figure below should be mounted with miniature stop lights on the far side of the crossing from the approaching user (with duplicates on the near side of the crossing)  If provided, miniature stop lights should be positioned to face toward an approaching user. Miniature stop lights should be clearly visible when opening associated gates.	
248	At footpath crossings the miniature stop lights should be placed on the far side of the crossing from an approaching user and face inwards towards the railway	A number of SPC-GMSL and SPC-MSL crossings do not match this description (most of which were installed before RSPG came into force). HMRI have stated that they no longer support the adoption of this design.
250	Miniature stop lights should be of adequate luminous intensity and hooded against sunlight	
254	The miniature stop lights should be operated by the approach of a train in order to give 20 seconds warning. This should be at least 5 seconds longer than the time taken to traverse the crossing.	
255	The green light should show until the red light appears. Once the train clears the crossing, the red light should be extinguished and the green light illuminated unless another train is approaching.	In the case of footpath crossings there is no requirement for an active audible warning of the approach of a second train (however, this is a requirement at automatic crossings)

Summary of Railway Group Standards and Guidance Appendix E

Standard	Clause	Requirement	RAIB Comment
7011 (withdrawn)	C.2.1	Every level crossing should be subject to a valid risk assessment. This should take into account: ● characteristics of railway traffic; ● types of users; ● level of use; ● effectiveness of safety measures that are in place; ● warning times; ● history of the crossing; ● local conditions.	
7011 (withdrawn)	C.2.2	A risk assessment should be carried out at least once every 5 years	
7011 (withdrawn)	C.2.3	Depending on the results of the risk assessment consideration should be given to the following: ● closure of the crossing (if the risk is assessed to unacceptable); ● upgrading of the crossing so far as this is reasonably practicable; ● no further action (if the risks are so low that any upgrade is considered not to be reasonably practicable).	
7011 (withdrawn)	C.3	All risk assessments should be suitably recorded.	
7011 (withdrawn)	C.4	All risk assessments should be carried out by competent persons	

Standard	Clause	Requirement	Comment
7011 (withdrawn)	Appendix 1	The minimum provision of level crossing control measures at station pedestrian crossings are shown as follows: **Monitoring of crossing required?** Not required **Type of barrier required?** Not required **Fixed signs required?** Yes **Phone to signaller required?** Not required **Active visible warning required?** Yes, if warning time is less than crossing time **Active audible warning required?** No **Limit on train speed?** Not to be provided	
7611 (guidance) (withdrawn)	C.1.2	The target for individual risk at level crossings is: 10^{-6} per annum (based on a person using the crossing 500 times per annum)	
7012	C.3.3	Pedestrian gates on footpath crossings must open away from the railway	
7012	C.4.1	Suitable signs to be displayed at station pedestrian crossings	
7012	C.6.2	At footpath crossings the miniature stop lights should be placed on the side of the crossing nearest an approaching user and face outwards away from the railway	This is in direct contradiction to the guidance contained in RSPG. Network Rail and HMRI have confirmed that they are agreed on a preference for miniature stop lights to be placed on the side nearest an approaching user.
7012	C.7.6	Whistle boards are permitted on the approach to a footpath crossing (subject to risk assessment)	

Summary of particular hazard factors at station pedestrian crossings (ie risks differing from those at footpath crossings.) Appendix F

	Risk factor	*Is risk factor considered to be higher or lower than for footpath crossings?*
a.	Station pedestrian crossings often approached at an acute angle (i.e. down the platform ramp, parallel with the railway line)	↑
b.	Potential for distraction and/or risk taking when wishing to catch trains	↑
c.	Potential for distraction when being met at station	↑
d.	Potential for persons to step out from behind a stationary train	↑
e.	Potential for a stationary train to block the view of an approaching train	↑
f.	Noise of slow moving or stationary trains can mask approach of another train	↑
g.	Failure to fully appreciate that some trains do not stop at stations	↑
h.	Need for repeated crossing of line to use station facilities (e.g. booking office or ticket machine)	↑
i.	Persons will tend to use the crossings around the time at which trains are scheduled to call.	↑
j.	Some regular users will gain knowledge of the timetable and can therefore use crossing without first checking that it is safe to do so.	**Not known**
k.	Large groups of persons using crossing together (e.g. after arrival of train or shortly before departure of train). Risk of 'herding' (tendency of persons to follow each other without assessing the safety of what they are about to do)	↑
l.	Many passengers will be carrying baggage etc.	↑
m.	Users are more likely to using mobile phones or texting on station pedestrian crossings	↑
n.	Intending passengers will time their journey to arrive at the station at the last minute or allow inadequate time to buy tickets (this means the use of station pedestrian crossings is often at the last minute)	↑
o.	Station pedestrian crossings are used by persons who see themselves as passengers in the care of the railway. This may produce different behaviour	↑
p.	Station pedestrian crossings are usually lit (reduction of slip, trip and falls *vs.* masking view of the headlights of an approaching train)	**Not known**
q.	Drivers are more alert on the approach to stations	↓
r.	Station pedestrian crossings have even non-slip surfaces and some are subject to gritting during bad weather	↓
s.	Most station pedestrian crossings have no gate. Where gates are provided these are non-latching	**Not known**

	Potential additional safety measure	Advantage	Disadvantage
1.	Closure of the crossing (pedestrians to use the vehicular crossing)	Removes risk on pedestrian crossing (this solution has already been applied at many locations where full barrier crossings have replaced manually operated gates)	Risk from persons being struck by road vehicles unless the width of the crossing (and gates) is increased to permit separate walking route Delays to intending passengers (waiting for vehicular gates to open)
2.	Improve the positioning of signage	Improve chances of modifying the behaviour of users	Improvements in behaviour likely to be marginal
3.	Update the wording 'IF NO LIGHT – BEWARE' to current standard ('IF NO LIGHT – PROCEED WITH CAUTION')	Consistency with railway standards and RSPG	Doubtful that the standard wording is more appropriate since it advises the user to proceed when no lights are showing.
4.	Add warning about 'another train coming'	Informs users of risks May modify the behaviour of users	Effectiveness not proven
5.	Improve the conspicuity of stop lights	Greater chance that a danger indication will be observed and acted upon	

	Potential additional safety measure	Advantage	Disadvantage
6.	Install a second set of stop lights on the far side of the crossing from an approaching user and facing inwards towards the railway. These should repeat the indication of the set of lights on the near side (i.e. co-acting signals)	Danger signal remains visible at all times Consistent with typical arrangement at traffic lights and pedestrian crossings on roads	May confuse users if the indication changes as the user is crossing
7.	Install a prominent device to display an illuminated message when a second train is approaching (as installed at some automatic crossings); e.g. 'ANOTHER TRAIN COMING'	Display of precise information to users Limited environmental impact	Visual messages are less effective than audible messages Information may not be understood by non-English speakers
8.	Upgrade the audible alarm to include a distinct tone to warn of the approach of a second train (this to sound as the front of the first train reaches the crossing)	May alert the user to the presence of another train	Meaning of second tone is not well understood
9.	Upgrade the audible alarm to include a voice message. These to include a warning on the approach of a second train (this to sound as the front of the first train reaches the crossing)	Information is more precise (provided the message is very simple) Warning of another train much more likely to be understood	Information may not be understood by non-English speakers

	Potential additional safety measure	Advantage	Disadvantage
10.	As above, but activated when the pedestrian gate is in the open position	Message is now transmitted in response to a specific action. For this reason it is likely to be more effective	Information may not be understood by non-English speakers Only suited to locations with pedestrian gates May not broadcast a warning to somebody who is already on the crossing
11.	Station pedestrian crossing gates to be locked when vehicular gates are closed to the highway	Provides same level of safety as for users in road vehicles	Delays to intending passengers, this may encourage misuse Pedestrian crossing must be seen to be clear before the gates are locked. For this reason this option will only work if the location is staffed or monitored by CCTV
12.	Station pedestrian crossing to be fitted with barriers that close at the same time as the vehicular gates	Provides same level of safety as for users in road vehicles	Delays to intending passengers, this may encourage misuse Pedestrian crossing must be seen to be clear before barriers are closed. For this reason this solution will only work if the location is staffed or monitored by CCTV Barriers may strike people Barriers may introduce reliability problems
13.	Installation of automatic locks that are activated by the approach of the train (with mechanism to allow the gates to be pushed open from the side closest to the track)	Prevents access to the crossing when the train is approaching Delays to users will be much less than with items 10 and 11 (30 seconds instead of 3 to 6 minutes)	High reliability of locking mechanism is essential: • if the gate remains locked the crossing will become unusable • if gates remains unlocked there is a risk that users will walk through when a train is approaching • if the gate cannot be opened from the inside users may become confused and act in an unsafe manner • gates that can be pushed open from one side can be pulled from another (complex design solution required)

	Potential additional safety measure	Advantage	Disadvantage
14.	Construction of footbridge or pedestrian subway (pedestrian crossing retained for use by the mobility impaired when the vehicular crossing is open to the highway)	Avoids the majority of users crossing the line at grade Safe step free route available for mobility impaired users (i.e. route can only be used when the vehicular gates are closed across the railway) Would avoid the need for long access ramps or lifts	If the gated crossing is later converted to full barriers alternative arrangements will be needed to ensure the supervision of the station pedestrian crossing (e.g. monitoring by CCTV)
15.	Construction of a footbridge with access ramps	Avoids users crossing the line at grade	Access ramps occupy much more space than stairs Access ramps are not suited for all mobility impaired persons (particularly unaccompanied users of unpowered wheelchairs)
16.	Construction of a footbridge with access lifts	Avoids users crossing the line at grade	High costs Lifts need to be monitored and supervised Vulnerable to breakdown and vandalism
17.	Installation of ticket machines on one platform to avoid the need to cross the line to visit the booking office	Would reduce the number of users requiring to cross the line	Additional maintenance and running costs

	Potential additional safety measure	Advantage	Disadvantage
18.	Special measures to enable passengers to travel on trains without first buying a ticket (to avoid the need to cross the line to visit the booking office)	Would reduce the number of users requiring to cross the line	Potential loss of revenue
19.	Extend duties of crossing keeper to include the supervision of the pedestrian crossing -	The crossing keeper has time between placing the gate keys into the control panel in his cabin and arrival of the train(s) to supervise the station pedestrian crossing. If the light shows red he is able to warn users to wait.	Difficult for the cross keeper to avert an accident without locking gate It is not possible for the crossing keeper to supervise both sides of the crossing Introduces a potential risk of miscommunication giving rise to an accident (unless gates are secured) Potential risk that passengers will become over-reliant on the crossing keeper
20.	Install fencing to direct passengers to approach the miniature stop lights head-on	Prevent users approaching the lights side-on thereby improving the chances of them observing the signal displayed and reading the associated signage.	May not be possible in all cases if there are space constraints
21.	Use of train horn on the approach to the station pedestrian crossing	Will alert any users on the station pedestrian crossing. It will also give an indication of the direction from which the train is coming Will provide a warning in case of failure of miniature stop lights and/or audible alarm	Unlikely to be heard above the sound of an audible alarm May give rise to environmental objections

	Potential additional safety measure	Advantage	Disadvantage
22.	Adjust the timetable to reduce the frequency of a non-stop train passing when a stopping train is in the station	Will reduce the risk to users from the second train	Only feasible at limited locations Imposes additional timetabling constraints Trains do not always keep to time
23.	Education of users in locality (publicity, school visits)	Better awareness and encouragement of compliance with rules	Benefits will be limited unless the programme is very targeted
24.	Enhanced policing of the crossing	Better awareness and encouragement of compliance with rules Deterrence of violations	Police require to direct finite resources at the crossings with the highest risk. These are automatic vehicular crossings Benefits will be limited unless the programme is very targeted
25.	CCTV surveillance to deter misuse	Deterrence of violations Assistance of post-incident investigations	
26.	Closure of the pedestrian crossing if the miniature stop lights are not functioning correctly	Enhance the safety of users	Pedestrians will require to cross the line by other means (e.g. via the vehicular crossing) and may therefore be exposed to higher levels of risk

List of references

Appendix H

No.	Reference	Title	Company	Author	Date	Other data
1	T332	Understanding the risk at station and barrow crossings.	RSSB	A D Little	October 2005	
2	T269	Human factors assessment of the risks associated with MWL crossings	RSSB	Human Engineering	21st June 2004	
3		Human factors inspection report	Report carried out for HMRI	Claire Dickinson	26th January 2006	
4	RR359	Level crossings summary of findings and key human factors issues	Health and Safety Executive	Davis Associates Limited	2005	
5	QINETIQ/D&TS/CS/CR0607991	Human factors and the risk to users of wicket gate crossings	QinetiQ	John Chappelow	June 2006	
6	T269	User behaviour at user worked crossings	RSSB	Human Engineering	21st June 2004	
7		Principles and guidelines to assist HSE in its judgements that duty-holders have reduced risk as low as reasonably practicable	Heath and Safety Executive			http://www.hse.gov.uk/risk/theory/alarp1.htm
8	Road Safety research Report No.60	Review of looked but failed to see accident causation factor	DfT			
9		Preventing child pedestrian accidents: Is motivational training needed?	West R, Yunger M and A Pickering			

No.	Reference	Title	Company	Author	Date	Other data
10	TRL 561	Adolescent road user behaviour	Transport Research Laboratory		March 2004	
11	TRL 599	Road safety behaviour of adolescent children in groups	Transport Research Laboratory		March 2004	
12	TRL 601	The attitudes and behaviour of adolescent road users: an application of the theory of planned behaviour	Transport Research Laboratory		March 2004	
13	FI3669/F	Formal Inquiry Report	RSSB		09 May 2006	
14		Engineering data compendium; human perception and performance Vol III.	Harry G Armstrong Medical Research Laboratory, Wright-Patterson Air Force Base, Ohio, USA	Boff, H.R and Lincoln, J.E	1988	
15	T269	Investigations into user acceptance of a novel warning device	RSSB	Human Engineering		
16		Code of Practice: Train and Station Services for Disabled People	SRA/DfT		30 August 2005	
17	HMS) 1983 ISBN 0 11 550596 2	Pedestrian Safety at Public Road Level Crossings	Report by Parliamentary Committee		1983	
18		First Report of the Working Party to the National Level Crossing Safety Group	National Level Crossing Safety Group		September 2006	

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APPENDIX A (Continued)

FOOTPATH CROSSINGS AT STATIONS

ASSESSMENT SHEET

ASSESSMENT SHEET FOR CROSSINGS LOCATED AT STATIONS

Name of Crossing _____

Territory _____

Name of Assessor _____

Date of Assessment _____

Reference _____

SCORE FOR CROSSING

If the crossing score is more than 55, then the risk must be reduced.

If the crossing score is between 35 and 55, then measures to reduce the risk must be considered.

APPENDIX A (Continued)

QUESTION	RESPONSES & SCORES	ASSESSOR'S NOTES	SCORE
1. Is there unauthorised use at the crossing?	None 0 Irregular 4 Regular 8 Constant 12		
2. How many people use the crossing in the busiest hour? (See the guidance for the equivalent daily figures)	Less than 5 0 5 – 15 4 16 - 50 8 More than 50 12		
3. How many trains pass over the crossing in the busiest hour! (See the guidance for the equivalent daily figures)	Less than 3 0 3 - 5 4 6 - 9 8 10- 13 12 More than 13 16		
4. Do any trains pass non-stop through the station?	None 0 Less than 10% 1 10%-50% 3 More than 50% 6		
5. What is the maximum likely speed of non-stop trains?	N/A 0 Up to 30 mph 1 31 - 75 mph 2 More than 75 mph 4		
6. How many lines are crossed (without refuge)?	1 line 0 2 lines 1 > 2 lines 3		
7. What is the warning time? (Timings are for crossings over 1 or 2 tacks. For more tracks see the guidance)	More than 30s 0 20s – 30s 6 Less than 20s 12		
8. What is the probability that customers could step out from behind a train and be hit by one travelling in the opposite direction? (See the guidance for detail on this)	Not possible 0 Unlikely 1 Possible 4 Likely 6		
9. Is there any environmental reason why passengers might not be able to hear trains approaching this location?	No 0 Yes 2		
10. Is there disproportionate use of the crossing by vulnerable, distracted or encumbered users? (See guidance for details on this)	No 0 Yes (by/with staff) 2 Yes (customers) 5		
11. Is the location susceptible to higher than average rain or snowfall, ice or frost?	No 0 Yes 1		
12. Is the location susceptible to any factors which might temporarily affect customers' ability to see trains (e.g. fog/smoke)?	No 0 Yes 2		
13. Is the crossing on canted track?	No 0 Yes 1		
14 Are there other local factors that could affect the risk?	None 0 Small 1 Significant 4		
Crossing Name:		**TOTAL**	
Standard of crossing Lighting. Signage & Maintenance Note here if any are inadequate			

APPENDIX A (Continued)

EXPLANATION OF FACTORS

1 **Crossing abuse**

If there is misuse of the crossing then the risk of someone crossing being struck by a train is increased. Staffed crossings are likely to score lower than unstaffed ones for this factor.

Score **0** for a no misuse
Score 4 for irregular misuse (less frequently than daily)
Score 8 for regular misuse (daily)
Score **12** for constant misuse (several times per day)

2 **Number of people using the crossing**

Use the numbers for a peak hour.

Score **0** for less than 5 people in an hour
Score 4 for at least 5 and not more than **15** people in an hour
Score 8 for more than **15** and not more than 50 people in an hour
Score **12** for more than 50 people in an hour

The use of 'peak hour' is intended to allow for those stations where the flow of people over a crossing (or the number of trains) changes during the day **(e.g.** due to passengers commuting). Where the level of use of the crossing does not change much during the day, and daily figures are available, then use the following scores:

Score **0** for less than 25 people in a day
Score 4 for at least 25 and not more than **100** people in a day
Score 8 for more than **100** and not more than 250 people in a day
Score **12** for more than 250 people in a day

Some stations have occasions where significant numbers use the crossing only on special occasions **– e.g.** steam specials. At such stations a separate assessment to cover the special occasions will be needed.

3 **Number of trains passing over the crossing**

Use the numbers in both directions for a peak hour (for the circumstances of factor **1** where a station crossing is sometimes staffed and sometimes not).

Score **0** for less than 3 trains in the busiest hour
Score 4 for between 3 and 5 trains inclusive in the busiest hour
Score 8 for between 6 and 9 trains inclusive in the busiest hour
Score **12** for between **10** and **13** trains inclusive in the busiest hour
score **16** for more than **13** trains in the busiest hour

Where the numbers of trains passing over the crossing does not change significantly during the day and the number of trains per day is known, use the following scores:

Score **0** for up to 20 trains in a day
Score 4 for between **21** and 60 trains inclusive in a day
Score 8 for between **61** and **120** trains inclusive in a day
Score **12** for between **121** and **180** trains inclusive in a day
Score **16** for more than **180** train in a day

APPENDIX A (Continued)

EXPLANATION OF FACTORS (Continued)

Data for this can be found from NETRAFF which provides a summary of train levels. In addition, a system is available which takes a snapshot from Trainplan of services at a particular TIPLOC over a day. The first of these will give some insight into the number of Short Term Plan (STP) freight services at a location. For more details on these tools, contact the Safety Risk Manager, Network Rail HQ.

4 Percentage of non-stop trains over the crossing

Include all types of trains in the busiest hour.

Score 0 for none
Score 1 for less than 10%
Score 3 for between 10% and 50%
Score 6 for greater than 50%

5 **Maximum speed of non-stop trains**

This factor is concerned with sighting and hearing distance and chance to evade an approaching train.

Score 0 for N/A
Score 1 for up to 30 mph
Score 2 for between 31 mph and 75 mph
Score 4 for over 75 mph

6 **Lines crossed without a refuge**

Score 0 for 1 line
Score 1 for 2 lines
Score 3 for more than 2 lines

7 **Warning time at the crossing**

What is the warning time at the crossing? Where there are no warning systems, score for the sighting time.

This should be calculated using the tables provided in Section 2.5 of RTIL SISIO 12:

Score 0 for warning time greater than 1.5 times crossing time
Score 6 for warning time between crossing time and 1.5 times crossing time
Score 12 for warning time less than crossing time

8 Chance of stepping out behind another train or obstruction and being hit by a train

The response for factor 4 (proportion of non-stopping trains) needs to be considered when determining the score for this factor, as does the position of trains on the platform (are they near to the crossing or is there some visibility?). Warning systems such as white lights will minimise the risk of this happening and hence should score 0, unless there is a significant risk of user abuse, when the appropriate score below should be used.

Score 0 for not possible
Score 1 for unlikely
Score 4 for possible
Score 6 for likely

APPENDIX A (Continued)

EXPLANATION OF FACTORS (Continued)

9 Loud external noise source

Is there a busy station, major road or other loud noise source nearby?

Score 0 for No
Score 2 for Yes

10 Use by significant numbers of vulnerable, distracted or encumbered users

This includes staff with catering trolleys, water bowsers, mail trolleys, etc. and public who are disabled or with cycles, pushchairs, etc. If there are such users from **both** staff and public users, score as for public.

Score 0 for No
Score 2 for Staff but not Public
Score 2 for Public, but only with staff assistance
Score 5 for Public using the crossing without staff assistance

Significant use means that there is a regular (daily) traffic from one or more of these groups.

11 Potential for slippery conditions

Is the crossing likely to be slippery due to high rain levels, snow, ice or frost?

Score 0 for No
Score 1 for Yes

12 Potential for fog/smoke

Is the crossing susceptible to factors that might temporarily affect visibility?

Score 0 for No
Score 2 for Yes

13 Is the crossing on canted track?

Score 0 for No
Score 1 for Yes

14 Other local factors

Are there any other factors that may affect risk at the crossing. This may include:
Variable warning times (e.g. due to both stopping and non-stopping trains – especially where warning lights are provided)
Other train routes nearby which may cause confusion when heard
Uneven passenger use (e.g. significant use at certain times of day or significant seasonal use)

Score 0 for No other factors
Score 1 for minor issues
Score 4 for major issues

The standard of crossing lighting, signage and maintenance should also be assessed. If any are inadequate, then this should be rectified if the crossing is to remain. Any inadequacies should be reported on the existing inspection form.

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