European Commission
DG Energy and Transport

High Level Group
Road Safety

Safety at Level Crossings

2nd Report of the Working Group on Level Crossings
Status : Public

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1. Introduction by the chairman

The High Level Group on Road Safety decided in 1999 to set up a working group on safety at rail/road level crossings. Apart from informing the Commission on the current state of practice as well as state of the art, the group was also meant to produce advice and foster the exchange of information between Member States in its domain of work.

During the year of 2003 some catastrophic accidents at level crossings grabbed media headlines. Even though less than one percent of the EU's road fatalities occur at level crossings, i.e. 330, public media attention is vast, and the local responsible often lack practice how to communicate with media.

The group finalised a first report in March 2000. It contains a typology of level crossings, which is in important prerequisite for risk analysis and development of a remedial programme, traffic rules and signing and signalling (optical and acoustical). This is the second report of the group. It was drafting during the years 2001, 2002 and 2003. On the one hand it provides an update of certain elements of its predecessor, e.g. as to accident data, on the other hand it contains completely new chapters, which were felt to be critical to safety management of level crossings. As had been the case from the beginning, the group's focus was the road side aspects of level crossings, while rail related questions were only touched marginally.

The Commission provided the chairman and the secretariat, and the members of the group were nominated by Member States or their delegates to the mentioned High Level Group. Also representatives from Norway and, especially at the last sessions, from accession states were present and played an active role. However, the wealth of the present document is not only originating from their own professional experience, but also from their national seconding organisations and their national network of experts, of which they made ample use.

Addressees of the report are decision takers at national and regional level, also practitioners at road authorities and private infrastructure providers. Where necessary, Member States should not hesitate to produce translations in order to facilitate a more effective dissemination.

An electronic version of this report is available on a free and unrestricted basis at the road safety section of the EU Commission's Europa server, see

http://europa.eu.int/comm/transport/road/roadsafety/index_en.htm

The report starts by drawing some conclusions and making recommendations for implementation.

This report is addressed to the European, the national and the regional legislators and executives in ministries, road institutes, road authorities and academia. It should serve as input to strategic road safety planning, the implementation of measures, the adoption of guidelines and their implementation. At the same time, the level of detail of this report is not sufficient for it to function as a guideline for direct use by practitioners.

The views expressed in this document are those of the experts in the working group and do not necessarily represent the position or views of the Commission. The European Commission, the authors and their organisations refuse any form of legal liability for the correctness of information provided in this document or any actions taken on its basis.

Last, but not least, the High Level Group have tasked their president, director Hilbrecht, to convey their appreciation and gratitude for the significant and important work done. Contact can be established via the list of members figuring as annex.

Chairman

2. Conclusions and Recommendations

1. As an average of the five-year period 1996 to 2000, the annual number of fatalities is 330 not including Greece and Spain.[1] Between 1996 and 2000, a downward trend could be observed. The total number of people killed by road traffic is around 40,000 persons in the EU 15.

2. Despite the large number of fatalities, level crossings cannot be considered less safe than other parts of the road network.

3. Regulation (EC) No 91/2003 on rail transport **statistics** will help overcome the current deficiencies as to accident data, accident types and different definitions of accident severity.

4. Accident analysis requires a large enough number of accidents. The existing national **accident data** should be made available to foreign safety offices. Therefore access to foreign **accident databases** is important. This way, the otherwise small sample size of accidents can be extended in order to devise more effective counter measures.
   Timeframe : short term

5. According to the first report of the group, Member States should adopt a **common classification** of level crossings. This is a prerequisite for accident reporting, analysis and assessment safety measures.
   Timeframe : short term

6. Level crossings that have seen an above average number of serious accidents in previous years should be candidates for inspection and measures to improve safety.
   Timeframe : short term

7. **Safety inspection**, which is a regular site visit by experts using a checklist, is not based on accidents. This can be a useful tool, especially for countries that already achieve a high level of safety.
   Timeframe : short term

8. Upgrading level crossings with traffic lights and barriers or eliminating a level crossing can significantly reduce risk, in some cases by 90%. Although such measures are costly, they may be efficient if targeted at level crossings that have had an above average number of serious accidents. One can also classify level crossings according to a set of criteria, such as traffic load, train speed, design of the crossing and distance to other road junctions. An average risk of a level crossing belonging to a certain class is then much higher than the risk of another class: one could decide to upgrade all level crossings in that 'dangerous' class.
   Timeframe : long term

[1] Due to incomplete reporting to the EU, the number of level crossing fatalities can only be estimated.

9. **Accident reports** should contain information on user behaviour as a contributing factor to accidents.
   Timeframe : short term

10. Road and rail accident **databanks exist separately** from each other. They should be merged, or at least some cross-referencing should be established.
    Timeframe : short term

11. **Enforcement** of traffic rules, especially if automated, can significantly reduce accident numbers. Train drivers should be asked about level crossings with a high number of near accidents, which could then be chosen as priority for enforcement. Enforcement can be made more acceptable if supported by awareness campaigns.
    Timeframe : short term

12. With a view to reduce staff and improve safety, **control equipment** for level crossings is offered on the market, such as obstacle detection, automatic train control, etc. Due to the variety of level crossings, the different combinations of traffic flows and train control systems, some of this equipment is still at the stage of development. Since there are no validated guidelines, further testing and validation is needed.
    Timeframe : long term

13. **Awareness campaigns** should target intentional offenders (risk seekers) and persons that do not know the rules, or the risk they take when offending. This target group need to be identified at the beginning of a campaign, and it will often contain young males between 15 and 25 as well as the elderly. Effects of awareness campaigns may be difficult to quantify. This should not be an excuse for not using them, as generally campaigns will create safety awareness.
    Timeframe : short term

14. **Catastrophic accidents** can be defined as collisions involving more than 5 fatalities, derailment or release of dangerous goods. Such accidents will attract huge media attention and sensational reporting. To avoid precipitated and ineffective action, accurate and factual information should be made available soon after the accident or even on the site.
    Timeframe : short term

15. The **number of level crossings should be reduced**. To this end, several countries have adopted policies of closing level crossings and not building any new ones.
    Timeframe : long term

16. In the future, **in-vehicle information systems** could warn drivers of a train crossing.
    Timeframe : long term

3. Accident Data

3.1 EVOLUTION OF ACCIDENTS 1996-2000

BACKGROUND AND ORIGIN OF THE DATA

The working group carried out a global statistical assessment of the Level Crossing safety at the European level.

The Member States taking part in the working group are: BE, FR, FIN, GB,GE, IE, LU, NL and PT. NO took also part.

Each participant provided his own checked exhaustive and updated national LC safety data in terms of number of accidents, fatalities, injuries etc…

A first assessment of the LC safety has been done at the European level from these national data, but no data being available from the missing Member States (AT, DK, ES, GR, IT and SV), the results dealt exclusively with the nine countries participating in the working group. The missing data were researched in the European accident database CARE.

EXHAUSTIVENESS AND RELIABILITY OF THE DATA

A level crossing collision involves different type of victims; an exhaustive statistical approach of LC safety must take into account both rail and road victims.

DATA PROVIDED BY THE WORKING GROUP MEMBERS

The members of the working group supplied the most exhaustive data gathered by the experts from rail and road sources. So the LC safety statistical results carried out from these data include rail and road victims, furthermore each Member State checked and updated his own data.

Data provided by the CARE database

Among the countries (AT, DK, ES,GR, IT and SV) not taking part in the working group two (ES and GR) do not supply in CARE the data related to the victims of the level crossing collisions as such.

The data of CARE are those collected by the Road administration of each Member State for their own national accident database; and in most cases, only the road victims of level crossing are recorded in these databases but the numbers of collisions are approximately the same.

Therefore, the severities of the level crossing collisions are systematically underestimated in comparison with the severities calculated from the data including road and rail victims provided by the Member States (BE, FR, FIN, GB,GE, IRL, LU, NL and PT)taking part in the Working Group

In order to take into account this underestimation, the number of killed at level crossings given by the CARE database (AT, DK, IT and SV) have been weighted by the average severity rate of level crossing collisions calculated from the data including road and rail victims given by BE, FR, FIN, GB,GE, IRL, LU, NL and PT.

Finally it seemed sound to assess the European level crossing safety by putting together the working group data and the CARE data, being nevertheless aware that the data of two countries (EL and ES) will remain missing.

GLOBAL LEVEL CROSSING SAFETY IN E.U. BETWEEN 1996 AND 2000

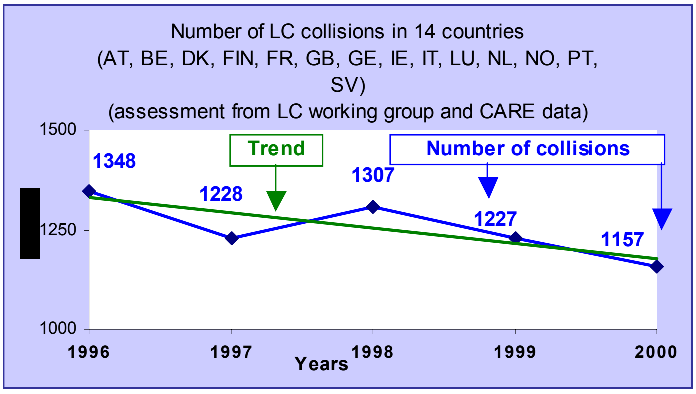
According to the availability of level crossing data described below, the following results have been drawn in terms of collisions, victims and severity. For of these indicators, the evolution has been examined over five years from 1996 to 2000 and the trends calculated by linear regression.

years	killed	collisions	severity
1996	298	1348	0,22
1997	284	1228	0,23
1998	308	1307	0,24
1999	296	1227	0,24
2000	280	1157	0,24
Total	1466	6267	

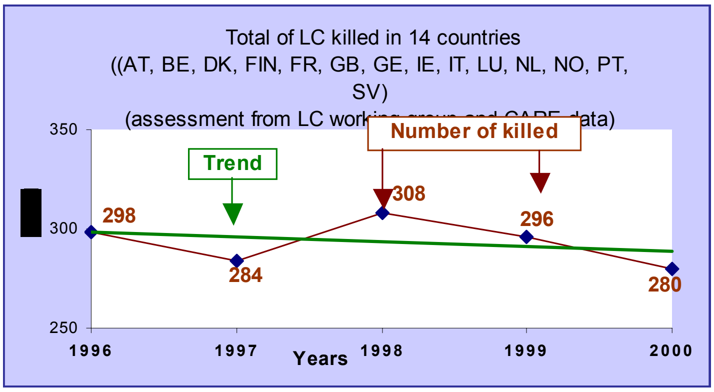
Table 1

- Over these five years, 1996-2000 there are on average 1236 collisions and 329 killed per year on level crossings in E.U. (see table 1).

- The number of collisions and the number of killed decrease (see graphs 1 and 2).

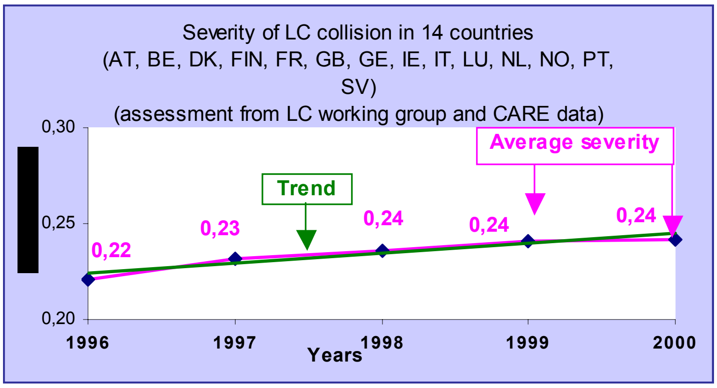


Graph 1



Graph 2

- On the other hand the severity of the collisions, defined as the rate of killed victims per collision, are approximately constant or slightly increasing (see graph 3



Graph 3

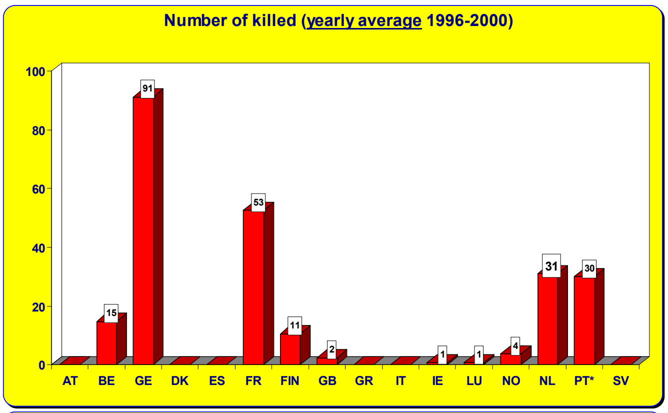
<u>Remarks</u>

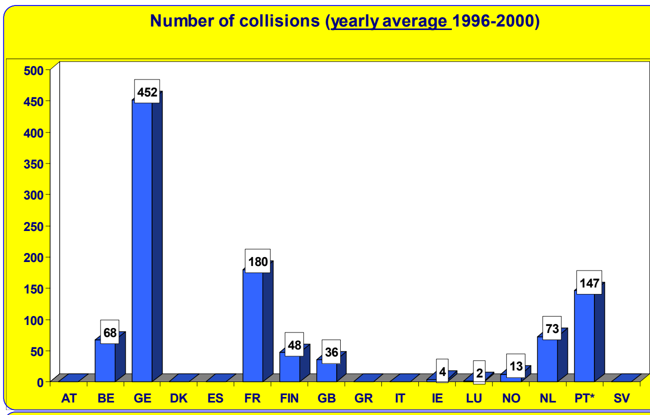
These results are a rough assessment, which provides a global idea of the weight of the level crossing safety in E.U. and requires the following comments:

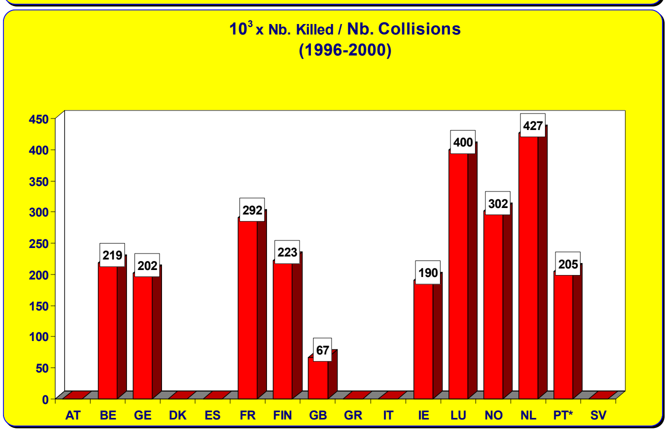
1. The number of collisions and killed victims at level crossing are in all probability undervalued because they concern only 14 countries, two (GR and ES), being missing.
2. The data emanate from two different sources (LC working group and CARE).
3. The numbers of killed victims emanating from CARE database have been weighted by the average severity calculated with the data emanating from the LC working group investigations, which include the rail victims. In others words one makes the assumption that the severity rate of the level crossings collisions in AT, DK, IT and SV, is close to the E.U average severity rate calculated from the exhaustive data.

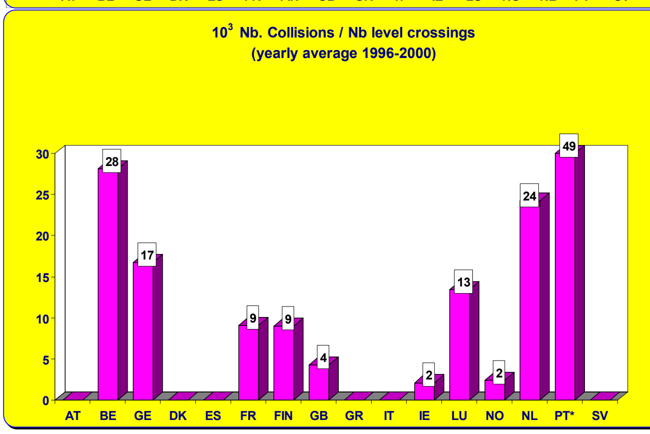
NATIONAL LEVEL CROSSING SAFETY IN E.U (BE, GE, FR, FIN, GB, IE, LU, NO, NL, PT,) BETWEEN 1996 AND 2000

The national statistics provided by the countries taking part in the working group allow some comparisons across these countries.
The distributions of collisions and killed are very heterogeneous across the countries (as shown on the graphs and tables below)









* *Results of Portugal 2000 estimated*

Furthermore this heterogeneousness is also verified in terms of severity taking into account the numbers of level crossings and collisions (see the tables below)

Country	Nb. of level crossings (1998)	Nb. of collisions (1996-2000)	Nb. of Killed (1996-2000)	Nb. of collisions yearly average (1996-2000)	Nb. of Killed yearly average (1996-2000)	10^3 Nb. Killed / Nb. Collision (1996-2000)
AT						
BE	2409	338	74	68	15	219
GE	26980	2259	456	452	91	202
DK						
ES						
FR	19831	902	263	180	53	292
FIN	5283	238	53	48	11	223
GB	8323	179	12	36	2	67
GR						
IT						
IE	1976	21	4	4	1	190
LU	149	10	4	2	1	400
NO	5090	63	19	13	4	302
NL	3006	363	155	73	31	427
PT*	2972	586	120	147	30	205
SV						

* *Results of Portugal 2000 estimated*

LEVEL CROSSING SAFETY in EUROPE from 1996 to 2000

	TOTAL E.U. + Norway		
	killed	collisions	killed / Collisions
2000	280	1157	0,2417
1999	296	1227	0,2412
1998	308	1307	0,2354
1997	284	1228	0,2314
1996	298	1348	0,2213
TOTAL	1466	6267	0,2339

	BE			FR			NO		
	killed	collisions	killed / Collisions	killed	collisions	killed / Collisions	killed	collisions	killed / Collisions
2000	9	50	0,18	51	170	0,30	9	16	0,56
1999	15	65	0,23	48	181	0,27	2	17	0,12
1998	18	72	0,25	53	176	0,30	6	12	0,50
1997	16	79	0,20	51	180	0,28	1	9	0,11
1996	16	72	0,22	59	195	0,30	1	9	0,11
TOTAL	74,00	338,00	0,22	262,00	902,00	0,29	19,00	63,00	0,30

	NL			PT*			FIN		
	killed	collisions	killed / Collisions	killed	collisions	killed / Collisions	killed	collisions	killed / Collisions
2000	30	66	0,45	22	104	0,21	11	52	0,21
1999	43	78	0,55	22	130	0,17	10	48	0,21
1998	25	72	0,35	24	146	0,16	12	39	0,31
1997	28	77	0,36	24	101	0,24	14	52	0,27
1996	29	70	0,41	28	105	0,27	6	47	0,13
TOTAL	155	363	0,43	120	586	0,20	53	238	0,22

	LU			GB			GE		
	killed	collisions	killed / Collisions	killed	collisions	killed / Collisions	killed	collisions	killed / Collisions
2000	0	3	0,00	3	32	0,09	75	373	0,20
1999	0	0	0,00	2	35	0,06	92	412	0,22
1998	1	2	0,50	5	39	0,13	101	483	0,21
1997	2	2	1,00	0	36	0,00	86	428	0,20
1996	1	3	0,33	2	37	0,05	102	563	0,18
TOTAL	4	10	0,40	12	179	0,07	456	2259	0,20

	IE			TOTAL (BE,FIN,FR,GB,GE,IE,LU,NO,NL,PT)			TOTAL (AT, DK, IT, SV) estimation		
	killed	collisions	Killed / Collisions	killed	collisions	Killed / Collisions	killed	collisions	Killed / Collisions
2000	0	3	0,00	210	869	0,24	70	288	0,24
1999	0	4	0,00	234	970	0,24	62	257	0,24
1998	1	4	0,25	246	1045	0,24	62	262	0,24
1997	2	4	0,50	224	968	0,23	60	260	0,23
1996	1	6	0,17	245	1107	0,22	53	241	0,22
TOTAL	4	21	0,19	1159	4959	0,23	304	1301	0,23

COMMENTS:
The above results have been drawn from two different sources:

1. Level Crossing Safety Working Group, accidents and killed (including road and train victims) have been given by the by the members(BE, FR, FI, GB, GE, IE, LU, NL, NO and PT)

2. CARE European accident database for the missing Member States (AT, DK, IT and SV)

The level crossing safety statistical results are not available for EL and GR

The numbers of killed drawn from the CARE database have been weighted by the average rate of collision severity because in most of cases the national accident database records only the road victims excluding the killed persons in the train,

* **Results of Portugal 2000 estimated**

3.2 INVENTORY OF ACCIDENT DATABANKS

A questionnaire was sent to all participants in the Working group to carry out a survey of existing Level crossing databases with the aim of making an inventory of the different national practices of data collection and risk models currently in use.
The questionnaire was filled in by seven Member States (BE, GE, FR, FIN, IE, LU and UK) as well as by NO taking part to the Level Crossing Safety Working Group .
This questionnaire was composed of three parts concerning:

1. The contents and use of databases.
2. The risk models.
3. The traffic conflict analysis.

The answers are summarised in a table below from which the following comments can be made.

1. **Contents and computerization of L.C. database**: All L.C. database are computerised (Excel, Oracle, Access etc…) and in most cases the data concerning rail-road equipment and safety are recorded in several databases. Only France put together all these data in the same computerised database and only B, D, and NO include environmental data in their database.
2. **Use and updating of L.C. database**: The national L.C. databases are mainly used for statistical analysis, accident investigations and administrative purposes. Other uses include investment planning, inventory or layout improvement.

All national databases are updated but follow different practices that can be classified either as a yearly updating or by demand for equipment changes or as a result of an accident.

3. **Risk models and risk assessment**: Most of the countries (GE, FR, FIN, IE, NO and UK) use an assessment model, with more or less similar inputs such as: accidents, rail traffic, road traffic and traffic moments, speeds, infrastructure and environmental data.

The classification methods or risk assessment are generally used (GE, FR, FIN, IE, UK) which are mainly based on risk indexes, by combining inputs such as accident descriptions, inventories and rates, risk of fatality, traffics, traffic moments, speeds, environmental data, etc.

4. **Traffic conflict analysis**: The results obtained by the risk models are sometimes (GE, FR, FIN, LU) completed by a traffic conflict analysis.

Conclusion,

1. There are many similarities in terms of inputs and type of classification in the existing National Level Crossing databases. The main disparities concern the level of sophistication of the data processing using complex methodological approaches.
2. A common classification of level crossing types by Member states would allow for easy comparison of L.C. safety performance between Member states.
3. Traffic conflict analysis is not an important issue for many Member states.
4. Databases should be accessible to other Member states to assist in their investigations

	BE	GE	FR	FIN	IE
A. LC DATABASE					
A1. LC data	2 databases	yes	Yes 1 database	5 databases	2 databases LC description Accidents description
- Rail	Administrative and technical s	yes	Rail Road	Yes	1. Rail 2. Road
- Environment	Yes	yes	No (scheduled)		No
- Equipment	Yes	yes	Yes	Yes	Yes
- Safety	2nd database	yes	Yes	Yes	Yes
A2. LC database computerised	Yes Access	yes	Yes Oracle	Yes + Internet	Yes (Excel database)
A3. Use of LC database	Statistics	Controlling, analysing, planning and upgrade of the Layout LC	LC inventory Accident occurrence LC classification Risk assessments Improvements assess.	FRA Maps Risk index Accident investigation	General Administration Reporting Work / Investment Planning Safety Related Projects
A4. LC data updating	Each year	All data A1Regulary 2 years or by demand	Rail/road data Accident data	Frequently updated	Technical Office, Infrastructure Any changed No frequency
B. RISK MODEL					
B1. Assessment model	No	yes	Yes	Risk index	Yes
B2. Inputs of risk model		Nr. accidents, reason of accidents, altering of Road traffic and environment	Traffic moments Nb of collisions	• Safety devices • Speeds • Nb of tracks • Nb of trains (average/day)	Crossing type, Crossing usage, Users views of the railway line, Road gradient Road rail traffic levels and speeds, Angle between level crossing and railwayWeather (e.g. Fog) Crossing type
B3. Classification methodology		Risk analysis, strong accident rates, high damage rates	Yes	• Risk index • Inventory • Safety audit	Risk of fatality
C. TRAFFIC CONFLICT ANALYSIS (tools)	No	traffic conflicts analysis In correspondence with road-owner	Yes	Yes	no

	LU	NO	GB
A. LC DATABASE			
A1. LC data	Different databases	Different databases	Yes
- Rail	Yes	Yes	Yes
- Environment		Yes	Yes
- Equipment	Yes	Yes	Yes
- Safety	Yes	Yes in a different database	Different databases
A2. LC database computerised	Yes	Yes	Yes
A3. Use of LC database	Statistical documentation	Administrative And statistics	Statistics and risk model
A4. LC data updating	Équipement changes Accident occurrences	Locally and continuously	?
B. RISK MODEL	No	Yes	
B1. Assessment model	No	Sophisticated model will be developed	Model of risk assessment
B2. Inputs of risk model	No	Nb accidents Vehicles, trains/day calibration factors Local conditions	Pedestrians and vehicle users Railway data (speeds frequencies…) Traffic moments Infrastructure and layout
B3. Classification methodology	No		Yes
C. TRAFFIC CONFLICT ANALYSIS (tools)	Only for specific case No conflict model		?

4. Automatic barriers on level crossings

1. Train speeds
The damage caused by collisions depends on the speed of the colliding vehicles. In collisions between trains and passenger cars the train mass is generally 50 to 100 times the car mass and it is therefore the train speed that generates the amount of damage. Heavy road vehicles can have the same mass as DMUs and, in cases where high speed is involved, can inflict serious damage on trains.
Little research has been done on the train speed factor, but the damage can be estimated to be proportional to the square of the train speed.

In those cases where motorists look along the track instead of at the flashing lights to see if it is possible to take a chance to cross the rails before the train arrives, it is hard to estimate the train speed when it is higher than usual on ordinary highways with level crossings.

2. Train and road traffic flows
Accident prediction models both for road/road and road/rail collisions generally are based on the result of the flows of conflicting traffic, also called the traffic moment. For crossings with low and medium flows the relation seems to be proportional to the traffic moment. For high flows with queue situations, it is harder to calibrate models, but such flows are not common on crossings with flashing lights and bells.
Example. Fifteen years ago, Sweden had about 40 collisions per year on a total of 1500 crossings protected with flashing lights and bells. The median traffic moment value was circa 1600 per day. Since then about 800 crossings with the highest traffic moments have been upgraded to automatic barriers or closed and road traffic diverted to safer routes. The effect has been a decrease to about 5 collisions per year on the remaining 700 crossings. A proposed goal for the next 12 years will be to upgrade or close all flashing light and bell crossings with a traffic moment over 800. This goal is based on cost/benefit analyses with a life value of 1.5 million Euro. The Swedish accident prediction model gives a 90% risk reduction when adding automatic barriers.

3. Road design and surrounding areas.
Clear visibility of flashing lights for approaching drivers is very important. It can be limited by hilltops, curves in combination with rock sides, houses, vegetation or snow walls. Some of these factors depend on season and climate. The active warning devices for crossings must be able to be seen within safe braking distances for road drivers, taking into account wet or icy conditions.

4. Number of tracks.
If there is more than one track, some drivers are tempted to cross just after the passage of a train. If a train then approaches on another track this creates a very high collision risk. The same situation also occurs if the motorist can only see slow shunting trains in a station area and fails to notice trains travelling at higher speeds.

5. Accident statistics on single crossings.
In nearly all countries the average number of collisions on crossings with flashing lights and bells are lower than 3 per 100 years. If several accidents happen on the

same crossing within a limited time, this is generally an effect of the slump factor. In these cases any accidents must be carefully investigated.
It can be good policy to install barriers at multi-accident crossings to calm public opinion.

6. Blocking risks.
Where a minor road crosses a main road where traffic has priority, drivers can be forced to wait for long periods. If a railway runs parallel with a main road, the waiting vehicle can be standing across the tracks when signalling commences. If the driver knows that a barrier will start lowering in a few seconds, he will feel under greater pressure to either reverse or turn into the main road.

It is also common for drivers on a minor road to concentrate their attention on traffic on the main road, thus forgetting to look at the flashing lights. A closed barrier is easier to see.

If crossings of this type are used by many long and heavy vehicles, it would be preferable to add obstacle detection to the safety system.

Summary

If one of the following criteria apply:
Train speed above 100 km p h
Traffic moment above 1000
Poor visibility from road
More than one track
Multiple accidents
Blocking risks

Then adding automatic barriers are recommended.

5. Inspection of Level Crossings

GOALS OF A COMMON INSPECTION

The objective of inspections is to avoid accidents at level crossings. Teams of experts that bring in a certain mix of safety expertise visit level crossings regularly and recommend measures to reduce risk. The selection of level crossings to be visited follows a pre-defined schedule. Objectives in more detail are

- to check whether the level crossing layout still meets the practical needs or whether the required performance is still realized;
- to better understand the needs as well as the financial and technical possibilities of the other party;
- to make a choice of the most effective measures for improvement of safety;
- to make a follow-up of previously decided measures;
- to inform each other about forthcoming changes in road traffic or railway operation;
- to decide about proposals of enforcing measures.

Current Situation

In general, the inspection of equipment at level crossings is done independently by the organizations or administrations responsible for either the railway side or the road side. The persons involved in these inspections check the conformity of installations as well as their maintenance condition according to existing laws, rules and regulations.

In most of the cases the general crossing layout neither its ability to still meeting the requested performance are not analysed. Anyway railwayside and roadside inspections are not systematically coordinated; normally they do not take place at the same time.

LEVEL CROSSING INSPECTION AS A COMMON DUTY

The safe-guarding of level crossings is by itself of a common interest to the two crossing transport networks.

Although the above mentioned inspections cover the majority of the aspects in relation to this topic, there remain items that can only be dealt with during a common inspection, because there is a need of coordination, comprehension and, if necessary, discussion and decision.

There is no doubt that a common inspection is able to procure an added value to the general level of safety on the level crossing.

PERIODICITY

There should be periodical and incidental common inspections. If there are no substantial changes in the environmental or traffic conditions of the level crossing, an inspection every three years is sufficient.

On initiative of any party a special inspection should take place if one of the following conditions is fulfilled:

- a collision has been reported;
- a dangerous nearly collision has been reported;
- a change of the level crossing layout is planned;
- a renewal of the concerned road or railway is planned;
- an environmental factor is coming to change, such as:
  creation of a new residential or industrial area, infrastructures for sports, schools, retirement houses, stops for public transport, etc;
- after frequent complaints from road users or train drivers.

ORGANIZATION

A schedule for visits should be established annually, no later than three months before the beginning of the year.

The bodies responsible for the roadside and the railwayside have to participate in the common inspection; other concerned parties are invited depending on the situation: the police, headmasters of schools, public transport authorities, maintenance contractors, etc.

If the road traffic is not measured regularly, a traffic count separated on modes (heavy/light, bicycles/pedestrians) has to be done before the inspection in order to have data for prediction of the traffic flows until the next inspection. Rail authorities have to present actual and planned schedules.

If necessary, a complementary inspection can be decided if special conditions have to be analysed such as night, fog or snow conditions or school related traffic.

A common document based on a template and a check list would be the best basis for reporting purposes.

EXAMPLE

In some federal "Länder" of Germany, a legislation regulating the common inspection on level crossings has been adopted recently. Annex 4 shows a draft for a possible example for a checklist for inspection of level crossings.

6. Risk Assessment of individual level crossings

1. Road and rail components of risk

1.1. In managing level crossing risk it is important to recognise that both the train and road accident components have to be considered.

1.2. Rail component: in the context of train accident risk where there are high public expectations and possibilities of outrage when there are catastrophic accidents involving multiple or even single passenger fatalities, the criteria for action to address the hazard and control the risk are those generally applicable to railway safety decisions. High values of preventing a fatality are either explicit or implicit in the taking of these decisions.

1.3. Road component: however, the greater component of the risk associated with level crossings relates to harm to users. Here the rational approach is to treat the issue in the context of the prevailing road safety decision criteria. However, because of the low proportion of road safety casualties occurring at level crossings this is not seen as a road safety imperative on the scale of driving under the influence of alcohol, controlling excessive speed and pedestrian casualties. It is important to recognise that collisions with buses and coaches on level crossings have the potential for a catastrophic loss of life of those travelling by road as evidenced in the 2003 collision at Siofok in Hungary. A further factor in reducing the perceived importance of addressing the non train accident component of level crossings is that a significant proportion of the casualties occur on private roads.

1.4. Therefore, because of the potential for catastrophic train accidents upon striking vehicles on level crossings, the rail sector's focus on level crossing safety is a magnitude greater than that of the road sector. Indeed, in the United Kingdom this has been exemplified by the rail value of preventing fatalities arising from potentially catastrophic events having been at least three times of that actually employed in the road sector.

1.5. From a rail perspective the greatest focus is addressing the potential for there to be catastrophic rail accidents. The methods used to address the potential for a catastrophic rail accident include:

- Reducing the number of level crossings,
- Setting maximum rail and road speeds at level crossings,
- Introduction of additional safeguards,
- Identifying high risk crossings,
- Setting priorities for attention,
- User training.

2. Understanding the risks

2.1. It is important that the generic levels of risk associated with particular types of level crossing are understood and those with poor records addressed as a priority. Evidence from the Netherlands, the United Kingdom and elsewhere suggests that risk is disproportionately concentrated at active open crossings on the public road. Passive open crossings are also generally accepted as a priority for action.

2.2. Having identified the generic types of level crossing with a greater risk propensity it is then important to identify from accident, incident and near miss data individual level crossings having a record as a "bad actor". The more precursor data can be gathered the more reliable the identification of crossings that need to be given priority attention. In parallel "bad actor" crossings within other generic categorisations of level crossings need to be identified in order that a prioritised risk assessment programme can be developed.

2.3. When addressing risk in the context of the generic type of level crossing it is possible to consider both the train accident and road user components of the risk. However, when working in the context of the individual crossing sufficient data is only available to consider the road user and pedestrian component effectively. A baseline target for an acceptable level of risk to road users needs to be set to inform the decision as to the appropriate remedial actions required to reduce accident potential. In the United Kingdom the target rate of fatality is set by the railway at 1 in 100,000 regular road users, subject to a test of reasonable practicability. A regular user is defined as a person who traverses the crossing 500 times a year.

2.4. In the United Kingdom a risk model was developed to aid the assessment of all automatic level crossings. This programme and the associated commitment to implement reasonably practicable control measures to reduce the risk to individual users have led to a statistically significant reduction in risk being delivered. This and the development of a network risk model has highlighted the disproportionate contribution of the automatic open crossings which are being further targeted to identify a prioritised programme for closure / upgrade to automatic half barriers leading to the eventual elimination of this type of crossing. This replicated the Dutch approach to this type of crossing. Consideration is being given to the development of a risk model for use at passive level crossings.

3. Risk assessment of individual level crossings

3.1. When conducting risk assessments in the context of the individual level crossing the following non-exhaustive list of factors needs to be considered:

3.1.1. Pedestrians and vehicle user components of risk separately assessed within an integrated framework.

3.1.2. The characteristics of the railway operations over the level crossing including frequency, speed, timetable, and patterns of trains, track layout and traction and signalling arrangements.

3.1.3 The characteristics of the level crossing users – vehicular, pedestrian and animals.

3.1.4. The level and patterns of use of the crossing by those users.

3.1.5. The resultant traffic moment (rail x road traverses of the crossing).

3.1.6 The characteristics and effectiveness of the level crossing protection provided. Protection includes visual and audible warnings, fences, gates and barriers and any interaction with railway staff (e.g. signaller by telephone).

3.1.7. For crossings not equipped with an active warning system, the relationship between decision plus crossing time and warning time.

3.1.8. The history of the crossing in respect of levels of crossing abuse (errors and violations), trespass, damage to equipment, "near miss" incidents and accidents.

3.1.9. Other local conditions (e.g. East – West alignment, low sun "swamping" lights) that may affect the safety of the crossing.

3.2. Common methodologies should be adopted to ensure that remedial measures are implemented on a prioritised basis. It is suggested that the initial risk assessment should be revisited if there is:

3.2.1. An accident involving a train at the level crossing.

3.2.2. An increase in the frequency of crossing abuse (errors and violations) or "near miss" incidents reported.

3.2.2. Any significant planned or effected change in the nature of rail operations over the crossing.

3.2.4. Any significant planned or effected change in the nature or extent of the use of the level crossing by vehicles, pedestrians or animals. Consideration needs to be given to local planning applications and other changes in land use and / or the highway network.

3.2.5. Changes in the environment surrounding the crossing.

3.2.6. Changes in crossing configuration, control equipment and protection arrangements are planned.

3.2.7. Other changes that may increase the risk associated with the level crossing.

3.2.8. A period of five years since the last assessment was undertaken.

3.3. At present practice is for the railway authorities to take the lead in the risk assessment processes because the primary objective of the railway is to minimise the risk of a catastrophic train accident. Additionally, the railway authorities are proactive in the management of level crossing risk because of duties of care to users and increasingly the need to manage issues of reputation associated with level crossing accidents being seen as a railway rather than a road accident. Given that the road accident component of risk is the greater it is appropriate to consider how best to involve the road authorities in these processes. However, this will not be easy as there is a body of evidence that shows the risk of an accident at a protected level crossing is many times less than the risks associated with a signalled road junction.

4. Benchmarking

Benchmarking across the EC of the relative levels of safety achieved at generic level crossing types is of significant value in identifying the different starting points from which further risk reduction can be achieved. On-going benchmarking should be pursued so as to identify the programmes and control measures (engineering, education and enforcement) that are effective.

5. A common approach

5.1. Given the common issues faced across the EC and indeed in North America, Australia etc., consideration should be given to an integrated programme to evaluate control measures (e.g. median strips), identify good practice and promote a prioritised application to reduce risks. The available control measures are not all engineering led and equal consideration needs to be given to education of users of level crossings on both public and private rights of way, both vehicular and pedestrian, with the intent of reducing levels of abuse of level crossings. Similarly, enforcement led controls (e.g. red light photo enforcement) will form part of a balanced portfolio of risk controls.

5.2. As a first step a protocol should be developed for the sharing of research conducted within the EC. As most of this has been undertaken by the rail sector this could, given the conceptual status of the European Rail Agency, be undertaken under the auspices of the UIC.

6. Conclusions and recommendations

6.1. The rail sector focus on level crossing safety is higher than the road sector because of the catastrophic rail accident potential. As a result the rail sector should continue to take the lead in the risk assessment process.

6.2. An acceptable level of risk to both rail and road users at level crossings needs to be set to inform the decision as to the appropriate remedial actions required to reduce accident potential at level crossings.

6.3. Consideration needs to be given as how best to involve the road authorities in reducing accident potential at level crossings. It must be kept in mind that all persons, including the road authorities, have a general duty of care not to cause an accident at a level crossing and to aid prevention.

6.4. Consideration should be given to an integrated programme to evaluate control measures, identify good practice and promote a prioritised application to reduce risks.

6.5. A protocol should be developed for the sharing of research within the EC.

6.6. Ongoing benchmarking should be pursued to identify the programmes and control measures that are effective in risk reduction. Given the commonality of the problem, the approach should be an integrated one across all member states and elsewhere.

7. Enforcement

In the United Kingdom there are two principal types of road traffic light signals; a conventional tricolour signal: Red, Amber, Green (Diagram 3000) and a two colour road traffic signal: Red Flashing and Steady Amber (Diagram 3014). This signal is also known as a ‘wig-wag’ signal, which relates to the two red flashing lamp units within the signal.

The conventional signal is used at road junctions. The ‘wig-wag’ is used at level crossings, fire stations, ambulance stations, airport runways, lifting bridges and other sites where the hazard is high risk.

UK legislation allows emergency service vehicles to pass the conventional signal (Diagram 3000) and also allows a Police Constable to authorise other motorists to pass such a signal when it is at danger (red). In respect of the wig-wag signal (Diagram 3014), NO one has authority to pass the signal at danger under any circumstances.

Both signals have transverse road markings associated with them in the form of a Stop line; in both cases the Highway Code requires motorists to stop if they are able to do so safely when the signal is displaying an amber aspect. When either signal is displaying a red aspect, it is an offence to cross the Stop line.

Two types of police enforcement camera have been introduced in the UK; one for red light offences and one for speeding offences. In January 2000, Red Light cameras were introduced on a trial basis at eight level crossings in Scotland operated by Railtrack (now Network Rail), the national rail operator. Some of the crossings are automatic half barriers, some are automatic open crossings (red lights, no barriers).

The cameras are fitted on both sides of the level crossing so as to film the vehicle registration number plate, the road traffic signal, the Stop line and the crossing. Beyond each Stop Line a detector loop is fitted into the road surface to detect vehicles crossing the stop line. A further inductive detector is attached to the cables that carry current to the signal lamps.

When the level crossing initiates, the camera does a self test. The lamp detectors confirm that the amber aspect shows for the requisite time, and then confirms that the red lights are flashing within the parameters laid down in legislation. If any of these tests fail, the camera shuts down. If the tests are successful, the camera will take a photograph of any vehicle passing the stop line detector.

Scottish legislation requires the Police to serve a Notice of Intended Prosecution within 14 days. The legislation also requires the registered vehicle owner to state who was driving the vehicle at the time of the offence when questioned by the police. This requires the cameras to be serviced and films removed on a 7 day cycle. Once the Police have served such a Notice, the Scottish Courts must instigate proceedings within 6 months.

The prosecutions at these trial sites have been undertaken by British Transport Police (Railway Police) at all sites. The attached Excel spreadsheet, reproduced by kind permission of Railtrack, Scotland, shows the offences recorded at each crossing since the trials began. About 83-86% of recorded offences have been taken to Court with a high degree of guilty verdicts being recorded. The remaining offences have not been pursued because of poor pictures, railway work being undertaken etc, where prosecution would fail.

Some technical problems have been causing concern. The cameras seem to be sensitive to railway traction supplies eg overhead traction cables. Problems have also been experienced at automatic half barrier crossings where it is believed that the lamp current detectors have been subjected to power surges when barriers start to operate. At some sites pictures of passing trains have occurred. All these matters are currently being subjected to detailed technical investigation.

At the present moment no detailed analysis into motorist behaviour has taken place. The initial results at one crossing, Cornton, suggest that the majority of offenders live locally to the crossing, many are female of 55 years and above, and most offences occur between 1000hrs and 1400hrs. Cornton has shown a substantial decrease in offences over the period of installation despite the technical problems highlighted above. Some of the other sites are showing an increase in offences; the reasons for this are currently unclear.

There is no earlier data pre-camera installation available. However the sites were chosen based on train drivers reporting incidents and near misses.

Conclusions

Train Driver reports are important in establishing sites where user indiscipline is a problem.

Further analysis of data is required. Some sites are showing a reduction of offences, whilst others are showing an increase.

It is likely that the UK railway industry will make further use of such cameras.

Both photographs reproduced by kind permission of British Transport Police.

Both photos show vehicles at Cornton Automatic Half Barrier Level Crossing, near Stirling, Scotland.

8. Awareness Campaigns

Contents

1 Awareness campaigns in Europe

There are basically two types of awareness campaign designed to promote railway level crossing safety: general, systematic and long-lasting such as Operation Lifesaver in the USA; or those such as in Europe which are local campaigns or campaigns targeted at special groups. The contents of campaigns are usually more or less the same all over Europe. They give general information on the speed and the braking distances of trains for the road user, in order to make them aware of the dangers and thus help them improve their behaviour at railway level crossings. Campaigns are launched by traffic safety authorities, railway companies, car driver organisations or police.
In some European countries there have not been any general awareness campaigns on level crossing safety for some time, for example in the Netherlands, Norway and Sweden. There are presently, however, campaigns going on or recently introduced in Finland, Germany, Ireland and the UK.

1.1 Finland: Level crossing, a significant place, (Merkillinen paikka tuo tasoristeys)

In Finland during the summer of 2002, a campaign was targeted at the inhabitants of the south-western part of the country. The reason for campaigning here was the increase in the number of collisions occurring at railway level crossings during the year 2001 compared to previous years. The campaign was launched in June 2002.

The campaign comprised of information and discussion events in two towns (Turku and Rauma) in the campaign area. Local residents' associations, farmers' associations, private road keepers and local communities were invited and campaign leaflets were distributed to residents living near the railway. Campaign events comprised of information on proper behaviour at level crossings and the speeds and braking distances of trains. The campaign was publicised by posters and radio ads.

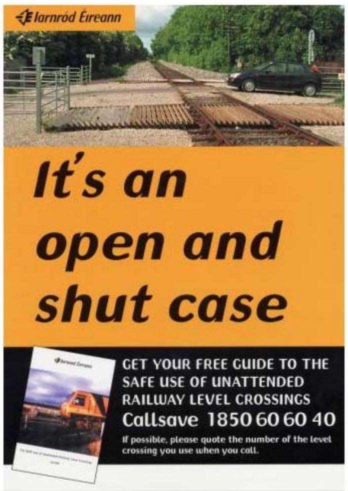
The Finnish campaign was produced by the Ministry of Transport and Communications, the Central Organisation for Traffic Safety in Finland, the Police, Finnish Rail Administration, Finnish Road Administration and VR Group (railway operator).

During the summer of 2003 the campaign will be targeted at residents of the Seinäjoki area, in western Finland (web site in Finnish: http://www.mintc.fi/www/sivut/suomi/tasoristeys/taso_kampanja.htm)

1.2 Germany: Crossing safely, (Sicher Drüber)

The campaign in Germany was launched in May 2002. The aim was to reduce the number of collisions at railway level crossings throughout the country. The campaign package is aimed at journalists, teachers and driving school instructors. The package, which can also be downloaded from the campaign website, includes background information, graphics on level crossing collisions and a film.The campaign is produced by German Railways (Deutsche Bahn AG), German Automobile Association and German Road Safety Council. (Web site in German: http://www.dvr.de/asp/dms.asp?url=aktuelles/kampagnen/inhalt.htm)

1.3 Ireland: It’s an open and shut case



In Ireland, a booklet on the safe behaviour at unattended railway level crossings was launched in 2001. The aim of publishing the booklet was to increase people’s awareness of the dangers involved in using level crossings and to provide clear instructions as to how the crossing should be used and what to do if something went wrong. The booklet was distributed to the users of unattended crossings (14,000 copies). The information on the back cover of the booklet was tailored to provide information on the location of the crossing and contact details for the nearest station/signal box.

The booklet was produced by Irish Rail (Iarnród Éireann). It was advertised in radio, newspapers and magazines, and posters for the campaign were displayed in stations and cattle markets.

This campaign is to be developed further in 2003 in two ways. An advertising campaign will be launched in newspapers, on radio and by a poster campaign focusing on general level crossing safety. The second part of the campaign will be TV advertisements targeted at user worked crossings focusing on ‘Keeping the Gates Shut’ after use, which is a major problem and a significant factor in many accidents.

1.4 UK Campaigns

A number of campaign areas are under development in the UK. At the moment these comprise of a number of small working groups, looking at ways of increasing awareness of level crossing issues.

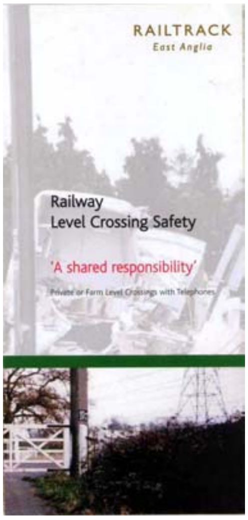
National Level Crossing Safety Group

This group has been under development for about a year and has now reached the point of having formal meetings. The Group was set up jointly by HM Railway Inspectorate, Network Rail and the Rail Safety & Standards Board. HMRI currently act as ‘Chair’ and the Rail Safety & Standards Board as ‘Secretary’. The Group has held several meetings with representatives of various other agencies invited to participate. These include the Department of Transport, the Police, the British Transport (UK Railway) Police, the Driving Standards Agency, the Automobile Association, etc. The eventual aim of the group will be to present a report/recommendations to the Health and Safety Commission.

Operation Lifesaver

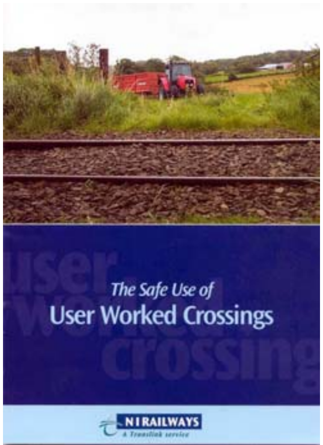
Network Rail and the Rail Safety & Standards Board are currently exploring the possibility of introducing the Operation Lifesaver model to the national railway network in an attempt to educate the public on level crossing and trespass issues.

Agricultural Group



A small group of Network Rail, HMRI, HSE Agricultural specialists and the National Farmers' Union are considering ways of improving farmer safety at private level crossings and educating farmers in disciplined use of such crossings.

Northern Ireland Railways



Northern Ireland Railways have published a booklet in a similar format to the Irish Rail publication mentioned above.

Miscellaneous Campaigns

Network Rail generally publish information leaflets for the local community when the method of control of a local level crossing is changed. They also publish more general leaflets on a zonal/regional level with specific topics.

A high profile campaign supported by a Member of Parliament has recently been held in Scotland in connection with the use of Red Light Enforcement cameras at level crossings in Scotland.

2. OPERATION LIFESAVER[2]

Operation Lifesaver (OL) is North America's premier public education programme dedicated to railway safety. The mission of OL is to end needless deaths and injuries at railway level crossings. In the USA during the year 2001 there were 961 rail-related fatalities and almost 96% of them involved level crossing collisions or trespasser accidents. Almost half of the level crossing collisions in 1998–2000 occurred at level crossings with warning devices (table 1). The proportion is about the same in European countries.

Table 1. Collisions at different types of railway level crossings in the USA during 1998-2000.

Device	% Collisions	% Crossings
Barriers	25.3%	22.1%
Flashing lights	23.0%	17.4%
STOP signs	10.6%	7.5%
Crossbucks	37.1%	46.0%

OL is based, like many traffic safety projects, on the "three E's" of Education, Engineering and Enforcement. In education, OL strives to increase public awareness about the dangers around the rails. The programme seeks to educate both drivers and pedestrians to make safe decisions at railway crossings and to avoid trespassing on tracks and property. In enforcement, OL promotes active enforcement of traffic laws relating to crossing signs and signals and private property laws related to trespassing. In the field of engineering, OL encourages continued engineering research and innovation to improve the safety of railway crossings.

Operation Lifesaver started in 1972 in Idaho as a one-off six-week campaign targeted at professional truck and bus drivers, students and civic leaders. During the first year of the campaign, Idaho's level crossing fatalities dropped by 43%. The next year the concept spread to Nebraska where the reduction in collisions was 26%. In 1986 Operation Lifesaver was incorporated as a national non-profit making educational organisation, Operation Lifesaver Incorporation (OLI). Today in the USA there are 49 state programmes with more than 2,500 trained, certified public speakers and hundreds of partners in the public and private sectors. International OL Programmes have been established in Canada, Mexico and South and Central America. During

[2] Chapter 4.2 is based on the presentation of Gerri Hall, the president of Operation Lifesaver Inc., given in London in June 2002 and on A Toolkit to Introduce Operation Lifesaver.

2002 the programme was introduced in Australia, the UK and Estonia and some OL-based trials on trespassing safety are planned for 2003 in Finland.

The first task of OLI is public education. In the USA some 40,000 presentations are given annually reaching an audience of about 2.5 million people. Target audiences include professional truck drivers, students, school bus drivers and law enforcement officials. Educational materials include videos, CD-ROMs and brochures, and pre-prepared lesson plans are available for teachers aimed at different student age groups. They are available from the OL web site (http://www.oli.org) or on CD-ROM.

The second task of OLI is media education. It aims to promote OLI film and photography guidelines and to raise awareness of 'bad ads' (advertisements in the media with no regard to rail safety). OLI has advertisements on television, radio and in print. The next challenge of OL in the USA is to involve the light rail industry as this mode of transport is increasing throughout the country.

3 Conclusions on the awareness campaigns

1) Level crossing users do not always know the traffic rules at railway level crossings

The basic reason for having the campaigns is that road users need to have information on railway level crossings. They need to be aware of level crossings and have proper knowledge on the speed of trains, the engine driver's options to avoid a crash and the consequences of a crash.

In Germany in 2001, Heiner Erke carried out a survey on behaviour at railway level crossings (Erke[3]). There were 2,500 subjects over 14 years old and they were interviewed by phone. The survey contained four questions concerning: 1. Confidence in the warning device; 2. Assumed causes for collisions; 3. Meaning of the red flashing signal at level crossings without barriers; and 4. Passing of half barriers when they are down.

48% of respondents had confidence in the warning devices at railway level crossings. The respondents were of the opinion that the most likely reasons for collisions are that car drivers are thoughtless (68%) or car drivers are inattentive (66%). Over a fifth of the respondents thought that the reason for collisions at railway level crossings is unreliable working of the warning device (29% said that barriers do not work properly and 25% said that the light signals fail). The meaning of a flashing red signal at a level crossing without barriers was unclear for the respondents. 22% of respondents concurred with the statement 'The flashing red signal is equivalent to the amber signal in normal traffic lights. Only continuous red means stop.' On the other hand 93% of respondents agreed that the 'Flashing red signal means stop, even if there is no train visible.'

The reasons for entering a level crossing when the half barriers are down were 'to show that I can handle critical situations' (7% of the respondents), 'I am in a hurry and the train is not visible (6%), 'I am sure that the train does not come immediately' (5%) and 'I can zigzag if there is no traffic, neither children nor police' (3%). The percentage of the responses given for entering a level crossing while the half barriers

[3] Erke, H. Highway Railway Level Crossings in Public Opinion. Presentation at EU level crossing safety working group meeting in Brussels on 20 November 2002.

are down were higher (18-29%) for young drivers. 84% of all respondents answered that they never drive round closed half barriers. It seems that the respondents were not always aware of proper behaviour at railway level crossings.

2) Contents should be based on facts, not emotionality, and offer means to prevent high risks

In general, campaigns that stress facts based on research are more effective than intuitive or emotional campaigns. According to health-risk communication theory, the best results are achieved when people believe that the threat is serious and that they are at risk of experiencing negative consequences from the threat. They also need to know that they have means to prevent a high-risk situation.

3) Recognising the correct target group

To make the campaign as successful as possible it is important to identify the correct target group. In the USA, in Michigan, a study was made to learn more about the kinds of individuals that were most at risk of train crashes (Witte & Donohue[4]). This study was carried out by surveying road users. The results indicated that the majority of drivers in Michigan are very cautious at railway level crossings. However, 10-20% of the respondents reported extremely risky behaviour such as trying to 'beat the train' for the thrill of it (risk seekers). Those risk seekers were most likely to be male, to engage other risky behaviours (like drinking, smoking, fighting), to have had personal frustrating experiences at level crossings, exhibit biased judgement processes about their ability to beat the train and be high sensation seekers. According to the study, effective communication campaigns in Michigan need to focus on high sensation seekers and the message of the campaigns should specifically address those frustrations. In this case the target group is the male in all age groups. The research also suggested that frustrated drivers need to have something to engage their attention while waiting for the train to cross.
There can also be problems in specific parts of the country or at some level crossings. In this case, campaigns should be targeted at the residents of that particular area.

4) Awareness campaigns do not always find an effective way to improve traffic safety

The effects of campaigns on road-user behaviour are very difficult to measure. Generally it is argued that campaigns are not a very effective way to improve traffic safety. In some European countries there have not been campaigns on safe behaviour at railway level crossings for some time because the other methods of improving traffic safety are considered more effective (e.g. developing warning devices). Also, the number of fatalities at railway level crossings is very low compared to the fatalities in road traffic in general.

[4] Witte, K & Donohue, W. Preventing vehicle crashes with trains at grade crossings: the risk seeker challenge. Accident Analysis and Prevention, 32/2000, pp. 127-139.

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Annex 2 Individual Country Statistics on annual basis 1996 - 2002

	AT			BE			DK			ES		
	Nb of LC in 2000 :			Nb of LC in 2000 :		2358	Nb of LC in 2000 :			Nb of LC in 2000 :		
	killed	collisions	killed/ collision	killed	collisions	killed/ collision	killed	collisions	killed/ collision	killed	collisions	killed/ collision
2002				**14**	**59**	0,24						
2001				**13**	**63**	0,21						
2000				**8**	**48**	0,17						
1999				15	**61**	0,25						
1998				18	**68**	0,26						
1997				16	**74**	0,22						
1996				16	**67**	0,24						
Total	0	0		100	440	0,23	0	0		0	0	

	FIN			FR			GB			GR		
	Nb of LC in 2000 :		5162	Nb of LC in 2000 :			Nb of LC in 2000 :		8106	Nb of LC in 2000 :		
	killed	collisions	killed/ collision	killed	collisions	killed/ collision	killed	collisions	killed/ collision	killed	collisions	killed/ collision
2002	**12**	**42**	0,29	**40**	**175**	0,23	**7**	**27**	0,26			
2001	**4**	**60**	0,07	**46**	**171**	0,27	**8**	**27**	0,30			
2000	11	52	0,21	51	170	0,30	10	31	0,32			
1999	10	48	0,21	48	181	0,27	6	29	0,21			
1998	12	39	0,31	53	176	0,30	12	25	0,48			
1997	14	52	0,27	51	180	0,28	12	36	0,33			
1996	6	47	0,13	59	195	0,30	5	37	0,14			
Total	69	340	0,20	348	1248	0,28	60	212	0,28	0	0	

	GE			IE			IT			LU		
	Nb of LC in 2000 :			Nb of LC in 2000 :			Nb of LC in 2000 :			Nb of LC in 2000 :		**150**
	killed	collisions	killed/ collision	killed	collisions	killed/ collision	killed	collisions	killed/ collision	killed	collisions	killed/ collision
2002				**1**	**4**	0,25				**0**	**2**	0,00
2001				**1**	**3**	0,33	8	163	0,05	**0**	**2**	0,00
2000	75	373	0,20	0	3	0,00	5	65	0,08	0	3	0,00
1999	92	412	0,22	0	6	0,00	4	52	0,08	0	0	0,00
1998	101	483	0,21	0	3	0,00	3	59	0,05	1	2	0,50
1997	86	428	0,20	1	4	0,25	2	69	0,03	2	2	1,00
1996	102	563	0,18	1	6	0,17	5	57	0,09	1	3	0,33
Total	456	2259	0,20	4	29	0,14	27	465	0,06	4	14	0,29

	NL			NO			PT			SV		
	Nb of LC in 2000 :			Nb of LC in 2000 :		**4645**	Nb of LC in 2000 :			Nb of LC in 2000 :		**8980**
	killed	collisions	killed/ collision	killed	collisions	killed/ collision	killed	collisions	killed/ collision	killed	collisions	killed/ collision
2002	**17**	**82**	0,21	**0**	**8**	0,00				**9**	**28**	0,32
2001	**20**	**76**	0,26	**2**	**14**	0,14				**3**	**23**	0,13
2000	30	66	0,45	9	16	0,56	22	104	0,21	14	30	0,47
1999	43	78	0,55	2	17	0,12	22	130	0,17	8	35	0,23
1998	25	72	0,35	6	12	0,50	24	146	0,16	7	25	0,28
1997	28	77	0,36	1	9	0,11	24	101	0,24	12	42	0,29
1996	29	70	0,41	1	9	0,11	28	105	0,27	7	27	0,26
Total	192	521	0,37	21	85	0,25	120	586	0,20	60	210	0,29

Annex 3 Level crossing accident prevention, Swedish experiences

Level crossing accident prevention, Swedish experiences

After the change in 1967 from left to right circulation on Swedish roads, the accident rate gradually sank to one of the lowest in Europe except for level crossings. A research group report, TFD S 1981:4 gave the following results and advice:
The accident rate seems to be proportional to the traffic moment and type of protection at the crossing. Per traffic moment unit, the relative risk for crossings with St Andrews cross/flashing lights and bell/automatic barriers during the period 1973-1977 were 40/10/1. The average traffic moments for the different types of protection were at that time 400/1600/10,000.
On railways with less than ten trains per day the relative collision risk was higher, probably because road users did not expect trains to pass. The fatality risk per accident was lower depending on relatively low train speeds along little-used railways.
At a number of crossings with flashing lights and bell, where the road and railway runs parallel and close to each other ahead of the crossing, accidents involving road and rail vehicles travelling in the same direction were about 7 times as frequent as those with vehicles travelling from the opposite direction.
Compared with other road accidents, collisions during darkness at crossings without automatic barriers were few. Train headlights seem to give good warning effects.
The main recommendations were: to add automatic barriers to crossings protected with flashing lights and bell; or to close them and also crossings without active protection and divert road traffic to safer crossings.

General improvement work

In 1985 the rail and road administrations raised the following objectives:
Crossings protected with flashing lights and bells should, before 1995, either be upgraded to automatic barriers or be closed if the traffic moment is more than 1600. This goal was reached along all main lines with passenger services but not on all country lines.
Crossings without active warning should be permanently closed.
Along double-track lines the number of level crossings should be reduced from 900 to 450. This goal was reached already during 1993.
In the present ten-year investment plan these goals have been extended to 2007 and developed to:
All crossings with a traffic moment multiplied by the permitted train speed in kph/100 exceeding the value 800 should have automatic barriers or be closed.
Along double-track lines all remaining crossings should have automatic barriers.

Along main lines the number of crossings without active warning systems should be reduced by 50%.

The number of collisions on level crossings have decreased from about 100 per year in around 1985 to about 30 per year over the last few years. The main part of the reduction has been on crossings with flashing lights and bells. During the same period, fatalities have fallen from 25-30 per year to less than 10 per year.

DEVELOPMENT OF HIGH CLASS BARRIER-CROSSINGS

About twenty years ago, Swedish State Railways took the decision to introduce tilting trains, which made it possible to raise top speeds along many main lines from 130 kph to 200 kph. If this had demanded a complete level separation of all road crossings along the lines, the investment costs would have stopped the project.
The decision was taken to upgrade all remaining crossings for train speeds over 160 kph with additional devices:
The warning portals for high tension in the catenary were covered with a blue and white pattern of reflective material.
Red and yellow hangers were adapted on the barriers.
Stronger red flashing lights were added in high positions.
Obstacle detection and broken barrier control were included in the ATP.
Since 1990 about 80 crossings have been upgraded to this standard. There have been no collisions but a few incidents on these crossings.

VISIONS FOR THE FUTURE

The efforts to level-separate or close crossings will continue.
All main lines will based on EU recommendations and probably within 20 years will have a new signal system ETCS installed. This will make it easier to improve signal communications between trains and crossings for obstacle detection and constant warning times.
Next generations of road vehicles will gradually be equipped with intelligent transport systems helping the driver to observe and avoid dangers, for example closed barriers.
GPS positioning could be used along low-flow railways to tell motorists that a train is close to a crossing.
At crossings where it is difficult to construct level separations, car-stopping devices can be installed behind the barriers.
Warning portals for high tension ought to be moved at least 25 meters from the track to prevent high vehicles hooking in the portals, thus blocking the track and causing collisions.

Annex 4 Inspection of Level Crossings: Checklist

Contents

Indication:

The check-list is an aid for all responsibilties of the level-crossings to reach for the goals of an inspection. For a self-controll, it is a summary of several questions, which may be important for every single level-crossing. The complete use of this check-list should be in a relationship to each level-crowssing situation.

Charakteristics	**Nr.**	**Questions**
Fundamentals		
1. Basic situation	1	Is the level-crossing situated in our out of a cross-town link?
	2	Which traffic importance has the road (major road, development road, rural road etc.)?
	3	Which traffic loading has the road (low traffic loading < 100 vehicles/day, moderate traffic loading < 2500 vehicles/day, high traffic loading > 2500 vehicles/day)? And which high-speed?
	4	Which road users with which traffic loading are in the area of the level crossing (motor cars, trucks, busses, school busses, bicycles, pedestrians, agriculture vehicles etc.)?
	5	Does seasonal traffic exist on the level crossing (seaside resort, skiing area etc.)?
	6	Which traffic importance has the railroad track?
	7	Which traffic loading has the railroad? And which high-speed?
	8	Which safe-guarding has the level crossin (technical protection, non-technical protection etc.)?
2. Traffic safety	1	Does accident analysis, accident reports or other accident datas exist of the last 3 years?
	2	Happened any defects or operation faults on the technical protection?
3. Traffic flow	1	Is the carriageway width on the level-crossing enough for oncoming traffic (curve for trucks etc.)? In which condition is the pavement (also on the road side)?
	2	Is the level crossing a bottleneck?
	3	Are additional traffic regulations or maintenance measures for the improvements of the sight necessary?
	4	Are the clearance distances on the level crossing kept free? Are additional traffic regulations necessary (stopping prohibited etc.)?

Charakteristics	Nr.	Questions
	5	Are pedestrian crossings, bus stops or roundabouts out of the clearing distance?
	6	Are peculiarities of the road users (trucks, busses, rural traffic etc.) and their traffic direction (left-turning lane considered? Are additional traffic regulations necessary (priority rule, one-way road etc.)?
	7	Are special measures for handicapped persons, in the neighbourhood of retirement homes or schools etc. necessary?
	8	Is the level crossing on the route of heavy duty traffic? Does special regulations exist for the heavy duty traffic?
	9	Is the level crossing on the route of a detour (permanent, short period)? Is the safeguarding enough in case of detours? Do regulations exist in case of detours (observer of the level crossing etc.)?
	10	Do other problems of traffic flow exist?
4. Traffic development	1	Will the traffic development increase or decrease (in case of a bypass road, new residential area, trade area, new traffic distributions etc.)?
<u>Peculiaritiy demands</u>		
5. Pedestrians and bicyclists	1	Are the pedestrians and bicyclists considered?
	2	Do footways and cycleways exist?
	3	Is the level crossing safety in case of the ending of a footway and/or a cycleway?
	4	Are the technical protections for pedestrians and cyclists functional (signals or barriers)?
	5	Are closures for pedestrians and cyclists available and functional?
	6	Do functional means of guiding traffic to the level crossing exist (railings, fences etc.)?
	7	Do pavement surface indicators for blind persons exist?
	8	Are pedestrian crossings, pedestrian signals etc. out of the clearance distances of the level crossing?
6. Public passenger transport	1	Is the public passenger transport and ist users considered?
	2	Are the stopps (bus stop etc.) out of the clearance distance of the level crossing?
	3	Do functional means of guiding traffic for the passengers exist (railings, fences etc.)?

Charakteristics	Nr.	Questions
7. Heavy duty traffic	1	Is the heavy duty traffic considered? Does special regulations exist for the heavy duty traffic
<u>Visibility and sight</u>		
8. Visibility on the level crossing	1	Is the visibility on the level crossing considered?
	2	Is the level crossing visable from all accesses? Do traffic signs to the level crossing exist on all accesses?
	3	Is a speed limit in the direction to the level crossing necessary (in case of non-existing visibility or non-existing sight triangles etc.)?
	4	Are additional overtaking traffic signs necessary?
	5	Is the existing technical protection in the best condition (position of the signals, visibility of the signals etc.)? Also from other accesses?
	6	Do the St. Andrew's cross and other traffic signs exist? Are they visable and in a good condition?
	7	Is a new technical protection necessary?
	8	Is a clearance of the right of way of the railroad traffic necessary (repeat of St. Andrew's cross as a pavement marking, overhead traffic signs, special colour of the pavement in front of the level crossing etc.)?
	9	Is the sight triangle kept free (exposed faces are in a relationship to the high speed of the vehicles and the trains. The exposed faces can be different in each of the 4 quadrants)?
	10	Are the stopping sight distances considered o all accesses?
	11	Is the sight to the level crossing or the sight triangles reducted (in case of fences, road equipments, road signs, landscapings, plantings, buildings, advertisements etc.)?
	12	Is the sight reducted temporary (in case of parking vehicles in bus stops, traffic jams etc.)?
<u>Traffic signs and markings</u>		
9. Traffic signs	1	Are the traffic signs complete (see the plans) and do they consider the local and traffic conditions?
	2	Are the road signs visable and readable?
	3	Are the road signs and the markings in the right relationship and without contradiction?

Charakteristics	Nr.	Questions
	4	Are the St. Andrew's cross and other road signs in the right position?
	5	Is a distinction of the right of way of the railroad traffic necessary (repeat of St. Andrew's cross as a pavement marking, overhead traffic signs, special colour of the pavement in front of the level crossing etc.)?
	6	Is a speed limit necessary?
	7	Is a stopping prohibited especially in the clearing distance necessary?
	8	Is the sight to the road signs reducted (in case of wrong positions, fences, road equipments, landscapings, plantings, buildings, advertisements etc.)?
	9	Are the road signs in a good condition (not damaged, reduction of retroreflexion etc.)?
	10	Are the road signs of the level crossing complete on **all** accesses?
10. Road-signals and barriers	1	Are the signals (yellow/red light or red flashing light) visible for the road user? Are the signals meaningful and enough also for all accesses (side lights for cross roads, side roads etc.)?
	2	For better visibility of the signals, is it meaningful to use overhead signals, bigger signals, other directions of the signal lights, better sunprotectors etc.)
	3	Is it possible, that the sun protectors of the signal can cover the lights for road users of side roads or for whom, who come out of a curve?
	4	Are the barriers of the level crossing for the roads users (the car driver, the cyclist, the pedestrian) meaningful, visible and enough?
	5	Are the Andrew's crosses visible and in the right location?
	6	Are dazzles possible in case of the low sun or other strong sources of light? Are light (sun) protectors, additional signals, signals on other locations necessary?
11. Road marking	1	Is the road marking clear and visible?
	2	Are the road signs and the marks without any contradictions and in the right relation?
	3	Are old markings eliminated (phantom markings)?
Road equipment		
12. Road equipment	1	Are special equipments necessary (safety barriers, rails etc.)?
13. Lighting	1	Is lighting necessary and meaningful?
	2	Is a contrast lighting necessary?
	3	Does the lighting of the surroundings need special standards?
14. Planting	1	Does the planting restrict the sight on the level crossing, on the technical safe

Charakteristics	Nr.	Questions
	2	guarding, on the road signs etc.? Does the planting restrict the sight in the sight triangle of a non-technical protected level crossing?
	3	Is the road user distracted or affected by the planting?
Road construction		
15. Highway condition	1	Are the standards of road building ups and the railway building ups (also the level crossing paving) adapted?
	2	Does the longitudinal evenness of the level crossing **and** the road exist (at-grated situation of the railroad track surface **and** the road surface, without longitudinal evenness, unevennesses etc.)?
	3	Does the transverse evenness exist (without ruts etc.)?
	4	Do surface distresses exist (potholes, potholes patchings, cracks, diagonal cracks, etc.)?
	5	Does the skid resistance of the road surface exist?
	6	Does the drainage work (minimum descending grade of 2.5%, cleanliness, good function of the gullies and the gutters etc.)? Do puddles exist?
16. Cross section	1	Is the cross section in the right relation to the road function?
	2	Are the peculiarities of the traffic composition considered (clearance distance etc.)?
	3	Is the width of the level crossing pavement (in curves also the curve widening) enough for big motor vehicles, that they don't need the lane for opposing traffic flow?
	4	Is the level crossing a bottleneck?
	5	Is the bottleneck safety?
17. Alignment	1	Are the peculiarities of the traffic composition considered clearance distance for the left turn vehicules etc.)?
	2	Is the alignment of the road in a good relation also for big motor vehicles, that they don't need the lane for opposing traffic flow?
	3	Is the level crossing in a critical location (crest, sag, curve, bad visibility etc.?
	4	Are the stopping sight distances considered?

Demands

On the level crossing are no changes necessary.

The level crossing must be eliminated.
The level crossing must be changed
On the level crossing are the following changes needed: