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Thematic Priority: Sustainable Surface Transport

**D14 - Recommendations for Standardisation**

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The document presents the Recommendations for Standardization resulting from the Work Packages 1,2 and 3 of the SELCAT project

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List of Acronyms

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<td>EMI</td>
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<td>Knowledge Management System</td>
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Executive Summary

Evaluating results and recommendations from the work packages of the SELCAT project has identified two areas with the potential for standardisation in the future.

The first item is based on the evaluation of level crossing legislation (WP1) during which it was realised that there are significant differences in road driver responsibilities between the member states. In particular the legislation of Eastern European countries requires the full personal responsibility of the road vehicle driver for their safe passage at level crossings. This applies even where that the level crossing is equipped with a safety system (such as warning lights or barriers). On the other hand in the majority of Western European countries the road vehicle driver can rely fully on the function of the safety system (where provided) and therefore does not need to be aware of an approaching train if this system is not activated (where the warning lights are not activated or the barriers are open). Following the tendency in some Western European countries (such as France, Germany or the United Kingdom) it is recommended that there is no need to provide a St. Andrew’s Cross sign at such level crossings, because there is no need of any increased awareness of the road vehicle driver. In the countries, where this awareness is required despite the existence of the safety system, the St. Andrew’s Cross should be further used on all level crossings types.

The second item concerns the evaluation of the level crossing risk. In order to provide similar safety conditions at all European level crossings it is sensible to harmonise risk assessment methodologies. Based on the conclusion that the statistically oriented risk modelling identified by SELCAT is the best risk assessment methodology, this should be widely adopted. Careful attention should be paid to the common set of information collected about level crossing operational conditions and on accidents which have occurred in the past. Such a list of relevant information could be the source of future European standards concerning the monitoring of level crossing safety performance.
Background and objectives

It seems a ‘good idea’ to promote standardisation of practices like safety targets, data collection, management processes. This helps promote good practice, allows comparisons to be made, and improvement areas to be targeted. The European Railway Agency is leading much of this work for the rail sector and hopefully will work closely with the road sector in the future.

It would also help with the completion of the single market to ensure that motorists were always presented with similar types of level crossing anywhere in Europe. The costs of this would generally fall on the rail infrastructure managers – who would find it difficult to justify the costs as the true safety benefit would be very low. Even the cost of standardising signage would be considerable - in one country like the United Kingdom changing all the road signs to a new standard would cost an estimated €15 Millions.

For this reason SELCAT sees the harmonisation of level crossing signage and other related legislative as a long term target. As a first step two issues of standardisation have been identified with a potential benefit at the European level. The reasons leading to it were:

- Differences in the responsibilities for level crossing safety in European member states
- Differences in assessment and evaluation of level crossing risks.

The following two chapters present the background of the issues identified and proposals from the SELCAT consortium how the existing situation could be improved or resolved. Both chapters also discuss the potential benefit of these proposals if the standardisation were supported at the European level.
1 Defining new meanings for the St. Andrew’s Cross Sign

1.1 Introduction

The first identified issue is based on the evaluation of level crossing legislation (WP1) during which it was realised that there are significant differences in road driver responsibilities between the member states. These responsibilities are part of the national highway codes of the member states and create difficulties for the drivers of the international road transport.

In particular the legislation of the most Eastern European countries requires the full personal responsibility of the road vehicle driver for their safe passage at level crossings. This applies even where that the level crossing is equipped with a safety system (such as warning lights or barriers).

As an example from the Czech and Slovak Republics the required interpretation of the visual level crossing warning can be mentioned:

If no flashing lights are showing this means that either:

- No train is approaching or
- The level crossing protection system is in a failure state

The required behaviour of the road vehicle drivers is stated in the Highway Code (SK) is as follows:

- The road driver is obliged to behave extremely carefully and
- When crossing the level crossing the driver should be sure that he / she can cross safely

Such a behaviour is also stated on the leaflet of a level crossing safety campaign as shown on the figure 1.
Fig1. Level crossing safety Campaign of Slovak railways warning the road vehicle drivers that a train has always right of way and that road driver must never enter the crossing if it cannot be crossed safely.

On the other hand in the majority of Western European countries the road vehicle drivers can rely fully on the function of the safety system (where provided) and therefore do not need to be aware of an approaching train if this system is not activated (where the warning lights are not activated or the barriers are open).

The required behaviour of the road vehicle drivers in Germany and in the United Kingdom is as follow:

- When no red light is flashing the road user should cross the LC with adequate speed.

 Provision of the ‘sight triangles’ allowing the road vehicle driver to recognise that a train is approaching is not necessary on technically equipped level crossings due to the fact that the level crossing protection system is designed in full fail-safe mode and in cases of its failure the train driver is informed by the signal or by the operator from the railway operational control centre. In such a cases the train driver is obliged (or forced by the train control system) to stop the train in direct proximity of the level crossing and to cross only when it is safe to do so.

**Can we live with such contradictory highway rules?**

1.2 Proposal

Following the tendency in some Western European countries (such as France, Germany or the United Kingdom) it is recommended that there is no need to provide a St. Andrew’s Cross sign at such level crossings, as there is no need for any increased awareness of the road vehicle driver.

![Figure 2 St. Andrew’s Cross according to the Vienna convention](image)

This would imply:

- When road users are fully responsible for safe passing over a level crossing the St. Andrew Cross should be used according to the Vienna Convention (see fig.3) This would apply to level crossings:
  - With no technical equipment (passive LC)
  - The LC equipment is not working in full safety mode
  - The LC equipment is operated manually by road users
• When the car drivers can rely fully on the technical equipment with warning and protection devices, St. Andrew’s Cross signs should not be used.

Figure 3 example of the use of St. Andrew cross in connection with level crossing warning lights

Figure 4 Example of a technically equipped level crossing without the use of St. Andrew cross

In the countries where the awareness of the road vehicle drivers is required despite the existence of the safety system, the St. Andrew’s Cross sign should be further used on all level crossings types.

1.3 Benefit

Standardisation of the new meaning of the St. Andrew cross at the European level would have the following benefits:

• Clear visualization of the expected behaviour to the car driver
• Significant contribution to the harmonized signage of level crossings at relatively low costs
• Support of existing philosophy of several member states (D, UK, F, etc.)

The level crossing accident statistics show that despite low traffic conditions the proportion of the overall level crossing risk is relatively high at passive level crossings [1] [3]. The clear visualization of the full responsibility for a vehicle driver’s own safety by St Andrew Cross signs would additionally allow the use of technologies with lower safety levels [2] at such crossings which could have a very positive cost benefit ratio. Even in the case of an unexpected failure of such technologies the road vehicle driver
would be clearly informed about his responsibilities and his required awareness of the existing risk. This is fully in line with the existing philosophy of member states like CZ, SK, PL, H, BG, etc.)

2 Approach to harmonised level crossing report and risk evaluation

2.1 Introduction
The second item concerns the evaluation of the level crossing risk. The work in WP 1 aimed among others to create a system allowing a proper comparison of level crossing risks. When collecting level crossing accident statistics it was realised that very different detail levels and data precision standards exist, related to the information at level crossings themselves and also to the accidents which have occurred. Such differences enable railways to achieve only limited objectivity for risk comparisons which are not suitable for the safety performance monitoring required by the Railway safety directive [4].

2.2 Proposal
In order to provide similar safety conditions at all European level crossings it is sensible to harmonise risk assessment methodologies. Based on the conclusion that the statistically oriented risk modelling identified by SELCAT is the best risk assessment methodology [3], this should be widely adopted. Careful attention should be paid to the common set of information collected about level crossing operational conditions and on accidents which have occurred in the past. Such a list of relevant information could be the source of future European standards concerning the monitoring of level crossing safety performance.

The use of statistically driven risk evaluation methods for level crossing allows for the:

- Comparison of the absolute risk
- Comparison of relative individual risk
- Comparison of relative social risk
- Prediction of risk

In order to enable the use of statistically driven risk evaluation methods it is recommended that statistical data relating to the areas described in the following sections be collected:

2.2.1 Data for absolute risk comparison
These data generally arise from accident reporting procedures. Their level of detail should allow the storage of suitable information about the causes, consequences and severity of a level crossing accident which has occurred. Thus in case of a level crossing accident it is recommended that information be collected on:

**Accident type:**

- Type of road vehicle (categories)
- Type of train (categories)
- Type of the level crossing (categories)
- Date of the accident including daytime

**Accident causes:**
- Responsible road vehicle driver (sex, age)
- Responsible train driver (sex, age)
- Responsible operations manager (sex, age)
- Involved pedestrians (sex, age)
- Zig-zagging N/Y
- Suicide/ vandalism N/Y
- Visibility N/Y
- Grounding N/Y
- Road Adhesion N/Y
- RV driver distraction N/Y
- Blocking-back N/Y
- Does the road layout leads to abuse N/Y
- Crossing reopens to road too early N/Y
- Crossing fails to close on train approach N/Y
- Long/slow vehicle times-out N/Y
- Second train arrives N/Y
- Error in automatic level crossing safety equipment (visual, physical etc.)
- Error in manual control N/Y (gate keeper, operation manager etc)
- Sun dazzle N/Y

**Accident consequences data:**
- Does the train derail after the incident? N/Y
- Car/ large vehicle (Vehicle type)
- Is the road vehicle carrying hazardous goods? N/Y
- Is there a significant spillage of hazardous goods? N/Y
- Is hazardous freight toxic or flammable? T/F
- Is there a fire? N/Y
- Train fails to maintains clearances N/Y
- Train rolls over onto side N/Y
- Secondary collision? N/Y
Accident severity (risk)

- Staff
  - Fatalities,
  - Major Injuries,
  - Minor Injuries
- Members of public (including road vehicle drivers)
  - Fatalities,
  - Major Injuries,
  - Minor Injuries
- Passengers
  - Fatalities,
  - Major Injuries,
  - Minor Injuries

The data identified represents a base for statistically driven risk modelling methods and allows quantification of the absolute level of crossing risk (e.g., in FWI). The data should be collected whenever an accident occurs. Ideally, an electronic accident report form in the national language including all identified data items should be used.

2.2.2 Data for national level crossing risk comparison

In order to allow comparisons between the individual and social risks, it is necessary to collect much more basic information on the level crossing where the accident occurred. These are recommended as follows:

- Level crossing type (ERA classification or functional specification according to SELCAT)
- Freight train frequency (categories)
- Passenger train frequency (categories)
- Number of passengers per train
- Number of passengers per road vehicle (if possible to estimate)

These can be collected after an accident has occurred or in advance if a level crossing database on actual traffic conditions is available.

2.2.3 Data for international level crossing risk comparison

International comparisons of level crossing risk (safety performance) were investigated in the context of WP3 and applied in practice to data collected in WP1. The most suitable scaling factors for evaluation of individual and societal risk have been identified. In order to enable their application for international level crossing safety performance monitoring, the following country-specific data should be available:

Individual road user risk evaluation

- Average number of passengers in a road vehicle
- Average number of road vehicles per hour typical for a level crossing type
Individual railway user risk evaluation

- Average number of passengers in the train/s
- Average number of trains per hour typical per a level crossing type

Societal risk evaluation

- Population of each level crossing type*
- Population of inhabitants in millions
- Number of inhabitants per square km
- Length of railway network (excluding high speed lines)*
- Train millions km per year, (eg excluding high speed lines)*
- Length of the road network (excluding motorways / highways)*
- Road passenger million km per year*
- Number of cars per 1000 inhabitants
- Number of road fatalities/year (average value of last 5 years)
- Total number of railway accidents (average value of last 5 years)
- Total number of LC accidents (average value of last 5 years)
- the number of million passenger-kilometres for buses and coaches;
- the number of million passenger-kilometres for cars;
- the number of million tonnes-kilometres for road freight / trucks;

*indicates the scaling factors required for recommended method of international level crossing risk comparison [D3]

These data identified are typical for each country and need to be collated annually. Most of the information is already being collected by the European database of statistics ‘EUROSTAT’.

2.2.4 Data for level crossing risk prediction

In order to be able to predict level crossing risk levels it is additionally needed to collect statistical information specific for each level crossing which is should be included in the evaluation and prediction processes. These include detailed information on:

Train service factors

- Freight train frequency (categories)
- Passenger train frequency (categories)
- Train type (diesel or electric)
- Passenger Train loading
  - % of time in band (Night, Off-peak, Peak, Crush-loaded)
  - Number of passengers per train (Night, Off-peak, Peak, Crush-loaded)
Information about the train type

- Proportion of old stock
- Proportion of modern, more crashworthy stock
- Average train speed at crossing (KMH)

Propensity for 2\textsuperscript{nd} train with barriers down (categories)

Road traffic

- Road vehicle frequency (12 cat.)
- Overrun or overspeeding (4 cat.)
- RV drivers have to stop at crossing (y/n)
- Use by long/slow vehicles (3 cat.)

Level Crossing features/road layout

- Use by long/slow vehicles
- Road surface: Grounding factor (3 cat.)
- Road surface: Adhesion factor (5 cat.)
- Road layout: Blocking-back factor (5 cat.)

Topographic factors

- Sun dazzle factor (y/n)
- Visibility (3 cat.)
- Track curvature
- Number of railway lines at crossing
- Are there structures close to the crossing (y/n)
- Are there facing points near (beyond) the crossing (y/n)

Level crossing equipment

- Crossing obstacle detection effectiveness (4 cat.)
- LC equipment integrity (4 cat.)
- Level crossing waiting time (9 cat.)
- Crossing reopens to road too early
- Crossing fails to close on train approach
- Level crossing type (ERA classification or functional specification according SELCAT)

Crossing's human factor features (relative to average)

- Propensity for misuse
- Propensity for zigzagging (3 cat.)
- Propensity for suicide or vandalism (4 cat.)
- Road vehicle distraction factor
- Road layout leads to abuse
➤ Propensity for crossing keeper/ signaller EPCs
➤ Network average data
➤ Number of level crossings of the particular type
➤ Average level crossing type road vehicle frequency per hour
➤ Average level crossing type train frequency per hour
➤ Average road vehicle wait time at level crossing (seconds)
➤ % of crossings with obstacle detection
➤ Average effectiveness of obstacle detection
➤ % Crossings where cars have to stop

All the information identified for level crossing risk prediction should be stored in level crossing databases and updated whenever level crossing inspections are carried out.

2.3 Benefit

The collection of all information identified can be directly used for the population of a level crossing risk model. A prototype of such a model has been developed in the context of the SELCAT WP3 using the example of automatic half barrier crossing. The model is implemented as a Microsoft Excel file and can be downloaded from the SELCAT web page [5]. The population, application and benefit of use of such a model are described in detail in deliverable D3 [3].

Deliverable D3 [3] also contains a detailed description of a methodology designed to produce a comparison between individual and societal risks between countries and between level crossing types. The data identified enables the practical application of these findings.
3 Conclusions

The two items recommended for standardisation and outlined above would be a first step to harmonisation in area of level crossing safety.

The first item addresses directly the most important difference in the safety philosophy of European level crossings concerning the responsibility for level crossing accidents. The proposed solution is in line with national developments concerning level crossing signage as well as with intended introduction of new technology based on a shift of the responsibility for safety from railway infrastructure managers to the road users. The proposed solution opens up the possibility of a significant increase of the number of technically equipped level crossings in a cost effective way.

The second standardisation proposal is a prerequisite for the objective monitoring of level crossing safety performance at the European level. In connection with the prototype of the level crossing risk model developed as part of the SELCAT project, this proposal would provide a risk prediction tool leading to the efficient introduction of risk reducing measures.

The evaluation and prediction of level crossing risk using the risk model prototype should be of increased importance especially with the proposed standardisation of the new meaning of the St. Andrew's Cross sign. It is exactly the result of risk analysis which must support any decision for introducing of technology fulfilling not the highest safety requirements (Safety Integrity Level 4). This approach is fully in line with the safety philosophy of the CENELEC Standards basing on the freedom of unacceptable risk of harm [EN 20 126].

References

[1] SELCAT Deliverable D1, Report about Statistics, Database Analysis and Regulations for Level Crossing