



TCA5-CT-2006-031487

SEL CAT

Safer European Level Crossing Appraisal and Technology

Instrument: Coordination Action

Thematic Priority: Sustainable Surface Transport

D13 - Recommendations for FP 7 Activities

Due date of deliverable: June 2008
Actual submission date: September 2008

Start date of project: 01.09.2006

Duration: 22 Months

Organisation name of lead contractor for this deliverable:

The French National Institute for Transport and Safety Research (INRETS)

Revision 3

Project co-funded by the European Commission within the Sixth Framework Programme (2002-2006)		
Dissemination Level		
PU	Public	X
PP	Restricted to other programme participants (including the Commission Services)	
RE	Restricted to a group specified by the consortium (including the Commission Services)	
CO	Confidential, only for members of the consortium (including the Commission Services)	

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Document ID:	SELCAT-D13-V2.1
Date:	August 8th 2008
Contract N°:	TCA5-CT-2006-031487

Type of document:	Report
Status:	Version 1.0
Confidentiality:	Public
WP allocation:	WP2
Distribution:	SELCAT partners
History:	Version 1.0, 13 th May 2008
	Version 2.0, 13 th June 2008
	Version 2.1, 8 th August 2008

Document Abstract:	Based on the conclusions drawn from the SELCAT project work packages WP1, WP2 and WP3 this document provides recommendations for further actions intended to improve safety at level crossings.
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Project Sponsor:	This report reflects work which is funded by the European Commission under the competitive and sustainable growth programme of DG Research.
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History	Author	Date
ERRIS	S. Fletcher	March 31, 2008
Draft	N.Lazarevic, E.M.El Kursi, S. Fletcher, L. Khoudour	May 13, 2008
Review	R. Slovak, (TUBS), E. Schnieder (TUBS)	June 10, 2008
Review	M. Woods	August 23, 2008

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1 Overview

Based on the conclusions drawn from the SELCAT¹ project work packages WP1 [1], WP2 [2], and WP3 [3, 4] including the discussions at the three SELCAT public workshops [proceedings WS1, WS2, WS3], this document provides recommendations for further action intended to improve safety at level crossings. The recommendations have been developed around two major ideas: (i) use of advanced technological solutions designed to minimise the impact of human factors as the main cause of accidents at level crossings and (ii) a joint rail and road sector strategy to control and reduce risks at level crossings. The final conclusion was to conceptualise the different approaches within a joint strategy.

2 Introduction

According to the evaluation of level crossing accident data, collected in the SELCAT WP1, about 91% of all accidents in the European Union are caused by erroneous human behaviour. From the level crossing accidents² analysed, more than 80% were caused by road vehicle drivers who failed to take notice of traffic rules. Another 10% of accidents were attributed to the fault of railway staff (train driver, level crossing keeper, etc.). Only a negligible portion is caused by the failure of railway technical equipment.

This analysis has clearly identified that human factors are the major cause of accidents at level crossings.

Despite the fact that more than 90% of all fatalities are attributed to faults by road vehicle drivers, society labels most fatal accidents at level crossings as a rail problem. The actions of, and misuse by, members of the public throughout Europe account disproportionately for over 35% of all accidents recorded in the UIC's safety database for the year 2005. However, over the same period, of all the road deaths in Europe (approximately 41,300³), only 2% occurred at level crossings.

Clearly, while level crossings represent a significant risk area for the safe operation of the rail network, this is in fact only a small element of the overall road safety issue.

3 SELCAT project overview

The SELCAT Coordination Action is responding to the call of the 6th Framework Programme of the European Commission in the area of "Sustainable Surface Transport Coordination Actions" towards the objective of "Increasing road, rail and waterborne safety and avoiding traffic congestion".

All the coordination activities of SELCAT are focused on creating an increase in level crossing safety, addressing all possible influencing factors. The first factor is learning from the current "state of the art", including an overview of the present status of level crossing accidents statistics, and that research completed during FP5 and FP6 which is relevant to the areas of rail and road transport safety (WP1). The second influencing factor is an examination of advanced technologies which could be applied in order to decrease the number of level crossing accidents (WP2). The third critical

¹ Safer European Level Crossing Appraisal and Technology

² 256 analyzed level crossing accidents in the year 2004

³ Source – Eurostat Transport Panorama – June 2007

factor is the need to understand how well expenditure on level crossing upgrades is aligned to operational risk evaluation, system safety, performance, and overall cost-benefit analysis (WP3).

4 Recommendations to enhance LC safety

The work carried out within WP2 has addressed possible technological solutions for improved level crossing safety. The deliverable D2 “Examination of actual and potential Technologies for Level Crossings” provides a study about possible technological solutions to reduce the number of accidents on level crossings. The basis for the study is the results of FP6 projects dealing with advanced technology, with special regard to ground transport applications. As a structure for the study, a suitable concept of modularisation of a generic level crossing safety system is used; and a set of possible technical solutions and improvements of contemporary technology are elaborated. Focus is given to the results of FP6 projects dealing with advanced technologies such as equipment designed to detect objects, such as road vehicles, on level crossings. The study is extended by a set of recommendations on how to increase people’s awareness of and respect for the proposed technical solutions. Special attention is given to the analysis of the impact of human factors in the context of level crossing safety.

In addition, a transmission system is required in order to send details of the state of the system, and updates, to the relevant decision making centres, as well as to provide triggers and signals for alarms in potentially dangerous situations, or in cases of system failure. With respect to the case study presented earlier, the transmission system would need high bandwidth to deal with video sequences. As bandwidth limitations must be taken into account, the question of the quality of the video to be transmitted becomes critical. One of the criteria to establish the acceptable quality of the received messages is determined by the perception of the human operator. Therefore, the design of the transmission system, as well as the safety system as a whole, needs to be based on the prior analysis of human factors in the level crossing environment.

Finally, an in-depth analysis of human factors in the context of level crossing safety has been presented. The work presented has paid special attention to human factors, in order to understand the degree of its impact on safety at LX and, thereafter, reduce the occurrences and consequences of human factors errors. WP1 investigated level crossing accidents based on accident and incident statistics. Unfortunately, most accident related data are not based on any theoretical framework of human error. The theoretical framework about human factors which we have introduced in this work serves as a basis for understanding the different human errors that may endanger safety at LX and, thereafter, for building new technologies that can consistently mitigate these human errors.

4.1 Information collection and dissemination, campaigns

The rail community is willing to play a very strong part in this activity but it cannot do it alone. Supported by the UIC and CER, the rail operators have been developing their role in this area over the past couple of years. They are prepared to engage with a range of players from other sectors, under the patronage of the EC, to ensure that this area of rail activity, from which there is significant risk, is managed in a coordinated and joined up way. The involvement of the ERA in this area is also strongly

encouraged. Recognising that there is no equivalent agency working within the roads sector, we would encourage the EC (DGTREN) to assume this role, at least in the short-term.

There should be encouragement for society to recognise the bi-modality of the road/rail interface and work closely with the road and rail sectors, and all relevant governmental agencies, to help reduce levels of risk from level crossings.

Amongst other elements, the strategy would:

- Highlight the need to systematically collect LC accident data through reporting and evaluation. Ensure that any improvements proposed are targeted at those level crossings with the highest safety risk and the greatest opportunity for improvement.
- Address road user behaviour through the introduction of measures to increase safety (education, campaigns, etc.) at a European level.
- Evaluate proposals for technological research and development for reduction of risk from level crossings
- Seek to develop guidance on managing safety at level crossings that is appropriate to the road and rail sectors and reflects current good practice.
- Promote the development of links with law enforcement agencies, to create a systematic approach to the codification of road user violations at level crossings.

4.2 Advanced Technological Solutions

The SELCAT project workshops, and discussions amongst the consortium stakeholders, have identified two major research priorities relevant for the improvement of the safety at level crossings: (i) the use of advanced technological solutions designed to minimise the impact of human factors as the main cause of accidents at level crossings; and (ii), to develop a harmonised methodology framework for the definition of functional and technological requirements for the optimal equipment to be used at each type of level crossing

The results of the investigation into the causes of level crossing accidents have identified inappropriate or inadequate human behaviour as the main source of the problem. Human factors play an important role on both the road and the rail side. Violations of traffic regulations, disregard of warning signals, and trespassing by road vehicle drivers and pedestrians contribute to most of the fatalities. On the rail side, the staff roles with safety related responsibilities (such as: manually operated level crossings, warnings given by train drivers, supervision, and fall back operations) are particularly vulnerable to human errors.

Therefore, the design of new technological solutions intended to minimise the impacts of human behaviour ought to be based on the analysis of human factors in the context of safety risk limitation at level crossings. Such an approach is expected to produce a twofold benefit: it will help increase people's awareness of the risk at level crossings and minimise the impact of voluntary and involuntary hazardous human behaviour.

4.3 Recommendations to FP7

Following the outcomes of the SELCAT-WP2 [2] our recommendations concerning the use of new technologies for existing level crossings are as follows:

- Design of any new safety system should be based on prior human factors impact analysis
- Low cost technology will allow its broader application and will contribute to a direct decrease in the number of accidents at an affordable cost
- Substitution of obsolescent technology with new technology where this can be justified on cost / benefit grounds.
- Substitution of human actions by new technology
- Assessment of safety and cost using a harmonised methodologies
- Supervision of danger zones: technological improvements to level crossing safety infrastructure, such as deployment of various types of sensors (audio, video, radar, lasers) for the timely detection of potentially hazardous situations
- Use of fast, reliable, wireless links to enable a seamless communication between the train, the level crossing, and the main control centre/s.
- Optimization and unification of crossing warning and closing times (for example, by rail board site positioning systems)
- Definition of main, basic level crossing types at a European level, based on modular designs
- The pilot development of advanced technologies for each of the basic European LC types, for the purpose of validating the proposed approaches
- Development of the harmonised level crossing information system on a European level
- Elaboration of the harmonised methodology for level crossing assessments, based on the findings of SELCAT
- Organization of a European campaign for car drivers, as well as for broader use in education

These recommendations are intended to instigate an initiative at the European level, the aims of which are: to develop methods and tools for reduction of safety risk at level crossings; demonstrated and tested on software simulations, level crossing prototypes and in-field tests based on the selected safety scenarios.

5 References

- [1] SELCAT Deliverable D1, *Report about Statistics, Database Analysis and Regulations for Level Crossing*, <https://www.levelcrossing.net/>
- [2] SELCAT Deliverable D2, *Report about Examination of actual and potential Technologies for Level Crossings*, August 2008, <https://www.levelcrossing.net/>
- [3] SELCAT Deliverable D3, *Report about Risk Modelling Techniques for level crossing risk and system safety evaluation*, <https://www.levelcrossing.net/>
- [4] SELCAT Deliverable D4, *Report on Cost Benefit Analysis methods for level crossings*, <https://www.levelcrossing.net/>

6 Publications

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Proceedings of the 2nd SELCAT Workshop “Technology”, Marrakech, Morocco, 22 November 2007

Proceedings of the 3rd SELCAT Workshop “Level Crossing Methodology”, Paris, France, 23 June 2008 European Rail/Road Interface Strategy resolution presented at the 2nd SELCAT Workshop