**ECBOS**

**Enhanced coach and bus occupant safety**

**Funding:** European (5th RTD Framework Programme)

**Duration:** Jan 2000 - Jun 2003

**Status:** Complete with results

**Background & policy context:**

In the EC approximately 30,000 people a year are injured as bus or coach occupants in accidents involving transports of more than 5,000 kg of weight. Some 150 of these suffer fatal injuries. The kind of accidents which occur throughout EU countries comprise collisions, single accidents as well as 'normal' driving manoeuvres.

The correlation between current test approvals on passive safety for buses and coaches and real-world accidents and incidents has been lacking. Reasons were on the one hand the missing statistical tendency of fatality and injury rates in bus and coach accidents over the last years, and on the other hand the lack of a research study on general bus and coach safety.

Although several studies on individual topics of passive safety for buses and coaches exist which explain single problems well, a comprehensive study that would consider the interaction of the main safety relevant cases (i.e. frontal crash and rollover) had not yet been undertaken.

**Objectives:**

Whilst a total of seven ECE regulations and 5 corresponding EC directives currently deal with structural and seat design for buses and coaches, ECBOS aimed at making improvements in current regulations and proposing new regulations and standards for the development of safer buses and coaches.

Particular objectives have been to:

- Develop cost effective test and evaluation methods for the assessment of the protection available to bus occupants and driver in frontal, oblique and rollover accidents;
- optimise restraint devices for occupants which were previously tailored to a standard male occupant;
- specify child restraint systems for buses and coaches;
- consider different sizes of buses according to ECE regulations used in public transport (i.e. up to 5 tonnes maximum weight, and in excess of 5 tonnes);
- put special emphasis on city buses, where passengers are often standing;
- draft new standards aiming to increase the safety of buses; and
- demonstrate the efficiency of those new standards through the use of numerical models on improved bus design.

**Methodology:**

A statistical accident analysis was performed in a first step to gain basic knowledge on information readily available from governmental databases. Despite the different ways of data collection among European countries, it was possible to identify a generic pattern. The results of this analysis were then used to perform an in-depth accident analysis including detailed accident reconstructions and the compilation of a newly set up bus and coach accident database.

The next step was the investigation of the main injury mechanisms according to type of crash, for which different kinds of component tests which were performed to analyse the impact behaviour of e.g. interior components, seat systems and structural parts were evaluated. These physical and material data were used in a further step to validate newly devised numerical simulation models for vehicle structures and occupant behaviour. Parameter studies, including type of occupant, type of vehicle and
type of restraint system completed this experimental and analytical work.

**Related Projects:**

None.

**Parent Programmes:**

*FP5-GROWTH KA2 - Sustainable Mobility and Intermodality*

**Institute type:** Public institution  
**Institute name:** European Commission, Directorate-General for Energy and Transport (DG TREN)  
**Funding type:** Public (EU)

**Partners:**

- Technical University Graz (AT);  
- Cranfield Impact Centre Ltd. (UK);  
- Gesamtverband der Deutschen Versicherungswirtschaft - GDV (DE);  
- Loughborough University - VSRC (UK);  
- Politecnico di Torino (IT);  
- TNO Automotive, Crash Safety Centre (NL);  
- Universidad Politecnica de Madrid - INSIA/UPM (ES).  

**Organisation:** Graz University of Technology (TU Graz), Institut für Allgemeine Mechanik  
**Address:** Kopernikusgasse 24  
**Zipcode:** 8010  
**City:** Graz  
**Contact country:** Austria  
**Telephone:** +43 316 873 7643  
**Fax Number:** +43 316 873 7647

**Key Results:**

ECBOS has:

- performed a statistical accident analysis exploiting governmental databases;  
- studied the main injury mechanisms according to crash type derived from detailed accident reconstructions, themselves drawing on component tests;  
- validated numerical simulation models for vehicles structures and occupant behaviour;  
- verified different test methods and numerical simulation methods; and  
- gave recommendations to amend existing regulations and directives, and suggest new regulations, respectively.

**Policy implications**

One of the key outputs of ECBOS have been detailed proposals for amending ECE regulations and related EC Directives on buses and coaches, in particular for vehicles with more than 5,000 kg of gross weight (categories M2 and M3).

In a subsequent step specific suggestions for new bus and coach safety regulations have been made, featuring:

- Recommendations on rollover accidents, such as  
  - mandatory use of seat belts,  
  - consideration of the mass of occupants for calculation and testing,  
  - inclusion of M2 buses in rollover tests,  
  - child restraint systems,  
  - abandoning of pendulum tests;
• recommendations on frontal/rear impacts, such as
  - use of a 3-point belt system,
  - combination tests for seats,
  - rigid platforms for seat testing,
  - crash pulse for M2 vehicles,
  - child restraint systems; and
• recommendations on new draft regulations, such as
  - research for driver/co-driver frontal impact safety,
  - compatibility between bus/coach and other vehicles,
  - double-deck coaches (superstructure resistance),
  - harmonised accident databases,
  - guidelines for using numerical techniques,
  - partial ejection out of the bus (side window/windscreen) should be avoided,
  - contact load with side (window or structure) should be as low as possible,
  - development of a rollover dummy is necessary to predict injury criteria,
  - further research on driver's impact on accident avoidance,
  - further research on possibilities for general rating of the passive safety.

Passenger

**Key Findings**

ECBOS has:

• Performed a statistical accident analysis exploiting governmental databases; and
• studied the main injury mechanisms according to crash type derived from detailed accident reconstructions, themselves drawing on component tests.

**Policy Implications**

No policy implications directly relevant to this theme. However, please note that implications for themes Safety and Security, and Vehicle Technology, respectively, are generically applicable.

Road

**Key Findings**

ECBOS has:

• Performed a statistical accident analysis exploiting governmental databases; and

Documents:

- ECBOS_Final_Report.pdf (Final report)

**STRIA Roadmaps:** Other specified

**Transport mode:** Road transport

**Transport sectors:** Passenger transport

**Transport policies:** Safety/Security

**Geo-spatial type:** Other