EEVC

Report on Recent Activities 2003

European Enhanced Vehicle-safety Committee

THE EUROPEAN ENHANCED VEHICLE-SAFETY COMMITTEE

1. INTRODUCTION

The European Experimental Vehicles Committee (EEVC) was founded in October 1970 in response to the US Department of Transportation's initiative for an international programme on Experimental Safety Vehicles (ESVs). Its scope was

> **"to ensure the continuing exchange of information between the participating governments, and their collaboration to achieve the best use of their available resources in response to the United States' invitation to participate in the development of experimental safety vehicles".**

The first chairman of EEVC, Mr Harold Taylor of the UK Transport and Road Research Laboratory, described the tasks at the sixth ESV Conference in 1976 as:

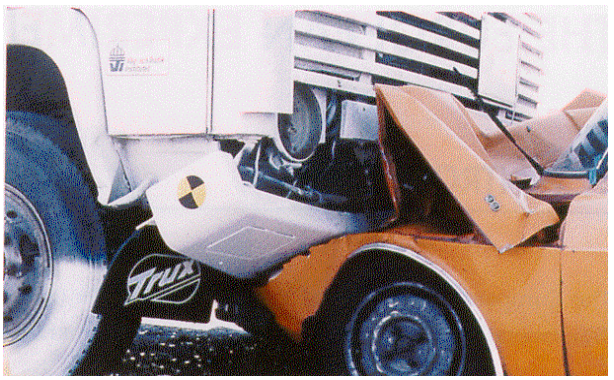
- **to maintain liaison between European national research and development activities, and**
- **to provide a forum for clarifying views on the various technical options and on the response that should be made to various international initiatives.**

Early FIAT Experimental Safety Device

The ESV programme is no longer focused on the specific development of experimental vehicles but on the broader field of improving the safety of vehicles on the road, as indicated by the change of name to Enhanced Safety Vehicle. Nevertheless, the general objectives and tasks of the EEVC remain much the same today. EEVC changed its name to European Enhanced Vehicle-safety Committee in 1997.

The governments of **France, Germany, Italy, the Netherlands, Spain, Sweden, the United Kingdom and Poland** are members of EEVC.

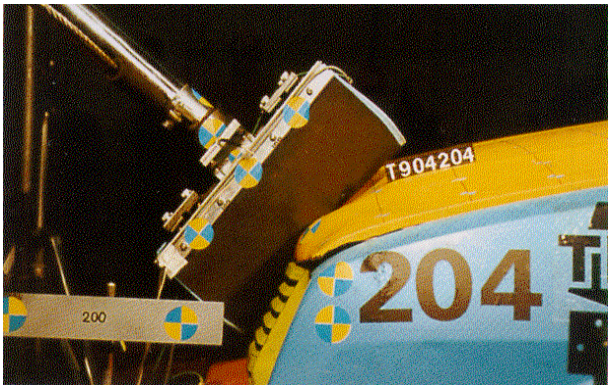
Car-to-Car Impact, BASt



Truck Front Underrun, VTI

EEVC has dealt with the following issues:

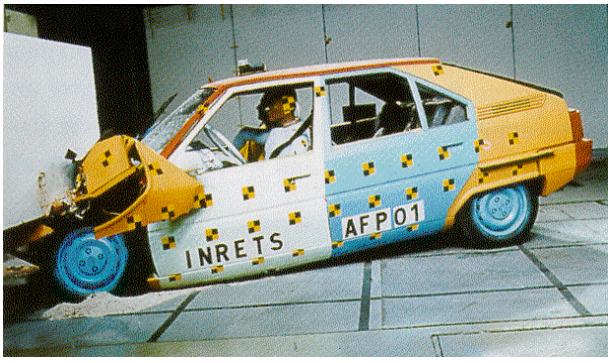
- Accident statistics
- Human tolerance and biomechanics
- Priorities for safer vehicles
- Side impact protection
- Pedestrian protection
- Cycle and light powered two-wheeler accidents
- Heavy goods vehicle safety
- Motorcycle safety
- Front impact protection
- Impact dummies development
- Compatibility
- Child protection
- Active/passive safety interaction
- Rear im pact protection



Pedestrian Impactor Test, TNO

Experimental Motorcycle Airbag, TRL

Side Impact Test, INTA



Underrun Test, INRETS

The EEVC has the full support of participating governments and their industries, and is able to draw on the best available expertise in all the safety fields considered. In addition to scientific and technical experts, the EEVC includes appropriate input from administrators and legislators. The reports of the EEVC are generally published in the proceedings of the ESV Conferences, and are also publicly available on the EEVC web site.

The EEVC provides the link between Government, Research and Development, Industry, Administration and Regulation in Europe in the quest for safer road vehicles.

This brochure describes the role, the organisation and the activities of EEVC.

2. THE ROLE OF THE EEVC

The work of the EEVC is pursued in a number of technical Working Groups, directed and overseen by the Steering Committee. The Steering Committee is composed of representatives nominated by the Governments of member countries. Each Government is entitled to nominate two members:

i) One member from the appropriate area of Government, who should have a comprehensive technical understanding of the issues relevant to vehicle research, and an appreciation of the needs of vehicle safety policy makers;

ii) One member from a governmental research establishment involved in vehicles research, with a good knowledge of the execution of vehicles safety research on behalf of Government.

The EEVC places emphasis on both types of representatives, because it is important that its research programme takes into account, at the same time, scientific needs and policy makers priorities. Experience has shown that the involvement of members from the policy areas of Government can provide a helpful focus for this. It is not the role of the EEVC to develop or draft vehicle regulations, but to act as technical advisor to the regulatory bodies, where this activity has been invited or requested, by:

- **identifying what progress in vehicle safety and other vehicle matters seems possible;**
- **carrying out research to determine the best way forward;**
- **demonstrating its practicality, and developing appropriate test procedures as necessary.**

This essential information can then be transmitted to the regulatory bodies, and to member governments, to take such action as seems most appropriate. It is important that the EEVC is able to pursue its work objectively and impartially, free from any sort of political pressure. Thus, the policy-based members are there merely *to* advise on relevance and application, and not to press national points of view. This mixture of expertise has worked very well in the past, and the conclusions of the various EEVC Working Groups have been based on an objective technical and scientific consensus, to provide unbiased advice.

The Steering Committee elects a chairman, a technical secretary and the chairpersons of the working groups. Till February 14, 2003, the Steering Committee was chaired by Dr B. Friedel from BASt, with Dr D. Cesari from INRETS being the Technical Secretary. Since then, Dr. D. Cesari has been elected as new chairman for 4 years, with Dr. A. Hobbs from TRL acting as technical secretary.

As the EEVC proposals must be fully practical, it is important that the knowledge and expertise of national representatives are complemented by those of the industry. For that purpose, experts from industry may be invited to attend working group meetings. These experts have observer status only, since it is essential to ensure that the research programme cannot be unduly influenced by the commercial concerns of industry. In practice, however, the work and the conclusions drawn are generally agreed by consensus and voting rights are rarely used.

Similarly in the interests of international harmonization, the Steering Committee may decide to invite observers from those other countries which play important roles in international regulation or which can offer relevant information. This ensures that, wherever possible, the European vehicles research programmes are aware of developments in other countries, so that unnecessary duplication can be avoided. As noted below, an excellent degree of collaboration has been achieved.

The working process of EEVC is based on terms of reference agreed by every country member (see Appendix 1). Presently, eight countries are EEVC members as listed in Appendix 3.

3. THE EEVC, THE EUROPEAN COMMISSION and THE UN-ECE

The European Union is responsible for directives governing road vehicles in Europe, and the most important role of the EEVC is to provide appropriate technical advice on which regulations can be based. Consequently, the European Commission has a very direct interest in the work of the EEVC, and has participated in the EEVC programme from its inception. The early studies of the EEVC showed the need for extensive research in the field of impact biomechanics if vehicle crash protection was to be improved, and in 1978 the Commission began funding the EEVC in a coordinated research programme in this field. The findings of this research were published in 1983, but the work is still recognised as an authoritative reference. The Commission, through Directorate-General Enterprise (DG ENTR) and Directorate-General Transport and Energy (DG TREN), has funded work to develop and assess improved test procedures for side impact protection, pedestrian protection, and frontal impact protection. This active involvement of the Commission is important to the success of the EEVC due to the need to establish a close working relationship with the body responsible for applying the results of the research.

The technical advice and the experience gathered by the EEVC is used to support the negotiations of the UN Economic Commission for Europe, in Working Party 29 on the construction of vehicles, and of other international bodies responsible for harmonisation of standards or international legislation.

4. THE EEVC OUTSIDE EUROPE

Cooperation between the research and development activities of the EEVC and those of the National Highway and Traffic Safety Administration of the USA is very well established, and the findings are also transmitted to Australia, Canada and Japan, and to the international scientific community in general.

IHRA

The International Harmonized Research Activities (IHRA) were established under the ESV Programme in 1996.

The aim of these activities is to conduct worldwide harmonized research in order to facilitate the establishment of global regulations. The activities address the following issues:

- Side impact
- Compatibility and frontal impact
- Pedestrian protection
- Biomechanics
- Intelligent Transportation Systems.

In IHRA, Australia, Japan, North America (USA and Canada) and Europe are working together. With the European Commission, the EEVC takes active part in all passive safety research groups of IHRA as well as in the IHRA steering committee, which is chaired by NHTSA.

5. PAST ACTIVITIES OF THE EEVC

During the past 25 years, the EEVC has contributed widely to the improvement of technical knowledge in the field of traffic accident analysis and measures to improve protection from injury through vehicle design. The first three Working Groups created at the time the EEVC was founded had the task of "making quick assessments of present knowledge of the accident situation and the prospects for safer cars". Later Working Groups were set up to make longer and more detailed studies of those issues considered to be especially in need of research.

The activities of each of these Working Groups are described briefly below, and their publications are listed in Appendix 2. The work of the more recent Working Groups is described in more detail in the next section.

Working Group 1: Accident Data

WG1 reviewed the sources of accident data available in Europe and commented on how these could best be developed to further the aims of car safety. This permitted the definition and classification of accident problems in order of importance. Recommendations for the improvement of accident studies were also made.

Accident Investigation in Germany

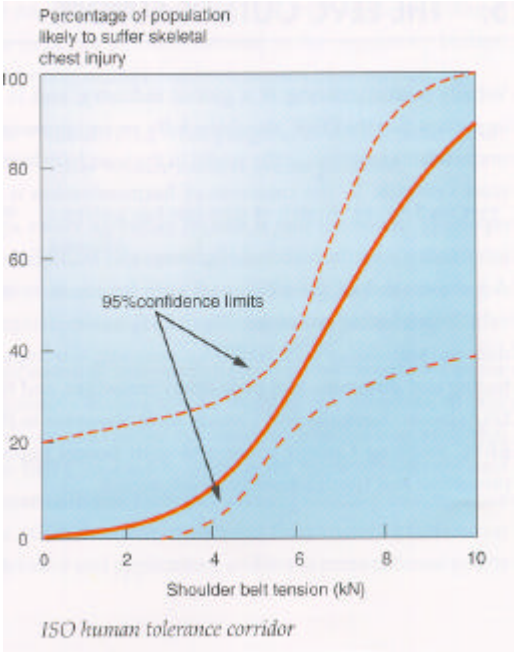
TRL: Early Safety Car

Working Group 2: Potential Safety Improvements

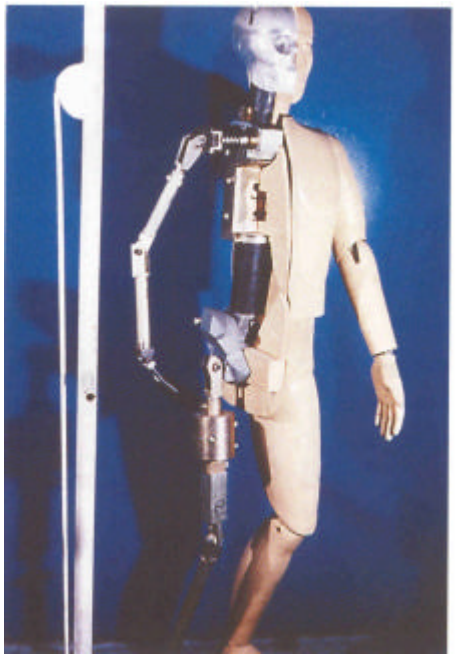
WG2 examined the information made available by WG1, and assessed realistic safety requirements, compared their priorities and identified scope for improvement.

Working Group 3: Human Tolerance Levels and Occupant Protection Evaluation Techniques

WG3 had the task of reviewing the technical problems involved in assessing occupant safety by impact test procedures. These studies included an assessment of currently available human injury tolerance limits, anthropomorphic dummies, and test techniques, together with recommendations for future research.



ISO human tolerance corridor


INRETS: Early Anthropometric Dummy

Working Group 4: Biomechanics

This Group extended the work of WG3 to identify the human tolerance parameters which need to be considered in impact testing, gaps in current knowledge, and application to the development of better front and side impact protection.

Working Group 5: Impact Test Procedures

On the basis of the findings of WG3 and WG4, this Working Group identified the sort of test procedures which could be expected to produce an improved level of occupant protection, for both front and side impacts.

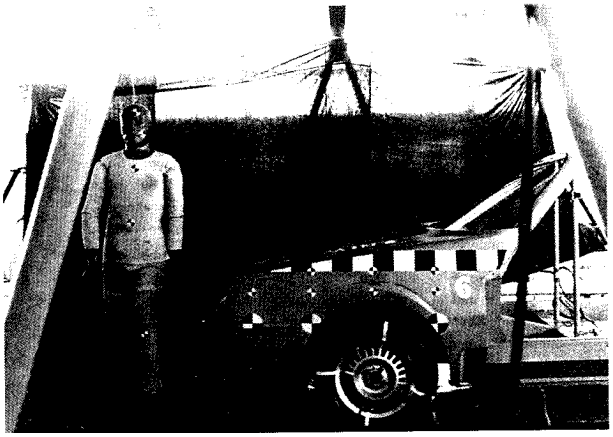
TRL: Full-Scale Impact Test

The final reports of WGs 1 to 5 allowed the EEVC to define, on the basis of European experience and technical knowledge, a sufficiently common view to provide an assessment of the future needs of car safety in Europe. Following this basic assessment, in the mid-1970s, the EEVC turned its attention primarily to the fields of car occupant protection in side impact, and to pedestrian protection by improved design of the fronts of cars.

Working Group 6: Structures for Improved Side Impact Protection in Europe

This Working Group expanded on studies of side impact done within WG5 to formulate a full-scale test procedure, in conjunction with an ad hoc group which was set up to consider the requirements for an anthropometric test dummy to indicate likely injury levels in a side impact.

INRETS: Car-to-Car Side Impact Test



BASt: Dummy Pedestrian Impact

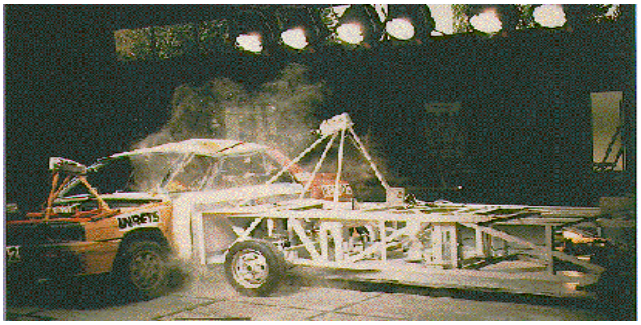
Working Group 7: Pedestrian Injury Accidents

The importance of pedestrian injuries had already been identified in the work of WG1, and this Working Group further analysed the available accident data to identify the most productive approaches to reduce this toll. An ad hoc group was constituted to consider the influence of car design and the types of injury caused to pedestrians.

Working Group 8: Cycle and Light-Powered Two-Wheeler Accidents

This study of two-wheelers was undertaken in parallel with the pedestrian studies of WG7 because of the prevalence of car/cycle collisions in the Netherlands especially. It examined the types of accident which occurred and reviewed the counter-measures which might be taken.

FIAT: Car/Cyclist Impact



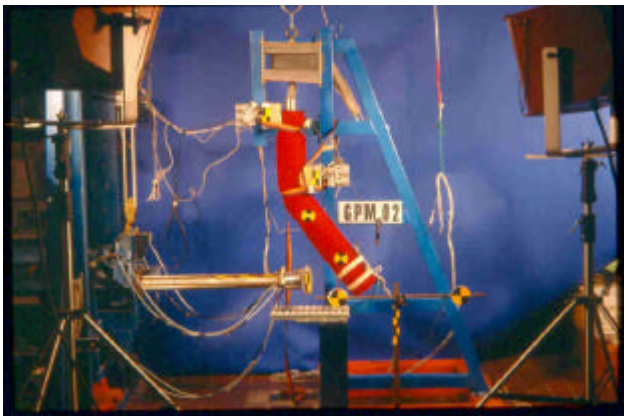
INRETS: Side Impact Deformable Barrier Test

Working Group 9: Side Impact Test Procedure

This working group analysed side impact accidents conditions to determine the test conditions of the proposed full-scale side impact test. Taking into account the characteristics of the cars on the roads in Europe, it has developed a deformable barrier to be used in revised European Side Impact Directive. It also proposed the use of the EuroSID dummy to assess the protection levels provided, and the relevant injury criteria to be used.

Working Group 10: Pedestrian Protection

This working group looked at accident data to prioritise injuries and the body segments to be protected. It has examined a large number of experimental impacts between whole cars, and car front sections on a test rig, and specially-developed instrumented dummies to represent both adult pedestrians and children. Computer simulation using the MADYMO package has also been used to aid understanding of the mechanisms involved. It concluded that the protection of pedestrians hit by cars can be assessed by the use of subsystems tests.



INRETS: Pedestrian Mechanical Leg Test

INRETS: Car-to-Offset Barrier Test

Ad Hoc Group on Motorcycle Safety

The EEVC has set up an Ad Hoc Group an Motorcycle Safety to review all aspects of motorcycle safety connected with the design of the machine or the rider's clothing, but excluding matters of rider behaviour and training. The Group reported in 1993, with a review covering accident and injury data, braking and handling, visibility, passive safety, leg protection, airbags, trajectory control, helmets and clothing, and the road environment. It is clear that this transport mode carries a much higher risk of injury than does an enclosed four-wheeled vehicle, but the study identified a number of promising approaches which might reduce the risk of accident and provide better protection. A summary of the findings was presented at the 1994 ESV Conference.

Working Group 11: Frontal Impact Test Procedure

EEVC Working Group 11 on Frontal Impact Test Procedure completed a series of frontal impact tests in 1993, with the Support of the EC, to determine the conditions for an offset deformable barrier test. A proposal for a new frontal impact test procedure was presented at the 1994 ESV Conference. The Working Group then evaluated this proposal by testing a wide range of modern vehicle designs and types. The final report was produced in autumn 1995. The test procedure has already been accepted by the UN-ECE WP29.
The European Commission has released a directive on frontal impact effective since October 1998.

TRL: Motorcycle Impact Test with Airbag and Leg Protection

Much of the work done in these earlier Working Groups has fed into the programmes of more recent Groups:

Working Group 12: Adult Dummies
Working Group 13: Side Impact Protection
Working Group 14: Energy Absorbing Truck Front Underrun
Working Group 15: Improvement of Crash Compatibility between Cars
Working Group 16: Advanced Offset Frontal Crash Protection
Working Group 17: Pedestrian Safety
Working Group 18: Car Child Occupant Safety
Working Group 19: Active-Passive Safety Interaction
Working Group 20: Whiplash

Much of the work of these more recent groups is described in the next section.

6. RECENT ACTIVITIES OF THE EEVC

6.1 Advanced Anthropomorphic Adult Crash Dummies

The work of EEVC on this issue was started in 1990 and focused on the following items:

- Frontal impact dummy
- EUROSID-2

The new EuroSID-2 Dummy

After some 10 years experience with research and regulatory testing using EuroSID-1, it was apparent that some aspects of its performance could be improved. It was therefore agreed that EEVC Working Group 12 would monitor and review design improvements being undertaken by the dummy manufacturers and also by WG12 members under the auspices of the EU programmes SID2000 and SIBER. In addition, under a Letter of Agreement with NHTSA, the concerns expressed by NHTSA regarding some aspects of the performance of EuroSID-1 evaluated in the safety standard FMVSS214 test procedure, were also taken into consideration. NHTSA undertook to review the revised design as a possible candidate dummy for use in FMVSS214.

The revised design has been named EuroSID-2 or ES-2 and, following a review of the extensive evaluation of this design, the EEVC has recommended its adoption in side impact testing in place of EuroSID-1. (EuroNCAP will use ES-2 with effect from 2003).

- **IHRA Biomechanics**

The corresponding IHRA working group on biomechanics has prepared a report on side impact dummy requirements, including EEVC proposals, which will be presented at the 18th ESV Conference. The main chapters of this report concern accident analysis results, anthropometry data, biofidelity requirements, and injury criteria proposals.

6.2 Side Impact Protection

Since the principle cause of fatal and serious casualties in road accidents is frontal collisions, most effort had historically been devoted to this accident configuration. However, side impact accidents do contribute a significant proportion of the casualties in European road accidents, so the EEVC organised a series of Working Groups to study various aspects of side impact.

The EEVC developed a major programme of research and development within its constituent research establishments aimed at understanding the problems of side impact performance, how this could be assessed and what remedial measures might prove effective. Working Group 9 on Side Impact Test Procedure addressed three separate but overlapping topics:

i) Development of a test procedure aimed at assessing the most important aspects of protection in real side accidents.

ii) Development of a Side Impact Dummy as a realistic indicator of likely injury.

iii) Examination of the side impact performance of current vehicle models, to identify practical ways of improving protection and to provide information on an acceptable pass mark for the test.

- **The test procedure**

Research on side impacts showed that the only effective and reliable way of assessing the very complex details of the structural collapse and interaction with the occupants would be a full-scale impact test. The procedure developed by EEVC was to run a mobile barrier, representing the "bullet" vehicle, at 50 kph directly into the side of the vehicle to be tested, centred on the vehicle 'R' point. The performance would be assessed by side impact dummies placed on the struck side in the front and rear seats. The front of the mobile barrier, was defined in terms of its dimensions and stiffness which varied across the barrier face in a way which represented the front of a "typical" European car.

- **The side impact dummy**

At the time that EEVC concluded that the assessment should be made by using side impact dummies, no suitable dummy existed. The European Side Impact Dummy, EuroSID, stemmed from a very productive collaborative project between five European research institutes. EuroSID used head and legs from standard Hybrid dummies, but in side impacts the performance of the thorax and pelvis is crucial, and the dummy's body had to be designed from first principles. TRL took responsibility for the thorax, INRETS for the pelvis, TNO for the abdomen and the Association Peugeot-Renault for the neck, while BAST and Ford contributed to the assessment and development programme.

It is important to ensure that a side impact dummy's response to impact agreed with what is known about biomechanical measurements on cadavers and volunteers, though it is obviously not possible to construct

a practical dummy which has a humanlike response in all possible characteristics, and it is necessary to concentrate on those aspects of biofidelity which are considered most important in real side impact injury mechanisms. EuroSID 1 was developed to respond as closely as practicable to the reference data available at the time. Testing within the EEVC member laboratories showed that, overall, EuroSID-1 was sufficiently biofidelic, robust, repeatable and reproducible to be able to distinguish between different levels of side impact protection and suitable to be used in side impact assessment tests.

- **Side-impact protection**

Before recommending the test procedure, EEVC applied the Side Impact Test Procedure to many different models of car with a variety of sizes and constructions and compared the effect of the Mobile Deformable Barrier with that of different "bullet" cars and with the NHTSA test procedure.

This research demonstrated that the level of side impact protection could be improved by careful design of the side of the car, but that this is not simply a matter of stiffening the side to resist intrusion, or of padding the interior. Both can help, but injuries are also greatly affected by the way in which the side of the vehicle collapses. Improving side-impact protection is not necessarily a matter of substantially increased production costs, but rather one of a better understanding of the mechanisms involved and appropriate design.

The EEVC test procedure has been used as the basis for the UN-ECE Regulation 95 on side impact protection and the equivalent EU Directive (96/27/EC), although only a front seat dummy is specified due to the difficulty in fitting a fiftieth percentile dummy in the rear seat of some smaller cars. The Directive became effective from Sept 1st 1998. The EEVC test procedure has also formed the basis of the EuroNCAP test for rating vehicles for their performance in side impacts.

- **Interior head protection**

While the full-scale side impact test evaluates the injury risk to the four major body areas that are seriously injured in side impacts (head, thorax, abdomen and pelvis), the head can contact a wide area in side impacts. Since head injuries account for a large proportion of serious injuries (over 40 percent of AIS 4) and fatalities (34 percent) in side impact accidents, EEVC Working Group 13 has been developing a simple head impact test procedure to assess head injury protection.

A number of candidate headforms and impact configurations have been examined in a series of test programmes undertaken by Working Group 13. The Working Group has concluded that the preferred test configuration is the use of the Free Motion Headform in free flight impacts at 6.7m/s. This also has the advantage of potential harmonisation since this is the test configuration used in the NHTSA safety standard FMVSS201u.

The EEVC has undertaken an accident review to determine potential contact zones and has proposed a test procedure limiting possible impact points geometrically to those liable to be contacted by a restrained occupant in the front seat. This draft proposal is currently the subject of a validation research programme by Working Group 13.

- **MDB specification**

In the original proposal for the EEVC side impact test procedure, the MDB face was specified in terms of the force/deformation characteristic of its six constituent blocks in a flat rigid loadcell wall impact test. Different designs of barrier face to this specification have been shown to result in different results in full-scale tests. Therefore Working Group 13 undertook an extensive test programme using specially developed test methods, in addition to full-scale tests, to determine how the reproducibility of the barrier performance in full-scale tests could be improved. The research results showed that the best solution would be to specify the detailed design and material of the MDB face.

In collaboration with the MDB face manufacturers, the EEVC has developed a revised specification for the MDB face, which will provide superior reproducibility between manufacturers, while still complying with the original performance specification. This revised specification has been proposed for future use in the ECE Regulation 95 and EU Directive 96/79/EC and also in the EuroNCAP test procedure.

- **IHRA Side Impact Working Group**

Activities in Europe and the USA have led to the development of two separate side impact test procedures using two different side impact dummies and different injury criteria. Unless there are sound reasons for the differences, this is wasteful of research, development and possibly manufacturing resources. The International Harmonised Research Activities organisation has been created to harmonise the research on vehicle safety with the aim of facilitating the development of harmonised standards where beneficial.

The EEVC provides the European contribution to the IHRA activities on side impact protection.

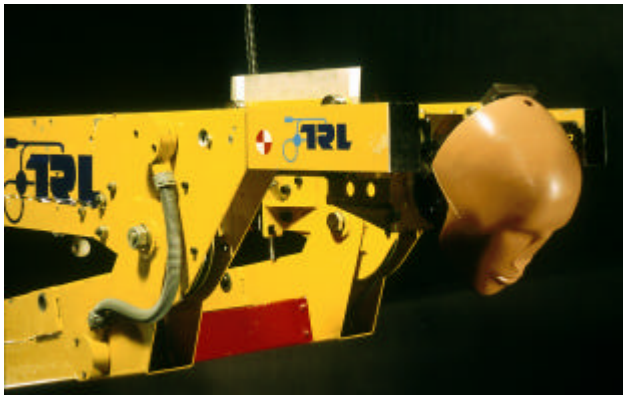
Deliberations within the IHRA Side Impact Working Group (SIWG) have led to the proposal for a four-part side impact test procedure; a mobile deformable barrier test, a pole impact test, an interior headform test and a side airbag-occupant interaction test. The MDB test procedure is proving to be the most difficult to harmonise. The main problem in side impact in North America currently appears to be with side impacts from light trucks and vans (LTVs). These comprise the larger SUVs and light trucks where the bonnet height is at or above the head height of car occupants, resulting in a problem of fatal head impacts. A new MDB has been developed by the Insurance Institute for Highway Safety to represent these vehicles.

Tests within EEVC with this MDB have shown that this is a very onerous test in comparison with the typical European situation where these very large vehicles are uncommon. It would appear that the research has demonstrated that the vehicles fleets are sufficiently different between Europe and North America that this is one aspect for which full harmonisation would be difficult to justify. Working Group 13 is researching the design of an alternative MDB that more closely represents the European fleet.

As the European car fleet design has changed markedly since the performance specification of the original EEVC MDB was created, the new design (Advanced European MDB) is expected to be somewhat different to the current MDB. Baseline car-to-car side impact tests have been performed and results with the new prototype MDB have been compared with these baseline tests. The WG is collaborating with the Japanese members of IHRA since the Japanese vehicle fleet is closer to that in Europe than that in North America. The new design appears promising but further testing is required. Following this research, the AE-MDB will be included as a second MDB in the IHRA proposed draft MDB test procedure, in addition to the IIHS MDB, so that regulatory authorities may choose one or both as appropriate for their vehicle fleets.

While the MDB specification may be difficult to harmonise, the human population should be similar in all parts of the world. Consequently there is much better potential for harmonising on the dummy or dummies used in the tests. It is anticipated that international action on the development of the next generation of side impact dummies will result in the specification of a single dummy design for the test procedure.
The EEVC research described above forms the basis for the IHRA proposal for the Interior Headform test procedure.
NHTSA is developing proposals for the pole test, while the ISO airbag interaction test procedures, as modified by the US industry group under the leadership of the IIHS, form the basis for the airbag interaction part of the IHRA proposals.

TRL: Side Impact Test Procedure



TRL: Head Protection Assessment in Side Impact

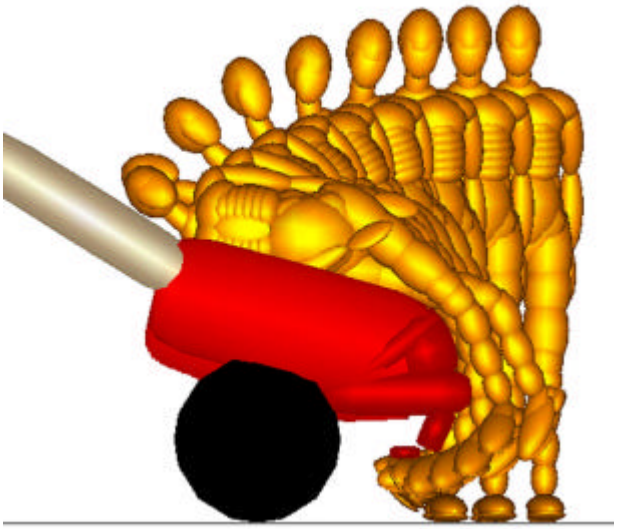
6.3 Pedestrian Protection

Pedestrian casualty numbers contain a disproportionately large number of elderly people and children, but pedestrians of any age are obviously very vulnerable when struck by a vehicle. Since it is not possible to provide the pedestrian directly with any useful protection, it might be thought that little could be done to reduce these casualties, and there is certainly little chance of avoiding serious injury or death in a high-speed collision. But 80 per cent of all car/pedestrian collisions, and 25 per cent of fatalities, occur at impact speeds of 40 kph or less. At these lower speeds, there is much which can be done to make the front of a car less injurious.

The EEVC set up Working Group 10 on Pedestrian Protection in 1988 to examine this problem and to develop a test procedure to assess the injury potential associated with any given car model. This work was requested, and funding provided by the European Commission for consideration as an EU Directive. Again, the work has been a fully collaborative research exercise between APR, BASt, INRETS, TNO and TRL.

Pedestrian injuries are most frequently to the legs, pelvis and head. The car bumper strikes the lower legs or knees, the bonnet leading edge strikes the upper legs or pelvis, or, in the case of children, the abdomen. The head of the pedestrian tends to swing down onto the bonnet top, the wings, or further back onto the scuttle or windscreen in the case of taller pedestrians, shorter bonnet or higher impact speeds.

To minimise injury, particularly to the knee joint, the bumper should spread the load of the initial contact along the length of the lower leg, avoiding any concentration on the knees, and its surface should deform to reduce the load. A deep bumper will accelerate the pedestrian's leg and cause it to break contact with the ground.



TNO: MADYMO Modelling Car to Pedestrian Impact

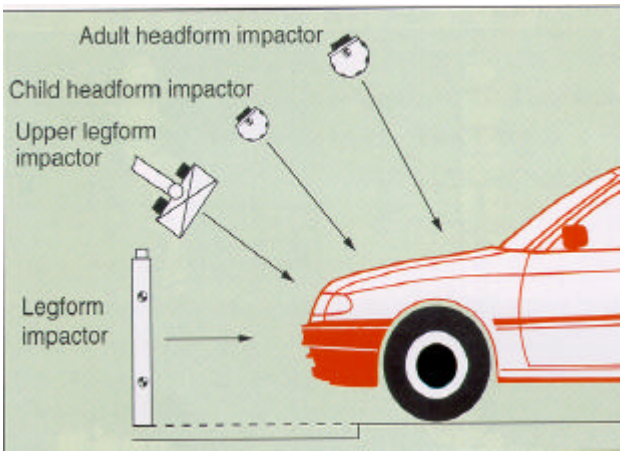
The bonnet leading edge, and as far as possible the tops of the wings and the corners of the car, needs to be deformable, to crumple and so absorb energy without

retaining strong, solid parts such as bonnet latches close to the edge.

Depending on the height of the pedestrian, speed of impact and bonnet length, the head may strike the bonnet top. The head injuries this causes can often be fatal, and to minimise the risk of this the bonnet should be designed to collapse in a controlled way, absorbing energy and without the many hard components in the engine compartment lying so high that they prevent the required amount of collapse.

To avoid the expense and complexity of a full-scale impact test, and to provide a better repeatability, the EEVC Working Group has developed a test of each of these three sub-systems: the bumper assembly, the bonnet leading edge and the bonnet top. These are struck by impactors designed to assess the protection afforded to, respectively, the legs, pelvis, and head of both child and adult pedestrians. The tests aim to ensure that the car front will minimise injuries, but without dictating styling. However, since the shape of the front determines the pedestrian's trajectory, the required impact speeds for the test impactors are determined by the geometry of the cars in question. The test procedure developed was submitted to the European Commission and these sub-system tests are already being used to help in the design of future, more pedestrian-friendly car models.

Legform impactor	- simulates impact of the leg to the bumper
Upper legform impactor	- simulates impact of the femur to the bonnet leading edge
Child headform impactor	- simulates impact of the child head to the forward section of the bonnet top
Adult headform impactor	- simulates impact of the adult head to the rearward section of the bonnet top



The Three EEVC Pedestrian Impactors

At higher speeds the heads of pedestrians are likely to be seriously injured by the hard structure surrounding the windscreen, and attention needs to be paid to this. But the improvements in car front and bonnet top which will be required by the EEVC test procedures will achieve a substantial reduction in pedestrian injury. The EEVC Working Group estimates that they are likely to reduce pedestrian fatalities by 6 to 10 per cent, and serious injuries by up to 30 per cent.
After more than three years of experience of subsystem tests, the report "Improved test methods to evaluate pedestrian protection afforded by passenger car", originally published in December 1998, has been recently updated.

6.4 Frontal Impact

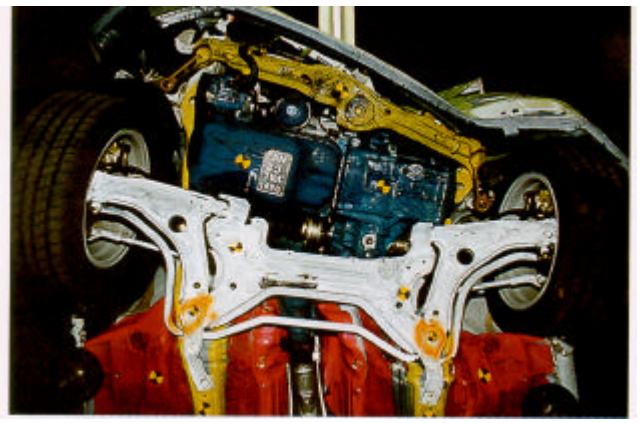
The EEVC Working Group Advanced Frontal Protection WG16 was formed in 1997 primarily to support the EC in the evaluation of the Frontal Impact Directive. Support to the IHRA has also been a major responsibility for the working group.

The major part of the evaluation of the Frontal Protection Directive was submitted to the EC in January 2000. Some additional facts concerning important barrier criteria were reported to the EC in February 2002. The latter report explores some of the reasons behind the design of the offset deformable barrier being proposed for the directive. A good understanding of the reasoning and compromises leading to the existing design is essential.

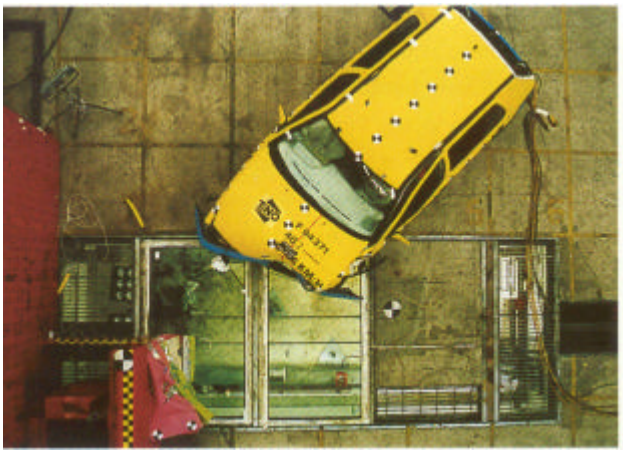
The working group is well underway with developing a method for measuring footwell intrusion. The method is aimed at measuring intrusion relative to a normal foot position.

There are links between primary protection, as explored in this working group, and secondary protection as discussed in the Crash Compatibility Group. As a result of this, the IHRA has merged the Frontal Protection Group with the Compatibility Group. The more holistic approach to crash safety gives good possibilities for the development of test methods which support one another minimising, or at least understanding potentially conflicting goals. Support to the IHRA is given by the Frontal Protection Group together with the Crash Compatibility Group.

Modern cars, to a very high degree, depend on the use of seat belts to give maximum protection. But seat belt use in crashes is still very low. The working group has developed recommendations for technical systems to support the use of seat belts. A report has been submitted to the EC and the ECE exploring the potential design of seat belt reminder systems.



BASt: Underside of Car after ODB Frontal Test



TNO: EEVC Offset Deformable Frontal Impact Test

6.5 Car to Truck Underrun

Due to the lack of financial support, the work of Working Group 14 has been delayed and has just started in summer 2002.

Based on the earlier work of WG14, the EC 5th framework project VC-COMPAT will be carried out over a period of 3 years. Most former members of WG14 and additionally some truck manufacturers are members of the VC-COMPAT consortium. The main project outputs with respect to car to truck compatibility are:

- Test procedures and associated performance criteria to assess and control truck frontal structures for frontal impact compatibility with cars.
- Suggestions for improving rear and side underrun safety.
- Indication of the benefits and costs of improved compatibility.

These outputs are partly in line with the present terms of reference for WG14, which are:

- Collect and present the state of the art in car to truck underrun (front rear).
- Present a practical test procedure which may be used in type approval (front).
- Establish link with WG15.
- This work may be completed within 30 months.

The above terms of reference could be shortly revised in taking into account the requirements of VC-COMPAT project which also covers car to car impacts like the work of WG15.

INRETS: Truck Front Underrun Test

6.6 Improvement of Crash Compatibility between Cars

In February 1996, the EEVC Working Group Improvement of Crash Compatibility Between Cars was established.

Compatibility considers collision partner protection as well as self protection in order to minimise overall injury risk.

The task of the group was to identify compatibility problems, determine the parameters which affect compatibility, identify potential benefits from improvements to compatibility and develop test methods and criteria for assessing compatibility.

Co-operative research work started in July 1997 with a two-year project partly funded by the EC. The goal of the project was to start a scientific approach to the understanding of compatibility. Initial effort was concentrated on the most important impact types: car to car frontal and side impacts.

The work covered three main activities:

- Data from in-depth accident studies was used to identify the most important problems related to compatibility.
- Typical accident configurations were replicated by carrying out experimental car to car impacts. These crash tests helped to identify the major problems occurring when two cars collide.
- Computer simulation modelling was used to study the sensitivity of main parameters such as stiffness and mass.

From the research activities, WG 15 derived the following principles for frontal impact compatibility:

- Good structural interaction.
- Control the strength of the passenger compartment to avoid collapse.
- Match frontal stiffnesses to manage vehicle deceleration.
- Provide predictable crash performance in a range of impact configurations.
- In setting the requirements, consider the future capabilities of advanced restraints while respecting the limitations of current restraint systems.

Although less is known about side impact compatibility, the following aspects are currently considered to be the most important:

- Geometry has a large effect.
- Mass and stiffness have smaller effects (frontal stiffness distribution of the bullet vehicle may be only relevant for about the first 100 mm).
- Vertical intrusion profile to distribute loads on the occupant.
- Sill engagement.

It was determined that, for car to car frontal impacts, the structural interaction between the two cars, the stiffness of the car front end and the strength of the passenger compartment are the first factors that should be studied to help in the assessment of compatibility.

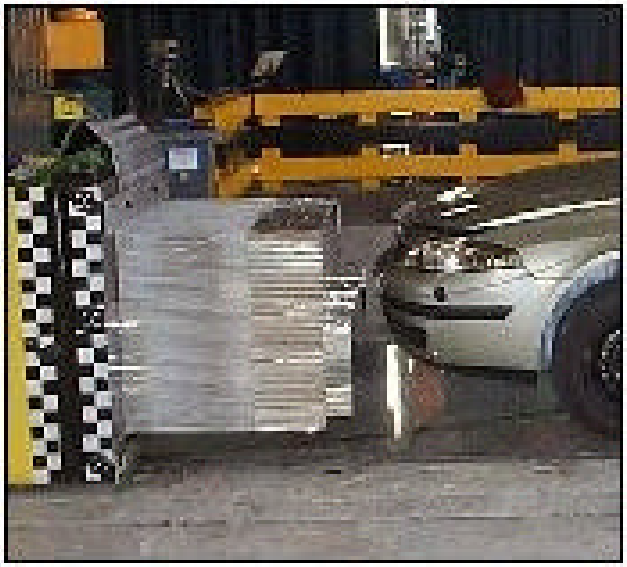
A further, partly EC funded, three years compatibility study is planned to start in 2003. From an interim study carried

out in 2001 and 2002 and other European research, a series of potential test procedures were developed. In future research, these will be further developed. Candidate tests are:

- Full-width frontal impact on a load sensing wall with a honeycomb face, to assess the homogeneity of the force distribution of the car front end and so assess its structural interaction capability.
- EEVC Offset Deformable Barrier (ODB) test at 64 km/h, with force sensing wall, to measure frontal stiffness.
- High speed ODB test at 80 km/h to determine the passenger compartment strength.
- As an alternative the Progressive Deformable Barrier test (PDB), with partial overlap, to generate vertical and lateral shear forces within the front end of the vehicle. The shear is generated by the design of the barrier which is made of progressive honeycombs designed to have the global behaviour of a car with its non-uniform stiffness distribution. This is made to assess the structural interaction capability and the frontal stiffness.

The EEVC WG 15 is not the only co-ordinated group working on compatibility. Its research activities were partially funded by the E.C. and fed by members' national contributions, but it also shares experience and results with the EUCAR Compatibility group and the IHRA Compatibility group. Thanks to fruitful exchanges and discussions within formal meetings and workshops, some key points have been identified as common agreement between all the groups.

Some differences in research priorities are still present between different groups. They are often linked to local fleet distribution and crash configuration. For example, NHTSA wants to deal with compatibility between passenger cars and LTVs, therefore it has a concern with respect to the issue of vehicle mass. Moreover, it is also concerned with angled frontal impacts which, amongst others, has resulted in the consideration of the use of a Mobile Deformable Barrier.



UTAC: Car to Progressive Deformable Barrier Test

TRL : Full-Width Test agains a Deformable Aluminium Honeycomb Barrier

6.7 Car Child Occupant Safety

A new Working Group on Car Child Occupant Safety was created in October 2000, with the following terms of reference:

- Review accident statistics with respect to car child occupant accidents and injuries in all types of car accidents
- Review research with respect to car child occupant safety.
- Describe the state of the art taking into account all relevant regulations.
- Identify lacks in knowledge, methods and tools
- Child protection in buses and coaches.

Accident statistics

Situation of children in cars

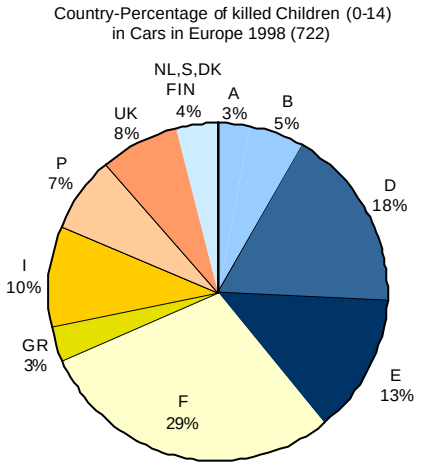
It was decided to review the existing accident databases according to the quality criteria concerning the conditions of the accident, the vehicle analysis, the occupant description, their injuries and the protection device used. This has led to the creation of a report in which most of the existing databases in Europe with data relative to children have been analysed as far as possible according the quantity and the quality of data.

For this, the databases have been put in three categories:

- ***European data***, which has been collected in different countries and stored in a large database where clear definitions have been given and data has been checked before being introduced in the database. This kind of data cannot lead to in-depth analysis of the protection of children in cars, but can show the

size of the problem the working group is dealing with. It is possible to compare countries in terms of numbers of children killed as car occupants, relative risk of being killed per 100.000 of population, in the last five years, etc., but no data is available on restraint use, type of impact or even on the exact age of children who are just put in age categories.

As an example, the following figure shows the repartition in 9 European countries of the children killed as car passenger in 1998.
The main point is that nearly 2 children are killed each day as car passengers on European roads and that the French figures account for nearly 30% of the total, followed by Germany and Spain.



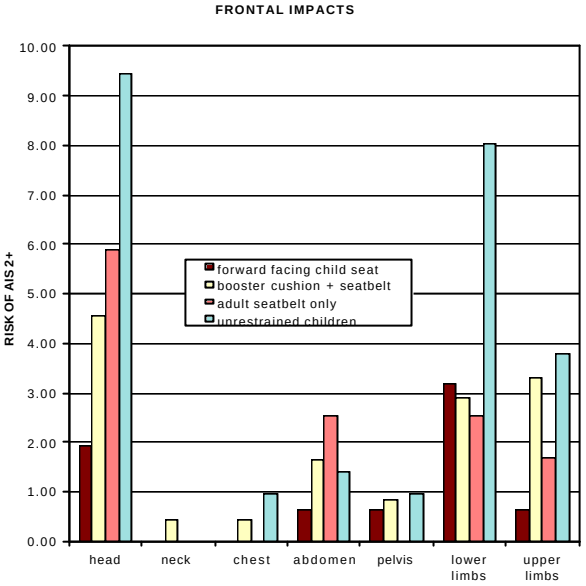
Repartition of children (0-14 years) killed as car passenger in Europe, 1998.
Total number for 1998: 722
Data source: IRTAD

- ***National data***, which are the official figures from European Governments. An in-depth analysis has been conducted for each country taking into account specific definitions and the specifics of the databases. Data available in Germany, France, United Kingdom, Sweden, Italy and Spain have been analysed. This has led to conclusions specific for each country and, also to a more general one, that the quality of the data collected is not the same in all the databases studied. A more uniform method of data collection is necessary on two different levels, the first concerns the definitions of the data that it is necessary to collect and the second relates to ensuring the reliability of the data collected. The results obtained in the different countries could then be more easily compared.

- ***Specific data***, which are collected by private institutes or European Research Projects and that have specific aims related to child safety, e.g. the CREST (Child REstraint STandards) accident database, the data on children contained in CCIS (Co-operative Crash Injury Study) database, in GIDAS (German In-Depth Accident Study) database, and in the LAB-CSFC 1996 (Child-safety Study on French Countryside) database.

The headlines of accident studies are summarised:

- Two child car passengers are killed everyday on European roads, the situation is different for different countries.
- Data collection is not uniform in Europe and results are not comparable. Content of international databases are not specifically related to child safety.
- CRS use and CRS behaviour in accident situations and the real effects of misuse in terms of injury are important factors in the protection of children, but are not currently well known.
- With respect to regulations, accidentology is able to provide orientation for the definition of test conditions and to determine the priority forbody segments that have to be protected for the different types of restraint systems.



Risk of injured body segment (AIS2+) for 100 children according type of CRS

For side impacts, roll-overs and rear impacts, it has been possible only to give the distribution of injured body segment and determine that the head was that which was most often injured, but no differentiation was possible according to the restraint type used due to too small a sample.

Situation of children in buses and coaches
A similar report with respect to the situation of children in buses and coaches will be carried out through the existing European accident databases.

Research programmes

It was decided to hold hearings of different representatives from working groups concerned with child protection. The aim is to review pending research programmes, to gather the results and to study the improvements that these programmes could bring to the area of regulation.

Regulations

A comparative analysis of the different regulations used in Europe will be made. The work will be focused on the European legislation and, although the context is different, it will examine recent decisions on regulations in the US, Australia, Canada.
The basis of this work is an existing document from ISO TC22/SC12/WG1.

Ways to progress

- The major way of reducing the number of children killed or severely injured is to have them restrained and encourage police forces to enforce regulations.
- To reduce misuse (incorrect use of a CRS) should be another significant step for child safety. Studies on the real situation and the effects of misuse in accidents are necessary to quantify the possible gain.
- Information on child safety could be given to children, parents, teachers, etc., and the risk of injury has to be stressed.
- Research work on the biomechanics of children still needs to be conducted.
- To improve the protection offered by restraint systems, test methods and regulation revisions should be based on injury criteria.

6.8 Active/Passive Safety Interaction

Due to modern technology developments, there is an influence of active safety measures on passive safety of vehicles. Therefore, the EEVC has recently created a new working group with the following terms of reference:

- overview of existing and future techniques and how this is coordinated by existing organisations.
- effect of these techniques on priorities for injury prevention.
- effect of these techniques on existing regulations.

6.9 Rear Impact Protection

Based on the work of an ad hoc group on whiplash injuries, the EEVC set up a working group on rear impact protection with the tasks of developing and validating test procedures, defining test devices and setting associated performance criteria. The final report on the EEVC whiplash ad hoc group is available on the EEVC website.

During the last 30 years, the EEVC proposals were used by legislative bodies and by industry to improve the passive safety of vehicles and to contribute to the decline of accident casualties in Europe. Thanks to the EEVC, the European Directives for frontal impact and side impact were enforced, and a pedestrian protection European Directive will follow soon. The contents of the EuroNCAP procedure are also based on the EEVC work.

EEVC is on the Internet where the above information is regularly updated
www.eevc.org

This brochure was issued in December 2002 and updated in February 2003.

APPENDIX 1
TERMS OF REFERENCE OF THE EEVC

Article 1

The EEVC shall pursue the following main aims:

- Impartial scientific research in the field of vehicle safety.
- Co-ordination of European research activities with regard to vehicle safety.

EEVC members are responsible to their own governments, but collectively decide on appropriate EEVC work programmes. As a scientifically neutral organisation within Europe, the EEVC may, if requested, provide impartial advice to European governments, the European Commission and the United Nations Economic Commission for Europe (UNECE) Working Party on the Construction of Vehicles (WP29), including its Groups of Experts, on vehicle safety. In this way, the EEVC may support specific research, evaluate technical proposals and define scientific tools (such as biomechanical criteria, test dummies, test procedures) needed for the further development of technical standards.

When invited, the EEVC may be represented at international meetings to provide impartial and balanced scientific advice, conforming with the provisions of Article 4, paragraph 7 and Article 5, paragraph 3. It has no direct mandate to negotiate with regard to vehicle safety regulations.

Article 2

The government of any European country which has sufficient scientific capacity to carry out practical research relevant to vehicle safety and is willing and able to contribute effectively to coordinated EEVC research programmes, may become a member of EEVC. Initially, the membership shall comprise those governments who were members of the European Experimental Vehicles Committee.

Application for membership by the governments of other European countries shall demonstrate that they have sufficient scientific capacity or are in a position effectively to contribute to EEVC research. Application will be made to the steering committee who shall agree to their membership unless at least one-third of the existing member governments object.

Article 3

The EEVC shall consist of the steering committee and the working groups. The chairman of the steering committee shall be supported by a technical secretary in his work.

Article 4

Each member government shall appoint up to two representatives to the steering committee. These representatives shall be appointed by virtue of their technical expertise in vehicle safety; one representative should have sufficient experience of international vehicle safety regulations and shall be a member of a government, the other representative should be mainly involved in the practical work of safety research activities. These members must conscientiously guard the impartiality of the EEVC and they must also ensure that the EEVC's research is relevant to improving vehicle safety and is of high quality.

The European Commission and the Economic Commission for Europe of the United Nations may participate in the meetings of the steering committee as observers.

The steering committee shall elect a chairman from amongst its members for a period of four years. The steering committee shall be convened at least twice a year.
The decisions of the steering committee shall insofar as possible be made by consensus but if necessary, by a simple majority of those member governments present with all member governments having one vote. In the case of an absent member government, its vote may be delegated to another member having also one vote only. In the case of an amendment of these terms of reference or an application to dissolve the EEVC, a two-thirds majority of all EEVC members shall be necessary for a decision.

The steering committee shall decide on work programmes and priorities with regard to the projects to be carried out.

The approval of the steering group is required before EEVC research may be published and distributed.

Working groups shall be convened by the steering committee. The steering committee shall nominate the chairpersons of the working groups. Mandates of the working groups shall be determined by the steering committee.

The chairperson of the steering committee shall represent the EEVC as and when required, although this responsibility may be delegated for certain questions for a limited period of time.

Article 5

The working groups shall consist of the scientific experts from the member countries. The experts from the various countries shall be requested to cooperate by their respective governments. Generally each member country shall be represented in these groups by one principal expert who may be accompanied by an additional expert. The chairperson may act also as the national principal expert.

The working groups may, in case of special meetings and with the consent of the steering committee, invite technical and scientific experts from governments which are not members of the EEVC to cooperate and they may similarly invite experts from industry.

The working groups shall report to the steering committee. So far as possible, the conclusions of the working groups shall be achieved by consensus but in the event of unresolvable disagreements, the report must correctly reflect both the majority and minority views. Reports of the working groups must be adopted by the steering committee before they become official EEVC reports.

Article 6

In the case of research requested by the authorities of the European Union, the Economic Commission for Europe of the United Nations or the national authorities of the countries involved, relevant reports shall be submitted to those authorities.

The publication of the results of EEVC research shall require the consent of the steering committee.

Article 7

The costs of participation in the work of EEVC shall be borne by the member governments involved. The European Commission, the Economic Commission for Europe of the United Nations or other scientific bodies may also share the costs of research work sponsored by these institutions.

APPENDIX 2
PUBLICATIONS OF THE EEVC

Working Group 1

1. European Experimental Vehicles Committee: Working Group 1 on Accident Data. A review of data sources for car safety improvements. Published in: The future for car safety in Europe, 5th ESV Conference, London, June 1974.

Working Group 2

2. European Experimental Vehicles Committee: Working Group 2 on Potential Safety Improvements. The order of priority and major requirements for safer cars for the near future. Published in: The future for car safety in Europe, 5th ESV Conference, London, June 1974.

Working Group 3

3. European Experimental Vehicles Committee: Working Group 3 on Human Tolerance Levels and Occupant Protection Evaluation Techniques. Human Tolerance levels and occupant protection evaluation techniques. Published in: The future for car safety in Europe, 5th ESV Conference, London, June 1974.

Working Group 4

4. European Experimental Vehicles Committee: Working Group 4 on Biomechanics. Report of a working group an biomechanics. Proceedings of the 6th ESV Conference, Washington, October 1976.
5. European Experimental Vehicles Committee: Working Group 4 on Biomechanics. Use of Cost/Effectiveness and Cost/Benefit Studies for the Selection of Vehicle Safety Measures. Proceedings of the 6th ESV Conference, Washington, October 1976.
6. European Experimental Vehicles Committee: Working Group 4 on Biomechanics. Report to the 6th ESV Conference. Proceedings of the 6th ESV Conference, Washington, October 1976.

Working Group 5

7. European Experimental Vehicles Committee: Working Group 5 on Impact Test Procedures. Impact Test Procedures. EEVC (not published).
8. European Experimental Vehicles Committee: Working Group 5 on Impact Test Procedures. EEVC Status Report 1980. Proceedings of the 8th ESV Conference, Wolfsburg, October 1980.

Working Group 6

9. European Experimental Vehicles Committee: Working Group 6 on Structures for Improved Side Impact Protection in Europe. Structures for Improved Side Impact Protection in Europe. Proceedings of the 9th ESV Conference, Kyoto, November 1982.

Working Group 7

10. European Experimental Vehicles Committee: Working Group 7 on Pedestrian Injury Accidents. Pedestrian Injury Accidents. Proceedings of the 9th ESV Conference, Kyoto, November 1982.

Working Group 8

11. European Experimental Vehicles Committee: Working Group 8 on Cycle and Light-Powered Two-Wheeler Accidents. Cycle and light powered two-wheeler accidents. Proceedings of the 9th IRCOBI Conference, Delft, September 1984, and Proceedings of the 10th ESV Conference, Oxford, July 1985.

Working Group 9

12. European Experimental Vehicles Committee: Working Group 9 on Side Impact Test Procedures. Further Considerations of the European Side Impact Test Procedure. Proceedings of the 11th ESV Conference, Washington, May 1987. (Cesari D and Neilson I D).
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14. Commission of the European Communities. The European Side Impact Dummy EUROSID. Proceedings of Seminar, Report EUR 1079, Brussels, December 1986.
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16. European Experimental Vehicles Committee: Working Group 9 on Side Impact Test Procedures. Status Report of the production prototype EUROSID 1988. Proceedings of the IRCOBI/EEVC Workshop on the Evaluation of Side Impact Dummies, Bergisch-Gladbach, September 1988. (Roberts A K, Cesari D, Glaeser K-P and Janssen E G).
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18. European Experimental Vehicles Committee: Working Group 9 on Side Impact Test Procedures. Report on the Side-Impact Test Procedure. Proceedings of the 12th ESV Conference, Gothenburg, May 1989.
19. European Experimental Vehicles Committee: Working Group 9 on Side Impact Test Procedures. Comparison of EUROSID and cadaver responses in side impacts. Proceedings of the 12th ESV Conference, Gothenburg, May 1989. (Janssen E G, Wismans J and de Coo P J A).

20. European Experimental Vehicles Committee: Working Group 9 on Side Impact Test Procedures. Report on EUROSID. Proceedings of the 12th ESV Conference, Gothenburg, May 1989.
21. European Experimental Vehicles Committee: Working Group 9 on Side Impact Test Procedures. The influence of car structures and padding on side-impact injuries. Proceedings of the 12th ESV Conference, Gothenburg, May 1989. (Hobbs C A).
22. European Experimental Vehicles Committee: Working Group 9 on Side Impact Test Procedures. Review of cadaver responses to lateral impact and derived biofidelity targets for dummies. Proceedings of the 1990 IRCOBI International Conference, Lyon, September 1990.
23. European Experimental Vehicles Committee: Working Group 9 on Side Impact Test Procedures. Experience of using EUROSID1 in Car Side Impacts. Proceedings of the 13th ESV Conference, Paris, November 1991. (Beusenberg M C, Janssen E G, Lowne R W, Roberts A K, Glaeser K-P and Cesari D).
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25. European Experimental Vehicles Committee: Working Group 9 on Side Impact Test Procedures. Test Procedures for Defining Biofidelity Targets for Lateral Impact Dummies. Proceedings of the 13th ESV Conference, Paris, November 1991. (Roberts A K, Lowne R W, Beusenberg M C and Cesari D).
26. European Experimental Vehicles Committee: Working Group 9 on Side Impact Test Procedures (1991). Five Years Experience of Using EUROSID-1 in Sled and Car Tests. Proceedings of the 14th ESV Conference, Munich, May 1994. (Beusenberg M C, Janssen E G and Schreuder J J H).

Working Group 10

27. European Experimental Vehicles Committee: Working Group 10 on Pedestrian Protection. A study of test methods to evaluate pedestrian protection for cars. Proceedings of the 12th ESV Conference, Gothenburg, May 1989.
28. European Experimental Vehicles Committee: Working Group 10 on Pedestrian Protection. The design and test requirements for cars to give improved pedestrian protection. Proceedings of the Institution of Mechanical Engineers Seminar on Vehicle Safety, London, 1990. (Harris J).
29. European Experimental Vehicles Committee: Working Group 10 on Pedestrian Protection. Sub-systems tests for assessing pedestrian protection based on computer simulations. Proceedings of the IRCOBI Conference, Berlin, September 1991. (Janssen E G and Nieboer J J).
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32. European Experimental Vehicles Committee: Working Group 10 on Pedestrian Protection. Subsystem test for Pedestrian Lower leg and Knee Protection. Proceedings of the 13th ESV Conference, Paris, November 1991. (Cesari D, Alonzo F and Matyjewski M).
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35. European Experimental Vehicles Committee: Working Group 10 on Pedestrian Protection. Proposals for methods to evaluate pedestrianprotection for passenger cars: Final Report. EEVC, November 1994.

Working Group 11

36. European Experimental Vehicles Committee: Working Group 11 on Frontal Impact. EEVC Working group 11 Report on the Development of a Front Impact Test Procedure. Proceedings of the 14th ESV Conference, Munich, May 1994. (Lowne R W).
37. European Experimental Vehicles Committee: Group 11 on Frontal Impact. Final Report on the Front Impact Test Procedure. EEVC, December 1995.

Working Group 12

38. EEVC report on Development and Evaluation of the ES-2 dummy, August 2001. (Wismans J et al).
39. Development and Evaluation of the ES-2 Side Impact Dummy, EEVC WG12, Netherlands, Sess. 1.1 / 336-0, Proceedings of the 17th ESV Conference, Amsterdam, May 2001. (van Ratingen M).
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Working Group 13

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45. Research Progress on Improved Side Impact Protection, Proceedings of the 17th ESV Conference, Amsterdam, May 2001.
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47. The Evaluation of Sub-Systems Methods for Measuring the Lateral Head Impact Performance of Cars,

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48. Test Methods for Evaluating and Comparing the Performance of Side Impact Barrier Faces, Proceedings of the 16th ESV Conference, Windsor (Canada), May 1998, Paper No 98-S8-O-02. (de Coo P, Roberts A K, Seeck A and Cesari D).
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50. A Review of the Front and Side Impact Directives. EEVC Report to the European Commission. www.eevc.org , Jan 2000.

Working Group 14

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In addition to the above publications, the Chairman of EEVC has presented a Status Report at each ESV Conference.

APPENDIX 3
CURRENT MEMBERS OF THE EEVC STEERING COMMITTEE (at December 2002)

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