



EUROPEAN ENHANCED VEHICLE-SAFETY COMMITTEE

**EEVC Report to EC DG Enterprise Regarding the
Revision of the Frontal and Side Impact Directives
January 2000**



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1 INTRODUCTION

When the EC Frontal and Side Impact Directives were published, they included the requirement to review certain technical aspects, within two years of their implementation date (1 October 1998).

The technical content of these Directives was based on proposals put forward by the EEVC. These EEVC recommendations were the culmination of many years of accident investigation, research and testing by a number of European institutions. However, since full scale testing using dummies was new for Europe, the reviews were built in to the first edition of the Directives to allow benefit to be taken of the latest research and experience with the tests when used within a legislative framework.

The EC invited the EEVC to propose a research programme to assist with the review process. Due to the short time scale available to conduct the full review process, the European Commission and EEVC agreed that an immediate review of European accident data was necessary as background to some of the review topics. This initial review of seven topic areas was conducted by a consortium of four European partners, formed from members of EEVC WG13 (side impact) and EEVC WG16 (frontal impact). The focus of this work was to provide the information necessary to establish whether or not further research or in-depth reviews were required. In addition, other aspects of the review were addressed through the normal research activities of the EEVC members. This report is the conclusion of EEVC, based on EEVC research together with the accident analysis study.

For the contribution to the review of the frontal impact directive 96/79/EC, the following technical issues were considered:

- (i.) test speed,
- (ii.) the neck injury criteria
- (iii.) the extension to N1 vehicles
- (iv.) measurement of footwell intrusion
- (v.) consideration of a biomechanical alternative to the steering wheel movement requirement

Items (i), (ii) and (iii) were addressed from the review of accident data while (ii), (iii), (iv) and (v) have also been addressed from other resources within EEVC

For the contribution to the review of the side impact directive 96/27/EC, the following technical issues were considered:

- (i) test speed,
- (ii) seating position derogation,
- (iii) the barrier height above the ground,
- (iv) the necessity of a pole test in addition to the side impact requirements of directive 96/27/EC.
- (v) Viscous criterion

Items (i) to (iv) were addressed from the review of accident data while item (v) made reference to EuroNCAP test results.

A number of additional items and small variants of the items identified in the Directives have been submitted to the EEVC for review and advice. This document lists the items brought to the EEVC for attention and provides the considered answers of the relevant EEVC Working Groups.

2 THE DIRECTIVE ON FRONT IMPACT PROTECTION

DIRECTIVE 96/79/EC.....On the protection of occupants of motor vehicles in the event of a frontal impact and amending Directive 70/156/EEC. 16 December 1996

2.1 Summary of articles relevant to the review of the directive on front impact protection

2.1.1 ARTICLE 4 The Commission shall:

- (a) review the Directive within two years of the date mentioned in Article 5 (1) [1 April 1997] with a view to increasing the test speed and including vehicles of category N1....The review will cover *inter alia* ...the existing performance requirements (both biomechanical and geometric) and the addition of new requirements relating to footwell intrusion. The review will examine the potential gains in occupant protection and industrial feasibility of increasing the test speed and extending the scope of the Directive to include vehicles of category N1.....
- (b) before the end of 1996, review...Appendix 7 to Annex 11 so as to take into account assessment tests on the Hybrid III dummy's ankle including vehicle tests.
- (c) Before the end of 1997, review and amend the limit values for neck injury on the basis of values recorded during type approval tests and on accident study and biomechanical research data.
- (d) Also make, before the end of 1997, the necessary amendments to separate directives....

2.1.2 Letter from Richard Wright 27/7/96

Short Term: (1 October 1998)

Confirmation of neck injury criterion

Finalisation of certification of ankle

Review and confirmation of all other criteria.

Medium Term (amendments for implementation 1 October 2001)

(increase in) test speed

barrier design

new requirements for footwell intrusion

possible replacement of steering wheel movement criterion with a biomechanical requirement

extension of scope to N1 vehicles

Other related work....

Directive 74/297/EEC [*Steering wheel/column performance*]

Consider..

- Deletion of old frontal impact test
- Extension of requirements to provide better protection against head injuries caused by contact with the steering wheel (using a non-destructive test method)
- Inclusion of requirements for airbags

2.1.3 Note from Herbert Henssler (DGIII) 4/9/97

“It has been agreed that EEVC would offer scientific input on:-

- benefits of increased test speed...with a view to possible consequences for the barrier specification and possible compatibility problems.
- {a} methodology for evaluating different barrier concepts
- {a} methodology for measuring in a repeatable and reliable manner intrusion in the footwell including recommendations for positioning the dummy foot
- ..extension of the ...requirements to light commercial vehicles up to 3.5 tonnes and passenger vehicles with up to 9 seats”

2.2 EEVC responses, by topic

2.2.1 Topic: increase in test speed.

EEVC response:

The accident analyses indicated that the test speed which would include 25 percent of fatal injuries in frontal impacts, was about 42km/h in the Swedish data, 77km/h for Germany and 64km/h for the UK. For 50 percent of the MAIS 3+ injuries, the test speeds were about 46km/h for Sweden, 66km/h for Germany and 64km/h for the UK. It was noted that, for the Swedish data, based on Volvo cars, the average age of the occupants was more than 10 years older than for the German and UK data, which might help to explain these differences. Taking this into account, this led the majority of the EEVC WG members to conclude that the test speed should be increased to include a significant range of the serious and fatal injury cases (as was described in the original EEVC proposal.)

A more detailed breakdown of the injury distribution into contact-associated injuries and acceleration-based injuries suggests that an increase in speed would not result in car designs that will give an overall increase in injuries due to an increase in the overall stiffness of cars.

Comparative test at 50km/h of two cars with differing performance at 64km/h in the EuroNCAP test indicated that the better performing car at the higher speed also performed best at the lower speed. This confirmed that good performance at 64km/h did not necessarily result in stiffer cars

that would perform worse at lower speeds. However, this is only one comparison and it would be advantageous to undertake a larger but limited test programme to determine whether it is generally the case that a good performance at the EuroNCAP speed was not necessarily associated with increased stiffness.

Experience at testing vehicles at the EuroNCAP speed of 64km/h has shown that raising the test speed to 60km/h (or 64km/h) would not have design implications for the current deformable face.

While the accident analysis described above suggests that the speed should be increased to perhaps 65km/h, concerns by some EEVC experts regarding compatibility had led to the recommendation to increase the speed initially to 60km/h until there is a better understanding of compatibility. . The EEVC recommends that the EC reviews this issue again when more is known about the likely influence on compatibility.

2.2.2 Topic: extension to N1 vehicles (and passenger vehicle with up to 9 seats)

EEVC Response:

Accident analysis shows that N1 vehicles are involved in similar accidents to M1 vehicles. The accident type and exposure are similar. However, there is some concern regarding the aggressivity of the heavier N1 vehicles. Consequently, EEVC does not recommend the application of the Directive to vehicles above 2.5 tonnes total permissible mass until there is better understanding of the influence that this would have on the compatibility of these vehicles. Nearly all of the N1 vehicles in this mass range are based on car designs. An analysis of vehicle type and structure indicates that application of the test procedure for car-derivative N1 vehicles should pose few problems. Therefore EEVC recommends extending the scope to N1 vehicles below 2.5 tonnes at the same test speed as that used for M1 vehicles until a test requirement for compatibility is developed and implemented.

It would be advisable to undertake a limited test programme on non-car-derivatives below 2.5 tonnes maximum permissible mass to confirm this advice.

There would also be the need for a research study on the application of the test procedure to N1 vehicles between 2.5 and 3.5 tonnes before EEVC can comment on the extension to this category.

There are similar concerns regarding the application of the test procedure to M1 vehicles greater than 2.5 tonnes maximum permissible weight. For conventional “car-type vehicles”, vehicles above 2.5 tonnes are relatively rare, while for other M1 vehicles over 2.5 tonnes, the effect of testing with the current barrier is unknown. Therefore, as for N1 vehicles above 2.5 tonnes, EEVC does not recommend extending scope to M1 vehicles above 2.5 tonnes, even at the current test speed, until a requirement for compatibility is developed and implemented.

Thus the EEVC recommends changing the Scope of the Directive to read

“ This Directive applies to power-driven vehicles of categories M1 and N1 of a total permissible mass not exceeding 2.5 tonnes,”

2.2.3 Topic: review of all existing performance requirements and the addition of new requirements relating to footwell intrusion

EEVC Response:

EEVC confirms that the criteria originally proposed by EEVC and adopted for use in the Directive remain the best currently available and address, as far as possible with the currently available dummy, the injury patterns seen in the accident analysis. EEVC concludes that there is an urgent need for more biomechanical research and for the development of improved dummies.

EEVC is developing a proposal for a criterion on intrusion in the footwell and a method for the reliable and consistent measurement of this intrusion. The current draft method currently subject to further development and assessment.

2.2.4 Topic: Amend Appendix 7, Annex 11 finalise ankle certification procedure

EEVC Response: A draft revision of the certification procedure, based on EEVC and First Technology testing, was provided to EEVC DGIII in March 1998 and formed the basis of the Technical Adaptation. This has now been published as Directive 1998/98/EC.

2.2.5 Topic: review limit values for neck injury

EEVC Response:

EEVC Working Group 12, after a review of recent research literature, provided preliminary advice in a letter sent to DGIII in 1997 that the neck performance criteria used in the Directive were the best currently available.

The more recent accident analysis demonstrated that neck injury represented a significant problem and a criterion needs to be retained for this body region.

An analysis of EuroNCAP and ADAC test results showed that none of the three criteria could be removed on the basis that it was never the highest rated criterion. For each of the criteria, there was at least one incidence where this criterion was the highest in relation to the performance limit.

It should be noted that the criteria currently in use do not address the Whiplash Associated Disorder injuries. EEVC recommends retaining all of the three current neck injury criteria.

2.2.6 Topic: possible replacement of steering wheel movement criterion with a biomechanical requirement.

EEVC Response: EEVC cannot envisage how a biomechanical criterion can replace the geometrical requirements which help to ensure a stable base for the deployment of the airbag. This helps to give confidence that the protection is available for a range of occupant sizes and a range of the principle direction of force in frontal impacts. A review of EuroNCAP test results, analysed for application of the EuroNCAP modifiers, shows that there is a need for an additional lateral displacement criterion of 100mm. EEVC recommends the retention of the existing geometrical requirements and the addition of a lateral displacement limit of 100mm.

2.2.7 Topic: Review of barrier design.

EEVC Response: EEVC has not considered the revision of the barrier face design. It believes that the application of the Directive to M1 and N1 vehicles greater than 2.5 tonnes may require a review of the barrier face design, but this has not yet been addressed. It would also be advisable to await a test procedure for compatibility before applying the requirements of the full ODB test to these vehicles. Experience with EuroNCAP testing demonstrates that an increase in the test speed would not result in the need to modify the deformable face design.

EEVC has produced a document describing the essential features of a deformable barrier face, such that these can be used to judge proposed changes to the design

2.2.8 Additional EEVC Comments relating to the Frontal Impact Directive.

EEVC wishes to remind the EC of the recommendation made in its report on the Offset Deformable Test Procedure (15th ESV Conference)*. In that Report EEVC concluded that (a) the Regulation should include a requirement for manufacturers to demonstrate that a mechanism was provided to ensure that fuel pumps were switched off at impact or when the engine stopped and (b) that it would appear to be appropriate to include requirements for fuel system integrity in the ODB test.

* EEVC WG11: "The Validation of the EEVC Frontal Impact Test Procedure" Proc 15th ESV Conf. Munich, 1996, paper 96-S3-O-28.

3 THE DIRECTIVE ON SIDE IMPACT PROTECTION

DIRECTIVE 96/27/EC.....on the protection of occupants of motor vehicles in the event of a side impact and amending Directive 70/156/EEC. 20 May 1996

3.1 Summary of articles relevant to the review of the directive on side impact protection

3.1.1 ARTICLE 4

... “within two years from {1 October 1998} a review shall be held by the Commission. It shall be based on a review of the technical criteria and, in particular, the viscous criterion, front seat position and ground clearance of the barrier.”...

3.1.2 Letter from Richard Wright 27/7/96

Short Term: (1 October 1998)

Confirmation of the value of the viscous criteria

Confirmation of the position of the front seat

Review and confirmation of all other criteria.

Medium term

Ground clearance of the barrier

Test speed.

3.1.3 Note from Mr Henssler 17/9/97

Review accident data to determine whether the present barrier position, especially the ground clearance, needs to be amended.

Potential benefits of an increase in test speed

Methodology for evaluating different barrier face designs with a view to amending the present performance specifications of the directive.

3.2 EEVC Responses.

3.2.1 Topic: Injury Criteria (including V*C)

EEVC Response

No further biomechanical research has been undertaken by EEVC regarding the injury criteria. However an analysis has been made of the results for the viscous criterion from the EuroNCAP tests which use a test procedure based on that specified within the Directive. The results indicate that the current value of 1.0 m/s is achieved by most of the cars that have been subject to the EuroNCAP test since the programme started, and all of the cars except for one ($V * C_{\max} = 1.01$) of the last two phases which primarily includes the more recent vehicle designs. The mean value of $V * C_{\max}$ for the last two phases was 0.48m/s.

The recommendation of EEVC is that the existing criteria, including the viscous criterion, should be retained at their current values unless future research indicated a need to refine these.

3.2.2 Topic: Front seat position

EEVC Response

The accident review indicted that there were clearly cases of injury due to contact with the B-pillar, particularly to the head but also to the chest and abdomen. However, the frequency of those contacts is not certain.

The derogation included in the Directive was introduced because technical solutions to the problem of impact to the B-pillar were unproven when the Directive was drafted. The introduction of side airbags demonstrates that this problem can now be solved. The derogation could now be removed and this would be expected to reduce the incidence of injuries, although the size of the reduction is not clear. If airbags are already being introduced by vehicle manufacturers to meet the current needs, then the cost of meeting the requirement at B-pillar positions should be negligible.

It should be borne in mind that the removal of the derogation may result in an effective mandatory fitment of side airbags. It may be advisable to undertake a research programme regarding the effect of side airbags on out-of-position occupants before making this commitment

3.2.3 Topic: Ground clearance of MDB Face

EEVC Response

An attempt was made to evaluate the appropriateness of the current MDB face ground clearance from the accident review. From the accident analyses, there was no strong evidence to suggest that the current ground clearance of the MDB face was inappropriate. The mean height of maximum intrusion in EuroNCAP and legislative tests that had been performed at one institute

was below that seen in accidents, suggesting that the ground clearance may be too low, but this was not so for another test institute.

An associated study of the front and side structures of modern cars suggests that the ground clearance (i.e. the height of the bottom surface of the MDB face) should be raised but not the level of the top of the MDB face. This would not be possible to achieve without a redesign of the whole MDB face.

EEVC recommends that note be taken of this indication that the ground clearance may need to be raised in the future but that no action should be taken in the short or medium term.

3.2.4 Topic Test Speed.

EEVC Response

There is an indication from the accident analysis that the overall severity of impact in the test procedure should be raised. The total intrusion seen in accidents is normally greater than that seen in the Side Impact test. However, there are a number of parameters that could influence this, including barrier mass, stiffness, height, in addition to the impact speed.

The accident data for two countries indicated that the current test speed included only about 25 per cent of serious injury cases and 10 – 20 per cent of fatal accidents, suggesting a potential benefit from an increased test speed.

It is recommended by EEVC that a research programme be undertaken to establish the performance of cars at higher impact speeds than the current level before any decision could be taken to recommend an increase in the test speed.

3.3 Additional relevant activities of EEVC

3.3.1 MDB Face Specification.

EEVC has undertaken a large MDB face evaluation programme. As a result of this study, EEVC is preparing recommendations on the revision to the specification of the MDB face (deformable element) to improve its repeatability and reproducibility when impact cars.

3.3.2 Pole Test

The accident study indicated that side impacts to poles and narrow objects constitute a significant proportion of MAIS 3+ side impact injury accidents. In the Netherlands, Sweden and the UK, these range from 12 percent to 16 percent while in Germany pole or narrow object impacts comprise 53 percent of all such side impacts. If struck side occupants only are considered, these figures are even higher. The accident statistics also show that these casualties are primarily young males, more than half being aged under 30 years.

EEVC recommends that consideration be given to the development of a suitable pole impact test for the longer term.