REVIEW OF THE EUROPEAN FRONTAL AND SIDE IMPACT DIRECTIVES

Mervyn Edwards, Adrian Fails, Huw Davies, Richard Lowne and Adrian Hobbs
TRL Ltd
United Kingdom
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ABSTRACT

The work reported here relates to a research project that was undertaken to support the current review of the European frontal and side impact Directives. The aim of the project was to conduct a general review focusing on the major issues identified in the Articles of the Directives and in a report to the European Commission on accident analyses. These are test speed, neck injury criteria and extension to N1 vehicles for frontal impact; and test severity, barrier height, seating position, Viscous Criterion and the necessity of a pole test for side impact. A comprehensive analysis of the results from the European New Car Assessment Programme (EuroNCAP) crash tests has been used to review the suitability of the current injury criteria, car structural performance requirements and test configuration. This is backed up with accident analysis using data from the UK Co-operative Crash Injury Study (CCIS) and the recent accident analysis co-funded by the European Commission. Full scale car crash testing has been used to help substantiate the findings of the study. The research was funded by the Department of the Environment, Transport and the Regions (DETR) and has been reported to the European Enhanced Vehicle-safety Committee (EEVC) frontal and side impact working groups.

INTRODUCTION

The European Directives on frontal and side impact became effective on the 1st October 1998. As a consequent of this, an improvement in vehicle crashworthiness coupled with a significant reduction in occupant injury is expected. The technical content of the Directives was based on test procedure proposals developed by the European Enhanced Vehicle-safety Committee (EEVC). These proposals were the result of many years of accident investigation, research and testing by a number of European institutions.

Since the test procedures were developed, car safety design has evolved rapidly. In anticipation of this, the Articles of each Directive contain a requirement to review certain technical aspects by the 1st October 2000. On behalf of the Department of Environment, Transport and the Regions (DETR), the Transport Research Laboratory (TRL) is carrying out research to support this review. As a member of the EEVC, the UK is committed to contribute to the assessment of the effectiveness of the Directives and suggest, justify and prepare amendments to improve them.

Recently, an analysis of European accident data, partly funded by the European Commission, has been conducted to support the Directive review (1). This analysis was performed by a consortium of four European partners, BASt, TNO, TRL and Volvo, all of whom are members of EEVC WG13 and EEVC WG16. The aim of this project was to conduct a general review focusing on the major issues identified in the Articles of the Directives and in the recent accident analysis described above. These are test speed, neck injury criteria and extension to N1 vehicles for frontal impact; and test severity, barrier ground clearance, seating position, the use of Viscous Criterion, and the necessity for a pole test, for side impact. This project has carried out accident analysis using the UK Co-operative Crash Injury Study (CCIS) database, full scale car crash tests and an analysis of the European New Car Assessment Programme (EuroNCAP) crash test results.

This research is contributing to the work of the EEVC frontal (WG16) and side (WG13) impact working groups, which have been tasked by the European Commission to review the Directives and recommend possible amendments.

This paper reports on the findings of the research and discusses possible amendments to the Directives.

FRONTAL IMPACT DIRECTIVE

Test Speed

A recent European accident analysis concludes that the test speed should be increased because the current speed of 56 km/h addresses significantly less than 50 percent of belted occupants having injuries MAIS 3+[1] (1). This is consistent with the original EEVC WG11

[1] An Abbreviated Injury Scale 3+ (AIS3+) injury severity level describes a "serious" injury, and the MAIS3+ description is applied to any occupant who was injured at or above this severity.

recommendation that in order to address an adequate proportion of fatal and serious injuries, the test should replicate a car to car impact speed of 60 km/h or greater (2). This corresponds to a test speed greater than 65 km/h. Initially, WG11 did conduct some ODB tests at 65 km/h, but some members were concerned that compliance at this speed might not be possible. Therefore, WG11 recommended that the test speed should initially be 56 km/h but it should be increased once the manufacturers had become accustomed to the engineering involved.

Analysis of the UK CCIS data, for accidents that occurred in the period June 1992 to March 1998, showed that a test speed of around 65 km/h would address approximately 50 percent of the MAIS3+ and 30 percent of the fatal restrained occupants[2]. Assuming the CCIS impact severity measure is linearly related to the test speed, further analysis showed that the current test speed of 56 km/h only addresses 34 and 18 percent of the MAIS3+ and fatal restrained occupants, respectively.

The GB national accident statistics (STATS19) record that there were 8004 seriously injured occupants and 452 fatally injured occupants, in car frontal crashes with one other vehicle in 1996. From these figures and the CCIS data above the benefits of increasing the test speed to around 65 km/h have been estimated using the following assumptions:

- Belt use rate for fatal and seriously injured occupants was 70 percent.
- The proportion of occupants reported to CCIS by the police as “seriously injured” who had suffered an injury at or above the AIS3 severity level was 25 percent.

Based on these assumptions, a test speed increase from 56 km/h to about 65 km/h would represent a benefit of addressing approximately a further 225 MAIS3+ seriously injured occupants and 38 fatalities, per year in GB. However, the actual reduction in injuries and fatalities will be a fraction of the number addressed and cannot be evaluated without a further extensive study. In addition, it is expected that there would also be benefits for single car frontal collisions.

The EuroNCAP test procedure is essentially the same as the Directive test with the exception that the test speed is 64 km/h. Examination of the EuroNCAP test data from the first six phases shows that from a total of 53 vehicles, 14 met all the current Directive requirements. Furthermore, 34 vehicles complied with just the dummy based limits, with twelve of the better performing cars significantly exceeding them. The analysis highlighted that the tibia index and steering wheel residual motion requirements appear to be the least frequently met criteria with current cars (Table 1). These results show that a number of manufacturers already produce cars that could meet and exceed the requirements of a Directive with a 64 km/h test speed, albeit these cars are generally the mid engine sized models.

Table 1.
Breakdown of Directive Limit Failures for 64 km/h Test Speed Showing High Occurrence of Tibia Index and Steering Wheel Movement Failures

Dummy Based Requirements	No. of Failures	Vehicle Based Requirements	No. of Failures
HIC_{36}	2	Steering Wheel Residual Movement	27
Head Acceleration	3	Dummy Entrapment	10
Neck (Not used as pass/fail criteria for Directive at present)	(1)	Door Opening during Test	8
Chest Compression	2		
Chest Viscous Criterion	1		
Femur Force (Worst case leg.)	4		
Knee Slider (Worst case leg.)	2		
Tibia Force (Worst case.)	0		
Tibia Index (Worst case.)	14		

Notes: 1. 53 vehicles included in analysis.
2. Some vehicles fail on more than one requirement.

[2] It should be noted that the fatal category is a subset of the MAIS3+ category.

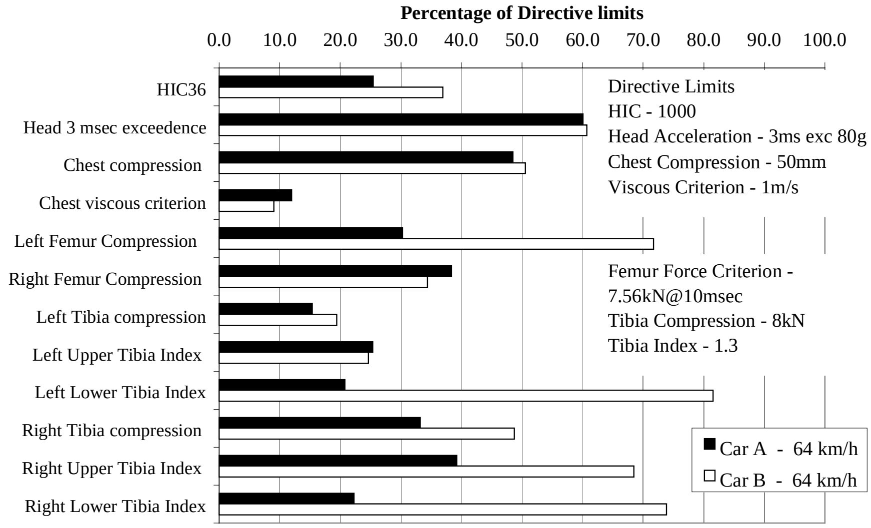

Figure 1. Comparison of dummy injury criteria for Car A and Car B for 64 km/h test speed showing better overall performance of Car A.

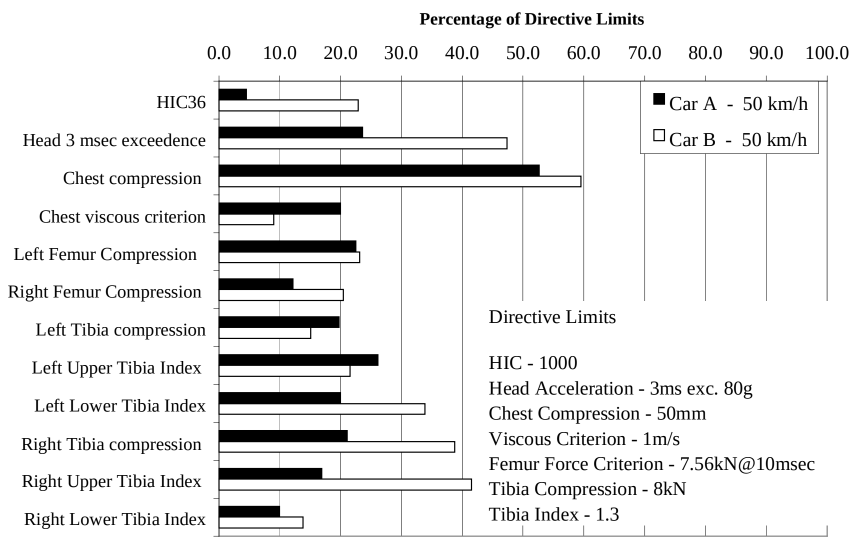

Figure 2. Comparison of dummy injury criteria for Car A and Car B for 50 km/h test speed showing better overall performance of Car A.

One of the concerns about increasing the test speed is that it may cause cars to be stiffer because they would be required to absorb the increased kinetic energy in the same deformation length. This could lead to increased injury in lower speed accidents, as the deceleration pulse might be more severe.

In order to address this concern the crash performances of two cars were compared at two test speeds, 50 km/h and 64 km/h. Car A was chosen to represent a car that should meet all of the Directive requirements with a test speed of around 65 km/h. Car B was chosen to represent a current car not designed to meet the requirements at around 65 km/h.

At 64 km/h, the structural performance of Car A, with 72 mm of A-pillar displacement measured at waist level, was far better than that of Car B with 171 mm of A-pillar displacement recorded. At 50 km/h, the structural performance of both vehicles was good with less than 20 mm A-pillar motion. A comparison of the driver dummy injury criteria for Car A and Car B at 64 km/h and 50 km/h shows that, in general, Car A's performance was comparable or substantially better than Car B at both test speeds (Figure 1) and (Figure 2). The underlying reason for this becomes apparent if the force / ridedown distance curves are examined (Figure 3).

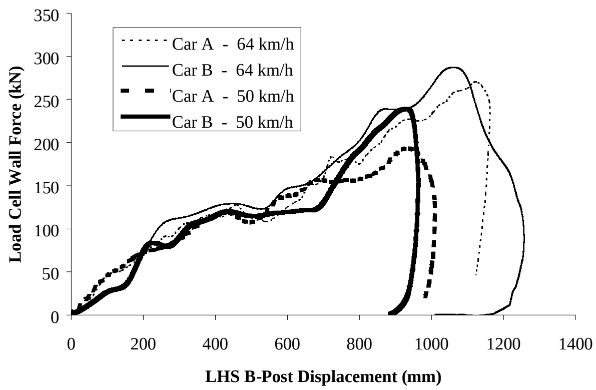

Figure 3. Force / ridedown distance curves for Car A and Car B for test speeds of 50 km/h and 64 km/h showing greater ridedown for Car A at 50 km/h.

The ridedown distance was calculated by performing a double integration of the measurement taken from an accelerometer mounted on the struck side B-pillar and includes the barrier deformation in all tests. The force measurement was taken from a load cell wall positioned behind the deformable barrier. For a test speed of 64 km/h, the ride down distance of Car A was 1160 mm, whereas Car B was 1260 mm, indicating that the Car A was the stiffer car.

However, for a test speed of 50 km/h the ridedown distance of Car A was 1010 mm, whereas Car B was 960 mm, indicating that Car B was the stiffer car. So although the overall stiffness of Car A was high enough to ensure good performance at a test speed of 64 km/h, its stiffness profile was such that it was less stiff than Car B in the 50 km/h test.

These results demonstrate that an increase in the test speed to 64 km/h would not necessarily result in car designs that are stiffer in low speed crashes leading to increased injury in lower speed accidents. In addition, the results indicate that perhaps the stiffness profile of vehicles should be controlled. Ideally, further tests should be performed with a variety of cars at different speeds and overlaps to support the conclusions drawn.

Another concern about increasing the test speed is that it might affect compatibility by encouraging a greater difference between the stiffnesses of small and large cars. Analyses of load cell wall force measurements from recent EuroNCAP tests indicate that this is generally not the case (3). These analyses showed that the average peak forces for phases 3, 4 and 7, family, large saloon and small family cars, respectively, were similar. This indicates that their global stiffnesses were similar. However, it should be noted that the average peak force for phase 6, MPVs, was significantly higher indicating a stiffness mismatch between MPVs and cars.

The above findings suggest that the test speed should be increased from 56 km/h to approximately 65 km/h. The main reasons for this are:

- The current test speed only addresses 34 and 18 percent of MAIS3+ and fatal restrained occupants, respectively, which is clearly not sufficient. A test speed increase to about 65 km/h would address 50 and 30 percent of MAIS3+ and fatal restrained occupants, respectively. For GB this would give the benefit of addressing approximately a further 225 MAIS3+ seriously injured occupants and 38 fatalities per year for car to one other vehicle collisions. It should be noted that the actual reduction in injuries and fatalities would be a fraction of the number addressed.
- It has been shown that a test speed around 65 km/h would not necessarily result in car designs that are stiffer in low speed impacts, which could lead to increased injury in lower speed accidents.
- A number of manufacturers are currently producing cars that would comply with a Directive having a test speed of about 64 km/h, albeit these cars are generally the mid engine sized models.

Neck Injury Criteria

A recent European accident data analysis found that neck injury is a significant problem and concluded that neck injury assessment should be included in the Directive test (1). This analysis excluded AIS 1 severity injuries, such as strain of the cervical spine. In order to determine whether all three neck injury criteria are necessary the EuroNCAP data were examined. The leading criterion is defined as the one that gives the highest value when expressed as a percentage of its proposed legislative limit. It was concluded that all three injury criteria are necessary, as they are all the leading criterion at least once.

Extension to Include N1 Vehicles (Vans)

A recent European accident data analysis examined the issue of extending the scope of the Directive to include N1 vehicles (1). It found no major differences in the accident type or exposure between N1 class vehicles and passenger cars (M1) and concluded that N1 vehicles should be considered for inclusion.

At the moment, an extension to include N1 vehicles less than 2.5 tonnes total permissible mass is being considered. The reason for not including heavy N1 vehicles (2.5t<N1<3.5t) is that it might encourage them to become even more aggressive. Once further progress on compatibility has been made this should be reviewed with the possibility of including these heavy vehicles. This extension will encompass the majority of car derived N1 vehicles but will include some non car derivatives. The application of the test procedure to car derived vehicles should not pose any significant problems, since the frontal structure is essentially the same as the M1 vehicle from which it is derived. However, problems could possibly occur for non car derived vehicles. To address this issue a 60 km/h ODB test has been performed using a typical non car derived van, test mass 1681 kg. The reason for choosing this test speed (The Directive test is currently 56 km/h) was because it is expected that the test speed for M1 vehicles will be increased to at least 60 km/h as a result of the Directive review.

The occupant cell of the non car derived van remained reasonably stable through the impact (Figure 4). All of the Directive requirements were met, with the exception of the steering wheel vertical motion and the driver 3 msec head acceleration exceedence and chest compression requirements (Table 2).

Figure 4. Deformation of the non car derived van showing reasonably stable passenger cell.

Examination of the results showed that the high head acceleration coincided with the steering wheel contacting the driver's chin area which indicated that the large steering wheel motion was, most likely, the cause of the high head acceleration. No problems were found with the practicality of the test, i.e. the van engaged the barrier well indicating that there was no conflict of the bonnet height or vehicle ground clearance with the Offset Deformable Barrier's dimensions.

Table 2.
Performance Criteria Values for Non Car Derived Van Test Showing Failure to meet Head, Chest and Steering Wheel Directive Requirements

	Test Result	Directive Requirement
Driver		
3 msec head exceedence (g)	83	80
Chest compression (mm)	58	50
Vehicle		
Steering wheel vertical motion (mm)	180	80

These test results indicate that the design changes required to enable the van tested to meet all of the criteria, even at 60 km/h, should not be too onerous, which supports the proposed amendment to extend the scope of the Directive to include N1 vehicles less than 2.5 tonnes.

Other Issues

It has been proposed by the automobile industry that the steering wheel residual displacement performance criteria should be replaced with biomechanical criteria. The authors cannot envisage how biomechanical criteria can replace the current geometrical requirements, which help to ensure a stable base for the deployment of the airbag. For example, during validation tests conducted by EEVC WG11, gross steering wheel motion into the face or neck of the dummy was observed but no dummy performance requirements were exceeded (2). In addition, analysis of the EuroNCAP results has shown that there is good correlation between steering wheel residual lateral displacement exceeding 100 mm and an unstable head to airbag contact. Head contact is defined to be unstable if its centre of gravity moves further than the outside edge of the airbag, during its forward motion (4). Because of the importance of maintaining a stable platform for airbag deployment it is suggested that the current steering wheel displacement limits should be maintained and an additional lateral limit of around 100 mm added.

SIDE IMPACT DIRECTIVE

Test Severity (Speed and MDB Mass)

A recent European accident analysis concluded that the severity of the test should be increased (1). This could be achieved by raising the test speed, the Mobile Deformable Barrier (MDB) mass or the barrier ground clearance.

For Great Britain, the national accident statistics (STATS19) records approximately 3000 occupants seriously injured and 300 fatally injured in side impact crashes involving another vehicle in 1996. Analysis of CCIS data shows that the current test speed of 50 km/h addresses approximately 25 percent of the MAIS3+ and 10 percent of the fatal struck-side restrained occupants in these crashes. The data used in this analysis were from accidents that occurred in the period June 1992 to March 1998. Using the same assumptions as for the frontal test speed calculation, the current test speed is estimated to address 190 MAIS3+ and 30 fatal occupants annually in Great Britain. This analysis clearly shows the benefit if the severity of the test could be raised to address a larger percentage of the serious injuries and fatalities. For example, should the test be made severe enough to address 50 percent of the MAIS3+ occupants, the CCIS analysis shows that it would address approximately 30 percent of the fatal occupants. This equates to addressing a further 185 MAIS3+ and 60 fatal occupants annually in Great Britain. It should be noted that the actual reduction in injuries and fatalities would be a fraction of the number addressed and cannot be evaluated without a further extensive study.

In order to assess the ability of current cars to meet the legislative requirements at an increased test speed, two crash tests were performed at test speeds of 55 and 60 km/h. A good performing EuroNCAP car was used for these tests, which was fitted with a seat mounted side airbag that offered chest and head protection. The 55 km/h impact showed a slight increase in most of the dummy injury criteria with the 60 km/h impact displaying a larger increase in the head and chest regions. However, all measurements were still below the limits (Figure 5).

The EUROSID back plate loads measured were less than 1.8 kN indicating that no significant contact was made between the back plate and the car structure (See section – Other Issues). The barrier deformable face did not fully collapse in either test, in fact there was more than 100 mm of crush depth remaining over most of the barrier even for the 60 km/h impact. This indicates that the barrier has adequate energy absorption capability for these higher speed impacts. Ideally further tests should be conducted with different vehicles to support this conclusion.

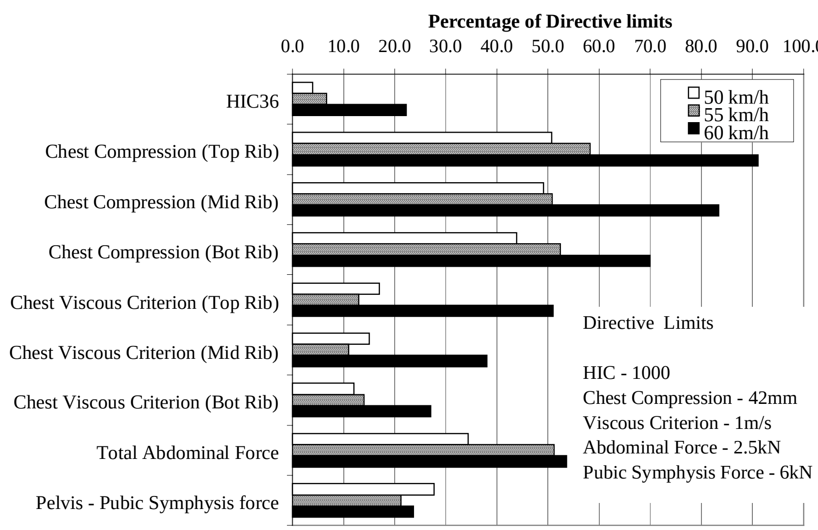

Figure 5. Comparison of dummy injury criteria for increased test speeds showing that current Directive requirements are met at 55 and 60 km/h.

The mass of the MDB is currently 950 kg, whereas a recent analysis has found that the median mass of cars sold in 1997 was 1135 kg (5). If it is intended that the mass of the barrier should be representative of a current median vehicle then its mass needs to be increased.

In summary, the accident analysis shows that the severity of the test needs to be increased. Should this be achieved by raising the test speed, it has been shown that a currently available car could meet the test requirements at 60 km/h. It should be noted that previous modelling and test work has shown that the closing speed and barrier ground clearance are far more significant factors than mass in side impact induced injuries (6, 7).

Barrier Ground Clearance

As mentioned above raising the barrier ground clearance could increase the test severity. The European accident data review attempted to evaluate the appropriateness of the current Mobile Deformable Barrier (MDB) face ground clearance but it found no strong evidence to suggest that it should be changed (1). However, an analysis of car structural data, using the EEVC WG15 database, indicated that the barrier ground clearance should be raised without altering the height of the barrier top surface (8). As this activity would involve a redesign of the barrier it is suggested that no action should be taken in the short term but the issue should be readdressed following further research.

Seating Position Derogation

When the Directive was written there was some doubt that vehicles could be designed to pass the test if the dummy received a direct impact from the B-pillar. As a consequence a derogation on the seating position was written to prevent the dummy being seated in alignment with the B-pillar. It should be noted that the wording of the derogation procedure does not entirely resolve this situation because even when following this procedure it is still possible to position the dummy with its head and chest in alignment with the B-pillar. The standard seating position is mid position. However, the Directive does allow the testing authority to select a higher risk position if it deems appropriate.

The European accident review showed that there were clearly cases of injury due to contact with the B-pillar, particularly to the head and abdomen (1). However, the frequency of these contacts was not certain.

Today, some currently available cars are fitted with side airbags, which could possibly offer sufficient protection from a direct B-pillar impact to fulfil the Directive requirements. An example of such a car, fitted with an airbag to protect the head and chest, was crash tested with the EuroSID seated in alignment with the B-pillar. The dummy injury criteria levels recorded in this test were lower than expected and similar to those measured with the dummy in the standard seating position (Figure 6).

It should be noted that examination of the photographic results showed that in this test the head airbag did not deploy correctly because it became entangled with the seatbelt near its upper B-pillar mounting point. For this seating position, it is likely that this problem could occur in other cars fitted with a seat-mounted airbag.

The test results above demonstrate that a car fitted with side airbags can meet the Directive requirements with the dummy seated in alignment with the B-pillar. Therefore the derogation could now be removed and this would be expected to reduce the incidence of injuries due to contact with the B-pillar, although the size of the reduction is not clear.

It should be noted that a consequence of removing the derogation might effectively be to mandate the fitting of side airbags. Therefore, it may be advisable to undertake a research programme to investigate the effect of these airbags on out of position occupants before a final decision is taken.

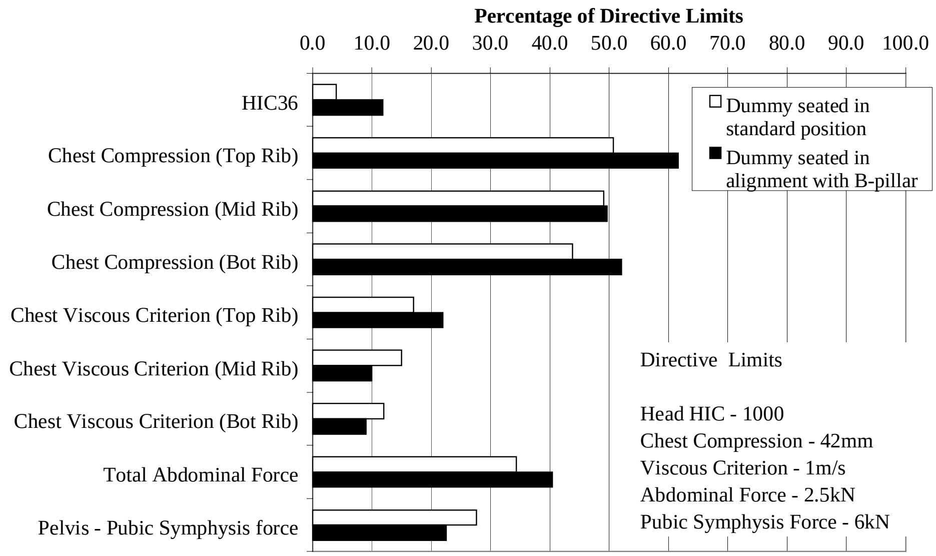

Figure 6. Comparison of the injury criteria measured for EuroSID seated in standard position and in alignment with B-pillar.

Viscous Criterion

Previous researchers have found that V*C is the best measure of chest injury for blunt impacts with the deformation velocities in the region of 3 to 30 m/s, which are typical of those seen in side impacts (9). To assess the contribution of the Viscous Criterion (V*C) to the chest injury rating the EuroNCAP results for 46 cars were analysed. The leading criterion was defined as the one that gave the highest value when expressed as a percentage of its Directive limit. V*C was found to be the leading criterion for 37 percent of the cases. Of the 15 cars that failed to meet the Directive chest compression and V*C requirements, 12 failed for exceeding both limits, 2 exceeded just the chest compression limit and 1 exceeded just the V*C limit.

It is suggested that V*C should be adopted with the proposed limit of 1.0 m/s because it is often the leading chest injury criterion and is generally accepted as one of the best measures of chest injury for the type of blunt impacts seen in the test.

Necessity for Pole Test

The recent European accident analysis addressed the necessity of a pole test and concluded that collisions with poles and narrow objects constitute a notable part of the side impact scene (1). It found that the head and thorax are the body regions most frequently injured, as they are for side impacts in general. However injuries to the femur also feature prominently. Quite differently from car to car side impacts, more than half of the victims of serious or fatal pole and narrow object side impacts are young male adults below 30 years old. The occurrence of this type of accident is far higher in Germany compared to the UK and Sweden. To determine the exact reason for this requires further investigation. However, one possible explanation could be the high number of preserved ‘tree alleys’ in Germany.

For the UK, the CCIS database shows that for side impacts the collision object is another car for 49 percent of seriously injured (MAIS3+) occupants. Poles, trees and other narrow objects account for a further 18 percent of such MAIS3+ occupants. A reliable impact severity estimate could be made for just over half of the occupants in pole impacts. From the available data it was shown that an Equivalent Test Speed (ETS) of about 37 km/h should address 50 percent of MAIS3+ injured occupants in impacts with pole and narrow objects (Figure 7). It should be noted that although there were 21 occupants in this data sample, ETS could only be calculated for 12 of them. ETS can be equated to test speed if it is assumed that the pole is rigid and the impacting vehicle does not rotate, i.e. all the vehicle’s initial kinetic energy is absorbed by its resulting deformation.

The necessity of a pole impact test in addition to the current side impact requirements is being considered. In contrast to the pole test used in the US, which mainly evaluates head protection, it is envisaged that this test would be designed to evaluate the protection for the whole body.

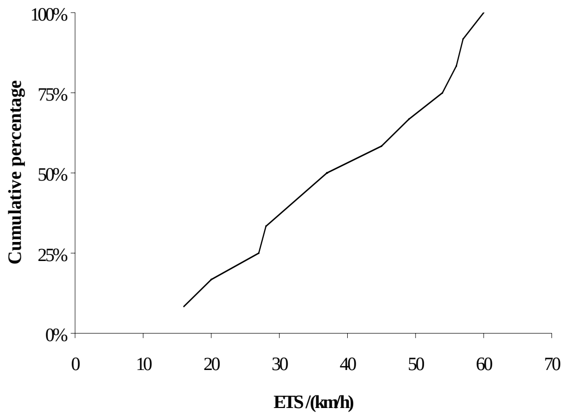

Figure 7. Cumulative speed distribution for MAIS 3+ struck-side occupants in pole and narrow objects side impact accidents for the UK.

The US Insurance Institute for Highway Safety (IIHS) has conducted a series of pole tests to assess the additional protection offered by two different head airbag systems. The impact speed for these tests was about 30 km/h. The results from these tests show that current airbag systems can provide good head protection for impacts up to about 30 km/h (Table 3).

Table 3.
Injury Criteria Results for IIHS Pole Impact Tests

Head airbag present	HIC	Neck Compression (kN)	Thoracic Trauma Index	Pelvis Lateral Accln (g)
Lincoln				
Yes	376	0.2	71	57
No	5390	6.4	71	63
BMW				
Yes	620	1.6	59	39
No	4720	6.5	66	48

In summary, the accident data indicates the need to introduce a pole test, which assesses the protection offered for the whole body. However, further work needs to be performed in order to evaluate up to what speed current technology can offer full body protection against a pole impact so that the possible benefits of introducing a pole impact test can be determined.

Other Issues

It should be noted that in some EuroNCAP tests evidence has been found of the EUROSID back plate forming an uninstrumented load path into the dummy by contacting stiff parts of the seat or the B-pillar. This can reduce the rib deflection measured, resulting in an incorrect indication of the injury risk. In addition, there is some concern that as a consequence of reducing chest loads, pelvic and abdomen loads may be increasing to a point high enough to cause spinal shear loads of an injurious level. In order to investigate these issues, EuroNCAP are now using a modified EUROSID with additional load cells to measure the back plate load and the spine load between the thorax and abdomen. These data should be available for analysis shortly.

SUMMARY OF RECOMMENDATIONS

The recommendations listed below are based on the data available. Ideally a larger number of tests to address issues of repeatability and differences in structure between vehicle models is required. The recommendations are:

Frontal Impact Directive

- The test speed should be increased from 56 to approximately 65 km/h.
- All three neck injury criteria should be adopted with the proposed limits.
- The scope of the Directive should be extended to include N1 vehicles (vans) less than 2.5 tonnes total permissible mass.
- The existing steering wheel residual displacement requirements should be retained with the addition of a lateral displacement limit of approximately 100 mm.

Side Impact Directive

- The severity of the side impact test needs to be increased. This could be achieved by raising the test speed, barrier ground clearance or mass. Further work is required to determine the correct way forward. Should this be achieved by raising the test speed it has been shown that a currently available car could meet the test requirements at 60 km/h. If it is intended that the mass of the barrier should be representative of a current median vehicle then its mass needs to be increased.

- The barrier ground clearance may need to be raised in the future to increase the test severity. However, no action should be taken in the short term, as this would involve a redesign of the barrier face.

- The derogation could be removed. However, it should be noted that a consequence of removing the derogation might effectively be to mandate the fitting of side airbags. Therefore, it may be advisable to undertake a research programme to investigate the effect of these airbags on out of position occupants before a final decision is taken.

- The Viscous Criterion should be adopted with the proposed limit of 1.0 m/s unless future research indicates otherwise.

- The introduction of a pole test is worth considering but the ability of current technology to meet the requirements of such a test needs to be further assessed before a decision can be taken.

In general, the recommendations listed above for frontal and side impact agree with those of the EEVC with one exception. This is that the EEVC recommend that the frontal test speed should be increased to 60 km/h because of concerns that increasing the test speed further might result in stiffer structures that perform worse in lower speed accidents. The EEVC recommendations were reported to the European Commission DG Enterprise in January 2000 for the purpose of reviewing the Directive.

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The data were collected by teams from the Birmingham Automotive Safety Centre of the University of Birmingham; the Vehicle Safety Research Centre of the University of Loughborough; and the Vehicle Inspectorate Executive Agency of the DETR.

Further information on CCIS can be found at http://www.ukccis.com/

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