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Vehicle design for pedestrian protection

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ABSTRACT

This report is a review of the regulation of vehicle design as it relates to the protection of a pedestrian in the event of a collision. It commences with a brief description of the background to the current approach to regulation in this area and then gives an overview of the requirements of the European and Japanese regulations. Moves by the UN/ECE through the Global Technical Regulations to develop an internationally acceptable standard are described in the context of the existing regulations and the on-going work of the International Harmonised Research Activities Pedestrian Safety Working Group. The report concludes with a description of the proposed European Directive for the regulation of the design of vehicle frontal protection systems (bull bars) to reduce the risk of injury to a pedestrian in a collision, and a comparison of these proposed requirements with the Australian Standard for Vehicle Frontal Protection Systems.

KEYWORDS

Vehicle design, Pedestrian, Traffic accident, Standardization.

Summary

This report is a review of the regulation of vehicle design as it relates to the protection of a pedestrian in the event of a collision.

It commences with a brief description of the background to the current approach to regulation in this area and then gives an overview of the requirements of the European and Japanese regulations. Moves by the UN/ECE through the Global Technical Regulations to develop an internationally acceptable standard are described in the context of the existing regulations and the on-going work of the International Harmonised Research Activities Pedestrian Safety Working Group.

The report concludes with a description of the proposed European Directive for the regulation of the design of vehicle frontal protection systems (bull bars) to reduce the risk of injury to a pedestrian in a collision, and a comparison of these proposed requirements with the Australian Standard for Vehicle Frontal Protection Systems.

Contents

1 Background

The relevance of vehicle design to the safety of car occupants was generally accepted by the late 1960s. Even then, however, there was little interest in attempting to protect the pedestrian by regulating the design of the car, other than by prohibiting the attachment of sharp objects such as some bonnet mascots. It was commonly assumed that a seriously injured pedestrian had been "run over" by the striking car and that, in any event, the typical impact was too great to be modified by any practicable change in vehicle design.

The first accurate description of the motion of a pedestrian struck by a car was based on the investigation of actual collisions in Adelaide. It was published in the proceedings of the Ninth Stapp Car Crash Conference, as follows:

> "The sequence of events when a car strikes a pedestrian is as follows, assuming the pedestrian is an adult, standing erect.
>
> The initial impact is from the bumper bar which strikes the lower leg. The effects of this impact for a given vehicle speed depend partly on the amount of body weight this limb is supporting at impact, and partly on the limb's own inertia. Almost at the same instant, but slightly later, the leading edge of the bonnet (hood) of the car will strike the hip of the pedestrian. If the speed of the car is great enough the pedestrian then rotates about this secondary impact point until his head and chest strike the bonnet, windscreen and/or the windscreen surroundings. The higher the impact speed the further back along the car this third impact point will be.
>
> At still higher speeds the pedestrian now rotates about his head and shoulders, i.e., the third impact point. This can result in either a fourth impact with the car or in the car passing under the pedestrian who then falls to the road. On this fourth impact with the car the pedestrian's legs strike the rear of the roof of the car. From this point, if the car does not slow down, the pedestrian, who is now travelling almost at the speed of the car, will fall to the road, either behind or on one side of the car.
>
> If the driver of the car should suddenly brake, the car will then slow down at a much faster rate than the pedestrian, who tends to continue forwards with undiminished speed, sliding over the roof and bonnet and then falling to the road in front of the car. He finally comes to rest after sliding and rolling along the road." (Ryan and McLean, 1966)

In the same paper it was also noted that:

> "With a larger amount of data it will be possible to describe the frontal shape of a car that will inflict minimal injuries when it strikes a pedestrian."

Today, four decades later, the properties of the front of a car that will inflict minimal injuries when it strikes a pedestrian are understood well enough to justify the regulation of vehicle design.

2 Development of pedestrian impact test procedures

Four groups have, or had, been working on the development of test procedures to be used in assessing the degree of pedestrian protection afforded by a given vehicle. They are the United States National Highway Traffic Safety Administration (NHTSA), the European Experimental Vehicles Committee (EEVC), the International Standards Organisation (ISO) and the International Harmonised Research Activities (IHRA). Each group has approached the task by developing component, or sub-system, tests rather than a whole system test. This is largely because of (1) intractable difficulties in ensuring repeatability in full scale collisions between a pedestrian dummy and a vehicle, (2) the need for a family of dummies to represent the pedestrian population (child through adult) and (3) concern about the biofidelity of a pedestrian dummy.

A full scale pedestrian crash test dummy, POLAR II, has been developed by Honda R&D in collaboration with GESAC and the Japan Automobile Research Institute. The Society of Automotive Engineers has a Pedestrian Dummy Task Group which is developing criteria for a full scale pedestrian dummy. However, at this stage these dummies are intended primarily for use in research. Neither has been referred to in any regulation of vehicle design and so they will not be considered further in this report.

During the 1980s the United States National Highway Traffic Safety Administration (NHTSA) was actively involved in the development of vehicle impact test methods for pedestrian protection. Although Notices of Proposed Rule Making were prepared, this work was suspended in 1992. (NHTSA, 1993) Today, there is some research being conducted in this area by NHTSA as the United States Government's contribution to the work of the International Harmonised Research Activities Pedestrian Safety Working Group (IHRA PS).

2.1 EEVC

The European Experimental Vehicles Committee (EEVC, now re-named the European Enhanced Vehicle-safety Committee) has played the major role in the development of pedestrian impact test procedures through its Working Groups (WG) 7, 10 and 17.

EEVC WG 7 (Pedestrians) was set up in 1982 to examine how car design could take into consideration pedestrian accidents in European countries. Its report addressed, inter alia, the improvement of vehicle design and test and assessment methods. (EEVC WG 7, 1982).

At the end of 1987 EEVC Working Group 10 "Pedestrian Protection" was established. The mandate of this Working Group was:

> ..... to determine test methods and acceptance levels for assessing the protection afforded to pedestrians by the fronts of cars in an accident. The test methods should be based on sub-system tests, essentially to the bumper, bonnet leading edge and bonnet top surface. The bumper test should include the air dam; the bonnet leading edge test should include the headlight surround and the leading edge of the wings; the test to the bonnet top should include the scuttle, the lower edge of the windscreen frame and the top of the wings. Test methods should be considered that evaluate the performance of each part of the vehicle structure with respect to both child and adult pedestrians, at car to pedestrian impact speeds of 40 km/h. The different impact characteristics associated with changes in the general shape of the car front should be allowed for by variations in the test conditions (e.g. impact mass and velocity, direction of impact). (EEVC WG 17, 1998 & 2002)

Working Group 10 proposed a 40 km/h test speed with a Head Injury Criterion (HIC) value of no more than 1,000 for a 2.5 kg child headform and for a 4.8 kg adult headform. The lower leg criteria were a maximum dynamic lateral bending angle of 15 degrees, maximum shearing displacement of 6 mm and a maximum acceleration of 150 g at the top of the tibia. For the upper leg the actual impactor speed was a function of the shape of the front of the

vehicle for a vehicle impact speed of 40 km/h. The instantaneous sum of the impact forces on the impactor was not to exceed 220 Nm and the bending moment on the impactor was not to exceed 220 Nm.

A summary of the test methods and acceptance criteria proposed by WG 10 is contained in the final report (EEVC, 1994) and in a paper by the chairman. (Janssen, 1996)

In May 1997 the former members of EEVC WG10, on request of the EEVC Steering Committee, met again to discuss technical progress and new developments with respect to the EEVC pedestrian protection test methods. Based on these discussions the Steering Committee decided in June 1997 to set up a new EEVC Working Group – WG 17 "Pedestrian Safety" – with two main tasks:

> 1. Review of the EEVC WG10 test methods (final report 1994) and propose possible adjustments taking into account new and existing data in the field of accident statistics, biomechanics and test results (to be completed within one year).
>
> 2. Prepare the EEVC contribution to the IHRA working group on pedestrian safety.

With respect to the first task, WG 17 reported that:

> Recent accident statistics have been analysed, showing among other findings a decrease in the proportion of injuries caused by the bonnet leading edge of modern streamlined passenger cars. Moreover, it is found that the windscreen and A-pillars of these cars are important injury areas, not covered by the EEVC test methods. Future research in this field is recommended. (EEVC WG 17, 1998 & 2002)

WG 17 also concluded that:

> ... the test methods, (....) have existed for many years and were used in a lot of test programmes. Current changes include improvements of definitions, interpretations and test repeatability. There is no need for further validation in terms of an evaluation of the test methods using recent cars, since the test methods were designed to work for cars generally. (ibid)

The Working Group also commented on the manner in which the test methods might be introduced in a European Directive for pedestrian protection.

> If the test methods can not be introduced completely in an European Directive, i.e. if it is decided that it would be desirable to introduce the procedure progressively, there are at least three possibilities: firstly only a proportion of the test areas could be required to meet all test requirements initially, with the proportion gradually increasing to 100 per cent over a fixed period (which is the method already suggested by EEVC WG10 in 1994), secondly the acceptance limits could be introduced at a higher level initially, gradually reducing to the limits proposed in this report or thirdly, the tests could be introduced progressively. If the latter option is selected, the following priority order for the test methods is proposed by EEVC WG17:
>
> > 1. Headform to bonnet top tests (higher priority for child headform test);
> >
> > 2. Legform to bumper test (up to 500 mm bumper height, above that height an optional, alternative upper legform to bumper test);
> >
> > 3. Upper legform to bonnet leading edge test. It should be noted that these test methods are linked to each other with respect to several definitions, test areas, tools and requirements." (ibid)

2.2 ISO

In 1983 the International Standards Organisation's (ISO) Technical Committee on Road Vehicles formed a Working Group to "Develop a method for discrimination between passenger car front ends as to their relative friendliness when impacting a pedestrian". (ISO/TC22/SC10, Document N173, 1983) The Working Group (WG2) met for the first time in 1988. The secretariat is based at the Japan Society of Automotive Engineers. There was substantial common membership with EEVC Working Group 10. Consequently it is not surprising that the work programs of the two groups were similar to each other. The recommendations of the ISO Group do differ somewhat from those of WG 10, however. For example, the child and adult headforms are of the same diameter (165 mm) and 3.5 and 4.5 kg mass, respectively.

Since the late 1990s the emphasis in international activity in pedestrian safety and vehicle design has shifted from the ISO Working Group to that of the International Harmonised Research Activities program.

2.3 IHRA

The International Harmonized Research Activities (IHRA) program was proposed at the 15th International Technical Conference on the Enhanced Safety of Vehicles (ESV) held in Melbourne in 1996. The primary tasks assigned to the Pedestrian Safety Working Group (PS-WG) were:

(a) To investigate and to analyze the latest pedestrian accidents in the IHRA member countries

(b) To establish harmonized test procedures that would reflect conditions typical of the pedestrian accident environment and would include vehicle structures that can be improved for the reduction of fatalities and alleviation of severe injuries in pedestrian vs. passenger car crashes

(c) To encourage the use of the research results as the basis for future harmonized technical pedestrian safety regulations

Test procedures for child and adult head impacts and the adult leg (in the vicinity of the knee joint) have been developed by the IHRA Working Group. These procedures are similar, but not identical, to the EEVC test procedures (the headform specifications are the same as those of the ISO Working Group).

The IHRA test procedures have been developed to be suitable for vehicle impact speeds ranging from 30 to 50 km/h. For a given vehicle impact speed the speed and angle of each headform impactor is determined by reference to the results of computer modelling of the pedestrian/vehicle collision which takes into account the frontal shape of the striking vehicle. However, the computer model is still being developed and so this aspect of the test procedure that is derived it may be subject to change. The Centre for Automotive Safety Research at the University of Adelaide is involved in the work of the IHRA Group, with McLean as the Australian representative and Anderson as chairman of the computer modelling committee.

2.4 NCAP pedestrian impact test procedures

2.4.1 Euro NCAP and Australian NCAP

There are three New Car Assessment Programs (NCAP) conducting pedestrian impact tests: Euro NCAP, Australian NCAP (ANCAP) and Japan NCAP (JNCAP).

Euro NCAP test procedures are based on those developed by EEVC and ANCAP pedestrian test procedures are identical to those of Euro NCAP.

However, because many, or possibly most, current vehicles have not been designed to comply with the EEVC criteria the Euro NCAP consortium introduced the following assessment changes:

> With the current level of pedestrian protection provided by car fronts, it would be optimistic to expect protection levels to exceed those proposed by the EEVC. In order to discriminate between cars which more nearly meet the EEVC requirements from those which greatly exceed them, a lower limit has been set. This has been derived from experience gained in the early phases of Euro NCAP.
>
> From Phase 3, a sliding scale system of points scoring has been used. This involves two limits for each parameter, a more demanding limit (higher performance), beyond which a maximum score is obtained and a less demanding limit (lower performance), below which no points are scored.
>
> For each impact site in the pedestrian tests, a maximum of two points are available. Where a value falls between the two limits, the score is calculated by linear interpolation.

(See: <http://www.euroncap.com/Content-Web-Page/fb5e236e-b11b-4598-8e20-3eced15ce74e/protocols.aspx>)

The higher and lower performance limits for head protection are HIC values of 1,000 and 1,350 for an impactor speed of 40 km/h.

2.4.2 Japan NCAP

JNCAP test procedures are limited to child and adult headform tests which are similar to the Japan Standard (see below) except that the headform impact velocity has been increased from 32 km/h to 35 km/h.

(See: <http://www.nasva.go.jp/mamoru/english/2006/protect/method.html>)

3 Vehicle safety standards for pedestrian protection

Vehicle safety standards for pedestrian protection have been introduced in Europe and Japan. They are reviewed in this section of the report. Standards relating to vehicle frontal protection systems (bull bars) are reviewed in the next section.

3.1 European Union Directive

The initial proposal for a European Union Directive relating to the protection of pedestrians and other vulnerable road users in the event of a collision with a motor vehicle was based on the EEVC test methods. (EEVC WG 17, 1998 & 2002) After extensive political discussions between the car industry, government representatives and the European Commission, the following negotiated agreement was reached:

> EU Ministers have reached a political agreement on the proposed directive on pedestrian protection, as amended after the European Parliament's first reading resolution.
>
> The proposed directive, which aims to mitigate the severity of injuries to pedestrians, lays down tests and limit values for the frontal structures of motor vehicles. Every year, some 8,000 pedestrians and cyclists are killed and a further 300,000 injured on Europe's roads.
>
> In a first phase, starting in 2005, new types of vehicles must comply with two tests to protect against head and leg injuries.
>
> In a second phase, starting in 2010, four tougher tests will be required for new types of vehicles: two tests concerning head injuries and two concerning leg injuries. These tests are based on the recommendations of the European Enhanced Vehicle Safety Committee (EEVC). Within five years from the start of the second phase, all new vehicles will have to comply with these test requirements.
>
> Depending on technological progress, alternative measures to the requirements laid down in the proposal might be developed, possibly including active safety measures designed to prevent accidents altogether. A feasibility assessment will be done by 1 July 2004 on other measures that may have at least equal protective effects and the proposed technical test provisions for the second phase tests. Should the assessment show that these alternatives have at least equal protective effects, the Commission will consider relevant proposals to amend or adapt the directive.
>
> (See <http://europa.eu.int/comm/enterprise/library/enterprise-europe/news-updates/internal-market/2003/20030923.htm>)

The Directive 2003/102/EC of the European Parliament is accessible on <http://europa.eu.int/comm/enterprise/automotive/pagesbackground/pedestrianprotection/index.htm>. The preamble and the main part of the Directive, together with the technical provisions, are listed in an Attachment to this report.

The EU directive is similar to the EEVC test procedures in that the test areas do not extend beyond the rear of the bonnet. (There is an exception to this in Phase 1 of the Directive which has a requirement for an adult headform test on the windscreen, as described in the next paragraph.)

The two phases of the EU directive differ markedly with respect to the requirements for protection against pedestrian head injury from impacts with the bonnet of the vehicle. In Phase 1, there is a requirement for a child headform test using a 3.5 kg impactor of 165 mm diameter at an impactor speed of 35 km/h. The value of HPC, the Head Performance Criterion as they call it (which is identical to HIC, the Head Injury Criterion), is not to exceed 1,000 over two thirds of the bonnet test area and 2,000 over the remaining one third. There is no mandatory compliance requirement for an adult headform test. but the HPC value

resulting from a 4.8 kg headform striking the windscreen at 35 km/h must be recorded and compared with HPC 1,000. The specification for this test ensures that no contact is made with the windscreen surrounds, including the A-pillars.

In Phase 2, a child and an adult head impact test are required, each at an impact speed of 40 km/h. The child test is to be conducted with a lighter and smaller impactor than in Phase 1, (2.5 kg and 130 mm diameter), and the adult test with a 4.8 kg (165 mm) impactor. The value of HPC is not to exceed 1,000 anywhere on the bonnet test area with either impactor.

The recommendation from EEVC WG 17, quoted above, regarding possible staged introduction of their tests, was that priority be given to headform rather than legform tests, although WG 17 did acknowledge the desirability of giving precedence to the child headform test over the adult should these two tests not be introduced simultaneously.

As indicated above, the EU Directive in its present form represents the result of considerable negotiation, which is ongoing for the more demanding second phase which comes into effect in 2010. The major topics being negotiated relate to the feasibility of the EEVC test requirements with respect to production vehicles and to the contribution of pedestrian collision prevention and injury mitigation measures such as brake assist.

The feasibility assessment referred to in the previous section was conducted by TRL Limited. (Lawrence et al, 2004) Their comprehensive and detailed report, together with the industry responses, and an addendum by TRL (Hardy and Lawrence, 2005) primarily on the likely benefits of brake assist, provide an excellent account of the matters that are being considered. Lawrence et al (2004) and sections of the industry are in favour of a relaxation of some of the Phase 2 requirements on the grounds of technical feasibility (see Lawrence et al, Chapter 11, pp 201-210 and Hardy and Lawrence, p 22).

3.2 Japan Technical Standard

The Japan Ministry of Land, Infrastructure and Transport (MLIT) has introduced a "Technical Standard for Protection of Heads of Pedestrians" applicable to new passenger cars and derivatives from 1 September 2005, and to existing models from 1 September 2010. For other types of vehicle, such as SUVs, trucks, cab-over, hybrid and extremely low height vehicles, the corresponding dates for new and existing vehicles are 1 September 2007 and 1 September 2012. An English language version of the Standard is accessible as Attachment 99 on the following website: <http://www.unece.org/trans/doc/2004/wp29grsp/ps-95.pdf>. (Note that there is an error in that Attachment. The scope (1) should read ....passenger capacity of 10 persons or more.... not "or less.")

This Standard is based on the headform impact tests proposed by the IHRA Pedestrian Safety Working Group.

The Japan Standard requires tests using a child and an adult headform according to the IHRA specification of a common diameter of 165 mm and a mass of 3.5 and 4.5 kg respectively.

The headform impact speed is 32 km/h, and the angle of its trajectory is dependent on the shape of the front of the vehicle, namely sedan, SUV and "one-box" (typically light vans). The values of these parameters are derived from computer simulations conducted for the IHRA Working Group. As indicated above, the computer model is still being developed and so it is possible that the headform impact speeds in the IHRA test procedure may change. However, there is no indication that that would affect the test procedures in the Japan Standard.

At present, it is expected that the Japan Standard will be aligned in terms of test requirements and compliance criteria with a Global technical regulation (see below).

3.3 Proposed draft Global Technical Regulation on pedestrian protection

The Japanese Government submitted a proposal to the UN/ECE World Forum for Harmonization of Vehicle Regulations, more commonly known as WP29, for a draft Global Technical Regulation (GTR) for pedestrian protection. WP29 referred it to GRSP, the working group on passive safety, which convened an Informal Group under the technical sponsorship of Japan. The initial meeting of the Informal Group was held in 2002.

> The purpose of this regulation is to bring about an improvement in the construction of the fronts of vehicles and, in particular, those areas which have been most frequently identified as causing injury when in collision with a pedestrian or other vulnerable road user. The tests required are limited to those elements of the child and adult body most frequently identified as sustaining injury, i.e. the adult head and leg and the child head. To achieve the required improvements in construction of vehicles, the tests are based on sub-system component impactors representing those body regions and impacted at speeds representative of that below which the majority of injuries occur.

(The above description can be found in PS /143/ Rev.1:
<http://www.unece.org/trans/main/wp29/wp29wgs/wp29grsp/pedestrian_8.html>)

Unlike the EU Directive, this proposed GTR does not include reference to pedestrian/vehicle collision avoidance measures:

> There was discussion on whether the proposed pedestrian gtr should regulate passive and/or active safety systems. Active safety systems such as brake assist, anti-lock brakes and day-light running lights were suggested as solutions for the reduction of pedestrian injuries, but it was ultimately counselled by GRSP and WP.29 to concentrate on passive systems for this gtr as this is the main domain of expertise of the GRSP experts and only to provide advice on the use of active systems. (ibid, page 7)

At the present stage this draft proposal refers to cars and car derivatives of a mass less than 2,500 kg. It comprises child and adult headform tests at 32 km/h with a maximum HIC value of 1,000 to the bonnet (as for the Japan Standard) and, where indicated by the wrap around distance to the rear reference line, to the windscreen (excluding any impact with the windscreen surround, including the A-pillars).

There is also a lower legform to bumper test at a speed of 40 km/h using, at this stage, a rigid impactor to the IHRA specification. Some members of the Informal Group strongly prefer a "flexible" lower legform impactor (FlexPLI), developed in Japan, to the TRL-developed "rigid" impactor which is specified by EEVC, EU, ISO, and IHRA. It is proposed that a Technical Evaluation group be formed to decide whether FlexPLI can be used for "testing and compliance verification purposes" and, if it can, that it replace the "rigid" impactor.

There is no provision for an upper legform test at this stage for the following reasons:

> Test results using the proposed upper legform to bonnet leading edge prescriptions are contradictory to the actual situation encountered in many real world accidents. This fact together with the existing concerns on the impact energy, the test tool biofidelity and the injury acceptance levels, caused the group to exclude the test at this stage. However, the group recognises that this test may have potential value and requests IHRA/PS to carry out further research into the needs and methods for this test. (ibid, page 9)

3.3.1 Regulatory impact and economic effectiveness

The tests in this GTR are all technically and economically feasible as outlined in section V regulatory impact and economic effectiveness, but it will be the decision of each jurisdiction to determine whether the benefits achieved by requiring these tests justify the costs of the improvements. Based on this determination, a jurisdiction can choose to limit the application in their own regulation to specific vehicle categories, it may also choose to limit the weight of the vehicle to which it applies, and/or it may decide to phase in the regulations over time. (ibid, page 8)

3.4 Pedestrian Safety Rulemaking in Korea

Although no specific notification has been given of the introduction of a pedestrian safety regulation in the Republic of Korea it is likely that a standard for pedestrian head protection will be introduced in 2010 and for leg protection in 2009. (Presentation by the Ministry of Construction and Transportation to the GRSP Informal Group on pedestrian protection in 2004.)

4 Vehicle safety standards for bull bars

4.1 Proposed European Union Directive

The UK Department of Environment, Transport and the Regions commissioned the Transport Research Laboratory to conduct an extensive series of tests on bull bars to the requirements of the EEVC pedestrian protection test methods. The results of these tests showed that it is feasible to make bull bars to meet the requirements of a 40 km/h sub-systems test method. (Lawrence et al, 2000)

The United Kingdom then prepared an outline proposal for discussion of a provisional draft European Commission Directive relating to the external projections of motor vehicles. This led on to the publication in 2003 of a proposal for an EU Directive relating to the use of frontal protection systems on motor vehicles. This proposal, and the associated technical provisions, are accessible on the following websites:

<http://europa.eu.int/prelex/detail_dossier_real.cfm?CL=en&DosId=185890>
<http://europa.eu.int/comm/enterprise/automotive/directives/proposals.htm>.

A summary of the proposed Directive is as follows:

> PURPOSE : to establish technical requirements for the type-approval of motor vehicles as regards frontal protection systems supplied as original equipment fitted to vehicles or as separate technical units.
>
> PROPOSED ACT : Directive of the European Parliament and of the Council.
>
> CONTENT : Systems providing additional frontal protection of motor vehicles ("frontal protection systems") have been increasingly used in recent years. Some of these systems constitute a risk to the safety of pedestrians and other road users in the case of a collision with a motor vehicle. This proposal aims to provide added protection to pedestrians and other vulnerable road users in the event of a collision with a motor vehicle fitted with a frontal protection system. It lays down requirements that must be complied with by frontal protection systems either as originally fitted to a vehicle or put on the market as separate technical units. As the construction of motor vehicles is covered by framework Directive 70/156/EEC establishing the EC type-approval system for vehicles, components and separate technical units, the proposed requirements will also be part of that system.
>
> Road accident statistics indicate that a significant proportion of casualties involve pedestrians and cyclists who are injured as a result of contact with a moving vehicle and notably the frontal structures of passenger cars.
>
> The Parliament, in its report of June 2002, invited the Commission to propose legislation banning rigid bull bars supplied as after market equipment.
>
> The scope of this Directive has been limited to vehicles of categories M1 and N1 up to 3.5 tonnes: since these vehicle categories represent the vast majority of vehicles currently in use, the proposed measures will have the widest practicable effect in reducing pedestrian injuries.
>
> The prescribed requirements for frontal protection systems are laid down in the form of tests, which are described in Section 4 of Annex I to the proposal.
>
> As of 1 July 2005, Member States will no longer grant EC type-approval for a type of vehicle on grounds relating to the fitting of frontal protection systems, or for a type of frontal protection system as separate technical unit, if the requirements of the Annexes of this Directive are not fulfilled. As of 1 January 2006 all new vehicles that are fitted with frontal protection systems and all new frontal protection systems put

on the market will have to comply with the proposed requirements.

The requirements will be tested according to detailed technical prescriptions which will be set out by the Commission in accordance with Article 13 of Directive 70/156/EEC.

<http://www2.europarl.eu.int/oeil/FindByProcnum.do?lang=2&procnum=COD/2003/0226>

The test procedures specify a child headform test at 40 km/h with a HIC limit of 1,000 to those parts of a vehicle frontal protection system that are more than 900 mm above the ground. The legform tests, which are conducted at a vehicle impact velocity of 40 km/h, can include both a lower and an upper legform test. However, if the frontal protection system lower "bumper" height is more than 500 m at the test position the manufacturer may elect to perform an upper rather than a lower legform test.

At the time of preparation of this review there had not been a decision by the European Parliament on this proposed Directive. There is some concern that the two classes of vehicle referred to, M1 and N1, are passenger cars and passenger car derivatives and therefore do not include some vans and 4WDs or SUVs. There is also consideration being given to requiring the level of protection provided a pedestrian by a frontal protection system to be shown to be better than that of the vehicle to which it is fitted.

4.2 Australian Standard for Motor Vehicle Frontal Protection Systems

The Australian Standard (AS 4876.1–2002, Motor vehicle frontal protection systems. Part 1: Road User Protection) is similar to the proposed EU Directive in that it requires child headform tests on those parts of the vehicle frontal protection system (VFPS) that are above a specified height. Apart from that similarity there is little in common between the two approaches.

As noted above, the draft EU Directive child headform test is to be conducted on parts of the VFPS that are more than 900 mm above the ground at a speed of 40 km/h with a resultant HIC value of no more than 1,000. The Australian Standard specifies a child headform test on parts of the VFPS that are more than 1,000 mm above the ground at a speed of 30 km/h with a resultant HIC value of no more than 1,500.

There is no requirement for a legform test in Australian Standard AS 4876.1–2002.

Neither the Australian Standard nor the proposed EU Directive take into account possible effects on the risk of abdominal injuries and on the overall kinematics of the pedestrian/vehicle collision resulting from the top rail of a frontal protection system striking an adult pedestrian above the top of the pelvis.

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Attachment

DIRECTIVE 2003/102/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL

of 17 November 2003

relating to the protection of pedestrians and other vulnerable road users before and in the event of a collision with a motor vehicle and amending Council Directive 70/156/EEC

THE EUROPEAN PARLIAMENT AND THE COUNCIL OF THE EUROPEAN UNION,

Having regard to the Treaty establishing the European Community, and in particular Article 95 thereof,

Having regard to the proposal from the Commission,

Having regard to the opinion of the European Economic and Social Committee [1],

Acting in accordance with the procedure laid down in Article 251 of the Treaty [2],

Whereas:

(1) In order to reduce the number of road accident casualties in the Community, it is necessary to introduce measures so as to improve the protection of pedestrians and other vulnerable road users before and in the event of a collision with the front of a motor vehicle.

(2) A package of passive and active measures for improving safety (avoidance of accidents and reduction of secondary effects by traffic calming and infrastructure improvements) for vulnerable road users, such as pedestrians, cyclists and motorcyclists, is urgently needed in the framework of the road safety action programme.

(3) The internal market comprises an area without internal frontiers in which the free movement of goods, persons, services and capital must be ensured and to that end a Community type-approval system for motor vehicles is in place; the technical requirements for the type-approval of motor vehicles with regard to pedestrian protection should be harmonised to avoid the adoption of requirements that differ from one Member State to another and to ensure the proper functioning of the internal market.

(4) Pedestrian protection objectives can be achieved by a combination of active and passive safety measures; the recommendations by the European Enhanced Vehicle-Safety Committee (EEVC) of June 1999 are the subject of a wide consensus in this area; those recommendations propose performance requirements for the frontal structures of certain categories of motor vehicles to reduce their aggressiveness; this Directive presents tests and limit values based on the EEVC recommendations.

(5) The Commission should examine the feasibility of extending the scope of this Directive to vehicles with a maximum mass of up to 3,5 tonnes, and report its findings to the European Parliament and to the Council.

(6) This Directive should be considered as one element of a broader package of measures, to be undertaken by the Community, the industry and the relevant authorities of the Member States, on the basis of exchanges in best practice, in order to address pre-crash (active), in-crash (passive), and post-crash safety of pedestrians and other vulnerable road users, with respect to road users, vehicles and infrastructure.

(7) In view of the speed of technological development in this area, alternative measures at least equivalent in terms of actual effectiveness to the requirements of this Directive — either passive or a combination of active and passive measures — may be proposed by the industry and shall be assessed following a feasibility study carried out by independent experts by 1 July 2004; the introduction of alternative measures at least equivalent in terms of actual effectiveness would require adapting or amending this Directive.

(8) Because of the ongoing research and technical progress in the area of pedestrian protection, it is appropriate to introduce a degree of flexibility in this field. Accordingly, this Directive should establish the fundamental provisions regarding pedestrian protection in the form of tests to be complied with by new types of vehicles and by new vehicles. The technical prescriptions for the application of such tests should be adopted by Commission decision.

(9) The rapidly advancing technology in active safety means that collision mitigation and avoidance systems could provide major safety benefits, for example in reducing collision speed and adjusting impact direction. The development of such technologies should be encouraged by this Directive.

(10) The associations representing the European, Japanese and Korean motor vehicle manufacturers have made commitments to start applying the EEVC recommendations concerning limit values and tests, or agreed alternative measures of at least equivalent effect, as from 2010, and a first set of limit values and tests as from 2005 to new types of vehicles and to apply the first set of tests to 80 % of all new vehicles as from 1 July 2010, to 90 % of all new vehicles as from 1 July 2011 and to all new vehicles as from 31 December 2012.

[1] OJ C 234, 30.9.2003, p. 10.
[2] Opinion of the European Parliament of 3 July 2003 (not yet published in the Official Journal) and Council Decision of 4 November 2003 (not yet published in the Official Journal).

(11) This Directive should also contribute to establishing a high level of protection in the context of the international harmonisation of legislation in this area, which started under the 1998 Agreement of the UN/ECE concerning the establishment of global technical regulations for wheeled vehicles, equipment and parts which can be fitted and/or be used on wheeled vehicles.

(12) This Directive is one of the separate Directives which have to be complied with in order to conform to the EC type-approval procedure established by Council Directive 70/156/EEC of 6 February 1970 on the approximation of the laws of the Member States relating to the type-approval of motor vehicles and their trailers [1].

(13) Directive 70/156/EEC should therefore be amended accordingly,

HAVE ADOPTED THIS DIRECTIVE:

Article 1

1. This Directive shall apply to the frontal surfaces of vehicles. For the purpose of this Directive, 'vehicle' means any motor vehicle as defined in Article 2 of and Annex II to Directive 70/156/EEC, of category M1, of a maximum mass not exceeding 2,5 tonnes, and N1 derived from M1, of a maximum mass not exceeding 2,5 tonnes.

2. The purpose of this Directive is to reduce injuries to pedestrians and other vulnerable road users who are hit by the frontal surfaces of the vehicles defined in paragraph 1.

Article 2

1. With effect from 1 January 2004 no Member State may, on grounds relating to pedestrian protection:

— refuse, in respect of a type of vehicle, to grant EC type-approval, or national type-approval, or

— prohibit the registration, sale or entry into service of vehicles,

provided that the vehicles comply with the technical provisions set out in section 3.1. or 3.2. of Annex I.

2. With effect from 1 October 2005, Member States shall no longer grant:

— EC type-approval, or

— national type-approval,

except where the provisions of Article 8(2) of Directive 70/156/EEC are invoked, for any type of vehicle on grounds relating to pedestrian protection if the technical provisions set out in section 3.1. or 3.2. of Annex I are not complied with.

3. Paragraph 2 shall not apply to vehicles which do not differ with respect to their essential aspects of bodywork construction and design forward of the A pillars from vehicle types which have been granted EC type-approval or national type-approval before 1 October 2005 and which have not already been approved under this Directive.

4. With effect from 1 September 2010, Member States shall no longer grant:

— EC type-approval, or

— national type-approval,

except where the provisions of Article 8(2) of Directive 70/156/EEC are invoked, for any type of vehicle on grounds relating to pedestrian protection if the technical provisions set out in section 3.2. of Annex I to this Directive are not complied with.

5. With effect from 31 December 2012, Member States shall:

— consider certificates of conformity which accompany new vehicles in accordance with the provisions of Directive 70/156/EEC to be no longer valid for the purposes of Article 7(1) of that Directive, and

— prohibit the registration, sale and entry into service of new vehicles which are not accompanied by a certificate of conformity in accordance with Directive 70/156/EEC,

on grounds relating to pedestrian protection if the technical provisions set out in section 3.1. or 3.2. of Annex I are not complied with.

6. With effect from 1 September 2015, Member States shall:

— consider certificates of conformity which accompany new vehicles in accordance with the provisions of Directive 70/156/EEC to be no longer valid for the purposes of Article 7(1) of that Directive, and

— prohibit the registration, sale and entry into service of new vehicles which are not accompanied by a certificate of conformity in accordance with Directive 70/156/EEC,

on grounds relating to pedestrian protection if the technical provisions set out in section 3.2. of Annex I are not complied with.

Article 3

Subject to the provisions of Article 2, Member States shall ensure that the tests laid down in section 3.1. or 3.2. of Annex I are carried out in accordance with the technical prescriptions to be specified by Commission decision.

Article 4

Every month the approval authorities of the Member States shall each send to the Commission a copy of the type-approval certificate, the model for which is set out in Appendix 2 to Annex II, in respect of each vehicle they have approved in accordance with this Directive during that month.

[1] OJ L 42, 23.2.1970, p. 1. Directive as last amended by Regulation (EC) No 807/2003 (OJ L 122, 16.5.2003, p. 36).

Article 5

1. The Commission, acting on the basis of relevant information communicated by the approval authorities and interested parties as well as of independent studies, shall monitor the progress made by the industry in the area of pedestrian protection, and shall carry out, by 1 July 2004, an independent feasibility assessment concerning the provisions of Annex I, section 3.2, and in particular alternative measures — either passive or a combination of active and passive measures — which are at least equivalent in terms of actual effectiveness. The feasibility study shall be based, *inter alia*, on practical tests and independent scientific studies.

2. If, as a result of the feasibility assessment referred to in paragraph 1, it is considered necessary to adapt the provisions of Annex I, section 3.2, to include a combination of passive and active measures which afford at least the same level of protection as the existing provisions of Annex I, section 3.2, the Commission shall submit a proposal to the European Parliament and the Council to amend this Directive accordingly.

3. As long as adaptation of this Directive is restricted to the introduction of alternative passive measures which afford at least the same level of protection as the existing provisions of Annex I, section 3.2, such adaptation may be carried out by the Committee for Adaptation to Technical Progress, in accordance with the procedure laid down in Article 13 of Directive 70/156/EEC.

4. Before 1 April 2006, and every two years thereafter, the Commission shall report to the European Parliament and the Council on the results of the monitoring referred to in paragraph 1.

Article 6

Directive 70/156/EEC is hereby amended as follows:

1. The following points shall be inserted in Annex I:

'9.23. Pedestrian protection

9.23.1. A detailed description, including photographs and/or drawings, of the vehicle with respect to the structure, the dimensions, the relevant reference lines and the constituent materials of the frontal part of the vehicle (interior and exterior) shall be provided. This description should include detail of any active protection system installed.'

2. The following points shall be inserted in Section A of Annex III:

'9.23. Pedestrian protection

9.23.1. A detailed description, including photographs and/or drawings, of the vehicle with respect to the structure, the dimensions, the relevant reference lines and the constituent materials of the frontal part of the vehicle (interior and exterior) shall be provided. This description should include detail of any active protection system installed.'

3. The following item 58 and footnotes shall be inserted in Part I of Annex IV:

Subject	Directive number	Official Journal reference	Applicability									
			M_1	M_2	M_3	N_1	N_2	N_3	O_1	O_2	O_3	O_4
'58 Pedestrian protection	2003/102/EC	OJ L 321, 6.12.2003, p. 15.	X (6)			X (6) (7)						

(6) not exceeding 2,5 tonnes maximum mass.
(7) derived from M_1 category vehicles.'

ANNEX I

TECHNICAL PROVISIONS

1. SCOPE

The Directive applies to the frontal surfaces of vehicles. For the purpose of this Directive, vehicle means any motor vehicle as defined in Article 2 of and Annex II to Directive 70/156/EEC of category M_1 of a maximum mass not exceeding 2,5 tonnes and to N_1 vehicles derived from M_1, of a maximum mass not exceeding 2,5 tonnes.

2. DEFINITIONS

For the purposes of this Directive:

2.1. 'A-pillar' means the foremost and outermost roof support extending from the chassis to the roof of the vehicle.

2.2. 'Bumper' means the front, lower, outer structure of a vehicle. It includes all structures that are intended to give protection to a vehicle when involved in a low speed frontal collision with another vehicle and also any attachments to this structure.

2.3. 'Bonnet leading edge' means the front upper outer structure including the bonnet and wings, the upper and side members of the headlight surround and any other attachments.

2.4. 'Bonnet top' means the outer structure that includes the upper surface of all outer structures except the windscreen, the A-pillars and structures rearward of them. It therefore includes, but is not limited to, the bonnet, wings, scuttle, wiper spindle and lower windscreen frame.

2.5. 'Head performance criterion (HPC)' is a calculation, over a specified time period, of the maximum resultant acceleration experienced during the impact.

2.6. 'Windscreen' means the frontal glazing of the vehicle which meets all the relevant requirements of Annex I to Directive 77/649/EEC [1].

2.7. 'Vehicle Type' means a category of vehicles which, forward of the A-pillars, do not differ in such essential respects as:

— the structure,

— the main dimensions,

— the materials of the outer surfaces of the vehicle,

— the component arrangement (external or internal),

insofar as they may be considered to have a negative effect on the results of the impact tests prescribed in this Directive;

2.8. 'Maximum mass' means the technically permissible maximum laden mass stated by the manufacturer pursuant to paragraph 2.8 of Annex I to Directive 70/156/EEC.

3. TEST PROVISIONS

3.1. The following tests are required to be carried out; however, the limit values specified in items 3.1.3 and 3.1.4 are required for monitoring purposes only.

3.1.1. Legform to bumper: one of the legform tests described in 3.1.1.1 or 3.1.1.2 is required to be performed:

3.1.1.1. Lower legform to bumper: The test is performed at an impact speed of 40 km/h. The maximum dynamic knee bending angle shall not exceed 21,0°, the maximum dynamic knee shearing displacement shall not exceed 6,0 mm, and the acceleration measured at the upper end of the tibia shall not exceed 200 g;

3.1.1.2. Upper legform to bumper: The test is performed at an impact speed of 40 km/h. The instantaneous sum of the impact forces with respect to time shall not exceed 7,5 kN and the bending moment on the test impactor shall not exceed 510 Nm.

[1] Council Directive 77/649/EEC of 27 September 1977 on the approximation of the laws of the Member States relating to the field of vision of motor vehicle drivers (OJ L 267, 19.10.1977, p. 1). Directive as last amended by Commission Directive 90/630/EEC (OJ L 341, 6.12.1990, p. 20).

3.1.2. Child/small adult headform to bonnet top: The test is performed at an impact speed of 35 km/h using a 3,5 kg test impactor. The head performance criterion (HPC) shall not exceed 1 000 over 2/3 of the bonnet test area and 2 000 for the remaining 1/3 of the bonnet test area.

3.1.3. Upper legform to bonnet leading edge: The test is performed at an impact speed up to 40 km/h. The instantaneous sum of the impact forces with respect to time should not exceed a possible target of 5,0 kN and the bending moment on the test impactor shall be recorded and compared with the possible target of 300 Nm.

3.1.4. Adult headform to windscreen: The test is performed at an impact speed of 35 km/h using a 4,8 kg test impactor. The HPC shall be recorded and compared with the possible target of 1 000.

3.2. The following tests are required to be carried out.

3.2.1. Legform to bumper: One of the legform tests described in 3.2.1.1 or 3.2.1.2 is required to be performed:

3.2.1.1. Lower legform to bumper: The test is performed at an impact speed of 40 km/h. The maximum dynamic knee bending angle shall not exceed 15,0°, the maximum dynamic knee shearing displacement shall not exceed 6,0 mm, and the acceleration measured at the upper end of the tibia shall not exceed 150 g.

3.2.1.2. Upper legform to bumper: The test is performed at an impact speed of 40 km/h. The instantaneous sum of the impact forces with respect to time shall not exceed 5,0 kN and the bending moment on the test impactor shall not exceed 300 Nm.

3.2.2. Child headform to bonnet top: The test is performed at an impact speed of 40 km/h using a 2,5 kg test impactor. The HPC shall not exceed 1 000 for the whole of the bonnet test area.

3.2.3. Upper legform to bonnet leading edge: The test is performed at an impact speed up to 40 km/h. The instantaneous sum of the impact forces with respect to time shall not exceed 5,0 kN and the bending moment on the test impactor shall not exceed 300 Nm.

3.2.4. Adult headform to bonnet top: The test performed at an impact speed of 40 km/h using a 4,8 kg test impactor. The HPC shall not exceed 1 000 for the whole bonnet test area.