INTRODUCTION

Pedestrian Safety Global Technical Regulation Preamble

A. STATEMENT OF TECHNICAL RATIONALE AND JUSTIFICATION

I. INTRODUCTION

(a) Pedestrian Accident situation and its analysis

Collected road accident statistics indicate that a significant proportion of road casualties are pedestrians and cyclists who are injured as a result of contact with a moving vehicle.

The majority of these injuries are caused by being struck by the front structure of the vehicle. Most of these accidents take place in urban areas where serious or fatal injuries can be sustained at relatively low speed, particularly in the case of children.

The group collected data from IHRA (International Harmonised Research Agenda) (INF GR/PS/3 and 31), Germany (INF GR/PS/12, 13 and 25), Italy (INF GR/PS/14), the UN ECE (INF GR/PS/15), Spain (INF GR/PS/16), ACEA (INF GR/PS/17), Canada (INF GR/PS/20), the Netherlands (INF GR/PS/21), Sweden (INF GR/PS/41) and Korea (INF GR/PS/70). This data showed that every year in the European Union about 8000 pedestrians and cyclists are killed and about 300,000 injured; in North America around 5000 pedestrians are killed and 85,000 injured; in Japan 3300 pedestrians and cyclists are killed and 27,000 seriously injured; in Korea around 3600 pedestrians are killed and 90,000 injured.

For a detailed analysis, only the IHRA Pedestrian Safety working group (IHRA/PS) can provide full accident study results. The group used the IHRA data as the basis for its study. The data was sourced from Australia, Germany, Japan and the United States.

The following are the IHRA/PS study results.

(i) Distribution of the injuries

Comparing the ages of those involved, statistics show the highest frequency of accidents is for children of 5 to 9 years old, and for adults over 60 years old. Children (aged 15 and under) account for nearly one-third of all injuries in the dataset, even though they constitute only 18 per cent of the population in the four countries included in the IHRA data.

The frequency of fatal and serious injuries (AIS 2-6) is highest for the child and adult head and adult leg body regions.

Each of these body regions covers more than 30 per cent of total accidents and the group believes it should focus on protecting these body regions.

For the vehicle parts, the major sources of adult head injuries are the top surface of bonnet/wing and windscreen area. For the child head injuries, this is the top surface of the bonnet/wing. For the adult leg injury, the major source is the front bumper of vehicles.

(ii) Crash Speeds

Nevertheless, it is considered that there is scope to mitigate the severity of injuries to pedestrians by improving the front structures of motor vehicles. Crash speeds between vehicles and pedestrians are collected from pedestrian accident data and the cumulative frequency of the crash speeds shows that a crash speed of up to 40 km/h can cover more than 75 per cent of total pedestrian injuries in all regions. If a speed of up to 40 km/h is considered, it will significantly reduce the levels of injury sustained by pedestrians involved in frontal impacts with motor vehicles.

(iii) Targeted motor vehicle categories

Clearly the maximum benefit from making vehicles pedestrian friendly would occur if all types of vehicles comply with these technical provisions, but it is recognized that their application to heavier vehicles (large trucks and buses) would be of limited value and may not be technically appropriate in their present form. For this reason, the scope of application will be limited to passenger cars, sport utility vehicles (SUV), light trucks and other light commercial vehicles. 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.

(b) Other safety measures

The group, taking note of the terms of reference, also considered the issue of other safety measures, such as road infrastructure measures, in addition to passive safety measures on the vehicle itself.

The group recognized that such other active safety measures are not within its field of competence but, at the same time, agreed that such issues should be brought to the attention of WP.29 and AC.3.

As pointed out by several experts, including OICA, pedestrian protection could be considered as a whole, including active and passive measures. Some experts noted that consideration of other safety measures, if properly balanced with the passive safety requirements, might help in ensuring that the vehicle passive safety requirements are kept at a realistic and feasible level.

OICA, in particular, mentioned brake assist systems which can, in emergency situations, substantially improve the braking performance and consequently reduce the impact speed when the impact is unavoidable. A study on the effectiveness of such a system was presented by OICA using the GIDAS (German In-Depth Accident Studies) database (INF GR/PS/25). This showed that if the vehicle speed is 50 km/h at the start of braking, the collision speed (car versus pedestrian) would be reduced to 40 km/h in general, to 35 km/h for an experienced driver and to 25 km/h for cars equipped with brake assist systems. Another study performed by the Technical University of Dresden on behalf of ACEA was presented by OICA (INF GR/PS/92). This study confirmed the positive effect of brake assist systems on pedestrian fatalities and injuries.

OICA also pointed to the importance of the infrastructure and presented the results of a 1998 study conducted on behalf of ACEA by the consultants ORIENTATIONS (F) and TMS Consultancy (UK) (INF GR/PS/29). This study, which evaluated the effect of infrastructural measures based on real data evaluations, concluded that such measures could dramatically reduce the number of pedestrian victims (fatalities/injuries) at low cost.

While it was agreed that such infrastructure measures were not within the remit of the group, it was agreed that it could be useful and efficient to inform WP.29/AC.3 as well as other authorities of the need to take these issues into account for real world safety improvements. The group also noted the importance of educational measures as well as the need to enforce existing road traffic legislation.

(c) Summary: description of the proposed regulation

Through the pedestrian accidents analysis, it has been concluded that child and adult heads and adult legs are the body regions to be most affected by contact with the front end of vehicles.

On vehicles themselves it has been seen that the bonnet top, the windscreen and the A-pillars are the vehicle regions mostly identified with a high potential for contact.

According to the IHRA/PS study, the above-mentioned areas can cover more than 65 per cent of the fatal and serious injuries.

The shape of the vehicle was also discussed as to its possible influence on the injury levels. Information on vehicle shapes was also provided by the IHRA/PS group and covered all major regions of the world.

The crash speed to be considered is 40 km/h which provides good coverage (more than 75 per cent of the pedestrian injured accidents reported by IHRA/PS) of the injury frequency.

Based on these study results, the informal group prioritized the development of the test procedures, and has developed test procedures for adult and child head protection and adult leg protection. To develop these test procedures, the group carefully studied the availability of the pedestrian dummy as an alternative method for the test procedures. Presently, there is no test dummy which could be considered suitable for regulatory use and so this group decided to select subsystem test methods which have the necessary reliability, repeatability and simplicity. In addition, there is ready availability of subsystem test impactors.

The group accepted these decisions and agreed on them as the basis for the development of the gtr.

II. PROCEDURAL BACKGROUND

During the one-hundred-and-twenty-sixth session of WP.29 in March 2002, AC.3 concluded their considerations of priorities for developing future global technical regulations. WP.29 adopted the 1998 Global Agreement Programme of Work, which included pedestrian safety, and decided to start the work on pedestrian safety at the thirty-first session of GRSP in May 2002, by creating an informal group to draft the gtr. The formal proposal to develop a gtr (WP.29/AC.3/7) was considered and adopted by the AC.3 at its tenth session, in March 2004. It is based on document TRANS/WP.29/2004/26, which had been submitted by the European Commission, which is the technical sponsor of the project.

Informal document 10 of the thirty-first session of GRSP lays down the terms of reference of the group and the document was adopted by GRSP (INF GR/PS/2).

Informal document 7 of the thirty-second session of GRSP reported on the result of the first meeting of the informal group (INF GR/PS/9).

Informal document 2 of the thirty-third session of GRSP (INF GR/PS/47 Rev1) was the first preliminary report of the informal group and responds to paragraph 5 of documents TRANS/WP.29/2002/24 and TRANS/WP.29/2002/49 as adopted by AC.3 and endorsed during the one-hundred-and-twenty-seventh session of WP.29. The documents were consolidated in the final document TRANS/WP.29/882. The preliminary report was adopted as WP.29/2003/99 by AC.3 in November 2003.

Informal document 2 of the thirty-fourth session of GRSP reported on the action plan of the informal group (INF GR/PS/62).

Informal document 5 of the thirty-fifth session of GRSP was the second preliminary report of the informal group (INF GR/PS/86 Rev2 and PS/88). This report was considered by AC.3 in June 2004 as informal document WP.29-133-7.

Informal document 1 of the thirty-sixth session of GRSP was the first draft gtr of the informal group (INF GR/PS/116).

TRANS/WP.29/GRSP/2005/3 was proposed at the thirty-seventh session of GRSP and was a revised draft gtr including the preamble, of the informal group (INF GR/PS/117).

The group has held the following meetings:

- 4-5 September, 2002, Paris
- 10 December, 2002, Geneva
- 15-16 January, 2003, Santa Oliva
- 15-16 May, 2003, Tokyo
- 10-12 September, 2003, Ottawa
- 24-26 February, 2004, Paris
- 28-30 September, 2004, Paris
- 11-13 July, 2005, Brussels
- 5-6 December, 2005, Geneva
- 16-19 January, 2006, Washington DC

The meetings were attended by representatives of:

The Netherlands, France, Germany, Canada, EC, Spain, Japan, USA, Korea, Italy, Turkey, EEVC, CI, CLEPA and OICA.

The meetings were chaired by Mr. Mizuno (Japan) and Mr. Friedel/Mr. Cesari (EC) whilst the secretariat was provided by Mr. Van der Plas (OICA).

III. EXISTING REGULATIONS, DIRECTIVES, AND INTERNATIONAL VOLUNTARY STANDARDS

At the present time, there are no regulations concerning the provision of improved protection for pedestrians and other vulnerable road users in the Compendium of Candidates.

The following is a summary of national and regional legislation and of work in international fora:

The Japanese Government has established a regulation on pedestrian protection. The regulation addresses the issues of providing protection for the child and adult heads. It applies to passenger cars with up to 10 seats and to small trucks of up to 2500 kg gross vehicle weight with application from 2005 for new vehicle types and from 2010 for existing vehicle types (certain other vehicles have a timetable which is postponed by two years). The regulation requires compliance with test requirements using representative head impactors.

The European Parliament and Council adopted the Directive 2003/102/EC which provides for the introduction of requirements for leg injuries, upper leg injuries and adult and child head injuries. The Directive and its requirements are incorporated into Community legislation under the European Union whole vehicle type approval system set up by EU Framework Directive 70/156/EEC. It applies to passenger cars of category M_1 and to light commercial vehicles derived from passenger cars of M_1 category, both up to 2500 kg gross vehicle weight, with application dates in two phases starting in 2005 and 2010. The requirements and the tests are based on the research results that were published by EEVC in the 1990es and that were introduced in a less severe form for the first phase and in the originally proposed form for the second phase. However, since EEVC results never have been fully accepted by all involved parties, the Directive provided for a review of the feasibility of the requirements of the second phase in 2004. This feasibility review has taken place and will result in amendments to the European requirements in its second phase, starting in 2010.

Canada is currently reviewing their bumper regulation. The Canadian bumper regulation is one of the most stringent in the world (all the safety features of the vehicle have to be functional after an 8 km/h impact). In addition Canada is investigating the effect of bumper design on different leg test devices (TRL legform impactor; Polar dummy and flexible pedestrian legform impactor Flex-PLI).

In the 1980’s, NHTSA had ongoing pedestrian protection programmes in two areas:
(a) pedestrian leg impacts; and
(b) child and adult pedestrian head and upper body impacts. NHTSA published an NPRM (Notice of Proposed Rulemaking) on improved pedestrian leg protection in 1981 (46 FR 7015). The NPRM proposed to limit the amount of force that could be exerted by a vehicle front structure, particularly the bumper, on an adult pedestrian’s leg in a crash. The proposed test requirement involved striking a car (at a speed up to 20 miles per hour (mph)) with a device designed to simulate the impact response of a pedestrian’s leg. The NPRM proposed limits on the simulator’s impact acceleration response and rebound velocity that were intended to reduce the severity of a pedestrian’s injury.
After the 1981 NPRM was published, a trend emerged toward lower passenger car front structures ("profiles"). The pedestrian leg protection rulemaking was terminated in 1991 when NHTSA determined that a bumper that had been identified in the NPRM as providing potential benefit did not in fact reduce the injury severity to the leg when the bumper was installed on

passenger cars with lower profiles. 69 FR 14495; April 10, 1991. "Absent data showing that vehicles that meet the requirements proposed by the NPRM would provide improved protection, the agency has no reason to mandate the soft bumper." (69 FR at 14496.)
Nonetheless, NHTSA's research on pedestrian head and upper body protection continued into the 1990's. The agency developed techniques for simulating pedestrian head impacts on vehicle surfaces. A pedestrian head impact simulator was developed, consisting of a variable mass headform on an impacting ram. Accident reconstruction testing enabled the agency to derive an injury criterion from injury severity. NHTSA tested production vehicle hoods, fenders and faces (grilles, headlight areas, leading edges of hoods and fenders) to determine the head injury potential of common vehicle hood, fender and face impact regions, and to understand how specific geometric and/or material characteristics influence injury severity. Research was also conducted to understand how those characteristics could be modified to reduce the severity of head impacts 1/ 2/.
The US pedestrian protection research programme continues today, with much of the effort being supportive of the IHRA objectives. Current activities include (1) pedestrian field data analysis to develop test conditions, (2) evaluation of pedestrian head and leg test tools, (3) experimental impact testing of vehicle structures to assess aggressivity, (4) pedestrian case reconstructions using a combination of field data, computer simulation, and testing to better understand injury mechanisms, (5) computer model development using available biomechanical literature, and (6) completion of other IHRA Pedestrian Safety Working Group (PS WG) action items.

IHRA has developed test procedures for head protection and is considering, as a new step, leg protection requirements. IHRA will be requested to research and report their recommendations to have an improved tool and test procedure for the upper legform to high bumper vehicle test. Additionally, IHRA will be requested to do further research on the upper legform impactor to bonnet leading edge test. This is discussed in detail in sections IV.d.ii. and IV.d.iii.

The International Organization for Standardization created the pedestrian protection working group (ISO/TC22/SC10/WG2) in 1987 to develop test methods for the reduction of serious injuries and fatality for pedestrian to car accidents.
Since then, the WG2 has developed pedestrian test procedures and has described the necessary test tools.

The standards and draft standards are:

- ISO 11096: 2002 Road vehicles—Pedestrian protection—Impact test method for pedestrian thigh, leg and knee,
- ISO/DIS 14514 Road vehicles—Pedestrian protection—Head impact test method,
- ISO/DIS 16850 Road vehicles—Pedestrian protection—Child head impact test method.

The mandate for ISO/WG2 is to produce test methods which will contribute to make cars pedestrian friendly. They cover crash speeds up to 40 km/h.
The study results were fully used in the IHRA/PS group, when they developed the adult and child impactors.
The ISO group is now starting the development of a new adult leg test method and its test tool.

1/ Saul, R.A., Edlefson, J.F., Jarrett, K.L., Marous, J.R.; "Vehicle Interactions with Pedestrians," Accidental Injury: Biomechanics and Prevention, New York: Springer-Verlag, 2002.

2/ "Report to Congress: Pedestrian Injury Reduction Research," NHTSA Report DOT HS 808 026, June 1993.

IV. DISCUSSION OF ISSUES ADDRESSED BY THE GTR

(a) Scope

From the review of pedestrian fatality and injury statistics from several countries, as discussed in the "Introduction" section, it was shown that the head and the legs are the most frequently injured body regions. For children, there was a high concentration (36 per cent - INF GR/PS/3 and 31) of head injuries due to contact with the vehicle bonnet/hood. For adults, the injuries were predominately to the head due to contact with the windscreen glass or bonnet/hood (more than 30 per cent, see INF GR/PS/3 and 31), and to the legs due to contact with the bumper (more than 30 per cent, see INF GR/PS/3 and 31). It was agreed that the gtr would encompass tests for the adult head and leg, and the child head. It was also shown by these studies that the majority of pedestrian injuries are occurring in urban environments; therefore the gtr should test those vehicles found in this environment, including passenger vehicles, vans, and light trucks.

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.

(b) Applicability

The application of the requirements of this gtr refers, to the extent possible, to the revised vehicle classification and definitions outlined in the 1998 Global Agreement Special Resolution 1 (SR 1). Difficulties, due to differing existing regulations and divergent vehicle fleets, were encountered in determining which vehicles would be included in the scope. The Japanese regulation applies to passenger cars for up to 10 passengers and commercial vehicles up to a Gross Vehicle Mass (GVM) of 2.5 tonnes. The IHRA recommends tests and procedures for passenger vehicles of GVM 2.5 tonnes or less. The European Union Directive applies to M_1 vehicles up to 2.5 tonnes and N_1 vehicles up to 2.5 tonnes, which are derived from M_1. The ISO recommendations are for M_1 and N_1 vehicles that have a GVM of 3.5 tonnes or less.

In addition, some countries, taking into account their current fleet composition, considered that care should be taken not to exclude from the requirements too large a number of vehicles, such as light trucks and sport utility vehicles.

The group originally reviewed in detail the IHRA recommendation to take into account the shape of the front of the vehicle, as an important parameter when discussing the types of pedestrian injuries to be mitigated.
IHRA specifies 3 groups of vehicle shape: sedan, SUV, and 1-box. For the adult and head impacts, IHRA foresees different impact test speeds and different impact angles. The EU requirements, on the contrary, do not differentiate between the various test speeds and impact angles.

The group compared these various considerations and, on the basis of simulations (INF GR/PS/129), concluded that the EU requirements in effect are more severe than the IHRA proposals. For safety reasons, the group therefore recommend to use the EU approach, not taking into account the shape of the vehicle front in defining the requirements. Furthermore, the group also considered that the IHRA recommendations would be difficult to put in place in the context of a regulatory and certification approach.

There was considerable discussion over the mass of the vehicles to which this gtr should apply. Using the categories described in SR1, there were several options examined. It was agreed that as a minimum the gtr should apply to all vehicles in Category 1-1 with a vehicle mass of less than 2.5 tonnes GVM. An argument for the 2.5 tonnes GVM maximum limit is that all existing tests were only validated for vehicles up to 2.5 tonnes GVM.
However, since some Category 1-1 vehicles weigh more than 2.5 tonnes GVM, some delegates argued that the gtr should be applicable to vehicles that weigh up to 3 or 3.5 tonnes GVM. These delegates argued that the front-end structure of these heavier vehicles usually is similar to lighter vehicles; therefore the application of the requirements should be the same.
The group confirmed its intention to include a maximum of vehicles representative of the current vehicle fleets worldwide, taking however into account their representativity in pedestrian accidents, the technical feasibility and cost/benefit considerations. In particular, it was recognised that the proposed tests are only validated up to a gross vehicle mass of 2500 kg. The group also recognised that a large proportion of current light trucks and sport utility vehicles would fall in the proposed category 1-1 below 2.5 tonnes; heavier vehicles of categories 1-1 only constitute a small portion of the vehicle fleet.

It was therefore agreed that the gtr would apply to all Category 1-1 vehicles with a gross vehicle mass not exceeding 2.5 tonnes and if a jurisdiction determines that its domestic regulatory scheme is such that limited applicability is inappropriate, it may extend domestic regulation to other Category 1-1 vehicles, provided that detailed justification regarding the applicability and validation of the requirements is offered.

Many vehicles in Category 2 are manufactured on the same platform as vehicles in Category 1-1 and have the same or similar front-end shapes. The group considered that these vehicles should be included in the proposed gtr, but noted the difficulty in defining this group of vehicles. The group agreed to use the term "derived from", as in the EU requirements, whereby "derived from" means that forward of the A-pillars, the general structure and the shape are the same. This would, as an example, be the case of a light truck built on the same platform and with the same front-end shape as a passenger car or SUV.
As for vehicles of Category 1-1, the group agreed to limit the application to those Category 2 vehicles with a Gross Vehicle Mass below 2.5 tonnes and if a jurisdiction determines that its domestic regulatory scheme is such that limited applicability is inappropriate, it may extend domestic regulation to other Category 2 vehicles provided that detailed justification regarding the applicability and validation of the requirements is offered.

The tests in this gtr are all considered to be technically and economically feasible as outlined in section V - Regulatory Impact and Economic Effectiveness. However, it will be the decision of each jurisdiction to determine whether the benefits achieved by requiring these tests justify the costs. Based on this determination, a jurisdiction can choose to further limit the application in their own regulation to specific vehicle categories and/or it may decide to phase in the regulations over time

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(c) Definitions

(i) Windscreen test area

Pedestrian accident study results included the A-pillar and peripheral area of the windscreen, but due to the difficulty of meeting the requirements using existing technology and not yet having a new technology available to apply in these areas, certain areas of the windscreen were excluded from the requirements. For this reason reference lines are introduced to define the test area in the windshield. Specially the definition of the lower windscreen reference line was discussed in detail. A compromise was chosen combining the already existing method for the bonnet rear reference line and a method similar to the definition in UNECE Regulation 43 on field of vision which is illustrated in INF GR / PS /155:

The "Lower Windscreen Reference Line" is the geometric trace of the furthest forward Lower Windscreen Reference Points A or B. Reference Points A and B are defined for each lateral position of the windscreen as mentioned below.
"Lower Windscreen Reference Points A" are the points 165 mm rearwards along the windscreen from the points of contact between a sphere and the windscreen, while determining the bonnet rear reference line.
"Lower Windscreen Reference Points B" are the points 82.5 mm rearwards along the windscreen from the points of intersection of lines in vehicle longitudinal planes projected rearwards, inclined 5° upwards with respect to the ground reference plane and contacting the uppermost surface of the instrument panel.

Definition of Points A logically applies to the windscreen the procedure which exists to define the rear bonnet reference line.
Definition of Points B takes into consideration the constraints faced by the manufacturers in the very first stage of vehicle concept: Driver's field of vision and other primary safety functional requirements such as demist/defrost etc.. These constraints limit the amount of space available between the windscreen and the instrument panel and therefore determine the ability to meet HIC requirements.
The combination of both Points A and B avoids excessively large exemption zones which may otherwise occur for some vehicle shapes.
Given the above unavoidable feasibility constraints this definition is valid only if it is adopted in conjunction with:

- a headform impact angle of 35° from the horizontal (see paragraph (g), (i))
- a relaxation zone of 1/3 of the windscreen test area with a HIC limit of 1700 (see paragraph (e), (i))
- sufficient lead time to allow for the design of compliant vehicles.

(ii) High bumper

The lower leg impactor against the bumper test has some limitations dependent on the bumper height. The contact point between impactor and bumper should be below the knee, due to the impactor's structure/characteristics.

As a result, the test to be used depends on the lower height of the bumper:
Upper legform to bumper tests shall be carried out if the lower bumper height is more than 500 mm. In case the lower bumper height is more than 400 mm but not more than 500 mm, the manufacturer can elect to perform an upper legform test instead of a lower legform to bumper test (INF GR / PS / 159)

EEVC WG10 stressed in its report (chapter 4.2) that the (lower) legform test procedure allows the evaluation of bumper heights of up to 500 mm. Experts therefore clearly recognized the limitations of the (lower) legform test and also recognized the need of an alternative test for vehicles with high bumpers.

EEVC WG17 Report, Paragraph 7.2.1:

"Some vehicles, like off-road vehicles, have high bumpers for certain functional reasons. These high bumpers will impact the femur part of the legform impactor, where no acceleration is measured to assess the risk of fractures. Moreover, there is often no structure below the bumper to restrain the tibia part of the legform, for instance because an off-road vehicle needs a certain ramp angle and ground clearance. Therefore WG17 decided to include an optional, alternative horizontal upper legform test with an impact speed of 40 km/h, when the lower bumper height is more than 500 mm above the ground."

The difficulties for Industry arise from the introduction of a lower bumper reference line definition during the activities of WG17 which kept the 500 mm value mentioned in the WG10 report as the upper limit of applicability. However, the upper limit of applicability mentioned in the WG10 report was the upper bumper reference line.

Investigations conducted with vehicles with off-road capabilities have shown that some of these vehicles have lower bumper heights between 400 and 500 mm.

In addition, the US and Canadian bumper regulations in part 581 prescribe the bumper height to be in a range of 16” to 20” (406 mm to 508 mm) for limitation of low speed collision damages. This is also beneficial for vehicle to vehicle crash compatibility.

Given the above pedestrian protection and vehicle compatibility reasons, and considering that the counter measures - addition of energy absorbing material in front of the structure - to comply with either the (lower) legform or the upper legform to bumper test are comparable, the Industry suggests the following compromise:

Maintain the definition of the lower bumper reference line and permit the optional use of either the (lower) legform or the upper legform impactor for vehicles with lower bumper heights between 400 and 500 mm.

(d) General Requirements

During the discussions, it became clear that some tests may have their limitations and the group recommended that the following issues should be resolved in the future:

(i) Lower legform impactor

As the FlexPLI is considered by some to have high biofidelity and excellent injury assessment ability, the FlexPLI should be adopted as the sole lower legform impactor for the future. However, because of the lack of experience in using the FlexPLI as a certification tool, a further confirmation process is needed. Therefore, WP.29/GRSP was requested to set up a Technical Evaluation Group (TEG). This TEG will, based on independent studies and relevant information provided by its members, monitor the reliability of the FlexPLI as a certification tool. The TEG will advise GRSP, by a date to be agreed, whether the FlexPLI can be used for testing and compliance verification purposes. The TEG should also propose the effective date of entry into force and the date at which the FlexPLI could supersede the rigid lower legform impactor. TEG will also propose a transitional period, during which the FlexPLI and the rigid lower legform impactor can be used as alternatives.

(ii) Upper legform impactor to high bumper test

The group decided to use EU's tool and test procedure. However, there are some concerns about the biofidelity of this tool and requirements.
Therefore, the group requests IHRA/PS to research and report their recommendations to have an improved tool and test procedure for possible future use.

(iii) Upper legform impactor to bonnet leading edge test

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 is shown in several accident studies comparing modern "streamline" vehicle fronts registered in or after 1990 and old vehicles from the eighties or seventies. The accident studies were performed using French data by the LAB (INF GR / PS / 30) or by the University of Dresden using the German GIDAS data (INF GR / PS / 92). In addition EEVC WG17 summarized in their 1998 report that no serious (AIS2+) upper leg or pelvis injuries caused by the bonnet leading edge were found for post-1990 car models impacting a pedestrian at a speed up to 40km/h.
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 recognizes that this test may have potential value and requests IHRA/PS to carry out further research into the needs and methods for this test.

(iv) Systems or components that change position such as pop-up headlamps or headlamp cleaners

Any vehicle system or component which could change shape or position, such as pop-up headlights or headlamp cleaners, other than active devices to protect pedestrians, shall be set to a shape or position that is considered to be the position of normal use. If there is more than one position of normal use, the system or component need to satisfy the requirements of the gtr in all positions.

(v) Active devices to protect pedestrians

If active devices, such as deployable bonnets, are used to provide protection to the pedestrians, the devices must not create a higher risk of injuries for the pedestrians. The devices are considered to meet this if they satisfy the requirements of the gtr and in addition comply with a certification procedure as defined in [Annex I] as an example.

(e) Performance Requirement

(i) Head Protection

It is important to evaluate the head protection performance because the majority of pedestrian fatalities in road accidents are caused by head injuries. The Head Injury Criteria (HIC) should be used to evaluate the head protection performance. A HIC value of 1000 is equivalent to approximately a 15 per cent risk of AIS 4+ head injury.

It is proposed to consider a HIC value calculated with 15 ms, and not 36 ms, which is generally used for car occupants. The main reason is that head impact to external car structure is very short, only a few milliseconds of contact. Then, using either 15 ms or 36 ms pulse window provides the same HIC value. As the pulse itself is so short time wise, there is no risk to loose part of the pulse during calculation when applying a 15 ms interval and thus arrive to a lower calculated HIC value. This means the level of HIC 1000 can be kept and does not need to be amended to a lower value. Moreover, taking a short time duration avoids the risk of considering a second impact after rebound, which may be processed if a longer duration is considered and may then give a wrong HIC value.

As the threshold, a HIC value of 1000 is considered appropriate, taking into account the relationship between HIC and AIS. However, relaxation zones have to be considered.

During the discussions feasibility studies were shown pointing out that some areas within the head test area will not be able to comply with the proposed HIC 1000 limit. This includes areas on the bonnet and the windscreen. For the windscreen area following studies showed the need to exclude the A-pillars and to stay away from the edges of the windshield (INF GR / PS / 72, 94, 102, 103). Indeed there are today and in the period of implementation no technical solutions that could help lower the HIC levels in areas of the A-pillars, of roof and cowl. For the remaining test area in the windscreen glass vehicle manufacturers found big problems related to scatter of HIC when performing tests in the windscreen, e.g. according to the European Directive Phase1 (INF GR / PS / 134). The reasons of the big scatter behaviour are still not fully known.

It is very important to adjust the performance criteria to the conflicting functional needs that could affect the HIC in this area, most of them linked to primary safety.

In the lower windscreen area the required deformation space for the head impact is restricted by the instrument panel. Some legal requirements, such as defrost/demist etc., make it impossible to lower the dashboard significantly. In addition, the structural components of the dashboard are important load paths in case of front or side crashes.

In addition, most manufacturers are currently developing systems aimed at accident avoidance or injury risk mitigation. Such devices mainly support the driver in the driving task (windscreen rain sensors, head up displays, night vision systems etc.). Some of these features need to be located on or directly behind the windscreen. This can significantly influence the HIC in this area by reducing the available deformation space or by increasing the effective mass. Considering that such systems have and will have a high effectiveness in protecting pedestrians, it is necessary to maintain the possibility to install them.

Finally, the breaking behaviour of the windscreen is still under investigation (e.g. EU funded research project APROSYS). First results show a high scatter in HIC values during windscreen tests which still needs to be explained.

The current situation and all these aspects would be taken into account when allowing an HIC value of maximum 1700 for one third of the windscreen test area while maintaining an HIC less than 1000 in the remaining windscreen test zone, irrespective of which of the headforms is used (INF GR / PS / 157).

As for the bonnet area the feasibility study detailed in INF GR / PS / 91 and 101 showed the problem areas on the bonnet. Also the feasibility study conducted on behalf of the European Commission (INF GR / PS / 89) acknowledged the need to define an area on the bonnet for which a higher HIC limit is needed. As the problems on the bonnet are not the same for every car model, it was felt necessary to set a maximum area with relaxed requirements that could be defined for every car by the manufacturer. Existing requirements and criteria of pedestrian protection regulations / directives contain relaxation zones providing for HIC values above 1000: HIC for 1/3 (33%) of the entire bonnet test area shall not exceed 2000; in the remaining part HIC shall be below 1000, independent of the headform impactor used. This is because it is not technically feasible to achieve HIC less than 1000 for the complete bonnet test area as confirmed by independent studies.

The headform test requirements for future regulations for pedestrian protection should be more demanding for vehicle fronts than existing requirements and thus more effective for pedestrians. However, the design solutions should remain technically feasible.

A first approach could be to apply the relaxation zone separately for the child and adult test areas, i.e. HIC below 1700 to a maximum of 1/3 of each test zone.

Necessary under-bonnet components such as locks, suspension tower etc. won't fundamentally change in their position. They need to be located in the child headform test area. This often results in more than 33% of relaxation zone for the child test area alone (see illustrations 1 and 2 of INF GR / PS / 158).

The combination of a significantly reduced maximum HIC value of 1700 and a relaxation zone maintained at 33% means that the above mentioned first approach is technically unfeasible. The very last consequence would be a withdrawal of some vehicle types from the market accompanied with huge social and economic problems.

An alternative approach could be as follows:

The HIC recorded shall not exceed 1000 over one half of the child headform test area and, in addition, shall not exceed 1000 over 2/3 of the combined child and adult headform test areas. The HIC of the remaining areas shall not exceed 1700.

A study of the effectiveness (percentage of saved pedestrians) in the bonnet test area for existing regulations is performed (HIC below 2000 in 33% of the entire test area) and compared to this alternative approach. The calculation method is the same as the one used by TRL in the study carried out for the European Commission (see illustration 3 of INF GR / PS / 158).

The comparison study shows that more pedestrians would be saved even if the relaxation zone of the bonnet test area is around 50%. This improvement is due to the significantly reduced HIC limit of 1700.

The requirements of this alternative approach are in harmony with the general targets of future legislation, i.e. better pedestrian protection while maintaining technical feasibility of possible design solutions.

(ii) Lower Leg Protection

Early accident studies, carried out by Germany, France and the United Kingdom, have shown that a high proportion of injured pedestrians sustain an injury to the lower leg (i.e. tibia/fibula) or knee. Although there was some variability evident in the trend for the figures, the EEVC concluded that lower leg and knee injuries are still frequently seen and should be addressed. It was agreed to use the rigid impactor developed by TRL, for the time being, in evaluation of the leg protection performance; however, it was also agreed to consider the possible future use of the Flex-PLI, which is considered by some to be more biofidelic and expected to be highly usable and repeatable, following the evaluation to be conducted by the Technical Evaluation Group (INF GR/PS/106) requested above.

It was noted that for leg and knee injuries not only the AIS level (i.e. life threatening injuries) should be considered but the long term disability risk should also be taken into account

Knee injuries are typical leg injuries in car to pedestrian collisions. Most frequent knee injuries are knee ligaments elongations/ruptures and/or knee articulation surfaces crush

(tibia plateau and/or femur condyle). The most common mechanism related to pedestrian knee injury is a lateral bending between the thigh and the leg, sometimes associated with shearing motion (horizontal displacement between the tibia top and the femur lower extremity in the direction of impact). Several experimental research works were conducted in Europe, Japan and the USA using PMHS components during the last decade; some of these works include numerical simulations in order to better understand what happens inside the knee joint during the loading process. These studies propose a bending limit in the range of 15 to 21°, for knee protection; it seems advisable to consider a value close to the upper limit (21°) of this range and not the average, for the following reasons: the absence of muscle tone in PMHS tests dropping the knee stiffness, and the high rigidity of the impactor bones which transfers to the knee joint a part of the impact energy normally absorbed by human long bones deformations. There are less research works dealing with knee shearing limits and it is acknowledged that it is almost impossible to precisely determine knee shearing motion during PMHS tests, as the values are low (a few millimeters), and the knee is covered with flesh and skin. The value of 6 mm as proposed seems to correspond to the (limited) knowledge available concerning knee shearing biomechanics, even if some other biomechanical researches have proposed higher values.
Results of a series of pedestrian PMHS tests performed with modern cars suggests an average value of 222g for tibia injury tests, and of 202 g for non tibia injury tests. A value of 200 g's would correspond to a 50% injury risk, and to protect a higher proportion of the population at risk, a lower value of tibia acceleration has to be selected.

As a result it was concluded that the acceptance levels for the legform test should be set at:

a. Maximum lateral knee bending angle ≤ 19.0°;
b. Maximum lateral knee shearing displacement ≤ 6.0 mm;
c. Maximum lateral tibia acceleration ≤ 170 g.

Following discussions with interested parties, it was accepted that a phased approach to the introduction of these requirements would be acceptable. Thus, the requirements for phase I of the EU Directive are 21° knee bending angle, 6 mm shear and 200 g acceleration.

For the Flex-PLI, a bending angle of 20 degrees for the knee and a bending moment of 350 Nm for the tibia would be considered appropriate as a threshold. These parameters are equivalent to a 50 per cent risk of knee injury and a mean tibial fracture load, respectively (INF GR/PS/82). The dynamic bending corridors were established by the University of Virginia (INF GR/PS/77). The bio-rating method of Maltese was used to check the FlexPLI biofidelity which proved to range from good to excellent (INF GR/PS/78 and 98).

(iii) Upper leg protection for high bumpers

The legform impactor has limited usage in the testing of vehicles whose bumpers strike the legs above knee level. Accordingly, on the group discussed the appropriate impactor to use for such vehicles and decided upon the upper legform impactor. The group decided to copy the requirements from the EU Directive and set the limits at: 7.5 kN for the impact force and 510 Nm for the bending moment. For high bumper, the car impact occurs above the knee, and then, the thigh is directly impacted by the car front.

Biomechanical research works conclude in a upper leg tolerance in bending in the range of 4 to 7 kN peak force, and 300 to 600 Nm bending moment; these values are based on PMHS test results, for a three-point bending in the middle of the femur. The absence of muscle tone in the PMHS tests and the difference in the impact point between the PMHS test and the car impact would support a higher tolerance, especially for the peak force value. The limits 7,5 kN and 510 Nm proposed for the upper leg impactor in high bumper tests seems then acceptable.

(f) Test Conditions

(i) Head Protection

As head injuries to both adults and children occur throughout a wide range of areas at the front of the vehicle, subsystem tests using the adult and child headform impactors should be performed.

Consideration was given as to how to specify both the number of test points and the minimum spacing of such test points.
However on consideration it was felt that the specification of such points did not have a place within this regulation as:-

1) For self certification it is not considered necessary to mention the number of tests required for head impact testing or their spacing as it is incumbent on vehicle manufacturers to ensure that vehicles comply with all the impact zone requirements defined within this gtr.

2) For type approval the number of tests that need to be carried out to satisfy the relevant authority that vehicles meet the requirements is an issue for that authority who would be expected to specify the number of tests & their distance apart.

3) The mention of a minimum number of tests or a minimum distance apart between tests could result in the manufactures being burdened with unnecessary tests, as it would be difficult to set a target that would encompass both the largest & smallest test zones, and the situation could arise where test zones could be smaller than the minimum number of test required that could be fitted into that zone.

The appropriate headform impactor size and mass, determined based on the characteristics of the human body, are as follows (INF GR/PS/46, 74 and 93):

Headform diameter:

- Child: 165 mm - Due to the fact that the majority of child pedestrian victims are 5 or 6 years old, this value was determined based on the average head diameter of a 6-year-old child (by averaging the diameter obtained from the circumference of the head and the longitudinal and lateral measurements of the head).

- Adult: 165 mm - Although the average diameter of an adult head was also considered, this value was determined based on the diameter of an existing adult headform specified in another regulation. This diameter appears to have been determined based on the diameter of the forehead of an adult male.

Headform mass:

As computer simulations conducted in the IHRA study show that the effective mass of the head in an impact with vehicles is identical to the actual mass of the head, the headform mass was therefore determined as follows:

- Adult: 4.5 kg - The mass of the head of an adult male (50th percentile adult male - AM50)
- Child: 3.5 kg - The mass of the head of a 6-year-old child

Adult headform characteristics have been analyzed by EEVC as reported in INF GR / PS / 148. This document proposes to keep a value of adult head moment of inertia of: 0.0110 kgm², allowing a variation of ± 0.001 kgm² (adult headform Moment of Inertia comprised between 0.0100 and 0.0120 kgm²). This has been agreed by EEVC WG17 and taken over by the informal group.

Headform accelerometer:

It is recommended to use a damped accelerometer (as specified in INF GR / PS / 133) in the adult / child headform impactor. As explained in INF GR / PS / 96, a research program in 2002 using the Japanese New Car Assessment Program (J-NCAP) headform test with undamped accelerometers, abnormal acceleration signals with highHIC values were recorded frequently in windshield impacts and also in bonnet impacts.
It was estimated that this was due to the resonance vibration of the undamped accelerometer, which would occur if the spectrum of the impact waveform was near to the resonance frequency of the accelerometer. Once a high resonance, over the CAC setting level, occurs, it has a high chance to deform the acceleration waveform, i.e. one cannot obtain a correct acceleration waveform from the undamped accelerometer.

(ii) Lower Leg Protection

As the majority of victims of leg injuries are adults, subsystem tests using legform impactors that simulate adult legs should be performed.

The size and mass of both the present rigid lower legform and the Flex-PLI were determined to be equivalent to those of an adult male (AM50) (INF GR/PS/79).
The results of computer simulation analyses and experimental data indicate that the mass of the upper body need not be taken into consideration for those impacts where the bumper strikes the legs below knee level (INF GR/PS/105).

(iii) Upper leg Protection on high bumpers

As the majority of victims of upper leg injuries are adults, subsystem tests using legform impactors that simulate to upper adult leg should be performed. The impactor specifications are those used in the EU Directive 2003/102/EC.

(g) Test Procedures

(i) Head Protection (INF GR/PS/58, 61 and 73)

Based on the data of actual accidents, the test area for evaluating the head protection performance should be the front of the vehicle and the windscreen area with a WAD (Wrap Around Distance) of 1000 mm to 2100 mm. In addition, the test area for adult head injury and that for child head injury should be separated by a boundary. Although an overlap area was also considered with a WAD of 1400 mm to 1700 mm where both adults and children have received head injuries in actual accidents, a defined boundary was determined to be more suitable because little difference in the life-saving rate was perceived between the two approaches and the boundary method provided a clearer approach.

The WAD1700 line should be the boundary between the test areas for adult head injuries and child head injuries from a standpoint of maximizing the life-saving rate.

The impact speed of the vehicle was determined to be 40 km/h as specified in the Introduction.

As stipulated before the head impact conditions (speed and angle) are to be considered together. During its research IHRA reviewed the potential of distinguishing between various vehicle shapes and the influence of this shape on the eventual impact angle. Simulations, conducted by JARI (Japan Automobile Research Institute), NHTSA and RARU (Road Accident Research Unit of Adelaide University), carried out as part of the IHRA study. In the computer simulations, an adult male model (AM50) and a child model (6-year-old) were used. The impacts were simulated using three types of walking position, three types of vehicle frontal shape and two types of bonnet stiffness as parameters, and the distribution of the headform impact speeds and angles in various impacts was obtained. The studies showed that the same headform impact speed could be used for any type of vehicle frontal shape and interpretation of the results indicated a speed of 32 km/h, which is 0.8 times the vehicle impact speed. Various angles for adult and child impact conditions and for the three different shapes were defined as well.
On the other hand EEVC had concluded that one set of angles for all vehicles is possible, simplifying any head test procedure dramatically.
The decisions concerning head impact angles for child and adult tests (respectively 50° and 65° to the horizontal) were based on 2 reports used as working documents. They are:

- Glaeser K.P. (1991) “Development of a Head Impact Test Procedure for Pedestrian Protection” BASt Report under contract N° ETD/89/7750/M1/28 to the E.C. (INF GR / PS / 150)
- Janssen E.G., Nieboer J.J. (1990) “Protection of vulnerable road users in the event of a collision with a passenger car, part1 – computer simulations”. TNO Report N° 75405002/1. (INF GR / PS / ???)

The EEVC values are a compromise between PMHS tests and simulation results. The PMHS tests gave a peak of the distribution at 60° and all the results were between 50° and 80°. Simulations gave a result around 67° for adults, with few influence of vehicle shape. EEVC choose a value of 65° close to the simulation and to the average of PMHS results. For children, EEVC considered simulations of small female (close in anthropometry to a 12 years old child) and of a 6 years old child. Results of small female simulations were very close to adult ones, and 6 years old child simulations suggested a value around 50°. EEVC picked a value of 50°, considering that a 6 year old child is more relevant than a 12 years old child for child pedestrian protection.

As the one set of angles from EEVC is at a different (higher) speed than those defined by IHRA, it was researched which of both is most stringent and thus offers most protection to the pedestrians. INF GR / PS / 129 showed by both numerical calculation and by simulation that the set of requirements as defined by EEVC is more severe than the requirements as defined by IHRA. The group thus concluded to use the EEVC requirements of 50° and 65° impact angle for child and adult head testing while maintaining the higher impact speed to the bonnet of 35km/h (compared to the IHRA speed of 32km/h) which is implemented in the European Directive Phase1 for pedestrian protection.

In the current Phase 1 of the EU Directive windscreen tests are performed with an impact angle of 35° to the horizontal. This is currently the only legal requirement on windscreen testing and the angle is similar to the findings of IHRA studies of 2002 where an impact angle of 40° was proposed, based on simulation of pedestrian impacts to vehicle with different front shapes (INF GR / PS / 156).

Therefore an impact angle of 35° is considered for windscreen headform tests for both, the child and adult headform impactor.

(ii) Leg Protection

The impact speed of the legform is the same as that of the vehicle and thus determined to be 40 km/h.

The actual accident data show that the majority of pedestrian accidents occur when the pedestrian crossing the street is struck by the vehicle directly from the side. Therefore, it was decided that the portion of the legform impactor which corresponds to the side of a human leg be impacted with the bumper.

Since pedestrians are usually wearing shoes, the bottom of the legform impactor was determined to be 25 mm above the ground, the same height as the sole of a shoe (INF GR/PS/98).

(iii) Upper leg Protection

The impact speed of the legform is the same as that of the vehicle and thus determined to be 40 km/h.

V. REGULATORY IMPACT AND ECONOMIC EFFECTIVENESS

The group already took note of the feasibility study performed in IHRA (INF GR/PS/5) on the EEVC WG17 proposed head tests. The main conclusions are:

- No vehicle fulfils EEVC/WG17 requirements completely
- No traditional solution currently exists to comply with EEVC/WG17 requirements (not possible with padding only)
- No sensor techniques are available yet to offer other active solutions

The group also checked with various NCAP (New Car Assessment Programme) programmes around the world to see if data from their tests could give an insight into the feasibility of certain pedestrian tests. Spain presented a study using data from cars tested in EURO-NCAP and compared these with the requirements set out in the first phase of the EU Directive 2003/102/EC on pedestrian protection (INF GR/PS/45). It concluded that, for child headform testing, current vehicles are still far away from being able to meet the proposed requirements. However, simple design changes on the best scoring vehicles will put them in a situation very close to meet the proposed requirements for the first phase of the EU Directive. For the lower legform testing the conclusion was that the majority of vehicles are performing well below the proposed requirements.

Another study was performed by Adelaide University (Australia) (INF GR/PS/66). The study reviewed 50 cars tested by AUS-NCAP and gave the detailed results of all pedestrian tests carried out.

Both ACEA and JAMA have performed their own feasibility studies on the content of the second phase of the EU Directive 2003/102/EC. The ACEA study (INF GR/PS/91) looked at various car types (super mini car, executive car, sport utility vehicle, sports car). They used FE modelling to adapt these models to the Phase 2 requirements and check what the remaining problems are. The results include for each of the types a list of remaining solvable problems and remaining unsolvable problems.

The JAMA study (INF GR/PS/101) looked at the technical feasibility study on EEVC/WG17 pedestrian headform to bonnet top test and on the EEVC/WG17 pedestrian upper legform to bonnet leading edge test. The study concluded, with respect to the headform tests, that a bonnet hinge complying with the EEVC/WG17 child headform to bonnet top test requirement could be developed but only under the unrealistic condition of removing the fender, and that such a hinge could not satisfy various required performances apart from pedestrian protection performance. As for the upper leg test the study concluded that the test poses serious problems in terms of the impact energy, the test tool in relation to biofidelity, and the injury acceptance levels. Additionally the test is apparently contradictory to the actual situation in a real-world car-pedestrian accident and it is not recommended to use this test in its present form.

In addition, the European Commission made its own feasibility study which was contracted out by TRL (United Kingdom). This feasibility study was required under EU Directive 2003/102/EC (INF GR/PS/89 and 120). The study concluded that, although meeting phase two of the Directive might be feasible for some types of vehicles, overall it would be unduly restrictive and is therefore not feasible without some modifications. A number of improvements to the test methods have been identified, the most significant of which are a heavier child headform impactor, revised upper legform test energies and new or reduced tolerances on test conditions. These changes will mean that the protection required will be more appropriate and it is thought that all the changes will make it easier for car manufacturers to achieve compliance. The study also evaluated the manufacturing cost and the estimated annual fatality reduction in the European Union (EU-25). The manufacturing cost to make cars compliant to the proposed amendments was assessed for all car categories and ranges from € 32.68 for a small family car up to € 406.61 for a roadster. The estimated annual fatality reduction in the European Union (EU-25) that would be obtained by implementing the suggested amendments was estimated at 1359 pedestrian and pedal cyclists lives saved and 34,305 serious injuries avoided. This would result in an estimated cost benefit ratio of 1 : 5.4 for the introduction of the revised requirements.

APPENDIX – REFERENCE DOCUMENTS USED BY THE WORKING GROUP

A list of informal documents used by this Informal group is listed and available on the UNECE WP.29 website (http://www.unece.org/trans/main/welcwp29.htm).

Number of informal document	Title of informal document
INF GR/PS/1*	Agenda 1st meeting
INF GR/PS/2	Terms of reference
INF GR/PS/3	IHRA accident study presentation
INF GR/PS/4*	JMLIT proposed legislation
INF GR/PS/5	IHRA feasibility study
INF GR/PS/6	J information on possible scope
INF GR/PS/7	Attendance list 1st meeting
INF GR/PS/8*	Draft Meeting Minutes 1st meeting
INF GR/PS/9*	Report to GRSP 32 inf doc
INF GR/PS/10	Draft action plan
INF GR/PS/11	Agenda 2nd meeting
INF GR/PS/12	GIDAS accident data
INF GR/PS/13	GIDAS accident data graphs
INF GR/PS/14	Italian accident data
INF GR/PS/15	UN accident data
INF GR/PS/16	Spanish accident data
INF GR/PS/17	ACEA accident data
INF GR/PS/18	Draft Meeting Minutes 2nd meeting
INF GR/PS/19	Agenda 3rd meeting
INF GR/PS/20	Canadian accident data
INF GR/PS/21	Netherlands accident data
INF GR/PS/22	Scope overview
INF GR/PS/23	Draft content table preliminary report
INF GR/PS/24	Attendance list 3rd meeting
INF GR/PS/25	GIDAS presentation
INF GR/PS/26	Leg injuries ITARDA
INF GR/PS/27*	Draft Meeting Minutes 3rd meeting
INF GR/PS/28	Technical feasibility general
INF GR/PS/29	Infrastructure effectiveness
INF GR/PS/30	Pelvis / Femur fracture
INF GR/PS/31	IHRA/PS-WG Pedestrian accident data
INF GR/PS/32	ESV summary paper on IHRA/PS-WG report
INF GR/PS/33	Introduction of the regulation of pedestrian head protection in Japan; Nishimoto, Toshiyuki
INF GR/PS/34	Proposal for a directive of the European Parliament and the Council relating to the protection of pedestrians and other vulnerable road users in the event of a collision with a motor vehicle and amending Directive 70/156/EEC; Commission of the European Communities, Brussels, February 2003
INF GR/PS/35	List of conflicts with existing legislation / requirements
INF GR/PS/36	Draft preliminary report
INF GR/PS/37	Agenda 4th meeting
INF GR/PS/38	Technical prescriptions concerning test provisions for pedestrian safety
INF GR/PS/39*	Vehicle safety standards report 1
INF GR/PS/40	US Cumulative 2002 Fleet GVMR
INF GR/PS/41	Swedish accident data

INF GR/PS/42	TRANS/WP.29/GRSG/2003/10 proposal for common definitions
INF GR/PS/43	Category 1-1 GVM
INF GR/PS/44	Light duty truck
INF GR/PS/45	EURO-NCAP results and what they mean in relation to EU Phase 1
INF GR/PS/46	JAMA / JARI child and adult head impactors
INF GR/PS/47*	Preliminary report to GRSP 33
INF GR/PS/48*	Draft meeting minutes 4th meeting
INF GR/PS/49	IHRA child head test method
INF GR/PS/50	IHRA adult head test method
INF GR/PS/51	Attendance list 4th meeting
INF GR/PS/52	Provisional agenda for the 5th meeting
INF GR/PS/53	Draft gtr format
INF GR/PS/54	gtr proposal to WP29
INF GR/PS/55	Draft gtr
INF GR/PS/56*	Comparison table
INF GR/PS/57	Proposed schedule of the group
INF GR/PS/58	Presentation on veh shape, bound line, ...
INF GR/PS/59	A-pillar IHRA OICA presentation
INF GR/PS/60	ISO/TC22/SC10/WG2 N613
INF GR/PS/61	IHRA PS 237
INF GR/PS/62	Action plan from 5 meeting
INF GR/PS/63	Attendance list 5th meeting
INF GR/PS/64*	Draft meeting minutes 5th meeting
INF GR/PS/65*	Provisional agenda for the 6th meeting
INF GR/PS/66	AUS-NCAP pedestrian data
INF GR/PS/67	Test-method - active hood / bonnet systems
INF GR/PS/68	Target population head injuries - US
INF GR/PS/69	Working paper draft gtr
INF GR/PS/70	Korean information
INF GR/PS/71	Head test area windscreen + A-pillar
INF GR/PS/72	Head test data on windscreen
INF GR/PS/73	Head impact angle / speed re-assessment based on vehicle geometry
INF GR/PS/74	IHRA/PS/270 headform impactor specification
INF GR/PS/75	Powerpoint explanation of PS/67
INF GR/PS/76	IHRA legform discussions
INF GR/PS/77	Corridors proposed by UVA (lower legform)
INF GR/PS/78	Bio rating method: Maltese
INF GR/PS/79	IHRA antropometric proposal
INF GR/PS/80	IHRA/PS/278
INF GR/PS/81	Schedule for legform impactor for gtr
INF GR/PS/82	Injury threshold for ped legform test
INF GR/PS/83	Decided items and action items of the 6th meeting
INF GR/PS/84	Draft meeting minutes of the 6th meeting
INF GR/PS/85	Attendance list of the 6th meeting
INF GR/PS/86	Draft gtr EU working document
INF GR/PS/87	IHRA PS 273 Development of FlexPLI2003
INF GR/PS/88	Second interim report to GRSP 35
INF GR/PS/89	EU Feasibility Study Phase 2
INF GR/PS/90	Provisional agenda for the 7th meeting
INF GR/PS/91	ACEA feasibility study Phase 2
INF GR/PS/92	ACEA equal effectiveness study Phase 2
INF GR/PS/93	Design of head impactor
INF GR/PS/94	Front windshield

INF GR/PS/95	JPN comment on PS 86 Rev 2 + English text of Japanese technical standard
INF GR/PS/96	Problem of undamped accelerometer
INF GR/PS/97	Durability and repeatability of headform skin
INF GR/PS/98	IHRA PS 310 decision for legform test
INF GR/PS/99	Skin aging of head impactor
INF GR/PS/100	OICA proposed amendments to PS/95
INF GR/PS/101	JAMA feasibility study Phase 2
INF GR/PS/102	OICA windscreen testing according to EURO-NCAP protocol
INF GR/PS/103	CLEPA windscreen testing on one car model
INF GR/PS/104	Draft CLEPA / OICA document on active bonnet testing
INF GR/PS/105	Lower leg research for developing corridors
INF GR/PS/106	J-MLIT proposal for FlexPLI answering item 9 of PS/83
INF GR/PS/107	NHTSA proposal for guidelines of preamble
INF GR/PS/108	JAMA information on high bumper definition
INF GR/PS/109	Chairman proposal for FlexPLI and rigid impactor use in gtr
INF GR/PS/110	OICA proposal for side and rear windscreen reference line
INF GR/PS/111	Guideline for preamble
INF GR/PS/112	Action plan
INF GR/PS/113	Revision of draft gtr
INF GR/PS/114	Attendance list
INF GR/PS/115*	Draft meeting minutes of the 7th meeting
INF GR/PS/116	Cleaned up version of draft gtr
INF GR/PS/117	Preamble and draft gtr off doc for GRSP 37
INF GR/PS/118	Provisional agenda for the 8th meeting
INF GR/PS/119	ISO Activities for Pedestrian Safety
INF GR/PS/120	EC final feasibility study
INF GR/PS/121	GRSP/2005/3 as amended during GRSP/37
INF GR/PS/122	GRSP-37-18
INF GR/PS/123	GRSP-37-15
INF GR/PS/124	GRSP-37-16
INF GR/PS/125	Short report on comments received during GRSP-37
INF GR/PS/126	July meeting task list
INF GR/PS/127	Presentation on EU Phase 2
INF GR/PS/128	The need for harmonised legislation on pedestrian protection
INF GR/PS/129	Comparison between the J standard and the EU Phase 2 proposal for head testing
INF GR/PS/130	List of references for EU / EEVC on head impact angles
INF GR/PS/131	Analysis of pedestrian accident situation and portion addressed by this gtr
INF GR/PS/132	gtr testing and what it means for the US situation
INF GR/PS/133*	Proposal to solve the undamped accelerometer problem
INF GR/PS/134	Concerns on §7.4 with testing on the centre of the windscreen
INF GR/PS/135	OICA proposal for §3.33
INF GR/PS/136	OICA proposal for a mass for the upper leg impactor
INF GR/PS/137	OICA proposal on definition of high bumper vehicles
INF GR/PS/138	Economic effectiveness study from Korea
INF GR/PS/139	Action list of 8th meeting
INF GR/PS/140	IHRA Injury breakdown background document for PS/131
INF GR/PS/141	Update of PS67 on certification standard for deployable systems
INF GR/PS/142	Relative humidity of Korea
INF GR/PS/143*	Draft gtr based on INF GR / PS / 121 as amended during the 8th meeting
INF GR/PS/144	Draft meeting minutes of the 8th meeting
INF GR/PS/145	Attendance list 8th meeting
INF GR/PS/146	Flex-TEG Activities updating PS 124

INF GR/PS/147	Actions 1 3 4 6 9 of 8th meeting
INF GR/PS/148	Action 9 of 8th meeting doc FTSS_4[1].5kg_headform
INF GR/PS/149	Adult headform moment of inertia
INF GR/PS/150	Development of a head impact test, Glaeser
INF GR/PS/151	gtr preamble for accelerometer
INF GR/PS/152	Provisional agenda for the 9th meeting
INF GR/PS/153	Explanation of amendments from PS143 to PS143 Rev1
INF GR/PS/154	Handling guide for the TRL leg
INF GR/PS/155	LWRL definition
INF GR/PS/156	Impact angles for headform to windscreen tests
INF GR/PS/157	HIC limits for headform to windscreen tests
INF GR/PS/158	Headform to bonnet tests
INF GR/PS/159	Definition high bumper vehicles
INF GR/PS/160	Revised preamble replacing the preamble in PS/143 Rev 1