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THIRD PROGRESS REPORT OF THE INFORMAL WORKING GROUP ON HEAD RESTRAINTS

(DRAFT)

(Transmitted by the Chair of the Head Restraint Informal Working Group)

1. INTRODUCTION

During the 126th session of WP.29 of March 2002, the Executive Committee of the 1998 Agreement adopted a Program of Work, which includes the development of a global technical regulation (gtr) to address neck injuries in crashes. The United States of America (U.S.) volunteered to lead the group's efforts and develop a document detailing the recommended requirements for the gtr. The United States presented an informal document (WP.29-134-12) in November 2004 proposing the work and highlighting the relevant issues to be addressed in the gtr. This proposal was adopted at the March 2005 session of WP.29 (TRANS/WP.29/AC.3/13).

At the November 2004 WP.29 session, the Executive Committee charged the Working Party on Passive Safety (GRSP) to form an informal working group on Head Restraints (working group) to discuss and evaluate relevant issues concerning requirements for head restraints to make recommendations regarding a potential gtr.

Under the guidelines governing the development of a gtr, the working group is to first evaluate the merits of the proposal. This evaluation should include:

1. An examination of the merits of the proposal in detail, outlining the pros and cons of the proposal;
2. Consideration of other regulations on the same subject, which are listed in the compendium;
3. A determination that the proposal addresses a problem of sufficient magnitude to warrant the development of a regulation;
4. An examination of whether the nature, extent and cause of the problem addressed by the proposal are correctly characterized;
5. An examination of whether the proposal provides a sufficiently effective, performance oriented approach to address the problem;
6. A determination that the approach identified in the proposal is appropriate to address the problem; and
7. A description of needed additional information.

The working group met to discuss the development of a gtr on head restraints on:
1-2 February 2005 in Paris, France
11-13 April 2005 in Paris, France
13-15 June 2005 in Washington, D.C., USA
7-9 September 2005 in Paris, France
23-26 January 2006 in Cologne, Germany
19-21 April 2006 in London, UK.

The Contracting Parties represented on the working group are the Netherlands, France, Canada, Japan, Germany, Spain, United Kingdom, United States of America, and the European Commission. Representatives from European Association of Automotive Suppliers (CLEPA) and International Organization of Motor Vehicle Manufacturers (OICA) are also participants.

The next meeting is scheduled for September 12-14, 2006 in Montreal, Canada.

This report summarizes the main issues discussed by the working party in evaluating the proposal to develop a draft global regulation on head restraints.

2. REQUEST TO PROCEED WITH THE DRAFTING OF A GTR

The United States recently upgraded its head restraint standard to provide more stringent requirements. In 1982, the United States assessed the performance of head restraints installed pursuant to the current standard and reported that integral head restraints are 17 percent effective at reducing neck injuries in rear impacts and adjustable head restraints are only 10 percent effective. The UNECE Regulations on head restraints were considerably more stringent than the old United States regulation, and were used as a baseline in developing the new upgraded United States head restraint regulation.

Due to the United States regulatory upgrade effort, this is an excellent opportunity for the international community to develop and establish a gtr in this area. It is the belief of the working group that everyone could benefit from harmonization and new technology based improvements of head restraints. The benefits to the governments would be the improved safety of the head restraints, leveraging of resources, and the harmonization of requirements. Manufacturers would benefit from reduction of the cost of development, testing, and fabrication process of new models. Finally, the consumers would benefit by having a choice of vehicles built to higher, globally recognized standards, providing a better level of safety at a lower price.

The proposed gtr will combine elements from UNECE Regulations Nos. 17, 25, and newly upgraded United States Federal Motor Vehicle Safety Standard (FMVSS) 202. While not all issues that would be addressed by a gtr have been resolved, no issues are sufficiently problematic to prevent the development of a draft regulation. It is proposed that a draft gtr could be prepared for discussion at the next GRSP meeting pursuant to the following schedule:

Tasks	**Dates**
1st Progress Report to GRSP	May 2005
1st Progress Report to AC.3	June 2005
3rd Working Group Meeting	June 2005
Development of draft gtr begins	June 2005
4th Working Group Meeting	September 2005
2nd Progress Report	December 2005
5th Working Group Meeting	January 2006
2nd Progress Report to AC.3	March 2006
6th Working Group Meeting	April 2006
3rd Progress Report and Draft gtr to GRSP	May 2006
3rd Progress Report to AC.3	June 2006
7th Working Group Meeting	September 2006
4th Progress Report/Approval of Final Draft gtr by GRSP	December 2006
Submittal of Final Draft gtr to AC.3	March 2007

3. EVALUATION OF THE SAFETY PROBLEM

In the United States, between 1988 and 1996, 805,581 whiplash injuries (non-contact Abbreviated Injury Scale (AIS 1) neck) occurred annually in all crashes of passenger cars and LTVs (light trucks, multipurpose passenger vehicles and vans). 272,464 of these whiplash injuries occurred as a result of

rear impacts. For rear impact crashes, the average cost of whiplash injuries in 2002 dollars is $9,994 (which includes $6,843 in economic costs and $3,151 in quality of life impacts, but not property damage), resulting in a total annual cost of approximately $2.7 billion. Although the front outboard seat occupants sustain most of these injuries, whiplash is an issue for rear seat passengers as well. During the same time frame, an estimated 5,440 whiplash injuries were reported annually for occupants of rear outboard seating positions.

A more detailed discussion of the safety problem in the United States and their new requirements in the upgraded FMVSS 202 can be reviewed in Informal Document HR-1-8.

4. REVIEW OF EXISTING INTERNATIONAL REGULATIONS

The following existing regulations, directives, and standards pertain to head restraints:

- UNECE Regulation No. 17 - Uniform provisions concerning the approval of vehicles with regard to the seats, their anchorages, and any head restraints
- UNECE Regulation No. 25 - Uniform provisions concerning the approval of head restraints (Head Rests), whether or not incorporated in vehicle seats
- European Union Directive 74/408EEC, concerning interior fittings of motor vehicles
- European Union Directive 96/03/EEC, adapting to technical progress Council Directive 74/408/EEC relating to the interior fittings of motor vehicles (strength of seats and of their anchorages)
- European Union Directive 78/932/EEC, concerning head restraints of seats of motor vehicles
- United States Code of Federal Regulations (CFR) Title 49: Transportation; Part 571.202: Head Restraints
- Australian Design Rule 3/00, Seats and Seat Anchorages
- Australian Design Rule 22/00, Head Restraints
- Japan Safety Regulation for Road Vehicles Article 22 – Seat
- Japan Safety Regulation for Road Vehicles Article 22-4 – Head Restraints, etc.
- Canada Motor Vehicle Safety Regulation No. 202 – Head Restraints
- International Voluntary Standards -SAE J211/1 revised March 1995 – Instrumentation for Impact Test – Part 1 – Electronic

Additionally, research and activities being conducted by European Enhanced Vehicle Safety Committee (EEVC) Working Group 12, EEVC Working Group 20, and EuroNCAP are also being considered.

5. DISCUSSION OF ISSUES TO BE ADDRESSED BY A GTR

The following discussions reflect the working group's identification of specific issues, as well as the group's evaluation of those issues. A draft comparison of the requirements of UNECE Regulation No. 17 and US FMVSS No. 202 is provided in the Appendix 1 of this document. The working group has started drafting the regulatory text for the gtr (Appendix 2). Discussions and recommendations are reflected in the text of this draft.

5.1. Applicability

The application of a head restraint gtr will, to the extent possible, use the revised vehicle classification and definitions of Special Resolution 1.

There has been extensive discussion of the applicability of this gtr. The application of US FMVSS No. 202 is different than UNECE Regulation No. 17. FMVSS No. 202 requires head restraints in all front

outboard seating positions and regulates head restraints optionally installed in the rear outboard seating positions for vehicles up to 4,536 kg. UNECE Regulation No. 17 requires head restraints in all front outboard seating positions of vehicles of category $M_{1/}$, vehicles of category $M_{2/}$, and vehicles of category $N_{1/}$ and allows for optional type approval of head restraints optionally installed in other seating positions, or in other vehicles. There is consensus to recommend that the gtr should recommend head restraints in all front outboard seating positions for Category 1-1 vehicles. Vehicles of category 1-2 and 2 2/ need more discussion especially on the mass limit.

It was proposed that the gtr, as it pertains to front outboard seats, should apply to vehicles up to 4,536 kg. The United States presented justification (see document No. HR-4-4 of the informal group HR-4-4), developed in 1989, when the applicability of their regulation was increased to 4,536 kg. By extending the applicability from passenger cars to include trucks, buses, and multipurpose passenger vehicles, there was an estimated reduction of 510 to 870 injuries at an average cost of $29.45 per vehicle (1989 dollars). Japan presented data (HR-4-10) showing the breakdown, by vehicle weight, of crashes resulting in whiplash injuries. They show 1,540 (0.7%) rear impacts involving vehicles with a GVW over 3,500 kg that resulted in bodily injury.

There is strong support to limit the weight of category 2 vehicles to 3500 kg. In this case, there would be discussion in the technical rational for Countries to expand as needed. It was stated that the gtr should reflect the lowest common denominator and countries can expand the

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1/ As defined in Annex 7 to the Consolidated Regulation on the Construction of Vehicles (R.E.3) (document TRANS/WP.29/78/Amend.2 at last amended by Amend. 4).

2/ As defined in the Special Resolution No. 1 concerning the PTO Common Definitions of Vehicle Categories, Masses and Dimensions (document TRANS/WP.29/1045).

application as needed. The US continues to state that it will be difficult for them to limit application of the gtr to anything less than 4,500 kg.

The applicability section remains in brackets. This discussion will continue at the September 2006 meeting.

5.2. Scope

At the April meeting, scope language was proposed: "This gtr specifies requirements for head restraints to reduce the frequency and severity of [neck injury] in rear end [and other collisions.]" At the June meeting, it was proposed to replace "neck injury" with "whiplash associated disorder".

There was concern about defining the scope using the injuries and the type of accidents in which those injuries occur. New text was proposed for the scope that addresses these issues: "This gtr specifies requirements for head restraints to reduce the frequency and severity of injuries caused by rearward displacement of the head." This text comes from the definition of head restraints and was accepted for recommendation by the informal working group.

5.3. Height of the Head Restraint

5.3.1. Front Outboard

Both UNECE Regulation No. 17 and the FMVSS No. 202 Final Rule require front outboard head restraints with a minimum height of 800 mm above the R-point/H-point, respectively. A proposal was made to recommend a minimum height of 850 mm, to accommodate the taller citizens of some countries.

Data was provided showing that the average sitting height for adults in Netherlands and the United States has increased over the last 10 years and a higher head restraint is needed to protect these occupants (see HR-3-6). Japan presented data (see HR-4-10) showing that Japanese females and males are smaller than the United States population. They stated that the current height requirement of 800 mm is appropriate and do not want to raise it to 850 mm. The United Kingdom also submitted data (see HR-4-14 and HR-6-11) that showed although their population is not increasing in size, they are tall enough to need taller head restraints.

Using the Netherlands and University of Michigan Transportation Research Institute (UMTRI) data for automotive sitting height, it was calculated that a 800 mm height of head restraints is sufficient to protect up to almost a 95th percentile Netherlands male (see HR-4-2). This data was revised to include spine straightening and it still did not support raising the height to 850 mm. There is support for this measurement calculation because it incorporates the effect of backset and it measures occupants as they sit in a vehicle.

The Netherlands data was stated to be more robust because it measures erect sitting height and does not need to take in account spine straightening. Some representatives questioned the necessity of taking into account spine straightening. It was stated that spine straightening may not be a factor when there is a reduced backset. Additionally, it was stated that the spine straightening research of Kroonenberg, which showed a T1 z-displacement of 34 mm (SAE paper 983158), was conducted on a standard (cushioned) car seat, and a similar research of Ono (which showed similar effects) was conducted on a rigid board. It was discussed that this phenomenon would not be as pronounced in a cushioned automotive seat.

It was stated by one representative that their head restraints are built with a compliance margin of 20 mm, therefore their head restraints are being built to 820 mm. If the height of the head restraint is required to be 850 mm, this representative would need to build their head restraints to 870 mm. It was noted that with an 800 m head restraint, it is starting to become a challenge to be able to install seats in the vehicle, and a larger head restraint can also restrict occupant visibility (blocking vision rearward and to the side) (see HR-3-5). Additional data was presented (see
HR-3- 4) that showed that in small cars (smaller than mini), 850 mm head restraints could severely restrict rearward vision in the rearview mirror.

The Netherlands stated that taller men are also presented in the statistics and that whiplash is a real problem in the Netherlands (50 percent insurance payments are to whiplash, there are problems with the hospitals, etc.). In Japan, females have a higher potential of whiplash injury
(see HR-4-10).

The United States reviewed their cost benefits analysis for height and backset and found that there are no benefits to increasing the height to 850 mm. The benefits calculated are solely influenced by the 55 mm backset. Benefits from height do not come into account until backset is very large.

In addition, there were concerns expressed over measuring active head restraint systems using the same methods to measure passive systems.

There is split support for both methods of calculations of needed height. Both the UK and the US will provide cost benefit analysis Discussion on these issues will continue at the next meeting.

5.3.2. Rear Outboard

It was proposed that optionally installed rear outboard head restraints have a minimum height of 750 mm. Additionally it was proposed to define a rear head restraint as any seat structure 700 mm above

the H-point. Current practice in UNECE is allowing the manufacturer designating what is and is not a head restraint. The United States standard requires that optionally installed rear outboard head restraints must meet the requirements of the standard. The recommendation of the group is that these head restraints if installed, must conform to the dimensional, with a 750 mm height, and static requirements, excluding backset.

5.3.3. Front Center/Rear Center

There was discussion on how front center head restraints are regulated under UNECE Regulation No. 17 and how to address these restraints in the gtr. Under UNECE Regulation No. 17, the manufacturer has the option to approve center head restraints to the requirements; meaning that the installation of a center head restraint does not necessarily mean it has been approved to the requirements. In this sense, United States regulations do not have the same capability as the UNECE Regulation. In general in the United States, if a manufacturer chooses to optionally install a piece of equipment, than that piece of equipment must meet the regulation. For example, manufacturers have the option to install rear outboard head restraints, but if they are installed, they must meet the requirements outlined in FMVSS 202.

Some delegates are concerned with the ability to justify regulating front center head restraints due to low occupancy rates. There is also concern that front center head restraints may impede visibility. It was stated that in Europe there is a UNECE requirement that limits obscurity of rearward visibility to 15 percent.

The working group recommends that front center head restraints be included in the gtr and regulated in the same manner as rear outboard head restraints (i.e. optional, no backset requirement, 750 mm height, etc.). Requirements for rear center head restraints have also been included. These head restraints have the same requirements as front center head restraints, but they do not have a height requirement (To be called a head restraint, it must have a minimum height of 700 mm).

5.3.4. Clearance Exemption

There is consensus to recommend, in the measurement of height, the allowance of a 25 mm clearance exemption for the "roofline or backlight." There is additional discussion on where this measurement is taken and the seat set-up when the measurement is taken.

There are two proposals being considered. One allows 25 mm of clearance between the head restraint and the roofline or rear window when the head restraint is in the lowest position, the seat is in the lowest position, and the seat back angle measures 25 degrees. This is based on the safety concern for maintaining the 800 mm height of the head restraint.

Another proposal was put forth to allow the clearance exemption be applied when the seat is in any position of adjustment. (see HR-4-15) It was stated that this exemption was needed to allow the rear seat passengers to exit the vehicle in emergency. Without the clearance, the seat could contact the vehicle structure and slow down the egress process.

Some delegates do not believe that emergency egress is an issue. There is also concern that the clearance exemption could be applied when the seat is in the highest position, thereby allowing head restraints as short as 700 mm. It was stated the reducing the height of a head restraint to less than approximately 780 mm will have an impact on the benefits.

After a review of the fleet, it was determined that the clearance exemption is not needed for front seats for folding positions and therefore it is recommended that this exemption only be applied in cases of interference with the roofline or backlight. This discussion will be re-opened if the height of the front

head restraints is raised to 850 mm. This exemption is currently used for some folding rear seats, and therefore the exemption is still being considered in those cases.

With regard to the seat setup, it was discussed that this exemption be applied when the seat is in the lowest position and the head restraint is in the highest position, since this would be the position of the tallest occupant. There is another recommendation that this clearance be applied when the seat is in design position. Evaluation of the proposed setup is still ongoing. The group does recommend that the measurement be taken at any point of forward or aft adjustment.

It was also requested that the working group consider convertible roofs as they are retracted. Further discussion on this issue will continue at the next meeting.

5.4. Adjustable Front Head Restraints – Front Surface Height

It has been proposed to include in the gtr the UNECE Regulation No. 17 requirement that the height of the head restraint face be a minimum of 100 mm to ensure sufficient surface for the occupant's head to contact. The UNECE Regulation No. 17 requirement is measured in the same manner as the overall height of the head restraint. There have been concerns expressed that the measurement taken in this manner does not address the effective height of the restraint. In the case of extremely contoured head restraints, the height of the surface that the head would contact is less than the measured height. It has been proposed that the 100 mm requirement be applied to this effective height of the head restraint. This proposal was countered by some as not necessary because the shape of the head restraint is governed by the displacement test, energy absorption test, and other requirements.

For inclusion in the gtr, this requirement needs to be justified and if the method of measurement is to be changed, an objective test procedure will need to be proposed.

5.5. Head Restraint Width

5.5.1. Front Seats

5.5.1.1. Single Seats

There is consensus to recommend that single front outboard seats have a minimum head restraint width of 170 mm.

5.5.1.2. Bench Seats

There is a proposal to recommend that head restraints have a minimum width of 254 mm when installed in the front outboard positions on bench seats. The need for this requirement has been argued because a bench seat can cause the occupant to sit off-center from the head restraint (especially if unbelted), therefore a wider head restraint is needed.

There was concern for regulating the wider head restraints because the gtr would be regulating misuse. Others stated this requirement is no longer necessary, because the vehicle bench seat of today is considerably different from the vehicle bench seat of 40 years ago. There is also a concern that wider head restraints could impact visibility.

At this time, it is difficult to justify this requirement. Unless justification is presented this requirement will not be included in the gtr and thus all head restraints would have a minimum width of 170 mm.

5.5.2. Rear Seats

There was consensus to recommend that rear outboard seats, if installed, have a minimum head restraint width of 170 mm.

5.6. Seat Set Up and Measuring Procedure for Height

There are two proposals under discussions concerning the set-up of the seat for measurement and the measurement procedure. One proposal is to use the manufacturer's recommended seating position as detailed in UNECE Regulation No. 17. The other is to use the procedure that is outlined in the recently adopted FMVSS No. 202, which positions the seat in the highest position of adjustment and sets the seat back angle at a fixed 25 degrees. The United States procedure allows for results of height and backset to be compared from vehicle to vehicle. The UNECE Regulation No. 17 procedure allows the seat to be measured at the same seat back angle that is used to determine other occupant design requirements, such as sight angles and has proved to be very repeatable and reproducible; concerns have been raised that the United States procedure would result in high variations at certification. UNECE Regulation No. 17 also takes into account the difference in seating positions for different vehicle types.

In addition to the set-up of the seat, the method of measuring height is under discussion. Some recommend taking all measurements from the R-point. Another proposal is to use the J826 manikin as the primary measurement tool. The use of the R-point allows measurements to be verified to known design points on the vehicle thus improving repeatability. The use of the J826 manikin allows the seat H-point to be measured as it exists in the vehicle and when it is under load. It was argued that options in seat materials and manikin set up can produce recordable differences from one seat to another. UNECE experience shows that the use of the R-point allows measurements to be easily verified on a drawing and is also very repeatable and reproducible when verified in a car. The use of H-point can address differences in measurements caused by seat materials.

Although there is considerable support to measure backset from the R-point, there is no test method or test device to do this. A proposal has been put forth to allow backset to be measured from R-point (HR-6-3 and HR-6-6). The test device and procedure will be further developed and validated. Further discussion is expected at the September 2006 informal working group meeting.

5.7. Backset

It was proposed to recommend a maximum backset of 55 mm for front outboard head restraints, using the Head Restraint Measuring Device (HRMD), as a measuring tool. There is general consensus to recommend the regulation of backset, but there was concern that the 55 mm requirement is too stringent.

Data has been presented with regard to concerns relating to repeatability/reproducibility issues with the test device and with using different technicians to measure the backset. It has been shown that for each degree of torso angle change, there is approximately 4.3 mm backset change and a 5 mm deviation in H-point could cause a 20 mm variability on backset. It has also been noted that H-point scatter around R-point can vary in all directions and that build variability can translate into significant variability in backset. Another study showed that vehicle orientation can impact backset variation and it has been recommended to use the design seating position to reduce variability. Other representatives acknowledged their desire to use the design seat back angle in measuring backset, noting that this would be the same angle that is used in other testing, like frontal impact.

There has also been concern for the comfort of the occupant. Representatives are starting to see customer complaints on head restraints that were built to a 50 mm backset. It was mentioned that if backset were regulated at 55 mm, then vehicles would be designed to 35-40 mm. A study was presented (see HR-4-7) based on eye-ellipse data from UMTRI in which interference between the head

restraint and head when the backset is 50 mm was calculated. In a seat that was designed for a 50 mm backset at 25° torso angle, with a mean driver selected seat back angle of 20°, there would be interference problem with about 35 to 40 percent of the occupants. At a mean driver selected seat back angle at 22°, approximately 10 percent of the occupants would have interference problems with the head restraint.

To alleviate some of the concerns with comfort on seats that have a very upright seat back design angle. The working group agreed to recommend that backset is measured at manufacturers seat back design angle.

There has also been concern for measuring active head restraint systems using the same methods to measure passive systems. Studies are ongoing to develop a test procedure to measure the backset when the seat is in the activated position.

Discussion on this issue continues.

5.8. Gaps

5.8.1. Gaps within Head Restraint

It has been proposed that all gaps within the head restraint have a maximum dimension of 60 mm when measured using a 165 mm sphere. There is general consensus to recommend the sphere measurement requirement.

In addition to this requirement, it has also been proposed to allow gaps larger than 60 mm if the displacement tests requirements can be met when the load is applied at the gap. A concern for safety has been expressed on allowing gaps that are too large. It has been suggested that some of these concerns are addressed by the backset requirement, but limitations on the HRMD do not allow for a full evaluation of the gap and the backset requirement does not apply to the rear seats. It was also stated that the displacement test accounts the density of the foam of the head restraint.

It was noted that there are some vehicles that utilize the exemption for gaps larger than 60 mm. In one vehicle in which this exemption was used in the rear seat, it was noted that the larger gaps were needed to address concerns with rearward visibility. The use of this exemption in these vehicles is being reviewed and this discussion will continue at the next meeting.

5.8.2. Gaps between bottom of head restraint and top of seat back

It has been proposed that gaps between the bottom of the head restraint and the top of the seat back have maximum dimension of 60 mm when measured using a 165 mm sphere. There has been an alternative proposal to allow a maximum height of 25 mm when measured using the same method to measure overall height as described in UNECE Regulation No. 17. It was also stated the 25 mm gap requirement is to prevent a gap that is too large. Requiring a minimum gap was established to prevent an occupant from contacting the head restraint posts or other structure when the head restraint is in the lowest position. It was noted that because of seat contours, there was concern that using the sphere to measure this gap could result in failure of gaps that would normally pass the UNECE Regulation No. 17 requirement or gaps that are extremely small.

There was consensus that this gap should be limited and it was agreed to recommend the option of meeting this requirement using either gap requirement/measuring technique.

5.9. Head Restraint Adjustment Retention Devices (Locks)

There is general consensus to recommend that if a device is adjustable for height, then it should hold its position when loaded in the downward direction. It has been proposed that downward force of 500 N be applied to the top of an adjustable head restraint to ensure the integrity of the height retention device. Concern was expressed that this load was overly severe, the forces were being applied in the wrong direction, and that such a requirement might negatively affect active head restraint system design. Data from Hybrid III dummies was provided on the representativeness of the force levels. It was stated that if there is still a concern with the 500 N load, than justified alternatives would be considered.

It was also questioned if the measurement taken at the top of the head restraint is the correct method, as it does not take into account the foam hysteresis. An alternative suggestion was made to use the bottom of the head restraint as reference. New regulatory text and test procedures were drafted (HR-6-9) and discussed. The informal working group is evaluating this proposal and will continue the discussion at the next meeting.

5.10. Removability

There is consensus to recommend the ability for head restraint removal via a deliberate action distinct from any act necessary for adjustment as stated in UNECE Regulation No. 17. There is discussion on the meaning of "a deliberate action distinct from any act necessary for adjustment." It has been proposed to allow for removal via a deliberate action distinct from any act necessary for upward adjustment. The working group as agreed on recommended language for the gtr to reflect this concept.

5.11. Non-use Positions

5.11.1. Front Seats

It has been proposed to allow non-use positions in the front seat, as long as they automatically return to the proper position when the seat is occupied. A test procedure using the 5th percentile female Hybrid III dummy or a human surrogate to evaluate these systems has been added to the gtr.

There is addition ongoing discussion to allow any validated method used to determine a non-use position in the rear seats, be allowed as a method to evaluate non-use in the front seats.

5.11.2. Rear Seats

5.11.2.1. Manually adjusted non-use positions

There is consensus to recommend regulation of non-use positions in the rear seats, as long as the position is "clearly recognizable to the occupant." There is discussion on how to objectively evaluate this requirement. One proposal is to define "clearly recognizable" as a head restraint that rotates a minimum of 60 degrees forward or aft. There was concern that this definition is too design restrictive as the sole method and additional methods have been proposed (see
HR-4-13).

A human factors study was conducted the evaluated the effectiveness of a 5º, 10º, and 15º torso angle degree change in causing an occupant to move the head restraint out of the non-use position. Based on the results of this study, the working group agreed to recommend the 10º torso angle change option as an alternative. This study also looked at the effectiveness of labels, and found them to have zero effectiveness in causing the occupant to move the head restraint, therefore this option was not incorporated in to the gtr.

Another proposal under consideration is a "discomfort metric" which defines the zone the head restraint is in when it is in the non-use position. This concept was accepted for recommendation by the working group, but the appropriate dimensional criteria needs to be determined. A study to evaluate the criteria is planned.

5.11.2.1. Automatically adjusted non-use positions

There is consensus, for the rear seats, to recommend regulation of non-use positions that automatically return to the proper position when the seat is occupied. A test procedure using the 5th percentile female Hybrid III dummy or a human surrogate to evaluate these systems has been added to the gtr.

5.12. Energy Absorption

5.12.1. Impactor

It has been proposed to recommend the energy absorption test defined in FMVSS No. 202. This test is similar to the test defined in UNECE Regulation No. 17, except for the testing device and the requirement to rigidly fix the seat back during testing. Data was presented (see HR-4-8) showing that the free motion head form produces equivalent results as a pendulum impactor on rigidly supported head restraint form. Additional testing was presented at the January meeting on the comparison of pendulum and linear impactor and the effect of rigidly fixing the seat back.

The working group agreed to recommend a test procedure that did not specify a type of impactor, but rather a required energy. This would allow either the linear impactor, the free motion impactor, or the pendulum impactor to be used for testing. Additionally, the working group agreed to recommend running the test without fixing the seat back.

5.12.1. Radius of Curvature

It has been proposed to incorporate the UNECE Regulation No. 17 requirement that designated parts of the front of the head restraint shall not exhibit areas with a radius of curvature less than 5 mm pre- and post-test. Justification for the post-test evaluation is that there could be interior breakage that would produce a sharp edge. There is concern for the protection of occupants from secondary impacts. It was stated that the pre-test requirement is very difficult to conduct under self-certification. Applying this to the rear of the head restraint is not within the scope of the gtr.

Delegates were tasked to either define an objective test procedure or consider whether a discussion in the preamble will address their concerns.

5.13. Displacement Test Procedures/Adjustable Backset Locking Test

A proposal was made to incorporate into the gtr the displacement test defined in FMVSS No. 202. This test adapted the displacement test procedure in UNECE Regulation No. 17 to incorporate an objective evaluation of adjustable backset locking systems.

The United States varies from the UNECE requirement in that the United States rigidly braces the seat back, and then applies the loading. The test is conducted as follows:

- A 37 Nm load is used to establish a reference position.
- This is increased to 373 Nm, and a limit of 102 mm of displacement is applied (as in UNECE Regulation No.17).
- The load is backed off to 37 Nm. The delta between initial reference load position and the current load position cannot be more than 13 mm.

- At this point, the displacement part of the test is completed.
- The fixation is removed.
- The ultimate load test is conducted. (i.e. nothing can break).

It was noted that the reason for the fixation was that there were concerns about the variability in the return to the reference load. It was found that the test procedure was more repeatable when the seat back was braced.

The UNECE Regulation No. 17 displacement test combines seat back and head restraint movement. From this perspective, it was suggested that this would be a much more severe test. However, it is unknown which is more stringent in terms of displacement.

Contingent on expected positive results of validation testing, the working group has agreed to recommend that if the backset retention requirement is included, then following the 373 Nm load, the applied load will be reduced to zero for ten minutes, and then increased to 37 Nm, before measuring the displacement.

There is considerable discussion on whether to include the backset retention requirements. Some believe that if an occupant adjusts their head restraint backset so that it is less than the requirement, then they should have some assurance that it will maintain that position when loaded. Others argue that the safety needs are met at the requirement and any further adjustment is for comfort. The discussion on this topic is ongoing.

5.14. Dynamic Test

A proposal was made to recommend incorporation of the optional dynamic test defined in FMVSS No. 202 into the gtr as an option to the static requirements. Data was presented positively correlating the dynamic test to real-world data. There was a great deal of concern expressed by some delegates and representatives with respect to using the Hybrid III dummy in a dynamic test because the spine is not human like and the dummy does not have humanlike motion in a dynamic test. It was stated that the BioRID dummy is preferred in Europe for dynamic testing, but it was acknowledged that it was not ready for regulation.

There are concerns for a dynamic test using the Hybrid III dummy. It was suggested that a dynamic test could be an iterative step, and the gtr can be amended when a better dummy and test procedure are available. If it is an iterative step, there needs to be further discussion on the appropriate measurement criteria and value. There is also some discussion that the dynamic test would be a second step to the gtr drafting process, and in the meantime alternative methods for the evaluation of active head restraints are being evaluated.

The working group requests that the GRSP to set-up an informal group to recommend a whiplash dummy and dynamic test to be added to the gtr. A volunteer is needed to chair this committee. It was recommended that the first step of this committee would be to develop a "Terms of Reference" document. It was also noted that this proposed group should coordinate with the activities of the EEVC on this issue.

6. LIST OF INFORMAL WORKING GROUP DOCUMENTS

HR-1-1	Attendance List, Paris, 1-2 February 2005
HR-1-2	(USA) Final Rule
HR-1-3	(USA) Final Regulatory Impact Analysis - FMVSS No. 202 Head Restraints for Passenger Vehicles

HR-1-4	(USA) Comparison of Head Restraint Regulations FMVSS 202 (Current standard, Final Rule, and UNECE Regulation No. 17)
HR-1-5	{Blank}
HR-1-6	Head Restraints for Rear Seating Positions
HR-1-7	(OICA) Abstract from ACEA Whiplash Test Series on Repeatability and Reproducibility of Proposed Test Procedures
HR-1-8	(USA) United States FMVSS No. 202 Final Rule
HR-1-9	GRSP informal group on head restraints 1st Meeting, Paris, 1-2 February 2005 Draft Summary Report
HR-1-9-Rev.1	GRSP informal group on head restraints 1st Meeting, Paris, 1-2 February 2005 Draft Summary Report
HR-2-1	(USA) The Displacement Test as an Alternative to the 60 mm Gap Requirement
HR-2-2	Head Restraint Informal Working Group Meeting - Agenda 11-13 April 2005, OICA Offices, Paris, France
HR-2-3	(Netherlands) Static geometric measurements on head restraints
HR-2-4	(USA) Justification for 254 mm width of Head Restraints on Bench Seats
HR-2-5	(Japan) Japan's Comments on Backset Requirements of FMVSS 202aS – Final Rule - Study of Variations in Backset Measurements
HR-2-6	(USA) Head Restraint Height Measurement - H-point vs. R-point
HR-2-7	(USA) Correlation of Dynamic Test - Procedure to Field Performance
HR-2-8	(USA) Justification for Load Values - FMVSS No. 202 Final Rule – Backset and Height Retention Testing
HR-2-9	BioRID ATD - Part of a Presentation from Matthew Avery / Thatcham for an EEVC WG12/20 joint meeting
HR-2-10	Neck Injuries - Real World Data - Male/Female Comparison - Raimondo Sferco/Bernd Lorenz - Ford Motor Company/BASt
HR-2-11	(Germany) Current Status of the Euro NCAP Whiplash Subgroup Bundesanstalt für Straßenwesen - Federal Highway Research Institute
HR-2-12	(Germany) Current Status of the EEVC WG 20 "Rear Impact test procedure(s) and the mitigation of neck injury" Bundesanstalt für Straßenwesen - Federal Highway Research Institute
HR-2-13	(OICA) Comment for Non Use Position of Non Use Position of Head Restraint gtr
HR-2-14	(Netherlands) Needed Height for Head Restraints
HR-2-15	Attendance List - GRSP Informal Group Meeting on Head Restraints Paris, 11-13 April 2005
HR-3-1	Head Restraint Informal Working Group Meeting - Agenda, 13-15 June 2005, NHTSA Office, Washington, D.C., USA
HR-3-2	Japan's Comments on Draft Action Items for June 2005 - Head Restraints gtr Meeting
HR-3-3	Japan's Comments on Backset Requirements of FMVSS 202aS - Final Rule
HR-3-4	Japan's Comments on Head Restraint Height Proposal from the Netherlands
HR-3-5	Height of Head Restraint - Impact of increased height threshold of head restraints
HR-3-6	(Netherlands) Calculation needed head restraint height
HR-3-7	(Japan) Biomechanical Responses of HY-III and BioRID II (Part 1)
HR-3-8	(Japan) Biomechanical Responses of HY-III and BioRID II (Part 2)
HR-3-9	(USA) Laboratory Test Procedure for FMVSS 202aS - Head Restraints – Static Requirements
HR-3-10	(OICA) Alliance of Automobile Manufacturers - Head Restraint gtrInput
HR-3-11	Attendance List - GRSP Informal Group Meeting on Head Restraint – Washington, D.C., 13-15 June 2005
HR-3-12	(USA) Final Rule
HR-3-13	(USA) Final Regulatory Evaluation: Extension of Head Restraint Requirements to Light Trucks, Buses, and Multipurpose Passenger Vehicles withGross Vehicle Weight Rating of 10.000 pounds or Less (FMVSS 202)

HR-3-14	(USA) An Evaluation of Head Restraints Federal Motor Vehicle Safety Standard 202, February 1982
HR-4-1	Agenda of the Head Restraint Informal Working Group Meeting – 7-9 September 2005, OICA Office, Paris, France
HR-4-2	(USA) United States' Analysis of the Need to Raise the Head Restraint Height to 850 mm
HR-4-3	(Japan) Japanese Backset Raw Data Revision B
HR-4-4	(USA) Extending the Applicability of United States FMVSS 202 to Light Trucks and Vans - Summary of HR-3-12 and HR-3-13
HR-4-5	(USA) United States Justification for "Other Collisions" in the Proposed Scope
HR-4-6	Draft Global Technical Regulation on Head Restraints
HR-4-7	(CLEPA) Head Positions, Summary of UMTRI Study and Vehicle Examples
HR-4-8	(CLEPA) Comparison between the Pendulum and the Free Motion Headform (FMH) energy dissipation test
HR-4-9	(Japan) Japan's Comments on Backset Requirements of FMVSS 202aS – Final Rule
HR-4-10	(Japan) Japan Accident Analyses for Application and Height on Head Restraints gtr
HR-4-11	(Japan) Japan Research Status for Bio-RID II Injury Parameters on HeadRestraints gtr
HR-4-12	(Japan) Japan Research Status for Bio-RID II Dummy Repeatability and Reproducibility on Head Restraints gtr
HR-4-13	(OICA) Head Restraint gtr Informal Working Group - OICA Data Submission, 7-9 September 2005
HR-4-14	(UK) UK Population Stature 1993-2003
HR-4-15	(OICA) Draft Proposal on Roof Clearance for Tip Forward Seat Backs
HR-4-16	(Netherlands) Netherlands' Comparison of Two Different Calculations of "Needed Head Restraint Height".
HR-4-17	HR-4-6 (202 Draft gtr) revised as of 9 September 2005 (HR-4-17)
HR-4-18	(OICA) Head Restraint Definition
HR-5-1	Meeting Agenda
HR-5-2	Draft GTR regulatory text
HR-5-3	OICA Non-Use Position proposal
HR-5-4	US Measurement Variability Presentation
HR-5-5	US Non-Use Position Study
HR-5-6	US Energy Absorption Test
HR-5-7	OICA Head Restraint Height Clearance
HR-5-8	UK Rear Impact Dummy Research
HR-5-9	OICA Backset Complaint Data
HR-5-10	US Measurement Variability Comparison
HR-5-11	OICA Dummy Performance Comparison
HR-5-12	CLEPA Dynamic tests with control yielding seats
HR-5-13	OICA Head Restraint Applicability data
HR-5-14	Canada Head Restraint Comparison Methods
HR-5-15	Status of Euro NCAP
HR-5-16	ESV Paper: The Role of Seatback and Head Restraint Design Parameters on Rear Impact Occupant Dynamics
HR-5-17	US Energy Absorption Test report
HR-5-18	Japan Presentation on Accident Data
HR-5-19	Japan Presentation on Reproducibility of Dummy Data
HR-5-20	Meeting Minutes – January 2006
HR-5-21	GTR regulatory text at end of meeting 1/27/06
HR-5-22	Draft GTR regulatory text for Height Retention of Head Restraints
HR-5-23	US Head Restraint Non-Use Position Report
HR-6-1	Meeting Agenda
HR-6-2	Draft GTR regulatory text - April 14, 2006

HR-6-3	(OICA) Test procedure for backset measurement from R-point
HR-6-4	Draft GTR regulatory text - April 21, 2006
HR-6-5	(Japan) Hybrid III T1G for whiplash evaluation in a dynamic test
HR-6-6	(OICA) Dimensional drawings for document HR-6-3
HR-6-7	(France) Consideration for measuring active head restraints
HR-6-8	(CLEPA) Test Procedures for Energy Dissipation Test
HR-6-9	(CLEPA) Foam Influence on height retention
HR-6-10	(Japan) Example of Gap greater than 60 mm
HR-6-11	(UK) Head Restraint Height Calculations

Note: All the documents of the informal group on Head Restraints are available at: http://www.unece.org/trans/main/welcwp29.htm

Head Restraint Component	U.S. – FMVSS 202 (current)	US FMVSS 202 Final Rule (FR)	UNECE Regulation No 17	Comments
A. Application **1. Vehicles**				
	Front outboard seating positions in passenger cars, MPVs and trucks with a GVWR ≤ 4536 kg	Front outboard and rear outboard (optional) seating positions in passenger cars, MPVs and trucks with a GVWR ≤ 4536 kg, with added exclusion for seating position adjacent to aisle on buses (more than 10 seats)	Front outboard and rear (optional) seating positions in vehicles of categories M1 and N1, and of vehicles of categories M2 up to 3,500 kg (paras. 5.3.1. to 5.3.2)	-If HR present in rear seat, UNECE 17 and 202 Final Rule regulates. -UNECE 17 regulates rear center head restraints if available.
2. Requirements				
a. Height				
1. Front outboard				
A. Fixed	At least 700 mm above H-point as measured parallel to the torso reference line.	Increased to 800 mm above H-point and measured with a SAE J826 manikin. Seat back angle set at 25 degrees. Seat cushion at highest position.	Same height as FR, but measured from R-point. Seat back angle is 25 degrees or manufacturer specified. Seat cushion at lowest position	Different seat set-up and measuring techniques used.
B. Adjustable	Same as 202-fixed	Must achieve a height of 800 mm and cannot be adjusted below 750 mm. Measured with a SAE J826 manikin. Seat back angle set at 25 degrees. Seat cushion in highest position.	Same height as FR, but measured from R-point and at manufacturer's suggested angle or 25 degrees. Seat cushion in highest position.	Different seat set-up and measuring techniques used.

	adjustable seat component attached to or adjacent to a seat back, that has a height equal or greater than 700 mm, in any position of backset and height adjustment.)			
A. Fixed	Not specified	If provided, minimum height of 750 mm above H-point. Measured with SAE J826 Manikin.	If provided, same height as FR, but measured from R-Point	Different seat set-up and measuring techniques used.
B. Adjustable	Not specified	If provided, no adjustment below 750 mm from H-point. Measured with SAE J826 Manikin.	If provided, same as FR, but measured from R-Point	Different seat set-up and measuring techniques used.
3. Rear Center				
	Not specified	Not specified	If provided, minimum height of 700 mm above R-point	
b. Backset				
1. Front outboard positions	Not specified	Backset limited to a maximum 55 mm as measured with HRMD. Head restraint in at any height adjustment between 750 and 800 mm, inclusive. Seat back angle set at 25 degrees. Seat cushion at highest position.	No backset specified, but there is a general requirement for the seat back angle to be set at manufacturer's suggested angle or 25 degrees and the seat cushion to be in the lowest position.	Different seat set-up and measuring techniques used.

	mm on single seats and 254 mm on bench seats	mm on single seats (outboard seats with no seat in between) and 254 mm on bench seats (outboard seats with seat in between).	mm for all seat types.	requires wider HRs on front outboard seats with a center seat between them.
2. Rear outboard	Not specified	If provided, minimum of 170 mm for all seat types	If provided, minimum of 170 mm.	
d. Height of adjustable head restraint front surface				
	Not specified	Not specified	Minimum height of 100 mm	
e. Gaps				
1. All outboard positions	Not specified	In all positions, gap between HR and seat back and within the HR is ≤ 60 mm. A 165 mm sphere is pressed against the gap with a load no more than 5 N	-In lowest position, gap is ≤ 25, with no reference to backset adjustment. Measured along straight line between HR and seat back. -In other positions the gap ≤ 60 mm as measured with 165 mm dia. sphere. -Gaps larger than 60 mm are allowed if they pass the energy absorption test.	-UNECE Regulation Nos. 17 and 25 does not specify load placed on the sphere to measure gap. UNECE Regulation Nos. 17 and 25 measures the gap between the HR in the lowest position and seat back differently from the gaps in the HR. -Larger gaps allowed by UNECE, but must be tested.

1. Height	Not specified	Must maintain height in highest position and at 800 mm and 750 mm for front and rear seats (if HR provided), respectively, while a downward force is applied. Seat back is rigidly constrained.	If adjustable, requires automatic locking system (UNECE Regulation No. 17, para. 5.1.1). No downward test required.	UNECE has no downward testing requirement.
2. Backset	Not specified	Under applied rearward moment, while adjusted to 800 mm for front and 750 mm for rear (if provided), HR must maintain any position of backset adjustment. Seat back is rigidly constrained.	Not specified.	
g. Removability				
1. Front	Not specified	Can be removed with deliberate action distinct from any act necessary for adjustment.	Same as 202 FR	
2. Rear	Not specified	Can be removed with deliberate action distinct from any act necessary for adjustment.	Same as 202 FR	

		allowed where rear HRs, when seat is occupied, interfere with roofline or rear window.	mm clear space allowed where interference with vehicle structure. Seat does not need to be occupied. Minimum height of 700 mm must be maintained.	mm gap is measured from any vehicle structure, not just roofline or rear window as in FR. -UNECE requires a minimum seat height if HR is present. FR defines a rear HR as having a height greater than 700 mm
i. Non-use positions				
1. Front	Not specified	Not allowed	Allowed, provided HR automatically returns to proper position when seat is occupied.	
2. Rear	Not specified	Allowed, provided HR automatically returns to proper position when seat is occupied or the HR is rotated a minimum of 60° forward or rearward.	Allowed as long as non-use position is "clearly recognizable to the occupant".	United States rule defines "clearly recognizable" as being rotated forward or rearward 60°.
j. Radius of Curvature				
	Not specified	In NPRM, requirement was same as UNECE Regulation No. 17. Requirement was deleted in final rule.	Parts of front and rear of HR shall not exhibit a radius of curvature less than 5 mm.	Deleted in FR because enforcement outweighs benefits. No commenter had info to support reg.

		impacted with head form at v=24.1 km/h. 3 ms deceleration of head form must not exceed 80 gs. Impactor is linear head form with mass of 6.8 kg.	pendulum impactor with same weight and velocity as linear impactor. Front and rear of HR tested.	and FR are functionally equivalent. Except FR does not test rear of HR.
l. Displacement Test Procedures				
	Load is applied to back pan of seat, load is applied to head restraint after seat load is removed. 102 mm of displacement allowed with 373 Nm moment. Load is increased until 890N or seat back fails. Use spherical or cylindrical form to apply load.	Test procedure modified from 202. Seat back and HR loaded together. Moments and displacements same. Maximum load the same, seat back cannot fail. Use spherical form to apply load	Same load and displacement requirements as FR.	FR provides a detailed test procedure, including load hold times.
m. Dynamic sled test (optional)				
	Seat accelerated so the pulse falls in a corridor defined by 2-½ sine waves with amplitudes of 78 m/s^2 and 86 m/s^2. Corridor cannot be met. 95th male dummy used, max rotation 45°.	New corridor based on scaled version 208 sled test. Target pulse the same as 202. 50th male dummy used in any seat, HR adjusted midway between lowest and highest position and any backset position. 12° max rotation.	Not specified	

Appendix 2
Draft Head Restraint Global Technical Regulation
Regulatory Text

Draft Global Technical Regulation on Head Restraints

B. Text of Regulation

1. **Scope and Purpose:** This gtr specifies requirements for head restraints to reduce the frequency and severity of injuries caused by rearward displacement of the head.

2. **Application:** This standard applies to all Category 1-1 vehicles; Category 1-2 vehicles with a Gross Vehicle Mass of up to 3,500 kg; and Category 2 vehicles, with a Gross Vehicle Mass of up to **[**3,500 kg[o1]**]** ~~**[**4,500 kg**]**~~.

3. **Definitions:**

3.0 Adjustable head restraint means a head restraint that is capable of movement independent of the seatback between at least two positions of adjustment intended for occupant use.

3.1. Backlight means rearward-facing window glazing located at the rear of the roof panel.

3.2. Backset means the minimum horizontal distance between the front surface of the head restraint and the rear surface of the head restraint measurement device, as measured in accordance with Annex 3[o2].

3.3 **[**Designated seating position – defined in domestic regulations and explained in the preamble.**]**

3.4. Head restraint means, at any designated seating position, a device that limits rearward displacement of a seated occupant's head relative to the occupant's torso that has a height equal to or greater than 700 mm at any point between two vertical longitudinal planes passing at 85 mm on either side of the torso reference line, in any position of backset and height adjustment, as measured in accordance Annex 1.

~~3.5. Headliner means any material covering the interior side of the roof. The portions of the same material covering the pillars are excluded from this definition.~~

3.6. Head restraint measurement device (HRMD) means the H-point machine with the head form, as defined in Annex 10, attached with sliding scale at the back of the head for the purpose of measuring backset.[1]

3.7. Three-dimensional H-point machine (H-point machine) means the device used for the determination of "H-points" and actual torso angles. This device is defined in Annex 10[o4].

3.8. Head Restraint Height means the distance from the **[**H-point**]** **[**R-point**]**, measured parallel to the torso reference line to the top of the head restraint on a plane normal to the torso reference line.

3.9. Intended for occupant use means, when used in reference to the adjustment of a seat and head restraint, adjustment positions used by seated occupants while the vehicle is in motion, and not those intended solely for the purpose of allowing ease of ingress and egress of occupants; access to cargo storage areas; and storage of cargo in the vehicle.

3.10. H-point means the pivot centre of the torso and thigh of the H-point machine when installed in a vehicle seat in accordance with Annex 10. Once determined in accordance with the procedure described in Annex 10, the "H" point is considered fixed in relation to the seat-cushion structure and is considered to move with it when the seat is adjusted.

3.11. R-point means a design point defined by the vehicle manufacturer for each designated seating position and established with respect to the three-dimensional reference system.

3.12. Top of the head restraint means the point on the head restraint centerline with the greatest height[o5].

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[1] The head form is designed by and available from the ICBC, 151 West Esplanade, North Vancouver, BC V7M 3H9, Canada (www.icbc.com).

4. General Requirements

4.1. Whenever a range of measurements is specified, the head restraint must meet the requirement at any position of adjustment as intended for occupant use.

4.2. In each vehicle subject to the requirements of this regulation, a head restraint that conforms to either 5.1. and 5.2., or 5.3. and **[**5.1.1. through[o6]**]** 5.1.6. of this regulation must be provided at each front outboard designated seating position.

4.3. For vehicles equipped with rear outboard and/or front center head restraints, the head restraint must conform to either 5.1. and 5.2. or 5.3. and **[**5.1.1. through[o7]**]** 5.1.6. of this regulation.

4.4. This regulation does not apply to auxiliary seats such as temporary or folding jump seats.

4.5. At designated seating positions incapable of seating a 50th percentile male Hybrid III test dummy, the applicable head restraint must conform to 5.1 and 5.2 of this regulation.

[4.6. During or after testing in accordance with this regulation, no sharp or unpadded components of the head restraint structure shall protrude from the front surface of the head restraint.**]**

5. Performance requirements

5.1. Dimensional requirements. Each front outboard head restraint must conform to 5.1.1., and 5.1.6. through 5.1.9. of this regulation; each front center head restraint must conform to 5.1.2, 5.1.6., 5.1.8. and 5.1.9. of this regulation; each rear outboard head restraint must conform to 5.1.4, 5.1.6., 5.1.8. and 5.1.9. of this regulation; each rear center head restraint must conform to 5.1.6., 5.1.8. and 5.1.9. of this regulation:

5.1.1. Front outboard designated seating positions. When measured in accordance with Annex 1, the top of a head restraint located in a front outboard designated seating position must have a height of: (a) not less than **[**800 mm**]** in at least one position of head restraint adjustment; and (b) not less than 750 mm in any position of head restraint adjustment. See exception in 5.1.3 of this regulation.

5.1.2. Front center designated seating positions equipped with head restraints. When measured in accordance with Annex 1, the top of a head restraint located in the front center designated seating position must have a height not less than 750 mm in any position of adjustment. See exception in 5.1.3 of this regulation.

5.1.3. Exception. The requirements of 5.1.1 and 5.1.2 of this regulation do not apply if the interior surface of the vehicle roofline, including the headliner, physically prevents a head restraint, located in the front outboard designated seating position, from attaining the required height. In those instances in which this head restraint cannot attain the required height, when measured in accordance with Annex 1, the maximum vertical distance between the top of the head restraint and the interior surface of the roofline, including the headliner, must not exceed 25 mm in the lowest position of seat adjustment; in any horizontal position of seat adjustment; and the highest position of head restraint adjustment intended for occupant use. Notwithstanding this exception, when measured in accordance with Annex 1, the top of a head restraint located in a front outboard designated seating position must have a height of not less than 700 mm in the lowest position of adjustment intended for occupant use.

5.1.4. Rear outboard designated seating positions equipped with head restraints. Except as provided in 5.1.5. of this regulation, when measured in accordance with Annex 1, the top of a head restraint located in a rear outboard designated seating position must have a height not less than 750 mm in any position of adjustment.

5.1.5. Exception. The requirements of 5.1.4 of this regulation do not apply if the interior surface of the vehicle roofline, including the headliner, or backlight physically prevent a head restraint, located in the rear outboard designated seating position, from attaining the required height and or folding to allow egress/ingress. In those instances in which this head restraint cannot attain the required height, when measured in accordance with Annex 1, the maximum vertical distance between the top of the head restraint and interior surface of the roofline, including the headliner, or the backlight must not exceed 25 mm in the lowest position of seat adjustment; in any horizontal position of seat adjustment; and the highest position of head restraint adjustment intended for occupant use.

5.1.6. Minimum width. When measured in accordance with Annex 2, the lateral width of a head restraint must be not less than 170 mm between two vertical longitudinal planes passing at 85 mm on either side of the torso reference line.

5.1.7. Minimum backset for front outboard designated seating positions. When measured in accordance with Annex 3, the backset must not be more than **[**55 mm**]**. For adjustable restraints, the requirements of this regulation must be met with the top of the head restraint in all height positions of adjustment between 750 mm and 800 mm, inclusive. If the top of the head restraint, in its lowest position of adjustment, is above 800 mm, the requirements of this regulation must be met at that position. If the front outboard head restraint is not attached to the seat back, the head restraint cannot be adjusted such that the backset is more than **[**55 mm**]** ~~when the seat back inclination is positioned closer to vertical than the **[**position specified in Appendix 3**]**~~. [o8]

5.1.8. Gaps within head restraint. When measured in accordance with Annex 4[o9], there must not be any gap greater than 60 mm within the head restraint fixed at any backset position of adjustment, **[**unless a rear head restraint can meet the requirements of S5.2.4[o10].**]**.

5.1.9. Gaps between head restraint and the top of the seat back. When measured in accordance with Annex 4, there must not be a gap greater than 60 mm between the head restraint and the seat if the head restraint is not adjustable[o11] vertically. When measured in accordance with Annex 4, there must not be a gap greater than 25 mm[o12] between a vertically adjustable head restraint and the seat, with the head restraint adjusted to its lowest height position.

5.2. Static performance requirements. Each head restraint must conform to paragraphs 5.2.1. through 5.2.5. of this regulation:

5.2.1. Energy absorption. When the front surface of the head restraint is impacted in accordance with Annex 5 the deceleration of the head form must not exceed 785 m/s^2 (80 g) continuously for more than 3 milliseconds.

5.2.2. ~~**[**Post-test damage. After being tested in accordance with Annex 5, no unpadded components of the head restraint structure shall be visible on the front surface of the head restraint**]**~~.[GF13]

5.2.3. Height retention. When tested in accordance with Annex 6, the **[**cylindrical test device**]** specified in Annex 6 must return to within 13 mm of its initial reference position after application of at least a 500 N load and subsequent reduction of the load to 50 N ± **[**2.5 N**]**. During application of the initial reference load specified in Annex 6, the **[**cylindrical test device**]** must not move downward more than 25 mm.

[5.2.3. Adjustable head restraint height retention. When tested in accordance with Annex 6, the mechanism of the adjustable head restraint shall not fail in such a way as to allow downward movement of the head restraint by more than 25 mm.

5.2.3.1. The mechanism shall be considered to have failed if during the test the vertical distance measured between the lowest point on the underside of the head restraint and the top of the seat back has been decreased by more that 25mm.

5.2.3.2. If the design of the head restraint is such that it is not possible to measure to the top of the seat then the vertical measurement shall be taken by marking a horizontal line across the front of the seat back at least 25mm below the lowest point of the head restraint and the measurement shall be taken from this line to the underside of the head restraint.[o14]**]**

5.2.4. Backset retention and displacement. When the head restraint is tested **[**in the rearmost (relative to the seat) position of horizontal adjustment**]** in accordance with Annex 7, the head form must:

[5.2.4.1. Not be displaced more than 25 mm during the application of the initial reference moment of 37 ± 0.7 Nm;**]**

5.2.4.2. Not be displaced more than 102 mm perpendicularly and posterior of the displaced extended torso reference line during the application of a 373 ± 7.5 Nm moment about the H-point; and

[5.2.4.3. Return to within 13 mm of its initial reference position after the following sequence occurs: application of a 373 ± 7.5 Nm moment about the H-point; reduction of the moment to 0 Nm; and by re-application of the initial reference load 37 ± 0.7 Nm.**]**

5.2.5. Head restraint strength. When the head restraint is tested in accordance with Annex 7, the load applied to the head restraint must reach 890 N and remain at 890 N for a period of 5 seconds.

5.3. [Dynamic performance requirements and width. In accordance with Annex 8, at each forward-facing outboard designated seating position equipped with a head restraint, the head restraint adjusted midway between the lowest and the highest position of adjustment, and at any position of backset adjustment, must conform to the following:

5.3.1. Injury criteria. When tested in accordance with 6.3 of this regulation, during a forward acceleration of the dynamic test platform described in 6.3.1, the head restraint must:

5.3.2. Angular rotation. Limit posterior angular rotation between the head and torso of the 50th percentile male Hybrid III test dummy to 12 degrees for the dummy in all outboard designated seating positions;

5.3.3. Head injury criteria. Limit the maximum HIC_{15} value to 500. HIC_{15} is calculated as follows: For any two points in time, t_1 and t_2, during the event which are separated by not more than a 15 millisecond time interval and where t_1 is less than t_2, the head injury criterion (HIC_{15}) is determined using the resultant head acceleration at the center of gravity of the dummy head, a_r, expressed as a multiple of g (the acceleration of gravity) and is calculated using the expression:

[Insert HIC calculation]]

5.4. Non-use positions. All rear head restraints and any front center head restraint may be adjusted to a position at which its height does not comply with the requirements of 5.1.2. and 5.1.4. of this regulation. However, in any such position, the head restraint must meet either 5.4.1, 5.4.2, or 5.4.3 of this regulation. A front outboard passenger head restraint maybe adjusted to a position at which its height does not comply with the requirements of 5.1.1. of this regulation. However, in any such position, the front outboard passenger head restraint must meet 5.4.1. of this regulation.[o17]

5.4.1. In all designated seating positions equipped with head restraints, except the driver's designated seating position, the head restraint must automatically return from a non-use position to a position in which its minimum height is not less than that specified in 5.1.2. and 5.1.4. of this regulation when a 5th percentile female Hybrid III test dummy is positioned in the seat in accordance with Annex 9. At the option of the manufacturer, instead of using a 5th percentile female Hybrid III test dummy, human beings may be used as specified in Annex 9; or

5.4.2. In rear and front center designated seating positions equipped with head restraints, the head restraint must, when tested in accordance with Annex 9, be capable of manually rotating either forward or rearward by not less than 60 degrees from any position of adjustment intended for occupant use in which its minimum height is not less than that specified in 5.1.2 or 5.1.4. of this regulation.

5.4.3. When measured in accordance with Annex 9, the lower edge of the head restraint (H_{LE}) must be not more than **[**460 mm**]**, but not less than 250 mm from the R-Point and the thickness (S) shall not be less than **[**25 mm**]**.

5.4.4 When tested in accordance with Annex 9, the head restraint must cause the torso reference line angle to be at least 10 degrees closer to vertical than when the head restraint is in any position of adjustment in which its height is not less than that specified in 5.1.1., 5.1.2., or 5.1.4. of this regulation and its backset is not more than that specified in 5.1.7. of this regulation.

5.5. Removability of head restraints. The head restraints must not be removable without a deliberate action distinct from any action necessary for upward head restraint adjustment.

6. Test conditions. Demonstrate compliance with 5.1 through 5.5 of this regulation with any adjustable lumbar support adjusted to its most rearward nominal design position. If the seat cushion adjusts independently of the seat back, **[**position the seat cushion such that the **[**highest[o19]**]** H-point position is achieved with respect to the seat back, as measured by H-point machine, with leg and thigh segments of the H-point machine adjusted to 414 mm and 401 mm[o20]**]**.

6.1. Seat setup. Except as specified in Annex 3, if the seat back is adjustable, it is set at an initial inclination position closest to design angle as measured by the H-point machine. If there is more than one inclination position closest to design angle, set the seat back inclination to the position closest to and rearward of 25 degrees. **[or design angle]**[o21]

6.2. Procedure for determining the presence of head restraints. In accordance with Annex 1, measure the height of the top of the seat back or the top of any independently adjustable seat component attached to or adjacent to the seat back between two vertical longitudinal planes passing at 85 mm on either side of the torso reference line in its highest position of adjustment using the H-point machine or an equivalent scale, which is positioned laterally within 15 mm of the centerline of the designated seating position ~~or any independently adjustable seat component attached to or adjacent to the seat back~~.[o22]

7. Test Procedures[o23]

7.1. Dimensional Requirements

7.1.1. Height of Head Restraints. Compliance with paragraphs 5.1.1., 5.1.2., 5.1.3., 5.1.4., and 5.1.5. is demonstrated in accordance with annex 1.

7.1.2. Minimum Width. Compliance with paragraph 5.1.6. is demonstrated in accordance with annex 2.

7.1.3. Minimum backset for front outboard designated seating positions. Compliance with paragraph 5.1.7. is demonstrated in accordance with annex 3.

7.1.4. Gaps within head restraints. Compliance with paragraph 5.1.8. is demonstrated in accordance with annex 4.

7.1.5. Gaps between head restraint and top of seat back. Compliance with paragraph 5.1.9. is demonstrated in accordance with annex 4.

7.2. Static Performance Requirements

7.2.1 Energy Absorption. Compliance with paragraph 5.2.1. is demonstrated in accordance with annex 5.

7.2.2. Height Retention. Compliance with paragraph 5.2.3. is demonstrated in accordance with annex 6.

7.2.3. Backset Retention and Displacement. Compliance with paragraph 5.2.4. is demonstrated in accordance with annex 7.

7.2.4. Head Restraint Strength. Compliance with paragraph 5.2.5. is demonstrated in accordance with annex 7.

7.3. Dynamic Performance Requirements. Compliance with paragraph 5.3. is demonstrated in accordance with annex 8.

7.4. Non-Use Positions. Compliance with paragraph 5.4. is demonstrated in accordance with annex 9.

Annex 1

Minimum Height Measurement Test procedure

1. Procedure for height measurement. Demonstrate compliance with 5.1.1. to 5.1.5. in accordance with 1.2. and 1.3 of this annex, **[**using the scale incorporated into the SAE J826 (rev. Jul 95) manikin or an equivalent scale**]**, which is positioned laterally within 15 mm of the head restraint centerline. If the seat back is adjustable, it is set at an initial inclination position closest to 25 degrees from the vertical. If there is more than one inclination position closest to 25 degrees from vertical, set the seat back inclination to the position closest to and rearward of 25 degrees. If the head restraint position is independent of the seat back inclination position, **[**compliance is determined at a seat back inclination position closest to 25 degrees from vertical~~, and each seat back inclination position less than 25 degrees from vertical~~.**]**

1.2. Height measurement for front outboard head restraints

1.2.1. For head restraints in front outboard designated seating positions, adjust the top of the head restraint to the highest position and measure the height.

1.2.2 For head restraints located in the front outboard designated seating positions that are prevented by the interior surface of the vehicle roofline from meeting the required height as specified in 5.1.1.2., measure the clearance between the top of the head restraint and the interior surface of the roofline, [with the seat adjusted to its lowest vertical position intended for occupant use], by attempting to pass a 25 mm sphere between them. Adjust the top of the head restraint to the lowest position and measure the height.

1.3 Height measurement for front center and rear outboard head restraints

1.3.1. For head restraints in all designated seating positions equipped with head restraints, adjust the top of the head restraint to the lowest position other than allowed by 5.4 and measure the height.

1.3.2. For head restraints located in rear designated seating positions that are prevented by the interior surface of the vehicle roofline or rear backlight from meeting the required height as specified in 5.1.5., measure the clearance between the top of the head restraint or the seat back and the roofline or the rear backlight, with the seat adjusted to its lowest vertical position intended for occupant use, by attempting to pass a 25 mm sphere between them.

Annex 2
Minimum Width Measurement Test procedure

1. Procedure for width measurement. Demonstrate compliance with paragraph 5.1.6 using **[**calipers**]** to measure the maximum dimension perpendicular to the vehicle vertical longitudinal plane of the intersection of the head restraint with a plane that is perpendicular ~~normal~~ to the torso reference line of SAE J826 (rev. Jul 95) manikin, and 68 ± 3 mm below the top of the head restraint.

Annex 3
Minimum Backset Measurement Test Procedure

1. Procedure for backset measurement. Demonstrate compliance with 5.1.7. using the HRMD positioned laterally within 15 mm of the head restraint centerline. Adjust the seatback to the design angle. Adjust the front head restraint so that its top is at any height between and inclusive of 750 mm and 800 mm and its backset is in the maximum position other than allowed by 5.3. If the lowest position of adjustment is above 800 mm, adjust the head restraint to that position. ~~If the head restraint position is independent of the seat back inclination position, compliance is determined at design angle~~.

Annex 4
Maximum Gap Measurement Test Procedure

1.1. Procedures for gap measurement. Demonstrate compliance with 5.1.8. and **[**5.1.9.**]** in accordance with the procedures of 1.2. through 1.4. of this annex, with the head restraint adjusted to its lowest height position and any backset position intended for occupant use.

1.2. The area of measurement is anywhere on the front ~~anterior~~ surface of the head restraint ~~or seat with a height greater than 540 mm~~ within the following distances from the centerline of the designated seating position:

1.2.1. **[**127 mm for seats required to have 254 mm minimum head restraint width; and**]**

1.2.2. 85 mm **[**for seats required to have a 170 mm head restraint width.**]**

1.3.1. Applying a load of no more than 5 N against the area of measurement specified in 1.2., place a 165 ± 2 mm diameter spherical head form against any gap such that at least two points of contact are made within the area. The surface roughness of the head form is less than 1.6 µm, root mean square.

1.3.2. Determine the gap dimension by measuring the ~~vertical~~ straight line distance between the inner edges of the two furthest contact points, as shown in Figures 2 and 3.

U.S. to consider using R17 as an alternative for measurement of *projected* gaps between the HR and the seat.

Annex 5

Energy Absorption Test Procedure

1. Procedures for energy absorption. Demonstrate compliance with 5.2.1. of this regulation in accordance with 1.1. through 1.4. of this Annex, and the adjustable head restraints in any height and backset position of adjustment.

[1.1. Seat setting up

The seat, as mounted in the vehicle, shall be firmly secured to the test bench with the attachment parts provided by the manufacturer, so as to remain stationary when the impact is applied.

The seat-back, if adjustable, shall be locked in the design position specified by the vehicle manufacturer.

If the seat is fitted with a head restraint, the head restraint shall be mounted on the seat-back as in the vehicle. Where the head restraint is separate, it shall be secured to the part of the vehicle structure to which it is normally attached.]

1.2. Test equipment

1.2.1. Use an impactor with a semispherical head form ~~and~~ of a 165 ± 2 mm diameter and a surface roughness of less than 1.6 µm, root mean square **for the impacting part of the impactor**. The head form and associated base have a combined mass **such that at a speed of 24.1 ± 0.5 km/h at the time of impact an energy of 152 ± 6 Joule will be reached.**

1.2.2. Instrument the impactor with an acceleration sensing device whose output is recorded in a data channel that conforms to the requirements for a 600 Hz channel class filter as specified **in ISO Standard 6487 (2002);** The axis of the acceleration-sensing device coincides with the geometric center of the head form and the direction of impact. **As an alternative the impactor can be equipped with 2 decelerometers sensing in the direction of impact and placed symmetrically in comparison to the geometric center of the spherical head form. In this case the deceleration rate shall be taken as the simultaneous average of the readings on the two decelerometers.**

1.3. Accuracy of the test equipment

The recording instruments used shall be such that measurements can be made with the following degrees of accuracy:

1.3.1. Acceleration:

Accuracy = + 5 % of the actual value;

Cross-axis sensitivity = < 5 % of the lowest point on the scale.

1.3.2. Speed:

Accuracy: + 2.5 % of the actual value;

Sensitivity: 0.5 km/h.

1.3.3. Time recording:

The instrumentation shall enable the action to be recorded throughout its duration and readings to be made to within one one-thousandth of a second;

the beginning of the impact at the moment of first contact between the headform and the item being tested shall be detected on the recordings used for analyzing the test.

1.4. Test procedure

1.4.1. Propel the impactor toward the head restraint. At the time of ~~launch~~ **impact**, the longitudinal axis of the impactor is within ±2 degrees of being horizontal and parallel to the vehicle longitudinal axis **and the impactor at a speed of not more than 24.1 km/h.**

1.2.4. ~~[Constrain the movement of the head form so that it travels linearly along the path described in 6.2.5.4 of this section for not less than 25 mm before making contact with the head restraint.]~~

1.4.2. Impact the anterior surface of the seat or head restraint at any point with a height greater than 635 mm **[from the R-point]** and within a distance of the head restraint vertical centerline of 70 mm.

Annex 6

Height Retention Test Procedure[o30]

1. Procedures for height retention. Demonstrate compliance with 5.2.3 of this regulation in accordance with 1.2. through 1.3. of this Annex.

1.2. Adjust the adjustable head restraint so that its top is at any of the following height positions at any backset position:

1.2.1. For front outboard designated seating positions:

1.2.1.1. The highest position; and

1.2.1.2. Not less than, but closest to 800 mm; and

1.2.2. For rear outboard and front center designated seating positions

1.2.2.1. The highest position; and

1.2.2.2. Not less than, but closest to 750 mm.

1.3. Orient a cylindrical test device having a 165 ± 2 mm diameter in plane view (perpendicular to the axis of revolution), and a 152 mm length in profile (through the axis of revolution) with a surface roughness of less than 1.6 µm, root mean square, such that the axis of the revolution is horizontal and in the longitudinal vertical plane through the longitudinal centerline of the head restraint. Position the midpoint of the bottom surface of the cylinder in contact with the head restraint.

~~1.3.1. Establish initial reference position by applying a vertical downward load of 50 ± 1 N.~~

1.3.2. Increase the load at the rate of 250 ± 50 N/minute to at least 500 N and maintain this load for not less than 5 seconds.

1.3.3. Reduce the load ~~at the rate of 250 ± 50 N/minute~~ to ~~50 ± 1 N~~ 0 N and determine the position of the cylindrical device with respect to its initial reference position.

Annex 7

Backset Retention, Displacement, and Strength Test Procedures

1. Procedures for backset retention, displacement, and strength. Demonstrate compliance with 5.2.4. and 5.2.5. of this regulation in accordance with 1.2. and 1.3. of this Annex. The load vectors that generate moment on the head restraint are initially contained in a vertical plane parallel to the vehicle longitudinal centerline.

1.2. Backset retention and displacement

1.2.1. Adjust the head restraint **[**to the highest position of vertical adjustment intended for occupant use**]** or **[**so that its top is at a height closest to and not less than:

1.2.1.1. 800 mm for front outboard designated seating positions (or the highest position of adjustment for head restraints subject to 5.1.3 of this regulations); and

1.2.1.2. 750 mm for rear outboard **[**and front center**]** designated seating positions equipped with head restraints (or the highest position of adjustment for rear head restraints subject to 5.1.5).**]**

1.2.3. Adjust the head restraint to **[**in the rearmost (relative to the seat) position of horizontal adjustment**]** backset position.

1.2.4. In the seat, place a test device having the back pan dimensions and torso reference line (vertical center line), when viewed laterally, with the head room probe in the full back position, of the three dimensional H-point machine;

1.2.5. Establish the displaced torso reference line by creating a posterior moment of 373 ± 7.5 Nm about the **[**H-point/R-point**]** by applying a force to the seat back through the back pan at the rate of **[**2.5 Nm/second to 37.3 Nm/second**]** **[**~~187 ± 37 Nm/minute~~**]**. The initial location on the back pan of the moment generating force vector has a height of 290 mm ± 13 mm. Apply the force vector normal to the torso reference line and maintain it within 2 degrees of a vertical plane parallel to the vehicle longitudinal centerline. Constrain the back pan to rotate about the **[**H-point/R-point**]**. Rotate the force vector direction with the back pan.

1.2.6. Maintain the position of the back pan as established in 1.2.5. of this Annex. Using a 165 ± 2 mm diameter spherical head form with a surface roughness of less than 1.6 µm, root mean square, establish the head form initial reference position by applying, perpendicular to the displaced torso reference line, a rearward initial load at the seat centerline at a height 65 ± 3 mm below the top of the head restraint that will produce a 36.5 ± 0.5 Nm moment about the

[H-point/R-point**]**. **[**Measure the rearward displacement of the head form during the application of the load**]**.

1.2.7. Increase the initial load at the rate of **[**2.5 Nm/second to 37.3 Nm/second**]** **[**~~187 ± 37 Nm/minute~~**]** until a 373 ± 7.5 Nm moment about the **[**H-point/R-point**]** is produced. Maintain the load level producing that moment for not less than 5 seconds and then measure the rearward displacement of the head form relative to the displaced torso reference line.

1.2.8. Reduce the load at the rate of **[**2.5 Nm/second to 37.3 Nm/second**]** **[**~~187 ± 37 Nm/minute~~**]** until 0 Nm. Wait 10 minutes. Re-load to 37 ± 0.7 Nm about the **[**H-point/R-point**]**. While maintaining the load level producing that moment, measure the **[**rearward**]** ~~posterior~~ displacement of the head form position with respect to its initial reference position; and

1.3. Strength. Increase the load specified in 1.2.8 of this annex at the rate of **[**5 N/second to 200 N/second**]** **[**~~250 ± 50 N/minute~~**]** to 885 N ± 5 N and maintain the applied load for not less than 5 seconds.

Annex 8

Dynamic Performance Test Procedure

1. Procedures for dynamic performance. Demonstrate compliance with 5.3 in accordance with this annex, using a 50th percentile male Hybrid III test dummy, and with the head restraint midway between the lowest and the highest position of adjustment, and at any position of backset adjustment.

1.2. Mount the vehicle on a dynamic test platform so that the longitudinal centerline of the vehicle is parallel to the direction of the test platform travel and so that movement between the base of the vehicle and the test platform is prevented. Instrument the platform with an accelerometer and data processing system. Position the accelerometer sensitive axis parallel to the direction of test platform travel.

1.3. Remove the tires, wheels, fluids, and all unsecured components. Remove or rigidly secure the engine, transmission, axles, exhaust, vehicle frame and any other vehicle component necessary to assure that all points on the acceleration vs. time plot measured by an accelerometer on the dynamic test platform fall within the corridor described in Figure 1 and Table 1.

1.4. Place any moveable windows in the fully open position.

1.5. Seat Adjustment. At each outboard designated seating position, using any control that primarily moves the entire seat vertically, [place the seat in the lowest position]. Using any control that primarily moves the entire seat in the fore and aft directions, place the seat midway between the forwardmost and rearmost position. If an adjustment position does not exist midway between the forwardmost and rearmost positions, the closest adjustment position to the rear of the midpoint is used. Adjust the seat cushion and seat back, without using any controls that move the entire seat, as required by 6 and 6.1 of this Regulation. If the specified position of the H-point can be achieved with a range of seat cushion inclination angles, adjust the seat inclination such that the most forward part of the seat cushion is [at its lowest position] with respect to the most rearward part. If the head restraint is adjustable, adjust the top of the head restraint to a position midway between the lowest position of adjustment and the highest position of adjustment. If an adjustment position midway between the lowest and the highest position does not exist, adjust the head restraint to a position below and nearest to midway between the lowest position of adjustment and the highest position of adjustment.

1.6. Seat Belt Adjustment. Prior to placing the Type 2 seat belt around the test dummy, fully extend the webbing from the seat belt retractor(s) and release it three times to remove slack. If an adjustable seat belt D-ring anchorage exists, place it in the adjustment position closest to the mid-position. If an adjustment position does not exist midway between the highest and lowest position, the closest adjustment position above the midpoint is used.

1.7. Dress and adjust each test dummy as follows:
Each test dummy is clothed in a form fitting cotton stretch short sleeve shirt with above-the-elbow sleeves and above-the-knee length pants. The weight of the shirt or pants shall not exceed 0.25 pounds each. Each foot of the test dummy is equipped with a size 11XW shoe which meets the configuration size, sole, and heel thickness specifications of MIL-S-13192 change "P" and whose weight is 1.25 ±0.2 pounds.
Limb joints are set at 1g, barely restraining the weight of the limb when extended horizontally. Leg joints are adjusted with the torso in the supine position.

1.8. Test dummy positioning procedure. Place a test dummy at each outboard designated seating position equipped with a head restraint.

1.9. Head. The transverse instrumentation platform of the head is level within 1/2 degree. To level the head of the test dummy, the following sequence is followed. First, adjust the position of the H point[2] to level the transverse instrumentation platform of the head of the test dummy. If the

[2] The H-points of the driver and passenger test dummies shall coincide within 1/2 inch in the vertical dimension and 1/2 inch in the horizontal dimension of a point 1/4 inch below the position of the H-point determined by using the equipment and procedures specified in SAE J826 (APR 1980) except that the length of the lower leg and thigh segments of the H-point machine shall be adjusted to 16.3 and 15.8 inches, respectively, instead of the 50th percentile values specified in Table 1 of SAE J826.

transverse instrumentation platform of the head is still not level, then adjust the pelvic angle of the test dummy. If the transverse instrumentation platform of the head is still not level, then adjust the neck bracket of the dummy the minimum amount necessary from the non-adjusted "0" setting to ensure that the transverse instrumentation platform of the head is horizontal within 1/2 degree. The test dummy remains within the limits specified in Footnote 2 after any adjustment of the neck bracket.

1.10. Upper arms and hands. Position each test dummy as specified below:

1.10.1. The driver's upper arms shall be adjacent to the torso with the centerlines as close to a vertical plane as possible.

1.10.2. The passenger's upper arms shall be in contact with the seat back and the sides of the torso.

1.10.3. The palms of the drivers test dummy shall be in contact with the outer part of the steering wheel rim at the rim's horizontal centerline. The thumbs shall be over the steering wheel rim and shall be lightly taped to the steering wheel rim so that if the hand of the test dummy is pushed upward by a force of not less than 2 pounds and not more than 5 pounds, the tape shall release the hand from the steering wheel rim.

1.10.4 The palms of the passenger test dummy shall be in contact with the outside of the thigh. The little finger shall be in contact with the seat cushion.

1.11. Torso. Position each test dummy as specified in [*insert text from S10.4.1.1, S10.4.1.2, and S10.4.2.1of §571.208*], except that the midsagittal plane of the dummy is aligned within 15 mm of the head restraint centerline. If the midsagittal plane of the dummy cannot be aligned within 15 mm of the head restraint centerline then align the midsagittal plane of the dummy as close as possible to the head restraint centerline.

1.12. Legs. Position each test dummy as follows:
The upper legs of the driver and passenger test dummies shall rest against the seat cushion to the extent permitted by placement of the feet. The initial distance between the outboard knee clevis flange surfaces shall be 10.6 inches. To the extent practicable, the left leg of the driver dummy and both legs of the passenger dummy shall be in vertical longitudinal planes. To the extent practicable, the right leg of the driver dummy shall be in a vertical plane. Final adjustment to accommodate the placement of feet in various passenger compartment configurations is permitted.

1.13. Feet. Position each test dummy as specified in *[*S10.6 of §571.208,[3]] except that for rear outboard designated seating positions the feet of the test dummy are placed flat on the floorpan and beneath the front seat as far forward as possible without front seat interference. For rear outboard designated seating position, if necessary, the distance between the knees can be changed in order to place the feet beneath the seat.

2.1. Accelerate the dynamic test platform to 17.3 ± 0.6 km/h. All of the points on the acceleration vs. time curve fall within the corridor described in Figure 1 and Table 5 when filtered to channel class 60, as specified in the SAE Recommended Practice J211/1 (rev. Mar 95). Measure the maximum posterior angular displacement.

2.2. Calculate the angular displacement from the output of instrumentation placed in the torso and head of the test dummy and an algorithm capable of determining the relative angular displacement to within one degree and conforming to the requirements of a 600 Hz channel class, as specified in SAE Recommended Practice J211/1, (rev. Mar 95). No data generated after 200 ms from the beginning of the forward acceleration are used in determining angular displacement of the head with respect to the torso.

2.3. Calculate the HIC_{15} from the output of instrumentation placed in the head of the test dummy, using the equation in 5.2.1.2 of this regulation and conforming to the requirements for a 1000 Hz channel class as specified in SAE Recommended Practice J211/1 (rev. Mar 95). No data generated after 200 ms from the beginning of the forward acceleration are used in determining HIC.

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[3] http://ecfr.gpoaccess.gov/cgi/t/text/text-idx?c=ecfr&sid=f71ca7d062d9b2fa66b9ddb3fec6e0e3&rgn=div5&view=text&node=49:5.1.2.3.36&idno=49#49:5.1.2.3.36.2.4.64.

Annex 9
Non-use position Test Procedure

1.1. Procedures for folding or retracting head restraints in all designated seating positions equipped with head restraints, except the driver's designated seating position.

1.2. Demonstrate compliance with 5.4.1, with the ignition on[o33], and using a 5th percentile female Hybrid III test dummy in accordance with 1.2.1.to 1.2.4. of this Annex, or a human surrogate in accordance with 1.3 of this Annex:

1.2.1. Position the test dummy in the seat such that the dummy's midsaggital plane is aligned within the 15 mm of the seating position centerline and is parallel to a vertical plane parallel to the vehicle longitudinal centerline.

1.2.2. Hold the dummy's thighs down and push rearward on the upper torso to maximize the dummy's pelvic angle.

1.2.3. Place the legs as close as possible to 90 degrees to the thighs. Push rearward on the dummy's knees to force the pelvis into the seat so there is no gap between the pelvis and the seat back or until contact occurs between the back of the dummy's calves and the front of the seat cushion such that the angle between the dummy's thighs and legs begins to change.

1.2.4. Note the position of the head restraint. Remove the dummy from the seat. If the head restraint returns to a retracted position upon removal of the dummy, manually place it in the noted position. Determine compliance with the height requirements of 5.1.1. and 5.1.2, and 5.1.4 by using the test procedures of Annex 1.

1.3. Human surrogate. For 1.2.1. to 1.2.4 of this Annex, instead of using the 5th percentile adult female test dummy, a human being who weighs between 47 and 51 kg, and who is between 140 and 150 cm tall may be used.

1.3.1. The human surrogate shall be dressed in a cotton T-shirt, full length cotton trousers, and sneakers. Specified weights and heights include clothing.

1.3[o34]. Procedures for the rear and front center designated seating positions equipped with head restraints.

1.3.1. Demonstrate compliance with 5.4.2 in accordance with the following procedure:

1.3.2. Place the head restraint in any position meeting the requirements of 5.1.2 or 5.1.4;

1.3.3. Mark a line on the head restraint. Measure the angle or range of angles of the head restraint reference line as projected onto a vertical longitudinal vehicle plane;

1.3.4. Fold or retract the head restraint to a position in which its minimum height is less than that specified in 5.1.2 or 5.1.4;

1.3.5. Determine the minimum change in the head restraint reference line angle as projected onto a vertical longitudinal vehicle plane from the angle or range of angles measured in 1.3.3 of this annex.

[1.4. Demonstrate compliance with 5.4.3 of this regulation in accordance with 1.4.1. through 1.4.4. of this Annex.

1.4.1. All lines, including the projection of the reference line, shall be drawn in the vertical median ~~plane of the~~ design torso reference plane of the seat ~~or seating position~~, the intersection of such plane with the seat determining the contour of the head restraint and of the seat-back (see figure 4 of this Annex).

1.4.2. Adjust the head restraint to its non use position.

1.4.3 Determine the height H_{LE} of the lower edge of the head restraint as shown in Figure 4.

1.4.4. ~~Position the manikin in accordance with Annex 11[o36].~~

1.4.5. The projection of the reference line of the manikin is then, in the seat concerned, drawn in the plane specified in paragraph 1.4.1. of this Annex above. The tangent T_H to the bottom of the head restraint is drawn perpendicular to the reference line.

1.4.6. The distance "H_{LE}" from the R-point to the tangent T_H is the height to be taken into consideration[GF37] in implementing the requirements of paragraph 5.3.2.2 of this regulation.

1.4.7. Measure S at the lower edge of the head restraint as shown in Figure 4.

1.4.8. The projection of the reference line of the manikin is, in the seat concerned, drawn in the plane specified in paragraph 1.1 above. A tangent T_S is drawn above and parallel to the tangent T_H, as specified in 1.4.5, with a distance of not more than *[25 mm]* above. A parallel P to the torso reference line passing through the intersection of tangent T_S with the surface of the head restraint is drawn in the same plane. The distance "S", measured perpendicular to the torso reference line, from parallel P to the surface of the seat back at this position is the thickness to be taken into consideration in implementing the requirements of paragraph 5.3.2.2 of this regulation.**]**

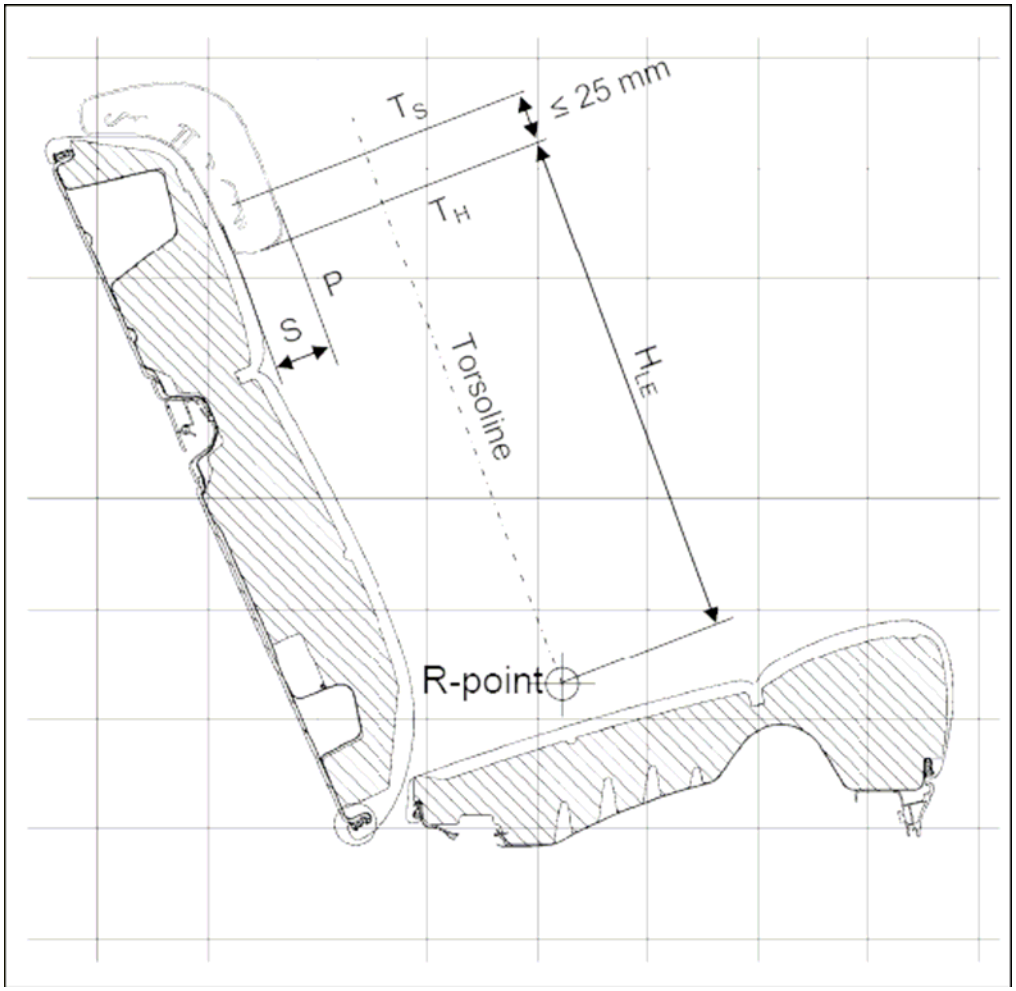

Figure 4

[Annex 10

DESCRIPTION OF THE THREE DIMENSIONAL "H" POINT MACHINE[4]

(3 DH machine)

1. BACK AND SEAT PANS. The back and seat pans are constructed of reinforced plastic and metal; they stimulate the human torso and thigh and are mechanically hinged at the "H" point. A quadrant is fastened to the probe hinged at the "H" point to measure the actual torso angle. An adjustable thigh bar, attached to the seat pan, establishes the thigh centreline and serves as a baseline for the hip angle quadrant.
2. BODY AND LEG ELEMENTS. Lower leg segments are connected to the seat pan assembly at the T-bar joining the knees, which is a lateral extension of the adjustable thigh bar. Quadrants are incorporated in the lower leg segments to measure knee angles. Shoe and foot assemblies are calibrated to measure the foot angle. Two spirit levels orient the device in space. Body element weights are placed at the corresponding centres of gravity to provide seat penetration equivalent to a 76 kg male. All joints of the 3 DH machine should be checked for free movement without encountering noticeable friction.**]**

[4] For details of the construction of the 3D H machine refer to Society of Automotive Engineers (SAE), 400 Commonwealth Drive, Warrendale, Pennsylvania 15096, United States of America. The machine corresponds to that described in ISO Standard 6549-1980.

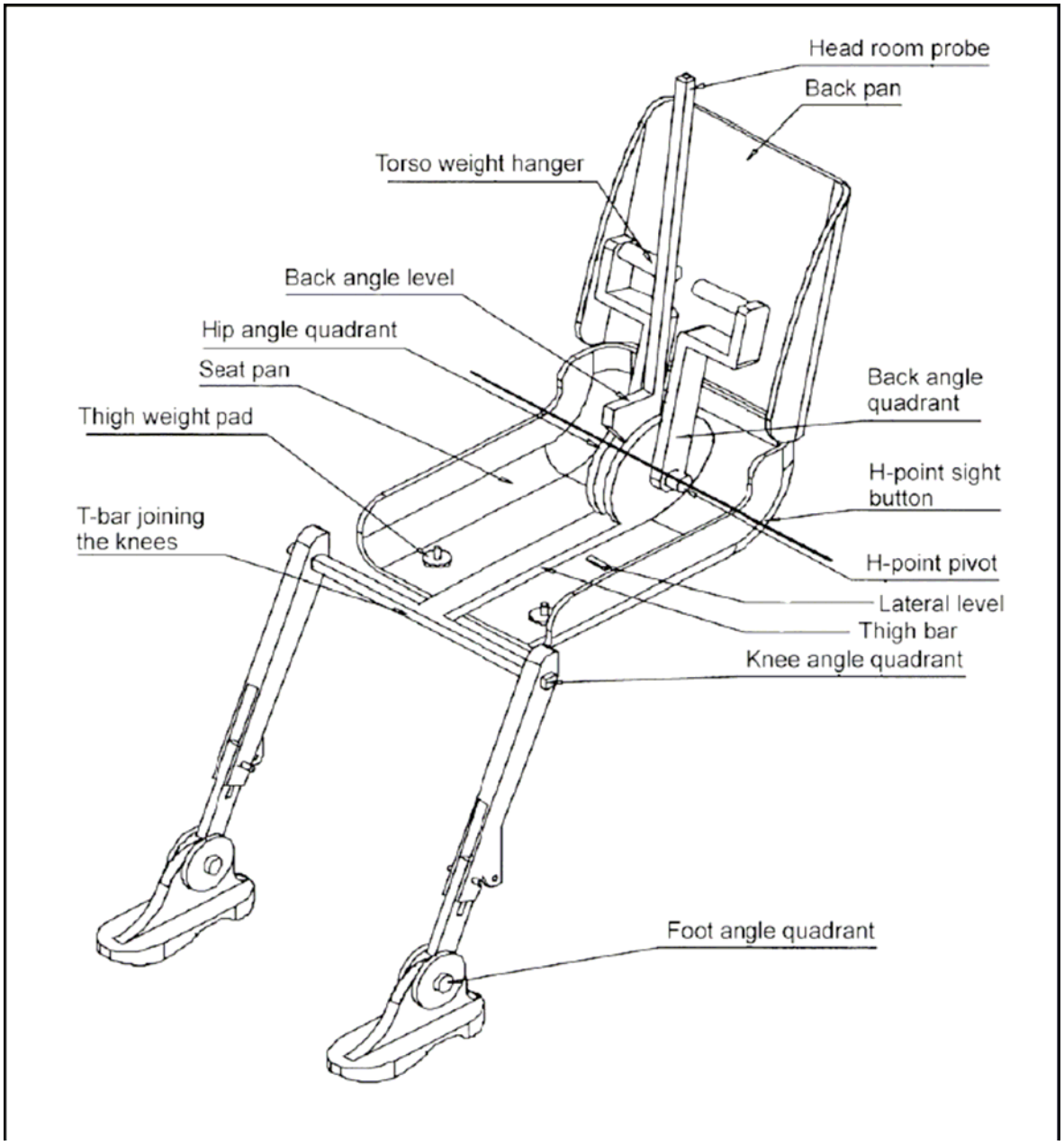

Figure 1 - 3D H machine elements designation

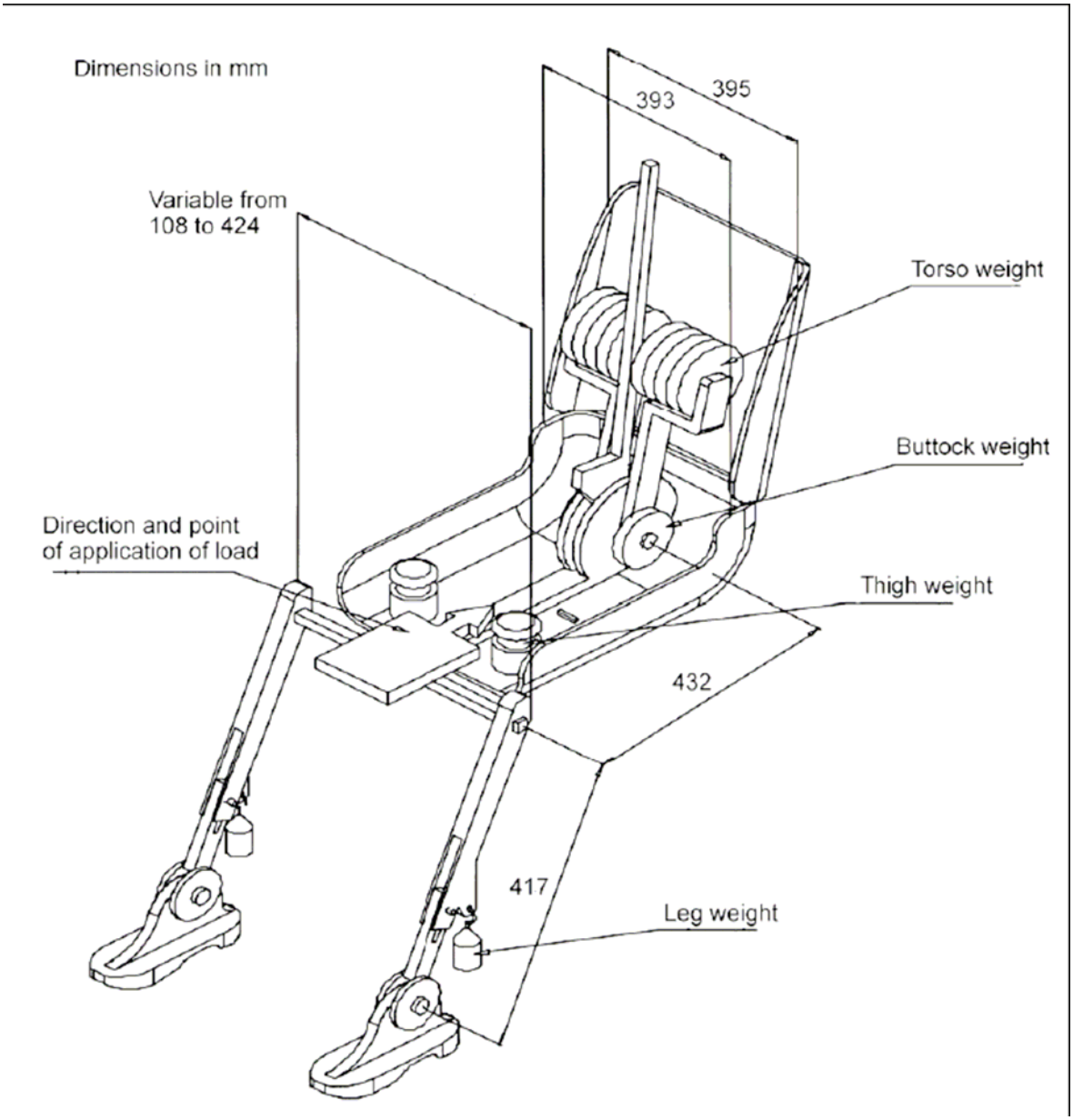

Figure 2 - Dimensions of the 3D H machine elements and load distribution

Annex 11[o38]

[PROCEDURE FOR DETERMINING THE "H/" POINT AND THE ACTUAL TORSO ANGLE FOR SEATING POSITIONS IN MOTOR VEHICLES

1. PURPOSE

The procedure described in this annex is used to establish the "H" point location and the actual torso angle for one or several seating positions in a motor vehicle and to verify the relationship of measured data to design specifications given by the vehicle manufacturer. ([5])

2. DEFINITIONS

For the purposes of this annex:

2.1. "Reference data" means one or several of the following characteristics of a seating position:

2.1.1. the "H" point and the "R" point and their relationship,

2.1.2. the actual torso angle and the design torso angle and their relationship.

2.2. "Three-dimensional 'H' point machine" (3-D H machine) means the device used for the determination of "H" points and actual torso angles. This device is described in appendix 1 to this annex;

2.3. "'H' point" means the pivot centre of the torso and thigh of the 3-D H machine installed in the vehicle seat in accordance with paragraph 4. below. The "H" point is located in the centre of the centreline of the device which is between the "H" point sight buttons on either side of the 3-D H machine. The "H" point corresponds theoretically to the "R" point (for tolerances see paragraph 3.2.2. below). Once determined in accordance with the procedure described in paragraph 4., the "H" point is considered fixed in relation to the seat-cushion structure and to move with it when the seat is adjusted;

2.4. "'R' point" or "seating reference point" means a design point defined by the vehicle manufacturer for each seating position and established with respect to the three-dimensional reference system;

2.5. "Torso-line" means the centreline of the probe of the 3-D H machine with the probe in the fully rearward position;

2.6. "Actual torso angle" means the angle measured between a vertical line through the "H" point and the torso line using the back angle quadrant on the 3-D H machine. The actual torso angle corresponds theoretically to the design torso angle (for tolerances see paragraph 3.2.2. below);

2.7. "Design torso angle" means the angle measured between a vertical line through the "R" point and the torso line in a position which corresponds to the design position of the seat-back established by the vehicle manufacturer;

2.8. "Centre plane of occupant" (C/LO) means the median plane of the 3-D H machine positioned in each designated seating position; it is represented by the co-ordinate of the "H" point on the "Y" axis. For individual seats, the centre plane of the seat coincides with the centre plane of the occupant. For other seats, the centre plane of the occupant is specified by the manufacturer;

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[5] In any seating position other than front seats where the "H" point cannot be determined using the "three-dimensional 'H' point machine" or procedures, the "R" point indicated by the manufacturer may be taken as a reference at the discretion of the competent authority.

2.9. "Three dimensional reference system" means a system as described in appendix 2 to this annex;

2.10. "Fiducial marks" are physical points (holes, surfaces, marks or indentations) on the vehicle body as defined by the manufacturer;

2.11. "Vehicle measuring attitude" means the position of the vehicle as defined by the co-ordinates of fiducial marks in the three-dimensional reference system.

3. REQUIREMENTS

3.1. Data presentation

For each seating position where reference data are required in order to demonstrate compliance with the provisions of the present Regulation, all or an appropriate selection of the following data shall be presented in the form indicated in appendix 3 to this annex:

3.1.1. the co-ordinates of the "R" point relative to the three-dimensional reference system;

3.1.2. the design torso angle;

3.1.3. all indications necessary to adjust the seat (if it is adjustable) to the measuring position set out in paragraph 4.3. below.

3.2. Relationship between measured data and design specifications

3.2.1. The co-ordinates of the "H" point and the value of the actual torso angle obtained by the procedure set out in paragraph 4. below shall be compared, respectively, with the co-ordinates of the "R" point and the value of the design torso angle indicated by the vehicle manufacturer.

3.2.2. The relative positions of the "R" point and the "H" point and the relationship between the design torso angle and the actual torso angle shall be considered satisfactory for the seating position in question if the "H" point, as defined by its co-ordinates, lies within a square of 50 mm side length with horizontal and vertical sides whose diagonals intersect at the "R" point, and if the actual torso angle is within 5 degree of the design torso angle.

3.2.3. If these conditions are met, the "R" point and the design torso angle, shall be used to demonstrate compliance with the provisions of this Regulation.

3.2.4. If the "H" point or the actual torso angle does not satisfy the requirements of paragraph 3.2.2. above, the "H" point and the actual torso angle shall be determined twice more (three times in all). If the results of two of these three operations satisfy the requirements, the conditions of paragraph 3.2.3. above shall apply.

3.2.5. If the results of at least two of the three operations described in paragraph 3.2.4. above do not satisfy the requirements of paragraph 3.2.2. above, or if the verification cannot take place because the vehicle manufacturer has failed to supply information regarding the position of the "R" point or regarding the design torso angle, the centroid of the three measured points or the average of the three measured angles shall be used and be regarded as applicable in all cases where the "R" point or the design torso angle is referred to in this Regulation.

4. PROCEDURE FOR "H" POINT AND ACTUAL TORSO ANGLE DETERMINATION

4.1. The vehicle shall be preconditioned at the manufacturer's discretion, at a temperature of 20 " 10 °C to ensure that the seat material reaches room temperature. If the seat to be checked has never been sat upon, a 70 to 80 kg person or device shall sit on the seat twice for one minute to flex the cushion and back. At the manufacturer's request, all seat assemblies shall remain unloaded for a minimum period of 30 minutes prior to installation of the 3-D H machine.

4.2. The vehicle shall be at the measuring attitude defined in paragraph 2.11. above.

4.3. The seat, if it is adjustable, shall be adjusted first to the rearmost normal driving or riding position, as indicated by the vehicle manufacturer, taking into consideration only the longitudinal adjustment of the seat, excluding seat travel used for purposes other than normal driving or riding positions. Where other modes of seat adjustment exist (vertical, angular, seat-back, etc.) these will be then adjusted to the position specified by the vehicle manufacturer. For suspension seats, the vertical position shall be rigidly fixed corresponding to a normal driving position as specified by the manufacturer.

4.4. The area of the seating position contacted by the 3-D H machine shall be covered by a muslin cotton, of sufficient size and appropriate texture, described as a plain cotton fabric having 18.9 threads per cm2 and weighing 0.228 kg m2 or knitted or non-woven fabric having equivalent characteristics. If the test is run on a seat outside the vehicle, the floor on which the seat is placed shall have the same essential characteristics ([6]) as the floor of the vehicle in which the seat is intended to be used.

4.5. Place the seat and back assembly of the 3-D H machine so that the centre plane of the occupant (C/LO) coincides with the centre plane of the 3-D H machine. At the manufacturer's request, the 3-D H machine may be moved inboard with respect to the C/LO if the 3-D H machine is located so far outboard that the seat edge will not permit levelling of the 3-D H machine.

4.6. Attach the foot and lower leg assemblies to the seat pan assembly, either individually or by using the T-bar and lower leg assembly. A line through the "H" point sight buttons shall be parallel to the ground and perpendicular to the longitudinal centre plane of the seat.

4.7. Adjust the feet and leg positions of the 3-D H machine as follows:

4.7.1. Designated seating position: driver and outside front passenger.

4.7.1.1. Both feet and leg assemblies shall be moved forward in such a way that the feet take up natural positions on the floor, between the operating pedals if necessary. Where possible the left foot shall be located approximately the same distance to the left of the centre plane of the 3-D H machine as the right foot is to the right. The spirit level verifying the transverse orientation of the 3-D H machine is brought to the horizontal by readjustment of the seat pan if necessary, or by adjusting the leg and foot assemblies towards the rear. The line passing through the "H" point sight buttons shall be maintained perpendicular to the longitudinal centre plane of the seat.

4.7.1.2. If the left leg cannot be kept parallel to the right leg and the left foot cannot be supported by the structure, move the left foot until it is supported. The alignment of the sight buttons shall be maintained.

4.7.2. Designated seating position: outboard rear For rear seats or auxiliary seats, the legs are located as specified by the manufacturer. If the feet then rest on parts of the floor which are at different levels, the foot which first comes into contact with the front seat shall serve as a reference and the other foot

[6] Tilt angle, height difference with a seat mounting, surface texture, etc.

shall be so arranged that the spirit level giving the transverse orientation of the seat of the device indicates the horizontal.

4.7.3. Other designated seating positions: The general procedure indicated in paragraph 4.7.1. above shall be followed except that the feet shall be placed as specified by the vehicle manufacturer.

4.8. Apply lower leg and thigh weights and level the 3-D H machine.

4.9. Tilt the back pan forward against the forward stop and draw the 3-D H machine away from the seat-back using the T-bar. Reposition the 3-D H machine on the seat by one of the following methods:

4.9.1. If the 3-D H machine tends to slide rearward, use the following procedure. Allow the 3-D H machine to slide rearward until a forward horizontal restraining load on the T-bar is no longer required i.e. until the seat pan contacts the seat-back. If necessary, reposition the lower leg.

4.9.2. If the 3-D H machine does not tend to slide rearward, use the following procedure. Slide the 3-D H machine rearwards by applying a horizontal rearward load to the T-bar until the seat pan contacts the seat-back (see figure 2 of appendix 1 to this annex).

4.10. Apply a 100 " 10 N load to the back and pan assembly of the 3-D H machine at the intersection of the hip angle quadrant and the T-bar housing. The direction of load application shall be maintained along a line passing by the above intersection to a point just above the thigh bar housing (see figure 2 of appendix 1 to this annex). Then carefully return the back pan to the seat-back. Care must be exercised throughout the remainder of the procedure to prevent the 3-D H machine from sliding forward.

4.11. Install the right and left buttock weights and then, alternately, the eight torso weights. Maintain the 3-D H machine level.

4.12. Tilt the back pan forward to release the tension on the seat-back. Rock the 3-D H machine from side to side through 10 degrees arc (5 degrees to each side of the vertical centre plane) for three complete cycles to release any accumulated friction between the 3-D H machine and the seat.

During the rocking action, the T-bar of the 3-D H machine may tend to diverge from the specified horizontal and vertical alignment. The T-bar must therefore be restrained by applying an appropriate lateral load during the rocking motions. Care shall be exercised in holding the T-bar and rocking the 3-D H machine to ensure that no inadvertent exterior loads are applied in a vertical or fore and aft direction.

The feet of the 3-D H machine are not to be restrained or held during this step. If the feet change position, they should be allowed to remain in that attitude for the moment.

Carefully return the back pan to the seat-back and check the two spirit levels for zero position. If any movement of the feet has occurred during the rocking operation of the 3-D H machine, they must be repositioned as follows:

Alternately, lift each foot off the floor the minimum necessary amount until no additional foot movement is obtained. During this lifting, the feet are to be free to rotate; and no forward or lateral loads are to be applied. When each foot is placed back in the down position, the heel is to be in contact with the structure designed for this.

Check the lateral spirit level for zero position; if necessary, apply a lateral load to the top of the back pan sufficient to level the 3-D H machine's seat pan on the seat.

4.13. Holding the T-bar to prevent the 3-D H machine from sliding forward on the seat cushion, proceed as follows:

(a) return the back pan to the seat-back;

(b) apply and release a horizontal rearward load, not to exceed 25 N, to the back angle bar at a height approximately at the centre of the torso weights until the hip angle quadrant indicates that a stable position has been reached after load release. Care shall be exercised to ensure that no exterior downward or lateral loads are applied to the 3-D H machine. If another level adjustment of the 3-D H machine is necessary, rotate the back pan forward, re-level, and repeat the procedure from paragraph 4.12.

4.14. Take all measurements:

4.14.1. The co-ordinates of the "H" point are measured with respect to the three-dimensional reference system.

4.14.2. The actual torso angle is read at the back angle quadrant of the 3-D H machine with the probe in its fully rearward position.

4.15. If a re-run of the installation of the 3-D H machine is desired, the seat assembly should remain unloaded for a minimum period of 30 minutes prior to the re-run. The 3-D H machine should not be left loaded on the seat assembly longer than the time required to perform the test.

4.16. If the seats in the same row can be regarded as similar (bench seat, identical seats, etc.) only one "H" point and one "actual torso angle" shall be determined for each row of seats, the 3-D H machine described in appendix 1 to this annex being seated in a place regarded as representative for the row. This place shall be:

4.16.1. in the case of the front row, the driver's seat;

4.16.2. in the case of the rear row or rows, an outer seat.**]**

Table 1 – Sled pulse corridor reference point locations.

Reference Point	Time (ms)	Acceleration (m/s^2)
A	0	10
B	28	94
C	60	94
D	92	0
E	4	0
F	38.5	80
G	49.5	80
H	84	0

Figure 1 - Sled pulse acceleration corridor. The target acceleration with time expressed in milliseconds is $a = 86 \text{ Sin}(\pi t/88)$ m/s^2, for V = 17.3 ± 0.6 km/h. The time zero for the test is defined by the point when the sled acceleration achieves 2.5 m/s^2 (0.25 G's).

[Insert corridor]

Figure 2 - Measurement of a vertical gap “a”.

[Insert drawing]

Figure 3 - Measurement of a horizontal gap “a”.

[Insert drawing]

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