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Working Party on Passive Safety (GRSP)
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agenda item 3.2)

PROPOSAL FOR DRAFT AMENDMENTS TO REGULATION NO. 17
(Rear Impact collision test procedure)

Transmitted by the Expert from Germany

Note: The text reproduced below has been prepared by the expert from Germany on the basis of **Informal** Document No.12 which has been distributed and discussed during the 27th session of GRSP, May 2000, and on the basis of the decision of WP.29 on its one-hundred-and-twenty-first session(July 2000) where a formal consent has been given to start a work on a new draft Regulation concerning a test procedure for the evaluation of injury risks to the cervical spine in a low speed rear end impact. The proposal should be incorporated in ECE- Regulations 17 and 25.

The following draft contains a proposal to amend ECE- Regulation No.17. The proposal will be extended by the experts from Austria, Switzerland and Germany till August 2001 and will be available as official document during the November/December 2001 meeting of GRSP

Note: This document is distributed to the Experts on Passive Safety only.

GE.00-XXXXX

PROPOSAL

Paragraph 1. **SCOPE**, amend to read:

This Regulation applies to the strength of seats, to their anchorages and to their head restraints, of vehicles of categories M1 and N, and to the strength of seats, to their anchorages and to their head restraints, of vehicles of categories M2 and M3, not covered by Regulation N° 80, 01 series of amendments.

It also applies to the design of rear parts of seat-backs, and to devices intended to protect the occupants from the danger resulting from the displacement of luggage in a frontal impact, of vehicles of category M1.

In addition it also applies to the behaviour of outboard front seats and their head restraints in case of a low speed rear end impact collision of vehicles of category M1 up to 2.5 t.

It does not apply to folding, side facing or rearward-facing seats, or to any head restraint fitted to these seats.

Justification:

Most head restraints of current cars are capable to minimise severe neck injuries such as bony fractures, luxations and ligament ruptures. However, so called minor soft tissue neck injuries of an AIS 1 injury severity degree still occur in considerable numbers. In many countries, the number of soft tissue injuries is even increasing. Some victims suffer serious impairment lasting for many years after even a “minor” event, also called “low speed rear end impact”. Collision analyses show that the majority of the neck injuries discussed here occur during rear end impacts of passenger cars or so called vehicles of category M1. ECE- Regulation 17 should be amended to avoid the above mentioned injuries by an improvement of the seat/ head restraint- arrangement of outboard front seats of passenger vehicles of category M1 up to 2.5 t.

Paragraph 2 **DEFINITIONS**, unchanged

Paragraph 3, **APPLICATION FOR APPROVAL**

Paragraphs 3.1. to 3.3.3.2., unchanged;

Add a new paragraph 3.3.4.

If test objects are necessary to carry out the tests according to annex 10, the manufacturer shall submit such part or parts to the technical service, responsible for the tests.

Justification:

It seems that the provision of the relevant paragraphs below paragraph 3.1. describing the minimum number of test objects should be amended by a new paragraph which requires that the necessary parts for the relevant tests can be determined by the manufacturer/ applicant in agreement with the technical service.

Paragraph 4. **APPROVAL**, unchanged

Paragraph 5. **REQUIREMENTS**,

Paragraphs 5.1 to 5.15.3 unchanged,

Add the following new paragraphs:

Paragraph 5.16.

Special requirements regarding to the reduction of the injury risks of the cervical spine of the occupants in a low speed rear end impact of vehicles of category M1 up to 2.5 t.

Paragraph 5.16.1.

Outboard front seats and their head restraints shall be so designed that in case of a low speed rear impact the soft tissue neck injuries caused by the rearward displacement of the occupant’s head will be reduced by the protection potential of the seat/head restraint- arrangement. The protection potential seems sufficient, if the seat/head restraint-arrangement fulfils the provisions, described in annex 10.

For compliance the manufacturer/applicant shall fulfil tests with positive results according to the above mentioned dynamic test procedure. The displacement test according to paragraphs 5.11./ 5.12. of the Regulation shall be kept

and shall demonstrate the behaviour of the head restraints during a static overload situation, but it is not necessary to fulfil the horizontal displacement value of 102 mm where a dynamic test has been demonstrated. After the tests, it shall be shown that the following criterion has been fulfilled:

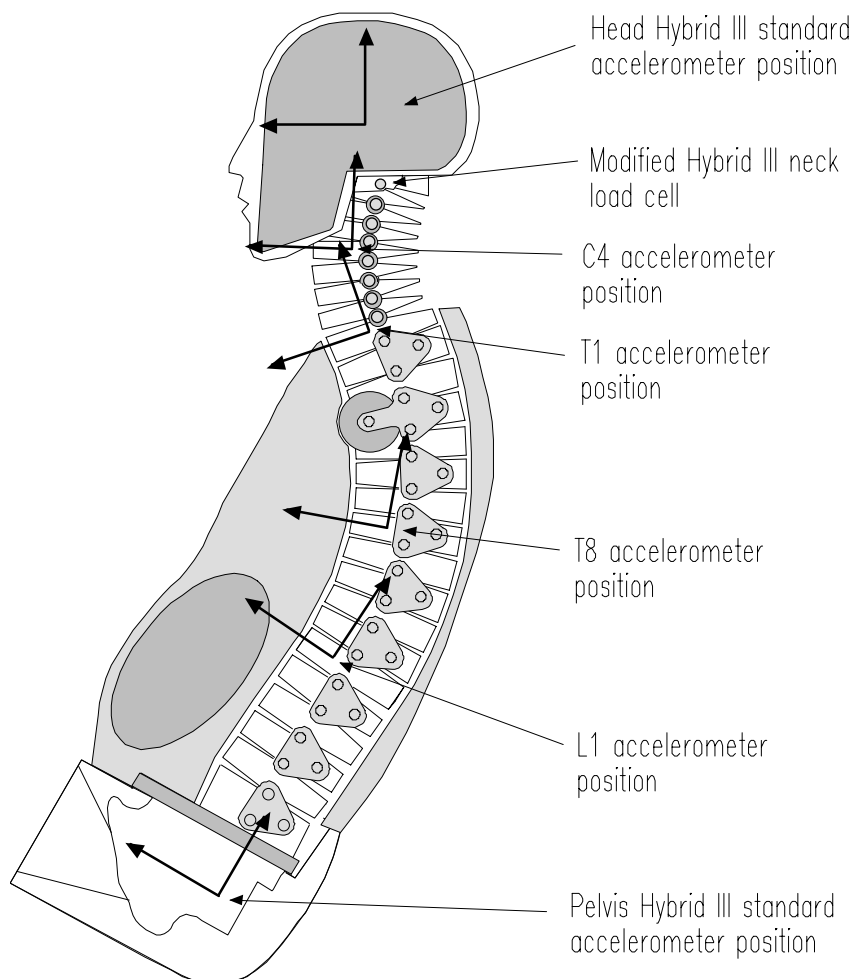
5.16.1.1. The NIC-RI- Criterion shall be equal or less than $[20 \text{ m}^2/\text{s}^2 - 25 \text{ m}^2/\text{s}^2]$.

Remark: The determination depends on the rear impact dummy and the AIS/probability- validation. The criterion will be added as soon as available.

5.16.1.2. The HIC (15 ms) shall be at most 150 (see NHTSA, S4.2.(ii), Doc.2000-85-70).

Remark: The determination depends on the rear impact dummy and the AIS/probability- validation.

5.16.1.3. The rebound velocity of T1 (the first thoracic vertebra) measured at the time point when, during rebound, T1 reaches the same x-coordinate relative to the sled or car coordinate system it had at $t=0$ or at the time point just before restraint system action sets in, whichever is earlier, shall be equal or less than (2.5 –3.0) m/s.



Drawing of BioRID and position of T1 accelerometer (Overview sketch)

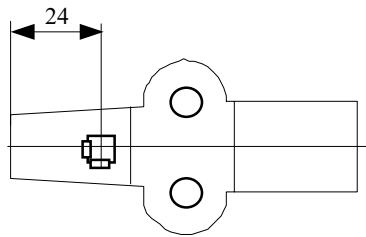


Figure 1:

Detail of the position of the T1 accelerometer

-X-axis of the acceleration sensor parallel with the inertial horizontal axis and -Z- axis of the acceleration sensor orthogonal to the inertial horizontal axis. Both accelerometer shall have a range of 50 to 200 g and a filter channel class 180 (according to SAE J211)

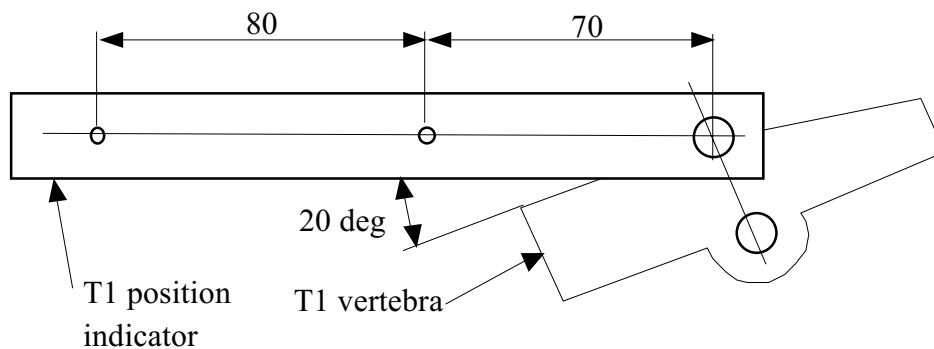


Figure 2:

Bar for special film targets

The above shown bar shall be fitted in addition at the T1-vertebra. Both holes are prepared 70 and 80 mm apart to provide locations for special film targets. The hole on the right side is provided for the fitting of an additional accelerometer. The x- axis of the additional accelerometer shall be parallel to the bar i.e. 20° in relation to the position of the first T1 accelerometer.

The moment around the head- joint surface (occipital condyles) shall be compensated as follows:

$$M_{ocy} = M_y - D * F_x$$

where

M_{ocy} Moment Y about the occipital condyle.

F_x Load cell force output in the X direction in Newton.

D Distance between the axis of the load cell and the axis of the condyle. For the BioRID II upper neck load cell (for example, Denton 2564 three channel neck load cell) the distance is 0.01778 m.

The sign convention in SAE J1733 is to be used.

5.16.1.4. Shear forces and moments of torque at the uppermost cervical vertebra/head joint: $N_{km} < 0.5 - 1.0$
 The forces and moments shall be calculated according to the following equation:

$$N_{km}(t) = \frac{F_x(t)}{F_{int}} + \frac{M_y(t)}{M_{int}}$$

or alternatively during the dynamic test the following values shall not be exceeded

<u>Load case</u>	<u>Value</u>
Extension	47.0 Nm
Flexion	88.0 Nm
Negative and positive shear forces	845 N

Justification:

Incorporation of new paragraphs and a reference to a new annex 10, where the provisions to evaluate the rear impact collision procedure is described in detail. The test procedure allows a new dynamic test for compliance.

REMARK: The above mentioned values are for a BioRID II Dummy.

Paragraph 6., **TESTS**, paragraphs 6.1. to 6.1.3. unchanged

Existing text:

6. 2. Test of strength of the seat-back and its adjustment systems

6. 2. 1. A force producing a moment of 53daNm in relation to the R point shall be applied longitudinally and rearwards to the upper part of the seat-back frame through a component simulating the back of the manikin shown in annex 3 to this Regulation. In the case of a bench seat, where part or all of the supporting frame (including that of the head restraints) is common to more than one seating position, the test shall be conducted simultaneously for all those seating positions.

Add a new paragraph 6.2.1.1.:

6.2.1.1 A force producing a moment of [160 daNm] shall be carried out during the test of outboard front seating positions according to annex 10 (Rear impact test procedure) of vehicles of category M1 up to 2.5 t. During and after the test no release of the locking systems shall occur. Deformations and ruptures may be accepted, if there is no increase of the risk of injuries for the occupants.

Paragraphs 6.3 to 6.9 unchanged

From paragraphs 7. **CONFORMITY OF PRODUCTION** to paragraph 12., **NAMES AND ADDRESSES OF TECHNICAL SERVICES**, no changes

Paragraph 13, **TRANSITIONAL PROVISIONS**

New paragraphs 13.7., 13.8. and 13.9.to be added:

Paragraph 13.7.

As from the official date of entry into force of the (08) series of amendments, no Contracting Party applying this Regulation shall refuse to grant ECE approvals under this Regulation as amended by the (08) series of amendments.

Paragraph 13.8.

As from 24 months after the date of entry into force of the (08) series of amendments, Contracting Parties applying this Regulation shall grant ECE approval only if the vehicle types which complies with the requirements of this Regulation as amended by the (08) series of amendments

Paragraph 13.9.

As from 48 months after the date of entry into force of the (08) series of amendments, existing approvals to this Regulation shall cease to be valid, except in case of vehicle types which comply with the requirements of this Regulation as amended by the (08) series of amendments

Justification:

Proposal for Transitional Provisions which may be discussed again after the group has finalized the technical amendments to ECE- Regulation 17.

From annex 1, **COMMUNICATION** to annex 9, **TEST PROCEDURE FOR DEVICES INTENDED TO PROTECT THE OCCUPANTS AGAINST DISPLACED LUGGAGE**, no changes.

Annex 10

TEST PROCEDURE FOR THE EVALUATION OF INJURY RISK TO THE CERVICAL SPINE IN A LOW SPEED REAR END IMPACT

1. General

The test procedure simulates a low speed rear end impact resulting in a delta-v of the struck car of (16) km/h. Its main purpose is the evaluation of outboard front seat systems under standard conditions with respect to their protection potential and the associated risk for soft tissue neck injuries.

The test procedure is designed for the fiftieth percentile male person/dummy. It is assumed that positive features of seats observed for this group of persons will also yield benefits for other (e.g. fifth percentile female) groups.

The injury protection potential of front seat systems in other collision situations is not covered by this procedure.

2. Determination of performance criteria

2.1 NIC-RI, the neck injury criterion

The neck injury criterion NIC-RI is calculated as follows:

$NIC(t) = a_{rel}(t) \cdot 0.2 + (v_{rel}(t))^2$, where

$$a_{rel}(t) = a_x^{T1}(t) - a_x^{Head}(t), \quad v_{rel}(t) = \int a_{rel}(t) dt, \quad \text{and}$$

$a_x^{T1}(t)$ = acceleration versus time measured in the antero – posterior (x) direction at the height of the first thoracic vertebra (lower neck accelerometer)

$a_x^{Head}(t)$ = the acceleration versus time measured in the antero – posterior (x) direction at the height of the c.o.g. of the head (head accelerometer), i.e. near the first cervical vertebra

The acceleration signals shall be filtered according to CFC180. The maximum value of NIC-RI(t) within an interval of 150 ms after the beginning of the sled acceleration shall be determined and documented as the NIC-RI_{max} value. If the head, after contacting the head restraint, reverses its direction of relative movement at a point in time before 150ms, the upper end of the interval of NIC-RI(t) for the determination of NIC-RI_{max} shall be limited by this point in time.

Justification:

In ECE-Regulation 17 a NIC-RI (RI stands for “Rear Impact”) has been defined to avoid a conflict with the NIC-definition of ECE-Regulation 94, see the extract mentioned below.

Extract from ECE- Regulation 94, Frontal Impact Test Definition of NIC:

2. NECK INJURY CRITERIA (NIC) 2. 1. These criteria are determined by the compressive axial force, the axial tensile force and the fore/ aft shear forces at the head/ neck interface, expressed in kN and measured according to paragraph 5. 2. 2. of annex 3 and by the duration of these forces expressed in ms.

Annex 3, paragraph 5.2.2.

5. 2. 2. Measurements in the thorax of the dummy

5. 2. 2. 1. The axial tensile force and the fore/ aft shear force at the neck/ head interface are measured with a CFC of 1000.

5. 2. 2. 2. The bending moment about a lateral axis at the neck/ head interface are measured with a CFC of 600.

2. 2. The neck bending moment criterion is determined by the bending moment, expressed in Nm, about a lateral axis at the head/ neck interface and measured according to paragraph 5. 2. 2. of annex 3.

2. 3. The neck flexion bending moment, expressed in Nm, shall be recorded.

2.2. HIC (15 ms), the head injury criterion.

The head injury criterion shall be calculated according to SAE J1727, which is attached as annex 10, appendix 2.

To be added till August 2001

3. Testing equipment

3.1. The test shall be performed on a deceleration or an acceleration sled test system

3.2. Test dummy

A BioRID II, alternatively RID 2 Alpha shall be used.

Note:

The technical specification and detailed drawings of BioRID II, corresponding to the principal dimensions of a fiftieth percentile male and the specifications for its adjustment for this test are deposited with the Secretary- General of the United Nations and may be consulted on request at the secretariat of the Economic Commission for Europe, Palace of Nations, Geneva, Switzerland.

3.3. Test objects:

Outboard front seats - equipped with head restraints – which are parts of passenger vehicles and which are located in standard positions as described in paragraphs 4.3. and 4.4. including the relevant part or parts of the body shell where the seats are fixed to. The seat belt/ restraint system of the relevant seat can be installed facultative at the provisions determined by the manufacturer.

4. Test procedure

4.1. Test dummy

The test dummy shall be instrumented as described in table 1. The head of the test dummy should be equipped with a device suitable for electronic detection of the time of the first contact of the head and the head restraint.

[The rotational acceleration may be measured using a second uniaxial accelerometer mounted on the head of the test dummy. This accelerometer shall be mounted with its sensitive axis parallel to the x-axis of the standard head accelerometer, and in a position on top of the head on the z-axis of the standard head accelerometer. In this case, the rotational acceleration of the head around the y-axis can be calculated as:

$$\dot{\omega} = \frac{a_{x,\text{head c.g.}} - a_{x,\text{add.}}}{d}$$

where:

$a_{x,\text{head c.g.}}$ = the x component of the standard head accelerometer

$a_{x,\text{add.}}$ = the signal from the additional accelerometer

d = the distance along the z-axis of the two accelerometers (in meters)

For this purpose, the acceleration signals shall be filtered according to CFC 1000.]

REMARK: The capitel rotational acceleration could be skipped if angle and rotational acceleration are determined by high speed video.

(Table must be correlated with therelevant impact dummy)

Position	Measurement	Axes	Filter
Head	Acceleration	x/(y)/z	CFC 1000 ¹
Upper neck (C1)	Force	x/z	CFC 1000
	Moment of torque	y	CFC 600
T 1	Acceleration	x	CFC 180

Note: For NIC-RI calculation, the x-axis signal needs to be filtered using CFC 180 as well.

Table 1: Standard Instrumentation

4.2. Test temperature

The ambient temperature during the test shall be $22^{\circ}\text{C} \pm 4^{\circ}\text{C}$ Celsius.

The temperature of the dummy and the system of measuring instruments shall be stabilised before the test and maintained so far as possible within a range between $(22 \pm 4^{\circ}\text{C})$.

4.3. Positioning of front seats on the sled

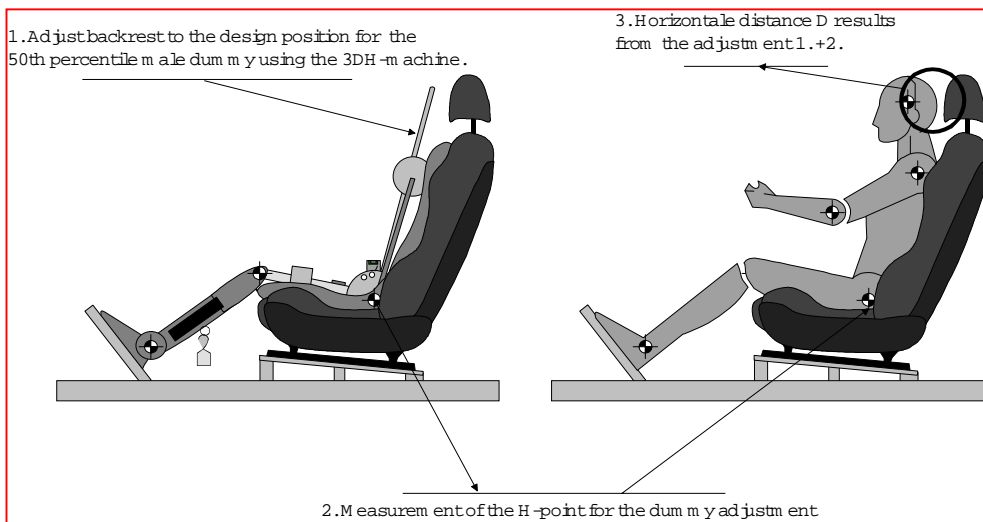
4.3.1

Seats adjustable longitudinally shall be placed so that their “H” point, determined in accordance with the procedure set out in annex 6 of ECE- Regulation 94 is in the middle position of travel or in the nearest locking position thereto, and at the height position defined by the manufacturer (if independently adjustable for height). In case of a bench seat, the reference shall be to the “H” point of the the driver’s place.

4.3.2

In cases where such specifications are not available, the seat shall be mounted on the sled and adjusted such that:

- the lordosis support is fixed at maximum retraction
- other parts not mentioned above shall be positioned as provided for a 50th percentile male occupant, normally the medium position.



4.4. Positioning of the test dummy on the seat

The test dummy is positioned according to the procedures as described in ECE R-94, Frontal Impact Procedure.

The H-point of the dummy shall be positioned within a square of [10]mm side length with horizontal and vertical sides whose diagonals intersect at the “R”-point location determined by the vehicle manufacturer.

4.4.1. Adjustment of restraint system

With the test dummy at its designated seating position as specified by the appropriate requirements, the belt shall be positioned around the test dummy and the latch should be fastened. Remove all slack from the lap belt. Pull the upper torso webbing out of the retractor and allow it to retract. Repeat this operation four times. Apply a 9 to 18 N tension load to the lap belt. If the belt system is equipped with a tension-relieving device, introduce the maximum amount of slack into the upper torso belt that is recommended by the manufacturer for normal use in the owner's manual for the vehicle. If the belt system is not equipped with a tension-relieving device, allow the excess webbing in the shoulder belt to be retracted by the retractive force of the retractor.

4.4.2 Adjustment of the head restraint.

The head restraint system shall be adjusted to the design position according to the recommendation made by the manufacturer.

4.5. Additional considerations

In cases where, due to the reclining movement of the seat during the test, a contact between the seat back and structural parts of the target vehicle (e.g. the rear wall in a two-seat sports car) is to be expected, such structural parts shall be replicated on the sled.

The body of the target vehicle may be mounted on the sled in order to replicate the seating position and the structural parts mentioned above.

5. Test

5.1. Test velocity

The sled test velocity shall be $(16) \pm 1$ km/h. At the request of the manufacturer a test with a complete vehicle and a specific deceleration/acceleration pulse with $\Delta v = 16$ km/h may be carried out.

The test velocity shall be calculated from the deceleration or acceleration time history according to SAE J211.

5.2. Deceleration/Acceleration pulse

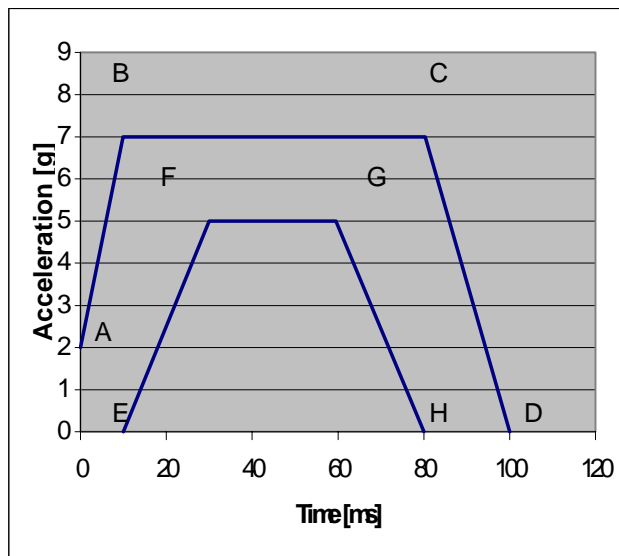


Figure 2: Deceleration/acceleration pulse- corridor

Time [ms]	Point	a [g]	Time [ms]	Point	a [g]
0	A	2	10	E	0
10	B	7	30	F	5
80	C	7	60	G	5
100	D	0	80	H	0

Table 3: Corridor for the deceleration/acceleration pulse

5.3. Active devices

The function of an active devices shall be described by the vehicle manufacturer. During the test according to paragraph 5 the device has to be triggered according to the provisions made by the manufacturer. The manufacturer shall prove that the trigger time corresponds to the trigger time that would be measured in the target vehicle under collision circumstances equal to those simulated by the sled test described above.

5.4. Data recording

The measurement data shall be recorded according to SAE J211/1. Measurement data shall be considered for evaluation

5.5. Measurements to be made on the dummy

The measurement channels as described in table 1 and the sled deceleration/acceleration shall be recorded electronically as a function of time. Data shall be recorded during a minimum of 400 ms after the onset of the sled deceleration/acceleration (t_0).

Where multiaxial accelerations are measured, the resulting accelerations shall be calculated, and the 3-ms-exceedence, HIC, and NIC-RI values shall be calculated. The moments of torque measured at the neck shall be documented without any corrections applied.

5.6. Test report

All data according to the provisions of paragraph 4 and 5 shall be recorded in a form as attached to annex 10, appendix 1 and shall be part of the test report

ANNEX 10, APPENDIX 1: TEST DATA

1. Reference data concerning the seating position and additional data concerning the head restraint

The reference data concerning the seating positions shall be prescribed according to annex 3, appendix 3 of the Regulation.

2. Measurements

2.1. Dummy: Measurements

	Value	measured at time [ms]
Time T of first contact head-head restraint		
NIC [m ² /s ²]		
My upper neck extension [Nm] (at t<T _k)		
My upper neck flexion [Nm] (at t<T _k)		
My upper neck extension [Nm] (at t>T _k)		
My upper neck flexion [Nm] (at t>T _k)		
Fx upper neck [N]		
Fz upper neck [N]		
Head resulting a3ms [g]		
HIC		

2.2 Dummy: Additional measurements:

	Value	measured at time [ms]
My lower neck extension [Nm]		
My lower neck flexion [Nm]		
Head rotational acceleration [rad/s ²]		
Fx lower neck [N]		
Fz lower neck [N]		

(Head-Torso Rotation) :
 Front seat right :
 Front seat left :

Sled velocity: _____ m/s,

Crash pulse within prescribed corridor: Y / N

Remarks:

(If more than one dummy is used, the table/ figure has been supplemented)