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Road vehicles — Sled test procedure for evaluating occupant head and neck interactions with seat/head restraint designs in low-speed rear-end impact

Véhicules routiers — Mode opératoire d'essai sur chariot pour évaluer les interactions de la tête et du cou de l'occupant avec le siège et l'appuie-tête lors d'un choc arrière à faible vitesse

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Contents

Page

Foreword

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International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 17373 was prepared by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 10, *Impact test procedures*.

Introduction

Most head restraints of current vehicles are designed to minimize the risk of severe neck injuries such as bony fractures, luxations and ligament ruptures. However, so called “whiplash associated disorders” (WAD) of an AIS 1 injury severity degree still occur in considerable numbers. The majority of persons with such minor neck disorders soon recover without ongoing symptoms. Some victims, however, report long term impairment after even a “minor” event, also called “low-speed rear-end impact”. These injuries are difficult to diagnose – even a careful medical examination including CT scan and MRI often reveals no visible reason for a reported disorder – and the complexities involved are often misunderstood. Therefore, legal and insurance related disputes are common.

It has been shown in the relevant scientific literature that:

— whiplash associated disorders (WAD) predominantly occur in the struck vehicle in rear-end impacts;

— discussions about better seat and head restraint design in order to reduce WAD have been ongoing for a long time, given the complexity of the subject;

— many organizations interested in seat design (manufacturers of automobiles or seats, universities, accident investigators, consumer test houses) have devised their own dynamic test procedures;

— to date, no standard test procedure is available that covers minor neck loading in typical “low-speed rear-end impacts”;

accidentology analyses show that the majority of the neck disorders discussed here occur during rear-end impacts which result in a velocity change of 10 km/h to 15 km/h for the struck vehicle.

Road vehicles — Sled test procedure for evaluating occupant head and neck interactions with seat/head restraint designs in low-speed rear-end impact

1 Scope

The sled test procedure described in this International Standard simulates low-speed rear-end impact resulting in a velocity change of the struck vehicle of 15 km/h. Its main purpose is the evaluation of the whiplash associated disorders due to seat occupant interactions with seat systems during the loading phase under standard conditions.

Seat-belts shall be used unless it is proven that they do not affect the occupant response.

The occupant protection potential of seat systems in other collision situations (e.g. higher velocity change/vehicle accelerations possibly resulting in large deformation of the seat back) is not covered by this International Standard.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 6487, *Road vehicles — Measurement techniques in impact tests — Instrumentation*

SAE J211/1, *Instrumentation for impacts Tests — Part 1: Electronic Instrumentation*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
delta-v
Δv
maximum velocity change of the sled

3.2
active system
any restraint system, including seat belt, triggered electronically or mechanically, designed to reduce the risk of occupant injuries

3.3
t_0
time corresponding to the first data point above 0,5 g as defined by the acceleration time curve measured on the sled filtered at CFC 60, on a specific sensor with a low amplitude range (e.g. 10 g)

[ISO 6487]

3.4
HRMD backset
horizontal measurement between the back surface of the HRMD head and the front surface of the head restraint as measured by the backset probe of the HRMD

See Annex A.

NOTE HRMD: head restraint measuring device.

3.5
dummy backset
horizontal distance between dummy's head and head restraint

See 6.5.

3.6
dummy height
vertical distance between dummy's head and head restraint

See 6.5.

4 Testing equipment

4.1 Test facility

The test shall be performed on an acceleration sled. If a deceleration system is used, film analysis shall be used to confirm proper dummy position immediately prior to t_0. Two sensors shall be used on the sled:

— one with a low amplitude range for the definition of t_0;

— the second for the complete pulse.

NOTE Proper dummy position means the dummy has not moved outside tolerances specified in the seating procedure.

4.2 Anthropomorphic test device (ATD)

4.2.1 Type

The test procedure is applicable to a 50th percentile male ATD.

Possible ATDs (dummies) that may be used are presented in Annexes A, B and C.

IMPORTANT — It is not in the scope of this test procedure to determine which dummy is to be used.

NOTE ISO experts in this field of standardization recommend using the BioRID II test dummy [1].

4.2.2 Clothing and shoes

The dummy shall be clothed as defined by the dummy manufacturer.

1) BioRID is the trade name of a product supplied by Denton. This information is given for the convenience of users of this International Standard and does not constitute an endorsement by ISO of the product named. Equivalent products may be used if they can be shown to lead to the same results. See 6.2.

4.2.3 Temperature

The dummy temperature shall be in the range of 22 °C ± 3 °C, unless specified differently by the dummy's manufacturer.

This temperature shall be obtained by soaking the dummy in temperatures that are within the range specified above for at least 5 h prior to the test.

The dummy temperature shall be maintained within the specified range between the time of setting the limbs and up to a maximum of 10 min before the time of the test.

4.2.4 Dummy joints

Dummy joint frictions shall be set according to dummy manufacturer's specified procedure or as defined in Annexes A, B and C. The dummy joint stiffnesses shall be set as close as possible to the time of the test and, in all cases, not more than 24 h before the test.

4.2.5 Post test dummy inspection

The dummies shall be visually inspected immediately after the test. Any lacerations of the skin or breakages of the dummy shall be noted in the test report.

4.3 Test objects

These are seat assemblies of passenger cars, light truck vehicles and light commercial vehicles.

5 Requirements

5.1 Anthropomorphic test device instrumentation and measurements

The ATD shall be instrumented according to the requirements of the relevant ISO standards. Table 1 provides an example of ATD measurements.

Table 1 — Examples of ATD measurements

	Position	Measurement	Axes
Recommended measurements	Head	Acceleration	x/y/z
	Upper neck (C1)	Force	x/z
		Moment of torque	y
	Lower neck at the junction of the cervical and thoracic spines	Acceleration	x
		Force	x/z
		Moment of torque	y
	Chest	Acceleration	x/z
	Pelvis	Acceleration	x/y/z
Optional measurements	Head	Rotational acceleration or velocity	y
	Upper neck (C1)	Force	y
		Moment of torque	x/z
	Lower neck at the junction of the cervical and thoracic spines	Force	y
		Moment of torque	x/z

5.2 Test temperature

The ambient temperature during the test shall be 22 °C ± 3 °C.

6 Test preparation

6.1 Mounting of the seat and seat belt system on the sled

6.1.1 General

The seat and seat belt system shall be mounted on the sled with the same position and orientation as in the intended vehicle and using the appropriate attachment hardware (see Table 2). The orientation of the seat and the seat belt system shall be assured by matching the relative co-ordinates of the attachment points.

The mounting supports on the sled and the adjustment mechanisms of the seat shall be adapted as described in 6.1.2 to 6.1.4.

6.1.2 Seat and seat belt adjustments requirements

Table 2 — Seat and seat belt adjustments

Adjustment	Required setting	Notes	Methods
Seat rails angle	Manufacturer's design position		
Seat fore/aft	Mid position as defined in 6.1.3	May be set to first notch rearwards of mid position if not lockable at mid position	See 6.1.3
Seat base tilt	Manufacturer's design position	Permissible up to mid Position	See 6.1.3.10
Seat height	Manufacturer's design position	Otherwise lowest position	
Seat back angle	Manufacturer's design position	Otherwise 25° rearward of vertical (as defined by torso angle of the H-point machine)	
Head restraint height	Manufacturer's design position		
Head restraint tilt	Manufacturer's design position		
Seat lumbar support	Manufacturer's design position	Otherwise fully retracted	See 6.1.3.11
Arm-rests	Manufacturer's design position	Otherwise in stowed position	
Belt anchorage points	Manufacturer's design position		
Shoulder belt	Manufacturer’s design position	If no design position then set to mid-position, or nearest notch upwards	
NOTE Adjustments not listed are set to mid-positions or nearest positions rearward, lower or outboard.			

6.1.3 Method for seat adjustments

6.1.3.1 Place a mark on the moving part of seat runner close to the non-moving seat guide.

6.1.3.2 Move the seat to its most forward position of travel.

6.1.3.3 Mark the unmoving seat guide in line with the mark on the seat runner. This corresponds to the seat in its most forward position.

6.1.3.4 Move the seat to its most rearward position.

6.1.3.5 Mark the unmoving seat guide in line with the mark on the seat runner. This corresponds to the seat in its most rearward position.

6.1.3.6 Measure the distance between the forward and rearward marks. Place a mark on the unmoving seat guide mid-way between the forward and rearward marks.

6.1.3.7 Move the seat so that the mark on the moving part of the seat runner aligns with the mid-way mark on the non-moving seat guide.

6.1.3.8 Lock the seat at this position. Ensure that the seat is fully latched in its runners on both sides (if so equipped) of the seat. The seat is now defined as being at its “mid seating position”. The seat is tested in this position.

6.1.3.9 If the seat does not lock in this position, move the seat to the first locking position that it is rearward of the mid seating position. The seat is tested in this position.

6.1.3.10 If the seat base is adjustable for tilt it may be set to any angle from the flattest up to its mid front tilt-up position according to the manufacturer’s preference.

6.1.3.11 If the seat back is adjustable for lumbar support it should be set to the fully retracted position, unless the manufacturer specifies otherwise.

6.1.3.12 The head restraint shall be adjusted as specified in Table 2.

6.1.4 Method for seat belt adjustments

The anchorage points shall be positioned as specified in Table 2. The tolerance on the position of the anchorage points is such that each anchorage point shall be situated at most at 50 mm from corresponding points.

6.2 Positioning of the ATD on the seat

6.2.1 General

The seating procedure depends on the dummy used. The following seating procedures are included for reference purposes.

6.2.2 Procedure for the BioRID II dummy

The procedure is presented in Annex A.

6.2.3 Procedure for the RID2 dummy

The procedure is presented in Annex B.

6.2.4 Procedure for the Hybrid III dummy

The procedure is presented in Annex C.

6.3 Additional considerations

In cases where, due to the rearward movement of the seat back 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 with all trim 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.

6.4 Film targets

6.4.1 ATD film targets

Film targets, as described in Table 3, shall be mounted on the side of the head at the location of the head centre of gravity and at a second location on the head in order to determine head rotation. A second set of film targets shall be rigidly mounted on the first thoracic vertebra to allow determination of the velocity and rotation of this vertebra.

6.4.2 Seat film targets

For a subsequent film analysis, the following film targets shall be applied to the seat, when possible (see Figure 1 and Table 4). These targets shall be linked to the seat structure to allow seat behaviour analysis.

— T2: on the side face of the head restraint, at the same height as the head centre of gravity.

— T2bis: on the side face of the head restraint, on its lower part.

— T3: on the back rest, at the same height of the shoulder joint.

— T4: on the back rest, according to Figure 1 relative to the H-point.

— T5: seat recliner centre.

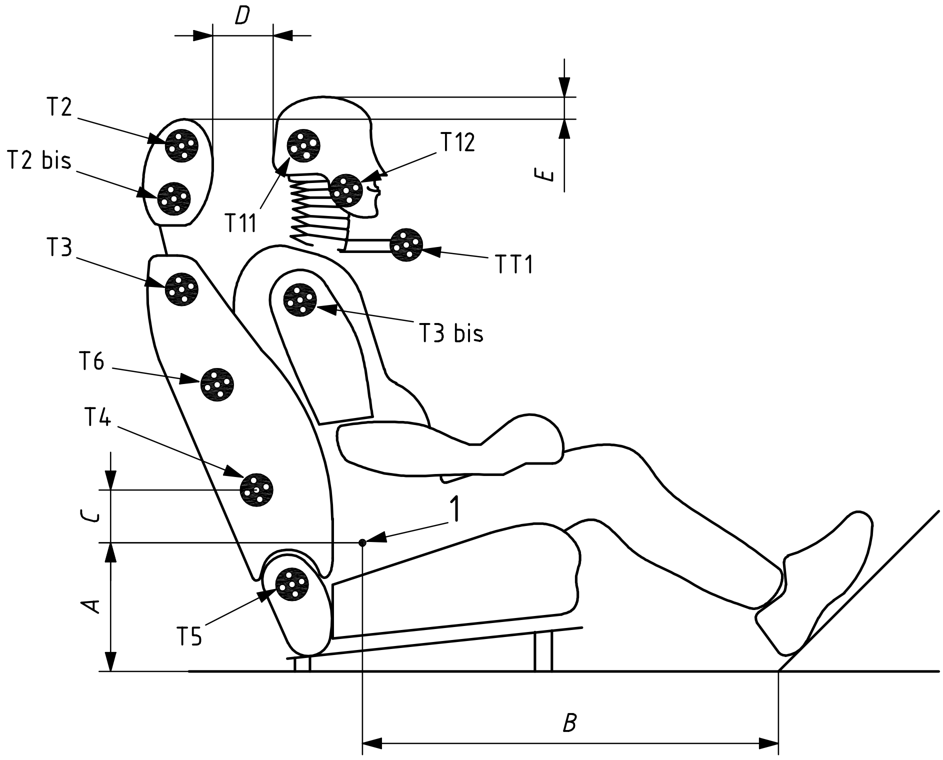
— T6: if the backrest has a second articulation in its upper part.

Additional targets may be added to suit individual requirements.

Instrumentation and targets shall not interfere with the restraint system.

Table 3 — Suggested dummy targets

Target number	Target location
T11	Head centre of gravity
T12	Cheek
T3bis	Shoulder joint
TT1	Junction of the cervical and thoracic spines
NOTE TT1 is the target used to determine head neck kinematics.	



Key

1 H-point

D Dummy backset.

E Dummy height.

Figure 1 — Example of dummy and seat film targets and measurements

Table 4 — Suggested dimensions for the test set-up

Designation	Description	Test device	Dimension
A	Vertical distance floor to H-point	H-point-Machine	As specified by manufacturer
B	Horizontal distance footrest to H-point	H-point-Machine	(850 ± 100) mm
C	Vertical distance H-point to target T4	ATD	(100 ± 5) mm
α	Angle of footrest to floor		As specified by manufacturer
φ	Pelvis angle	ATD	Depending on the ATD

6.5 Test report

The measured co-ordinates/angles of H-point, pelvis and torso, and all film target locations shall be documented in a test report, e.g. as given in Annex D.

Dummy backset, D, and height, E, shall be measured as follows and should be included in the test report:

— dummy backset is the horizontal distance between the rearmost point of the dummy's head and the forward most point on the centreline of the head restraint (see Figure 1);

— dummy height is the vertical distance between the upper most point of the dummy head and the uppermost part of the head restraint (see Figure 1).

All deviations from required settings shall be documented in the test report.

6.6 Camera positions

Cameras, preferably on-board cameras, shall be used, showing a side view of the torso, head and the complete seat.

It shall be ascertained that the seat back, the head restraint, and the upper body parts of the ATD are visible on the film/video during a time interval equal to or longer than 300 ms after the onset of the sled deceleration/acceleration, t_0.

The camera frame rate shall be equal to or greater than 500 frames/sec. It is recommended to use a setting of 1 000 frames/sec.

7 Test conditions

7.1 Acceleration/deceleration pulse

The test pulse is defined in Figure 2 and Table 5. It is defined by a change of velocity of 15,5 km/h and an average acceleration of 5 g over a duration of 91 ms. It is a triangular pulse with a peak acceleration of 10 g at 27 ms.

In a case of an accelerated sled, the test velocity shall be measured immediately after the acceleration phase has been completed. If a decelerated sled is used, the test velocity shall be measured immediately before the impact using a suitable measurement device.

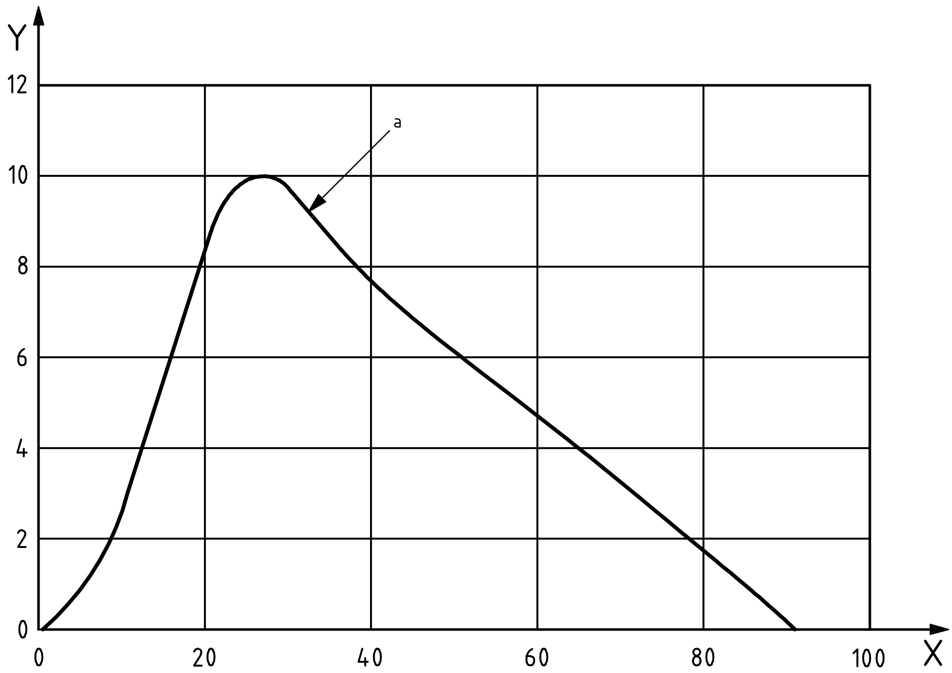
7.2 Active systems

Systems that require a trigger signal in order to deploy during the collision shall be installed such that deployment occurs under the same conditions as in the target vehicle.

If such systems are triggered electronically, the trigger unit may be mounted on the sled. As an alternative, the trigger point can be specified as a time delay with respect to t_0, according to the manufacturer's specifications.

If such systems are triggered mechanically, it shall be ascertained that the triggering mechanics be mounted in a position corresponding to the mounting arrangement in the target vehicle.

The triggering configuration and the status of the device after the test (deployed/not deployed, time of deployment, remarks) shall be documented in the test report.



Key

X time (ms)

Y acceleration due to gravity (g)

[a] 15,5 km/h, 5 g mean acceleration.

Figure 2 — Acceleration/deceleration pulse

Table 5 — Windows for the acceleration/deceleration pulse

Time ms	**Acceleration** g	Δv km/h
0	See definition 3.3	
27	10 ± 0,5	15,5 ± 0,7
91 ± 3	0	

8 Data recording

8.1 General

The measurement data shall be recorded in accordance with ISO 6487 or SAE J211/1. Measurement data shall be considered for evaluation

— until the point in time at which the head centre of gravity film target (T11) reaches the position x_0 during the rebound phase, i.e. its position shows same horizontal (x)co-ordinate relative to the sled as at the beginning of the deceleration/acceleration phase, or

— at 300 ms after t_0,

— whichever occurs first.

8.2 Post-test measurements

After the test, any damage to the seat shall be recorded.

Annex A
(normative)

Positioning procedure for BioRID II

A.1 Introduction

The following positioning procedure has been developed for use with the Denton BioRID IIg Dummy, but is applicable to all BioRID II variants.

A.2 Tools

H-Point machine (SAE J826 [3]).

Head restraint measuring device (HRMD) (SAE paper 1999-01-0639)

A.3 Establish BioRID position targets

A.3.1 The seat shall be set according to Table 2 (see 6.1.2).

A.3.2 Determine the H-point of the test seat using the H-point machine fitted with the HRMD and following the RCAR procedure [4]. (It should be noted that the H-point thus defined may differ slightly from that defined using the H-Point machine without the HRMD.)

A.3.3 Set the head restraint to the test position and measure the head to head restraint distance (HRMD backset and height) following the instructions in A.5.1.

A.3.4 Remove the HRMD and H-point machine.

A.4 Install BioRID in the seat

A.4.1 The H-Point shall be located 20 mm forward (± 10 mm) and 6 mm below (± 10mm) the location recorded in A.3.2.

A.4.2 The pelvis angle shall be 26,5° from horizontal (± 2,5°).

A.4.3 The instrumentation plane of the head shall be level (± 1°).

A.4.4 The centre lines of the knees and ankles shall be 200 mm (± 10 mm) apart.

A.4.5 The upper arms shall be in contact with the seat back with elbows bent so that small fingers of both hands are in contact with the vehicle seat and the palms are facing the dummy's thighs.

A.4.6 Measure the distance between the head restraint and the back of the head (BioRID backset), following the instructions in A.5.2. Two configurations can occur:

a) if the BioRID backset is less than the HRMD backset (see A.3.3) plus 20 mm, then proceed with the test;

b) if the BioRID backset is more than 20 mm greater than the HRMD backset (as recorded in A.3.3), then adjust the position and orientation of the pelvis within the limits specified in A.4.4.1 to A.4.4.4 to achieve a BioRID backset that is 15 mm greater (± 5 mm) than the HRMD backset recorded in A.3.3.

NOTE The dummy may be set up taking advantage of the tolerance bands for pelvis angle and H-point location in order to minimize the difference between actual and target BioRID backset. Use of the BioRID backset tolerance should be undertaken once all other tolerance values have been used.

The BioRID setup is summarized in Table A.1.

Table A.1 — BioRID setup summary

Location	Target measurements with HRMD	Tolerance
Dummy H-Point (X-axis)	Seat H point + 20 mm (forward)	± 10 mm
Dummy H-Point (Z-axis)	Seat H point + 6 mm (lower)	± 10 mm
Pelvis angle	26,5°	± 2,5°
Head plane	0° (level)	± 1°
Dummy backset	HRMD backset + 15 mm (forward)	± 5 mm

A.5 Backset measurements for BioRID positioning

A.5.1 HRMD backset measuring procedure to establish positioning target

a) Locate the screw on the centre of the rear surface of the HRMD backset probe.

b) Mark the forward most point of the head restraint along the vertical centreline of the head restraint.

c) Measure the backset as shown in Figure A.1; it is the horizontal distance between the rearmost point on the HRMD skull (i.e. the screw on the backset probe) and the forward most point on centreline of the head restraint.

Key

1 backset for BioRID positioning

Figure A.1 — Measuring HRMD backset to establish BioRID positioning target

A.5.2 BioRID backset measuring procedure

a) Mark the farthest rearward point on the centreline of the dummy's skullcap. This point is 9 cm below the top centre edge of the skull cap flesh measured along the contour skull cap.

b) Measure the backset as shown in Figure A.2; it is the horizontal distance between the rearmost point on the head and the forward most location on the head restraint as establish in A.5.1.

Key

1 backset for BioRID positioning

Figure A.2 — Measuring BioRID backset

Annex B
(normative)

Positioning procedure for RID2

B.1 Introduction

This annex describes the steps needed to position the RID2 dummy correctly in a vehicle seat prior to rear-end impact testing. In order to obtain reproducible results, the procedure shall be applied each time the dummy is used for a test. This holds also for multiple tests with one or more similar seats. The most important parameter in this procedure is the distance between dummy's head and head restraint, referred to as RID2 backset, whereas the pelvis position and angle are less important.

B.2 Tools

— H-Point machine (SAE J826 [3]);

— Head restraint measuring device (SAE paper 1999-01-0639) (Optional);

— RID2 tilt sensor positioning system (TPS);

— RID2 H-point locator.

B.3 Procedure

a) Set seat and head restraint according to seat adjustments requirements.

b) Determine the H-point of the seat using an H-point machine and using the RCAR procedure [4].

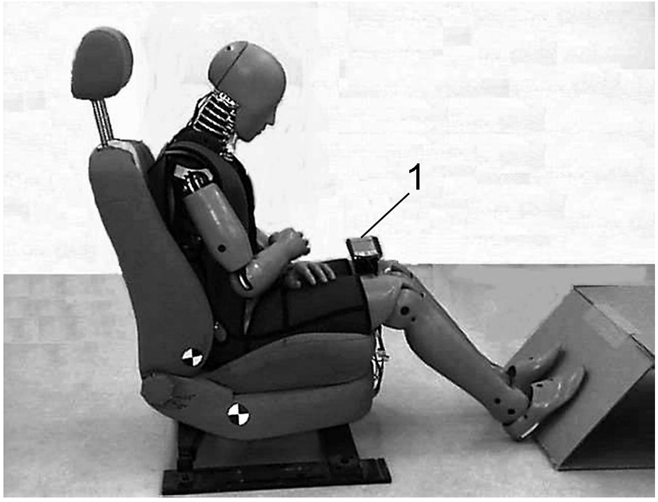
c) Check if the shoulder, elbow, wrist, knee and ankle joints are set to 0 g friction (hip joints require also 0 g friction setting and shall have friction setting bolts removed).

d) Seating of the dummy:

1) Unlock the lumbar bracket of the RID2 [as described in b)].

2) Position the dummy in the seat. Initial seating of the dummy is most convenient when the lifting gear supports the dummy. The H-point of the dummy, given by the H-point locator [see c)], shall be the most rearward as possible. The best way to do this is by pushing the knees of the dummy into the seat and pulling the torso slightly forward (see Figure B.1), while lowering the dummy into the seat. Put the feet of the dummy on the foot panel. As a consequence, the torso will be tilted forward (Figure B.2), depending on the seat type.

Figure B.1 — Seating RID2 into seat, H-point as most rearward as possible



Key

1 tilt sensor display unit

Figure B.2 — Initial seating posture of RID2

e) Set the pelvis to the initial position: Pull the knees forward so that the dummy's H-point coincides with the H-point of the seat with a tolerance of $^{+50}_{-25}$ mm [see f) 5]. The pelvis angle (TPS display: Pelvis_Y) should be 22,5° ± 5°, the lateral angle about the x-axis (TPS display Pelvis_X) should be 0° ± 1°.

f) Check/set distance between head and head restraint (RID2 backset):

1) Settle the dummy into the backrest upholstery by pushing firmly on to the sternum by hand force. Wait until the neck base angle, Th1_Y sensor shows a stable reading.

2) Unlock the neck base and adjust to 0° horizontal with the required tolerance of $^{0}_{-1}$ ° (TPS display Th1_Y)

3) Set the head horizontal (TPS display Head_Y: 0° $^{0}_{-1}$ ° and Head_X: 0° ± 1°), see c) for how to do so. Note that the neck base should be horizontal and the neck vertical and the tolerance allows for 1° forward flexion. This is specified by a negative angle of – 1°.

4) Check the RID2 backset. RID2 backset is the minimum horizontal distance between the head and the head restraint measured along the head midsagittal plane. If no specific required distance is defined, the RID2 backset should be 65 mm ± 25 mm. Note that the RID2 backset should be consistent with the value set in previous tests, in order to allow comparison of seat performance.

5) If the required RID2 backset cannot be achieved, the pelvis needs to be repositioned. To change the RID2 backet, slide the pelvis of the dummy forward by pulling at the knees so the upper torso can move closer to the seat back and the RID2 backset decreases. The pelvis needs to be pushed further into the seat to increase the RID2 backset by pushing the knees backward and bending the torso forward. The pelvis tilt sensor measurement (Pelvis_Y) may change to values ranging from 17,5° to 27,5°, while the dummy's H-point will move rear-forward within – 25 mm to + 50 mm from the H-point. This is not a problem as long as the same procedure, H-point position and tilt sensor measurements are applied in all similar runs. In case the RID2 backset remains too large, use the dummy position in which the head is as close as possible to the head restraint, yet fulfilling the remaining procedure. Set the neck base and head again to 0° $^{0}_{-1}$ ° and check the RID2 backset.

g) Repeat step 6 until the required RID2 backset is obtained.

h) Position the feet on the foot panel. Adjust the centre line of the knees to 200 mm ± 10 mm apart and do likewise for the ankles.

i) Position the hands in the lap of the dummy on top of each other. Tape the thumbs of the dummy to each other and then verify that the head and neck angles have not changed.

j) The dummy is left to rest for 15 min. During this period, the dummy's back and the seat back will reach a stable equilibrium situation.

k) Thereafter, the lumbar bracket shall be locked. In no case shall the lumbar bracket be unlocked again prior the test.

l) The positions, angles and adjustments are registered according to Table B.1.

m) The head set-up may change after setting and therefore shall be set as close to the start of the test, timewise, as laboratory safety procedures allow.

Table B.1 — Summary of requirements for positioning the RID2

Angle/distance to be set	Required value	TPS reading
Pelvis angle (about X-axis)	0° ± 1°	Pelvis_X
Pelvis angle (about Y-axis)	22,5° ± 5°	Pelvis_Y
T1 angle (neck base-plate angle)	$0°\ {}^{0}_{-1}{}^{\circ}$	Th1_Y
Head angle	$0°\ {}^{0}_{-1}{}^{\circ}$	Head_Y
Head to head restraint distance [a]	65 mm ± 25 mm	n.a.
H-point of the dummy with respect to H-point of car/seat [b]	0 mm $^{+50}_{-25}$ mm	n.a.
Distance of centre line of knees and ankles	200 mm ± 10 mm	n.a.

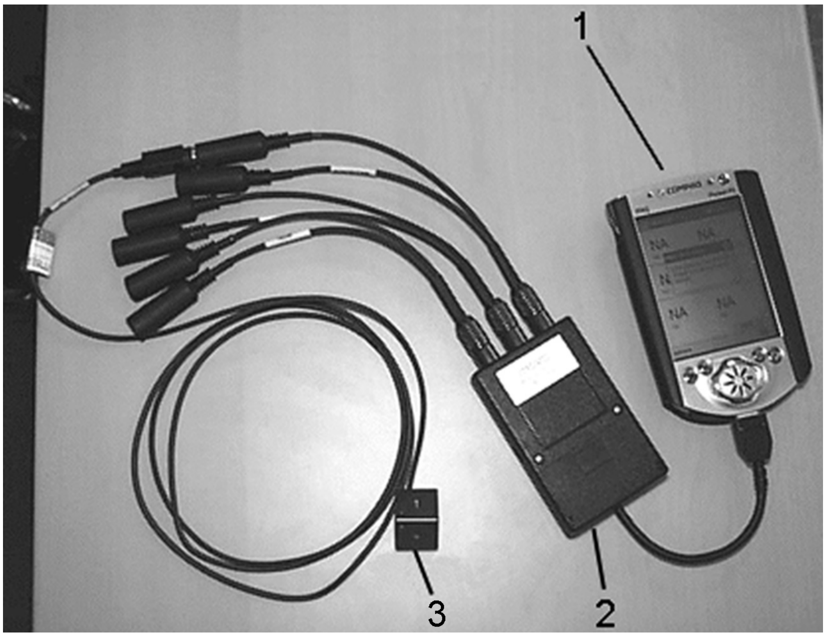
[a] In case required head-head restraint distance is not specified otherwise.

[b] H-point of car/seat = H-point location as determined with H-point mannequin.

B.4 Tilt sensors

The tilt sensors are to be used for measuring the initial orientation of the dummy in the seat. The sensors hook up to a control/display unit. See Figure B.3 and B.4.

There are 6 sensors, all bi-axial: x-axis pointing posterior-anterior corresponding to lateral left-right angular orientation and y-axis pointing left-right corresponding to flexion-extension. Where 0° is horizontal, extension (rearward rotation) is positive and flexion (forward rotation) negative.



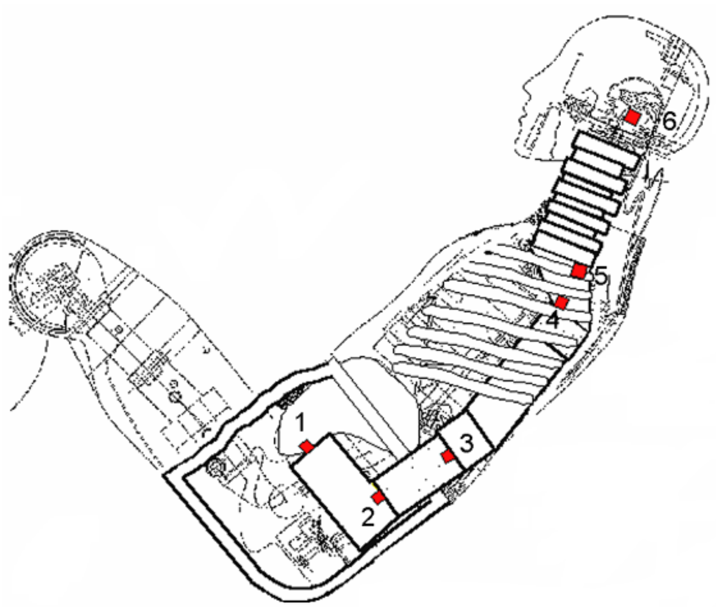
Key

1 tilt sensor control/display

2 adaptor

3 tilt sensor

Figure B.3 — Tilt sensor positioning system,1 sensor hooked up to the adaptor for the control/display unit



Key

1 pelvis

2 lower lumbar

3 thoracal

4 thorax

5 neck base-plate

6 head

Figure B.4 — Tilt sensor positions

B.5 Adjustable lumbar bracket

Using a 1/2″ square drive wrench, the two parts of the lumbar bracket can be locked and unlocked. The square end of the drive fits into a square hole at the side of the lumbar bracket, as indicated in

Key

1 1/2″ square drive hole to adjust lumbar bracket orientation

Figure B.5 — Hole for 1/2″ **square drive to adjust lumbar bracket orientation**

When the lumbar bracket is assembled to the pelvis, it is possible to reach the lumbar bracket with a 1/2″ square drive wrench through a hole at the side of the pelvis, as indicated in Figure B.7. Unlocking on left side is by anticlockwise rotation of wrench, on right side by clockwise rotation.

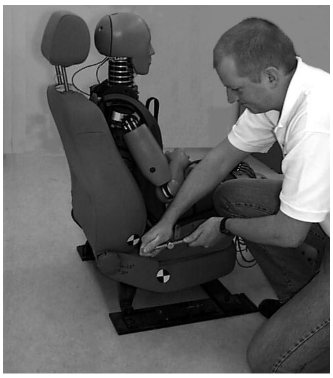
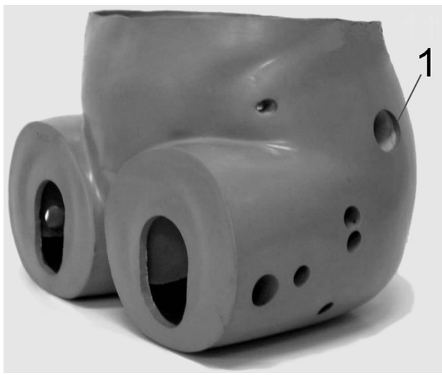


Figure B.6 — (Un)Locking the lumbar bracket



Key

1 hole in pelvis through which the lumbar bracket can be adjusted

Figure B.7 — Hole for 1/2″ **square drive to reach lumbar bracket**

B.6 Adjustable neck bracket and head positioning

The adjustable neck bracket consists of two parts that rotate with respect to each other. The upper part of the neck bracket rotates around the dummy's T1 level, which is defined as the bottom centre of the neck. The orientation of the neck bracket can be adjusted be means of two 5/16″ cap head screws. When the dummy is fully assembled and has been positioned before a test, these cap head screws can be reached through two holes in the shoulder pads, as shown in Figure B.8.

Set the neck base horizontal, TPS display shows Th1-Y $0^{\circ}{}^{\,0}_{-1}{}^{\circ}$ to allow the neck to be set vertical, by lifting the head neck by the neck base-plate and rotating it forward-backward.

Key

1 hole in shoulderpad to gain access to head bracket bolt

Figure B.8 — (Un)locking the neck bracket

a Head-neck joint free range of rotation.

Figure B.9 — Head nodding joint with flexion and extension buffer

The head is positioned as follows.

— Rotate the head forward until the nodding joint reaches its flexion stop. The nodding joint and buffers are illustrated in Figure B.9.

— Push the head forward until the neck reaches maximum flexion, maintaining the nodding joint in flexion. See Figure B.10.

— Rotate only the head backward until the nodding joint reaches its extension stop, maintaining the neck flexion. See Figure B.11.

— Move the head backward until the head is horizontal, Head_Y angle is $0^{\circ}\,{}^{0}_{-1}{}^{\circ}$ and the nodding joint is still at its exterior stop, Release the head. If this procedure is performed correctly, the head will remain in the current position, Figure B.12.

— The nodding joint should remain fully extended. This can be checked by the zero clearance between the upper neck load cell and the extension buffer.

Neck cable tension should be adjusted per dummy user's manual.

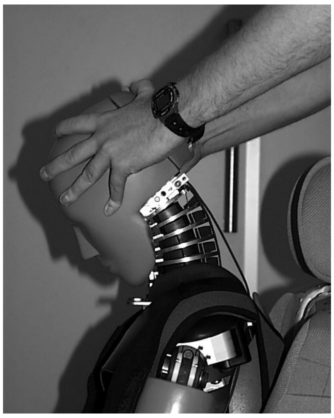


Figure B.10 — Head pushed forward, neck in maximum flexion

Figure B.11 — Head rotated backward until nodding joint extension stop

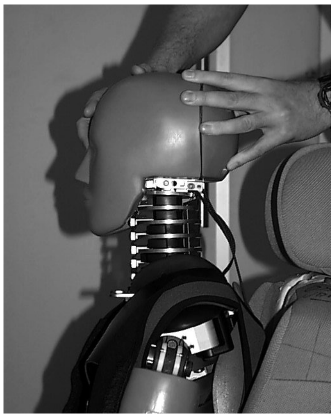
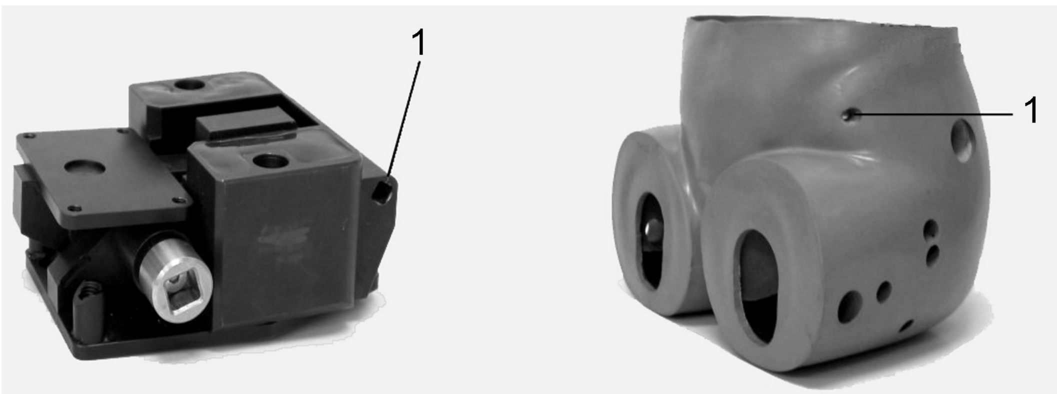


Figure B.12 — Head pushed backward until head is horizontal, nodding joint remains in extension

B.7 Use of H-point locator

The location of the H-point of the RID2 prototype dummy can be determined with the H-point locator. This tool must be inserted in a hole in the lumbar bracket as indicated in Figure B.13 (a). When the lumbar bracket is assembled to the pelvis, the hole can be reached through a hole in the front of the pelvis, as indicated in Figure B.13 (b).



Key

1 hole in lumbar bracket for H-point locator

a)

Key

1 hole in pelvis for H-point locator

b)

Figure B.13 — Lumbar bracket and pelvis with H-point locator positions

Figure B.14 — H-point locator

Key

1 H-point locator

Figure B.15 — Mounted H-point locator

Annex C
(normative)

Positioning procedure for Hybrid III

a) Place the dummy in the seat so that its upper torso rests against the seat back.

b) The dummy shall be positioned so that its midsagittal plane is vertical and coincides with the longitudinal centreline of the designated seating position.

c) The H-point of the test dummy shall coincide to within 12,7 mm (1/2 inch) in the vertical dimension and 12,7 mm in the horizontal dimension of a point 6,35 mm (1/4 inch) below the position of the H-point determined by using the equipment and procedures specified in SAE J826 except that the length of the lower leg and thigh segments of the H-point machine shall be adjusted to 414,02 mm and 401,32 mm (16,3 inches and 15,8 inches) respectively, instead of the 50th percentile values specified in Table 1 of SAE J826:1995.

d) As determined using the pelvic angle gauge (GM drawing 78051–532, incorporated by reference in part 572, subpart E) which is inserted into the H-point gauging hole of the dummy, the angle measured from the horizontal on the 76,2 mm (3 inch) flat surface of the gage shall be 22,5° ± 2,5°.

e) Check that the transverse instrumentation platform of the head is level to within 0,5°.

f) If the transverse instrumentation platform of the head is 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 to within 0,5°.

g) Check that the H-point and the pelvic angle of the test dummy remained within their respective limits as previously specified after any adjustment of the neck bracket. Readjust if necessary.

h) Place the upper legs of the test dummy so that they rest against the seat cushion to the extent permitted by placement of the feet.

i) The initial distance between the outboard knee clevis flange surfaces shall be 269,24 mm (10,6 inches). To the extent practicable, both legs of the passenger dummy shall be in vertical longitudinal planes. Final adjustment to accommodate the placement of feet for various passenger compartment configurations is permitted.

j) Place the right and the left feet on the footrest with the heels resting on the floor pan as close as possible to the intersection point with the footrest. If the feet cannot be placed flat on the toe board, set them perpendicular to the lower leg centre lines and place them as far forward as possible with the heels resting on the floor pan.

k) Place the dummy's upper arms so that they make contact with the seat back and the sides of the torso.

l) Place the palms of the dummy so that they make contact with the outside of the thigh and the little finger makes contact with the seat cushion.

m) Check that the H-point, pelvic angle and angle of the instrumentation platform of the head of the test dummy remain within their respective limits as previously. Readjust if necessary.

n) Record the H-point, pelvic angle and the angle of the instrumentation platform of the head.

Annex D
(informative)

Test report

Test Laboratory:

Date:

Test N°:

SEAT:

Manufacturer: Target vehicle:

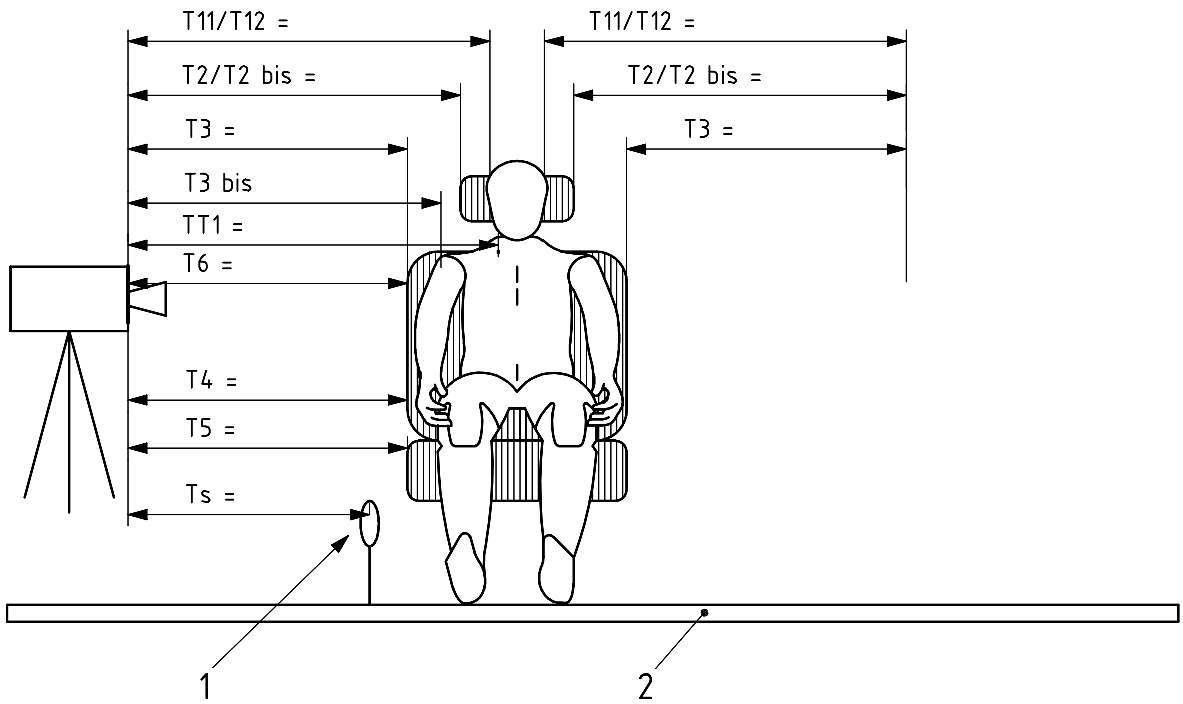
Model: Model year:

ATD measurement pre-test

Dimensions in millimetres

	Description	H-point machine	ATD	Difference
A	Vertical distance floor-H-point			
B	Horizontal distance footrest-H-point			
C	Vertical distance H-point/target T4	n.a	**100**	n.a
H	H-point coordinate (static)	X: Z:	X: Z:	
D	Dummy backset			
E	Dummy height (with respect to head restraint)			

Figure D.1 — Example of test report data sheet



Key

1 target level Ts of sled

2 sled

Figure D.2 — Distances between film cameras and seat/dummy

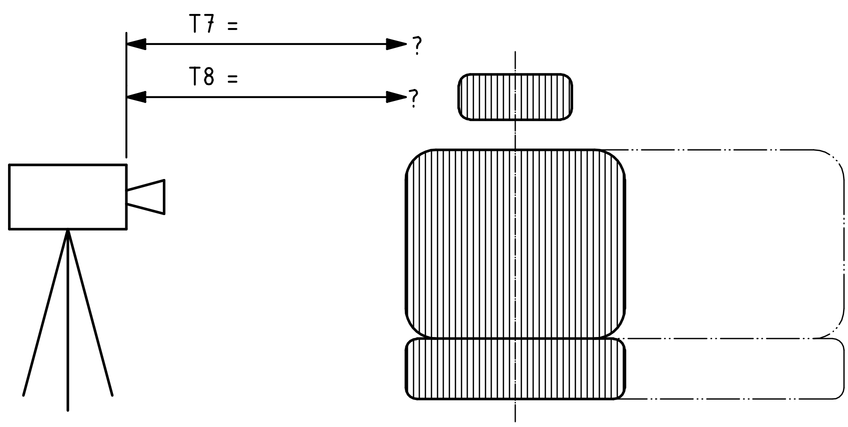


Figure D.3 — Optional film targets on seat

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[1] ISO 6549, *Road vehicles — Procedure for H- and R-point determination*

[2] ISO 12353-1, *Road vehicles — Traffic accident analysis — Part 1: Vocabulary*

[3] SAE J826:1995, *Devices for Use in Defining and Measuring Vehicle Seating and Accommodation*

[4] RCAR procedure, *Static evaluation of head restraints* (www.rcar.org)

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