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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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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.

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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.	