
**Road vehicles — Design and
performance specifications for the
WorldSID 50th percentile male side-
impact dummy —**

Part 1:

Vocabulary and rationale

*Véhicules routiers — Conception et spécifications de performance
pour le mannequin mondial (WorldSID), 50e percentile homme, de
choc latéral —*

Partie 1: Vocabulaire et raisonnement

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Published in Switzerland

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 36, *Safety and impact testing*.

This third edition cancels and replaces the second edition (ISO 15830-1:2013), which has been technically revised.

The main changes are as follows:

- in [B.3.3.3](#) and [Table B.4](#), corrected biofidelity rating of neck test 2;
- in [B.3.6.3](#) and [Table B.7](#), corrected biofidelity rating of abdomen test 3;
- in [Table B.9](#), corrected biofidelity ratings;
- in [Table B.10](#), replaced “rotation accelerometer” with “angular accelerometer or ARS”;
- in [Table B.10](#), replaced “IR-TRACC” with “deflection sensors”;
- in [Table B.10](#), removed ankle rotation sensors;
- replaced “WorldSID production dummy” with “WorldSID (May 2005 version)”;
- in [Figure C.15](#), corrected zero offset;
- in [Table C.3](#), corrected biofidelity rating of neck test 2;
- in [Table C.13](#), corrected biofidelity ratings of abdomen test 3;
- in [Table C.20](#), corrected biofidelity ratings.

A list of all parts in the ISO 15830 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

The purpose of the ISO 15830 series is to document the design and specifications of this side-impact dummy in a form suitable and intended for worldwide use.

In 1997, the WorldSID 50th percentile adult male dummy development was initiated, with the aims of defining a global-consensus side-impact dummy, with more human-like anthropometry, improved biofidelity, and increased injury-monitoring capabilities, suitable, for example, for regulatory use. Participating in the development were research institutes, dummy and instrumentation manufacturers, governments, and vehicle manufacturers from around the world.

This document is intended to document information and design changes which have become available since the publication of the second edition of the ISO 15830 series (2013-05-15).

In order to apply the ISO 15830 series properly, it is important that all four parts be used together.

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Road vehicles — Design and performance specifications for the WorldSID 50th percentile male side-impact dummy —

Part 1: Vocabulary and rationale

1 Scope

This document provides the vocabulary, symbols, and rationale used in all parts of the ISO 15830 series for the WorldSID 50th percentile side-impact dummy, a standardized anthropomorphic dummy for near-side-impact tests of road vehicles.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

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

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <https://www.electropedia.org/>

3.1

1-to-2-g-setting

joint friction setting which will support the weight of a horizontally extended limb segment but will not support twice the limb segment weight

3.2

abdomen rib

lowest two ribs of the six mechanical ribs in the WorldSID dummy

3.3

aluminium honeycomb

manufactured material comprising multi-layered bonded sheets of aluminium bent or corrugated in a rib pattern, in which there is an internal pattern of hexagonal cylindrical spaces

3.4

angular rate sensor

ARS

sensor which records angular velocity

3.5

arm

assembly of the WorldSID dummy comprising dedicated upper arm components which are different from the components of the *full arm* (3.12)

Note 1 to entry: Unless otherwise specified, arm refers to the half arm for the ISO 15830 series.

3.6

C7

location corresponding to the seventh cervical vertebra in a human

3.7

capacity

maximum designed range for force or moment measurements

3.8

cheese screw

slotted button head screw

Note 1 to entry: This concept is also referred to as a slotted cheese head screw as defined by ISO 1207.

3.9

data acquisition system

DAS

system that includes sensors, recorders, cables and other associated hardware

3.10

docking station

data recorder connection point inside the dummy which allows the recorder to be conveniently disconnected from the sensors

3.11

frontal

forward-facing or anterior surfaces of the dummy, when it is in a standing posture

3.12

full arm

optional assembly of the WorldSID dummy comprising the articulated upper arm and forearm, including the hand

3.13

H-point

point on the outer surface of the dummy on an imaginary line which passes through the left and right hip ball centres

3.14

H-point tool

device which can be inserted into index holes in the dummy pelvis to provide an external surface for indicating the orientation of the pelvis and an imaginary line connecting the left and right hip ball joint centres

3.15

head form

mechanical device with the same mass and I_{xx} inertia as the WorldSID head, used for lateral neck validation (3.33) tests

3.16

infrared telescoping rod for assessment of chest compression

IR-TRACC

sensor for deflection measurements

3.17

L1

location corresponding to the first lumbar vertebra in a human

3.18

L5

location corresponding to the fifth lumbar vertebra in a human

3.19**lower leg**

portion of the lower extremity between the knee and the ankle

3.20**mass replacement**

non-electronic component which is substituted for a given dummy electronic component, which has the same mass as the given electronic component, and which does not act as a structural component of the dummy (e.g. an accelerometer)

3.21**rib deflection**

change in distance between the accelerometer mount on the rib and the spine box

3.22**S1**

location corresponding to the first sacral vertebra in a human

3.23**shoulder rib**

upper-most rib of the six mechanical ribs in the WorldSID dummy

3.24**side impact dummy**

dummy used to evaluate performance of impacts lateral to the dummy

3.25**structural replacement**

non-electronic component which is substituted for a given dummy electronic component (e.g. a load cell), which has the same mass as the given component, and which also acts as a structural component of the dummy

3.26**thorax rib**

second, third, and fourth upper-most ribs of the six mechanical ribs in the WorldSID dummy

3.27**T1**

location corresponding to the first thoracic vertebra in a human

3.28**T4**

location corresponding to the fourth thoracic vertebra in a human

3.29**T12**

location corresponding to the twelfth thoracic vertebra in a human

3.30**tilt sensor**

sensor that measures angle relative to gravity

3.31**universal**

capable of being mounted at several different locations on the dummy

3.32**upper leg**

portion of the lower extremity between the knee and the hip ball

**3.33
validation**

process by which the relevant dummy component or whole dummy is verified and documented to meet the specifications

**3.34
validation bench**

specialized seat with defined seat bottom and seat back angles used to position the dummy for *validation* (3.33) tests

**3.35
W50-**

prefix denoting WorldSID 50th percentile adult male dummy part or drawing number

4 Symbols, subscripts and abbreviated terms

4.1 Symbols

See [Table 1](#).

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Table 1 — Symbols and their meanings

Symbol	Meaning
a	Linear acceleration
B	Biofidelity rating for a body region
F	Force
g	Acceleration due to gravity (9,81 m/s ²)
M	Moment
R	Biofidelity rating for how well an individual response meets its requirement
V	Biofidelity weighting factor for a test condition of a body region
W	Biofidelity weighting factor for an individual response measurement
x	Coordinate in accordance with SAE J1733
y	Coordinate in accordance with SAE J1733
z	Coordinate in accordance with SAE J1733
α	Angular acceleration
β	Maximum angular displacement of the head form relative to the neck pendulum
δ	Deflection
θ	Tilt angle
φ	Angular displacement
ω	Angular rate

4.2 Subscripts

See [Table 2](#).

Table 2 — Subscripts and their meanings

Symbol	Meaning
F	Forward pendulum-to-head form sliding rod
H	Head form
R	Rearward pendulum-to-head form sliding rod
i, j, k	Biofidelity rating: i: body region j: test condition for a given body region k: response measurement for a given test condition j and body region i
x, y, z	Coordinate system: In the x, y, or z direction; about the x, y, or z axis where x, y, or z are in accordance SAE J1733

4.3 Abbreviated terms

See [Table 3](#).

Table 3 — Abbreviated terms

Abbrevia- tion	Meaning
AMVO	Anthropometry for Motor Vehicle Occupants data set (established by UMTRI)
APR	Association Peugeot-Renault
A-P	Anterior-posterior
ASIS	Anterior superior iliac spine

Table 3 (continued)

Abbreviation	Meaning
ATD	Anthropomorphic test device
BHCS	Button head cap screw, also referred to as a hexagon socket button head screw as defined by the ISO 7380 series
CG	Centre of gravity
CFC	Channel frequency class
CPSS	Cone point set screw, also referred to as a hexagon socket set screw with cone point as defined by ISO 4027
CPSSS	Cone point socket set screw as defined by ISO 4027
CPNT	Cone point nylon tip
DAS	Data acquisition system
FHCS	Flat head cap screw, also referred to as a hexagon socket countersunk head screw as defined by ISO 10642
IARV	Injury assessment reference value
ISO	International Organization for Standardization
LHSHCS	Low head socket head cap screw
MDB	Movable deformable barrier
NHTSA	National Highway Traffic Administration
NM	Not measured
OC	Occipital condyle
PTFE	Polytetrafluoroethylene
R-L	Right-left
ROM	Range of motion
SHCS	Socket head cap screw, also referred to as a hexagon socket head cap screw as defined by ISO 4762
SHSS	Socket head shoulder screw, also referred to as a hexagon socket head shoulder screw as defined by ISO 7379
SI	Sacroiliac
SSCP	Set screw with cup point, also referred to as a hexagon socket set screw with cup point as defined by ISO 4029
SSFP	Set screw with flat point, also referred to as a hexagon socket set screw with flat point as defined by ISO 4026
SSHDP	Set screw with half dog point, as defined by ISO 4026
SSNT	Set screw with nylon tip
UMTRI	University of Michigan Transportation Research Institute
WSU	Wayne State University

5 Technical targets and performance of WorldSID

Technical targets and brief background for WorldSID are given in [Annex A](#).

WorldSID performance relative to the technical targets is given in [Annex B](#).

Data from WorldSID biofidelity tests is given in [Annex C](#).

Data from WorldSID repeatability and reproducibility tests is given in [Annex D](#).

Annex A (informative)

Rationale regarding background and goals for WorldSID

A.1 Historical background

A.1.1 General

In November 1997, the WorldSID task group was formed to develop a technologically advanced side-impact dummy with better biofidelity and to replace the variety of side-impact dummies used in regulatory and other tests.

The resulting WorldSID 50th percentile adult male side-impact dummy has an overall biofidelity classification of 8,0 (“good”) using the ISO/TR 9790 biofidelity rating scale. The WorldSID 50th percentile adult male has a mass of 74,35 kg, a theoretical standing height of 1 753 mm, and a seated height of 911 mm. It can accommodate over 200 permissible sensor channels (including six tilt sensors) and associated cabling, and up to 192 recording channels with an optional in-dummy data acquisition system (DAS).

A.1.2 Need for an International Standard side-impact dummy

As of December 2008, six other mid-sized male side-impact dummies were available for regulatory, consumer information and development use. These were the USDOT-SID dummy, which was utilized in the United States side-impact protection regulation^[42]; the EuroSID-1 dummy, which was regulated in a European standard^[24]; the ES-2 dummy, the ES-2re; the SID/Hybrid III dummy, which was utilized in the United States side-impact protection regulation FMVSS-201; and the BioSID dummy, which was available for developmental purposes. None of these dummies had “good” biofidelity (i.e. they all had a less than “6,5” rating using the ISO/TR 9790 biofidelity rating scale). The six dummies are structurally different and have different instrumentation capabilities and associated injury assessment criteria. Because of these differences, as well as the differences in the associated test procedures, these dummies typically provided different design directions in the vehicle development process. This could result in substantially different vehicle designs with regard to side-impact protection in the different world regions, despite the similarity in occupant protection needs among the regions.

A.1.3 Biofidelity comparisons with previous side-impact dummies

The six mid-sized male side-impact dummies, as well as some variations thereto, available for use in December 2008 have different levels of biofidelity. The USDOT-SID, EuroSID-1, ES-2, ES-2re, BioSID dummies have each been rated using the ISO/TR 9790 biofidelity scale that provides classifications, as shown in [Table A.1](#). These classifications quantify how closely the dummy dynamic response matches those of a sample of human subjects. The USDOT-SID has an ISO biofidelity classification of “unacceptable”, the EuroSID-1 and ES-2re have a classification of “marginal,” and the BioSID and ES-2 have a classification of “fair”.

Table A.1 — ISO biofidelity rating scale

Excellent	> 8,6 to 10
Good	> 6,5 to 8,6
Fair	> 4,4 to 6,5
Marginal	> 2,6 to 4,4
Unacceptable	0 to 2,6

The ISO/TR 9790 biofidelity ratings of the WorldSID, USDOT-SID, EuroSID-1, ES-2, and BioSID are reported in Reference [39] as shown in Table A.2. WorldSID achieved the best overall dummy rating and the best single body region ratings for the head, shoulder, thorax, and abdomen.

Table A.2 — Biofidelity comparison of side-impact dummies

	Biofidelity rating						
	Head	Neck	Shoulder	Thorax	Abdomen	Pelvis	Overall
WorldSID (2005 version)	10,0	5,3	10,0	8,2	9,3	5,1	8,0
BioSID	6,7	6,7	7,3	6,3	3,8	4,0	5,7
ES-2	5,0	4,4	5,3	5,2	2,6	5,3	4,6
EuroSID-1	5,0	7,8	7,3	5,4	0,9	1,5	4,4
ES-2re	5,0	4,2	4,5	4,0	4,1	3,2	4,2
USDOT-SID	0,0	2,5	0,0	3,1	4,4	2,5	2,3

Independently, the US/NHTSA (National Highway Traffic Safety Administration) evaluated the WorldSID prototype with the ES-2 and the SID/Hybrid III, to Bio Rank, a more recently developed biofidelity ranking system, as reported by Reference [36].

The Bio Rank system quantifies the ability of a dummy to load a sled wall as a cadaver does (external biofidelity) and the ability of a dummy to replicate those cadaver responses that best predict injury potential (internal biofidelity). The ranking is based on the ratio of the cumulative variance of the dummy response relative to the mean cadaver response and the cumulative variance of the mean cadaver response relative to the mean plus one standard deviation. That ratio expresses how well a dummy duplicates a cadaver response. Contrary to the ISO/TR 9790 rating system, the lower the rating value, the better the biofidelity.

Although still under development and not in use by the international community, the data presented by Reference [36] indicate that this assessment system also showed the WorldSID prototype to have the best biofidelity out of the three tested dummies.

In summary, compared with other contemporary mid-sized adult male side-impact dummies, the WorldSID overall ratings are better than all others using either biofidelity rating system.

A.2 Technical targets for the WorldSID prototype

A.2.1 General

The WorldSID task group developed a comprehensive set of technical targets in the following categories:

- functional description;
- loading conditions and interactions;
- anthropometry;
- biofidelity;
- instrumentation;
- repeatability and reproducibility;
- durability;

- robustness;
- handling;
- validation;
- miscellaneous.

Detailed targets in each of these areas were identified for the overall dummy and for each of the following body regions:

- head;
- neck;
- shoulder-thorax-abdomen;
- full arms;
- half arms;
- lumbar spine;
- pelvis;
- upper legs;
- lower legs;
- clothing.

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In addition, targets for internal electronic measurement components were identified, including those for the following:

- accelerometers;
- load cells;
- displacement transducers;
- tilt sensors, to facilitate dummy positioning;
- in-dummy data acquisition system.

During the development, the highest priority among these targets was given to the goal of matching the biofidelity (i.e. human dynamic response) targets specified in ISO/TR 9790. The target performance was that a rating of “good” to “excellent” be achieved on the biofidelity rating scale contained in ISO/TR 9790, for all segments of the dummy, and for the overall dummy.

The WorldSID task group reviewed all of the currently existing side-impact dummies to determine what functions and features to incorporate into the WorldSID. Various proposals and ideas from dummy and instrumentation manufacturers and research organizations were reviewed. The majority of the WorldSID consists of new design concepts, with the exception of the neck, which is mainly from the ES-2 dummy (all parts except for the neck buffers).

The WorldSID dummy shall be capable of:

- left-right symmetrical design instrumented on both sides simultaneously;
- off-axis loading for $\pm 30^\circ$ in the horizontal plane and $\pm 10^\circ$ in the vertical plane without binding or producing unreasonable data;
- optional in-dummy DAS to enable properly positioning the highly-instrumented dummy without a large bundle of cables.