
**Road vehicles — Test procedures for
evaluating out-of-position vehicle
occupant interactions with deploying
side air bags**

*Véhicules routiers — Méthodes d'essai pour l'évaluation des
interactions d'un occupant en position anormale dans un véhicule
avec les sacs gonflables latéraux en cours de déploiement*

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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.

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.

In exceptional circumstances, when a technical committee has collected data of a different kind from that which is normally published as an International Standard ("state of the art", for example), it may decide by a simple majority vote of its participating members to publish a Technical Report. A Technical Report is entirely informative in nature and does not have to be reviewed until the data it provides are considered to be no longer valid or useful.

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/TR 14933 was prepared by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 10, *Impact test procedures*.

This second edition cancels and replaces the first edition (ISO/TR 14933:2001), which has been technically revised.

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Introduction

Side air bags (SAB) are inflatable devices intended to help reduce the risk of injury to the head and/or the chest and/or the pelvis of vehicle occupants adjacent to the impacted side of the vehicle. Side impact accident data indicate that the vehicle side is most likely to come into contact with a passenger car, a truck or a fixed object, such as a pole or tree¹⁾. Accident data also indicate that serious-to-fatal injuries in side impact are most likely to occur to the head, neck, chest, abdomen, pelvis and extremities.

During its inflation process in an accident, an air bag generates a considerable amount of kinetic energy and, as a result, substantial forces can be developed between the deploying air bag and the nearby occupant. A considerable but unknown portion of the occupant population does not drive/ride in exactly the vehicle design position, but lean/rest in various ways against the armrest, door, glazing or other side panel of the vehicle, where air bag reaction forces may be even greater. These test procedures were developed to help improve the understanding of such interactions and to help aid in the assessment of future air bag designs.

This Technical Report describes the more common interactions, recognizing that the range of possible interactions is essentially limitless.

References^[1] to^[5] provide some background on human impact tolerance and criteria, while references^[6] and^[7] describe scaling techniques for different size occupants and references^[8] to^[10] offer interpretations of dummy responses relative to human injury potential that may be helpful in the evaluation.

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1) The vehicle side may also come into contact with the ground during rollovers, but such contact is generally expected to be less severe than when coming into contact with the three main objects mentioned above.

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Road vehicles — Test procedures for evaluating out-of-position vehicle occupant interactions with deploying side air bags

1 Scope

This Technical Report outlines test procedures for evaluating the effects of the interactions between deploying side air bags (SAB) and vehicle occupants. The in-position test procedures are referred to in other ISO international standards, such as, full-vehicle pole crash tests (ISO 15829) and instrumented arm evaluations (ISO 15827). Out-of-position vehicle occupant test procedures are described in this Technical Report.

This Technical Report describes dummies, procedures, instrumentation and test configurations that can be used for investigating the interactions that occur between a deploying side air bag and a vehicle occupant in front and rear seats. Air bags may deploy from the door or side trim panel, the armrest, the seat back or cushion, the roof support pillars, and the roof rail area. Occupants can range in size from young children through very large adults. These test procedures are sufficiently broad to cover these areas. Static tests are used for these evaluations, since external forces do not accelerate the vehicle buck.

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 6487:2012, *Road vehicles — Measurement techniques in impact tests — Instrumentation*

ISO/TR 12349 (all parts):1999, *Road vehicles — Dummies for restraint system testing*

ISO/TR 15827:2007, *Road vehicles — Test procedures — Evaluating small female dummy arm and forearm interactions with driver frontal airbags and side airbags*

ISO/TR 15829:2004, *Road vehicles — Side impact test procedures for the evaluation of occupant interactions with side airbags by pole impact simulation*

SAE J211-1:2007, *Instrumentation for impact test — Part 1: Electronic instrumentation*

SAE J211-2:2008, *Instrumentation for impact test — Part 2: Photographic instrumentation*

3 Definitions

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

3.1

side air bag

SAB

air bag designed primarily to help reduce occupant injury potential where the significant collision force vector is lateral

3.2

head air bag

air bag that deploys between the occupant's head and the vehicle side structure or an external object that could contact the head

3.3

chest (thoracic) air bag

air bag that deploys between the occupants upper torso and the vehicle side structure

3.4

pelvic air bag

air bag that deploys between the occupant's pelvis/thigh area and the vehicle side structure

3.5

combination air bag

air bag that deploys to help protect two or more occupants' body areas

EXAMPLE A head and chest combination air bag.

3.6

out-of-position occupant

occupant who is seated within the deployment area of a side air bag (for side impact collisions)

3.7

instrumented arm

upper and/or lower arm that fits on a production dummy, with accelerometers and/or load cells to help measure the interactive forces, accelerations and moments on the upper extremities during air bag deployment

3.8

rigid pole

vertically-oriented circular, rigid pole-like structure, beginning no more than 100 mm above the ground, and extending above the roof of the impacting vehicle

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Note 1 to entry: See ISO 3560 and ISO 15829.

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3.9

seat bight

seat back/seat cushion junction

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4 Tests

4.1 General

Tests described in this Technical Report should be selected to produce the most comprehensive assessment of the occupant protection system in out-of-position conditions. Additional tests may need to be conducted with slight modifications of the dummy positioning to help ensure the robustness of the occupant interaction measurements.

4.2 Test device

4.2.1 General

Refer to [Tables 2](#) and [3](#) for the dummies that are appropriate for use in this Technical Report. These dummies are referenced in ISO/TR 12349 (all parts).

The dummy's head skin should be cleaned with alcohol and dusted with baby powder to achieve acceptable frictional characteristics.

4.2.2 SID-IIs

The SID-IIs represents a 50th percentile 12 to 13 year old adolescent or small adult generic dummy designed to indicate injury potential to the head, neck, shoulder, arm, chest, abdomen, lumbar spine, pelvis, thighs and legs as described in Part 572. The SID-IIs has been fully evaluated and has been adopted

into ISO/TR 12349 for use. See references[11] to[13] for instrumentation details. It was specifically designed to help evaluate the injury potential of side air bags[11] to.[13]

5 Instrumentation

5.1 General

Measurements, possibly applicable to air bag testing, that can be made using the approved anthropomorphic test device for each age group are contained in ISO/TR 12349. All measurements should be recorded and filtered according to the latest version of ISO 6487 and SAE J211 for body regions. These measurements should be continuous functions of time, so that other quantities referred to in the references may be derived. Caution must be exercised with dummy compression measurements. In some of these tests, the rate of loading may be high enough to cause discontinuities in the compression data of the SID-IIs.

Monitor the air bag deployment and dummy interactions by high-speed cameras (or equivalent video equipment) operating at a minimum speed of 1000 frames per second (3000 fps is recommended). The cameras should be positioned so that the field-of-view encompasses the test setup and includes the anticipated movement of the dummy during the test.

5.2 Dummy test temperature

The test dummy temperature should be within a temperature range of 20,6 °C to 22,2 °C at a relative humidity to 10 % to 70 % after a soak period of at least 4 h prior to its application in a test, or that specified for the dummy by the manufacturer.

5.3 Electrical grounding

The test dummy, vehicle and all related instrumentation must be grounded to the data collection system. The test dummy shall be grounded with cables attached to the dummy's head, thorax and pelvis, which shall be connected to earth ground during all testing. Between tests, spray the dummy with an anti-static spray. These are both very important due to the high likelihood for electrostatic discharges as a result of the inflating air bag.

6 Air bag location/impacting object/other test matrix

The vehicle-to-fixed pole crash test procedure was selected in [Table 1](#) instead of a dynamic side impact crash test or high-hooded vehicle simulation crash test. The rationale is that a pole crash test is the most severe and produces the highest dummy interaction responses. Additionally, a pole test presents the greatest challenge for designing the side air bag sensor system. The child/adult out-of-position and instrumented arm interaction tests are shown in [Tables 2](#) and [3](#) for front and rear seating positions.

Table 1 — Pole test matrix

Air bag types	Seat position		
	Foremost	Mid	Rearmost
Seat	X	X	X
Door	X	X	X
Roof-rail	X	X	X

Table 2 — Side air bag OOP summary test matrix for driver seat (small - large adults)

Air Bag Types	Test Devices	Test Positions	Body Regions
Seat Mount	SID-IIs, with ½ Arm (If same air bag as passenger, tests may be conducted in either position.)	7.2.8.1 - Inboard facing, leaning against door	Head, Neck, Thoracic, Abdominal
	SID-IIs, with Instrumented Arm	7.1.2.1 - Arm on armrest	Arm
Door Mount	SID-IIs, with ½ Arm (If same air bag as passenger, tests may be conducted in either position.)	7.2.7.1 - Forward facing against door trim	Neck, Thoracic, Abdominal
	SID-IIs with Instrumented Arm	7.1.2.1 - Arm on armrest	Arm
Roof-Rail Mount	SID-IIs, with ½ Arm or Hybrid III Small Female (If same air bag as passenger, tests may be conducted in either position.)	7.2.7.2 - Forward facing, against door trim, seat highest position	Head, Neck

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Table 3 — Side air bag summary test matrix for front passenger and rear seats (children - adults)

Air Bag Types	Test Devices	Test Positions	Body Regions
Seat Mount	3-year-old Child Hybrid III	7.2.2.1 - Child on booster seat facing forward leaning against door trim	Head, Neck, Thoracic, Abdominal
		7.2.3 - Facing rearward leaning against door	Head, Neck, Thoracic
		7.2.6.2 - Lying across seat, head on door trim, wedge support	Head, Neck
	6-year-old Child Hybrid III	7.2.2.2 - Child on booster seat facing forward leaning against door trim	Head, Neck, Thoracic, Abdominal
	SID-IIs, with ½ Arm	7.2.8.1 - Inboard facing against door	Head, Neck, Thoracic, Abdominal
	SID-IIs, with Instrumented Arm	7.1.2.1 - Arm on armrest	Arm
Door/Quarter Panel Mount	3-year-old Child Hybrid III	7.2.4 - Outboard facing, leaning against door trim	Head, Neck, Thoracic
		7.2.5.1 - Inboard facing, leaning back against door trim	Head, Neck
		7.2.6.1 - Lying across seat, head against door trim	Head, Neck
		7.2.6.2 - Lying across seat, head on door trim, wedge support	Head, Neck
	SID-IIs, with ½ Arm	7.2.7.1 - Forward facing against door trim	Neck, Thoracic, Abdominal
	SID-IIs, with Instrumented Arm	7.1.2.1 - Arm on armrest	Arm

Table 3 (continued)

Air Bag Types	Test Devices	Test Positions	Body Regions
Roof-Rail Mount	6-year-old Child Hybrid III	7.2.5.2 – Inboard facing, leaning back against door, seated on booster	Head, Neck
	SID-IIs, with ½ Arm or Hybrid III Small Female	7.2.7.2 – Forward facing against door trim, seat highest position	Head, Neck
		7.2.8.2 – Facing inboard against door, seat highest position	Head, Neck

7 Test details

7.1 Test procedures referenced in other ISO international standards

7.1.1 Dynamic vehicle-to-pole crash test

Refer to [Table 1](#) and the ISO 15829 test procedure.

7.1.2 Instrumented arm static test procedure

Refer to [Tables 2](#) and [3](#) and ISO/TR 15827 for test matrices.

7.1.2.1 Elbow on armrest

Refer to the ISO/TR 15827 test procedure.

7.2 Child and small adult out-of-position static tests.

7.2.1 General

These tests have been developed to help evaluate the inflation induced injury potential of side air bags. The test dummy positions were developed to both block the deployment path of the side air bags and also to position the measurement systems of the dummy in the path of the deployment of the air bags. The tests are conducted in a static mode. Evaluations should be conducted with representative seats and door trim panels located in the vehicle design position.

Tests are conducted with the seat in its rearmost seat track and its full-down position, unless otherwise specified. Position the seat back to manufacturer's design angle or 25 degrees. The headrest is adjusted to its full-down position. The upper safety belt anchor adjustment is set to its highest position. All windows on the inflation side should be in the closed position, unless otherwise specified.

To aid in the dummy positioning, identify and mark the centreline of the seat back and seat cushion. Additionally, draw a horizontal line locating the top edge of the side air bag module, *line A*.

In vehicles with more than one type of side air bag system per seating position, the evaluations should be conducted individually and as a system.

7.2.2 Child on booster seat facing forward leaning against the door trim panel

These positions are for seat-mounted air bag systems ([Table 3](#)). The intention of this test is to maximize the head/neck interaction by aligning the neck with the top of the side air bag module. Modifications may have to be made to this procedure to achieve this goal. The test is conducted using both the 3-year-old and 6-year-old child Hybrid-III dummies as described in Part 572.

The booster seat foam block dimensions are 300 mm deep by 450 mm wide by 75 mm thick. The foam has a density of 40 g/l-80 g/l. A typical foam material is expanded polypropylene (EPP).