TECHNICAL REPORT

# ISO/TR 14933

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# Road vehicles — Test procedures for evaluating occupant interactions with deploying side impact airbags

*Véhicules routiers — Méthodes d'essai pour évaluer les interactions de l'occupant 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 3.

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is entirely informative in nature and does not have to be reviewed until the data it provides are considered to be no longer valid or useful.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 Technical Report 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*.

## Introduction

Side air bags (SAB) are inflatable devices intended to help reduce the risk of injury to the head, chest or pelvis, or all these, of vehicle occupants adjacent to the impacted side of the vehicle. Side impact accident data indicate that the vehicle side is most likely to be contacted by a passenger car, a truck or a fixed object such as a pole or tree (the vehicle side also may contact the ground during rollovers, but such contact is generally expected to be less severe than when contacted by the three main objects mentioned above). 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 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 or ride in exactly the vehicle design position, but leans or rests 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.

# Road vehicles — Test procedures for evaluating occupant interactions with deploying side impact airbags

## 1 Scope

This Technical Report outlines test procedures for evaluating the effects of the interactions between deploying side air bags (SAB) and occupants. Out-of-position occupant test procedures are described in this Technical Report, while in-position test procedures are covered in other ISO Technical Reports, for example, full vehicle pole crash tests [9] and instrumented arm evaluations [8].

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 to 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.

Engineering judgment should be used in selecting the tests to be conducted with each individual system. Such tests should be selected to produce the most comprehensive assessment of the system. Additional tests may need to be conducted with slight modifications of the dummy positioning to help ensure the robustness of the occupant interaction measurements.



References [13] to [17] in the Bibliography provide some background on human impact tolerance and criteria, while references [18] and [19] describe scaling techniques for different size occupants and references [20] to [22] offer interpretations of dummy responses relative to human injury potential that may be helpful in the evaluation.



## 2 Terms and definitions

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

**2.1**
**side air bag**
**SAB**
air bag designed primarily to help reduce occupant injury potential where the significant collision force vector is lateral

**2.1.1**
**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

**2.1.2**
**chest (thoracic) air bag**
air bag that deploys between the occupants upper torso and the vehicle side structure

**2.1.3**
**pelvic air bag**
air bag that deploys between the occupant's pelvis/thigh area and the vehicle side structure

**2.1.4**
**combination air bag**
air bag that deploys to help protect two or more occupants' body areas (e.g. a head-and-chest-combination air bag)

**2.2**
**out-of-position occupant**
〈side impact collisions〉 occupant who is seated within the deployment area of a side air bag

**2.3**
**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

**2.4**
**moving deformable barrier**
**MDB**
energy-absorbing movable barrier used to impact either side of a test vehicle

[ISO 10997:1996]

**2.5**
**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

NOTE The pole is preferably (350 ± 10) mm in diameter and set off from any vertical mounting surface (e.g. if attached to a fixed rigid barrier face) by at least 1 500 mm (see ISO 3560 and [9]).



**2.6**
**seat bight**
seat back/seat cushion junction



**2.7**
**high-hooded vehicle**
vehicle such as a large van or truck that has the top of its hood or radiator higher than 1 000 mm above ground

## 3 Test device

### 3.1 General

Refer to Tables 2 and 3 for the dummies that are appropriate for use in the test described in this Technical Report.

NOTE These dummies are referenced in ISO/TR 12349-1 and ISO/TR 12349-2.

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

### 3.2 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. The SID-IIs has been fully evaluated and has been adopted for use in ISO/TR 12349-1. It was specifically designed to help evaluate the injury potential of side air bags.

NOTE 1 See Bibliography (Daniel et al. [23], Kinkish et al. [24] and Sherer et al. [25] for instrumentation details and side air bag injury potential.

# 4 Instrumentation

## 4.1 General

Measurements, possibly applicable to air bag testing, which can be made using the approved anthropomorphic test device for each age group are given in ISO/TR 12349-1 and ISO/TR 12349-2. All measurements should be recorded and filtered according to ISO 6487 and SAE J211 (most recent edition) for body regions. These measurements should be continuous functions of time, so that other quantities referred to in the Bibliographical 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 1 000 frames per second (3 000 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.

## 4.2 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 four hours prior to its application in a test, or that specified for the dummy by the manufacturer.

## 4.3 Electrical grounding



The test dummy, vehicle and all related instrumentation shall be grounded. 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. Both grounding and spraying are very important due to the high likelihood for electrostatic discharges resulting from the inflation of the air bag.



# 5 Air bag location/impacting object/other test matrix

The vehicle-to-fixed pole crash test procedure has been selected instead of a dynamic side impact crash test or high-hooded vehicle simulation crash test (see Table 1). 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. Engineering judgment should be used to determine the appropriate seat track positions when conducting the pole test. The child/adult out-of-position (OOP) 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 type | Test device | Test position | Body regions |
|---|---|---|---|
| **Seat mount** | SID-IIs, with 1/2 arm<br><br>(If same air bag as passenger, tests may be conducted in either position.) | Inboard facing, leaning against door (see 6.2.8.2) | Head, neck, thoracic, abdominal |
| | SID-IIs, with instrumented arm | Arm on armrest (see 6.1.2.2) | Arm |
| **Door mount** | SID-IIs, with 1/2 arm<br><br>(If same air bag as passenger, tests may be conducted in either position.) | Forward facing against door trim (see 6.2.7.2) | Neck, thoracic, abdominal |
| | SID-IIs, with instrumented arm | Arm on armrest (see 6.1.2.2) | Arm |
| **Roof-rail mount** | SID-IIs, with 1/2 arm or Hybrid III small female<br><br>(If same air bag as passenger, tests may be conducted in either position.) | Forward facing, against door trim, seat highest position (see 6.2.7.3) | Head, neck |

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

| Air bag type | Test device | Test position | Body regions |
|---|---|---|---|
| **Seat mount** | 3-year-old child Hybrid III | Child on booster seat facing forward leaning against door trim (see 6.2.2.2) | Head, neck, thoracic, abdominal |
| | | Facing rearward leaning against door (see 6.2.3) | Head, neck, thoracic, |
| | | Lying across seat, head on door trim, wedge support (see 6.2.6.3) | Head, neck |
| | 6-year-old child Hybrid III | Child on booster seat facing forward leaning against door trim (see 6.2.2.3) | Head, neck, thoracic, abdominal |
| | SID-IIs, with 1/2 arm | Inboard facing against door (see 6.2.8.2) | Head, neck, thoracic, abdominal |
| | SID-IIs, with instrumented arm | Arm on armrest (see 6.1.2.2) | Arm |
| **Door/Quarter panel mount** | 3-year-old child Hybrid III | Outboard facing, leaning against door trim (see 6.2.4) | Head, neck, thoracic |
| | | Inboard facing, leaning back against door trim (see 6.2.5.2) | Head, neck |
| | | Lying across seat, head against door trim (see 6.2.6.2) | Head, neck |
| | | Lying across seat, head on door trim, wedge support (see 6.2.6.3) | Head, neck |
| | SID-IIs, with 1/2 arm | Forward facing against door trim (see 6.2.7.2) | Neck, thoracic, abdominal |
| | SID-IIs, with instrumented arm | Arm on armrest (see 6.1.2.2) | Arm |
| **Roof-rail mount** | 6-year-old child Hybrid III | Inboard facing, leaning back against door, seated on booster (see 6.2.5.3) | Head, neck |
| | SID-IIs, with 1/2 arm or Hybrid III small female | Forward facing against door trim, seat highest position (see 6.2.7.3) | Head, neck |
| | | Facing inboard against door, seat highest position (see 6.2.8.3) | Head, neck |



# 6 Test details

## 6.1 Test procedures referenced in other ISO documents

### 6.1.1 Dynamic vehicle-to-pole crash test

Refer to Table 1 and the test procedure given in [9].

### 6.1.2 Instrumented arm static test procedure

#### 6.1.2.1 General

Refer to Tables 2 and 3 for test matrices.

#### 6.1.2.2 Elbow on armrest

Refer to the test procedures given in [8].