TECHNICAL REPORT

ISO/TR 10982

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1998-03-15

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

Véhicules routiers — Méthodes d'essai pour l'évaluation des interactions d'un occupant en position anormale dans un véhicule et des sacs gonflables 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.

The main task of technical committees is to prepare International Standards, but in exceptional circumstances a technical committee may propose the publication of a Technical Report of one of the following types:

— type 1, when the required support cannot be obtained for the publication of an International Standard, despite repeated efforts;

— type 2, when the subject is still under technical development or where for any other reason there is the future but not immediate possibility of an agreement on an International Standard;

— type 3, 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).

Technical Reports of types 1 and 2 are subject to review within three years of publication, to decide whether they can be transformed into International Standards. Technical Reports of type 3 do not necessarily have to be reviewed until the data they provide are considered to be no longer valid or useful.

ISO/TR 10982, which is a Technical Report of type 2, was prepared by Technical Committee ISO/TC 22, *Road vehicles,* Subcommittee SC 10, *Impact test procedures*.

This document is published as a Technical Report, rather than as an International Standard, because of the general inexperience in air bag testing and the lack of real-world accident data correlation. When sufficient real-world data are available and/or there is sufficient testing experience, it may be appropriate to develop an International Standard.

Annex A of this Technical Report is for information only.

Introduction

Although laws concerning the mandatory use of seat belts and child restraints have been enacted in most ISO member countries, surveys and accident statistics indicate that between 10 % and 50 % of front seat occupants involved in accidents had not used these restraint systems. Most, if not all, new vehicles marketed with air bags in ISO member countries specify that the air bag is supplemental to the existing belt/child seat restraint systems. However, front seat occupants may not comply with manufacturers' recommendations and laws. Hence, they may be near or against deploying driver and/or passenger air bag modules during collisions. Some data indicate that small, unrestrained children may get into such positions due to voluntary precrash riding positions [1] and/or due to preimpact braking and/or collision forces [2]. These factors may also cause some adults to be near the air bag modules, but preimpact braking is likely to have less effect on adults.

During its inflation process, 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 out-of-position occupant. Accident data [3] and laboratory test results [4-9] have indicated that these forces could cause injuries to the head, neck, thorax, abdomen and legs.

Both mild and moderate severity crash pulses are described in the Technical Report. These pulses represent general deceleration-time histories. The mild severity crash pulse is near the threshold of many air bag deployments and represents a frequent accident event. This pulse can be used for child testing, since they are more likely than adults to be near the air bag modules in threshold deployment collisions. Since preimpact bracking has much less of an effect on adults, the moderate severity crash pulse can be used for adult testing. These described pulses or other vehicle-specific pulses may be used.

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

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

1 Scope

This Technical Report outlines a number of test procedures that can be used for investigating the interactions that could occur between the deploying air bag and the occupant who is near the module at the time of deployment. Static and dynamic tests to investigate both driver and passenger systems are described. Comparative evaluation of the designs can be conducted using static tests. Favorable systems may be evaluated, if deemed necessary, by appropriate dynamic tests. Children and infants restrained in child or infants seats are the subject of another Technical Report [20].

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this Technical Report. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this Technical Report are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 6487:—[1)], *Road vehicles — Measurement techniques in impact tests — Instrumentation.*

SAE J 211:1995, *Instrumentation for impact test.*

SAE J 1517:1990, *Driver selected seat position.*

3 Definitions

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

3.1 Passenger air bag module location

3.1.1 low mounted: Rearward deploying module location in the area of the instrument panel, normally used for knee bolsters.

3.1.2 mid mounted: Rearward deploying module location above the knee bolster area in the instrument panel.

3.1.3 top mounted: Air bag system that deploys through the top surface of the instrument panel.

3.2 out-of-position occupant: Vehicle occupant who is near the air bag module at the time of deployment.

1) To be published. (Revision of ISO 6487:1987)

4 Test device

4.1 General

Two sizes of adult dummies and one child size dummy are available for out-of-position occupant investigations. It is suggested that the adult dummies be equipped with an optional neck cover to give a more humanlike shape to the neck and neck-head junction.

4.2 50th percentile male Hybrid II dummy

This dummy is specified in part 572, subpart E of FMVSS 208 [10].

4.3 "Small female" Hybrid III dummy

The small female dummy is a scaled-down version of the Hybrid III 50th percentile male dummy. The size, shape, response and measurement capability were defined by a task force of the SAE Human Biomechanics and Simulation Standards Committee [11].

4.4 Three-year-old child Hybrid III dummy

This dummy was developed for passenger air bag testing [12] by a task force of the SAE Human Biomechanics and Simulation Standards Committee and is commercially available.

5 Instrumentation

5.1 Adult size dummy

Measurements that can be made or calculated using these test devices are listed below:

- facial forces [19];
- head triaxial acceleration (three channels);
- head angular acceleration in sagittal plane (at least one channel for an extra linear accelerometer);
- upper neck (C-1: occipital condyles) forces and moments (six channels);
- lower neck (C-7, T-1) forces and moments (six channels);
- chest triaxial acceleration (three channels);
- mid-sternum to thoracic spine deflection (one channel);
- mid-sternum acceleration (one channel);
- upper and lower ribcage deflection[2)] (five channels);
- lower thoracic spine (T-12) forces and moments[3)] (five to six channels);
- pelvis triaxial acceleration (three channels);
- for systems using inflatable knee restraints, the full spectrum of Hybrid III multi-channel femur and tibia load cells and knee displacement transducers can be used to measure leg loading.

2) Instrumentation for measurements is being developed and is expected to be available for both dummies at a later date.

3) Only available for the small female.

5.2 Three-year-old child dummy

Measurements that can be made or calculated using the child dummy are listed below:

— head triaxial acceleration (three channels);

— head angular acceleration in sagittal plane (at least one channel for an extra linear accelerometer);

— upper neck (C-1) forces and moments (six channels);

— lower neck (C-1/T-1) forces and moments (six channels);

— shoulder forces (F_x, F_z; four channels);

— sternal acceleration (a_x; two channels);

— sternal deflection (one channel);

— spine triaxial accelerations (T-1, T-4, T-12; nine channels);

— lumbar forces and moments (six channels);

— pubic forces (F_x, F_z; two channels);

— pelvis triaxial acceleration (three channels).

5.3 Data requirements

All measurements should be recorded and filtered according to ISO 6487 and SAE J 211 for body regions. These measurements should be continuous functions of time so other quantities, such as those found in references [8], [9], [13-17], may be derived.

5.4 Dummy test temperature

The test dummy temperature should be within the range of 20,6 °C to 22,2 °C (69 °F to 72 °F) at a relative humidity of 10 % to 70 % after a soak period of at least four hours prior to its application in a test.

6 Sled pulses

6.1 General

Mild severity and moderate severity crash pulses are defined in 6.2 and 6.3. The out-of-position child may be exposed to a pulse similar to the mild severity crash pulse since collisions of similar severity occur most often, and preimpact braking will cause the child to be out-of-position more often than the collision dynamics.

6.2 Mild severity crash pulse

This pulse is a half sine type with a peak acceleration occurring near the centre of the time duration of $(8 \pm 1)g$[4] between 40 ms to 100 ms, a velocity change of (25 ± 1) km/h, and a (150 ± 5) ms pulse duration. Typical acceleration-time and velocity-time curves, and nominal acceleration are shown in figures 1 and 2.

6.3 Moderate severity crash pulse

This pulse is a half sine type with a peak acceleration occurring near the centre of the time duration of $(13 \pm 1)g$ between 40 ms to 80 ms, a velocity change of (29 ± 1) km/h and a (110 ± 5) ms pulse duration. Typical acceleration-time and velocity-time curves, and nominal acceleration are shown in figures 3 and 4.

4) g = 9,806 65 m/s^2

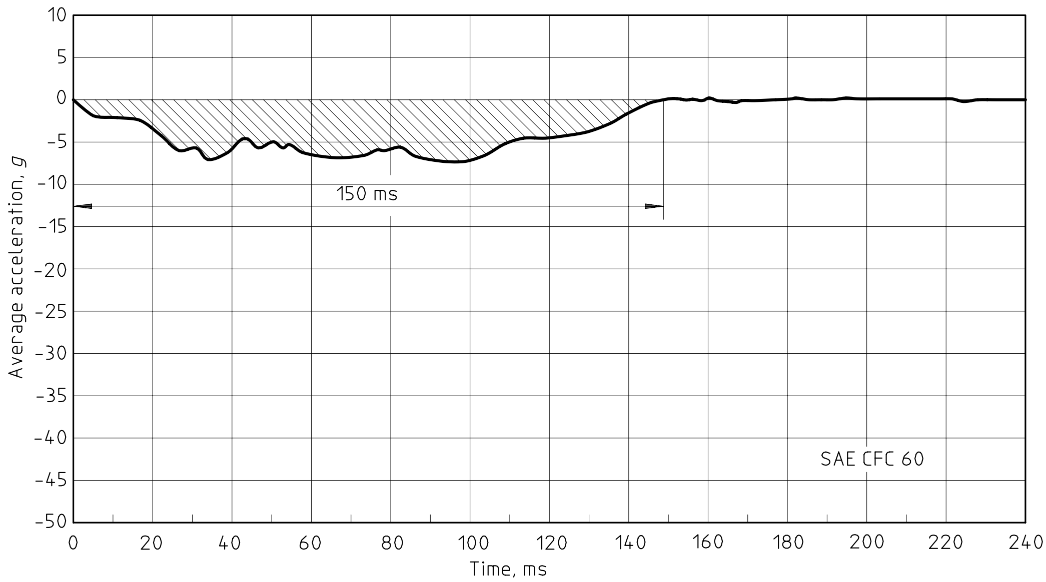

Figure 1 — Generic HYGE sled pulse for a mild crash severity

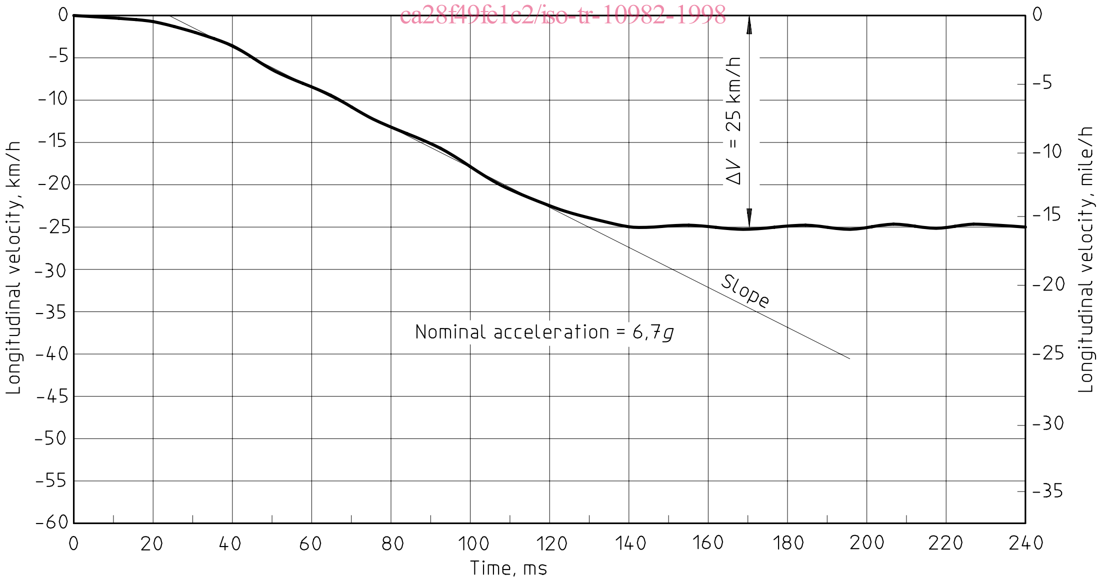

Figure 2 — Velocity-time history of the generic mild crash severity sled pulse

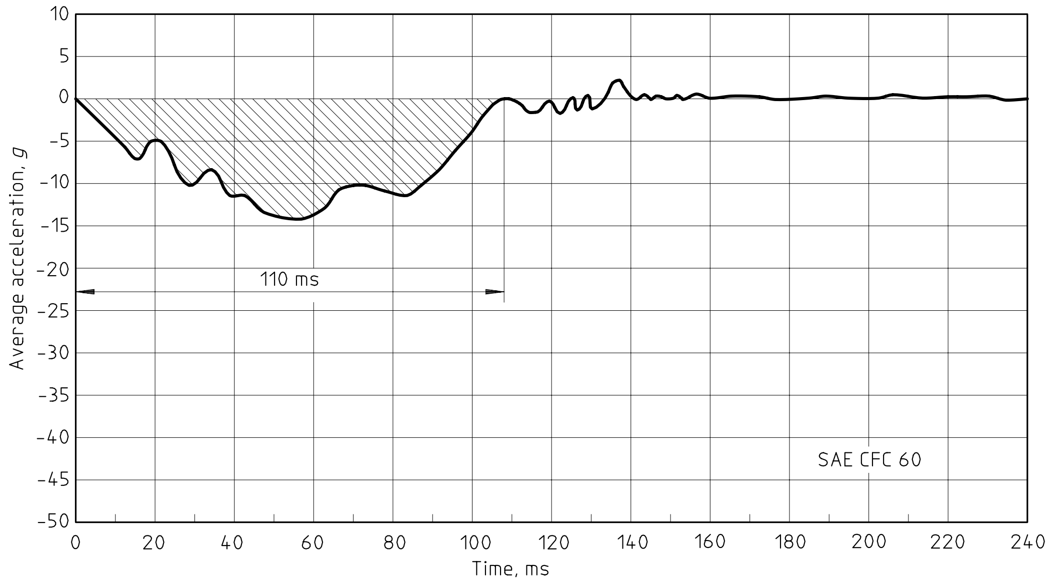

Figure 3 — Generic Hyge sled pulse for a moderate crash pulse

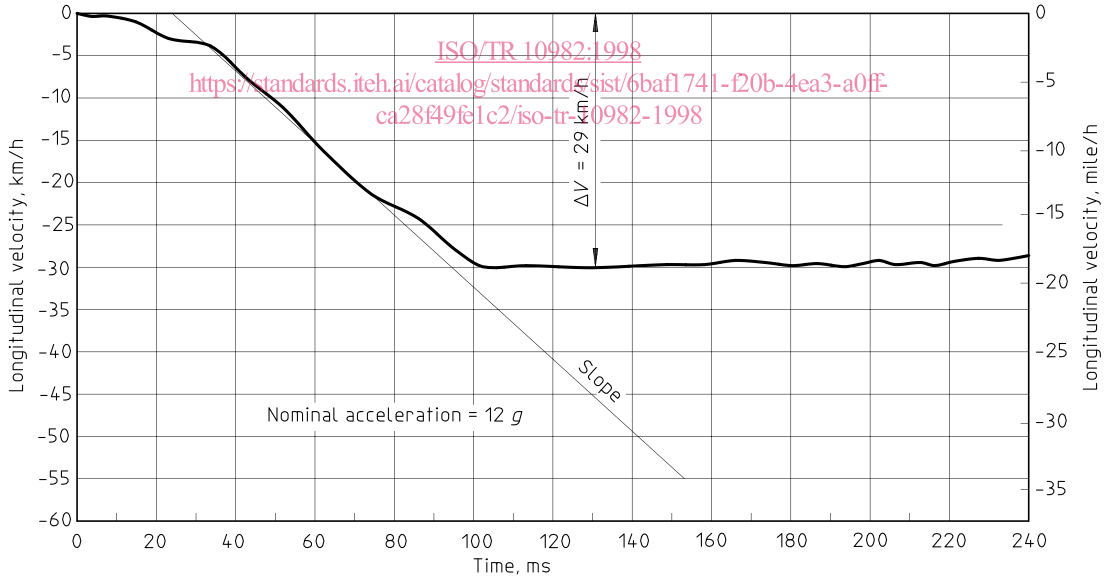

Figure 4 — Velocity-time history of the generic moderate crash severity sled pulse