TECHNICAL REPORT

ISO/TR 14645

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Road vehicles — Test procedures for evaluating child restraint system interactions with deploying air bags

Véhicules routiers — Méthodes d'essai pour l'évaluation des interactions des systèmes de retenue pour enfants 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 Technical Reports of type 3 do not necessarily have to be reviewed until the data they provide are considered to be no longer valid or useful.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 14645, 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 testing the interaction between child restraint systems (CRS) and deploying air bags, and the lack of real-world accident data. When statistically significant, real-word data are available, in which air bags have contacted a variety of child restraints, and there is more testing experience with this interaction, it may be appropriate to develop an International Standard.

Annex A of this Technical Report is for information only.

Introduction

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 child restraint system (CRS). (For background on air bag design and deployment, see references [1] and [2]). Although there is very little experience with vehicles equipped with passenger air bags, preliminary laboratory tests have indicated that these forces can be sufficient to produce serious injury to the CRS occupant. The National Highway Traffic Safety Administration has recommended that rear-facing child restraints of current design be used only in the rear seat of vehicles equipped with such air bags [3]. Even so, many children may be restrained in either rear- or forward-facing CRSs in the front seat of such vehicles, and the child and/or the CRS may interact with the air bag. These guidelines were developed to improve the understanding of such interactions and to aid in the assessment of future designs.

A mild-severity crash pulse is described in this Technical Report. This pulse is not vehicle-specific, but represents general acceleration-time histories. This mild-severity pulse approximates a crash that would just deploy a typical air bag. This pulse is used to evaluate the effect of the energy of the deploying air bag when the CRS and dummy are exerting the least amount of inertial force in the forward direction, but the dummy and/or CRS is moved forward by that inertial force. This generic pulse or other vehicle-specific pulses may be used as appropriate. Differences in shape between the generic and the vehicle-specific pulses are expected with corresponding differences expected in dummy responses.

This Technical Report encourages the use of a wide range of test configurations and conditions, while recognizing that the range of possible interactions is essentially limitless and beyond testing capability. Furthermore, measurements of primary importance for the various configurations are given in table 1, but performance limits are not specified. References [4 to 9] give some background on human impact tolerance and criteria, describe scaling techniques for different size occupants, and offer interpretations of dummy responses relative to human injury potential that may be helpful in the evaluation. These and additional background papers on air bag development and deployment can be found in references [10] and [11].

Road vehicles — Test procedures for evaluating child restraint system interactions with deploying air bags

1 Scope

This Technical Report describes dummies, procedures, and configurations that can be used to investigate the interactions that occur between a deploying air bag and a Child Restraint System (CRS) that would have been considered properly installed and used in the outer and centre front passenger positions. Static tests may be used to sort CRS/air bag interaction on a comparative basis in either an actual or a simulated vehicle environment. Systems that appear to warrant further testing may be subjected to an appropriate dynamic test at a speed near that needed to deploy an air bag or at a higher speed commonly used to evaluate CRS performance. No test matrix is specified at this time for evaluating either a CRS or an air bag during interaction with each other. Instead, engineering judgement based on prior experience with CRS and/or air bag testing should be used in selecting the tests to be conducted with each individual system. Such tests may be aimed not only at producing interactions with the most severe results but also at identifying those conditions that produce the least interaction and/or satisfactory CRS performance results. Baseline tests to indicate the performance of a CRS in the absence of air bag deployment are also recommended for comparison purposes.

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.*

UN-ECE Regulation No. 44, *United Nations Agreement Concerning the Adoption of Uniform Conditions of Approval and Reciprocal Recognition of Approval for Motor Vehicle Equipment and Parts.*

49 CFR Part 572, *Anthropomorphic Test Dummy.*[2)]

3 Definitions

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

3.1 rear-facing, R: child restraint that positions the child to face the rear of the vehicle.

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

2) CFR: Code of Federal Regulations, issued by the National Highway Traffic Safety Administration, Department of Transportation, USA.

3.2 laterally-positioned, L**:** Child restraint that positions a prone or supine child perpendicular to the direction of vehicle travel.

3.3 forward-facing, F**:** Child restraint that positions the child to face the front of the vehicle.

3.4 booster, B**:** Normally used to better position adult belt restraints on the child.

4 Test device

4.1 General

Five sizes of child dummies, from six-month to age six, are available for CRS/air bag investigations.

4.2 Six-month-old infant dummies

4.2.1 CRABI six-month

With specifications from the SAE Infant dummy task group, a six-month size dummy has been developed that allows measurement of head, chest, and pelvic accelerations, as well as upper and lower neck and lumbar spine forces and moments. A special six-channel transducer has also been developed for use in any of the spinal locations.

4.3 Nine-month-old infant dummy

4.3.1 P-3/4

This dummy is specified in UN-ECE Regulation 44, annex 8, and has been incorporated without instrumentation in 49 CFR, Part 572, subpart J. It has main-joint articulation and has provision for head and chest accelerometers and for modelling clay in the abdomen to detect penetration. A three-channel neck transducer has been developed for use with this dummy.

4.4 Twelve-month-old infant dummy

4.4.1 CRABI twelve-month

With specifications from the SAE Infant dummy task group, a twelve-month size dummy has been developed that allows measurement of head, chest and pelvic accelerations, as well as upper and lower neck and lumbar spine forces and moments.

4.5 Three-year-old child dummies

The standard child dummy for FMVSS and CMVSS 213 testing is specified in 49 CFR Part 572, subpart C. This dummy has provision for head and chest accelerometers. Use of the "new" vinyl-covered fiberglass head, specified in part 572.16(a) (1), is recommended over the old head.

4.5.1 Three-year-old child Hybrid II

This dummy was developed for passenger air bag testing [16] by a task force of the SAE Human Biomechanics and Simulation Standards Committee and is commercially available.

4.5.2 P-3

This dummy is specified in UN-ECE Regulation 44, annex 8. It has main-joint articulation and provisions for head and chest accelerometers and for modelling clay in the abdomen to detect penetration.

4.6 Six-year-old child dummies

4.6.1 P-6

This dummy is specified in UN-ECE Regulation 44, annex 8. It has main-joint articulation and has provision for head and chest accelerometers and for modelling clay in the abdomen to detect penetration.

4.6.2 Hybrid-II six-year

This dummy was developed under a grant from the Centers for Disease Control (CDC), with input from SAE committees, and allows measurement of head, chest, and pelvic accelerations; neck, lumbar, and femur forces and moments; and chest displacement.

5 Instrumentation

5.1 Measurements

Measurements that can be made or calculated using the most advanced anthropomorphic test device in each age-group are listed in 5.2 to 5.7. 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 that other quantities referred to in the references may be derived.

5.2 CRABI six-month and twelve-month

— Head triaxial acceleration

— Head angular acceleration (one channel)

— Upper neck forces and moments (six channels)

— Lower neck forces and moments (six channels)

— Chest triaxial acceleration

— Lumbar spine forces and moments (six channels)

— Pelvic triaxial acceleration

5.3 P-3/4 nine-month

— Head triaxial acceleration (three channels)

— Upper neck forces (F_x, F_z) and moment (F_y)

— Chest triaxial acceleration

5.4 Hybrid III three-year

— Head triaxial acceleration

— Head angular acceleration in sagittal plane (one channel)

— 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 accelaration (three channels)

5.5 P-3 three-year

— Head triaxial acceleration (three channels)

— Upper neck (C–1) forces and moments (six channels)

— Spine (T–12) triaxial acceleration (three channels)

5.6 Hybrid II six-year

— Head triaxial acceleration

— Head angular acceleration in sagittal plane (one channel)

— Upper neck forces and moments (six channels)

— Lower neck forces and moments (five channels)

— Chest triaxial acceleration

— Chest mid-sternum displacement (one channel)

— Sternal acceleration (a_x; two channels)

— Lumbar spine forces and moments (five channels)

— Pelvic triaxial acceleration

— Pelvic submarining (four channels)

— Femur forces and moments (six channels)

5.7 P-6 six-year

— Head triaxial acceleration (three channels)

— Spine (T–12) triaxial acceleration (three channels)

— Pelvis triaxial acceleration (three channels)

5.8 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 pulse

6.1 General

For sled tests, a mild-severity crash pulse is defined in 6.2. A vehicle-specific pulse may also be used as appropriate.

6.2 Mild-severity crash pulse

The mild-severity pulse is intended to be just severe enough to position the dummy and/or the CRS forward and to deploy the air bag. This pulse is a half-sine type with a peak acceleration occurring near the centre of the time duration of $(8 \pm 1)g$[3] 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 are shown in figures 1 and 2.

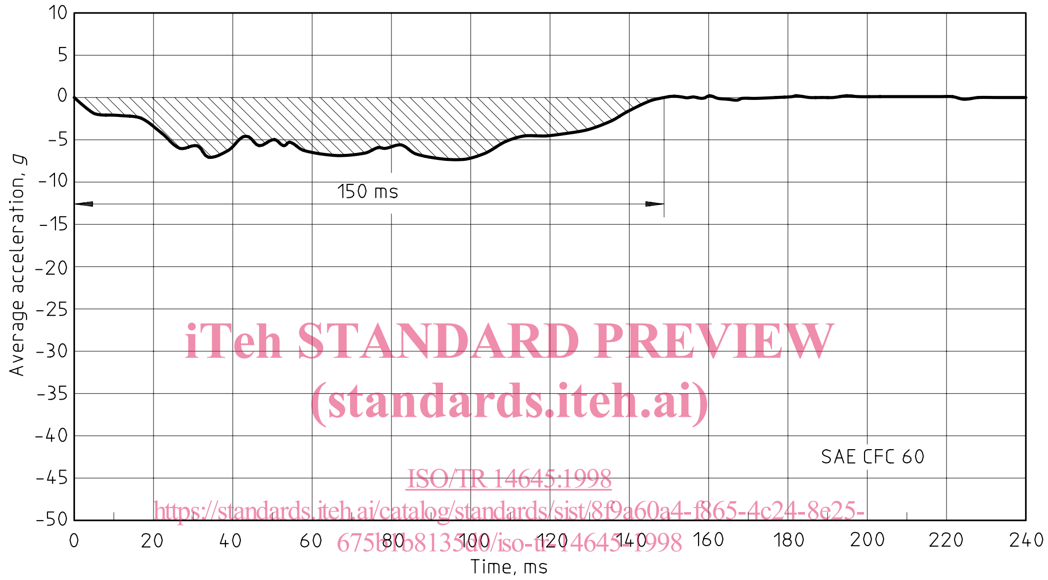

Figure 1 — Generic HYGE sled pulse for a mild crash severity

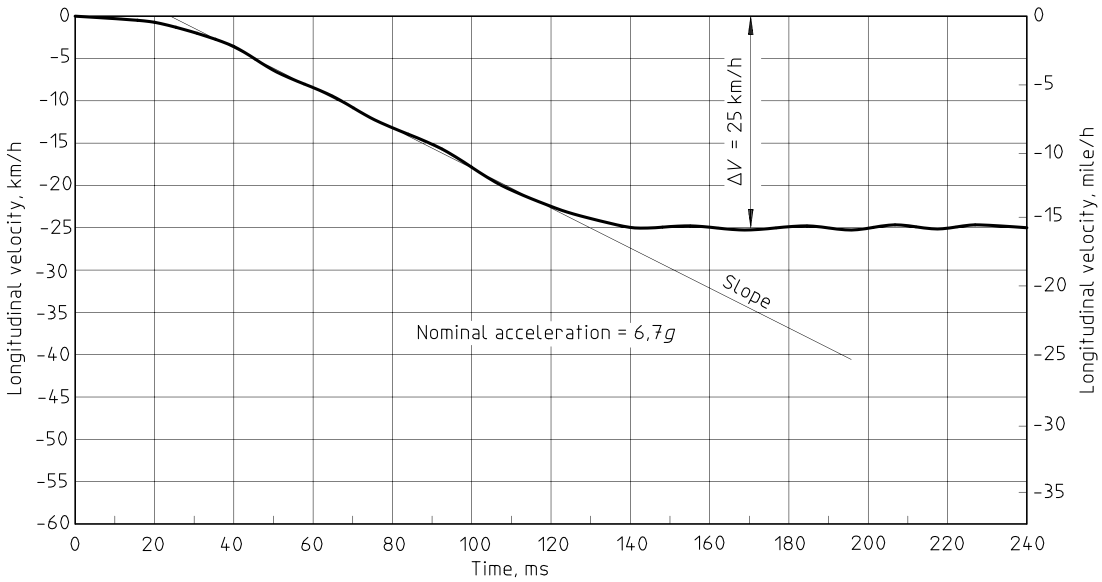

Figure 2 — Velocity-time history of the generic mild crash severity sled pulse

3) $g = 9{,}806\ 65\ m/s^2$