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ISO/TC 22 / SC 12

Title

PASSIVE SAFETY CRASH PROTECTION SYSTEMS

Secretariat **AFNOR/BNA**

Circulated to P- and O-members, and to technical committees and organizations in liaison for:

☐ discussion at on
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P-members of the technical committee or subcommittee concerned have an obligation to vote.

English title

Road vehicles — Sled test method to enable the evaluation of side impact protection of child restraint systems — Essential parameters (request of UNECE/GRSP)

French title

Véhicules routiers — Méthode d'essai sur chariot pour permettre l'évaluation de la protection en choc latéral des dispositifs de retenues pour enfants — Paramètres essentiels (demande de l'UNECE/GRSP)

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Introductory note

The UN-ECE GRSP Working Group on Child Restraint Systems sent in April 2008 a request to ISO/TC22/SC12 to support their work on defining a side impact test procedure for CRS homologation based on the state of the art research and experience.

The GRSP-CRS Working Group shall introduce, in its draft Regulation on the CRS, requirements dealing with the level of protection of such systems in case of side impact. Having considered that to date there was not yet an International consensus on a dynamic test method and taking into account of the target date fixed (December 2009) to propose a text to GRSP, the Working Group has considered that, based on works already carried out within ISO/TC22/SC12, ISO could define essential parameters (energy, orientation, velocity, position, ... of the lateral load) of a simplified test method that should allow to ensure that the Child Restraint System has, at minimum, a sufficient capacity to contain the child and to absorb energy in case of side impact exposure.

This request has been endorsed by ISO/TC22/SC12 at its meeting on October 30th 2008. GRSP-CRS Working group having accepted the alternative 1 described by resolution SC12 n° 335 then a draft proposal has been elaborated within SC12/WG1 and approved by the experts. The present document ISO/TC22/SC12 N 623 is now forwarded to SC12 Members for a final CD vote procedure. In case of approval,and to make the document available by the target date defined by GRSP the present draft will be published as an ISO/PAS

(Publicly Available Specification).

Mrs Michèle MAITRE

SC12 Secretary

ISO TC 22/SC 12 N 623

Date: 2009-03-08

ISO/PDPAS 13396

ISO TC 22/SC 12/WG 1

Secretariat: AFNOR

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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 other circumstances, particularly when there is an urgent market requirement for such documents, a technical committee may decide to publish other types of normative document:

— an ISO Publicly Available Specification (ISO/PAS) represents an agreement between technical experts in an ISO working group and is accepted for publication if it is approved by more than 50 % of the members of the parent committee casting a vote;

— an ISO Technical Specification (ISO/TS) represents an agreement between the members of a technical committee and is accepted for publication if it is approved by 2/3 of the members of the committee casting a vote.

An ISO/PAS or ISO/TS is reviewed after three years in order to decide whether it will be confirmed for a further three years, revised to become an International Standard, or withdrawn. If the ISO/PAS or ISO/TS is confirmed, it is reviewed again after a further three years, at which time it must either be transformed into an International Standard or be withdrawn.

ISO/PAS 13396 was prepared by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 12, *Passive safety crash protection systems*.

Introduction

The UN-ECE GRSP Working Group on Child Restraint Systems sent in April 2008 the following request to ISO/TC22/SC12 to support their work on defining a side impact test procedure for CRS homologation based on the state of the art research and experience.

"To answer to the mandate that has been fixed by GRSP to the Informal Working Group on CRS (Child Restraint Systems) that I chair, and after agreement of GRSP (See abstract of minutes of 43rd GRSP enclosed) this group should have a demand to formulate towards ISO/TC22/SC12.

The Group shall introduce, in its draft Regulation on the CRS, requirements dealing with the level of protection of such systems in case of side impact. Having considered that to date there was not yet an International consensus on a dynamic test method and taking into account of the target date fixed (December 2009) to propose a text to GRSP, the Working Group has considered that, based on works already carried out within ISO/TC22/SC12, ISO could define essential parameters (energy, orientation, velocity, position, ... of the lateral load) of a simplified test method that should allow to ensure that the Child Restraint System has, at minimum, a sufficient capacity to contain the child and to absorb energy in case of side impact exposure.

Wishing that ISO/TC22/SC12 could be able to help us in the achievement of our mandate".

(Signed by Chairman Pierre Castaing)

The aim of this ISO/PAS is to answer the GRSP request.

Road vehicles — Sled test method to enable the evaluation of side impact protection of child restraint systems — Essential parameters (request of UNECE/GRSP)

1 Scope

This Publicly Available Specification mainly summarises the content of ISO/TR 14646 to assist the Informal Group on CRS of UNECE/GRSP in their development of a simplified side impact method based on commonly agreed input data. In addition to the content of ISO/TR 14646 new data and further recommendations have been included. Where not otherwise stated, ISO/TR 14646 is reference source.

The essential input parameters given below are applicable to accessory child restraint systems aiming to offer side impact protection.

2 Accident statistics

The accident data presented in ISO/TR 14646 shows that side impacts are severe ones especially for those children (age up to 12 years) sitting on the struck side. Head, neck and chest are the body regions showing most frequently severe injuries, and the head in particular needs to be protected. Comparison of accident data from different years (1985 to 1990; 1991 to 1996 and 1997 to 2001) and without any filter on product age shows however decreasing risk for head injuries and increasing risk for neck injuries in the recent data compared to the older data.

Based on results of the EC funded CHILD project and the EEVC/WG18 Report (Feb 2006), non-head containment combined with intrusion loading are found to be one of the major reasons for head injuries in side impacts involving rearward facing and forward facing harness type CRS as well as high back booster and backless booster [Johannsen, 2006; EEVC, 2006].

Analysis of accident data involving children in side impacts from different sources and different regions of the world (Germany, Sweden and USA) indicates that the purely lateral impact (due to the accident data coding with ± 15° deviation) is possibly more severe than angled ones while the share of perpendicular and angled impacts with forward component is nearly equal [Johannsen, 2007]. Although all three sources show the same tendency, final conclusions are not possible as the number of involved children is too small to allow statistical significant results. This data regards all types of impact objects and restraint use.

Henary et al [Henary, 2007] found when comparing the risk of injury between children (aged 0-23 months) in side impacts, using US crash data (NASS-CDS), a significant higher benefit for children in rearward facing compared to forward facing harness type CRS. The authors conclude that this is likely because a forward component in the vehicle travel direction in many of the cases will move the head forward during the crash.

The struck car is in many cases subject to an angled acceleration due to its initial speed. The main expected influence of a possible forward component would be an increase in head forward motion. Head forward trajectory can also be influenced by pre-braking conditions. Maltese et al [Maltese, 2007] mapped probable head contact points for 4 to 15 year old injured children (not using child seats) involved in a side impact seated on the struck side in the rear seat. The contacts were mainly found adjacent to the likely initial position of the head of the in-position rear seat child occupant, and adjusted forward. The authors state this forward adjustment is likely due to the forward component.

3 Input parameters for side impact test procedure

Relevant input parameters for defining a side impact test procedure for CRS based on experience from accident data analysis, full-scale tests and sled tests as described in ISO/TR 14646 are presented below. These input parameters are divided into the sections body regions to be protected, occupant kinematics, test severity, validation and field of application.

3.1 Body regions to be protected

Based on accident data, the body region to be protected with highest priority is the head followed by neck and chest. Especially for the protection of the head, body kinematics as well as energy management capabilities of the CRS are important.

3.2 Occupant kinematics

As head containment and head loadings are crucial issues with respect to the assessment of the performance of a CRS in side impact, it is necessary to utilise a test procedure capable of simulating real world occupant kinematics and realistic loading conditions.

Containing the head within the CRS is more a challenge for the larger dummies, representing the upper limit of the respective CRS group in a given CRS than with smaller ones based on experience with different side impact test procedures within the development of ISO/TR 14646 and ISO/TS 29062[1)].

The application of side impact test procedures needs to be defined carefully taking into account the protection capabilities of today's cars.

3.3 Test characteristics

When designing a sled test method, the ambition should be to replicate the characteristics of a full scale side impact test situation, but in a simplified way and as generic as possible. The characteristics are derived from vehicle acceleration, vehicle velocity, intrusion depth and intrusion velocity, but also by geometrical measurements such as the distance of the CRS in relation to the structure and the coverage/profile of the intruding vehicle structure.

The analysis of full-scale side impact tests presented in ISO/TR 14646 shows that the performance of current cars has been significantly improved, especially with respect to intrusion velocity during the last years. However, the test severity of the full-scale test is subject to several discussions as it is felt to be too moderate. One example of higher severity tests is the IIHS test procedure, where the mass of the barrier as well as the stiffness and shape of the barrier face cause a more aggressive contact with the car in comparison to ECE Regulation No. 95 and FMVSS 214 test conditions.

Summing up the results presented in ISO/TR 14646 and the statements above, the following properties defining the test characteristics are suggested as a generic and representative (for a majority of cars in use) side impact sled test method.

3.3.1 Intrusion velocity

Figure 1 shows the intrusion velocity characteristics measured in a large number of cars of different manufacturing dates in ECE R95 tests. In these tests the lateral intrusion was measured close to the dummies head using either string potentiometers or cross tubes. Intrusion velocity was computed from the intrusion.

The corridor lines shown in Figure 1 are meant as borders for defining a suitable intrusion velocity corridor. However, the allowed tolerance is too large to define a proper test procedure. It is crucial to define the

1) To be published.

intrusion velocity carefully, as it is an input parameter with considerable influence on the dummy measurements.

A maximum intrusion velocity between 7 m/s and 10 m/s at approximately 30 ms close to the dummy's head is required to represent realistic loading conditions.

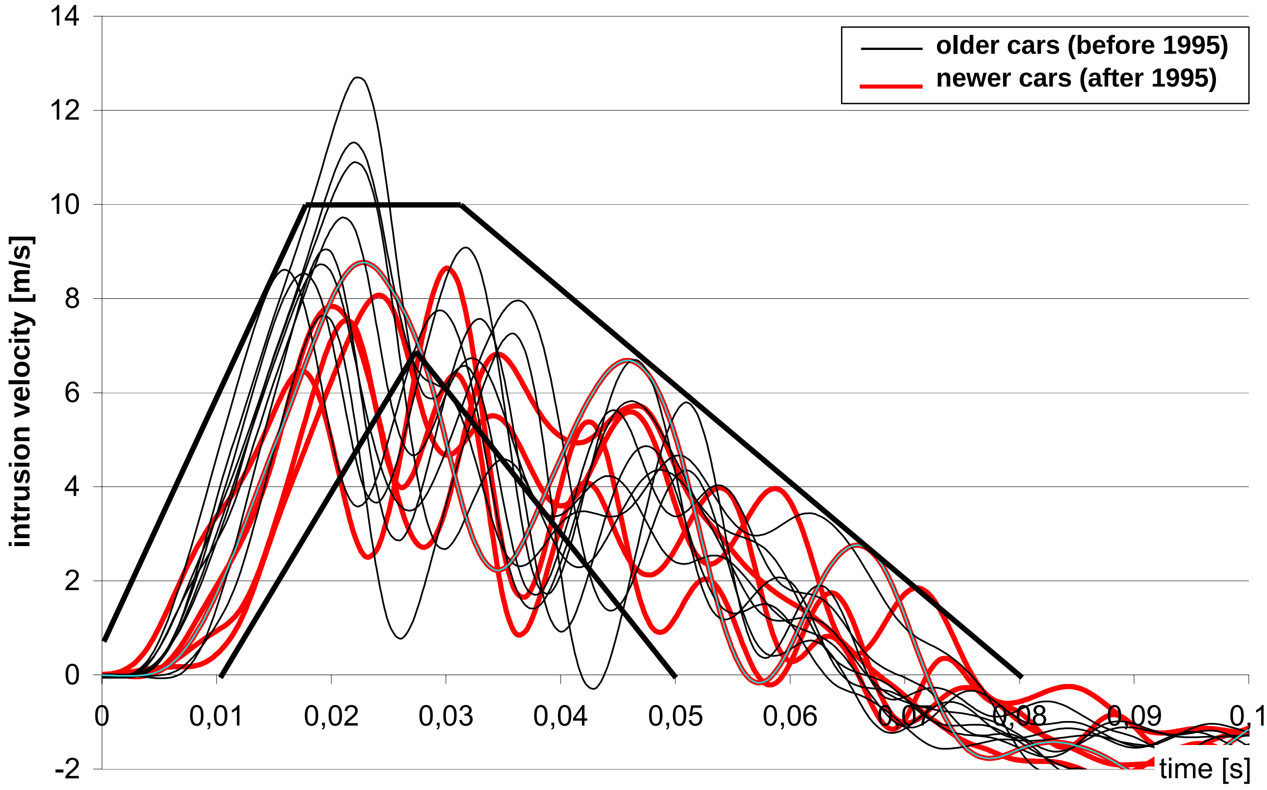


Figure 1 — General requirements for intrusion specification

For defining of a test procedure one has to take into account the combination of intrusion velocity and struck car velocity, defining the intrusion velocity relative to the ground.

3.3.2 Intrusion depth

Figure 2 shows the intrusion depth characteristics measured in a number of cars representing different sizes and different manufacturing dates in ECE R95 tests. In these tests the lateral intrusion was measured close to the dummies head using either string potentiometers or cross tubes.

The dynamic intrusion depths should be between 200 and 300 mm to represent realistic loading conditions.

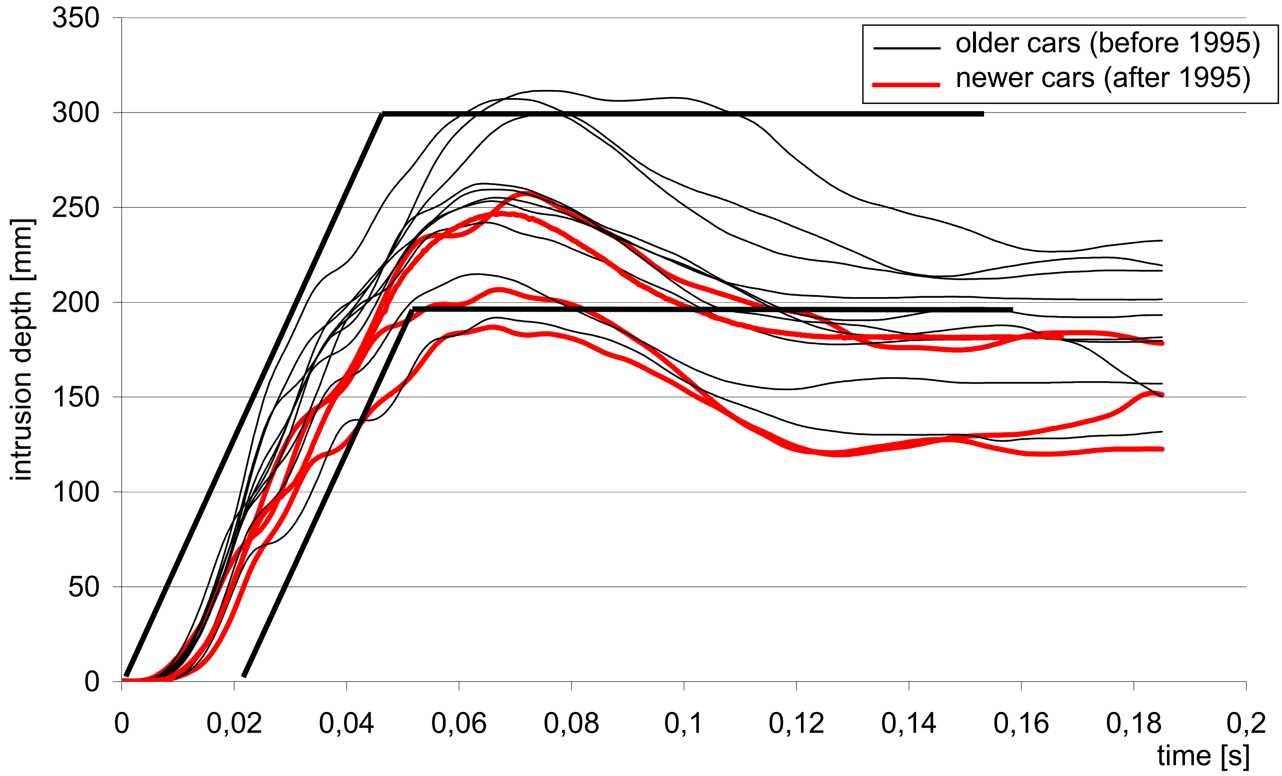


Figure 2 — General requirements for intrusion depth

3.3.3 Struck car acceleration range and struck car delta-v

Figure 3 shows the struck car acceleration measured at the non-struck side in a number of cars representing different sizes and different manufacturing dates in ECE R95 tests.

The sled acceleration should be between 10 and 14 *g* to represent realistic loading conditions.

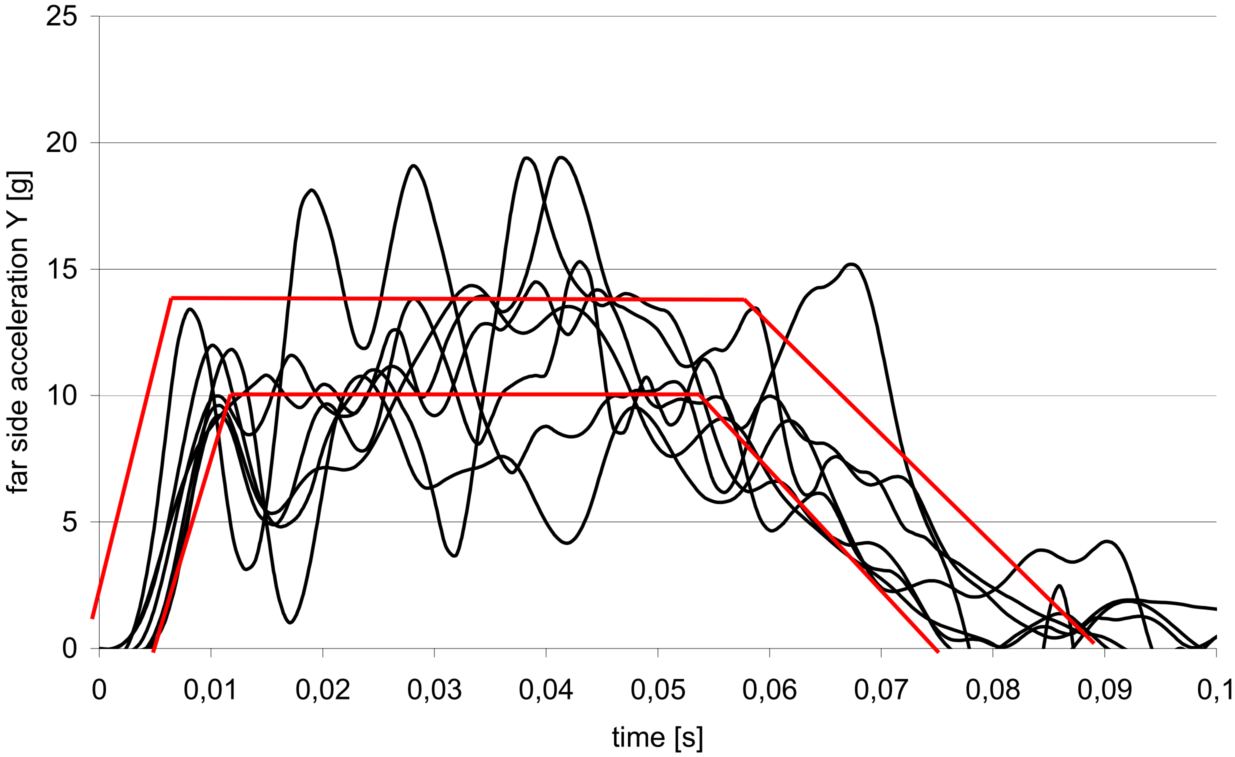


Figure 3 — General requirements for sled acceleration

Figure 4 shows the struck car delta-v computed from the acceleration presented in Figure 3.

The sled delta-v should be approximately 25 km/h to represent realistic loading conditions. The delta-v of 25 km/h represents the theoretical delta-v if one car hits with 50 km/h another car of the same mass.

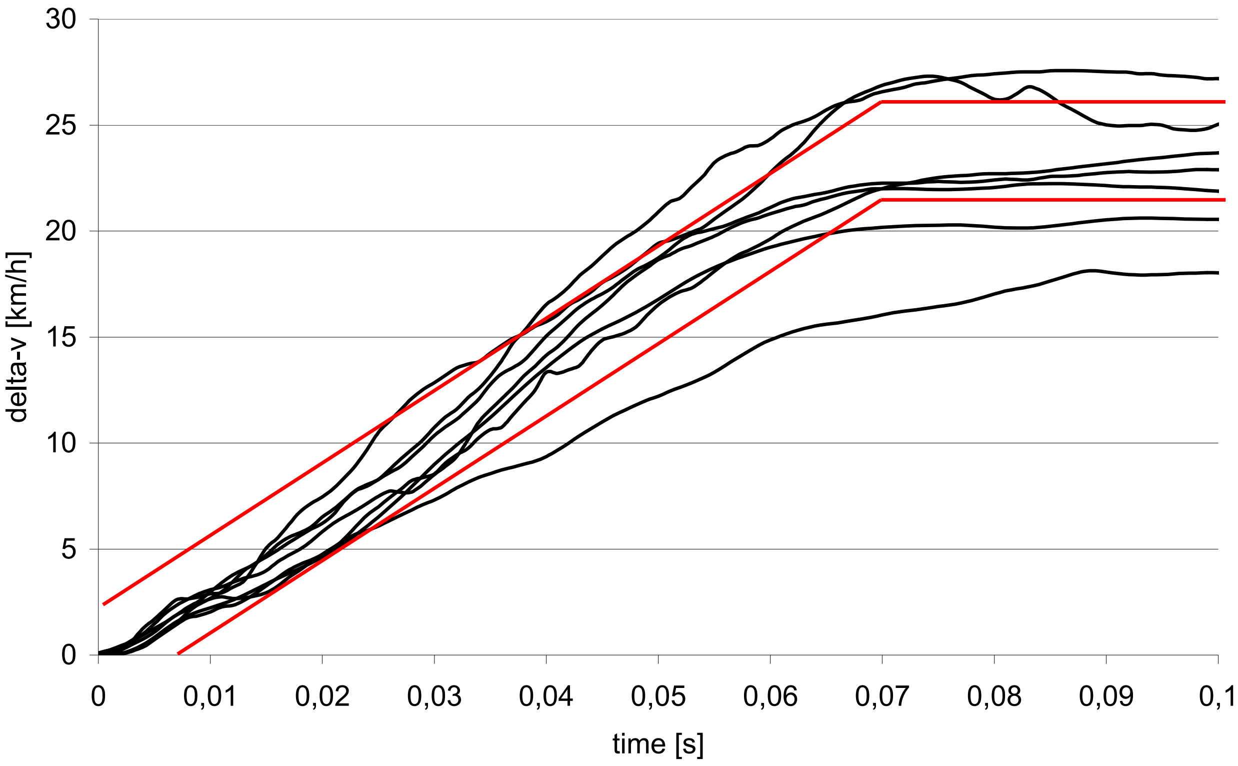


Figure 4 — General requirements for sled delta-v

Based on the results of the analysis of impact angles from real world accidents in combination with the results of tests with intrusion the test procedure should focus on a perpendicular impact.

3.3.4 Geometry requirements

The initial **distance between the CRS centre line and the intrusion surface should be approximately 300 mm**.

The intrusion surface should have a **height of approximately 500 mm with respect to the CR-point**.

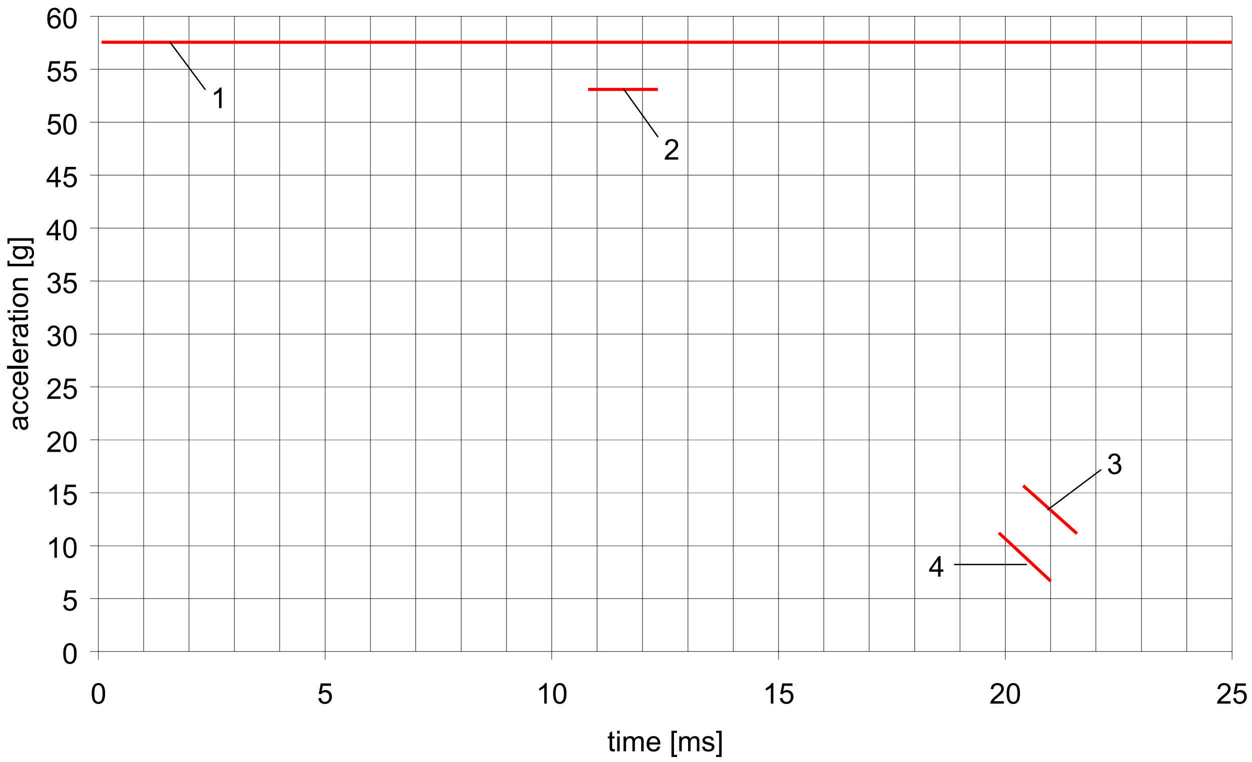
3.3.5 Intrusion surface properties

The rigid intrusion surface should be covered by **55 mm deformable material** as described below.

The properties of the padding material for the intrusion surface are defined by performance criteria in a simple drop test. The test set up consists of a simple drop test using a spherical head form. The spherical head form has a diameter of 150 mm and a mass of 6 kg (±0,1 kg). The impact speed is 4 m/s (± 0,1 m/s). The instrumentation should allow the assessment of the time of first contact between the impactor and the sample as well as the head form acceleration at least in direction of impact (Z direction).

The material sample should have the dimensions of 400 X 400 mm. The sample should be impacted in its centre.

The time of first contact between sample material and head form (t_0) is 0 ms. The impactor acceleration shall not exceed 58 *g*. See Figure 5.



Key

1 Upper limit of 58 g

2 Lower limit for the maximum peak at 53 *g* (11 to 12 ms)

3 Upper limit for the decline of acceleration (15 *g* at 20,5 ms to 10 *g* at 21,5 ms)

4 Lower limit for the decline of acceleration (10 *g* at 20 ms to 7 *g* at 21 ms)

Figure 5 — Corridor for the padding material

3.4 Anchorages

Vehicle seat belt anchorages and ISOFIX anchorages are subject to deformation and displacement in side impacts, resulting from displacement of the b-pillar, the complete seat etc. In sled tests anchorages are normally strengthened to allow reuse and good repeatability. Taking into account the actual movement of anchorages in cars and the reinforcing of anchorages in sled tests, it is reasonable to allow dedicated movement of anchorages in a side impact test procedure.

3.5 Validation

The test procedure shall be repeatable, reproducible and impartial.

3.6 Field of application

The performance of test procedure needs to cater for all CRS types. However, it is important to specify in detail which “age groups” shall be considered taking into account the protection capabilities of today's cars for older children.

4 Summary

Intrusion loading is the most often cause for injuries in side impacts. For the protection of children in car side impacts, a combined assessment of body kinematics and energy management capabilities of the CRS is important.

Looking at the different body regions the head needs to be protected with highest priority followed by neck and chest.

The test input parameters are defined by the intrusion (specified by intrusion shape, intrusion depth and intrusion velocity), the bench acceleration and delta-v as well as by geometrical properties. The parameters are summarised below:

— Intrusion velocity: maximum between 7 and 10 m/s at approx. 30 ms close to the dummy’s head

— Intrusion depth: dynamic intrusion depths should be between 200 and 300 mm

— Sled acceleration range: 10 – 14 *g* (sled delta-v should be approximately 25 km/h)

— Intrusion surface height: approx. 500 mm with respect to CR point

— Initial distance between CRS centre line and intrusion surface: approx. 300 mm

Based on the results of the analysis of impact angles the test procedure should focus on a perpendicular impact.

Table 1 lists the essential input parameters and their respective weight and is intended to support the assessment of different test procedures.

Table 1 — Matrix of essential parameters to support the assessment of side impact test procedures

Essential parameter	Reference value	Weighing factor	Method A	Method B	Method C	Method D
Loading conditions	intrusion loading	A				
Loading conditions	assessment of occupant kinematics and energy management	A				
Relevant body regions to be addressed	1. head 2. neck 3. chest	1: A 2: B 3: B				
Maximum intrusion velocity	7 to 10 m/s at approx. 30 ms close to the dummy’s head	A				
Maximum intrusion depths	200 to 300 mm	B				
Sled acceleration range	10 to 14 g	C				
Sled delta-v	approx. 25 km/h	B				
Intrusion surface height	approx. 500 mm with regard to CR line	B				
Initial distance between intrusion surface and CRS centre line	approx. 300 mm	B				

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