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Road vehicles — Side impact test procedures for the evaluation of occupant interactions with side airbags by pole impact simulation

Véhicules routiers — Modes opératoires d'essai de choc latéral dynamique pour l'évaluation de l'interaction des occupants avec les sacs gonflables latéraux par simulation d'une collision contre un poteau

Reference number
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Foreword

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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 15829 was prepared by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 10, *Impact test procedures*.

Introduction

Side airbags/curtains (SAB) are deployable devices intended to help reduce the risk of injury to the head and/or chest and/or pelvis of vehicle occupants. 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 a tree. Accident data also indicate that serious to fatal injury in side impact is most likely to occur to the head, chest and abdomen, neck, pelvis and extremities.

During its inflation process, an airbag generates a considerable amount of kinetic energy and, as a result, substantial forces can be developed between the deploying airbag and the nearby occupant. Although there is very little experience with vehicles equipped with SAB, preliminary laboratory tests indicate that these forces can be sufficient to injure the vehicle occupant. Further, 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 or other side panel of the vehicle, where airbag reaction forces may be even greater. These test procedures were developed to improve the understanding of such interactions during vehicle-to-pole crashes and to help aid in the assessment of future airbag designs.

SAB 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. In some cases, dynamic sled tests with partial vehicle bodies may suffice; in others, the whole vehicle is dynamically tested. Engineering judgement needs to be used when 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 most satisfactory injury criteria (performance) results.

Road vehicles — Side impact test procedures for the evaluation of occupant interactions with side airbags by pole impact simulation

1 Scope

This International Standard specifies dynamic side impact test procedures with poles for evaluating the effects of the interaction between side airbags and occupants of road vehicles.

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 1176:1990, *Road vehicles — Masses — Vocabulary and codes*

ISO 3784, *Road vehicles — Measurement of impact velocity in collision tests*

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

ISO 6549, *Road vehicles — Procedure for H and R-point determination*

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

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

3 Terms and definitions

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

3.1
side airbag
SAB
airbag designed primarily to help reduce occupant injury potential where the significant collision force vector is lateral

3.1.1
head airbag
airbag that deploys between the occupant's head and the vehicle side structure or an external object that could contact the head

3.1.2
chest airbag
thoracic airbag
airbag that deploys between the occupant's upper torso and the vehicle side structure

3.1.3
pelvic airbag
airbag that deploys between an occupant's pelvis/thigh area and the vehicle side structure

3.1.4
combination airbag
airbag that deploys to help protect two or more body areas of an occupant

EXAMPLE Head and chest combination airbag.

3.2
rigid pole
vertically-oriented, circular, rigid structure, beginning no more than 100 mm above the ground and extending above the roof of the impacting vehicle

NOTE The pole will preferably be 350 mm ± 10 mm in diameter and set off from any vertical mounting surface (such as if attached to a fixed rigid barrier face) by at least 1 500 mm (see ISO 3560).

4 Test facility and equipment

4.1 Impact test site

The impact test site shall be a horizontal, smooth and hard surface of sufficient area to allow the specified speed to be reached prior to impact and to permit post-crash deceleration of the test vehicle while it remains on the surface of the test site.

4.2 Propulsion of test vehicle

The test vehicle shall be propelled to a point as close as possible to the rigid pole, at which point it shall be released to travel freely.

4.3 Locus of side impact on test vehicle

The test vehicle may be impacted from either side. The impact point shall be visibly marked on the outside of the test vehicle prior to the test.

The maximum lateral offset to the prescribed impact point shall be ± 20 mm.

4.4 Angle of impact

The side impact shall be performed with an impact angle of 90 °± 3 °.

5 Test configurations

5.1 Dynamic pole crash test

Slide or propel the vehicle sideways into a rigid pole. Propulsion examples of how this is done by three major testers are given in Annexes A, B and C.

The vertical plane of impact shall be perpendicular to the longitudinal median plane of the vehicle and pass through the centre of gravity of the head.

6 Preparation of test vehicle

6.1 Mass of test vehicle

The vehicle test mass, m_t, shall be calculated as follows:

$$m_t = m_k + m_l + m_d$$

where

m_k is the complete vehicle kerb mass (ISO-M06) as defined in ISO 1176:1990, 4.6, in kilograms;

m_l is the rated cargo and luggage mass, in kilograms, such that

$$m_l = m_p - (68 \times \text{DSC})$$

where

m_p is the maximum design pay mass (ISO-M09) as defined in ISO 1176:1990, 4.6, in kilograms;

DSC is the designated seating capacity of the test vehicle;

m_d is the test dummy mass in kilograms.

The vehicle shall be ballasted to achieve the test mass to within $\pm$ 10 kg. The ballast shall be located and secured to the vehicle so that it does not alter the structural characteristics of the parts of the vehicle expected to deform during the test.

At the time of impact, the vehicle shall be at its normal ride height and attitude defined by the manufacturer.

The instrumentation and cameras required for testing should not change the mass distribution between the axles by more than 20 kg.

6.2 Condition of test vehicle

6.2.1 General

The test vehicle doors shall be fully closed and latched, but not locked. Window(s) adjacent to the test dummy shall be closed, with appropriate glazing in place without protective or optical film applied on the glazing.

If the test vehicle has seats equipped with adjustable side bolsters or wings, these shall be adjusted to their nominal position, as defined by the manufacturer. If the nominal position does not allow the test device to be positioned, the adjustable seat side bolsters or wings shall be adjusted to fit the test device.

The steering wheel, if adjustable, shall be placed in the normal position indicated by the manufacturer or, if not possible, midway between the limits of its range(s) of adjustment.

Adjustable steering controls shall be adjusted so that the steering wheel hub is located in the manufacturer's nominal design riding position.

The parking brake shall be disengaged. The transmission shall be in neutral.

All tyres shall be inflated to the manufacturer's specifications.

If the test vehicle has a convertible top, the convertible structure shall be in the “up” position for the test.

The test dummy temperature should be within a temperature range, and at a relative humidity, specified by the dummy's manufacturer.

6.2.2 Seat position

Separately adjustable seats in a vertical direction shall be at the position defined by the manufacturer. If, on the same model, adjustable and fixed seats exist, the vertical position of the fixed seat shall be used.

The seats shall be positioned, as desired, by the test requestor.

6.2.2.1 Foremost-seat position

For adjustable seats, the adjustment position shall be as far forward on the seat track as possible.

6.2.2.2 Mid-seat position

For adjustable seats, the adjustment position shall be midway between the foremost and rearmost position, but If an adjustment position at this point does not exist, the adjustment position closest to the rear of the midpoint shall be used.

6.2.2.3 Rearmost-seat position

For adjustable seats, the adjustment position shall be as far rearward on the seat track as possible.

6.2.2.4 Position of the front seat-backs

If adjustable, the seat-backs shall be adjusted so that the resulting inclination of the torso of the dummy is as close as possible to that recommended by the manufacturer for normal use or, in the absence of any particular recommendation by the manufacturer, to 25° towards the rear from the vertical.

7 Test devices

The dummies that may be used for SAB investigations are EUROSID 1 and 2, BIOSID, SID-IIs.

8 Instrumentation

All measurements should be recorded and filtered according to ISO 6487, ISO 8721 and SAE J211-1 and SAE J211-2. These measurements should be continuous functions of time, so that other quantities referred to in the references may be derived.

The airbag deployment and dummy interactions should be monitored by high-speed cameras (or equivalent video or digital equipment) operating at a minimum speed of a thousand frames per second.

9 Installation of test dummy

9.1 General

Locate the H-point in the vehicle in accordance with ISO 6549. If this can only be done in the rearmost position of the seat, locate the H-point relative to the seat prior to moving the seat forward into the test position. Using the package drawing, correlate the H-point to the seating position used for the test. Locate the lateral centreline of the seating position.

Mark the test dummy for its midsagittal plane, the centre-of-gravity of the head and the H-point. Mark a hip pivot point, or another mark that approximately coincides with the ISO 6549 manikin H-point. Use instrumentation to measure the test dummy's pelvic angle.

The dummy's upper torso or head may be lightly taped to the seat back so that it does not move relative to the seat during final instrumentation checks, etc. The tape may be left in place for the test, provided that it will break when subjected to a load $\leqslant$ 50 N.

If the positioned dummy remains in the seat longer than 3 h before a test, check the head centre-of-gravity vertical position. If the head centre-of-gravity has changed by more than 5 mm, reposition the dummy.

9.2 Dummy segment positioning

9.2.1 Torso

9.2.1.1 Test dummy in driver's position

9.2.1.1.1 Bench seat

The upper torso of the test dummy shall rest against the seat back. The dummy's midsagittal plane shall be vertical and parallel to the vehicle's longitudinal centreline and pass through the centre of the steering wheel. If the seat has a contour, the dummy shall be centred in the contour as determined using the ISO 6549 manikin procedure.

9.2.1.1.2 Bucket or contoured seat

The upper torso of the test dummy shall rest against the seat back. The midsagittal plane of the test dummy shall be vertical and coincide with the longitudinal centreline of the bucket or contoured seat.

9.2.1.2 Test dummy in front outboard passenger position

9.2.1.2.1 Bench seat

The upper torso of the test dummy shall rest against the seat back. The midsagittal plane of the test dummy shall be vertical and parallel to the vehicle's longitudinal centreline and the same distance from the vehicle's longitudinal centreline as would be the midsagittal plane of a test dummy in the driver's position according to 9.2.1.1. If the seat has a contour, the test dummy shall be centred in the contour as determined using the ISO 6549 manikin procedure.

9.2.1.2.2 Bucket or contoured seat

The upper torso of the test dummy shall rest against the seat back. The midsagittal plane of the test dummy shall be vertical and parallel to the vehicle's longitudinal centreline and coincide with the longitudinal centreline of the bucket or contoured seat.

9.2.2 H-point of dummy

The H-point of the test dummy shall be within 15 mm in the vertical dimension, and 15 mm in the horizontal dimension, of the H-point determined using the equipment and procedure specified in ISO 6549, except that the length of the leg and thigh segments of the H-point machine shall be adjusted to 415 mm and 400 mm, respectively.

9.2.3 Pelvic angle

Set the pelvic angle at $30{,}5° \; {}^{+2{,}5°}_{0}$ for the EUROSID-1 and BIOSID test dummies and $20° \; {}^{+2{,}5°}_{0}$ for the SID-IIs.

9.2.4 Thighs and legs

The thighs of the test dummy shall rest against the seat cushion to the extent permitted by placement of the feet. To the extent practicable, the left leg of a test dummy in the driver position and both legs of the test dummy in the outboard passenger position shall be in vertical longitudinal planes. Final adjustment to accommodate placement of feet in accordance with 9.2.6 for various passenger compartment configurations is permitted.

9.2.5 Arms

The test dummy's arms (if equipped) shall be in the desired position and this shall be noted in the test report.

9.2.6 Feet

9.2.6.1 Test dummy in driver position

The right foot of the test dummy shall rest on the undepressed accelerator pedal with the heel resting as far forward as possible on the floorpan. If the right foot cannot be placed on the undepressed accelerator pedal, then position that foot the same as for the left foot. The left foot shall be set perpendicular to the leg and placed as far forward as possible such that the heel rests on the floorpan.

9.2.6.2 Test dummy in front outboard passenger position

Both feet of the test dummy shall be placed on the vehicle's toeboard with the heels resting on the floorpan as close as possible to the intersection of the toeboard and floorpan. If the feet cannot be placed flat on the toeboard, set them perpendicular to the legs and place them as far forward as possible such that the heels rest on the floorpan.

9.3 Restraint usage

If occupant restraint systems are fitted to the car, they shall be used during the test.

10 Impact response measurement

Data acquisition shall be in accordance with ISO 6487 and SAE J211-1 and SAE J211-2.

See Table 1.

11 Velocity

The velocity (of the vehicle) shall be measured within 0,5 m prior to impact in accordance with ISO 3784.

The velocity at the time of impact shall be that specified in the applicable test requirements. The impact velocity tolerance shall be ± 0,5 km/h of the desired velocity.

Table 1 — Directions for measurements

Dummy measurement	Direction(s)
Required	
Head [a]	
Acceleration at CG	3 axes
Thorax	
Displacement of ribs	Y-axis
Acceleration of ribs	Y-axis
Acceleration of the upper spine	Y-axis
Acceleration of the lower spine	Y-axis
Abdomen	
Force (EUROSID-1), or deflection (BIOSID and SID-IIs)	—
Pelvis	
Pubic symphysis load	F_Y
Acceleration	3 axes
Optional	
Upper neck	
Forces and moments (BIOSID and SID-IIs)	F_Y, F_Z, M_X
Shoulder	
Force (BIOSID and SID-IIs)	Y axis
Displacement	Y axis
Acceleration	3 axes

[a] Dummy head contact with the vehicle interior or the pole shall be identified by chalking or painting the outboard side of the dummy head prior to the test.

Annex A
(informative)

Side impact against pole test procedure 1

A.1 Before the test

A.1.1 Trolley set up

Centre the trolley over the launch rail, with the launch rail of the centre trolley aligned perpendicular to the barrier.

Position the trolley on the guide rails to ensure a proper alignment at the point of impact.

A.1.2 Placement of vehicle on trolley

Centre the vehicle over the longitudinal axes of the trolley, with hand brake on and in gear. Place the side of the vehicle to be tested 300 mm from the forward edge of the trolley. Mark the vehicle centre of impact using target stickers.

A.1.3 Pole set-up

Fix the pole perpendicular to the barrier, in line with the launch rail and point of impact on the vehicle.

A.1.4 Securing vehicle on trolley

Before backing up the trolley, position straps on the wheels (opposite the side of impact) to prevent the vehicle from slipping during the launch. Several metres before the barrier, disconnect the straps to ensure the free movement of the vehicle during the impact (release the straps by the impact of two release blocks fixed to the ground between the guide rails).

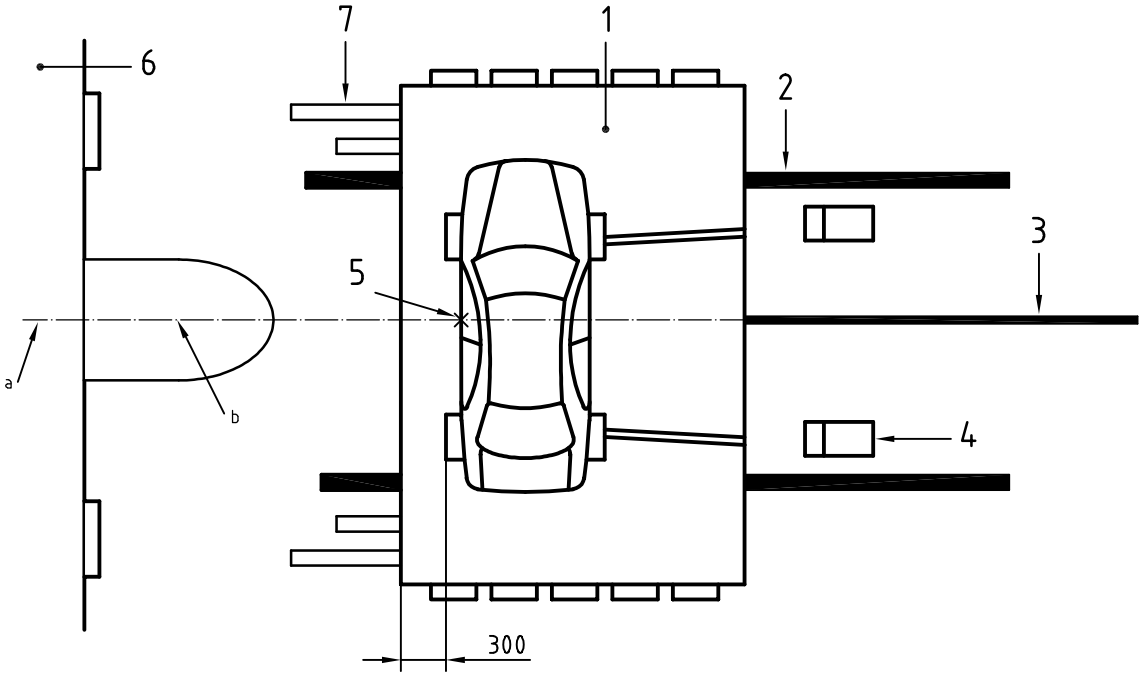
A.2 Test

Launch the entire unit against the pole. The braking mechanism for the trolley shall be a series of aluminium tubes (80 mm in diameter) which are crushed upon impact.

A.3 Description of entire unit

See Figure A.1.

Dimensions in millimetres



Key

1 trolley
2 guide rails
3 launch rail
4 release block
5 line impact (perpendicular to barrier)
6 barrier
7 aluminium tubes

a Barrier axis.
b Pole axis.

Figure A.1

Annex B
(informative)

Side impact against pole test procedure 2

B.1 Summary

The vehicle is placed laterally on a sled system moved towards a fixed pole. Before impact, the sled is stopped by a braking system and the vehicle slides into the pole.

B.2 Purpose of test

The purpose of this test is to simulate a lateral pole impact with good repeatability.

B.3 Test equipment

B.3.1 Sled system crashtrack 1A

B.3.2 Pole test table

B.3.3 Pole test fixture

B.3.4 Pole

B.3.5 Crash test dummy, EUROSID, US-SID or BIOSID, fully instrumented.

B.3.6 Sled accelerometer, horizontal direction.

B.3.7 On-board cameras, one rear and one front view, HS video or 16 mm.

B.3.8 Stationary cameras, front, rear, side/front, side/rear, top, top-close up. HS video or 16 mm.

B.3.9 Data acquisition system

B.3.10 Vehicle sensors, according to customer requirements.

B.4 Test procedure

NOTE Vehicle preparation, sensor setting, dummies, camera set-up and photographs are given in the Protocol Barrier Tests.

— Mount the pole test table on the sled, and the pole fixture and pole on the barrier, as shown in Figures B.1 and B.2.

— Place bending bars in the stop device.

— Place thin plastic plates on the table with grease between the table and the plates (see Figure B.3).

— Position the vehicle on the table with the tires on the plates. Place a block of wood behind the tires to prevent the vehicle slipping laterally backwards before impact.

— Position the dummy according to the Protocol Barrier Tests. Lock the head of the dummy laterally using a piece of tape.

— Move the sled towards the bending bar system.

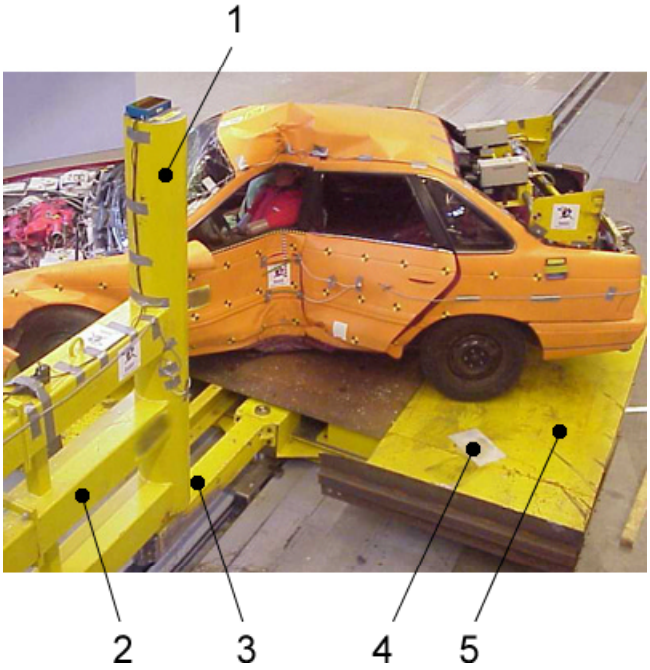
— Position the vehicle at a distance of 150 mm from the pole. The impact point shall be according to the Protocol Barrier Tests.

— Mark the target impact point on the vehicle with Patric-marks. Mark a line on the pole with colour.

— Move the sled to the starting position. Check the dummy position once more.

— Check the points in the checklist before the test on crashtrack 1. When all points are signed off, the test may be performed.

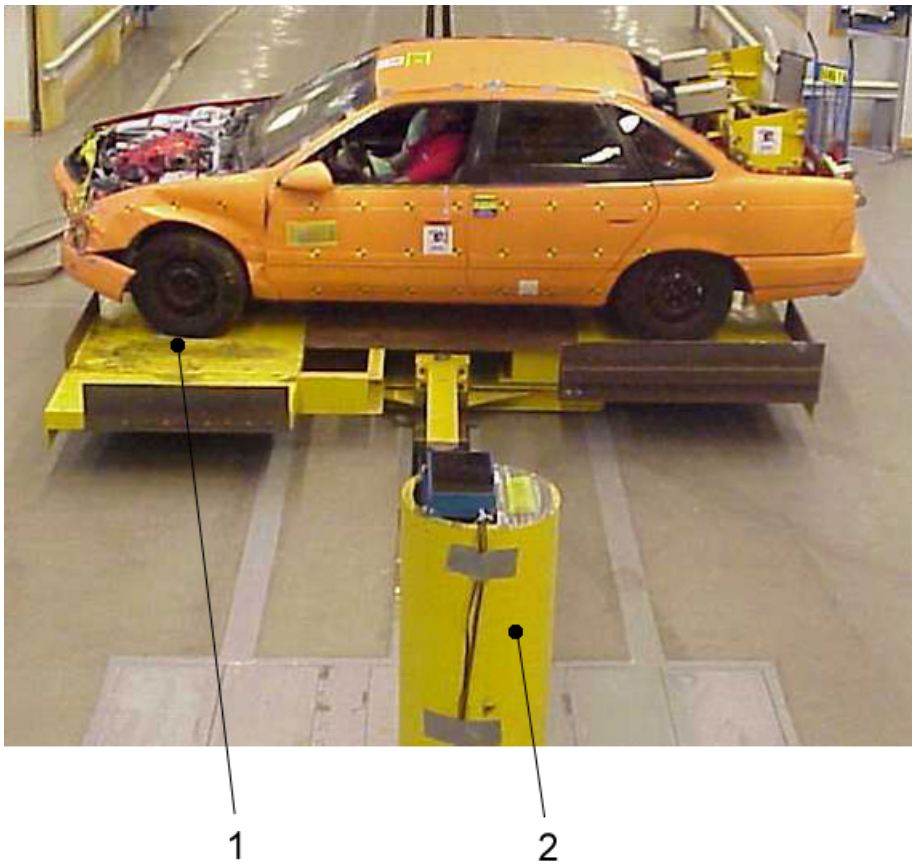
Figure B.1



Key

1 pole
2 pole fixture
3 bending bar system
4 plastic plates
5 table

Figure B.2



Key

1 plate with grease
2 pole

Figure B.3

Annex C
(informative)

Side impact against pole test procedure 3

C.1 Test equipment for vehicle acceleration facility for test (see Figure C.1)

C.1.1 Vehicle rollers, for moving the crash vehicle along the Y-axis, replacing the wheels.

NOTE The height of the vehicle rollers can be adjusted by installing spacers along the Z-axis, and the rollers can be adjusted along the Z-axis for setting the track width.

C.1.2 Towing chain, for towing the crash vehicle jerk-free to the crash point.

C.1.3 Rear coupling trolley, for lashing the crash vehicle, rigidly attaching the rear coupling trolley to the pulling trolley so that the crash vehicle can be guided precisely along the acceleration stretch between the starting and release points.

C.1.4 Tensioning strap, used to fasten and lash the crash vehicle to the rear coupling trolley, so that the crash vehicle is precisely guided from the starting point to the crash point.

C.2 Test set-up and procedure

C.2.1 Vehicle preparation in workshop

Lock the vehicle steering by welding the steering rod in the straight-ahead position.

The vehicle brakes shall not be jammed.

C.2.2 Vehicle dimensioning (M)

Subject the vehicle to 3-D dimensioning with transfer of the following coordinates to the vehicle:

— origin of the design coordinates, corresponding to the dimensional design;

— dummy head centre-of-gravity coordinates on the crash side of the vehicle corresponding to the dimensional design;

— towing point coordinates on the driver's and passenger's sides, centred between the jacking brackets or between the attaching points of the towing chain and the tensioning strap.

C.2.3 Installation of crash equipment

After dimensioning, install the measurement and filming equipment and place the dummies placed in the vehicle.

C.2.4 Installation of vehicle rollers, maintenance and alignment

Replace the wheels on the vehicle by flanging on the vehicle rollers.

Replace the wheels of the vehicle rollers after three trials, owing to wear.

C.2.5 Pole alignment

Align the pole at the barrier. Adjust the centre point of the pole according to the dimensional difference between the tow coordinates and the head centre-of-gravity coordinates.

Align the vehicle in correspondence to the head centre-of-gravity coordinates, for adjusting the film equipment and photo documentation at the pole.

Connect the measurement equipment via the towing cable and check.

C.2.6 Conversion of the vehicle acceleration facility

Optimise the drive unit for the pole crash test. Gently accelerate the vehicle so that the dummy remains seated in position.

C.2.7 Setting up and lashing vehicle at starting position

Bring the vehicle to the starting position and align it orthogonally (90°) to the X-axis by tugging on both the driver's and passenger's sides of the towing point towards the centre of the rope/trolley channel.

Check the track of the vehicle rollers using a try square and adjust if necessary. Attach the try square at the rope channel and adjust the vehicle rollers perpendicular to the rope/trolley channel with slight toe-in.

Attach the towing chain to the jacking brackets on the driver's side and connect it to the trolley.

Attach the tensioning straps to the jacking brackets on the passenger's side and connect to the trolley rear coupling. Firmly lash the vehicle to the trolley via the adjustable tensioning straps and the towing chain while keeping the vehicle aligned.

By means of a try square, set the vehicle rollers orthogonal (90°) to the X-axis, with slight toe-in.

C.2.8 Dummy position

Check the seat and dummy positions prior to the crash by remeasuring the H-point positioning.

C.2.9 Vehicle guidance

Clamp the vehicle between trolley and rear car by towing chains and tensioning straps and, in this way, guide it over the 32 m acceleration and control stretch.

C.2.10 Uncoupling/free run of vehicle

Uncouple the rear coupling from the vehicle approx. 6,5 m prior to pole impact.

Uncouple the front approx. 0,6 m prior to pole impact.

C.2.11 Advantages

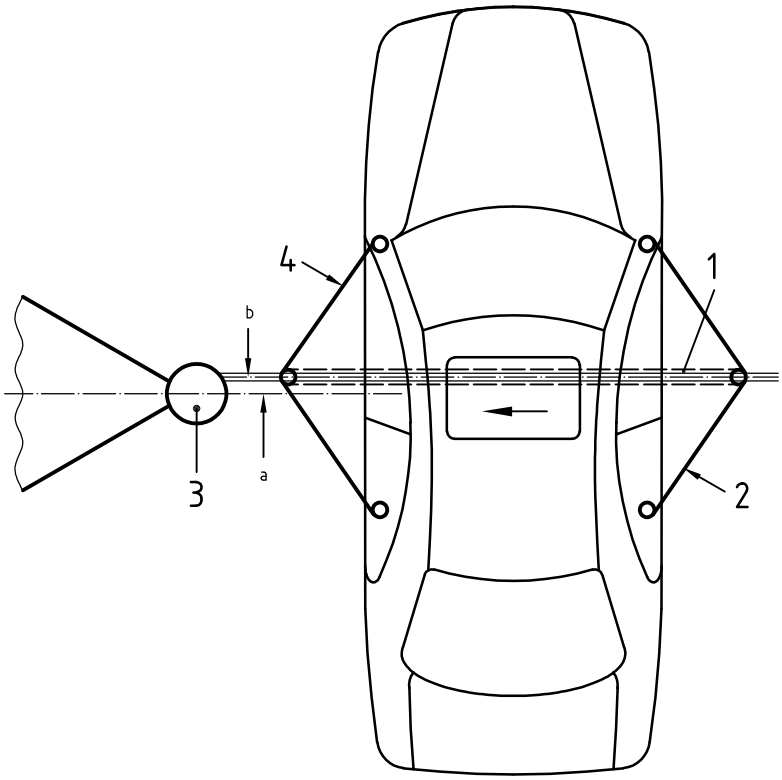
The advantages of this test procedure are the following.

a) Reproducibility:

   — accuracy of impact speed: ± 0,1 km/h;

   — striking accuracy at the crash point: ± 20 mm.

b) Economical solution: fast preparation and performance.



Key

1 trolley
2 tensioning device
3 pole
4 towing chain

a Coordinate of the head centre of gravity.
b Towing coordinate.

Figure C.1

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[1] ISO 3833, *Road vehicles — Types — Terms and definitions*

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[3] ISO 10997, *Passenger vehicles — Side impact with deformable moving barrier — Full scale test*

[4] ISO/TR 12351, *Road vehicles — Determination of moment and duration of head contact in impact tests*

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