SURFACE VEHICLE RECOMMENDED PRACTICE

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Fixed Rigid Barrier Collision Tests

RATIONALE

This procedure is superceded in the industry by multiple test methods which represent more closely the impact conditions for current vehicles on the road. The document should be Stabilized and retained for its historical reference only.

STABILIZED NOTICE

This document has been declared "Stabilized" by the SAE Impact and Rollover Test Procedure Standards Committee and will no longer be subjected to periodic reviews for currency. Users are responsible for verifying references and continued suitability of technical requirements. Newer technology may exist.

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1. SCOPE

Fixed rigid barrier collisions can represent severe automotive impacts. Barrier collision tests are conducted on automotive vehicles to obtain information of value in reducing occupant injuries and in evaluating structural integrity. The purpose of this SAE Recommended Practice is to establish sufficient standardization of barrier collision methods so that results of similar tests conducted at different facilities can be compared. The barrier device may be of almost any configuration, such as flat, round, offset, etc.

1.1 Objectives

The primary objective of this standard test method is to provide realistic simulation of the forces which act on vehicles and occupants during collisions with fixed objects. Measurements of structural loads and deflections, determination of occupant dynamics, and photographic and post-collision observations of pertinent special events may be useful in establishing design criteria.

2. REFERENCES

2.1 Applicable Publications

The following publications form a part of this specification to the extent specified herein. Unless otherwise specified, the latest issue of SAE publications shall apply.

2.1.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or 724-776-4970 (outside USA), www.sae.org.

SAE J211/1 Instrumentation for Impact Test—Part 1: Electronic Instrumentation

SAE J211/2 Instrumentation for Impact Test—Part 2: Photographic Instrumentation

2.1.2 FMVSS Publications

Available from the United States Government Printing Office, 732 North Capitol Street, NW, Washington, DC 20401, Tel: 202-512-1800, www.gpoaccess.gov/cfr/retrieve.html.

FMVSS 208 Occupant Crash Protection (49 CFR Part 571.208)

3. CRASH TEST FACILITY

3.1 Test Site, General

The test site should encompass sufficient area to provide accommodations for the barrier, location of various photographic (or video recording) equipment, a protected observer area, and acceleration of the test vehicle to desired speed at impact.

3.1.1 The immediate crash site should be level.

3.1.2 The approach and surface at the impact area should be paved and free from any surface irregularities that could impart vertical accelerations or displacements of the test vehicle. The surface friction coefficient should be representative of typical road surface friction (typically 0.7 to 0.8).

3.1.3 Allowances for precise positioning of photographic (or video) equipment should be made.

3.1.4 A pit may be installed in front of the impacted device to accommodate under-vehicle photography.

3.2 Barrier

A flat barrier suitable for impact testing of passenger cars and light trucks and vans should have the characteristics listed as follows:

3.2.1 The barrier face should be at least 3 m (10 ft) wide and 1.5 m (5 ft) high, but shall be large enough to accommodate the entire frontal crush area of the vehicle.

3.2.2 The barrier face should be normal to the final approach path and shall be faced with 1.9 cm (0.75 in) plywood.

3.2.3 The barrier size and construction should be sufficient to limit barrier face motion to less than 1% of the permanent crush of the vehicle.

3.2.4 The effective mass of the barrier may be achieved with reinforced concrete and compacted fill.

3.2.5 The barrier face may include a load-measuring device provided the combination of the barrier and load-measuring device shall conform to 3.2.1, 3.2.2, and 3.2.3.

3.3 Alternative Impact Barriers

Fixtures may be attached to the barrier or to an equivalent rigid structure to simulate the forces acting on the vehicle and occupants under alternative impact conditions. Typical fixtures include offset barriers, angled barriers, poles, and other roadside devices.

3.3.1 Fixtures may incorporate load-measuring devices provided the combination of the barrier (or rigid structure), the fixture, and the load-measuring device(s) conform to 3.2.3.

3.3.2 Details of the load-measurement techniques will be unique to each application and should be defined.

3.3.3 This document does not specify fixture geometry as this will depend upon the application. However, the fixture design shall be documented so that other facilities can reproduce the fixture. Typical variables to be determined for each application include barrier angle (30 degrees is typical), pole diameter, lateral offset, and corner radius of an offset barrier.

3.4 Barrier Approach

The type approach required depends upon the technique employed to obtain desired crash speed of the test vehicle. A practical barrier approach is level, straight, and of sufficient length to permit the test vehicle to be towed along a rail guidance system with the barrier impact occurring after the vehicle is released from the tow force and released from guidance at the end of the rail.

3.5 Protective Measures

Protective measures should be taken to insure the safety of test personnel and observers.

4. METHODOLOGY

4.1 Vehicular collision responses are complex by nature even during a relatively simple barrier collision. Careful control of the impact parameters must be exercised. As a standard evaluation procedure, an impact speed of 48 km/h (30 mph) is typical; however, other impact speeds may be chosen for special studies.

In order that neither acceleration nor deceleration inertial effects may possibly influence vehicle attitude, deformation characteristics, and subsequent occupant reactions, the impacting vehicle should be accelerated at a rate not to exceed 0.3 g, and hit the collision barrier while moving at essentially constant speed. The test vehicle should impact into a flat barrier target center so that the test vehicle's longitudinal axis is perpendicular to the plane of the barrier, except where the independent variable under investigation is yaw rate or angle of approach to the barrier. The lateral alignment of the test vehicle relative to the desired impact point on a flat barrier or an attached fixture should be within ±76 mm (±3 in) so that high-speed cameras may be correctly focused pretest. Lateral alignment precision is also important for pole and offset barrier fixtures. In such a case, the desired impact point should be at least within ±25 mm (±1 in) so that meaningful comparisons can be made.

Adequate lighting and a clear background, preferably of consistent texture and void of moving objects, is also desired for acceptable photographic coverage.

4.2 Test vehicle directional control can be achieved by use of a guide track, by following a pretest tracking trial with remote system, or by means of similar safe procedures to accomplish the desired objectives.

5. INSTRUMENTATION AND EQUIPMENT

To obtain meaningful information from a collision test, it is important that adequate means be provided to observe and record test results. Inasmuch as the objectives of any one impact are limited, the instrumentation to be used will need to be tailored to the type of instrumentation and equipment which can be employed to obtain desired data on the movements and loads experienced by the vehicle, its components, or its occupants during a crash test. It is essential that the recording system, including transducers and mounting systems, contain no resonant frequencies within the frequency response range of data interest. The instrumentation and data acquisition system shall meet the requirements of the current SAE J211.

5.1 Vehicle Accelerations Measurements

Accelerations may be measured by accelerometers located on the floor pan, frame, body sill, or body components. Accelerometers intended to measure whole vehicle decelerations should not be mounted in areas of localized resonant vibrations or distortion such as seat belt anchorages. Accelerometers mounted on both sides of the vehicle are recommended, in duplicate where needed for data backup purposes.

5.2 Occupant Data

Anthropomorphic test devices (ATD's) are used to obtain data on restraint system and occupant loading during frontal barrier tests. The Hybrid III family of dummies which represent small females, mid-size males, and large adult males are recommended for use in evaluating occupant restraints in frontal impact crashes. The Hybrid III 3- and 6-year-old children, along with the CRABI (child restraint air bag interaction) family of 6-, 12-, and 18-month-old infant dummies are recommended for use in frontal impact evaluation of child restraint systems. A ten year old Hybrid III dummy has been developed and is under review (in 2009) by the NHTSA.

NOTE: Descriptions of most dummies can be found in Part 572 of Title 49 of the Code of Federal Regulations.

5.3 Loads on Occupant Restraint Devices

To measure the dynamic loads sustained by occupant restraint devices installed in the vehicle, transducers may be used. The number of transducers used in each crash test should be sufficient to provide adequate recording of the loads imposed on these devices.

5.4 Contact Recordings and Documentation

Electrical conductive surfaces may be installed on the head, chest, or knees of the appropriate dummies so that a time history of their contact with conducting surfaces on sun visors or header, windshield, instrument panel, steering wheel, or knee bolsters can be recorded with respect to the vehicle impact time. Contact-indicative paint or chalk may be used to visually display (post crash) areas of relative contact.

5.5 Impact Speed

Provisions should be made to measure the speed of the vehicle immediately prior to the barrier impact. Refer to current SAE J211-1 and SAE J211-2.

5.6 Photographic Instrumentation

It is desirable to provide comprehensive photographic coverage of each barrier crash test. However, in cases where this is not possible, the following represent the recommended minimum coverage for meaningful information.

5.6.1 High-Speed Cameras

A minimum of two high-speed cameras is required.

5.6.1.1 Broadside Cameras

At least one high-speed camera should be located on each side of the crash site. Locating axes for precise positioning of photographic equipment should be provided. These cameras should be positioned so that the field of view is large enough to include only the test vehicle and is perpendicular to the path of that vehicle at the instant of barrier contact. Each camera should have provisions for recording a time signal and should have a framing rate sufficient to facilitate accurate micromotion analysis of the data. (Frame rates of 200 to 1000 frames/s are normally employed.) Suitable calibration and position reference targets, should be applied to both stationary objects, and to the vehicle and occupants. Information obtainable from this data through micromotion analysis include total vehicle displacement, velocity, and deceleration. In addition, micromotion studies of the kinematics of the various occupants of the vehicle may be performed, and compared to their transducer records.

5.6.1.2 Overhead Cameras

Cameras may also be placed directly above the crash site. At least one camera should be positioned perpendicular to the path of the vehicle at the moment of barrier contact and with a field of view sufficient to include the entire vehicle. A second camera should be placed to record the post-impact trajectory for vehicle impact analysis.

5.6.1.3 Underneath Cameras

Cameras may also be placed directly beneath the crash site to photograph the chassis and components which are visible only from beneath the vehicle. Data from these cameras can also be used for motion analysis if provisions in 5.7.1 are included.

5.6.1.4 Passenger Compartment

Suitable high “g” camera may be installed onboard to view the passenger compartment of the test vehicle to record the kinematics of specific occupants.

5.6.2 Still Camera(s)

Before and after test still photographs should be taken done to document test conditions and results.

5.7 Miscellaneous

5.7.1 Electronic and Photographic Instrumentation Coordination

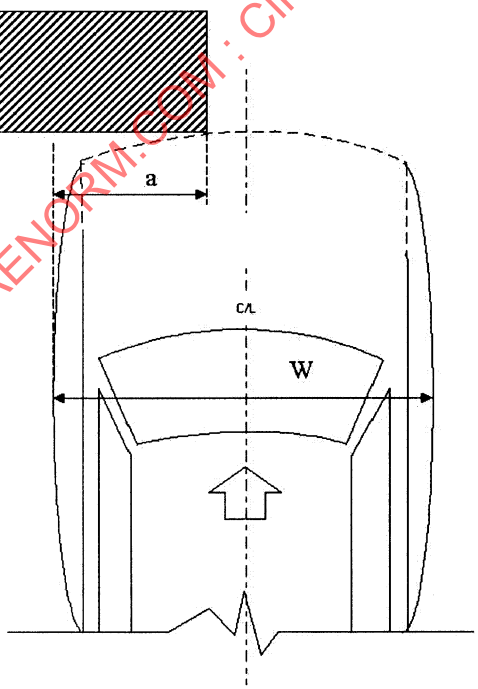
Provision should be made for synchronizing electronic and photographic instrumentation.

5.7.2 Vehicle Deformation

Measurements should be made before and after the barrier impact test to determine the total residual deformation, and the dimensional changes recorded. It is recommended that crush measurements be made and recorded in accordance with established accident reconstruction crash deformation standards. Any significant interior deformation, or energy-absorption device function, should be documented by measurement and/or photography.

5.7.3 Vehicle Overlap Definition

Overlap is defined as the percentage of vehicle width directly in line with the barrier face. See Figure 1.



$$\frac{a}{W} \bullet 100 = (\%)\ \text{Overlap}$$

FIGURE 1 - VEHICLE OVERLAP DEFINITION