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INTERNATIONAL
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SURFACE VEHICLE RECOMMENDED PRACTICE

Submitted for recognition as an American National Standard

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(R) FIXED RIGID BARRIER COLLISION TESTS

1. ***Scope and Purpose***—Fixed rigid barrier collisions can represent severe automotive impacts. Deceleration conditions during fixed rigid barrier collisions are more readily reproducible than those occurring during impacts with yielding barriers. 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 accidental 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 Documents**—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, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

SAE J211/1—Instrumentation for Impact Test—Part 1—Electronic Instrumentation
SAE J211/2—Instrumentation for Impact Test—Part 2—Photographic Instrumentation
SAE EA-23—Owner's Manual for Hybrid III Dummy
SAE EA-25—Calibration Procedures—Hybrid III Small Female Dummy
SAE EA-26—Calibration Procedures—Hybrid III Large Male Test Dummy
SAE EA-27—User's Guide for the Twelve and Eighteen Month Old Infant Dummies (CRABI)
SAE EA-28—User's Guide for the Six Month Old Infant Dummy (CRABI)

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.

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 undervehicle 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. Practical barrier approaches include the following:

3.4.1 Suitable grade of sufficient slope and length to allow acceleration of the test vehicle to crash speed.

3.4.2 Level surface of sufficient length to permit any one of the following:

3.4.2.1 Test vehicle to be towed to crash speed.

3.4.2.2 Test vehicle to be driven to crash speed under a remote or other control system.

3.4.2.3 Test vehicle to be towed or driven with suitable guidance.

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 recommended; however, other impact speeds may be chosen for special studies.

In order that neither acceleration nor deceleration inertial effects may possibly influence vehicle attitude or deformation characteristics and subsequent occupant reactions, the impacting vehicle should 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 within ±25 mm (±1 in) so that meaningful comparisons can be made.

Other requirements for acceptable photographic coverage are adequate lighting and a clear background, preferably of consistent texture and void of moving objects.

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. For other than flat and full width collisions, accelerometers on both sides of the vehicle are recommended, as well as multiple installations for data backup purposes.

5.2 Occupant Data—Anthropomorphic test devices (dummies) are used to obtain data on restraint system and occupant loading during frontal barrier tests. The Hybrid family of dummies which represent 3- and 6-year-old children and small female, mid-size male and large adults and 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 restraint systems. Physical characteristics and response verification procedures for these dummies (except for the 3- and 6-year-old) are given in SAE Engineering Aids 23, 25, 26, 27, and 28. Engineering Aids for the 3- and 6-year-old dummies are expected in 1996.

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 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.

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. Equivalent video equipment may be substituted.

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 provision for recording a timed pulse signal on the film and should have a framing rate sufficient to facilitate accurate micromotion analysis of the film. (Film frame rates of 200 to 1,000 frames/s are normally employed.) Suitable calibration and position reference targets, both stationary and on the vehicle and occupants, should be provided. Information obtainable from this film 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. Film from these cameras can be used for motion analysis if provisions stated in 5.7.1 are included.

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. Film 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 photographic coverage should be 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.