SURFACE VEHICLE RECOMMENDED PRACTICE

J2481 | OCT2013

Issued 1999-03
Revised 2013-10

Superseding J2481 NOV2009

Dynamic Simulation Sled Testing

RATIONALE

The document is being revised to update for the current NHTSA frontal barrier crash test parameters and to make it consistent for use with both acceleration and deceleration sleds.

1. SCOPE

Dynamic simulation sled testing can represent various automotive collision conditions. Acceleration conditions during sled testing are readily reproducible and can be tuned to simulate collision events that occur during vehicle impacts with a fixed barrier or vehicle. Sled tests are conducted on automotive vehicle bodies or other structures to obtain valuable information. This information can be used to evaluate the dynamic performance of, but not limited to, vehicle restraint systems, vehicle seating systems, and body closure systems.

1.1 Purpose

The purpose of this SAE Recommended Practice is to establish sufficient standardization of dynamic simulation sled testing methods so that results of similar tests conducted at different facilities can be compared.

1.2 Objectives

The primary objective of this standard test method is to provide realistic simulation of the forces, which act on vehicle systems and occupants during vehicle collisions. This document also describes photographic documentation and measurements of occupant dynamics useful in evaluating restraint system designs.

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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 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

SAE J1733 Sign Convention for Vehicle Crash Testing

SAE J1980 Guidelines for Evaluating Out-of-Position Vehicle Occupant Interactions with Deploying Frontal Airbags

2.1.2 Federal 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.

49 CFR Part 571 Federal Motor Vehicle Safety Standard (FMVSS)

FMVSS 206 Door Locks and Door Retention Components

FMVSS 208 Occupant crash protection

FMVSS 213 Child Restraint Systems

3. SLED TEST FACILITY

3.1 Sled Test Site, General

The sled test site should encompass sufficient area to provide accommodations for the sled fixture, various photographic/video equipment, and a protected observation area.

3.1.1 Allowances for precise positioning of photographic/video equipment should be made, both on-board and off board.

3.2 Dynamic Simulation Sled

A sled test facility suitable for testing of passenger cars, light trucks, and vans should have the characteristics listed as follows:

3.2.1 A sled test facility should be able to reproduce a variety of acceleration pulses in a repeatable manner. This can be accomplished either through use of a deceleration sled or acceleration sled. Several standardized pulses used in various test procedures are given in Appendix A.

3.2.2 The sled carriage shall be large enough to accommodate the test subject, photographic equipment, and instrumentation, without any unintended interference in the movement of ATDs, seats or restraint systems. The test subject may be a full vehicle body, a live body (an unreinforced vehicle body shell), the passenger compartment or a rigidized portion of a passenger compartment, or simply the seat and restraint system mounted to a rigid structure.

3.2.3 The effective mass of the sled module (passenger compartment, anthropomorphic test devices [ATD's], and on-board instrumentation) shall not exceed the limits of the sled facility. In cases where the load capacity of the sled facility may be exceeded, portions of the full vehicle, live body or rigidized passenger compartment may be modified to reduce the mass, insomuch as it does not alter the response of the passenger compartment. In addition, instrumentation and/or photographic equipment considered non-essential might be eliminated. The final configuration is left to the discretion of the vehicle manufacturer or test engineer.

3.3 Protective Measures

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

4. METHODOLOGY

4.1 Dynamic simulation sled testing responses are complex by nature even during a relatively simple fixed frontal barrier crash test. Careful control of the impact parameters must be exercised. As a standard evaluation procedure, a simulated impact speed should be chosen which represents the total change in both the acceleration and velocity over time as related to the target load case, including any rebound velocity that may influence performance.

Requirements for acceptable photographic coverage include adequate lighting, and a clear background, which would preferably be of consistent texture and void of moving objects.

5. INSTRUMENTATION AND EQUIPMENT

To obtain meaningful information from a collision simulation sled test, it is important that adequate means be provided to observe and record test results. Inasmuch as the objectives of any one impact simulation 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 or sled buck, its components, or its occupants during a crash test simulation. It is essential that the recording system, including transducers and mounting systems, is not subject to resonant frequencies within the frequency response range of data of interest. The instrumentation and data acquisition system shall meet the requirements of the current SAE J211-1 and SAE J211-2. Data acquisition should begin at least 10 milliseconds prior to "time zero" for the purpose of channel nulling operations and to facilitate application of standard data processing, and continue well beyond the time frame of interest. Selection of "time zero" in the data set may be based on an acceleration threshold (such as 0.5g), other methods as appropriate for specific test applications, or as indicated by the test specification being used.

5.1 Vehicle Accelerations Measurements

Accelerations may be measured by accelerometers located on the sled buck itself (per FMVSS 208) or on the floor pan, frame, body sill, body components as required by the test engineer. Accelerometers intended to measure whole vehicle or sled buck accelerations should not be mounted in areas of localized resonant vibrations or distortion such as a seat belt anchorage. For data backup purposes, multiple installations of accelerometers on the vehicle or test buck are recommended.

If the mass of the ATDs is a significant portion of the entire test subject and carriage mass, the dynamic loading of the restraints by the ATDs may have a significant effect on the acceleration pulse of the carriage. When the ATD mass ratio is high this will need to be taken into consideration in the design of the deceleration pulse, or ballast will need to be added to the carriage to minimize this effect.

5.2 Occupant Data

A variety of ATDs are available for use in obtaining data on restraint systems and occupant loading during sled tests. The instrumentation and data acquisition system shall meet the requirements of the current SAE J211-1 and SAE J211-2.

5.3 Loads on Occupant Restraint Devices

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

5.4 Contact Recordings and Documentation

Electrically 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 can be recorded with respect to the onset of the simulated impact. Conductive surfaces could be placed on the sun visors/header, windshield, instrument panel, steering wheel, and knee bolsters. Contact-indicative paint or chalk may be used to visually display (post crash) areas of relative contact.

5.4.1 Speed Measurement

Impact speed for a deceleration sled can be captured with provisions such as the use of a speed trap. To measure and record total change in velocity (including any rebound velocity when using deceleration sleds), integration of acceleration should be utilized. Refer to SAE J211-1.

5.5 Photographic Documentation

It is desirable to provide comprehensive photographic coverage of each sled 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. Refer to SAE J211-2

5.5.1 High-Speed Cameras

A minimum of two high-speed cameras is recommended.

5.5.1.1 Broadside Cameras

At least one high-speed camera should be located on each side of the crash simulation site, except when the test buck geometry does not allow for a useful view from a ground-based camera. 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 the test sled buck throughout the duration of the pulse and when an ATD is utilized, any relevant excursion outside of the sled buck. The orientation should be perpendicular to the path of that sled buck at the onset of the simulated impact. Each camera should have provision for recording time code and should have a framing rate sufficient to facilitate accurate video analysis (frame rates of 200 to 1000 frames per second are normally employed, 3000 to 5000 for documenting airbag deployment). Suitable calibration and position reference targets, both stationary and on the vehicle or test buck and occupants, should be provided. Information obtained through video analysis includes total vehicle or test buck displacement, velocity, and deceleration. In addition, video motion studies of the kinematics of the various occupants of the vehicle may be performed.

5.5.1.2 Overhead Cameras

Cameras may also be placed directly above the test site. Images from these cameras can be used for motion analysis if provisions stated in 5.5.1.1 are included.

5.5.1.3 Passenger Compartment

Suitable acceleration resistant cameras may be installed on-board to view the passenger compartment of the test vehicle in order to record the occupant kinematics. On-board cameras for video analysis should be installed as close to perpendicular to anticipated plane of travel as reasonably possible.

5.5.2 Still Camera(s)

Pre- and post-test still photographs should be taken to document test conditions, including ATD positioning, restraint condition, installed instrumentation and results such as witness marks on the vehicle interior.

6. MISCELLANEOUS

6.1 Electronic and Photographic Instrumentation Coordination

Provisions should be made for synchronizing electronic and photographic instrumentation.

6.2 Vehicle Interior Deformation

Any significant interior deformation, or energy-absorption device function, should be documented by measurement and/or photography.

6.3 Vehicle Data and Definition

Basic vehicle data should be recorded or photo documented prior to conducting the dynamic simulation. These data should include, but not be limited to:

a. Sled and test vehicle/buck mass

b. Vehicle production identification (make, model, model year, trim level, etc.)

c. Any significant variation from production conditions including corrosion, crash damage, or modifications to reinforce the sled buck.

7. NOTES

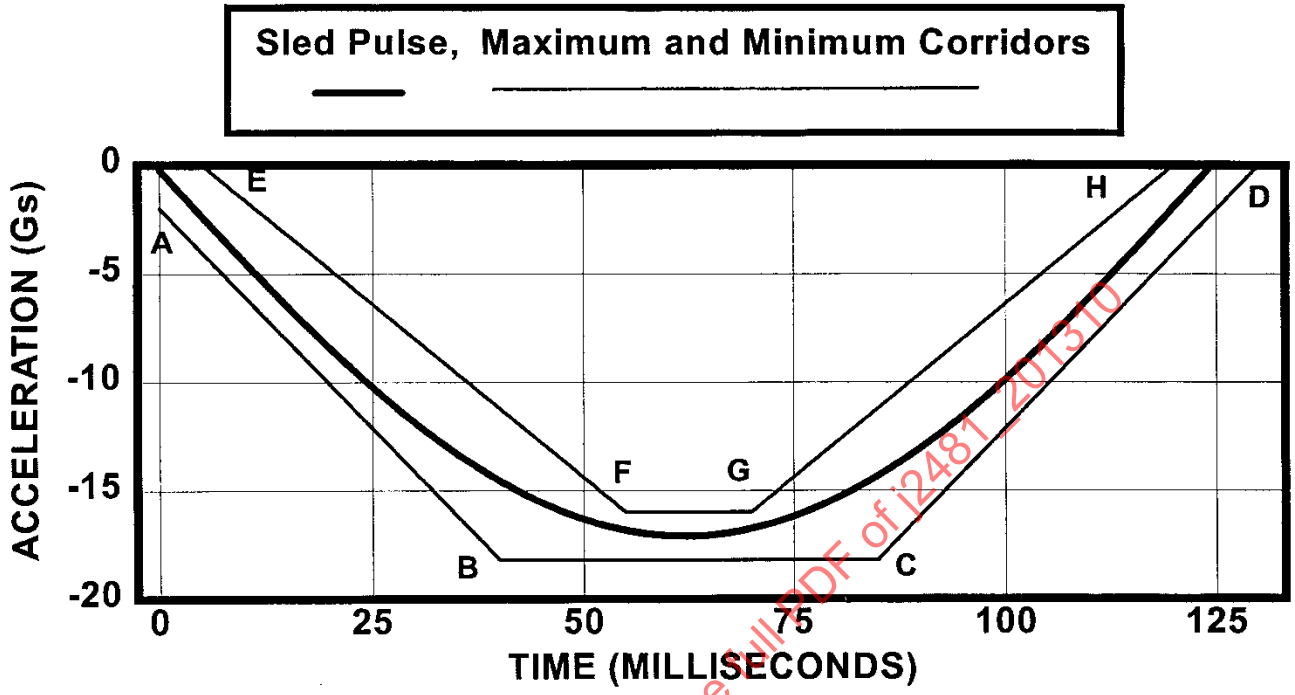
7.1 Marginal Indicia

A change bar (l) located in the left margin is for the convenience of the user in locating areas where technical revisions, not editorial changes, have been made to the previous issue of this document. An (R) symbol to the left of the document title indicates a complete revision of the document, including technical revisions. Change bars and (R) are not used in original publications, nor in documents that contain editorial changes only.

PREPARED BY THE SAE IMPACT AND ROLLOVER TEST PROCEDURE STANDARDS COMMITTEE

APPENDIX A

Figure A1 was taken directly from the revised portions of FMVSS 49 CFR Part 571, section 571.208.[1]



Sled pulse acceleration, expressed in G's = 17.2 Sin(t/125)

for delta V = 30(+0,-2) mph

Reference point	t (ms)	Acceleration (G)
A	0	-2
B	40	-18.2
C	85	-18.2
D	130	0
E	5	0
F	55	-16
G	70	-16
H	120	0.00

FIGURE A1 - SLED PULSE AND COORDINATES

[1] An electronic version of the complete document (49 CFR Part 571 [Docket No. 74-14; Notice 114]) can be obtained via the World Wide Web at: http://www.dot.gov/affairs/index.htm.