



# SURFACE VEHICLE RECOMMENDED PRACTICE

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Occupant Restraint and Equipment Mounting Integrity -  
Rear Impact System-Level Ambulance Patient Compartment

## RATIONALE

This SAE Recommended Practice was developed by members of the SAE Truck Crashworthiness Committee in support of the ambulance industry's need to apply science to the mounting of equipment and retention of occupants inside the patient compartment of an ambulance. The Recommended Practice was validated collaboratively by industry and government partners through extensive testing funded and managed by the National Institute for Occupational Safety and Health, the Department of Homeland Security and the Ambulance Manufacturers Division of the NTEA. Analysis of the data and development of the representative crash pulse corridor was performed by a consensus of automotive crash testing laboratories.

### 1. SCOPE

This SAE Recommended Practice describes the test procedures for conducting rear impact occupant restraint and equipment mounting integrity tests for ambulance patient compartment applications. Its purpose is to describe crash pulse characteristics and establish recommended test procedures that will standardize restraint system and equipment mount testing for ambulances. Descriptions of the test set-up, test instrumentation, photographic/video coverage, and the test fixtures are included.

### 2. REFERENCES

#### 2.1 Applicable Documents

The following publications form a part of the specification to the extent specified herein. Unless otherwise indicated, the latest revision 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](http://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 Engineering Aid 23 "Users' Manual for the 50th-Percentile Hybrid-III Test Dummy," June 1985

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## 2.2 Related Publications

The following publications are provided for information purposes only and are not a required part of this SAE Technical Report.

Code of Federal Regulations, Title 49, Part 571.208.

Code of Federal Regulations, Title 49, Part 571.214.

Code of Federal Regulations, Title 49, Part 572

Current, R., Moore, P., Green, J., Yannaccone, J., et. al., "Crash Testing of Ambulance Chassis Cab Vehicles", SAE Technical Paper 2007-01-4267 – 2007, doi: 10.4271/2007-01-4267

CAPE Report CTR07376 - Type III Ambulance Rear Impact, NTIS Accession Number PB2014101523

CAPE Report CTR07872 - Type II Ambulance Rear Impact, NTIS Accession Number PB2014101524

## 3. TEST DUMMIES

For the dynamic tests described in the following sections, restraint systems should be evaluated with the aid of a test dummy. The test dummy should be of a type that will closely represent the size, weight, and articulation characteristics of a 50th percentile male in a seated position. Examples of such a test dummy include the Hybrid-III and Euro SID2 with rib extensions 50th percentile male anthropomorphic test devices (ATD). The dummy should be selected appropriately based on the orientation of the seat relative to the direction of travel and the purpose of the test. The physical characteristics of these ATD's are described in 49 CFR 572 subparts E and U.

Applicable measurement capabilities of the Hybrid-III 50th percentile male test dummy are described in 49 CFR 571.208 and applicable measurement capabilities of the Euro SID2-re 50th percentile male test dummy are described in 49 CFR 571.214.

Test dummies of other sizes (i.e., 95th-percentile male, 5th-percentile female, etc.) may be used to evaluate restraint system performance for various occupant sizes.

## 4. DYNAMIC SLED TESTS

For the restraint system tests, all interior cab components that are potential occupant contact surfaces (cabinets, countertops, patient cots, etc...) should be installed on the test sled where practical. Proper geometry relative to the components being tested should be maintained. Wherever practicable, actual production components should be used. If not, components with performance characteristics near those expected for production should be used. Seat tethers should be set according to the manufacturer's specifications. The primary purpose of this test pulse is to evaluate restraint system performance, occupant excursion, equipment mounting integrity, and occupant interaction with interior components when subjected to a representative real-world rear impact crash pulse.

### 4.1 Test Fixture

For the rear impact tests, a sled fixture mounted on a uni-directional tracking system is required. Typical sled fixture systems are of the deceleration and acceleration types. For the deceleration system, the sled fixture is accelerated to a desired speed and then decelerated through the programmed pulse via energy-absorbing methods (i.e., honeycomb, extruded steel rods, etc.). For the acceleration system, the programmed pulse is applied as a rearward acceleration to the sled fixture, which is initially at rest.

### 4.2 Rear Impact Sled Pulse Specification

For rear impact tests, a sled deceleration pulse is applied parallel to the vehicle longitudinal axis. The pulse profile must fall within the corridor delineated by the plots in Figure 1 and the values in Table 1. Total velocity change during the test shall be  $10 \pm 0.5$  mph.

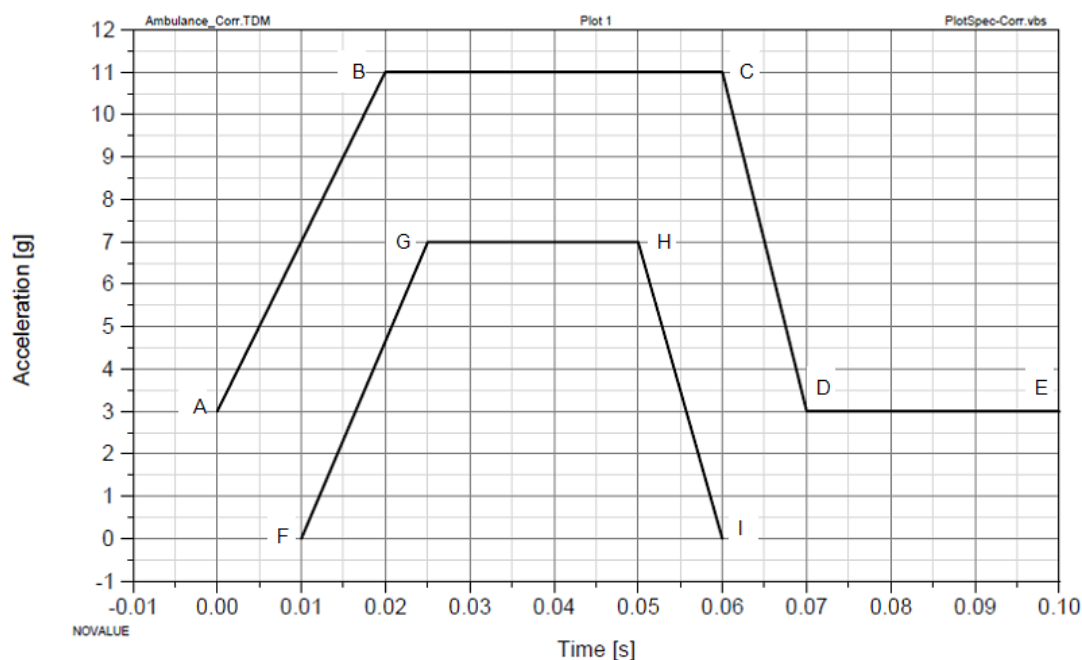


FIGURE 1 - DYNAMIC SLED CORRIDOR

TABLE 1 - DYNAMIC SLED CORRIDOR BREAK POINTS

Position	Time (sec)	Acceleration (g)
A	0.00	3.0
B	0.02	11.0
C	0.06	11.0
D	0.07	3.0
E	0.10	3.0

Position	Time (sec)	Acceleration (g)
F	0.01	0.0
G	0.025	7.0
H	0.05	7.0
I	0.06	0.0

#### 4.3 Dummy Positioning

Test dummy positioning procedures for this testing should be consistent with the positioning procedures outlined in 49 CFR 571.208 and 49 CFR 571.214, where practicable.

#### 5. INSTRUMENTATION

To record the deceleration pulse, accelerometers may be mounted to the sled fixture. Dummy instrumentation may include any of the measurements mentioned in Section 3. Dynamic seat belt loads may be recorded by installing webbing load transducers on the seat belts. All measurements should be recorded, filtered and processed according to the most recent versions of SAE J211-1 and SAE J1727.

## 6. PHOTOGRAPHIC INSTRUMENTATION

High-speed cameras should be used to document the dynamic tests. The field of view of these cameras should be large enough to document the entire range of motion of the test dummy and/or mounted equipment during the deceleration event. Wherever possible, off-board cameras should be used to allow for the use of longer focal-length lenses and, therefore, less lens distortion error when performing analysis of the high-speed footage.

If complete coverage of occupant kinematics is not possible with off-board cameras only, the use of on-board cameras will be required.

Each high-speed camera should operate at a frame rate sufficient to facilitate motion analysis of the film. A minimum frame rate of 500 frames per second is recommended. Sufficient reference targets, both stationary and on the test sled/fixture and test dummy, should be provided. Provisions should be made for synchronizing electronic and photographic instrumentation. Wherever possible, the cameras should be mounted such that they are perpendicular to the axis of motion. All video should be captured and processed according to the most recent version of SAE J211-1."

## 7. NOTES

### 7.1 Marginal Indicia

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