

Occupant Restraint System Evaluation— Frontal Impact System-Level Heavy Trucks

1. Scope—This SAE Recommended Practice describes the test procedures for conducting frontal impact restraint system tests for heavy truck applications. Its purpose is to establish recommended test procedures that will standardize restraint system testing for heavy trucks. Descriptions of the test set-up, test instrumentation, photographic/video coverage, and the test fixtures are included.

2. References

2.1 Applicable Publications—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, 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 Engineering Aid 23—"Users' Manual for the 50th-Percentile Hybrid-III Test Dummy," June 1985

SAE CRP-9—"Heavy Truck Crashworthiness (Statistics, Accident Reconstruction, Occupant Dynamics Simulation)," March 1995

SAE CRP-13—"Heavy Truck Crashworthiness (Phase III)," April 1997

2.2 Other Publications

Code of Federal Regulations, Title 49, Part 571.208.

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. An example of such a test dummy is the Hybrid-III 50th percentile male anthropomorphic test device. The physical characteristics of this dummy are described in SAE's Engineering Aid 23, "Users' Manual for the 50th Percentile Hybrid III Test Dummy," June 1985.

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Applicable measurement capabilities of the Hybrid-III 50th percentile male test dummy are as follows:

- Head triaxial acceleration (3 channels)
- Upper neck forces and moments (6 channels)
- Lower neck forces and moments (6 channels)
- Chest triaxial acceleration (3 channels)
- Chest deflection (1 channel)
- Lumbar forces and moments (6 channels)
- Pelvic triaxial accelerations (3 channels)
- Femur loads (2 channels)

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 (i.e., steering wheel, dashboard, doghouse, etc.) shall be installed on the test sled. Proper geometry, relative to the seat and restraint system, should be maintained. Wherever practicable, actual cab components should be used. If not, components with performance characteristics near those expected for production should be mocked into the test fixture. Seat tethers should be set according to the manufacturer's specifications. The primary purpose of this test is to evaluate restraint system performance, occupant excursion, and occupant interaction with interior components when subjected to a representative real-world frontal crash pulse.

4.1 Test Fixture—For the frontal impact tests, a sled fixture mounted on a uni-directional tracking system is required. Typical sled fixture systems are of the deceleration and HYPE 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 HYPE system, the programmed pulse is applied as a rearward acceleration to the sled fixture, which is initially at rest.

4.2 Frontal Impact Sled Pulse Specification—For frontal impact restraint system tests, a sled deceleration pulse is applied parallel to the seat/restraint system longitudinal axis. Wherever possible, vehicle-specific deceleration pulses should be used. If a vehicle-specific pulse is not known, then a generic sled pulse corresponding to the following analytical expression should be used. (See Equation 1.)

$$a(t) = \frac{1}{2}A \left(1 - \cos\left(\frac{2\pi}{T}t\right) \right) \quad (\text{Eq. 1})$$

where:

A = 11 g
T = 0.13 s

The acceleration-time and ΔV -time curves for the generic sled pulse are presented in Figures 1 and 2, respectively.

4.3 Dummy Positioning—Test dummy positioning procedures for this testing should be consistent with the positioning procedures outlined in 49 CFR 571.208, 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. Also, dynamic seat belt loads may be recorded by installing webbing load transducers on the seat belts. All measurements should be recorded and filtered according to the most recent version of SAE J211-1 and J211-2.

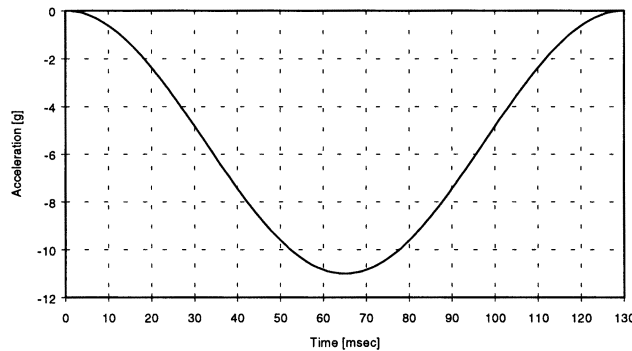


FIGURE 1—DECELERATION PULSE FOR FRONTAL IMPACT TEST

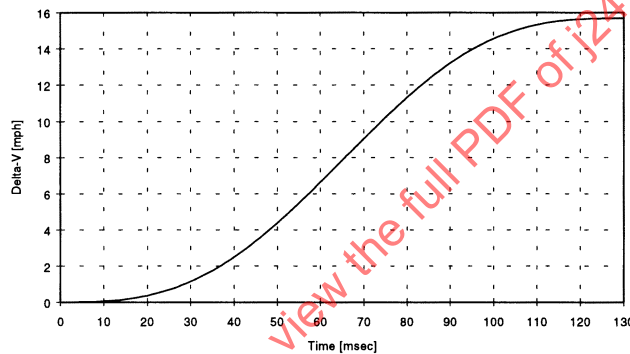


FIGURE 2—ΔV-TIME HISTORY FOR FRONTAL IMPACT TEST

6. **Photographic Instrumentation**—For the dynamic test described previously, high-speed cameras are recommended. The field of view of these cameras should be large enough to document the entire range of motion of the test dummy 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. However, for the system-level testing, complete coverage of occupant kinematics may not be possible with off-board cameras only, and the use of on-board cameras will be required. Each camera should operate at a frame rate sufficient to facilitate motion analysis of the film. Frame rates of 200 to 1000 frames per second are usually employed. If using film cameras, each camera should have provision for recording a timed pulse signal on the film. 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.