SAE International™

SURFACE VEHICLE RECOMMENDED PRACTICE

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Occupant Restraint System Evaluation—Lateral Rollover System-Level Heavy Trucks

1. ***Scope—***This SAE Recommended Practice describes the test procedures for conducting simulated dynamic lateral rollover 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.
SAECRP-9—"Heavy Truck Crashworthiness (Statistics, Accident Reconstruction, Occupant Dynamics Simulation)", March 1995.
SAE CRP-13—"Heavy Truck Crashworthiness (Phase III)", April 1997.

2.1.2 FEDERAL PUBLICATION—Available from the Superintendent of Documents, U. S. Government Printing Office, Mail Stop: SSOP, Washington, DC 20402-9320.

Code of Federal Regulations, Title 49, Part 571.208.

3. ***Test Dummies—***For the dynamic lateral rollover 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)

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

4. ***Dynamic Lateral Rollover Simulator Tests—***For the simulated rollover tests, all interior cab components that are potential occupant contact surfaces shall be installed on the test fixture with the proper geometrical relationships. Wherever practicable, actual cab components should be used. If not, components with performance characteristics near those expected for production should be mocked in the test fixture. Seat tethers should be set according to the manufacturer's specifications. The primary purpose of the rollover simulator tests is to evaluate restraint system performance, occupant excursion, and occupant interaction with interior components during a real-world lateral rollover crash pulse.

4.1 **Lateral Rollover Simulator Test Fixture—**For the lateral rollover simulator test, a fixture with a single-degree-of-freedom rotational axis is required. The pivot point, through which this rotation occurs, shall represent the appropriate outboard tire/ground contact point for the roll direction being examined. All seat, restraint, and interior component hardware should be installed on the test fixture in the proper locations relative to the pivot point for a given heavy truck cab design. For this test configuration, an angular deceleration pulse is applied to the test fixture after the fixture has rotated through an angular displacement of 90 degrees. A schematic of this test fixture is presented in Figure 1. Wherever possible, the pre-deceleration roll history of the fixture should represent real-world data.

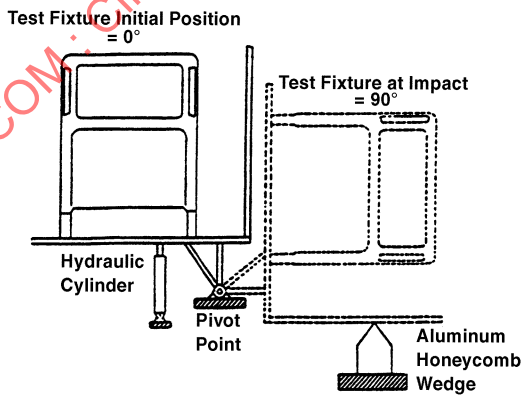

FIGURE 1—LATERAL ROLLOVER SIMULATOR TEST SCHEMATIC

4.2 Generic Rollover Simulator Deceleration Pulse—Wherever possible, vehicle-specific deceleration pulses should be used. If a vehicle-specific pulse is not known, then a generic angular deceleration corresponding to the following analytical expression should be used.

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

where:

α_p = 6875 degrees/s^2
T = 0.05 s

Typical angular acceleration-time and angular velocity-time curves are presented in Figures 2 and 3, respectively.

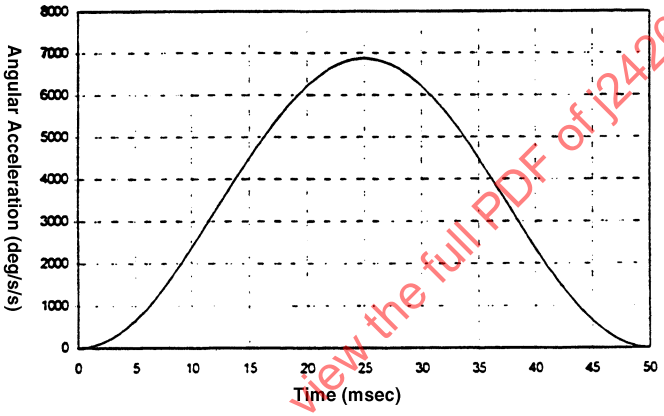

FIGURE 2—GENERIC DECELERATION PULSE FOR LATERAL ROLLOVER SIMULATOR TEST

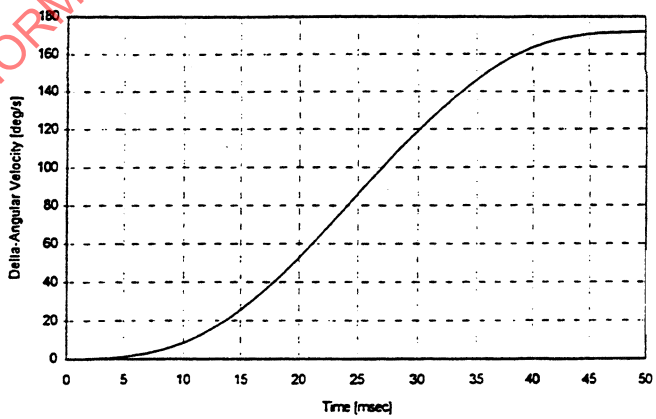

FIGURE 3—GENERIC ANGULAR VELOCITY—TIME HISTORY FOR LATERAL SIMULATOR TEST

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 test fixture. Care should be taken in locating these accelerometers to assist in interpreting the deceleration pulse in terms of an *angular* declaration, and to minimize the effects of localized vibrations. 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 SAE J211-2.

6. Photographic Instrumentation—For the dynamic tests 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, offboard 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, 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.

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