SAE International

# SURFACE VEHICLE RECOMMENDED PRACTICE

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## A Tilt Table Procedure for Measuring the Static Rollover Threshold for Heavy Trucks

### RATIONALE

The Vehicle Characterization Committee which owned the report has become inactivated and the technical expertise for the subject report within the Truck-Bus Council is not available at this time.

### STABILIZED NOTICE

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***Foreword***—This SAE Recommended Practice is intended as a guide toward a standard practice and is subject to change to keep pace with experience and technical advances.

The term "tilt table" refers to a device that rolls (rotates) the surface ("table") supporting a vehicle about a longitudinal axis. These devices may have one table that is larger than the vehicle's wheelbase (2.1.1) or a number of smaller tables, each large enough to support the wheels on an axle (2.1.2). In the case of multiple tables, the pivot axes should be aligned to fall on a common line. The important quality of the device is to maintain equal angles of tilt (within 0.1 degree if possible) under the wheels of all axles.

The test is conceptually very simple. The vehicle is driven onto the table (or tables) and then one side of the table is gradually elevated thereby placing the vehicle at a sequence of roll angles due to the tilting of the table.

When the table is at a tilt angle, the test simulates a nonvibratory steady turn. The "simulated" weight of the vehicle is the load perpendicular to the table surface, that is, the actual weight of the vehicle times the cosine of the angle of tilt. The "simulated" lateral acceleration force is the component of load horizontal to the table surface, that is, the actual weight of the vehicle times the sine of the tilt angle. The simulated lateral acceleration is the simulated lateral force divided by the simulated weight, that is, the tangent of the tilt angle. Thus, the static rollover threshold of the vehicle, in g's (1 g = the acceleration of gravity) of lateral acceleration, can be measured by determining the tangent of the tilt angle at which the vehicle just becomes unstable in roll.

***1. Scope***—The test procedure applies to roll coupled units such as straight trucks, tractor semitrailers, full trailers, B-trains, etc. The test is aimed at evaluating the level of lateral acceleration required to rollover a vehicle or a roll-coupled unit of a vehicle in a steady turning situation. Transient, vibratory, or dynamic rollover situations are not simulated by this test. Furthermore, the accuracy of the test decreases as the tilt angle increases, although this is a small effect at the levels of tilt angle used in testing heavy trucks. The test accuracy is accepted for vehicles that will rollover at lateral acceleration levels below 0.5 g corresponding to a tilt table angle of less than approximately 27 degrees. Even so, the results for heavy trucks with rollover thresholds greater than 0.5 g could be used for comparing their relative static roll stability.

**1.1 Purpose**—The purpose of this SAE Recommended Practice is to provide an interim test procedure for using tilt tables to measure a static rollover threshold for heavy trucks.

## *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 L. Laird, "Measurement of Heavy Vehicle Suspension Roll-Stability Properties, and a Method to Evaluate Overall Stability Performance," SAE Paper No. 881869.

2.1.2 C. Winkler, "Experimental Determination of the Rollover Threshold of Four Tractor-Semitrailer Combination Vehicles," University of Michigan Transportation Research Institute report No. UMTRI-87-31.

2.1.3 G. Box, W. Hunter, and J. Hunter, "Statistics for Experimenters," Part I: Comparing Two Treatments, Wiley Interscience.

2.1.4 C. Winkler and M. Hagan, "A Test Facility for the Measurement of Heavy Vehicle Suspension Parameters," SAE Paper No. 800906.

***3. Vehicle Identification, Test Setup, and Instruments—***When preparing the test vehicle for testing, several vehicle factors (that play an important role in determining rollover threshold) need to be considered. These factors are:

a. Payload—its weight, center of gravity location, and how it is attached to the vehicle.
b. Tires—size, model, construction type, and pressure setting and wear state (Nomenclature and DOT identification number).
c. Suspension—model, size, type, and characteristics such as air spring height. (Height regulation valves should be deactivated [held at static values] during the actual tilt to avoid inflation/deflation of the air bag during the tilt. Cross coupling air lines from side to side may need to be deactivated. The investigation of active suspensions is beyond the scope of this procedure.)

In addition, the experimenter should note that the trailer(s) and the tractor comprise the "test vehicle." For articulated vehicles, all units that are roll coupled should be tested together. Each vehicle unit that is free to roll independently is tested separately. For example, since a fifth wheel provides roll coupling, a tractor and semitrailer combination comprise a single roll unit to be tested. Full trailers, of the type which are connected to their towing unit without roll coupling (such as through a pintle hitch), comprise a single roll unit to be tested.

(Individual testing of tractors and semitrailers is conceptually possible, but beyond the scope of this procedure. The roll stability properties of roll coupled units such as tractors and semitrailers generally have a highly nonlinear, synergistic relationship with one another. For example, it is very possible for two trailers, which show very similar results when coupled to one particular tractor, to show very dissimilar results when coupled to different tractors.)

All of the factors discussed previously can affect the rollover threshold. Care should be exercised in choosing realistic and repeatable test conditions. The test vehicle, including payload, tire, and suspension characteristics as listed previously, shall be identified and an adequate description shall be included with the results. This documentation is needed so that users of the results will understand the test conditions and not be misled since there are many possible choices of loading states, suspensions, and tires for heavy trucks.

(Also, the influences of stick-slip in the vehicle's compliant and coupling components should be taken into account. It can generally be expected that typical levels of hysteresis in suspensions and other elements of the vehicle will have minimal influence on measured roll stability [that is, the rollover threshold]. However, hysteresis may significantly influence other "events," such as initial wheel lift, which occurs prior to rollover at relatively low levels of tilt angle. Since hysteresis is difficult or practically impossible to control directly, the vehicle may be removed from the table in between tests and driven around to "randomize" or "equalize" the influences of hysteresis and stick-slip. Any procedures used to control stick-slip and hysteresis should be