SURFACE VEHICLE RECOMMENDED PRACTICE

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Anti-Lock Brake System (ABS) Road Test Evaluation Procedure for Trucks, Truck-Tractors, and Buses

RATIONALE

This document has been revised to update Section 2 and Table 1 regarding references to ASTM.

1. SCOPE

Test procedure for anti-lock brake system (ABS/anti-lock) performance for trucks, truck-tractors, and buses over 4536 kg (10000 pounds).

1.1 Purpose

This test procedure is intended to evaluate vehicle stability, stopping capability, system function, and energy consumption on various road surface conditions, including variable and uniform friction surfaces with full-treadle/pedal brake application, to obtain maximum performance with activation of ABS/anti-lock.

This procedure does not cover radio frequency interference or power consumption testing.

Refer to SAE J46 for passenger car and light truck test procedure.

2. REFERENCES

2.1 Applicable Documents

The following publications form a part of this specification to the extent specified herein. Unless otherwise indicated, 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 +1 724-776-4970 (outside USA), www.sae.org.

SAE J46 Wheel-Slip Brake-Control System Road Test Code

SAE J299 Stopping Distance Test Procedure

SAE J693 Truck Overall Widths Across Dual Tires

SAE J1626 Braking, Stability, and Control Performance Test Procedures for Air- and Hydraulic Brake-Equipped Trucks, Truck-Tractors, and Buses

TO PLACE A DOCUMENT ORDER: **Tel: 877-606-7323 (inside USA and Canada)**
Tel: +1 724-776-4970 (outside USA)
Fax: 724-776-0790
Email: CustomerService@sae.org
SAE WEB ADDRESS: **http://www.sae.org**

For more information on this standard, visit
https://www.sae.org/standards/content/J2536_202304/

2.1.2 ASTM Publications

Available from ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959, Tel: 610-832-9585, www.astm.org.

ASTM E1337 Standard Test Method for Determining Longitudinal Peak Braking Coefficient of Paved Surfaces Using a Standard Reference Test Tire

ASTM F2493 Specification for Radial Stanard Reference Test Tire

3. INSTRUMENTATION/EQUIPMENT TO DISPLAY AND/OR RECORD

a. Vehicle speed and stopping distance—Fifth wheel or other device to measure and display (or record) vehicle speed (±0.8 km/h or 0.5 mph) and stopping distance (±5.0%).

b. Deceleration (±0.15 mpsps or 0.5 fpsps).

c. Wheel speeds for each wheel controlled or indirectly controlled by ABS (±5 rpm). (Optional for wheels not controlled by ABS.)

d. Yaw at end of stop (±5 degrees).

e. Lateral deviation at end of stop (±0.15 m or 0.5 foot).

f. System pressure(s) (±5.0%).

g. A device to indicate first brake control (treadle or brake pedal) movement, ±1% of indicated value; full brake control displacement or brake control pressure, ±1% of indicated value versus time, capable of 0.1 second resolution; or brake pedal force, ±1% of indicated value versus time, capable of 0.1 second resolution.

h. Maximum steering wheel rotation angle over duration of stop (±15 degrees). Driver's estimate may be adequate if not specifically measured.

i. Brake lining temperature per SAE J1626.

j. Measure trip distance (±1%).

k. Determine tire pressure (±1%).

l. Protect from roll-over where possible.

m. Restrain tractor/trailer articulation when applicable.

n. Other devices as necessary to operate the vehicle safely during testing.

4. FACILITIES

4.1 The road surfaces for testing shall be 3.66 m (12 feet) wide with sufficient space on all sides for approach, spin out, and/or recovery. See Figures 1 and 2 for general reference. Constant friction testing can utilize portion(s) of surfaces from Figures 1 and 2. Graded loose gravel configuration may be determined by the testing organization.

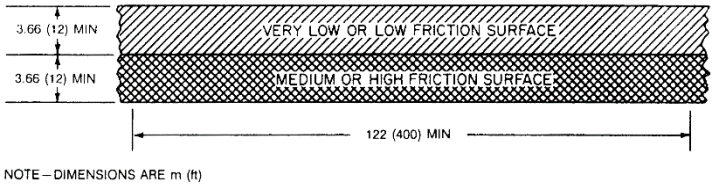

Figure 1 - Split-friction surface test facility

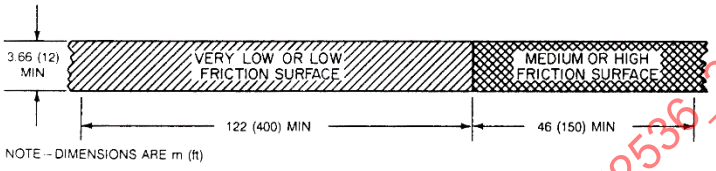

Figure 2 - Changing-friction surface test facility

4.2 The surfaces shall have the friction levels/peak friction coefficients (PFCs) as outlined in Table 1. The surface finish shall be consistent for the full length of the test surface. The lengths noted are for guidance only.

4.3 Test surface shall be flat with no more than 1% grade in all directions, including crown.

4.4 Ambient air temperature must be between -40 to 37.8 °C (-40 to 100 °F).

NOTE: Temperatures below freezing are to accommodate the “very low” PFC friction condition by using ice as a test surface.

4.5 Pylons or other equivalent markers shall be used to define lanes for maneuvers to assure repeatable tests and to provide reference of vehicle position before, during, and after test stop(s). Land boundaries are defined by 12 to 18 inch high vertical markers (such as cones) on a 20 foot spacing with the inside base edge of the markers placed on the 12 foot wide lane boundaries.

4.6 Speeds for the various test stops/maneuvers and guidelines for the lengths, surface friction levels/PFCs of the test surface are defined in Table 1.

Table 1 - Friction levels PFC

Surface[1] Friction	Description - PFC	Length Meters (Feet)	Max Speed km/h (mph)
Very low	0.05-0.25	122 (400)	32 (20)
Low	0.30-0.50	122 (400)	48 (30)
Medium	0.55-0.75	91 (300)	64 (40)
High	0.85-1.00	122 (400)	97 (60)
Special graded loose gravel		76 (250)	48 (30)

(1) Per methods ASTM E1337 and F2493.

5. VEHICLE PREPARATION

5.1 Inspect the brake lining and mating surface. Replace if abnormal conditions exist or if worn beyond manufacturer's recommended limits. Brake lining wear and mating surface condition should be considered when conducting comparison testing.

5.2 Check for brake adjustment. Automatic adjusters must be activated for the duration of the testing. Severity of the test sequence may require frequent checks to avoid over or misadjustment of brakes.

5.3 Install and calibrate equipment. Refer to SAE J1626 for typical thermocouple installation.

5.4 Inspect tires and replace if worn beyond manufacturer's recommended limits or abnormal tire condition. Similar tires and tire condition should be used for comparison testing. Adjust tire pressure per vehicle manufacturer's load recommendations.

5.5 Inspect axles and suspension components such as brackets, U-bolts, etc., to assure they are functionally satisfactory for the testing to be performed.

5.6 Determine compressor/pump or other pressure source cutout pressure and adjust to manufacturer's specification, if required.

5.7 Install rollover protection as required.

5.8 Install articulation restraints on articulated vehicles as required.

6. GENERAL NOTES

6.1 Record information of the vehicle on Figures 3A to 3C.

6.2 During all phases of this procedure, note and record any unusual braking or handling characteristics of the vehicle, e.g., sustained lockup of a controlled wheel, activation of a warning signal, application of a secondary or parking brake system, excessive lateral deviation, excessive yaw, cycling roughness, steering wheel pull, excessive steering correction required, etc.

6.3 Initial brake temperature (IBT) shall be 66 to 93 °C (150 to 200 °F) when not otherwise specified. This shall be the average temperature of brakes on the hottest axle at 0.32 km (0.2 mile) of initiating the stop. Warm the brakes to the required temperature if necessary by making 64 to 32 km/h (40 to 20 mph) snubs at 3 mpsps (10 fpsps).

6.4 Assure the brake system source pressure if charged to maximum within 0.32 km (0.2 mile) before initiating each test stop.

6.5 Note the system source pressure immediately at the end of each test stop.

6.6 Unless otherwise specified, the transmission shall be in neutral or clutch depressed for all stops and snubs.

6.7 Unless otherwise specified, the brake control is to be applied to a full brake application to obtain maximum performance with activation of ABS. Refer to SAE J1626 for full brake application.

6.8 The vehicle shall be aligned with the center of the roadway/lane at the beginning of each stop.

6.9 Vehicle yaw is defined as the vehicle's angular deviation between the point at which the brake control is actuated and the point at which the vehicle comes to rest. That is, one complete revolution in the clockwise direction would be a yaw of +360 degrees, while a quarter of a revolution in the counter-clockwise direction would be -90 degrees. For combination vehicles, the yaw angle of each unit is to be noted. It shall be noted if articulation restraints are utilized and if the limits of those restraints are reached.

6.10 Vehicle lateral deviation is defined as the greater of the distance between a reference point on the front and the rear of the vehicle at the longitudinal centerline and the centerline of the lane in which a stop has been completed. For combination vehicles, the lateral deviation of each unit is to the noted.

6.11 Vehicle deceleration is defined as the value at which the deceleration device reading/output is nearly constant for the majority of the stopping distance on any given surface condition, or it may be calculated as average deceleration if it is based upon vehicle speed and stopping distance only.

6.12 Vehicles equipped with an interlocking axle system or front wheel drive system capable of being manually engaged by the driver shall be tested with the system engaged up to speeds recommended by the manufacturer and disengaged.

6.13 Any auxiliary braking device (driveline retarders, etc.) capable of being manually engaged and disengaged shall be tested with the system engaged and disengaged. Validate that automatic disengagement will occur when the ABS is activated if the device is engaged.

6.14 If the vehicle is equipped with an on-road/off-road ABS switch, (1) it shall be tested with the switch in the appropriate position for the test that is to be conducted, and (2) also determine if automatic disengagement occurs if the switch is not in the appropriate position for the test being conducted. (See Table 2. The switch should appropriately be in the off-road position for graded loose gravel tests and in the on-road position for all other surfaces.)

6.15 The driver may steer as necessary to stay within the lane and maintain vehicle control.

6.16 Vehicle speed to be within the tolerance specified and stopping distance corrected per SAE J299.

6.17 Unless otherwise specified, vehicle testing to be conducted at lightly loaded vehicle weight (LLVW) and gross vehicle weight rating (GVWR).

6.18 Lightly loaded vehicle weight (LLVW) per SAE J1626. Other test conditions may be desirable for further evaluation (e.g., truck-tractors with empty semi-trailer).

6.19 Vehicles loaded to GVWR per SAE J1626. Liftable axles shall be down for GVWR tests. Truck-tractors are to be loaded to GVWR using a single axle unbraked control trailer.

6.20 Tests may be conducted such that all LLVW are conducted in one sequence and GVWR tests in another sequence.

7. BURNISH

7.1 Vehicles with new lining and drums/rotors shall be burnished per SAE J1626.

8. CONSTANT FRICTION SURFACE TEST

8.1 Record the following while making stops at GVWR for each speed and constant friction surface conditions listed in Table 2.

a. Vehicle stopping distance.

b. Final lateral deviation.

c. Yaw.

d. System source pressure at beginning and end of stop.

Table 2 - Test stops, constant friction

Surface Description	Number of Stops	Speed km/h (mph)
Very low	4	32 (20)
Low	4	32 (20)
Low	4	48 (30)
Medium	4	32 (20)
Medium	4	64 (40)
High	4	32 (20)
High	4	64 (40)
High	4	97 (60)
Graded loose gravel	4	48 (30)

NOTE: During all stops, watch for wheel lock and deceleration rates that are appropriate for each surface.

8.2 Record test data on the Figure 4 data sheet.

8.3 Repeat 8.1 with the vehicle at LLVW as per 6.17. Sequence may be varied as per 6.20.

9. SPLIT SURFACE FRICTION TEST

9.1 Record the following while making stops at GVWR for each speed and split friction surface conditions listed in Table 3.

a. Vehicle stopping distance.

b. Final lateral deviation.

c. Yaw.

d. System source pressure at beginning and end of stop.

9.2 Initiate stops in line with and centered on the junction of two friction surfaces (Figure 1). One side of the vehicle is to be on the lower friction surface, with the other side on the higher friction surface side. Reverse direction after each stop, e.g., first stop with left side of vehicle on lower friction surface and the second stop with it on the right side of the vehicle.

9.3 Record test data on the Figure 4 data sheet.

9.4 Repeat 9.1 and 9.2 with the vehicle at LLVW as per 6.17. Sequence may be varied as per 6.20.

Table 3 - Test stops, split coefficient friction

Lower Friction Side	Number of Stops	Speed km/h (mph)
Left	4	32 (20)
Right	4	32 (20)
Left	4	64 (40)
Right	4	64 (40)

NOTE: During all stops, watch for wheel lockup, steering wheel pull, excessive steering correction required.

10. CHANGING FRICTION TEST

10.1 Record the following while making stops at GVWR for each of the speed and changing friction surface conditions listed in Table 4.

a. Vehicle deceleration.

b. Final lateral deviation.

c. Yaw.

d. System source pressure at beginning and end of stop.

10.2 All stops are to be made 56 km/h (40 mph) while traveling from one surface friction condition to another per Figure 2. The brakes are to be applied to achieve the friction transition at approximately 75% of the initial speed at the axle(s) being tested. Reverse direction after each stop; e.g., low to high then high to low.

Table 4 - Test stops, changing friction

Direction	Number of Stops	Speed km/h (mph)
Low to high	4	64 (40)
High to low	4	64 (40)

NOTE: (1) During high to low friction stops, watch for wheel lockup. (2) During low to high friction stops, watch for deceleration rates that are appropriate for each surface.

10.3 Record test data on the Figure 4 data sheet.

10.4 Repeat 10.1 and 10.2 with the vehicle at LLVW at GVWR. Sequence may be varied as per 6.20.

11. NOTES

11.1 Revision Indicator

A change bar (I) 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.

Test No.: _____ Test Date(s) - From: _____ To: _____
Test Organization: _____ Test Location: _____
Make: _____ Type: _____ Model: _____
VIN: _____ D.O.M.: _____ Wheelbase, in.: _____ GVWR, lbs.: _____
CG Ht. (in. above ground) – Unloaded Chassis: _____ @ LLVW: _____ @ GVWR: _____
CG Ht. (in. above 5th Wheel) Trailer Ballast: _____ CG Ht. (in. above top of frame)Truck Ballast: _____
Axle Configuration[1]: _____ Retarder(s) Type(s): _____

Foundation Brakes:

Axle	Type[2]	Make	Size (in)	Lining Make	Lining Edge Code
1					
2					
3					
4					
5					
6					
7					

Brake Drum /Rotor

Axle	Type[3]	Make	Weight (lbs.)	Dust Shields (Y/N)
1				
2				
3				
4				
5				
6				
7				

Air Actuation Details:

Axle	Air Chambers Make	Air Chambers Type[4]	Slack Adjusters Length or Wedge Angle	Slack Adjusters Make	Slack Adjusters Cam Rotation[5]
1					
2					
3					
4					
5					
6					
7					

ABS

Make: _____ Model: _____ Config: _____ Axles Sensed[6]: ____ , ____ , ____

Figure 3A - Vehicle information