

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

RATIONALE

J2536 has been reaffirmed to comply with the SAE 5-Year Review policy.

1. Scope—Test procedure for Anti-Lock brake system (ABS/Anti-Lock) performance for trucks, truck-tractors and buses over 4536 kg (10 000 lb).

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.

Reference SAE J46 Wheel-Slip Brake Control Road Test Code for passenger car and light truck test procedure.

2. References

2.1 Applicable Publications—The following publications form a part of this specification to the extent specified herein. Unless otherwise indicated, the latest version of SAE publications shall apply.

2.1.1 SAE PUBLICATIONS—Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

- 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

2.1.2 ASTM PUBLICATIONS—Available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.

- ASTM E 1136—Specification for a Radial Standard Reference Test Tire
- ASTM E 1337—Standard Test Method for Determining Longitudinal Peak Braking Coefficient of Paved Surfaces Using a Standard Reference Test Tire

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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 kph or 0.5 mph), and stopping distance $\pm 5.0\%$
- 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 ft)
- f. System pressure(s): ($\pm 5.0\%$)
- g. A device to indicate first brake control (treadle or brake pedal) movement, $\pm 1\%$ of indicated value, and full brake control displacement, or brake control pressure, $\pm 1\%$ of indicated value versus time, capable of 0.1 s resolution, or brake pedal force, $\pm 1\%$ of indicated value versus time, capable of 0.1 s resolution.
- h. Maximum steering wheel rotation angle over duration of stop ($\pm 15^\circ$). Driver's estimate may be adequate if not specifically measured.
- i. Brake lining temperature per SAE J1626
- j. Measure trip distance ($\pm 1\%$)
- k. Determine tire pressure ($\pm 1\%$)
- l. Protect from roll-over where applicable
- 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 ft) 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 testing organization.

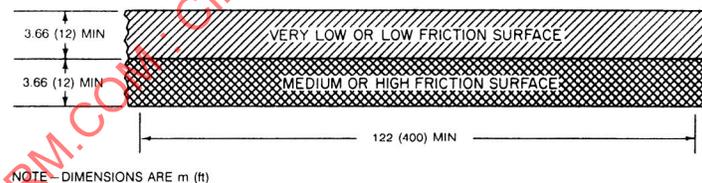


FIGURE 1—SPLIT-FRICTION SURFACE TEST FACILITY

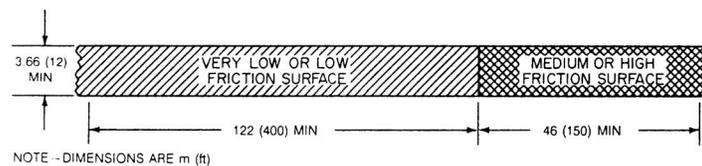


FIGURE 2—CHANGING-FRICTION SURFACE TEST FACILITY

- 4.2 The surfaces shall have the friction levels/peak friction coefficients (PFC) as outlined in Table 1. The surface finish shall be consistent for the full length of the test surface. The lengths noted are for guideline only.
- 4.3 Test surface shall be flat with no more than one (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). Lane boundaries are defined by 12 to 18 in high vertical markers (such as cones) on a 20 ft spacing with the inside base edge of the markers placed on the 12 ft wide lane boundaries.
- 4.6 Speeds for the various test stops/maneuvers and guidelines for the lengths, surface friction levels/PFC's of the test surface are defined in Table 1.

TABLE 1—FRICTION LEVELS PFC

Surface ⁽¹⁾ Friction Description - PFC	Length m (ft)	Max Speed km/h (m/h)
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 E 1337 and E 1136.

5. **Vehicle Preparation**

- 5.1 Inspect the brake lining and mating surface. Replace if abnormal conditions exist or if worn beyond manufacturers 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. See SAE J1626 for typical thermocouple installation.
- 5.4 Inspect tires and replace if worn beyond manufacturers 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 "Vehicle Information Sheet", 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 mi) of initiating the stop. Warm the brakes to the required temperature if necessary by making 64 to 32 kph (40 to 20 mph) snubs at 3 mpsps (10 fpsps).
- 6.4 Assure the brake system source pressure is charged to maximum within 0.32 km (0.2 mi) 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 be 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. (Refer to 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 for example.)

- 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. Lifiable 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***—Vehicles with new linings 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.
- vehicle stopping distance,
 - final lateral deviation
 - yaw
 - 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 1—During all stops, watch for wheel lock and deceleration rates that are appropriate for each surface.

- 8.2** Record test data on “Wheel Slip Control Performance Test Data Sheet”, Figure 4.
- 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.
- vehicle stopping distance,
 - final lateral deviation
 - yaw
 - system source pressure at beginning and end of stop

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.

- 9.2 Record test data on “Wheel Slip Control Performance Test Data Sheet”, Figure 4.
- 9.3 Repeat 9.1 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 1—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.
- vehicle deceleration
 - final lateral deviation
 - yaw
 - system source pressure at beginning and end of stop

All stops are to be made 64 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 Hi	4	64 (40)
Hi to Low	4	" "

NOTE 1—During high to low friction stops, watch for wheel lockup.

NOTE 2—During low to high friction stops, watch for deceleration rates that are appropriate for each surface.

10.2 Record test data on “Wheel Slip Control Performance Test Data Sheet”, Figure 4.

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

11. Notes

11.1 Marginal Indicia. The change bar (l) located in the left margin is for the convenience of the user in locating areas where revisions have been made to the previous issue of the report. An (R) symbol to the left of the document title indicates a complete revision of the report.

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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: _____ @ LLWV: _____ @ GVWR: _____
 CG Ht. (in. above 5th Wheel) Trailer Ballast: _____ CG Ht. (in. above top of frame)Truck Ballast: _____
 Axle Configuration¹: _____ 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		Slack Adjusters		Cam Rotation ⁵
	Make	Type ⁴	Length or Wedge Angle	Make	
1	_____	_____	_____	_____	_____
2	_____	_____	_____	_____	_____
3	_____	_____	_____	_____	_____
4	_____	_____	_____	_____	_____
5	_____	_____	_____	_____	_____
6	_____	_____	_____	_____	_____
7	_____	_____	_____	_____	_____

ABS

Make: _____ Model: _____ Config: _____ Axles Sensed⁶: _____ , _____ , _____

FIGURE 3A—VEHICLE INFORMATION