

**Anti-Lock Brake System (ABS) Road Test Evaluation Procedure for
On-Highway Commercial Vehicles**

1. **Scope**—Test procedure for Anti-Lock brake system (ABS/Anti-Lock) performance for on-highway commercial vehicles over 4536 kg (10 000 lb).

1.1 **Purpose**—This test procedure is intended to determine vehicle stability, maneuverability, stopping capability and system function on various road surface conditions including variable and uniform friction surfaces while brakes are modulated 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-Braked-Equipped Trucks

2.1.2 ASTM PUBLICATIONS—Available from

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

SAE Technical Standards Board Rules provide that: "This report is published by SAE to advance the state of technical and engineering sciences. The use of this report is entirely voluntary, and its applicability and suitability for any particular use, including any patent infringement arising therefrom, is the sole responsibility of the user."

SAE reviews each technical report at least every five years at which time it may be reaffirmed, revised, or cancelled. SAE invites your written comments and suggestions.

TO PLACE A DOCUMENT ORDER: +1 (724) 776-4970 FAX: +1 (724) 776-0790
SAE WEB ADDRESS <http://www.sae.org>

3. Instrumentation/Equipment to Display and/or Record:

- a. Vehicle speed (± 0.8 kph or 0.5 mph)
- b. Deceleration (± 0.15 mpsps or 0.5 fpsps)
- c. Wheel speeds for each wheel (± 5 rpm)
- d. Yaw (± 5 degrees)
- e. Lateral deviation (± 0.15 m or 0.5 ft)
- f. System pressure(s): ($\pm 5.0\%$) Reservoir, application pressure, brake chambers, etc.
- g. Point at which the brakes are applied ($\pm 1\%$)
- h. Stopping distance from point at which the brakes are applied ($\pm 5\%$)
- 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 3.7 m (12 ft) wide with sufficient space on all sides for approach, spin out and/or recovery. Reference Figures 1 and 2.

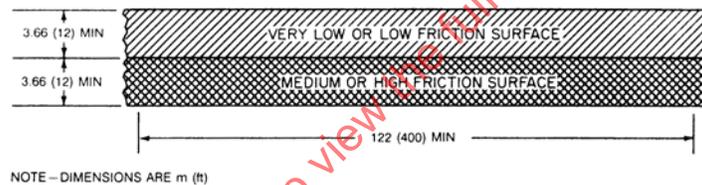


FIGURE 1—SPLIT-FRICTION SURFACE TEST FACILITY

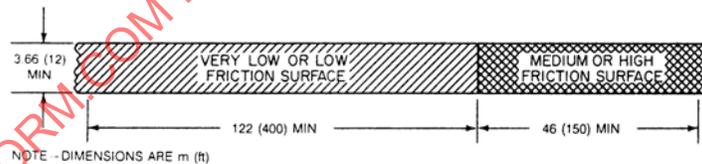


FIGURE 2—CHANGING-FRICTION SURFACE TEST FACILITY

- 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).

- 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, cycling roughness, steering wheel pull, etc.
- 6.3 Initial brake temperature (IBT) shall be 66–93 °C (150–200 °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 64–32 kph (40–20 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.

SAE J2536 Issued FEB2002

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 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

Hydraulic Actuation Details:

Axle	Disc Calipers		Wheel Cylinder	
	Make	Size	Make	Size
1	_____	_____	_____	_____
2	_____	_____	_____	_____

Power Unit: Hydraulic, Vacuum, etc. _____

Brake Power Assist Unit: Yes _____ No _____

Brake Power Unit w/Accumulator: Yes _____ No _____

Power Assist or Power Unit w/Backup: Yes _____ No _____

Variable Proportioning System: Yes _____ No _____

Parking Mechanism: Yes _____ No _____

Description: Friction-Type Parking Brake _____

Non-Service Brake Type Parking Brake _____

Master Cylinder Diameter: _____

Pedal Ratio: _____

Describe Hydraulic Circuit Split: _____

Air System:

Compressor Capacity (cfm): _____ Cut-out (psi): _____ Cut-in (psi): _____

Air Dryer – Make: _____ Model: _____ Type: _____

Regen. Valve Pressure Drop, psi: _____ Valve Location (circuit): _____

Valve Crack Pressures & Treadle Differential (psi) Axle 1: _____ Axle 2: _____ Axle 3: _____

Axle 4: _____ Axle 5: _____ Axle 6: _____ Axle 7: _____ Treadle: _____

Bobtail Proportioning (Y/N): _____ Front Axle Limiting (Y/N): _____

Spring Brake Inversion Valve Make: _____ Model: _____ Axles Controlled: _____

Specifics Regarding Air Brake System Components: _____

Air Tank Volumes, (cu. in.):

Supply: _____ Primary: _____ Secondary: _____

Auxiliary: _____ Isolated From Service? _____

Hydraulic System:

Reservoir Volume: _____

Steering Pump Output (psi) at Idle Engine Speed: _____

Flow (gpm) at Idle Engine Speed: _____

Pedal Valve: _____

Specifics Regarding Hydraulic Brake System Components: _____

FIGURE 3B—VEHICLE INFORMATION (CONTINUED)

Axles/Suspensions

Axle	Type ⁸	O.A. Width ⁹	Dist. To Steer Axle	Liftable (Y/N)	Type	Suspension Description	
						Make	Model
1							
2							
3							
4							
5							
6							
7							

Tires:

Axle	No. per Axle	PSI	Size	Make	Model	Data Book SLR (in)
1						
2						
3						
4						
5						
6						
7						

Fifth Wheel:

Fifth Wheel Height Relative to Ground Unladen (in): _____ Fifth Wheel Position(in)¹⁰: _____

Special Conditions:

Special conditions or equipment which might affect brake performance: _____

Weights (lbs.):

Axle No(s).	LLVW	Burnish	Fully Loaded	GAWR
Subtotal	N/A			
Trailer	N/A			
Total				

Footnotes for Vehicle Information Sheets (pages 22-24):

- ¹ 4x2, 6x4, 10x4, etc.
- ² Cam, disc, wedge, etc.
- ³ Cast or composite drum, vented or non-vented rotor, etc.
- ⁴ Size; If piston type follow size with "P"; If long stroke diaphragm type follow with "L"
- ⁵ Same or opposite to forward wheel rotation
- ⁶ Number of the axle where sensors are located
- ⁷ Total crack pressures between treadle valve and brake chambers
- ⁸ Steer, drive, pusher, tag
- ⁹ Measured as per SAE J693
- ¹⁰ Relative to rear drive axle(s) centerline ("+" = ahead, "-" = behind)

FIGURE 3C—VEHICLE INFORMATION (CONTINUED)

SAE J2536 Issued FEB2002

- 6.5 Note the system source pressure immediately at the end of each test stop.
- 6.6 Transmission shall be in neutral or clutch depressed for all stops and snubs.
- 6.7 Unless otherwise specified, the brake control may be applied and modulated at any desired rate 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 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.
- 6.14 If the vehicle is equipped with an "On-road/Off-road" ABS switch, it shall be tested with the switch in the appropriate position for the test that is to be conducted. (Refer to Table 2, The switch should 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.
- 6.19 Vehicles loaded to GVWR per SAE J1626. Lifiable axles shall be down for GVWR tests.
- 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 for each speed and constant friction surface conditions listed in Table 2.

- a. vehicle stopping distance,
- b. final lateral deviation
- c. yaw

**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)

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