

(R) Parking Brake Drawbar Pull Test Procedure—Commercial Vehicle

1. **Scope**—This SAE Recommended Practice provides a test method and instructions for measuring performance of parking brakes on air- or hydraulic-braked vehicles equipped with in-wheel or drive-line parking brakes. This procedure applies to truck, tractor, trailer, and bus.

1.1 **Purpose**—This document establishes a uniform procedure for determining retardation force capability of the parking brakes of new commercial vehicles.

2. **References**

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

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

SAE J360—Truck and Bus Grade Parking Performance Test Procedure

SAE J1452—Trailer Grade Parking Performance Test Procedure

SAE J2115—Brake Performance and Wear Test Code Commercial Vehicle Inertia Dynamometer

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

2.1.2 FEDERAL PUBLICATIONS—Available from The Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.

49 CFR 571.105—Brake Performance—Hydraulic Brake Systems

49 CFR 571.121—Brake Performance—Air Brake Systems

3. **Instrumentation and Equipment**

3.1 **Instrumentation Required**

3.1.1 TEMPERATURE MEASURING DEVICE—0 to 540 °C (0 to 1000 °F), to measure parking brake lining pad or shoe as per figure described in SAE J2115 and display monitor/recording brake lining temperature accurate to ± 5.6 °C (± 10 °F).

3.1.2 LOAD CELL—0 to 89 kN (0 to 20 000 lbf) capacity accurate to ± 445 N (100 lbf).

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- 3.1.3 PRESSURE GAUGE—0 to 900 kPa (0 to 130 lbf/in²) for air brake application pressure measurements.
- 3.1.4 DECELEROMETER—0 to 9.8 m/s² (0 to 32.2 ft/s²), to measure vehicle deceleration during burnish or establishing IBT.
- 3.1.5 FORCE MEASURING DEVICE—0 to 890 N (0 to 200 lbf), to measure hand or foot application force.
- 3.1.6 AXLE WEIGHT MEASURING DEVICE—±1.0% of indicated weight.
- 3.1.7 Device or method of measuring wheel rotation, ±5% of indicated value once the parking brake has been applied.

3.2 Equipment Required

- 3.2.1 A device capable of providing a steady-state pull to the vehicle with park brake applied, at the required rate of 1.2 m/min (4 ft/min) or less.

4. Vehicle Information and Data

- 4.1 Test Data Sheet 1 (Figures 1A and 1B) to be used as a work sheet during testing.
- 4.2 Vehicle information shall be documented as described in SAE J1626 Section 5, Figures 1A through 1C (see Data Sheet 1 of SAE J1626).
- 4.3 **Vehicle Conditions**—To insure the accuracy and validity of results, the following conditions should be met:
 - 4.3.1 On the brakes applied by the parking brake system, use new thermocouple lining and drums or discs of original equipment material and install in accordance with the vehicle manufacturer's specifications.
 - 4.3.2 Parking brake assemblies and actuation systems are to be installed, lubricated, adjusted, and inspected in accordance with the vehicle manufacturer's specifications.
 - 4.3.3 Tires must not be more than 20% worn, largest diameter specified for the vehicle at the test GVWR and inflated to the pressure specified by the vehicle manufacturer for the GVWR, measured cold (at the beginning of each test day).
 - 4.3.4 For driveline type parking brakes, the rear axle ratio should be at the specified manufacturer value to generate the highest torque in combination with 4.3.3 tire size during drawbar pull.
 - 4.3.5 The vehicle is to be tested in the fully loaded condition. For the purposes of this test procedure, fully loaded shall be the manufacturer's gross vehicle weight rating (GVWR) distributed proportionately to individual axle weight ratings (GAWR's) per SAE J1626 Section 3.

NOTE— FMVSS 121 allows the option of performing the grade holding test at LLVW and GVWR or the static retardation force parking brake test at GVWR.

- 4.3.5.1 *Truck, Tractor, and Bus*—Load to GVWR.
- 4.3.5.2 *Trailer*—Hook up trailer to tractor. Add ballast to trailer until weight of trailer and tractor equal trailer GAWR(s). Position ballast over trailer axle(s) to prevent wheel slide. If a wheel slides during test, load trailer axle to GAWR. Conduct burnish as described in Appendix A.

5. Test Conditions and Facilities

- 5.1 Ambient air temperature must be between 0 and 38 °C (32 and 100 °F).
- 5.2 Wind velocity should not exceed 24 km/h (15 mph).
- 5.3 Unless otherwise specified, the transmission shall be in neutral or the clutch depressed during burnish snubs.
- 5.4 All vehicle openings (doors, windows, hood, etc.) must be closed except as required for instrumentation purposes.
- 5.5 Roadway shall be flat with no more than a 1% grade in all directions, including crown for burnish snubs and initial brake temperature (IBT) conditioning.
- 5.6 Automatic adjusters must remain activated for the duration of the test.
- 5.7 Unless otherwise specified, parking brakes can be adjusted per the vehicle manufacturer's procedure at anytime.
- 5.8 Individual parking brake lining temperatures should be less than 95 °C (200 °F) when being adjusted or checked.
- 5.9 All park brake tests should be conducted on a dry, level, smooth Portland cement concrete surface or equivalent.
- 5.10 Initial Brake Temperature (IBT)**—For vehicles with a parking brake system that utilizes friction elements of the service brake system, the lining temperature just prior to any parking brake test must be between 65 and 95 °C (150 and 200 °F). Temperature condition the lining material by conducting brake snubs from 64 to 32km/h (40 to 20 mph) speed at 3 m/s² (10 ft/s²) deceleration at 1.6 km (1 mile) intervals (If speed or deceleration is not attainable, run at maximum speed or deceleration).
- For vehicles with a parking brake system that does not utilize the service brakes including hydraulic brake school bus, the lining material temperature just prior to any parking brake test shall not be more than 65 °C (150°F) (when the temperature of components on both ends of an axle are averaged or the temperature of the driveline type parking brake material). Temperature condition the lining material per the vehicle manufacturers recommendation but not to exceed the 65 °C (150 °F) requirement per FMVSS 105.
- 5.11 With variable input systems, conduct the test to establish the applied manual effort or pressure required to lock the braked wheels. With pressure-applied/mechanically locked actuators, make observations after releasing the application pressure.
- 5.12 With fixed input systems, determine the manual effort required to actuate the system control and observe whether the braked wheels lock or roll.
- 5.13 For vehicles having any equipment (such as driver-controlled interaxle differentials or multi-speed axles), which can be placed in or out engagement by the driver so as to vary either the number of axles braked or the amount of torque imposed on the parking brake or brakes, conduct the test to determine parking performance under the condition that requires highest parking brake torque and under the condition that requires highest tire-to-road tractive force.
- 5.14 Parking brake systems employing service brakes or those employing non-service brakes for which the manufacturer provides the purchaser with a published burnish procedure need not be tested before burnishing because of the difficulty in obtaining reliable and repeatable pre-burnish data.

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5.15 Vehicles equipped with parking brake systems employing cable or rod actuation of service brakes shall be allowed to roll between each pull and data reading. This will improve repeatability of results by allowing realignment between axle and actuation parts and by removing system hysteresis.

5.16 Air braked trucks with more than two axles shall disable parking brake chambers on those axles other than the test axle per FMVSS 121.

5.17 Method of Conducting Parking Brake Retardation Force Test

NOTE— For air brake vehicles, the following procedures apply only to vehicles equipped with conventional spring-applied, air-release parking brake systems from which air is exhausted after actuation of the parking brake control.

5.17.1 TEST PREPARATION

5.17.1.1 Install instrumentation and equipment based on the type of parking brake system as described in Section 3.

5.17.1.2 Install new thermocouple lining and drums/discs. Lining grind and surface finish of drums/discs, including all other brake components must be within vehicle manufacturer's specifications.

5.17.1.3 Adjust brakes to vehicle manufacturer's specifications. Where applicable, measure and record pushrod travel with only service brakes applied at 620 kPa (90 psi) at chamber.

5.17.1.4 Adjust vehicle weight to appropriate load condition as per test sequence, if required.

5.17.1.5 For vehicles with a parking brake system that does not utilize the service brakes, burnish brakes as described in 6.1.1.

5.17.1.6 For vehicles with a parking brake system that utilize friction elements of the service brake system, burnish the brakes as described in 6.2.1.

5.17.1.7 Install/prepare drawbar pull device, load cell, and wheel or driveline parking brake rotation measuring device or method.

5.17.1.8 For hydraulic brake school buses, install force transducer for foot and/or hand control applied efforts.

5.17.1.9 For vehicles having any equipment (axle differential locks or multi-speed axles) which is driver-controlled, the test must be conducted in the conditions which requires the highest parking brake torque.

5.17.2 TEST PROCEDURE

5.17.2.1 Temperature condition the parking brake lining material based on vehicle type per 5.10.

5.17.2.2 Position vehicle on a dry level Portland cement concrete or equivalent surface in line with pull cable or equivalent device. Connect pull cable and force measuring device so that cable is level within ± 5 degrees.

5.17.2.3 Mark circumference of tire(s) on braked wheel(s) at point of tire/ground contact or driveline parking brake at one point on the drum or disc contact and at 90, 180, and 270 degrees from that point.

5.17.2.4 For air brake vehicles, disable spring brake chambers on axle(s) other than the axle being tested.

5.17.2.5 Charge air brake system reservoirs to compressor governor cut-out pressure.

5.17.2.6 Place driver selected equipment in desired condition.

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5.17.2.7 With vehicle at rest and transmission in neutral, actuate brakes as follows:

5.17.2.7.1 Air-Braked Vehicle—Apply and hold service brakes by using maximum treadle (pedal) travel with system at compressor cut-out pressure. Apply parking brake(s). Release service brakes after parking brake control is at the fully-applied position.

5.17.2.7.2 Hydraulic-Braked Vehicle—Apply and hold service brakes with 667 N (150 lbf) force. Apply parking brake(s). Release service brakes after parking brake control is at the fully-applied position. Hydraulic brake school buses with a GVWR >4540 kg (10 000 lb) apply a maximum of 667 N (150 lb) to the foot control or 556 N (125 lb) to the hand control parking brake. If the vehicle does not remain stationary, reapplication of the service brakes to hold the vehicle stationary, with reapplication of the force to the parking brake control at the level specified as appropriate for the vehicle being tested may be used twice to attain a stationary position per FMVSS 105.

5.17.2.8 Turn off engine.

5.17.2.9 For variable input systems, record the minimum applied effort or pressure to lock the braked wheels. For fixed input systems, record the applied effort or pressure and observe if the braked wheels are rolling or locked. Observe vehicle performance whether brake locks and wheel slides, etc. If the system is a cable or rod actuated service brake, allow vehicle to roll between each reading as noted in 5.15.

5.17.2.10 Pull vehicle forward at a maximum rate of 1.2 m/min (4 ft/min) until the wheel or driveline parking brake rotates 90 degrees. Record force in the data sheet of Figures 1A and 1B.

5.17.2.11 Release brakes and re-apply as in 5.17.2.7.1 or 5.17.2.7.2. Repeat 5.17.2.10 until wheels have rotated 360 degrees.

5.17.2.12 Record peak drawbar force in 90 degrees of wheel rotation until wheels have rotated 360 degrees.

5.17.2.13 Repeat all steps in 5.17.2 for each test condition of driver selected equipment. Temperature condition brakes, if necessary, to achieve specified IBT.

5.17.2.14 Repeat all steps in 5.17.2 except pull in reverse direction. Temperature condition brakes, if necessary, to achieve specified IBT.

5.17.2.15 Repeat all steps in 5.17.2 for all remaining air braked truck axles to be tested. Temperature condition brakes, if necessary, to achieve specified IBT.

5.17.2.16 Repeat all steps in 5.17.2 to obtain a minimum of four readings at each combination.

5.17.3 TEST DATA RECORDING—Data sheet as presented in Figures 1A and 1B (Data Sheet 1) should be utilized but not limited for recording the following data:

- a. Test date
- b. Ambient temperature
- c. Parking brake material description
- d. Parking brake lining material IBT
- e. Condition of test surface pad
- f. Indication of whether or not brakes were burnished
- g. Direction of drawbar pull
- h. Condition of driver selected equipment
- i. Hydraulic brake school buses, record foot and/or hand control parking brake applied force
- j. Service brake application pressure or pedal force
- k. Record peak drawbar pull force for each 90 degrees of wheel or driveline parking brake rotation.

I. Loaded vehicle weight and identification of items/equipment making up the weight.

NOTE— Record GVWR for tractors with more than 2 axles or GAWR for axle being tested on 4X2 tractors and all trucks.

6. Test Sequence

6.1 For vehicles with a parking brake system that does not utilize the service brakes:

6.1.1 Burnish parking brake in accordance with manufacturer's instructions to purchaser including recommended vehicle weight. If no instructions are provided, no burnish is to be performed.

6.1.2 Adjust the parking brake and its actuation system in accordance with the vehicle manufacturer's specifications.

6.1.3 Conduct loaded vehicle test in accordance with 5.17, while limiting parking brake actuation forces to 556 N (125 lbf) for hand-operated or 667 N (150 lbf) for foot-operated system.

6.2 For vehicles with a parking brake system that utilizes friction elements of the service brake system:

6.2.1 Burnish the loaded vehicle as described in SAE J1626 section 11.

6.2.2 When burnishing trailer brakes, disable tractor brakes.

6.2.3 Adjust the parking brake and its actuation system in accordance with the vehicle manufacturer's specifications.

6.2.4 Conduct loaded vehicle test in accordance with 5.17.

7. Reporting of Performance

7.1 Vehicle parking performance shall be expressed as the amount and type of effort or pressure applied to the parking brake system required to lock the braked wheels and generate peak drawbar force, for a vehicle weight, selected axle and the condition of driver-selected equipment. The applied effort or pressure shall be the higher value with respect to the forward and reverse directional pulls. If pertinent to the parking performance, the items making up vehicle weight and their location should be reported.

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Vehicle: _____ GVWR _____
 Date: _____ Driver: _____ Observer: _____

TEST SPECIFICATIONS:

- Check Parking Brake Adjustment (optional)
- Disable Spring Brake Chambers on Axles Not Being Tested
- Transmission in Neutral
- Full Apply of Service Brake Before Applying Parking Brake (release service brake before drawbar pull)
- For Air Brake Vehicles, Parking Brake Temperature Between 65 to 95°C (150 to 200°F)
- For Hydraulic Brake School Buses, Parking Brake Temperature Shall Not Be More Than 95°C (150°F).
- Hydraulic Brake School Buses With a GVWR > 4540 kg (10,000 lb.) Apply a Maximum Allowable 667 N (150 lb.) to the Foot Control or 556 N (125 lb.) to the Hand Control Parking Brake.

Parking Brake Material Description: _____

Items and Equipment Making up the Loaded Weight: _____

Parking Brakes Burnished: Yes or No _____

Condition of Test _____

Surface: _____

Service Brake Application Pressure or Pedal _____

Force: _____

AXLE# _____ DRAWBAR PULL – PEAK FORCE DURING WHEEL OR DRIVELINE PARKING BRAKE ROTATION:

Parking Brake Temperature Before Forward Pull: _____ Before Reverse Pull: _____

Pull Direction	Driver Selected Equip.	0-90° Rotation Pull Force kN (lb.)	Foot or Hand Ctrl Force N (lb.)	90-180° Rotation Pull Force kN (lb.)	Foot or Hand Ctrl Force N (lb.)	180-270° Rotation Pull Force kN (lb.)	Foot or Hand Ctrl Force N (lb.)	270-360° Rotation Pull Force kN (lb.)	Foot or Hand Ctrl Force N (lb.)
Forward #1									
Forward #2									
Forward #3									
Forward #4									
Reverse #1									
Reverse #2									
Reverse #3									
Reverse #4									

Parking Brake Temperature After Forward Pull: _____ After Reverse Pull: _____

GVWR or GAWR: _____

Comments: _____

FIGURE 1A—DATA SHEET 1—STATIC RETARDATION FORCE PARKING BRAKE

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Vehicle: _____ GVWR _____
 Date: _____ Driver: _____ Observer: _____

AXLE# _____ DRAWBAR PULL – PEAK FORCE DURING WHEEL OR DRIVELINE PARKING
 BRAKE ROTATION:

Parking Brake Temperature Before Forward Pull: _____ Before Reverse Pull: _____

Pull Direction	Driver Selected Equip.	0-90° Rotation Pull Force kN (lb.)	Foot or Hand Ctrl Force N (lb.)	90-180° Rotation Pull Force kN (lb.)	Foot or Hand Ctrl Force N (lb.)	180-270° Rotation Pull Force kN (lb.)	Foot or Hand Ctrl Force N (lb.)	270-360° Rotation Pull Force kN (lb.)	Foot or Hand Ctrl Force N (lb.)
Forward #1									
Forward #2									
Forward #3									
Forward #4									
Reverse #1									
Reverse #2									
Reverse #3									
Reverse #4									

Parking Brake Temperature After Forward Pull: _____ After Reverse Pull: _____

GVWR or GAWR: _____

Comments: _____

FIGURE 1B—DATA SHEET 1—STATIC RETARDATION FORCE PARKING BRAKE

8. Notes

8.1 Marginal Indicia—The change bar (I) located in the left margin is for the convenience of the user in locating areas where technical 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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