

Submitted for recognition as an American National Standard

**(R) Truck and Bus Grade Parking Performance Test Procedure**

**Foreword**—The ability to hold a vehicle stationary on a grade involves two performance factors: (a) overcoming the downhill grade force with the parking brake system by preventing rotation of the braked wheels, and (b) having sufficient weight on the braked wheels to prevent the vehicle from sliding on the roadway. By the use of this procedure, the manually applied input effort required to prevent braked wheel rotation can be measured and the stability of a vehicle parked on a grade can be observed.

1. **Scope**—This SAE Recommended Practice establishes methods to determine grade parking performance with respect to:

- a. Ability of the parking brake system to lock the braked wheels.
- b. The vehicle holding or sliding on the grade, fully loaded or unloaded.
- c. Applied manual effort.
- d. Unburnished or burnished brake lining friction conditions.
- e. Down and up grade directions.

1.1 **Purpose**—This document establishes a uniform procedure for determining the parking performance on a grade by the parking brake systems of new trucks and buses over 4540 kg (10 000 lb) gross vehicle weight rating (GVWR) intended for roadway use.

2. **References**

2.1 **Applicable Publications**—The following publication forms 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 J293—Vehicle Grade Parking Performance Requirements

SAEJ1626—Braking, Stability, and Control Performance Test Procedures for Air- and Hydraulic-Brake-Equipped Trucks, Truck-Tractors and Buses

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

2.1.2 FEDERAL PUBLICATION—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

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**3. Instrumentation and Equipment**

- 3.1 Force Measuring Device**—0 to 890 N (0 to 200 lbf), to measure hand or foot application force.
- 3.2 Decelerometer**—0 to 9.8 m/s<sup>2</sup> (0 to 32.2 ft/s<sup>2</sup>), to measure vehicle deceleration during burnish or establishing IBT.
- 3.3 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).
- 3.4 Stopwatch**—0 to 5 min, method to measure and document test time.
- 3.5 Pressure Gauge**—0 to 900 kPa (0 to 130 lbf/in<sup>2</sup>) for air brake application pressure measurements.
- 3.6 Inclinator**—0 to 30%, or other method to measure surface grade/slope.
- 3.7 Axle Weight Measuring Device**—±1.0% of indicated weight.
- 3.8** A device, ±50 mm (±2.0 in), or method to measure vehicle movement once the parking brake has been applied.

**4. Vehicle Information and Data**

- 4.1** Test Data Sheet 1 (Figure 1) 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 grade holding.
  - 4.3.5** The vehicle is to be tested in both the fully loaded and unloaded 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. Truck, tractor and buses shall be loaded to GVWR. The unloaded vehicle shall be as defined in 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.

The sequence of testing may be arranged to suit the desired order of vehicle loading and unloading.

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Vehicle: \_\_\_\_\_ GVWR \_\_\_\_\_ LLVW \_\_\_\_\_  
 Date: \_\_\_\_\_ Driver: \_\_\_\_\_ Observer: \_\_\_\_\_

**TEST SPECIFICATIONS:**

- Check Parking Brake Adjustment (optional)
- 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)
- 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)
- Hold on Grade With Full Application of Service Brake
- Place Transmission in Neutral
- Turn Engine Off and Apply Parking Brake
- Release Service Brakes
- Hydraulic brake type 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  
 Percent/Slope of Grade: \_\_\_\_\_

Condition of Grade: \_\_\_\_\_

	Vehicle Direction on Grade	Driver Selected Equip.	Parking Brake IBT °C (°F)	Service Brake Application Pressure or Pedal Force kPa (PSI) or N (lb.)	Foot or Hand Ctrl Force N (lb.)	Movement to Become Stationary on Grade mm (inches)	Stationary on Grade for 5 min. Yes or No
Test 1	Up Grade						
	Down Grade						
Test 2	Up Grade						
	Down Grade						
Test 3	Up Grade						
	Down Grade						

Date	AMB °C (°F)	Wind Speed, KPH (MPH)	Wind Direction	Odometer, miles

Comments: \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

FIGURE 1—DATA SHEET 1—GRADE HOLDING PARKING BRAKE

**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** Conduct the test on a 20% (+1%/-0%) dry, smooth Portland cement concrete surface (or other surface of equivalent coefficient of surface friction) that is free from loose materials and has a grade equal to or greater than any specified grade requirement for the test vehicle, as designated in SAE J293.
- 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 32 km/h (40 to 20 mph) speed at 3 m/s<sup>2</sup> (10 ft/s<sup>2</sup>) 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 manufactures 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 of 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.

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

**5.16 Method of Conducting Grade Holding Test**

**5.16.1 TEST PREPARATION**

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

**5.16.1.2** 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.

**5.16.1.3** 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.

**5.16.1.4** Adjust vehicle weight to appropriate load condition as per test sequence.

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

**5.16.1.6** 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.

**5.16.1.7** Install/prepare device to measure vehicle movement on the grade.

**5.16.1.8** *Test Facility*—A 20% (+1%/-0%) grade of dry smooth Portland cement concrete or equivalent as described in 5.9.

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

NOTE—It is recognized that the weight of the truck-tractor/test trailer combination (GCW) is greater than the tractor GVWR. If the combination will not park on the test grade at the GCW, reduce the weight to equal truck-tractor GVWR and retest.

**5.16.1.10** 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.

**5.16.2 TEST PROCEDURE**

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

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

**5.16.2.3** Place driver selected equipment in desired condition.

**5.16.2.4** Ascend 20% grade (dry Portland cement concrete or equivalent surface), stop, and hold with the service brakes.

**5.16.2.5** With vehicle declutched or transmission in neutral, actuate brakes as follows:

**5.16.2.5.1** *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.

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- 5.16.2.5.2 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.
- 5.16.2.6 Turn off engine.
- 5.16.2.7 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 stability and record performance whether vehicle holds for at least 5 min or slides on the grade.
- 5.16.2.8 Apply service brakes and release the parking brake and repeat test to obtain a minimum of three consistent readings. If the system is a cable or rod actuated service brake, remove vehicle from grade after each reading as noted in 5.15.
- 5.16.2.9 Repeat all steps in 5.16.2 except reposition the vehicle in the descending direction. Temperature condition the parking brake lining material, if necessary, to achieve specified IBT per 5.10.
- 5.16.2.10 Repeat all steps in 5.16.2 for each test condition of driver selected equipment.
- 5.16.3 TEST DATA RECORDING—Data sheet as presented in Figure 1 (Data Sheet 1) should be utilized but not limited for recording the following data:
- Test date
  - Ambient temperature
  - Parking brake material description
  - Parking brake lining material IBT
  - Loaded vehicle weight and identification of items/equipment making up the weight
  - Unloaded weight, braked axle weight
  - Percent grade or grade angle and condition of grade
  - Indication of whether or not brakes were burnished
  - Direction of vehicle on the grade
  - Condition of driver selected equipment
  - Hydraulic brake school buses, record foot and/or hand control parking brake applied force
  - Service brake application pressure or pedal force
  - Movement of vehicle that takes place after release of service brakes until vehicle becomes stationary including wheel (s) roll or lock
  - Ability to hold vehicle stationary for 5 min including wheel(s) roll, lock or slide

## 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.