SURFACE VEHICLE RECOMMENDED PRACTICE

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Truck and Bus Grade Parking Performance Test Procedure

RATIONALE

SAE J360 has been reaffirmed to comply with the SAE Five-Year Review policy.

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 intended for roadway use.. By the use of this procedure, the manually applied input effort required to prevent braked wheel rotation can be measured and the sliding or stability of a vehicle parked on a grade can be observed. This procedure applies to truck-tractors, trailers, trucks and buses.

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.

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1.1 Purpose

This document establishes a uniform procedure for determining the parking performance on a grade by the parking brake systems of new vehicles over 4536 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 International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or 724-776-4970 (outside USA), www.sae.org.

SAE J293 Truck and Bus Grade Parking Performance Requirements

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

SAE J1729 Parking Brake Drawbar Pull Test Procedure—Truck and Bus

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

2.1.2 Federal Publications

Available from the Superintendent of Documents, U.S. Government Printing Office, Mail Stop: SSOP, Washington, DC 20402-9320.

49 CFR 571.105 Brake Performance—Hydraulic Brake Systems

49 CFR 571.121 Brake Performance—Air Brake Systems

3. INSTRUMENTATION AND EQUIPMENT

3.1 Force Measuring Device

0 to 890 N (0 to 200 lbf), to measure park brake hand or foot application force and hydraulic brake vehicle service brake application measurements.

3.2 Decelerometer

0 to 9.8 m/s^2 (0 to 32.2 ft/s^2), to measure vehicle deceleration during burnish or establishing initial brake temperature (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^2) for air brake application pressure measurements.

3.6 Inclinometer

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 Data Sheets – Vehicle Information.

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 Definitions. The vehicle shall be loaded to GVWR. The unloaded vehicle shall be as defined in SAE J1626 Definitions.

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 as per SAE J1729.

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

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 the highest gear appropriate for a speed of 40 mph during burnish snubs per SAE J1626.

Vehicle:		GVWR		LLVW	
Vehicle Type:		Front Axle:		Front Axle:	
Vehicle Make:		Rear Axle 1:		Rear Axle 1:	
Vehicle Model:		Rear Axle 2:		Rear Axle 2:	
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 hydraulic vehicles with a parking brake system that does not utilize the service brakes, 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 vehicles with a GVWR > 4536 kg (10 000 lb) can apply up to a maximum allowable 667 N (150 lb) to the park brake 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)	Park Brake 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 Start/Ending

Comments:_____

FIGURE 1 - DATA SHEET 1 - GRADE HOLDING PARKING BRAKE

5.4 All vehicle openings (doors, windows, hood, etc.) must be closed except as required for instrumentation purposes.

5.5 The road surface used for vehicle parking brake conditioning shall be dry with a peak friction coefficient (PFC) less than 0.9 per SAE J1626, 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.

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%) Grade of dry, smooth Portland cement concrete surface (or other surface of equivalent coefficient of surface friction) that is free from loose materials or 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^2 (10 ft/s^2) deceleration at 1.6 km (1 mile) intervals (If speed or deceleration is not attainable, run at maximum speed or deceleration).

For hydraulic vehicles with a parking brake system that does not utilize the service brakes, 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 and observe whether the braked wheels lock or roll.

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. It is suggested that all conditions be tested.

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 +0,-5 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 vehicles, install force transducer for park brake 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 condition 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 cutout 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.

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 vehicles with a GVWR > 4536 kg (10 000 lb) can apply up to a maximum of 667 N (150 lb) to the park brake 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.