

BRAKE SYSTEM ROAD TEST CODE—PASSENGER CAR AND LIGHT-DUTY TRUCK

Foreword—This reaffirmed document has been changed only to reflect the new SAE Technical Standards Board format.

1. Scope—This SAE Recommended Practice establishes a uniform procedure for the level road test of the brake systems of new light-duty trucks and new multipurpose passenger vehicles¹ up to and including 2700 kg (6000 lb) GVW and all classes of new passenger cars.

1.1 Purpose—The purpose of the test code is to establish brake system capabilities with regard to:

- a. Deceleration versus input, as affected by vehicle speed, brake temperature, and usage
- b. Brake system integrity
- c. Stopping ability during emergency or inoperative power assist conditions
- d. Water recovery characteristics

2. References—There are no referenced publications specified herein.

3. Instrumentation

- 3.1** Line pressure or pedal force gage
- 3.2** Decelerometer
- 3.3** Direct reading temperature instrument
- 3.4** Speedometer (calibrated) or fifth wheel pousometer
- 3.5** Tire pressure gage
- 3.6** Odometer (calibrated)
- 3.7** Thermometer—ambient (or ambient sensitive thermocouple)
- 3.8** Stopmeter (fifth wheel, distance only)

1. Multipurpose passenger vehicle means a motor vehicle with power, except a trailer, designed to carry 10 persons or less, which is constructed either on a truck chassis or with special features for occasional off-road operations.

3.9 Optional Instrumentation

- a. Pedal travel gage
- b. Solenoid stop counter
- c. Stopwatch

4. Installation Details

4.1 Friction Material Preparation—Attach and finish friction material per vehicle manufacturer's specifications.

4.2 Thermocouples—Install plug-type thermocouple in each brake. See Figure 1.

4.3 Brake Drum (or Rotor) and Hub Assembly—New drums (or rotors) recommended. Surface finish, dimensional characteristics, with special emphasis on runout of rubbing surface, shall be in accordance with vehicle manufacturer's specifications.

4.4 Brake Assembly—Brakes shall be prepared in accordance with vehicle manufacturer's specification with special attention to required load characteristics on all brake springs. New linings are recommended on all brakes. Adjust brakes to manufacturer's specifications.

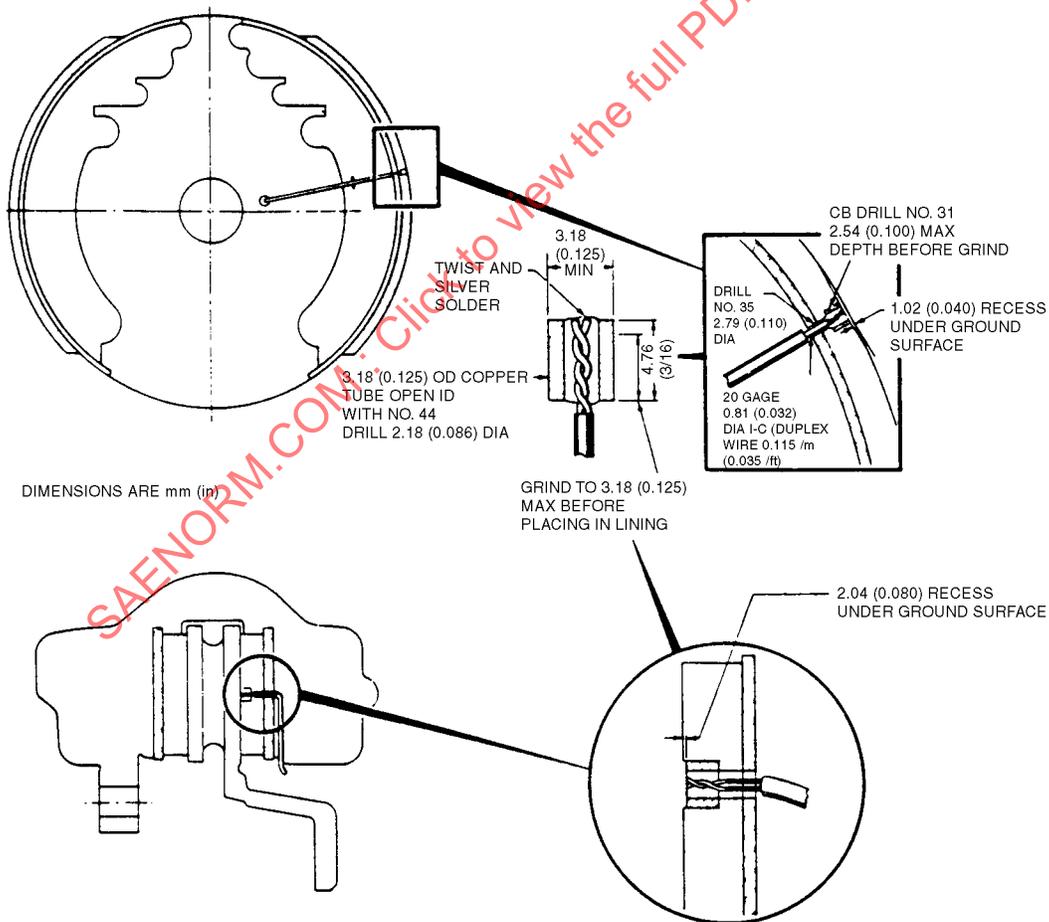


FIGURE 1—TYPICAL PLUG THERMOCOUPLE INSTALLATIONS

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4.5 Vehicle Test Weight—Vehicle manufacturer's recommended axle test loading² shall be maintained throughout full test procedure except during the minimum load test (5.8).

5. Test Procedure

5.1 Test Notes

- 5.1.1 Effectiveness, fade, and recovery test stops shall be conducted on a substantially level (not to exceed a $\pm 1\%$ grade), dry, smooth, hardsurfaced roadway of Portland cement concrete (or other surface with equivalent coefficient of surface friction) that is free from loose materials.
- 5.1.2 During all phases of this procedure, any unusual performance such as wrap-up or noise characteristics are to be noted and recorded. Note any uncontrollable braking action causing the vehicle to pull or swerve out of a 3.7 km (12 ft) wide roadway lane.
- 5.1.3 "Initial brake temperature" is defined as 0.3 km (0.2 mile) before stop (average temperature of brakes on hottest axle), brakes off.
- 5.1.4 If brakes require warming to prescribed temperature, use burnish procedure and shorten interval if necessary.
- 5.1.5 Because variations in ambient temperature have a significant effect on test results, fade and recovery tests must be conducted within a range of ambient temperature of 4.4 to 32.2 °C (40 to 90 °F).
- 5.1.6 Decelerations used in the various fade, recovery, or warmup procedures refer to values at which the decelerometer is held approximately constant during the stop by varying the input pressure.
- 5.1.7 Deceleration and line pressure (pedal force) readings shall not be taken below 8 km/h (5 mph).
- 5.1.8 On vehicles with manual transmissions, disengage clutch below 16 km/h (10 mph).

5.2 Preburnish Check—In order to allow for a general check of instrumentation, brakes, and vehicle function, the following stops are to be run: 10 stops, 48 to 0 km/h (30 to 0 mph), 3 m/s² (10 ft/s²), 1.6 km (1 mile) interval, 64 km/h (40 mph) cooling speed in normal driving gear.

Record—Maximum line pressure (pedal force).

NOTE— Assuming instrumentation, brakes, and vehicle are functioning satisfactorily, proceed immediately with First Effectiveness Test.

5.3 First (Preburnish) Effectiveness Test—Initial brake temperature, 93.3 °C (200 °F) before each application.

- 5.3.1 STOP SPEED—48 and 97 km/h (30 and 60 mph) (full stops in neutral).
- 5.3.2 INCREMENTS—Curve to be defined to point of incipient skid by adequate number of points.
- 5.3.3 RECORD—Deceleration and line pressure (pedal force) and method of brake application (that is, machine or manual). When using manual method, full stops shall be defined by maximum line pressure (pedal force) and minimum deceleration. Also note, at the appropriate stop, which wheel or wheels skidded.

2. For light truck—Manufacturer's GVW rating not to be exceeded. For passenger car—Normally curb weight plus 270 kg (+600 lb) for vehicles four or more passengers.

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5.4 Burnish

5.4.1 STOP SPEED—64 to 0 km/h (40 to 0 mph).

5.4.2 STOP DECELERATION— 3.7 m/s^2 (12 ft/s^2) (in normal driving gear).

5.4.3 STOP INTERVAL—As required to achieve $121 \text{ }^\circ\text{C}$ ($250 \text{ }^\circ\text{F}$) "initial brake temperature"³ or a maximum of 1.6 km (1 mile).

NOTE— The 1.6 km (1 mile) maximum must be observed even though the initial temperature exceeds $121 \text{ }^\circ\text{C}$ ($250 \text{ }^\circ\text{F}$).

5.4.4 COOLING SPEED—64 km/h (40 mph) (moderate acceleration to cooling speed).

5.4.5 STOPS REQUIRED—200.

5.4.6 OPTIONAL—Inspect and/or adjust brakes after burnish cycle. Record if either operation is performed.

5.5 Emergency Brake System Test—This test can be run separately. It need not necessarily be run after 5.4. If run separately, brakes are to be burnished per 5.4.

5.5.1 INITIAL BRAKE TEMPERATURE— $65.6 \text{ }^\circ\text{C}$ ($150 \text{ }^\circ\text{F}$) before each stop.

5.5.2 PROCEDURE—With one-half of system open to the atmosphere, determine the pedal force to cause failure warning system to operate. Determine the pedal force required to provide minimum stopping distance. The maximum pedal force must not exceed 890 N (200 lb). Stops are to be made in normal driving gear from 97 km/h (60 mph) without leaving a 3.7 m (12 ft) lane. Repeat the procedure with only the other half of the system open to the atmosphere.

5.5.3 RECORD—Pedal force required to actuate failure warning system, maximum pedal force, minimum deceleration, and stopping distance for each failure mode.

5.6 Inoperative Power Assist System Test—This test can be run separately. It need not necessarily be run after 5.5. If run separately, brakes are to be burnished per 5.4.

5.6.1 INITIAL BRAKE TEMPERATURE— $65.6 \text{ }^\circ\text{C}$ ($150 \text{ }^\circ\text{F}$).

5.6.2 PROCEDURE—With primary source of power inoperative and its reserve depleted, determine the pedal force required to provide minimum stopping distance. The maximum pedal force must not exceed 890 N (200 lb). Stops are to be made in normal driving gear from 97 km/h (60 mph) without leaving a 3.7 m (12 ft) lane.

5.6.3 RECORD—Maximum pedal force, minimum deceleration, and stopping distance.

5.7 Second Effectiveness Test—Repeat 5.3, except add 129 km/h (80 mph) stop speed or maximum vehicle speed as achieved by maximum acceleration for 1.6 km (1 mile) from zero speed if 129 km/h (80 mph) is not attainable. Record stop speed attained.

5.8 Minimum Load Test—This test can be run as a separate test. It need not necessarily be run after 5.7. If run separately, brakes are to be burnished per 5.4.

5.8.1 If run after 5.7, a 35 stop reburnish per 5.4 is required.

3. See Test Notes, 5.1.3 .

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- 5.8.2 Remove weights, and with curb weight plus 140 kg (300 lb) maximum, conduct Effectiveness Test.
- 5.8.3 INITIAL BRAKE TEMPERATURE—93.3 °C (200 °F).
- 5.8.4 STOP SPEED—97 km/h (60 mph) (full stops in neutral).
- 5.8.5 INCREMENTS—Curve to be defined to point of incipient skid by an adequate number of points.
- 5.8.6 RECORD—Deceleration and line pressure (pedal force) and method of brake application (that is, machine or manual). When using manual method, full stops to be defined by maximum line pressure (pedal force) and minimum deceleration. Also note, at the appropriate stop, which wheel or wheels skidded.
- 5.9 High Speed Stop Test**—This test can be run as a separate test. It need not necessarily be run after 5.8. If run separately, brakes are to be burnished per 5.4.
- 5.9.1 Conduct at original test weight per 4.5.
- 5.9.2 INITIAL BRAKE TEMPERATURE—65.6 °C (150 °F).
- 5.9.3 STOPS REQUIRED—1.
- 5.9.4 STOP SPEED—As achieved by maximum obtainable acceleration for 1.6 km (1 mile) from zero speed but not to exceed 100 mph (161 km/h).
- 5.9.5 STOP DECELERATION—4.6 m/s² (15 ft/s²) in normal driving gear or maximum attainable at 890 N (200 lb) pedal force.
- 5.9.6 RECORD—Stop speed, maximum line pressure (pedal force), and deceleration (if 4.6 m/s² [15 ft/s²] cannot be held).
- 5.10 First Reburnish**—Repeat 5.4, except 35 stops required.
- 5.11 First Fade and Recovery Test**
- 5.11.1 BASELINE CHECK STOPS
- 5.11.1.1 *Initial Brake Temperature*—65.6 °C (150 °F) before each stop.
- 5.11.1.2 *Stops Required*—3.
- 5.11.1.3 *Stop Speed*—48 to 0 km/h (30 to 0 mph).
- 5.11.1.4 *Stop Deceleration*—3 m/s² (10 ft/s²) (in normal driving gear).
- 5.11.1.5 *Record*—Maximum line pressure (pedal force).
- 5.11.2 FADE
- 5.11.2.1 *Initial Brake Temperature*—65.6 °C (150 °F) before first stop.
- 5.11.2.2 *Stops Required*—10.
- 5.11.2.3 *Stop Speed*—97 to 0 km/h (60 to 0 mph).

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- 5.11.2.4 *Stop Deceleration*—4.6 m/s² (15 ft/s²) (in normal driving gear) or maximum obtainable at 890 N (200 lb) pedal force (or equivalent line pressure).
- 5.11.2.5 *Stop Interval*—0.6 km (0.4 mile).
- 5.11.2.6 *Cooling Speed*—97 km/h (60 mph).
- 5.11.2.7 *Acceleration to Cooling Speed*—Immediate to maximum.
- 5.11.2.8 *Record*—Maximum line pressure (pedal force) and deceleration (if 4.6 m/s² [15 ft/s²] cannot be held). Initial brake temperature before every stop, all brakes. Ambient air temperature at beginning of run. Total elapsed time from end of the first fade stop to end of the last fade stop—to maintain a check on driver consistency and vehicle performance.

NOTE— Drive 1.6 km (1 mile) at 64 km/h (40 mph) after last fade stop and make first recovery stop.

5.11.3 RECOVERY

- 5.11.3.1 *Stops Required*—12 minimum.
- 5.11.3.2 *Stop Speed*—48 to 0 km/h (30 to 0 mph).
- 5.11.3.3 *Stop Deceleration*—3 m/s² (10 ft/s²) (in normal driving gear), or maximum obtainable at 890 N (200 lb) pedal force (or equivalent line pressure).
- 5.11.3.4 *Stop Interval*—1.6 km (1 mile).
- 5.11.3.5 *Cooling Speed*—64 km/h (40 mph).
- 5.11.3.6 *Rate of Acceleration to Cooling Speed*—Moderate.
- 5.11.3.7 *Record*—Maximum line pressure (pedal force) and deceleration (if 3 m/s² [10 ft/s²] cannot be held). Initial brake temperatures before every stop, all brakes.

5.12 First Effectiveness Spot Check

- 5.12.1 INITIAL BRAKE TEMPERATURE—93.3 °C (200 °F) before each stop.
- 5.12.2 STOPS REQUIRED—2.
- 5.12.3 STOP SPEED—97 to 0 km/h (60 to 0 mph).
- 5.12.4 STOP DECELERATION—4.6 m/s² (15 ft/s²) (in normal driving gear).

5.13 Second Reburnish—Repeat 5.4, except 35 stops required.

5.14 Second Fade and Recovery Test—Repeat 5.11, except 15 fade stops required.

5.15 Second Effectiveness Spot Check—Repeat 5.12.

5.16 Third Reburnish—Repeat 5.13.

5.17 Final Effectiveness Test—Repeat 5.7.

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5.18 Final Inspection—Disassemble all brakes, inspect, and record all pertinent observations.

5.19 Water Recovery Test—This test can be run separately. It need not necessarily be run after 5.18. If run separately, brakes are to be burnished per 5.4.

5.19.1 BASELINE CHECK STOPS

5.19.1.1 *Initial Brake Temperature*—65.6 °C (150 °F) before each stop.

5.19.1.2 *Stops Required*—3.

5.19.1.3 *Stop Speed*—40 to 0 km/h (25 to 0 mph).

5.19.1.4 *Stop Deceleration*—2.4 m/s² (8 ft/s²) (in normal driving gear).

5.19.1.5 *Record*—Maximum line pressure (pedal force) for each stop.

5.19.2 WETTING OF BRAKES

5.19.2.1 *Wetting Time*—2 min minimum.

5.19.2.2 *Wetting Procedure*—With the brakes fully released, wet all brakes thoroughly by slowly driving through a trough of suitable depth or equivalent method. Start recovery stops not more than 1 min after wetting brakes. Do not exceed 40 km/h (25 mph) prior to recovery stops.

5.19.3 WATER RECOVERY STOPS

5.19.3.1 *Stop Speed*—40 to 0 km/h (25 to 0 mph).

5.19.3.2 *Speed Between Stops*—40 km/h (25 mph).

5.19.3.3 *Stop Deceleration*—2.4 m/s² (8 ft/s²) (in normal driving gear) or maximum obtainable at 890 N (200 lb) pedal force (or equivalent line pressure).

5.19.3.4 *Stop Interval*—0.5 mile.

5.19.3.5 *Stops Required*—15.

5.19.3.6 *Record*—Maximum line pressure (pedal force) for each stop and deceleration (if 2.4 m/s² [8 ft/s²] cannot be held).

6. Report Forms and Graph Sheets

6.1 General Data and Summary Sheet, Figure 2.

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VEHICLE: MAKE _____ MODEL _____ YEAR _____
 ENGINE _____ TRANSMISSION _____ AXLE _____
 WEIGHT _____ kg (1b) FRONT WEIGHT _____ kg (1b) REAR WEIGHT _____ kg (1b)
 BALLAST _____ kg (1b) TEST WEIGHT _____
 EMPTY WEIGHT _____ GENERAL DATA _____
 TIRE SIZE: FRONT _____ REAR _____ MAKE: FRONT _____ REAR _____
 MANUFACTURER'S DESIGNATION: FRONT _____ REAR _____

BRAKES: FRONT-SIZE _____ TYPE _____ CYL DIA _____
 REAR-SIZE _____ TYPE _____ CYL DIA _____
 LINING-FRONT _____ REAR _____
 DRUM (ROTOR) TYPE-FRONT _____ REAR _____
 MASTER CYL DIA _____ PEDAL RATIO _____ POWER BRAKE: YES _____ NO _____ TYPE _____

TEST INFORMATION: THERMOCOUPLE INSTALLATION METHOD: _____
 SPECIAL EQUIPMENT _____
 TESTED BY _____ LOCATION _____ DATE _____

TEST PHASE	TEST RESULTS
PREBURNISH CHECK	PF LB
EFFECTIVENESS TESTS	1st 2nd 3rd
48 km/h (30 mph) at _____ m/s ² (ft/s ²)	_____ N (1b) PF
97 km/h (60 mph) at _____ m/s ² (ft/s ²)	_____ N (1b) PF
129 km/h (80 mph) at _____ m/s ² (ft/s ²)	_____ N (1b) PF
EMERGENCY BRAKE TEST	
WARNING SYSTEM ACTUATION	TYPE: POWER MANUAL
97 km/h (60 mph) STOPPING DISTANCE	FRT _____ RR _____ N (1b) PF FRT _____ m (ft) _____ N (1b) PF RR _____ m (ft) _____ N (1b) PF
INOPERATIVE POWER ASSIST SYSTEM TEST	
97 km/h (60 mph) STOPPING DISTANCE	_____ m (ft) _____ N (1b) PF
MINIMUM LOAD TEST	_____ m/s ² (ft/s ²) _____ N (1b) PF
HIGH SPEED STOP TEST	_____ m/s ² (ft/s ²) _____ N (1b) PF
FIRST FADE AND RECOVERY TEST	
FADE STOPS 1-4	_____ N (1b)
RECOVERY STOPS 1-5	_____ m/s ² (ft/s ²) BY _____ N (1b)
RECOVERY STOPS 6-12	_____ N (1b) PF MAX
SECOND FADE AND RECOVERY TEST	
FADE STOPS 1-8	_____ N (1b) PF
RECOVERY STOPS 1-5	_____ m/s ² (ft/s ²) BY _____ N (1b)
RECOVERY STOPS 6-12	_____ N (1b) PF MAX
STABILITY DURING EFFECTIVENESS TESTS	CONTROLLABLE BRAKING
	BELOW _____ m/s ² (ft/s ²) YES _____ NO _____
FINAL INSPECTION	
LINING INTEGRITY	YES _____ NO _____
MECHANICAL INTEGRITY	YES _____ NO _____
HYDRAULIC INTEGRITY	YES _____ NO _____
WATER RECOVERY TEST	
AVERAGE BASELINE PF	AVG BASE _____ N (1b) PF
RECOVERY STOPS 4-6	_____ N (1b) PF MAX
RECOVERY STOPS 7-14	_____ N (1b) PF MAX
RECOVERY STOP 15	_____ N (1b) PF FROM BASE
COMMENTS _____	
REPORTED BY _____	DATE _____

FIGURE 2—GENERAL DATA AND SUMMARY SHEET

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6.5 Final Inspection and Water Recovery Data Sheet, Figure 6.

VEHICLE _____
TESTED BY _____
DATE _____

FINAL INSPECTION

FRICITION MATERIAL CONDITION:
LF
RF
LR
RR
DRUM (OR ROTOR) CONDITION:
LF
RF
LR
RR
MECHANICAL COMPONENT CONDITION:
LF
RF
LR
RR
BRAKE PEDAL
POWER BRAKE
STOPLIGHTS
HYDRAULIC COMPONENT CONDITION:
LF
RF
LR
RR
MASTER CYLINDER

INSPECTION COMMENTS: _____

FIGURE 6—FINAL INSPECTION AND WATER RECOVERY DATA SHEET