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LAND SEA AIR SPACE

TECHNICAL REPORT J212

BRAKE SYSTEM DYNAMOMETER TEST PROCEDURE—PASSENGER CAR—SAE J212

SAE Recommended Practice

Report of Brake Committee approved July 1971.

1. Introduction—This SAE Recommended Practice is based upon SAE J843 and is intended to provide a laboratory simulation of vehicle brake system performance (based on simultaneous testing of one front and one rear brake). Certain details of this dynamometer procedure have been purposely left flexible because of varying equipment, and results should not be construed as providing absolute correlation with road tests.

2. Scope—This procedure establishes a uniform laboratory dynamometer method of testing all classes of passenger car brake systems.

3. Purpose—The purpose of the practice is to establish brake system capabilities with regard to:

3.1 Deceleration versus input, as affected by speed, brake temperature, and usage.

3.2 Brake system integrity.

3.3 Stopping ability during emergency or inoperative power assist conditions.

4. Equipment and Instrumentation

4.1 Equipment

4.1.1 An inertia type dual brake dynamometer.

4.1.2 Means for varying brake cooling.

4.1.3 Means for simulating partial brake system failure (half of system open to atmosphere).

4.1.4 Means for applying brake system pressure at a specified rate.

4.2 Instrumentation

4.2.1 REQUIRED

4.2.1.1 Means for recording hydraulic line pressures.

4.2.1.2 Means for recording brake torques.

4.2.1.3 Means for recording brake lining temperatures.

4.2.1.4 Means for recording shaft speed.

4.2.1.5 Cooling air temperature indicators.

4.2.1.6 Revolutions to stop indicator for measurement of equivalent stopping distance.

4.2.2 OPTIONAL INSTRUMENTATION

4.2.2.1 Cooling air velocity indicators.

4.2.2.2 Drum or disc temperature indication and/or recording equipment.

4.2.2.3 Fluid displacement indicators.

4.2.2.4 Stopping time indicator.

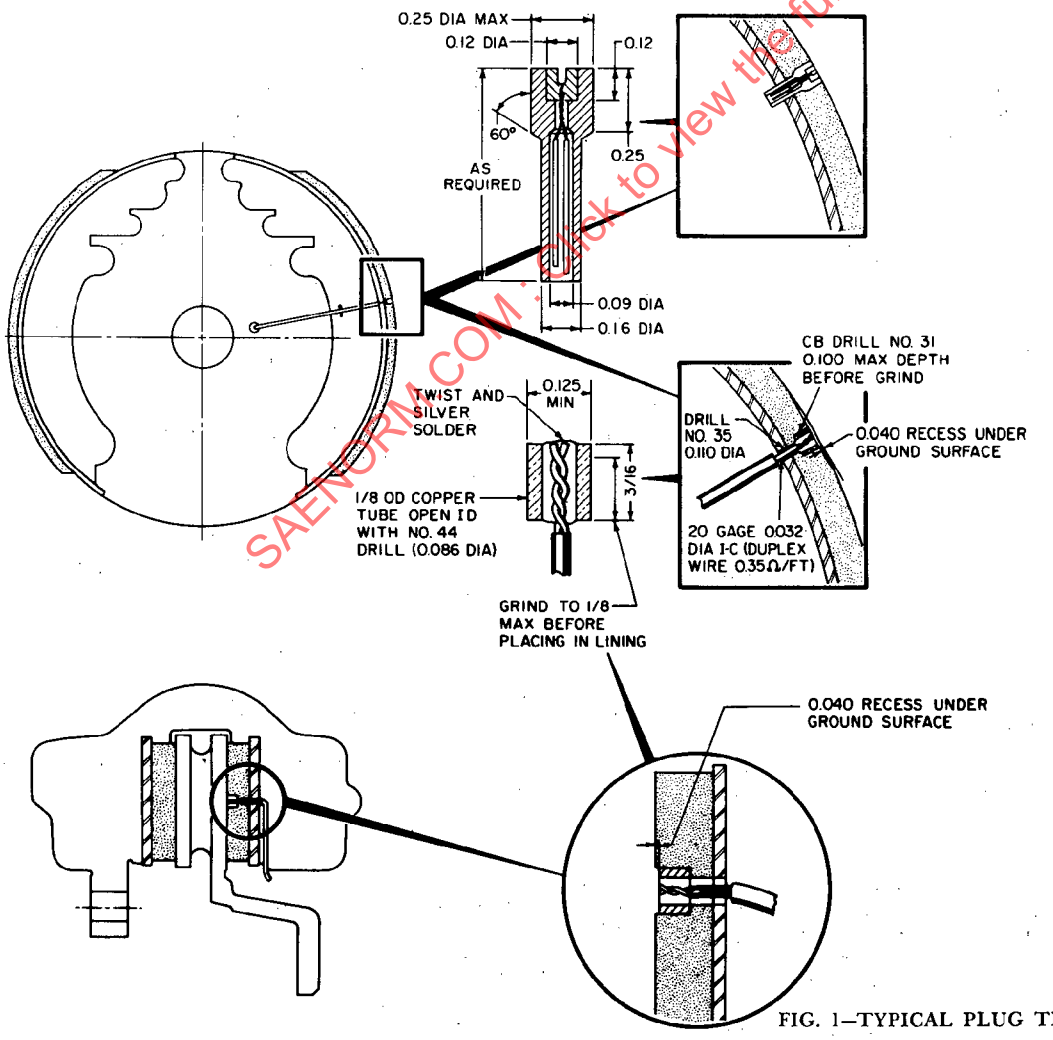

FIG. 1—TYPICAL PLUG THERMOCOUPLE INSTALLATIONS

4.3 System Accuracy

4.3.1 ACCURACY OF INSTRUMENTATION—The overall system accuracy for all recording or indicating instruments shall be ± 2% of full-scale or better.

4.3.2 CONTROL PARAMETER ACCURACY

4.3.2.1 Line pressures, torques, and temperatures shall be maintained within ± 5% of the desired value.

4.3.2.2 Speed shall be maintained within ± 2% of the desired value.

4.3.2.3 Test moment of inertia shall be within ± 1.5 ft-lb-s² of value calculated from paragraph 5.7.

5. Test Preparation and Installation Details

5.1 Friction Material Preparation—Attach and finish friction material per manufacturer's specifications, unless otherwise noted.

5.2 Thermocouples—Install plug type thermocouples in each brake as shown in Fig. 1. All thermocouples are to be located in the approximate center of the most heavily loaded shoe, one per brake. Indicate location on data sheet.

5.3 Brake Drum or Disc Assembly—New drums or discs should be used for each test. Surface finish, dimensional characteristics (with special emphasis on thickness variation and runout of rubbing surface), and material properties shall be in accordance with manufacturer's specifications.

5.4 Brakes shall be prepared in accordance with manufacturer's specifications. Adjust brakes to manufacturer's specifications where applicable.

5.5 Brake Mounting—Shall be mounted essentially as in service.

5.6 Hydraulic System—Shall incorporate pressure proportioning valve and/or hold-off valve if used on the vehicle being simulated.

5.7 Test Moment of Inertia—Calculate the moment of inertia required as follows:

$$I = \frac{Wr^2}{2g}$$

where: I = moment of inertia required, ft-lb-s²

W = car test weight, lb × 0.86 (0.86 = correction for parasitic losses). Car test weight is normally curb + 600 lb

r = effective radius of tire, ft

$$= \frac{5280}{2\pi \times \text{wheel}}$$

g = 32.2 fpsps

5.8 Test rpm—As required to simulate specified test speeds. Calculate rpm as follows:

$$\text{rpm} = \frac{14.02 \times \text{mph}}{r}, \text{ or rpm} = \frac{\text{Tire rpm} \times \text{mph}}{60}$$

where: r = effective tire radius, ft

5.9 Test Deceleration—All control decelerations shall be converted to torque for the dynamometer settings by the following formula:

$$T = \frac{W \times r \times a}{2g}$$

where: T = torque required, ft-lb

a = control deceleration, fpsps

W,r,g = from paragraph 5.7

6. Test Procedure—Performance

6.1 Test Notes

6.1.1 During all phases of this procedure, any unusual performance characteristics such as noise, roughness, etc., are to be noted and recorded.

6.1.2 Initial brake temperature is defined as the lining temperature at which the brake application is initiated.

6.1.3 If the brakes require warming to prescribed initial temperature, use the burnish procedure, except cycle time is not to be less than 45 s.

6.1.4 "Sustained" torque or line pressure normally is interpreted herein to mean that torque or line pressure at which a leveling off occurs during a stop. If no leveling off occurs, "sustained" values should be recorded as that indicated at one-half the stopping time.

6.1.5 "Final" torque or line pressure readings shall be taken at an rpm equivalent to 5 mph.

6.1.6 The cooling speed (speed at which the rotating portion of the brake is moving between successive brake applications) shall be set at approximately stop speed for all phases. Stop speed is that at which the brake is applied.

6.1.7 During all phases of this procedure, cooling air speeds for each brake must be controlled to produce the brake temperatures normally experienced on the particular vehicle or vehicle brake system being simulated. In other words, for each brake system, a particular set of cooling air control settings must be worked out on a "baseline" test for which comparable vehicle test data are available. It is especially important that proper temperatures be attained during burnish, fades, and recoveries.

6.1.8 Rate of pressure rise during all phases of the test shall be 1000-2000 psi/s.

6.2 Preburnish Check—In order to allow for a general check of instrumentation, brakes, and dynamometer function, run the following stops: 10 stops, 30 mph, 10 fpsps, 90 s cycle.

6.3 First (Preburnish) Effectiveness Test

6.3.1 Initial brake temperature (each stop)—200 F (hottest brake).

6.3.2 Stop speed—30 and 60 mph.

6.3.3 Test methods—Curve to be defined at each speed by adequate number of points. Optional methods are as follows (specify which used):

6.3.3.1 A minimum of five consecutive stops at constant line pressure increments. If this method is used, use line pressure increments of not over 100 psi at 30 mph to 30 fpsps; of not over 150 psi at 60 mph to 30 fpsps; and of not over 200 psi at 80 mph to 30 fpsps (on second and final effectiveness tests only).

6.3.3.2 A series of consecutive stops at constant deceleration increments. If this method is used, make checks at 5, 10, 15, 20, 25, and 30 fpsps at each speed.

6.3.4 Report—Maximum line pressure on constant deceleration stops, and minimum torque on constant pressure stops.

6.4 Burnish

6.4.1 Stop speed—40 mph.

6.4.2 Stops required—200.

6.4.3 Stop deceleration—12 fpsps.

6.4.4 Stop cycle—As required to maintain 250 F initial brake temperature on hottest brake, or a maximum of 90 s.

6.4.5 Report—Maximum line pressure every 20 stops.

6.5 Second (Burnished) Effectiveness Test—Repeat paragraph 6.3, except add 80 mph stop speed.

6.6 High Speed Stop Test

6.6.1 Stop speed—As achieved by maximum attainable acceleration for 1 mile from zero speed but not to exceed 100 mph (to be determined with actual vehicle being simulated).

6.6.2 Stops required—1.

6.6.3 Stop deceleration—15 fpsps.

6.6.4 Initial brake temperature—150 F (hottest brake).

6.6.5 Report—Maximum line pressure and deceleration if 15 fpsps cannot be held.

6.7 First Reburnish—Repeat paragraph 6.4, except 35 stops.

6.8 First Fade and Recovery Test

6.8.1 BASELINE CHECK STOPS

6.8.1.1 Stop speed—30 mph.

6.8.1.2 Stops required—3.

6.8.1.3 Stop deceleration—10 fpsps.

6.8.1.4 Initial brake temperature—150 F hottest brake each stop.

6.8.1.5 Report—Maximum line pressures.

6.8.2 FADE

6.8.2.1 Stop speed—60 mph.

6.8.2.2 Stops required—10.

6.8.2.3 Stop deceleration—15 fpsps.

6.8.2.4 Initial brake temperature—150 F hottest brake for first stop.

6.8.2.5 Stop cycle—35 s.

6.8.2.6 Report—Maximum line pressure, initial brake temperature, cooling air temperature, deceleration values.

6.8.3 NOTE—Run 90 s at 30 mph after last fade stop and make first recovery stop.

6.8.4 RECOVERY

6.8.4.1 Stop speed—30 mph.

6.8.4.2 Stops required—12.

6.8.4.3 Stop deceleration—10 fpsps.

6.8.4.4 Stop cycle—2 min.

6.8.4.5 Report—Same as for fade run (paragraph 6.8.2.6).

6.9 First Effectiveness Spot Check

6.9.1 Stop speed—60 mph.

6.9.2 Stops required—2.
6.9.3 Stop deceleration—15 fpsps.
6.9.4 Initial brake temperature—200 F hottest brake each stop.
6.9.5 Report—Maximum line pressure.

6.10 Second Reburnish—Repeat paragraph 6.4, except 35 stops.

6.11 Second Fade and Recovery Test—Repeat paragraph 6.8, except 15 fade stops in paragraph 6.8.2.2.

6.12 Second Effectiveness Spot Check—Repeat paragraph 6.9.

6.13 Third Reburnish—Repeat paragraph 6.4, except 35 stops.

6.14 Final Effectiveness Test—Repeat paragraph 6.5.

6.15 Fourth Reburnish—Repeat paragraph 6.4, except 35 stops.

6.16 Emergency Brake System and Inoperative Power System Test

6.16.1 Test Notes

6.16.1.1 Calculate wheel revolutions equivalent to 600 ft for the vehicle being simulated.

6.16.1.2 Obtain "with vacuum" and "no vacuum" pedal forceline pressure calibration curves for the vehicle being simulated.

6.16.1.3 All stops in this section are to be made at constant line pressure from 60 mph at an initial brake temperature of 150 F (hottest brake).

6.16.2 Stopping Test with Failed Front System

6.16.2.1 Determine the constant *master cylinder* hydraulic pressure to stop in the equivalent of 500 +0, −60 ft, using the rear brake only (front system open to atmosphere).

6.16.2.2 Report—Constant master cylinder pressure to stop with rear brake only (P_r), the "with vacuum" pedal force to produce P_r (F_r), the actual revolutions to stop (RTS_r).

6.16.3 Stopping Test with Failed Rear System

6.16.3.1 Determine the constant *master cylinder* hydraulic pressures to stop in the equivalent of 600 +0, −60 ft using the front brake only (rear system open to atmosphere).

6.16.3.2 Report—Constant master cylinder pressure to stop with front brake only (P_f), the "with vacuum" pedal force to produce P_f (F_f), the actual revolutions to stop (RTS_f).

6.16.4 Stopping Test with Inoperative Power System

6.16.4.1 From the "no vacuum" pedal force-line pressure calibration curve, determine the master cylinder hydraulic pressure (P_{nv}) produced by a pedal force of 200 lb.

6.16.4.2 Determine the revolutions to stop (RTS_{nv}) for a master cylinder hydraulic line pressure of P_{nv} using both front and rear brakes.

6.16.4.3 Report—Revolutions to stop (RTS_{nv}).

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

7. *Report Forms*

7.1 Brake Dynamometer Test Data, Fig. 2.

7.2 Preburnish Check, Preburnish Effectiveness, and Burnish Report Form, Fig. 3.

7.3 Burnished Effectiveness, High Speed Stop, First Reburnish, and First Baseline Check Report Form, Fig. 4.

7.4 First Fade, First Recovery, and First Effectiveness Spot Check Report Form, Fig. 5.

7.5 Second Reburnish, Second Baseline Check, and Second Fade Report Form, Fig. 6.

7.6 Second Recovery, Second Effectiveness Spot Check, Third Reburnish, and Final Effectiveness Report Form, Fig. 7.

7.7 Fourth Reburnish, and Emergency Brake System and Inoperative Power System Test Report Form, Fig. 8.

BRAKE DYNAMOMETER TEST DATA

VEHICLE SIMULATED _____ DATE _____

TEST WEIGHT _____ LB _____ FT-LB-S^2 _____ TEST NO _____

EFFECTIVE TIRE RADIUS _____ FT TIRE SIZE _____

BRAKES - FRONT: SIZE _____ TYPE _____ CYL DIA _____

REAR: SIZE _____ TYPE _____ CYL DIA _____

BRAKE LININGS - FRONT _____ REAR _____

ROTOR/DRUM TYPE - FRONT _____ REAR _____

SPECIAL EQUIPMENT _____

GENERAL INFORMATION _____

LINE PRESSURE - PEDAL FORCE CURVES FOR VEHICLE BEING SIMULATED (WITH AND WITHOUT VACUUM)

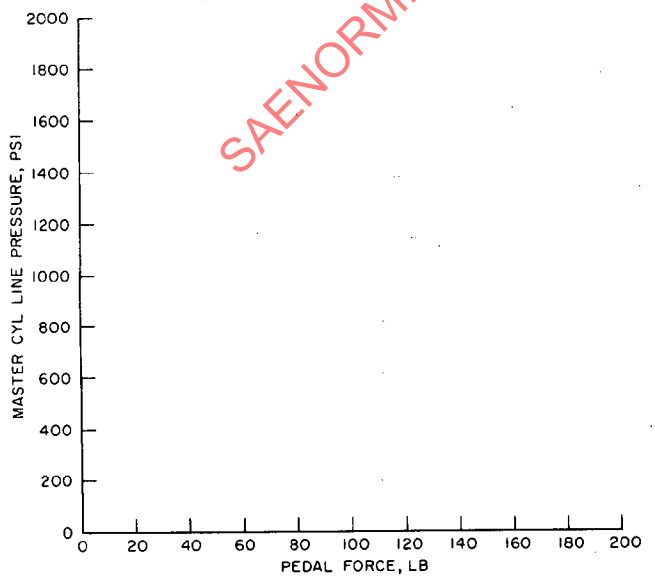

FIG. 2—BRAKE DYNAMOMETER TEST DATA

PREBURNISH CHECK, PREBURNISH EFFECTIVENESS, AND BURNISH REPORT FORM

TEST NO. _____
VEHICLE _____
DATE _____

PREBURNISH CHECK

STOP	LINE PRESSURE	COMMENTS
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

PREBURNISH EFFECTIVENESS

30 MPH			60 MPH		
DECELERATION	LINE PRESSURE	TEMPERATURE	DECELERATION	LINE PRESSURE	TEMPERATURE

COMMENTS: _____

BURNISH

STOP	LINE PRESSURE	COMMENTS	STOP	LINE PRESSURE	COMMENTS
1			120		
20			140		
40			160		
60			180		
80			200		
100					

FIG. 3—PREBURNISH CHECK, PREBURNISH EFFECTIVENESS, AND BURNISH REPORT FORM

BURNISHED EFFECTIVENESS, HIGH SPEED STOP, FIRST REBURNISH AND FIRST BASELINE CHECK REPORT FORM

TEST NO. _____
VEHICLE _____
DATE _____

BURNISHED EFFECTIVENESS

30 MPH			60 MPH			80 MPH		
DECELERATION	LINE PRESSURE	TEMPERATURE	DECELERATION	LINE PRESSURE	TEMPERATURE	DECELERATION	LINE PRESSURE	TEMPERATURE

HIGH SPEED STOP

SPEED	DECELERATION	LINE PRESSURE	COMMENTS

FIRST REBURNISH

STOP	LINE PRESSURE	COMMENTS
1		
10		
25		
35		

FIRST BASELINE CHECK

STOP	LINE PRESSURE	COMMENTS
1		
2		
3		

FIG. 4—BURNISHED EFFECTIVENESS, HIGH SPEED STOP, FIRST REBURNISH, AND FIRST BASELINE CHECK REPORT FORM

FIRST FADE, FIRST RECOVERY, AND FIRST EFFECTIVENESS SPOT CHECK REPORT FORM

TEST NO. _____
VEHICLE _____
DATE _____

FIRST FADE

STOP	DECELERATION	LINE PRESSURE	INITIAL TEMPERATURES	COMMENTS
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
COOLING AIR TEMPERATURE:				

FIRST RECOVERY

STOP	DECELERATION	LINE PRESSURE	INITIAL TEMPERATURES	COMMENTS
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				

FIRST EFFECTIVENESS SPOT CHECK

STOP	DECELERATION	LINE PRESSURE	INITIAL TEMPERATURES	COMMENTS
1				
2				

FIG. 5—FIRST FADE, FIRST RECOVERY, AND FIRST EFFECTIVENESS SPOT CHECK REPORT FORM

SECOND REBURNISH, SECOND BASELINE CHECK, AND SECOND FADE REPORT FORM

TEST NO. _____
VEHICLE _____
DATE _____

SECOND REBURNISH

STOP	LINE PRESSURE	COMMENTS
1		
10		
25		
35		

SECOND BASELINE CHECK

STOP	LINE PRESSURE	COMMENTS
1		
2		
3		

SECOND FADE

STOP	DECELERATION	LINE PRESSURE	INITIAL TEMPERATURES	COMMENTS
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
COOLING AIR TEMPERATURE:				

FIG. 6—SECOND REBURNISH, SECOND BASELINE CHECK, AND SECOND FADE REPORT FORM