The Engineering Society For Advancing Mobility Land Sea Air and Space®
INTERNATIONAL
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SURFACE VEHICLE RECOMMENDED PRACTICE

SAE J46

REAF. OCT93

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Superseding J46 JUN80

Submitted for recognition as an American National Standard

WHEEL-SLIP BRAKE-CONTROL SYSTEM ROAD TEST CODE

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

1. ***Scope*—**The test code establishes wheel-slip brake-control system capabilities with regard to:

1.1 Vehicle stability, maneuverability, and system function on various road surface conditions, including variable friction surfaces as well as uniform friction surfaces.

1.2 Vehicle stopping distance on various road surface conditions.

1.3 Not covered by this SAE Recommended Practice are:

a. Radio frequency interference testing
b. Extensive power consumption testing

1.4 **Purpose—**This document establishes a uniform procedure for the road test of wheel-slip brake-control systems on passenger cars, trucks, buses, and combination vehicles.

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

3. ***Instrumentation and Equipment***

3.1 Decelerometer.

3.2 Brake temperature instrumentation.

3.3 Vehicle velocity and wheel-speed instrumentation.

3.4 Odometer.

3.5 Tire pressure gage.

3.6 Stopping distance instrumentation.

3.7 Vehicle yaw measuring device.

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3.8 Articulation restraints for trailers (optional where applicable).

3.9 Means for disabling wheel-slip control system.

3.10 System pressure instrumentation (optional where applicable).

3.11 Vehicle stabilizer (optional when needed for vehicle stability).

3.12 Means to designate the point at which the brakes are applied (such as a detonator).

4. ***Facilities—***3.7 m (12 ft) wide road surfaces of various friction levels are required with sufficient space on all sides for approach, spin-out, and recovery conditions. See Figures 1, Figure 2 and Figure 3.

4.1 Road surface description and suggested (guidelines only) lengths of uniform surface facilities assuming that all the brakes are working normally and the maximum speed is as indicated in Table 1.

4.2 Pylons as required.

TABLE 1—MAXIMUM SPEED

Surface	Suggested Length m	Suggested Length ft	Assumed Max (1) Speed km/h	Assumed Max(1) Speed mph
Very low friction—smooth ice or equivalent	122	400	32	20
Low friction—wet jennite or equivalent	122	400	48	30
Medium friction—wet asphalt or wet concrete	91	300	64	40
High friction—dry asphalt or dry concrete	122	400	97	60
Special—graded loose gravel	76	250	48	30

1. Recommend moving up to speed in steps.

5. ***Vehicle Preparation***

5.1 Inspect the brake-friction elements and replace if over 25% are worn or if any abnormal condition exists. Severity of test sequences may require frequent checks to avoid overadjustment of the brakes.

5.2 Install and calibrate equipment. See Figure 4 for brake thermocouple installation method.

5.3 Install ballast if necessary to simulate the desired vehicle loading condition.

5.4 Inspect tires and replace if an objectionable wear condition exists. Adjust tire pressure per vehicle manufacturer's load recommendations on vehicles 4500 kg (10 000 lb) GVWR or under. For vehicles with GVWR greater than 4500 kg (10 000 lb), use maximum vehicle manufacturer's recommended pressure.

5.5 On vehicles equipped with adjustable power systems, adjust the system to maximum recommended cutout pressure.

5.6 On articulated vehicles, install articulation restraints.

$$P = \frac{V_b}{V_d}$$

FIGURE 1—SPLIT-FRICTION SURFACE TEST FACILITY

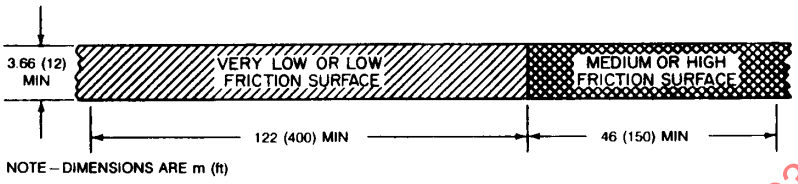

FIGURE 2—CHANGING-FRICTION SURFACE TEST FACILITY

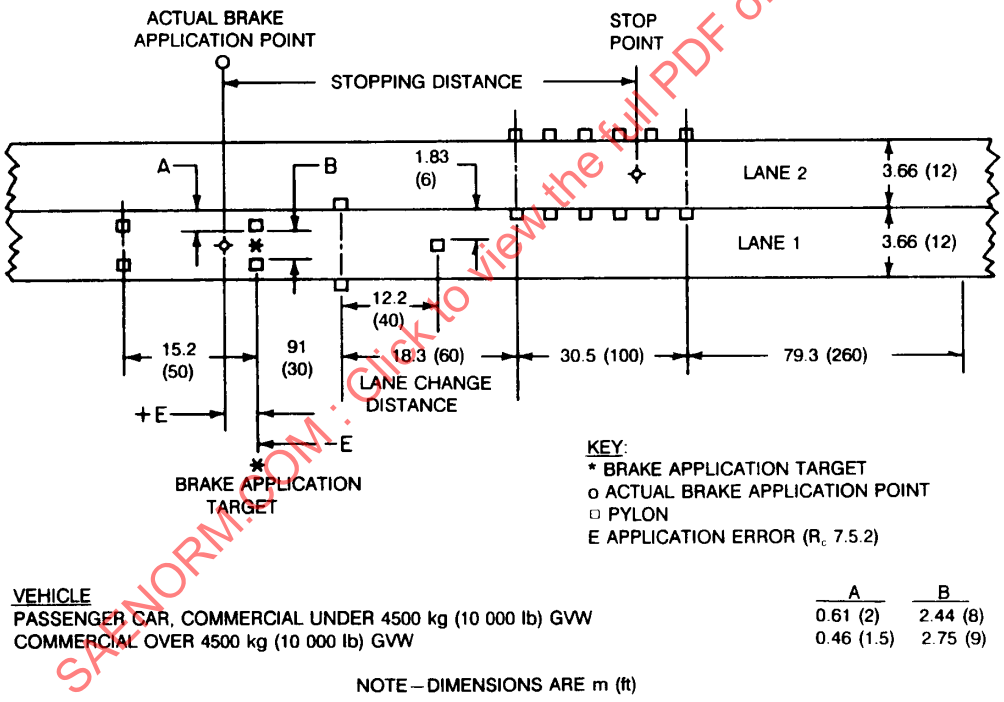

FIGURE 3—LANE CHANGE TEST FACILITY (LOW-FRICTION SURFACE)

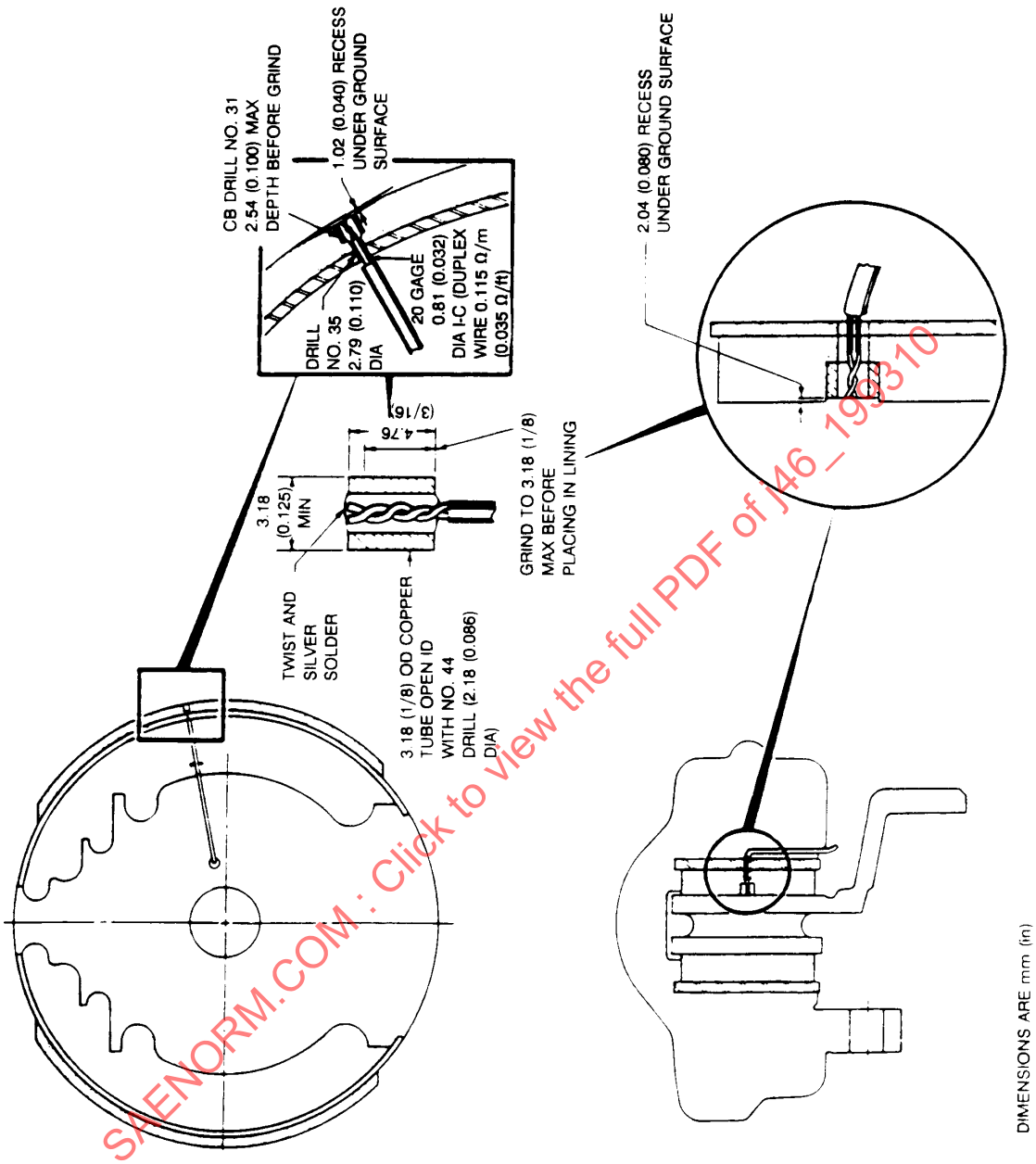

FIGURE 4—TYPICAL PLUG THERMOCOUPLE INSTALLATIONS

6. General Notes

6.1 During all phases of this procedure, note and record any unusual braking or handling characteristics of the vehicle, such as sustained lockup of a controlled wheel, activation of a warning signal, application of a secondary or parking brake system, excessive lateral deviation, etc.

6.2 **Initial Brake Temperature—**The brake temperature occurring within 0.32 km (0.2 mile) of initiating the stop (average temperature of brakes on hottest axle, brakes off).

6.2.1 When not otherwise specified, initial brake temperature shall be 66 to 93 °C (150 to 200 °F).

6.3 On vehicles so equipped, charge the system power supply pressure (vacuum) to maximum before each test stop and note the system pressure (vacuum) at the end of the stop.

6.4 Brake applications are to be made in normal driving gear. On vehicles with manual transmission, disengage the clutch.

6.5 **Stopping Distance—**is defined as the distance traveled between the point at which the driver starts to move the braking control and the point at which the vehicle comes to rest. Since stopping distance on a given road surface varies approximately as the square of initial speed, comparative checks will require that the vehicle speed at which the brake control is initially moved be within 1% of the nominal value for each test condition.

Alternatively, speed variation up to a suggested maximum of ±5% can be tolerated by multiplying each measured stopping distance by the square of the initial speed ratio (nominal speed/actual speed).

6.6 **Vehicle "Yaw"—**is defined as the vehicle's angular deviation between the point at which the brake control is actuated and the point at which the vehicle comes to rest. (That is, one complete revolution in clockwise direction would be a yaw of +360 degrees, while a quarter of a revolution in the counter-clockwise direction would be –90 degrees.) For combination vehicles, the yaw angle of each vehicle is to be noted.

6.7 Vehicle lateral deviation is defined as the greater of the distance between a reference point on the front and the rear of the vehicle at the longitudinal centerline and the centerline of the lane in which a stop is to be completed. For combination vehicles, the lateral deviation of each vehicle is to be noted.

6.8 Vehicle deceleration is defined as the value at which the decelerometer is nearly constant for the majority of the stopping distance on any given surface condition.

6.9 Steering corrections may be made during tests.

6.10 Unless otherwise specified, vehicle testing is to be conducted at unloaded and loaded GVWR conditions.

6.11 Clear tires of stones and foreign material except where not possible for special surfaces.

6.12 Brake pedal application shall be made as rapidly as possible for each test.

7. Procedure

7.1 For vehicles with new linings and drums or with brakes giving inconsistent results, burnish brakes as follows:

7.1.1 For passenger cars and vehicles 4500 kg (10 000 lb) GVW and under, burnish brakes by making at least 200 stops from 64 km/h (40 mph) at 3.7 m/s^2 (12 ft/s^2). Stop interval shall be as required to achieve 121 °C (250 °F).

NOTE— The 1.6 km (1 mile) maximum must be observed even though the initial temperature exceeds 121°C (250 °F).

7.1.2 For vehicles over 4500 kg (10 000 lb) GVW, make 500 brake applications (transmission in neutral or clutch disengaged) in accordance with Table 2. When, during any series, the hottest brake reaches 260 °C (500 °F), continue at that snub condition for an accumulated total of 500 burnish snubs, except that a higher or lower energy snub condition shall be followed when necessary to maintain a temperature of 260 °C ± 10 °C (500 °F ± 50 °F). Record temperature immediately following each snub.

TABLE 2—BRAKE APPLICATIONS

Series	Snubs	Snub Conditions, at 1.6 km (1 mile) Intervals at 3m/s^2 (10 ft/s^2) (or Maximum Possible Less Than 10) km/h	Snub Conditions, at 1.6 km (1 mile) Intervals at 3m/s^2 (10 ft/s^2) (or Maximum Possible Less Than 10) mph
1	175	64 to 32	40 to 20
2	25	72 to 32	45 to 20
3	25	80 to 32	50 to 20
4	25	88 to 32	55 to 20
5	25	97 to 32	60 to 20

7.1.3 After burnishing, adjust brakes per manufacturer's specifications.

7.2 Constant Friction Surface Test—Record vehicle stopping distance, final lateral deviation, and yaw while making the indicated number of rapid application stops for each of the speed and constant friction surface conditions listed as follows. Alternate on and off stops, sampling both directions if two directions are used. The number of stops is the suggested minimum. Safety considerations may warrant deletion of hazardous "off" stops.

7.2.1 Four stops "on" and four stops "off" from 32 km/h (20 mph) on a very low-friction surface (if available).

7.2.2 Four stops "on" and four stops "off" from 32 km/h (20 mph) on a low-friction surface.

7.2.3 Four stops "on" and four stops "off" from 48 km/h (30 mph) on a low-friction surface.

7.2.4 Four stops "on" and two stops "off" from 32 km/h (20 mph) on a medium-friction surface.

7.2.5 Four stops "on" and two stops "off" from 64 km/h (40 mph) on a medium-friction surface.

7.2.6 Four stops "on" and four stops "off" from 48 km/h (30 mph) on a special-friction surface.

7.2.7 Four stops "on" and two stops "off" from 32 km/h (20 mph) on a high-friction surface.

7.2.8 Four stops "on" and two stops "off" from 64 km/h (40 mph) on a high-friction surface. Optional for passenger vehicles under 4500 kg (10 000 lb).

7.2.9 Four stops "on" from 97 km/h (60 mph) on a high-friction surface.

7.3 Split Friction Surface Test—Record vehicle stopping distance, final lateral deviation, and yaw for eight rapid application stops from 32 km/h (20 mph) and eight from 64 km/h (40 mph), starting in line with and centered on the split of two different friction surfaces (Figure 2). One side of the vehicle is to be on the very low- or low-friction surface, while the other side is to be on the medium- or high-friction surface used in 7.2. The high-friction surface should be at least twice the lower-friction surface as measured by locked wheel deceleration or stopping distance. Reverse stop direction each stop (that is, first stop with left side of vehicle on lower-friction surface, second stop with right side on lower-friction, etc.).

7.3.1 Four stops "on" from 32 km/h (20 mph) with lower-friction on left side.

7.3.2 Four stops "on" from 32 km/h (20 mph) with lower-friction on right side.

7.3.3 Four stops "on" from 64 km/h (40 mph) with lower-friction on left side.

7.3.4 Four stops "on" from 64 km/h (40 mph) with lower-friction on right side.

7.4 Changing Friction Surface Test—Record vehicle deceleration, final lateral deviation, and yaw for four rapid application stops from 64 km/h (40 mph) while traveling from one surface friction condition to another (Figure 3). One surface is to be very low- or low-friction, while the other is to be medium- or high-friction. The high-friction surface should be at least twice the lower-friction surface as measured by the locked wheel deceleration or stopping distance. Two stops are to be made on the low-to-high friction surfaces and two stops on the high-to-low friction surfaces. The brakes are to be applied to achieve the friction transition at approximately three-fourths of the initial speed at the axle that is being tested.

NOTE— During high-to-low friction, watch for wheel lockup and during low-to-high friction, watch for deceleration rates that are appropriate for each surface.

7.4.1 Two stops from 64 km/h (40 mph) on lower-to-high friction surfaces.

7.4.2 Two stops from 64 km/h (40 mph) on high-to-lower friction surfaces.

7.5 Lane Change Test, If Applicable—Make the lane change maneuver on the low-friction course detailed in Figure 3 with the vehicle in the unloaded condition.

7.5.1 Drive through the lane change course at a constant speed without braking. Increase the speed for each successive drive through until the pylons are hit. Determine the maximum drive-through speed that the lane change can be made without hitting any pylons for at least three of six consecutive identical drive-through runs. Repeat if necessary. Record the speed for each of the six drive-through runs and the number of pylons hit, if any.

7.5.2 Drive to the brake application point of the lane change course at a constant speed, make a rapid application stop, and steer through the course (Figure 3). Increase the initial braking speed for each successive braking run until the pylons are hit. Determine the maximum initial braking speed that the lane change can be made without hitting any pylons for at least three of six consecutive identical braking runs. Repeat if necessary. Record the initial braking speed for each braking run and the number of pylons hit, if any. Also record application error, stopping distance, final vehicle lateral deviation, and final vehicle yaw. The brake application error, E, must be within ± 1.5 m (±5 ft) to be used in determining maximum braking speed.

7.5.3 LANE CHANGE PERFORMANCE—The lane change performance is the ratio of the maximum braking speed, V_b, to the maximum drive through speed, V_d (see Equation 1):

$$P = \frac{V_b}{V_d} \qquad \text{(Eq. 1)}$$

8. Report Forms

8.1 Vehicle Information Sheet, Figure 5.

VEHICLE INFORMATION SHEET

TEST NO. _____ DATE _____

TEST FACILITY AND LOCATION _____

VEHICLE MAKE AND MODEL _____

EMPTY WEIGHT: FRONT AXLE _____ REAR AXLE(S) _____ TOTAL _____

WHEELBASE _____ TRAILER AXLE(S) _____

ESTIMATED C.G. _____ COMBINATION TOTAL _____

LOADED WEIGHT: FRONT AXLE _____ REAR AXLE(S) _____ TOTAL _____

ESTIMATED C. G. _____ TRAILER AXLE(S) _____

COMBINATION TOTAL _____

SPECIAL CONDITIONS WHICH MIGHT AFFECT BRAKE PERFORMANCE _____

TIRE SIZE, MAKE, AND TYPE:

FRONT _____ REAR _____ TRAILER _____

DRUM: (ROTOR) DATA

FRONT _____ REAR _____ TRAILER _____

BRAKES:

FRONT	SIZE	_____	TYPE	_____
REAR-FORWARD	SIZE	_____	TYPE	_____
REAR-REAR	SIZE	_____	TYPE	_____
TRAILER	SIZE	_____	TYPE	_____

ACTUATION DETAILS: (FILL OUT PER HEADING FOR EITHER HYDRAULIC OR AIR BRAKES)

IF HYDRAULIC:	VACUUM BOOSTER OR AIR CHAMBER TYPE AND SIZE	PEDAL RATIO AND USABLE TRAVEL	MASTER CYLINDER DIA AND STROKE	WHEEL CYLINDER DIA (S)
FRONT				
REAR-FORWARD				
REAR-REAR				
TRAILER				

IF AIR:	AIR CHAMBER TYPE & SIZE	SLACK ADJUSTER LENGTH OR WEDGE ANGLE	CAM RADIUS	CAM ROTATION (WITH OR OPPOSITE DRUM)
FRONT				
REAR-FORWARD				
REAR-REAR				
TRAILER				

WHEEL SLIP CONTROL SYSTEM(S) DESCRIPTION (VALVES, SENSOR & LOGIC)

FRONT _____

REAR-FORWARD _____

REAR-REAR _____

TRAILER(S) _____

REMARKS:

_____

_____

_____

FIGURE 5—VEHICLE INFORMATION SHEET