SAE International®

SURFACE VEHICLE STANDARD

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Superseding J2430 AUG1999

Dynamometer Effectiveness Characterization Test for Passenger Car and Light Truck Brake Friction Products

RATIONALE

This Recommended Practices has been replaced by the SAE J2784 based on (1) SAE J2784's ability to better reproduce the FMVSS sequences for vehicles with Gross Vehicle Weight Rating of 4,540 kg or less, (2) industry consensus to simplify the number of dynamometer testing for performance evaluation, and (3) availability of more specific procedures to assess friction behavior (sensitivity) as a function of speed, pressure, temperature, and braking history like SAE J2522 and ISO 26867, which are used on a regular basis by the automotive industry.

1. Scope

1.1 This SAE Recommended Practice establishes an inertia dynamometer test procedure, using exemplar caliper disc or drum brakes, to characterize the effectiveness of brake friction products for passenger cars and light trucks, up to and including 3500 kg GVW.

SAE J2430 provides a method of characterizing friction material effectiveness, using vehicle specific brake hardware and test conditions that approximate those for U.S. mandated new vehicle brake tests.

1.2 Rationale—SAE J2430 is an improvement over SAE J661/J866 as a friction material effectiveness characterization test of replacement brake linings. SAE J661 uses a one-inch square sample running against a large drum and is known to have shortcomings for characterizing the vehicle performance of different types of automotive brake linings.

1.2.1 SAE J2430 simulates certain sections of FMVSS 135. SAE J2430 is based on the controlled testing of unused friction materials against a new drum or rotor, using a prescribed set of test conditions that approximate those on a vehicle using the exemplar brakes. The FMVSS 135 vehicle test procedure emphasizes rapid braking from different speeds and includes a brake fade section.

1.2.2 Interactive conditioning between brakes occurs during vehicle braking. These interactions can affect work history for both front and rear brakes with a higher relative magnitude for rears. Variations in work history are known to cause variations in effectiveness. Also, it is recognized that brake effectiveness values can be influenced by brake and vehicle design, as well as by friction material characteristics.

For the previous reasons, material effectiveness comparisons using SAE J2430, should be based on testing with the same vehicle relevant brake and test conditions.

1.2.3 SAE J2430 is not intended to characterize all aspects of friction material effectiveness, such as light duty performance, environmental sensitivity, or effectiveness drift after extended service. Also, SAE J2430 is not intended to provide a reliable characterization of lining wear, noise, or drum/rotor compatibility in typical customer service vehicle usage.

1.2.4 SAE J2430 uses new, original equipment drums or rotors of prescribed chemistry, microstructure, and dimensions. Friction materials which require or use a unique mating surface may not be properly characterized by this test procedure.

1.3 Test Features—Brake effectiveness is reported as REGRESSED SPECIFIC TORQUE for ramp applications and as AVERAGE SPECIFIC TORQUE for torque and pressure controlled applications.

1.4 Test Application—Brake effectiveness values calculated from SAE J2430 may be used to aid in the selection of replacement friction materials for automotive disc and drum brakes that are similar in design and usage to that of the exemplar brake.

2. References

2.1 Applicable Publications—The following publications form a part of this specification to the extent specified herein. Unless otherwise indicated, the latest version of SAE publications shall apply.

2.1.1 SAE PUBLICATIONS—Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

SAE J661—Brake Lining Quality Control Test Procedure
SAE J866—Friction Coefficient Identification System for Brake Lining
SAE J2115—Brake Performance and Wear Test Code Commercial Vehicle Inertia Dynamometer

2.1.2 FMVSS PUBLICATIONS—Available from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.

FMVSS 116
FMVSS 135

2.2 Related Publication—The following publication is provided for information purposes only and is not a required part of this document.

2.2.1 SAE PUBLICATION—Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

SAE J1652—Dynamometer Effectiveness Characterization Test for Passenger Car and Light Truck Caliper Disc Brake Friction Materials

3. Test Preparation

3.1 Dynamometer Configuration—SAE J2430 is to be run on an inertia dynamometer with the following minimum capabilities:

3.1.1 Variable speed drive system with speed resolution to ±1 rpm and calibrated to ±0.5% accuracy at 160 km/h. The drive should have the capability to accelerate the required inertia from 0 to 1500 rpm in 20 s.

3.1.2 Incremental inertia discs to simulate specified brake inertia within ±2 kg*m^2.

3.1.2.1 Specified brake inertia values are determined from in-stop torque/distance calculations as outlined in Appendix A.

3.1.3 Test brake station, fully enclosed in an air duct of sufficient size to accept the brake hardware and meet brake cooling specifications.

3.1.3.1 For caliper disc brakes, the brake test fixture is constructed from a vehicle knuckle, caliper, and rotor that meet original equipment specifications. An adapter attaches the knuckle to the dynamometer tailstock.

3.1.3.2 For drum brakes, the test brake is constructed from a brake fixture, backing plate, and drum that meet original equipment specifications.

A stub axle and adapter attach the backing plate to the dynamometer tailstock.

A wheel or wheel section may be included to increase brake stiffness or assist in meeting the brake cooling rate.

3.1.4 A pressure transducer, accurate to within ±0.5% of the reading and calibrated over the range from 300 to 14 000 kPa.

3.1.4.1 The pressure transducer is mounted just outside the air duct to minimize transducer thermal drift. A short (150 mm) brake line connects the transducer to the brake. (7.1)[1]

3.1.4.2 For disc brakes, a pressure connection is made at the piston centerline on the back of the caliper, or at the caliper bleed screw to measure output pressure.

3.1.4.3 For drum brakes, a pressure connection is made through a T adapter at the wheel cylinder bleed screw.

3.1.5 A tailstock section and load cell connected to the test brake. Load cell is calibrated over the required range and measures brake torque with an accuracy of ±0.5% at a torque corresponding to 1.0 g deceleration

3.1.6 A closed loop servo system to control brake applications under specified conditions.

a. Servo system capabilities include:

1. Linear pressure rise rate, over the specified range from 300 kPa through 95% of maximum pressure for the applications. For certain rear brakes, the pressure rise rate may be bilinear with pre- and post-knee slope that simulate vehicle specific proportioning valve characteristics.
2. Torque rise rate during ramp, free of inflection points other than those due to friction material characteristics, or to the programmed change in pressure rise rate, over the range from 50 N·m through 95% of maximum torque during the ramp portion of a brake application.
3. Not more than 5% torque or pressure over-shoot beyond specified preset level.
4. For torque and pressure control applications, transition from ramp control to sustained torque or pressure control, should be within +0, –3% of the specified sustained level.
5. Maintain an average sustained torque or pressure within ±1% of the specified level. The range of 100 Hz torque values during the sustained portion of a torque control application should not exceed 50 N·m.

3.1.7 Automated and integrated temperature control and data acquisition system. Calibrated to ±1% at 500 °C.

3.1.8 A negative pressure, closed loop brake cooling system to maintain required cooling air velocity and temperature during and between each test section. A metal screen with nominal 6 to 12 mm openings in the air duct, about 30 cm upstream of the brake, is recommended to improve air flow uniformity.

3.1.9 An automated and integrated data acquisition system to record specified data.

1. Section 7 provides supplementary Test Notes.

3.1.10 The frequency content of the information gathered in SAE J2430 is typically less than 15 Hz. Appropriate analog and digital filtering is necessary to insure good analog amplitude quantification. Therefore, minimum analog filtering with a 200 Hz, low pass, two-pole filter is required along with a minimum digital sampling rate of 400 Hz for speed, torque, and pressure data. This data is digitally filtered in a manner that does not insert a relative phase shift between measured channels. All instantaneous data is reported as 100 Hz filtered values that meet the previous criteria.

3.2 Data Processing System—An automated data processing system is recommended to carry out specified calculations, including least squares regression analysis and effective inertia, as well as distance averaged torque and pressure values.

3.3 Drum Brake Components—Use only original equipment brake hardware and component parts that meet all applicable vehicle manufacturer's specifications.

3.3.1 BRAKE DRUM—For each test, use a new, original equipment drum. Verify that test drum meets vehicle manufacturer's specifications for inside diameter, ovality, and surface finish. (7.2)

Test drum should be free of nicks, corrosion, or surface contamination. Do not grind or lathe cut inside diameter before use unless drum is outside vehicle manufacturer's specifications.

3.3.1.1 Install a plug type copper thermocouple in the drum. Drill 3.0 mm hole through drum at the center of lining rubbing track. Debur hole and mount thermocouple 1.0 mm below drum wear surface. Prepare thermocouple with #24 AWG "J" type thermocouple wire (solid, glass on glass) or equivalent, at least 60 cm long. Use 3.18 mm silver soldered, copper thermocouple plug per SAE J2115. It is recommended that plug be formed slightly out of round to insure a secure fit into the drilled hole.

3.3.1.2 Just prior to running SAE J2430, thoroughly clean drum surface with isopropyl alcohol and paper towels. (7.3)

3.3.2 LINED BRAKE SHOES

3.3.2.1 Aftermarket lined brake shoes are supplied a minimum of 1 mm over original equipment specified thickness to allow for final friction material grind based on actual drum diameter. Original equipment lined brake shoes are tested as manufactured.

3.3.2.2 Use bonded or riveted lined brake shoes which correspond to commercial products.

3.3.2.3 Use new original equipment or equivalent brake shoes.

3.3.2.4 Locate friction material on shoes per original equipment specifications. Assemble linings parallel to shoe table with no overhang. Heel and toe lining chamfer is optional, but should be consistent with commercial products.

3.3.2.5 Using an appropriate fixture and shoe grinder, final grind lined shoes to 0.45 to 0.55 mm under the average inside drum diameter to insure consistent contact at the horizontal midpoint of lining and avoid heel/toe contact. See 7.2.

3.3.2.6 Install lining thermocouples. Drill 3.0 mm holes through each shoe and lining 1.0 mm off the centerline at the horizontal center of each shoe. Use #24 AWG "J" type thermocouple wire (solid, glass on glass) or equivalent, at least 60 cm long. Use 3.18 mm X 3.18 mm silver soldered, copper thermocouple plug per SAE J2115. Mount thermocouple 1.5 mm below lining wear surface.

It is recommended that plugs be formed slightly out of round to insure a secure fit into the drilled hole. Run thermocouple wire through backing plate side of the shoe web to the tailstock connector.

3.3.3 WHEEL CYLINDER—Use an original equipment wheel cylinder. Inspect prior to each test and replace wheel cylinder if there is any evidence of leaks or thermal abuse.

3.3.4 SPRINGS, CLIPS, AND PINS

3.3.4.1 Use new, original equipment springs, clips, and pins for each test.

3.3.5 BACKING PLATE—Inspect backing plate prior to each test. Replace if there is any evidence of wear or bending.

3.3.6 FIXTURE ASSEMBLY AND ALIGNMENT—Using a dial indicator mounted on the drive shaft, align dynamometer tailstock shaft to driveshaft before mounting brake fixture or drum. Alignment should be square and concentric with 0.1 mm maximum TIR. Mount stub axle fixture with backing plate to tailstock flange without shoes. Locate backing plate such that wheel cylinder axis is horizontal. Torque backing plate mounting bolts per manufacturer's recommendation. Use dial indicator mounted on driveshaft to indicate drum pilot hole concentricity and flange squareness with 0.1 mm maximum TIR.

With dial indicator on driveshaft, indicate squareness of backing plate shoe support platforms. TIR should not exceed 0.25 mm over all shoe support platforms.

3.3.6.1 Measure and report mounted drum run-out by drilling a small hole in backing plate for dial indicator. Verify that drum is on center with driver. Re-index or replace drum if mounted drum run-out exceeds 0.07 mm.

3.3.6.2 Assemble shoes, springs, and parking brake lever, without a cable, to backing plate.

3.3.6.3 Cover backing plate cable hole to reduce air flow inside brake.

3.3.7 BRAKE ASSEMBLY—Assemble brake per manufacturer's recommendations. Connect lining thermocouple wires to tailstock connectors and drum thermocouple wire to slip ring. Use average drum diameter from 3.3.1 and manually adjust shoes with star wheel to a cage diameter on horizontal line of brake to 0.45 to 0.55 mm under drum diameter.

3.3.7.1 Close brake and manually rotate drum to verify minimal rubbing torque.

3.3.7.2 Thoroughly bleed brake at wheel cylinder T valve and at master cylinder.

3.4 Disc Brake Components

3.4.1 BRAKE ROTOR—Use a new, original equipment rotor for each test. Rotors should not be lathe cut or ground prior to use and should be free of surface corrosion, contamination, or nicks. Verify that test rotor meets vehicle manufacturer's specifications for run-out, and surface finish.

3.4.1.1 Use #24 AWG “J” type thermocouple wire (solid glass on glass), or equivalent, at least 60 cm long to connect rotor thermocouple to tailstock slip ring. Use 3.18 mm OD x 3.18 mm long silver soldered copper plug thermocouple per SAE J2115. It is recommended that plugs be formed slightly out of round to insure a secure fit into drilled holes. For a vented rotor, drill a 3.0 mm hole through the inner pad rotor face. Locate hole between ribs at the center point of rubbing track. Debur hole and mount thermocouple 1.0 mm below rotor wear surface. For a solid rotor, drill a 3.0 mm hole from rotor OD to ID with a center 2.5mm in from the inner pad rotor face. Locate thermocouple plug in hole at centerline of rubbing track.

3.4.1.2 Just prior to running SAE J2430, clean rotor with isopropyl alcohol and paper towels. (7.3)

3.4.2 DISC BRAKE FRICTION PARTS—Friction material/backing plate attachment should be consistent with production. Part dimensions are to be within original equipment specifications.

3.4.2.1 For riveted assemblies, minimum rivet break away torque is 500 m·N·m with semi-tubular rivets or 340 m.N.m with eyelets. Except where parts are manufactured with an insulator attached to the backing plate, tests should be run without external shims. Where used in production parts, a backing composite may be used between the friction material and backing plate.

3.4.2.2 Install lining thermocouple. Use #24 AWG "J" type thermocouple wire (solid, glass on glass), or equivalent, at least 60 cm long for pad thermocouple wires. For inner pad, drill a 3.0 mm hole through steel backing plate and friction material. Hole location is to be on the centerline of the pad long axis, 13mm forward of the center point or as close to 13 mm forward as practical. Locate thermocouple plug 1.5 mm below wear surface. For outer pad, drill a 3.0 mm hole through the backing plate and friction material. Hole location is to be at the midpoint of the pad long axis, equidistant between pad OD and ID. If required by an outboard piston or other design feature, locate thermocouple toward leading edge as required to avoid the obstruction. Locate thermocouple plug 1.5 mm below the wear surface.

3.4.3 CALIPER AND KNUCKLE—Verify that caliper to knuckle clearance meets original equipment specifications before each test. Inspect for dirt, corrosion, or build-up on the caliper/knuckle interface and for out-of-square caliper mounting on the knuckle.

3.4.3.1 Inspect and assemble caliper per manufacturer's recommendations. Replace caliper or knuckle if abutment surfaces show signs of peening or indentations. Manually verify low caliper slide force.

3.4.3.2 Inspect seals and boots before each test. Replace if there is any indication of wear or thermal abuse.

3.4.3.3 Inspect caliper slide pins before each test. Replace if there is any indication of bending, Brinell marks, or corrosion.

3.4.4 FIXTURE ASSEMBLY AND ALIGNMENT

a. Install and align brakes per vehicle manufacturer's recommendations.
b. Check knuckle to drive axis run-out at two bearing lands with tailstock locked. Adjust to not more than 0.10 mm TIR before proceeding.
c. Install rotor and measure run-out with rotor free turning. Replace rotor if mounted run-out exceeds 0.10 mm. Rotor run-out is measured on the inner pad face, 13 mm from rotor outside diameter.
d. Engage rotor to the drive and recheck run-out at low speed with tailstock locked. Run-out should not exceed 0.10 mm.

3.4.4.1 Long axis of caliper should be parallel within ±15 degrees of air flow direction.

3.4.4.2 Mount friction material assemblies in caliper and assemble brake. Bleed caliper thoroughly after mounting on knuckle. Connect rotor thermocouple to a slip ring and pad thermocouples to tailstock connectors.

3.5 Brake Fluid—Use glycol based, original equipment quality brake fluid such as DOW HD50-4 or equivalent that meets minimum requirements of FMVSS 116. (7.4)

If an alternate fluid has been used, flush system thoroughly and replace seals or wheel cylinder prior to running SAE J2430.

3.6 Dynamometer Checklist

3.6.1 Appendix B, Figures B1 and B2 provide a guide to assist in dynamometer set up and brake installation for disc and drum brake tests. It is recommended that this CHECKLIST be completed as values are obtained and included in the TEST REPORT.

4. Test Parameters and Control Specifications—SAE J2430 is run with vehicle specific brake hardware and test parameters. Table 1 summarizes input control specifications for the SAE J2430 procedure.

SAE J2430 specifies input controls in terms of vehicle parameters, such as sustained deceleration and brake pedal force. To run SAE J2430 for a specific brake application, it is necessary to convert vehicle parameters into the required brake parameters. The following are suggested for running SAE J2430 on a single end inertia dynamometer:

a. Brake Inertia—Run inertia adjustment tests as outlined in Appendix C as an estimate of front and rear brake inertia.
b. Rolling Radius—Available from vehicle dealership or from vehicle measurements.
c. Sustained Torque at Specified Sustained Deceleration Levels: Calculated from sustained deceleration, brake inertia, and rolling radius.
d. Brake Pressure Corresponding to Specified Pedal Force Values—Available from vehicle floor check measurements.
e. Proportioning Valve Activation Pressure and Post Knee Rear Brake Pressure Apply Slope (as percent of pre- knee pressure apply rate)—Available from vehicle floor check measurements.

4.1 Input Control Parameters

4.1.1 INERTIA (kg*m^2)—Dynamometer inertia weights are selected to provide an EFFECTIVE BRAKE INERTIA within ±2.0 kg*m^2 of the specified brake inertia.

4.1.2 TIRE ROLLING RADIUS (m)—Rolling radius is the distance from the road to the axle centerline.

4.1.3 SUSTAINED TORQUE (N·m)—Applicable to torque and pressure controlled applications only. Average sustained torque is to be within ±1% of the specified level. Use the distance averaged torque. For deceleration controlled applications, sustained torque is calculated from the specified mean fully developed deceleration (MFDD), brake inertia, and rolling radius.

4.1.4 PRESSURE RAMP RATES (kPa/s)—For all front axle brake applications, apply pressure is at a rate which equates to a pedal force apply rate of 135 N/s ± 5% for the specified vehicle application. For rear axle brakes, pressure apply rate is the same as the front brake up to the proportioning valve activation pressure if applicable. Above a proportioning valve activation pressure, rear brake pressure apply rate simulates post-knee slope for the vehicle application.

For all SAE J2430 brake applications, maintain the specified pressure apply rate through at least 95% of specified brake release or sustained control level. Pressure ramp rate is calculated from in-stop pressure/time data within the window from 50 N·m to 90% of maximum apply pressure.

4.1.5 BRAKE APPLY SPEED (km/h)—Brake apply speed should be within ±1% of the specified value for each test section.

4.1.6 INITIAL TEMPERATURES (°C)—Use initial drum or rotor temperature for all temperature controlled brake applications. Initial temperatures are measured at brake apply and should be within ±3 °C of specified.

TABLE 1—SAE J2430 INPUT CONTROL SPECIFICATIONS

Test Section	Number Stops	Speed (km/h) Initial	Brake Release	Sust. Pressure (kPa)	Sust. Torque	Maximum Torque (N·m)	Temp (°C) Rotor/Drum	Cycle Time (second)	Data Collect Range 50 N·m to ___	Effectiveness Range Calculation	Brake Inertia (kg*m^2)	Air Flow Vehicle Speed (km/h)
I.C. 50 km/h Torque Control	5	49.0 to 51.0	2.9 to 3.1		=0.31 ± 0.05 g		Amb to 103		8.0 km/h	50 N·m to 8.0 km/h	Spec ± 2 kg	80
I.C. 100 km/h Torque Control	5	99.0 to 101.0	2.9 to 3.1		=0.31 ± 0.05 g		97 to 103		8.0 km/h	50 N·m to 8.0 km/h		80
I.C. Pressure Control	3	49.0 to 51.0	2.9 to 3.1	=75 ± 5 N			97 to 103		8.0 km/h	50 N·m to 8.0 km/h		80
I.C. 50 km/h Ramp	5	49.0 to 51.0				=0.80 ± 0.01 g	97 to 103		0.80 g	0.15 g to 0.76 g		80
I.C. 100 km/h Ramp	5	99.0 to 101.0				=0.80 ± 0.01 g	97 to 103		0.80 g	0.15 g to 0.76 g		80
I.C. Cooling Curve												80
Burnish	200	79.0 to 81.0	2.9 to 3.1		=0.31 ± 0.05 g			97 s/100 °C	8.0 km/h	50 N·m to 8.0 km/h		80
Post Burnish 50 km/h Ramp	5	49.0 to 51.0				=0.80 ± 0.01 g	97 to 103		0.80 g	0.15 g to 0.76 g		80
Post Burnish 100 km/h Ramp	5	99.0 to 101.0				=0.80 ± 0.01 g	97 to 103		0.80 g	0.15 g to 0.76 g		80
Post Burnish Cold Effect	6	99.0 to 101.0	2.9 to 3.1		=0.65 ± 0.05 g		97 to 103		8.0 km/h	50 N·m to 8.0 km/h		80
Fade	15	119.0 to 121.0	55.8 to 56.2		=0.31 ± 0.05 g		50 to 60 first snub	44.5 to 45.5	60.0 km/h	50 N·m to 60.0 km/h		112
Hot Effectiveness	2	99.0 to 101.0	2.9 to 3.1	1) Avg from cold effect 2) = 500 N				1) 34.5 to 35.5 2) 29.5 to 30.5	8.0 km/h 8.0 km/h	50 N·m to 8.0 km/h		112
Cooling	4	49.0 to 51.0	2.9 to 3.1		=0.31 ± 0.05 g			119.5 to 120.5	8.0 km/h	50 N·m to 8.0 km/h		80
Recovery 100 km/h Ramps	2	99.0 to 101.0				=0.80 ± 0.01 g			0.80 g	0.15 g to 0.76 g		80
Reburnish	35	79.0 to 81.0	2.9 to 3.1		=0.31 ± 0.05 g			97 s/100 °C	8.0 km/h	50 N·m to 8.0 km/h		80
Final 50 km/h Ramp	5	49.0 to 51.0				=0.80 ± 0.01 g	97 to 103		0.80 g	0.15 g to 0.76 g		80
Final 100 km/h Ramp	5	99.0 to 101.0				=0.80 ± 0.01 g	97 to 103		0.80 g	0.15 g to 0.76 g		80
Final 160 km/h Ramp	5	159.0 to 161.0				=0.80 ± 0.01 g	97 to 103		0.80 g	0.15 g to 0.76 g		80
Post Test Cooling Curves												80 and 112

4.1.7 CYCLE TIME (S)—Actual time between brake applications. Once the INSTRUMENT CHECK has started, SAE J2430 is to be completed without unscheduled shutdown or delays between sections. A delay of up to 10 min may be required between the INSTRUMENT CHECK and the BURNISH sections to generate and analyze data from the INSTRUMENT CHECK SECTION.

Also, the test may be briefly suspended between COLD EFFECTIVENESS and FADE HEATING sections.

4.1.8 BRAKE RELEASE—SAE J2430 specifies the speed, maximum torque, or maximum pressure for brake release.

4.1.8.1 For ramp applications, brake release is at the maximum torque corresponding to a 0.80 g decel or at a pressure corresponding to 13 800 kPa, or at 3 km/h, whichever occurs first.

4.1.8.2 For torque and pressure control stops, brake release is at 3 km/h.

4.1.8.3 For torque control fade snubs, brake release is at 56 km/h.

4.2 Test Output Data

4.2.1 FINAL SPEED (km/h)—Speed at end of data collection interval.

4.2.2 STOPPING DISTANCE (m)—Distance from brake apply to end of data collection interval.

4.2.3 REGRESSED SPECIFIC TORQUE (N·m/kPa)—Applicable to ramp applications only. Regressed specific torque is the linear least squares regression coefficient for torque versus brake pressure.

4.2.4 COEFFICIENT OF DETERMINATION (R^2)—The Coefficient of Determination is the square of the correlation coefficient between observed and fitted torque values and is generated as part of the least square regression analysis.

4.2.5 AVERAGE TORQUE (N·m)—Applicable to all brake applications. Use the distance averaged torque within the specified effectiveness calculation range. See Appendix A for distance average torque calculation.

4.2.6 DRAG TORQUE (N·m)—Drag torque is the sustained torque with brake released and drive rotating. If drag torque exceeds 5 N·m during the INSTRUMENT CHECK COOLING CURVE, suspend test. Repair or replace parts and start a new test with the same drum or rotor and linings. If drag torque exceeds 5 N·m a second time, abort test. Instantaneous (100 Hz) torque within 0.20 s before any brake application should not exceed ±2 N·m.

4.2.7 MAXIMUM TORQUE (N·m)—Maximum torque is the maximum 100 Hz torque value within data collection range specified for each brake application (7.5). A maximum torque corresponding to a 1.0 g decel is recommended for all SAE J2430 brake applications.

4.2.8 AVERAGE SPECIFIC TORQUE (N·m/kPa)—Applicable to all brake applications. Average Specific Torque is defined as Average Torque/Average Pressure calculated over the specified range.

4.2.9 AVERAGE PRESSURE (kPa)—Applicable to all brake applications. Use the distance averaged pressure over the specified effectiveness calculation range.

4.2.10 MAXIMUM PRESSURE (kPa)—Maximum pressure is the maximum 100 Hz pressure value over the specified data collection range. A maximum pressure of 13 800 kPa is recommended for all SAE J2430 brake applications.

4.2.11 SUSTAINED PRESSURE (kPa)—Applicable to torque and pressure control applications only. Use the distance averaged pressure from level reached through the specified data collection range. For INSTRUMENT CHECK pressure control stops use the sustained pressure corresponding to a pedal force of 75 N.

4.2.12 HOLD OFF PRESSURE (kPa)—Hold off pressure is calculated from the least square regression analysis at zero torque. (7.6)

4.2.13 FINAL TEMPERATURE (°C)—Final drum or rotor and lining temperatures are measured 5 s after brake release.

4.3 Data Collection and Effectiveness Calculation Ranges—As shown in Table 1, data collection and effectiveness calculation ranges differ from brake release speed.

For all SAE J2430 brake applications, data collection starts at the first data point after reaching 50 N·m torque. This data point is to be within 10 ms after reaching 50 N·m.

4.4 Brake Cooling—Brake cooling rate for SAE J2430 is established to simulate the brake cooling rate for the vehicle application. SAE J2430 brake cooling rate is specified as a band for rotor or drum temperature versus time. The band is generated using ±10% from nominal vehicle based cooling coefficients at 80 km/h and at 112 km/h initial vehicle speed with a specified initial rotor or drum temperature. Cooling curve calculations are based on 27 °C ambient air temperature. Prior to starting a test, duct air velocity is adjusted as required to maintain brake cooling rate within the specified band.

4.4.1 Based on the nominal vehicle based brake cooling coefficients at 80 and 112 km/h vehicle speed, 200 °C ± 5 °C initial front temperature or 150 °C ± 5 °C initial rear brake temperature and 27 °C ambient air temperature, calculate a maximum and minimum dynamometer cooling band using ±10% from the nominal cooling coefficient. (7.7)

4.4.2 Set up the test brake on the dynamometer using original equipment friction material and drum or rotor. The drum or rotor does not have to be new, but should be within vehicle manufacturer's dimensional specifications.

4.4.3 Establish duct air velocity required to meet the cooling band at 80 and 112 km/h. When running brake cooling trials with an initially cold dynamometer, a minimum of 50 burnish applications (5.3) are recommended to warm and stabilize temperatures before running cooling trials.

4.4.3.1 For front brakes, accelerate to the required speed, apply 125 N·m torque and drag brake (45 s on, 10 s off) to 230 to 250 °C. Release brake, maintain speed with pre-established air flow, and allow brake to cool. Measure rotor and lining temperature, as well as brake drag at 15-s intervals (3 s on) from 200 °C for 270 s.

4.4.3.2 For rear disc or drum brakes, follow the procedure outlined in 4.4.3.1 except drag to 170-200 °C and measure rotor or drum temperature, lining temperature, and brake drag from 150 °C for 270 s.

4.4.4 Repeat sections 4.4.3.1 or 4.4.3.2 as required to establish duct air velocity required to meet the cooling bands at 80 and 112 km/h for the specific dynamometer and brake.

4.4.4.1 Duct air temperature, low drag torque, and stabilized brake hardware temperature are required to achieve reliable duct air velocity.

4.4.5 Remove the set up friction material and drum or rotor from the dynamometer and install new test parts.

4.4.6 Run SAE J2430 tests with test brake using air velocities established previously.

4.4.7 Cooling air temperature in the duct, 70 cm ± 5 cm upstream of the brake fixture is specified at 21to 28 °C during and between all test sections.

4.4.8 In addition to drum or rotor temperature and drag torque at 80 and 112 km/h, record ambient relative humidity and duct air temperature for each test.

4.4.9 Brake cooling speed between applications is the braking speed for the following cycle.

5. Test Procedure

5.1 Synopsis—See Table 2 for a synopsis of the SAE J2430 test procedure. (7.8)

TABLE 2—SAE J2430 PROCEDURE SYNOPSIS

	Number of Applications	Speed km/h	Sustained Decel m/s^2	Sustained Pressure kPa	Initial Temp. Drum °C	Cooling Air Vehicle Speed	Comments
L. Check	5	50-3	3	—	<100	80 km/h	
	5	100-3	3	—	100	80 km/h	
	3	50-3	—	=75 N	100	80 km/h	
	5	50	RAMP	—	100	80 km/h	
	5	100	RAMP	—	100	80 km/h	
	INSTRUMENT CHECK COOLING CURVE					80/km/h	
Burnish	200	80-3	3	—	—	80 km/h	97 s/100 °C
Effectiveness	5	50	RAMP		100	80 km/h	
	5	100	RAMP		100	80 km/h	
	6	100-3	6.4		100	80 km/h	
Fade	15	120-56	3	—	55 First Snub	112 km/h	45 s Cycle Time
Hot Performance	2	100-3		1) Best Cold Effect 2) @ 500 N	—	112 km/h	30 and 35 s
Cooling	4	50-3	3	—	—	80 km/h	120 s
Recovery Ramp	2	100	RAMP	—	—	80 km/h	60 s
Reburnish	35	80-3	3	—	100 First Stop	80 km/h	97 s/100 °C
Effectiveness	5	50	RAMP	—	100	80 km/h	
	5	100	RAMP	—	100	80 km/h	
	5	160	RAMP	—	100	80 km/h	
	POST TEST COOLING CURVES					80 and 112 km/h	

5.2 Instrument Check—The purpose of the INSTRUMENT CHECK SECTION is to verify input control parameters.

5.2.1 Run INSTRUMENT CHECK applications, including “drag to” heat and cooling curve, at the cooling air velocity established in 4.4 for 80 km/h vehicle speed.

5.2.2 TORQUE CONTROL APPLICATIONS—Make 5, 0.31 g MFDD, torque controlled applications from 50-3 km/h at 100 °C. Make 5 additional 0.31 g MFDD torque controlled applications from 100-3 km/h at the same sustained torque and temperature.

5.2.2.1 Run initial 50 km/h applications at 30 s cycle time to achieve 100 °C then hold 100 °C through remaining 50 and 100 km/h applications.

5.2.3 Constant Pressure Applications—Make 3 pressure controlled applications from 50 to 3 km/h at 100 °C at the sustained pressure corresponding to a pedal force of 75 N.

5.2.4 Ramp Applications—Make 5 ramp applications from 50 km/h at 100 °C then 5 additional ramp applications from 100 km/h at 100 °C.

5.2.5 Instrument Check Cooling Curve—Immediately following the final 100 km/h ramp application, increase speed to 80 km/h, apply 125 N·m torque specified in 4.4.3.1 or 4.4.3.2. Release brake, maintain 80 km/h with pre-established air flow and allow brake to cool. During cooling, measure drum or rotor and lining temperatures, as well as drag torque at 15-s intervals (3 s on) from 200 °C for front disc brakes and 150 °C for rear disc or drum brakes, for 270 s.

5.2.5.1 Immediately after completion of the INSTRUMENT CHECK COOLING CURVE, accelerate to 80 km/h, and initiate first BURNISH application.

5.2.6 During the INSTRUMENT CHECK, or early portion of the BURNISH, verify that the following test specifications are satisfied. If one or more conditions are not met, suspend the test, make adjustments as required and repeat 5.2.2 through 5.2.5 with the same brake hardware and linings. If results still do not meet the following specifications, abort the test.

5.2.6.1 Ramp rates and linearity during 50 and 100 km/h torque control and ramp applications as specified in 4.1.4.

5.2.6.2 Maximum torque range per revolution during second half of pressure control applications does not exceed 50 N·m. (7.9)

5.2.6.3 Brake release during 50 and 100 km/h ramp applications per 4.1.8.1.

5.2.6.4 Drum or rotor temperature cooling rate at the air velocity and duct air temperature per 4.4.

5.2.6.5 Sustained torque (brake drag) during cooling curve does not exceed 5 N·m.

5.2.6.6 For ramp, torque control, and pressure control applications, specified ramp rate is maintained through at least 95% of specified level.

5.3 Burnish

5.3.1 Make 200, 0.31 g MFDD torque control applications from 80-3 km/h. Start to start interval between BURNISH applications is 97.0 s (7.10) or 100 °C drum or rotor temperature, whichever occurs first.

5.3.2 Immediately after the final BURNISH application, accelerate to 50 km/h for POST BURNISH RAMPS.

5.4 Post Burnish Ramps

5.4.1 Make 5 ramp applications from 50 km/h at 100 °C then 5 additional ramp applications from 100 km/h at 100 °C.

5.4.2 Immediately after the final 100 km/h POST BURNISH RAMP, accelerate to 100 km/h for first COLD EFFECTIVENESS stop.

5.5 Cold Effectiveness Stops—Make 6, 0.65 g MFDD torque control stops from 100 to 3 km/h and 100 °C initial drum or rotor temperature. Maximum pressure should not exceed that corresponding to 500 N pedal force during any COLD EFFECTIVENESS STOP.

5.5.1 Immediately after final COLD EFFECTIVENESS STOP, suspend test only long enough to identify the minimum sustained pressure during the 6 COLD EFFECTIVENESS STOPS.

Include this sustained pressure in the dynamometer control program for the first HOT PERFORMANCE STOP.

5.5.2 Adjust duct air flow to the rate previously established to meet the brake cooling band at 112 km/h. Accelerate to 120 km/h and allow brake to cool to 55 °C rotor or drum temperature.

5.6 Fade Heating Snubs

5.6.1 Make 15, 0.31 g MFDD, torque control snubs from 120-56 km/h. First snub is at 55 °C, then use 45 s brake apply to brake apply cycle times for remaining applications.

5.6.2 Maximum pressure during FADE HEATING SNUBS should not exceed that corresponding to 500 N pedal force.

5.6.3 Immediately after the 15th FADE HEATING SNUB, accelerate to 100 km/h for HOT PERFORMANCE STOPS.

5.7 Hot Performance Stops

5.7.1 Make 2, pressure control stops at from 100-3 km/h.

5.7.2 First HOT PERFORMANCE STOP is run at a sustained pressure corresponding to the minimum sustained pressure during the 6 COLD EFFECTIVENESS STOPS. Initiate first HOT PERFORMANCE STOP 35 s after start of 15th FADE HEATING SNUB.

5.7.3 Second HOT PERFORMANCE STOP is run at a sustained pressure corresponding to 500 N pedal force with vacuum assist. Initiate second HOT PERFORMANCE STOP 30 s after start of first HOT PERFORMANCE STOP.

5.7.4 Immediately after second HOT PERFORMANCE STOP, adjust air flow to correspond to brake cooling band at 80 km/h and accelerate to 50 km/h for the first COOLING CYCLE stop.

5.8 COOLING CYCLE

5.8.1 Make 4, 0.31 g MFDD torque control stops from 50 to 3 km/h.

5.8.2 Maintain 50 km/h for 120 s between start of the second HOT PERFORMANCE STOP and the first COOLING CYCLE STOP. Make the 3 remaining COOLING CYCLE STOPS at 120 s, start to start intervals.

5.8.3 Immediately after the 4th COOLING CYCLE STOP, accelerate to 100 km/h for the first RECOVERY RAMP application.

5.9 Recovery Ramps

5.9.1 Make 2 ramp applications from 100 km/h.

5.9.1.1 Initiate first RECOVERY RAMP application 60 s after the start of the 4th COOLING CYCLE STOP.

5.9.1.2 Initiate 2nd RECOVERY RAMP application 60 s after the start of the first RECOVERY RAMP application.

5.9.2 Immediately after the 2nd RECOVERY RAMP application, accelerate to 80 km/h for the first REBURNISH application.

5.10 Reburnish

5.10.1 Make 35, 0.31 g MFDD, torque control applications from 80 to 3 km/h. First REBURNISH application is at 100 °C. The start to start interval between subsequent applications is 97.0 s or 100 °C initial drum or rotor temperature, whichever occurs first.

5.10.2 Immediately after the final REBURNISH application, accelerate to 50 km/h for first POST FADE RAMP application.

5.11 Post Fade Ramps

5.11.1 Make 5 ramp applications from 50 km/h then 5 ramp applications from 100 km/h and 5 ramp applications from 160 km/h. All POST FADE RAMP applications are run at 100 °C.

5.11.2 Immediately after the final 160 km/h POST FADE RAMP, accelerate to 80 km/h and initiate the POST TEST COOLING CURVES.

5.12 Post Test Cooling Curves

5.12.1 Heat drum or rotor to the specified temperature by applying 125 N·m torque and drag at 80 km/h. Release brake, maintain 80 km/h with pre-established air flow and duct air temperature. Allow brake to cool. During cooling, measure drum or rotor and lining temperature, as well as drag torque at 15-s intervals (3 s on) from the specified temperature for 270 s. Repeat POST TEST COOLING CURVE at 112 km/h using previously established air flow rate. (7.11)

END OF TEST (TOTAL 312 BRAKE APPLICATIONS)

6. Final Inspection and Test Report

6.1 Disassemble brake and inspect all test parts.

6.1.1 For friction material test parts, report any abnormal conditions such as cracking, crushing, loose rivets, debond, lining separation from shoe, tapered wear or dimensional changes in shoe or backing plate.

6.1.2 For drums or rotors, report any abnormal surface conditions such as cracks, heat check, scoring or other abnormal surface conditions.

6.2 Include INSTRUMENT CHECK and POST TEST COOLING CURVE results in TEST REPORT.

6.3 Report BURNISH data for the first and each 10th application.

6.4 Report REBURNISH data for the first and each 5th application.

6.5 Calculate and report REGRESSED SPECIFIC TORQUE for each ramp application using a least squares regression algorithm within the ranges specified in Table 1.

6.5.1 Calculate and report the COEFFICIENT OF DETERMINATION (R^2) for each ramp application.

6.6 Calculate and report AVERAGE SPECIFIC TORQUE for all brake applications.

6.7 Calculate and report effective brake inertia for all brake applications.

6.8 Calculate and report HOLD OFF PRESSURE for ramp applications.

6.9 Complete DYNAMOMETER CHECK TEST, (Figure B1 or B2) and include in TEST REPORT.

6.10 Generate a SUMMARY TEST REPORT, including data for each brake application with column definitions as specified in 4.1 and 4.2.

7. Test Notes

7.1 Excess distance between the brake and pressure transducer results in a high indicated pressure level before torque response. As a guide, pressure should not exceed 250 kPa over push out pressure, when torque reaches 50 N·m.

7.2 It is recommended that initial drum diameter be measured at 3 locations, 120 degrees apart. Drum diameter measurements are made to ±0.01mm at locations 6 mm in from open end. Ovality is the difference between maximum and minimum drum diameter values.

7.3 Original equipment service drums and rotors may be treated with an anti-corrosion oil which vehicle manufacturers indicate will be removed during burnish.

7.4 Brake fluid chemistry can affect seal roll-back. Also, silicon-based fluids are more compressible than gylcol-based fluids at high temperature.

7.5 All data within the specified range is to be included in calculations for each application. No data is to be excluded during or after transition from ramp control to torque or pressure control.

7.6 Hold off pressure can be useful to detect abnormal hold off springs.

7.7 Brake Cooling Band Calculations

7.7.1 Slow cooling (upper) rate limit on front brake.

Calculate:

$$\frac{[\log((Ti - Ta) - 0.9*cc*t)]}{t = 0 \text{ to } 270 \text{ s}} \quad \text{(Eq. 1)}$$

where:

Ti = initial temperature (205 °C)
Ta = ambient temperature (27 °C)
cc = cooling coefficient
t = time in seconds

Anti LOG of [log(Ti–Ta) – 0.9*cc*t] gives (T–Ta) at time t. Using Ta = 27 °C, calculate front rotor temperature versus time at 15-s intervals from 0 to 270 s.

7.7.2 For the fast cooling (lower) rate on front brakes, use the previous calculations except Ti = 195 °C and use 1.10*cc.

7.7.3 Rear brake upper and lower band limits are calculated as previous mentioned except Ti = 155 and 145 °C.

7.8 No reverse direction brake applications are permitted during an SAE J2430 test. No unspecified brake applications are to be run before, during, or after the test.

7.9 Torque fluctuation per revolution during the low speed portion of a pressure control stop can be a useful measure of drum ovality, mounted drum run out, or rotor thickness variation.

7.10 The 97-s cycle time is calculated from distance to stop, distance to accelerate back to 80 km/h (same as stop distance) plus time at 80 km/h to total 2 km.

7.11 POST TEST COOLING CURVES are included for diagnostic purposes only. Meeting the specified bands is not necessarily a criterion for a valid test. A POST TEST cooling rate within the specified band, indicates that air flow and temperature have not changed through the test. If the POST TEST cooling rate deviates from the band, or if final drag torque exceeds specification, this may indicate friction material drag, a drum ovality/ mounting problem, or a change in air flow rate or temperature. Further investigation is recommended.

PREPARED BY THE SAE BRAKE DYNAMOMETER TEST CODE STANDARDS COMMITTEE

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