

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 $\pm 0.5\%$ 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 $\pm 2 \text{ kg}\cdot\text{m}^2$.

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 $\pm 0.5\%$ 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 $\pm 0.5\%$ 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 $\pm 1\%$ 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 $\pm 1\%$ 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
- Install and align brakes per vehicle manufacturer's recommendations.
 - 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.
 - 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.
 - 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.