SAE International

SURFACE VEHICLE RECOMMENDED PRACTICE

SAE J160 FEB2013

Issued 1970-07
Revised 2013-02

Superseding J160 OCT2001

(R) Swell, Growth, and Dimensional Stability of Friction Materials and Noise Insulators when Exposed to Elevated Temperatures

RATIONALE

This revision includes changes to definitions, requires the use of a cover around the machine to reduce external effects on temperature build-up, provides more details on the measurement points, increases the number of measurement points to increase the accuracy of the measurement, harmonizes test temperatures with the ISO 6313 and the JIS D4416, and allows different types of samples for the test. In addition, it allows other means of preloading the sample different from a mechanical device, and indicates five samples as the default number per product. This revision also incorporates a direct reference to ISO 6313:1980 and JIS D4416:1998. When a product or platform specification migrates to or from the ISO 6313:1980 or the JIS D4416:1998 procedures, the task force recommends proper accuracy studies for repeatability, reproducibility, and correlation between the legacy and the new procedure.

FOREWORD

The dimensional stability of friction materials when exposed to elevated temperatures is an important aspect of brake performance and an indication of the different formulation and manufacturing effects. The swell and/or growth of the friction material may create unintended contact with the rubbing surface with potential effects like brake drag, development of rotor thickness variation, or change in brake pedal feel. This revised standard provides a precise method to quantify dimensional changes at temperatures and conditions relevant to actual usage, known as method A. The former procedure (oven method B) is retained as an approximate method for drum brake linings.

1. SCOPE

This performance standard specifies a universal method of measuring the dimensional change of friction materials to determine the effects of temperature. The test applies to both, disc and drum type linings commonly used in hydraulic and air brake systems for automotive or commercial vehicle applications.

This standard describes two main test procedures. Method A, where the friction material is in contact with a heated surface to simulate the heat input to the pad that occurs during actual usage. Method B uses an oven to heat the freestanding material and is an approximate procedure requiring less instrumentation. Method A is recommended for disc brake pad assemblies, noise insulators, or flat coupons; while Method B is recommended for curved drum brake linings.

1.1 Purpose

This test procedure establishes common laboratory test methods to determine the dimensional stability of friction materials when exposed to elevated temperatures. The intent of this procedure is to characterize swell and growth.

TO PLACE A DOCUMENT ORDER: **Tel: 877-606-7323 (inside USA and Canada)**
Tel: +1 724-776-4970 (outside USA)
Fax: 724-776-0790
Email: CustomerService@sae.org
SAE WEB ADDRESS: http://www.sae.org

SAE values your input. To provide feedback on this Technical Report, please visit
http://www.sae.org/technical/standards/J160_201302

2. REFERENCES

2.1 Related Publications

The following publications are provided for information purposes only and are not a required part of this SAE Technical Report.

2.1.1 ISO Publication

Available from American National Standards Institute, 25 West 43rd Street, New York, NY 10036-8002, Tel: 212-642-4900, www.ansi.org.

ISO 6313:1980 Road vehicles - Brake linings - Effects of heat on dimensions and form of disc brake pads—Test procedure

2.1.2 JIS Publication

Available from Japanese Standards Association, 4-1-24, Akasaka Minato-ku, Tokyo 107-8440, Japan, Tel: +81-3-3583-8005, www.jsa.or.jp.

JIS D 4416:1998 Test Procedure of Thermal Expansion for Brake Linings and Pads of Automobiles

JIS B 7502:1994 Micrometer Calipers

3. DEFINITIONS

3.1 Green Swell

Transient change in the outer dimensions of a friction material during the first brake heating event. The largest portion of the green swell occurs when the friction material temperature is above the temperature used for curing in the manufacturing process. Green swell includes both, swell and growth.

3.2 Growth

The permanent change of the outer dimensions of a friction material test sample when returned to ambient conditions, after exposure to an elevated temperature cycle.

3.3 Swell

The temporary change in the outer dimensions of a friction material due to exposure to elevated temperatures

3.4 Swell Curve

The transient change in the thickness of a friction material as a function of temperature. The swell curve is a useful tool to assess specific conditions and characteristics of the friction product under testing

4. SYMBOLS

See Table 1.

TABLE 1 - SYMBOLS

Symbols		Designation
z_i	z_f	mean thickness of test specimen, i-initial, f-final
y_i	y_f	mean width of a test specimen, i-initial, f-final
x_i	x_f	mean length of a test specimen, i-initial, f-final
d_i	d_f	movement of upper platen, i-initial, f-final
t		time

5. TEST METHOD A – HOT PLATE METHOD

5.1 Equipment (See Figure 1)

The test equipment is comprised of the following primary elements (reference ISO 6313:1980 and JIS D 4416:1998 for additional loading systems that are also allowed for this method):

5.1.1 Base and Fixtures

Includes fixtures to match the sample under test and to react to the applied forces without deformation.

5.1.2 Heating Platen

An electrically-heated steel plate with facilities to mount fixtures to emulate the braking surface for each test sample. The test equipment shall have a cover or enclosure around the heating platen to minimize cold air drafts around the sample.

5.1.3 Pad assembly or noise insulator locator (not shown on Figure 1)

Device used to ensure proper and repeatable alignment and positioning of the brake pad assembly (or noise insulator) with the piston(s) simulator, resembling the vehicle/caliper relative position of the piston(s) and the test item (brake pad assembly or noise insulator).

5.1.4 Loading System

A mechanism capable of maintaining a normal load on the test sample equivalent to 30 kPa ± 10 kPa over the sample surface area in contact with the heating platen. For noise insulator testing use the contact area for the intended brake pad assembly

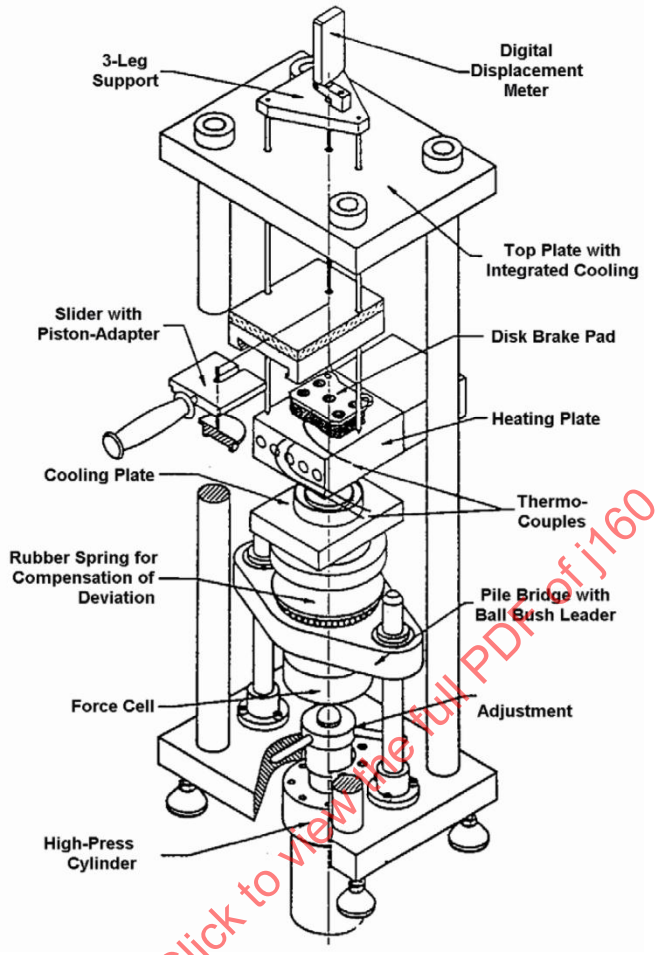

FIGURE 1 - TYPICAL TEST APPARATUS

5.2 Measurement Systems

5.2.1 Displacement Measurement Device

Capable of measuring the dynamic change in sample thickness with an accuracy of ± 0.0001 mm throughout the displacement range; with appropriate temperature compensation for the thermal expansion of the measuring device.

NOTE: Alternatively, preheat the test system by: (a) inserting a 15 mm- thick flat and polished steel plate and a piston simulator, (b) bringing the heating platen temperature to the test temperature, and (c) applying test preload per 5.1.3 for at least 30 minutes to ensure uniform temperature of the heating platen and the displacement measurement device

5.2.2 Thickness Measurement Device

Capable of measuring the entire thickness of the sample or coupon with an accuracy of ± 0.001 mm.

5.3 Control and Data Gathering System

Capable of controlling and monitoring temperatures with accuracy of ± 1 °C throughout the temperature range

5.4 Data Recording System

Monitors and records pertinent test results and enables the plotting of sample temperature versus sample thickness

5.5 Sample Preparation

Test specimens shall be prepared in accordance with each specific brake type.

5.5.1 Disc Pads (passenger cars, light and medium-duty trucks, and commercial vehicles)

The entire disc pad assembly without noise insulators or a coupon of the disc pad assembly that meets the maximum size limitations of the machine.

5.5.2 Noise insulators

Mount (bond or adhere) each noise insulator onto a flat steel plate per the insulator (or friction material) manufacturer's instructions.

5.5.3 Drum lining

5.5.3.1 Flat coupon (truck brake block for commercial vehicles, typically in sets of eight per axle)

Prepare a square test sample 80 mm x 80 mm from the thickest end of the block. Document the location used to prepare the sample. Machine the sample flat to within 0.01 mm; prevent overheating during the machining operation to avoid surface curing of the different resins and binders on the friction material.

5.5.3.2 Curved coupon (drum lining, typically in sets of four per axle)

Prepare a curved test sample 80 mm x 80 mm or square using the full width of the original friction material. Document the location of the segment used to prepare the coupon. The coupon holder and the heating surface need to have a matching surface to ensure proper contact of the entire area of the coupon on both sides. Document the coupon geometry and size as well as the method used to machine it.

5.6 Provisions for Measurements and Thermocouples

5.6.1 For initial and final thickness measurements, mark the sample on the flat (or concave) surface (opposite side of the heated surface).

5.6.2 For complete disk pads assemblies mark the sample in ten locations (five on each side of the centerline or center slot) approximately 5 mm from the edges on the friction material, using the side in contact with the heating platen as illustrated in Figure 2.

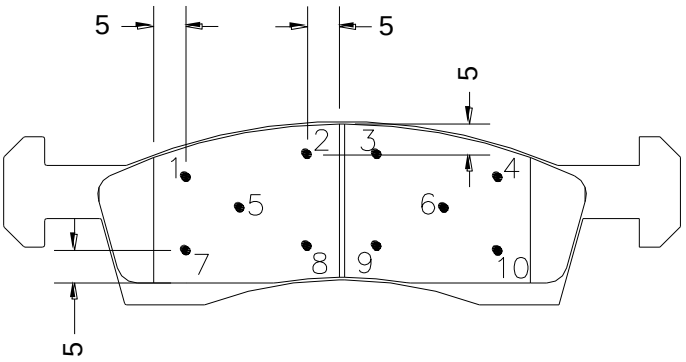

FIGURE 2 - MEASUREMENT POINTS FOR DISC PAD ASSEMBLIES

5.6.2.1 For coupons or segments cut from disk pad assemblies, mark the sample in five locations on the friction material side in contact with the heating platen.

5.6.2.2 For truck blocks or drum segments mark the sample in nine locations on the friction material side in contact with the heating platen as illustrated in Figure 3.

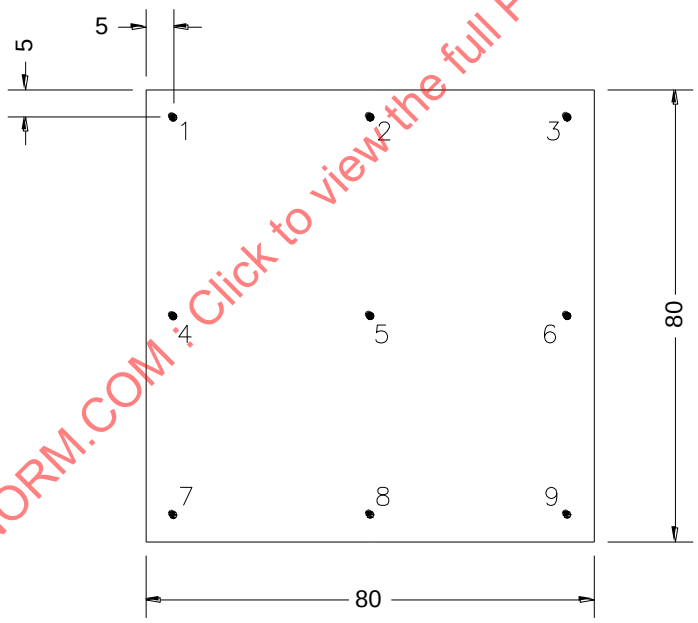

FIGURE 3 - MEASUREMENT POINTS FOR TRUCK BLOCKS OR DRUM SEGMENTS

5.6.3 Thermocouple location

Unless specified by the test requestor, for disc pad assemblies install the two measurement thermocouples as illustrated in Figure 4 to record temperature at the friction interface with the heating platen and at the center of the shoe plate, or in the absence of a shoe plate, at a point farthest from the heated surfaces. For friction materials with center slots, offset the thermocouples approximately 5 mm from the edge of the slot. For commercial vehicle brake blocks or drum segments, install only the thermocouple at the interface surface with the heating platen and use a piston simulator with a center slot to allow the proper routing of the thermocouple wire. Install one thermocouple recessed 1.0 mm $\pm$ 0.1 mm below the friction surface per figure 4. Install a second thermocouple near the mid-point of the backing plate in line with the first thermocouple.

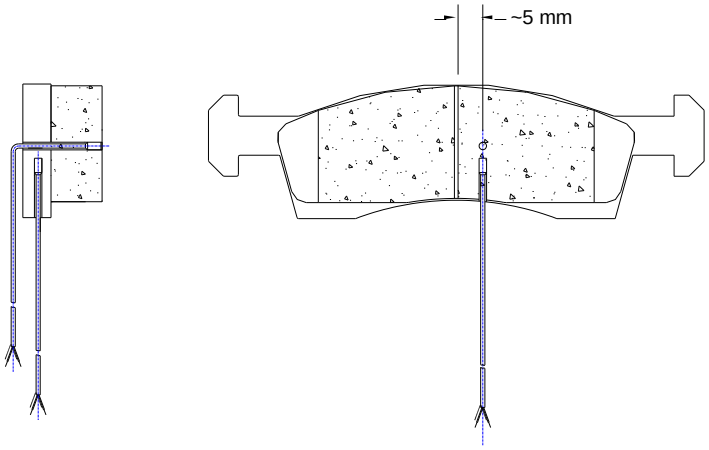

FIGURE 4 - LOCATION OF THERMOCOUPLE

6. FIXTURES

6.1.1 The lower and upper fixture plates must closely follow the contour of the test sample such that a 0.1 mm feeler gauge does not fit between the sample and the fixture at any point around the periphery of the sample.

7. MEASUREMENTS

7.1 Measure the thickness of all sample or coupons per items 5.2.2 and 5.6.

7.2 Measure other characteristics that may be applicable to the purpose of the test such as length (y) and width (x).

8. NUMBER OF SAMPLES

Unless otherwise indicated by the test requestor, conduct the test using five samples

9. TEST METHOD A - MACHINE METHOD

9.1 Ensure calibration status of test stand is current

9.2 Measure and record thickness of sample per item 5.6.1

9.3 Heat stand to 400 °C ± 10 °C (200 °C ± 10 °C for noise insulators) or as specified by the test requestor

9.4 Insert thermocouple per item 5.6.3

9.5 Insert sample in stand using sample holder

9.6 Apply pre-load per 5.1.3 over the sample area in contact with the heating platen

9.7 Begin recording data

9.8 Record sample thickness and temperature for 30 min at 1 s intervals

9.9 Release pre-load and remove sample

9.10 Allow sample to cool to room temperature

9.11 Measure and record thickness of samples

9.12 Repeat steps 9.5 through 9.11 (rerun or steady state measurement)

10. TEST REPORT

10.1 Calculate individual growth as the difference between the final and the initial thickness measurements at room temperature for each measurement points. Overall growth is the mean of all the differences.

10.2 Plot green swell and re-run swell on a chart using sample temperature as the X-axis and sample swell as the Y-axis (see Figure 5).

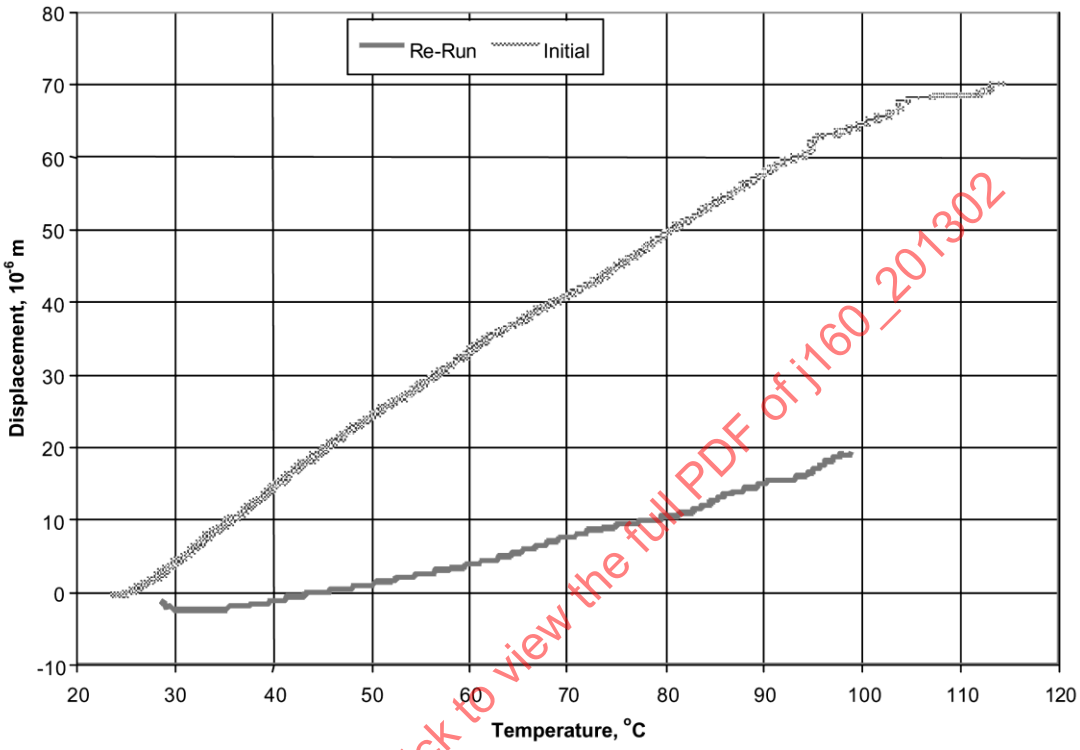

FIGURE 5 - EXAMPLE DATA PLOT

10.3 Plot sample swell versus time

10.4 The test report shall contain the following items:

10.4.1 Sample identification including material description, fixturing, test parameters, and preparation procedure

10.4.2 Test conditions including location of thermocouple

10.4.3 Mean thickness z_i at the beginning of the test at ambient temperature

10.4.4 Mean thickness z_f at the end of the test at ambient temperature

10.4.5 Residual change of thickness and any other dimensional changes of the material at the end of the test after the cool down to room temperature

10.4.6 The maximum swell with the corresponding the time and temperature at which it occurred

10.4.7 Maximum temperature reached

10.4.8 Swell at highest temperature for the green and re-run conditions

10.4.9 Appearance of the friction material after the test, noting especially, formation of blisters, cracks, peeling, chipping of friction material, or detachment from the backing plate