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# SURFACE VEHICLE STANDARD

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## (R) Dimensional Stability of Friction Materials When Exposed to Elevated Temperatures

***Foreword*—**The dimensional stability of friction materials when exposed to elevated temperatures is an important aspect of brake performance. The swell and/or growth of the friction material may create unintended contact with the rubbing surface. This revised performance standard was developed to provide a precise means to quantify dimensional changes at temperatures and conditions relevant to actual usage. The former procedure is retained as an approximate method, Test Method B, in this new procedure.

***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 automotive and truck type braking systems.

**1.1 Purpose—**The purpose of this test procedure shall be to establish a common laboratory test method for determining the dimensional stability of friction materials when exposed to elevated thermal conditions. The intent of this procedure is to characterize material swell and growth.

***2. References***

**2.1 Related Publications—**The following publications are for information purposes only and are not a required part of this document.

2.1.1 ISO PUBLICATION—Available from 25 West 43rd Street, 4th Floor, New York, NY 10036.

ISO 6313—Road vehicles—Brake linings—Effectives 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, JAPAN, 107.

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





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***3.*** ***Definitions—***Two test procedures are described. Method A, which simulates the Friction Material in contact with a heated rubbing surface, is preferred as it provides higher accuracy. Method B, which uses an oven to heat the freestanding material, is an approximate procedure requiring less instrumentation and is not recommended for qualification testing.

**3.1** **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.

**3.2** **Swell—**The change in the dimensions of a friction material test sample due to exposure to elevated temperatures.

***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 Technique – Preferred***

**5.1** **Equipment—**(See Figure 1) - The test equipment is comprised of the following primary elements.

5.1.1 BASE AND FIXTURES—Includes fixtures to match the sample under test and to resist apply forces without deformation.

5.1.2 HEATING PLATEN—An electrically heated steel plate with facilities to mount fixtures to emulate the rubbing surface for each test sample

5.1.3 MECHANICAL LOADING SYSTEM—A mechanism capable of maintaining a normal load to the test sample equivalent to 50 kPa ± 30 kPa (7.25 lb/in$^2$ ± 4.35 lb/in$^2$) over the sample surface area.

**5.2** **Measurement Systems**

5.2.1 DISPLACEMENT MEASUREMENT SYSTEM—Capable of measuring the dynamic change in sample thickness with accuracy of 0.001 mm (0.00004 in) throughout the displacement range.

5.2.2 CONTROL AND DATA GATHERING SYSTEM—Enables temperatures to be controlled and monitored with accuracy of 1 °C (2 °F) throughout the temperature range.

5.2.3 DATA RECORDING SYSTEM—Monitors and records pertinent test results and enables the plotting of sample temperature versus sample thickness.

**5.3** **Sample Preparation—**Test specimens shall be prepared in accordance with each specific brake type.

5.3.1 DISC PADS—The entire disc pad assembly with or without shoe flats and damper, or a sample of the disc pad shall be used that meets the maximum size limitations of the machine.

5.3.2 TRUCK BLOCKS—Prepare a test sample of 80 mm x 80 mm (3.2 in x 3.2 in) from the thicker end of the block.

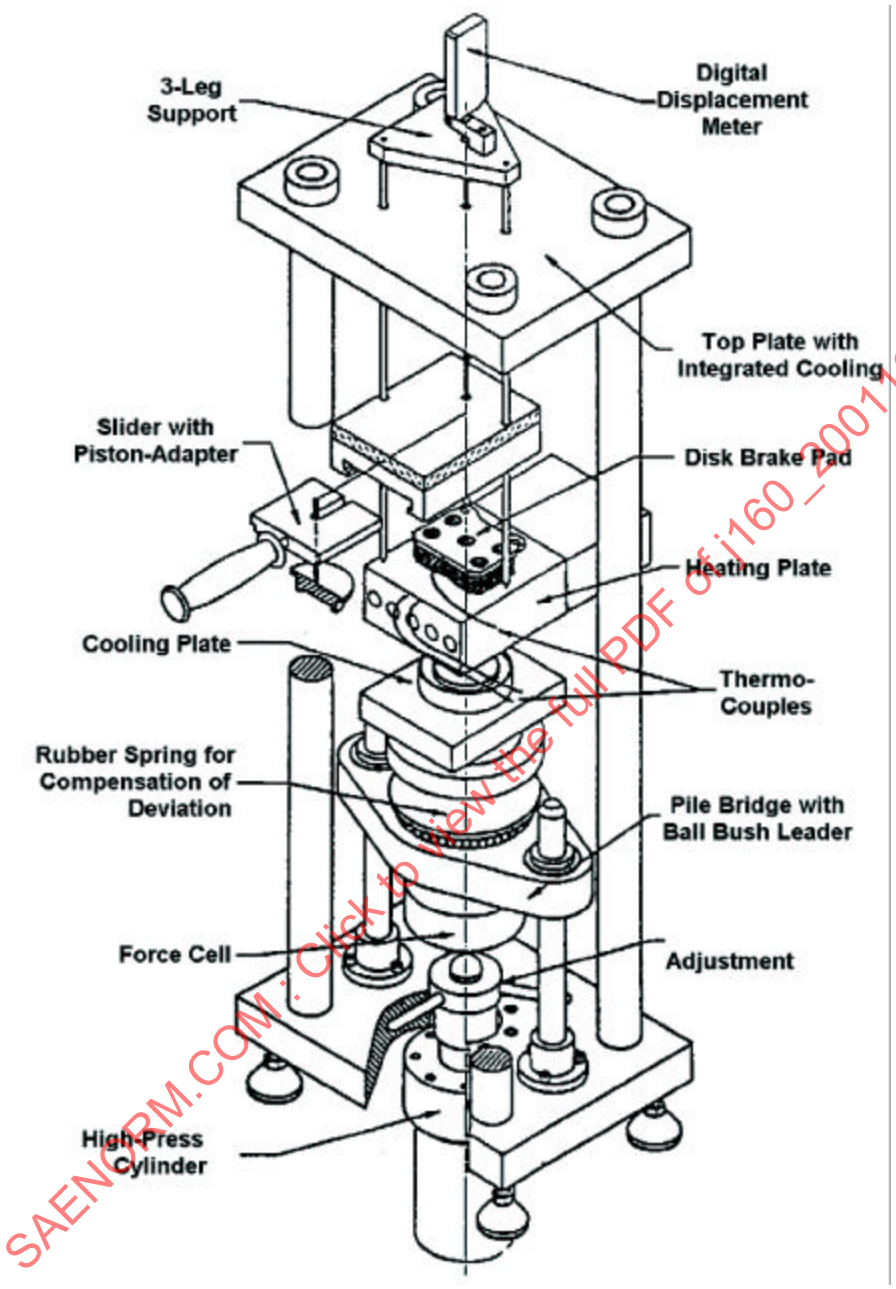




FIGURE 1—TEST APPARATUS

5.3.3 DRUM SEGMENTS—Prepare a 80 mm x 80 mm (3.2 in x 3.2 in) or full width specimen from the thickest portion of the segment. Shorter specimens are acceptable where fixturing limitations dictate.

**5.4 Provisions for Measurements and Thermocouples**

5.4.1 For initial and final thickness measurements mark the sample in five locations on the flat (or concave) surface (opposite heated surface).

5.4.2 Unless specified by the test requester, install the thermocouple as illustrated in Figure 2 to a position at the center of the shoe plate, or in the absence of a shoe plate, at a point farthest from the heated surfaces.

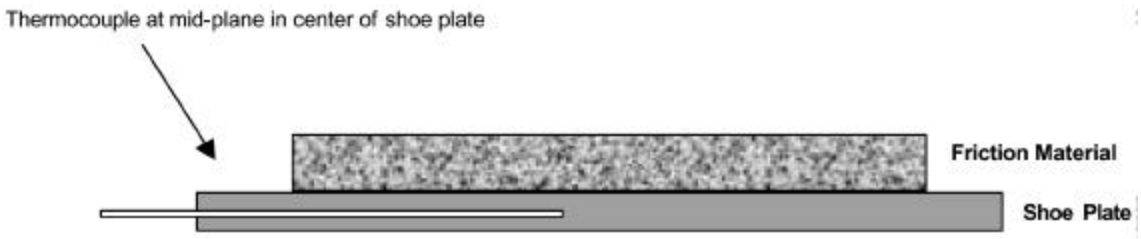


FIGURE 2—LOCATION OF THERMOCOUPLE

**5.5 Fixtures**

5.5.1 The lower and upper fixture plates must closely follow the contour of the test sample such that a 0.1 mm (0.004 in) feeler gauge may not be inserted between the sample and the fixture at any point across the surface of the sample.

**5.6 Measurements**

5.6.1 Measure the sample thickness at the five points referenced in 5.4.1 using a precision instrument +0.01 mm (0.0004 in). More accurate measurement techniques are required for growth values less than 50 mm (0.002in).

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

**5.7 Test Method**

5.7.1 Ensure calibration status of test stand is current.

5.7.2 Measure and record thickness of sample at 5 locations (ref. 5.6.1).

5.7.3 Heat stand to 300 °C ± 5 °C (572 °F ± 9 °F) or as specified by the test requester.

5.7.4 Insert thermocouple. (Ref. 5.4.2)

5.7.5 Insert sample in stand using sample holder.

5.7.6 Apply Pre-load. 50 kPa ± 30 kPa (7.25 lb/in$^2$ ± 4.35 lb/in$^2$) over the sample area.

5.7.7 Begin logging data.

5.7.8 Record sample thickness and temperature for 10 min at 5-s intervals.

5.7.9 Release pre-load and remove sample.

5.7.10 Allow sample to cool to room temperature.

5.7.11 Measure and record thickness of sample at 5 marked locations

5.7.12 Repeat 5.7.3 through 5.7.11 (rerun)

**5.8** Test Report Calculate difference as final minus initial measurements at room temperature for each of 5 measured points. Growth is the mean of the five differences.

5.8.1 Plot initial swell z data and second (rerun) swell z data on a chart using sample temperature as the X-axis and sample swell as the Y-axis (see Figure 3).

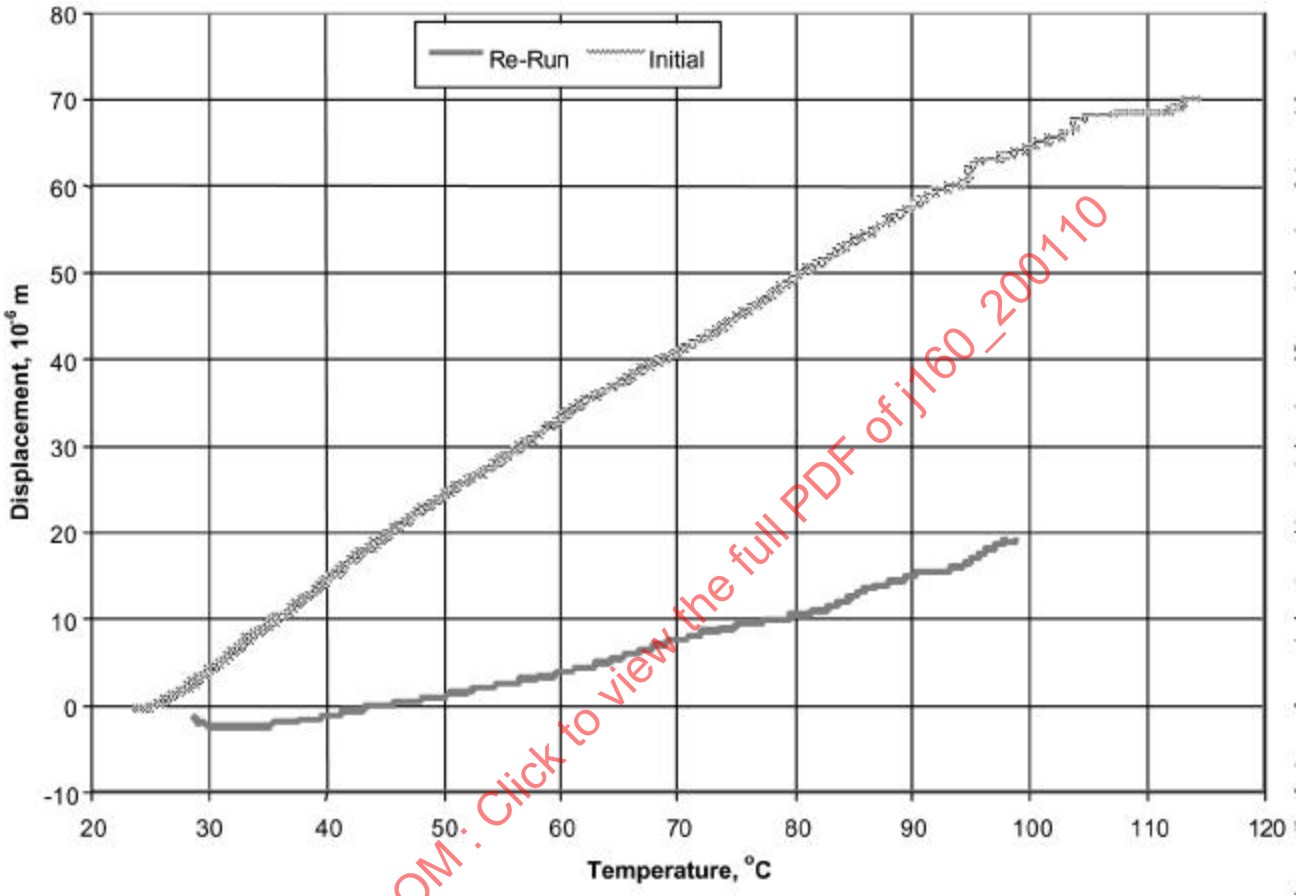


FIGURE 3—EXAMPLE DATA PLOT



5.8.2 Plot swell versus time.

5.8.3 The test report shall contain the following particulars.

*5.8.3.1* Sample identity including sample description, fixturing, test parameters and preparation procedure.

*5.8.3.2* Test conditions including location of thermal couple.

*5.8.3.3* Mean thickness $z_i$ at the beginning of the test at ambient temperature.

*5.8.3.4* Mean thickness $z_f$ at the end of the test at ambient temperature.

*5.8.3.5* Residual change of thickness and any other dimensional changes of the material at the end of the test when cooled down to room temperature.

*5.8.3.6* Maximum values of change of material thickness with the corresponding temperature.

*5.8.3.7* The maximum swell and report the time and temperature at which it occurred.

*5.8.3.8* Maximum temperature reached.

*5.8.3.9* Swell at highest temperature for the first and the second test period.

*5.8.3.10* Appearance of the friction material after the test, noting especially any formation of blisters, cracks and bubbles, peeling or chipping of friction material and detachment from the backing plate.

## *6. Test Method B- Oven Technique — Oven Method — Approximate*

**6.1 Scope—**These tests are designed to provide an estimate of dimensional changes at elevated temperature with minimal time and investment.

**6.2 Equipment—**Conventional oven with capacity to maintain temperature of 200 °C ± 5 °C (392 °F ± 9 °F).

### 6.3 Swell and Growth

6.3.1 Obtain initial room temperature thickness readings to the nearest 0.025 mm (0.001 in), measuring the specimen at not less than six points located approximately 0.5 in – 0.8 in in from the lining edge.

6.3.2 Place the unconfined specimen in an oven at room temperature. Increase oven temperature to 200 °C ± 5°C (392 °F ± 9 °F). Rise time to, 200 °C ± 5 °C (392 °F ± 9 °F) shall be 1/2 to 1 h. Allow specimen to remain in oven for 30 to 45 min at 200 °C ± 5 °C (392 °F ± 9 °F).

6.3.3 Remove the specimen from the oven and while still hot measure thickness at the same points used for obtaining initial thickness. Record the increase in thickness as swell within three minutes.

6.3.4 Allow specimen to cool completely, in still air, to room temperature and again measure thickness. Record the increase in thickness as growth.

NOTE— The dimensional stability test may be performed at the same time and on the same specimen as the swell and growth test, if desired.

### 6.4 Dimensional Stability Test Procedure

6.4.1 Place the specimen, at room temperature, on a piece of paper and trace its outline. Record the outside arc length of the specimen.

6.4.2 Place the unconfined specimen, on one of its arcuate edges in oven at room temperature. Increase oven temperature to 200 °C ± 5 °C (392 °F ± 9 °F). Rise time to 200 °C ± 5 °C (392 °F ± 9 °F) shall be 30 to 60min. A specimen is to remain in oven for 30 to 40 min at 200 °C ± 5 °C (392 °F ± 9 °F).

6.4.3 Allow the specimen to cool completely, in still air, to room temperature and again place it on the paper so that the center of the specimen coincides with that of the original trace at the center and shows approximately equal deviation from the original trace at each end. Again trace specimen outline and compare it to the original.

### 6.5 Procedural Notes

6.5.1 Blisters and surface abnormalities at measured reference points shall be recorded.

6.5.2 Care should be taken that transfer of material to the holding or measuring devices does not affect the accuracy of the measurements.