SURFACE VEHICLE RECOMMENDED PRACTICE

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Method for the Determination of Expansion and Water Absorption in Automotive Sealers

RATIONALE

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Foreword—This document describes three different methods for measuring the expansion of an automotive sealer

Method #1—Gravimetric Method
Method #2—Volumetric Method
Method #3—Vertical Method

and two methods for measuring water absorption

Method #1—Uncut Method
Method #2—Cut Method

The gravimetric and volumetric methods would be used to determine the amount of compound needed to completely fill an enclosed or “boxed in” area to effect a moisture and/or sound resistant barrier. The gravimetric method, Method #1, is analytical in nature and thus is more precise in its calculated values, and is especialy useful when measuring expansions of less than 100%. The volumetric method, Method #2, is a quick way to check expansion where errors of ±5% points are not crucial.

The vertical expansion method, Method #3, measures the vertical rise that a sealer achieves and is useful in determining bead size and expansion requirements in sealing applications, such as roof bows, where the critical function of the compound involves “jumping” an air gap, thereby joining two irregularly spaced surfaces.

The water absorption methods measure a sealer’s resistance to moisture transmission when the sealer’s outer surface is intact and/or damaged. Generally water absorption values, after 24 h immersion, of 2% or less for intact films and 3% or less for cut films are acceptable.

1. Scope—This SAE Recommended Practice sets forth methods for determining total expansion gravimetrically and volumetrically, calculating vertical expansion and measuring the water absorption of cut and uncut sealer beads.

2. References

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

2.1.1 DAIMLERCHRYSLER PUBLICATIONS—Available from DaimlerChrysler Corporation, ????

LP-463NB-5-01 Change C—Volume Change of Heat Expandable Sealers—Determination of, DaimlerChrylser Corporation, Laboratory Procedure (Gravimetric Test Method)
LP-463NB-33-01 Change A—Sealers—Vertical Rise Method of Determining Volume Change, DaimlerChrysler Corporation, Laboratory Procedure (Vertical Expansion Test Method)
LP-463NB-07-01 Change C—Sealers—Water Absorption—Determination of, DaimlerChrysler Corporation, Laboratory Procedure (Water Absorption Test Method)

2.1.2 FORD PUBLICATIONS—Available from Ford Motor Company, ????

FLTM BV 108-02 1992 01 21—Volume Change Test for Adhesives and Sealants, Ford Motor Company, Automotive Safety and Engineering Standards (Gravimetric Test Methods)
ESB-M18P11-A 1988 12 09—3.8 Expansion, Ford Motor Company, Engineering Material Specification (Vertical Expansion Test Method)
FLTM BV 117-01 1992 02 03—Water Absorption Test for Adhesives and Sealants, Ford Motor Company, Engineering Material Specification (Water Absorption Test Method)

2.1.3 GENERAL MOTORS CORPORATION—Available from General Motors Corporation, ????

GM9037P September 1988—Test for Measuring Expansion of Sealers, General Motors Engineering Standards, Materials and Processes—Procedures (Gravimetric Test Method)
GM9640P January 1992—Water Absorption Test for Adhesives and Sealants, General Motors Engineering Standards, Materials and Processes—Procedures (Water Absorption Test Method)
GM9764P October 1989—Test for Measuring the Ramp Expansion of Sealers, General Motors Engineering Standards, Materials and Processes—Procedures (Vertical Expansion Test Method)

*3. Equipment—*The following materials are required:

3.1 Expansion

3.1.1 GRAVIMETRIC TEST METHODS (METHOD #1)

a. Sealer to be tested
b. Mechanical Convection Oven
c. Analytical Balance (0.0001 g accuracy)
d. 150 mL beaker
e. Three count 0.9 x 25 x 62 mm (0.035 x 1 x 2.5 in) Aluminum Coupons with 0.25 mm diameter wire
f. 0.9 x 300 x 300 mm (0.035 x 12 x 12 in) Cold Rolled Steel Panel
g. 0.9 x 75 x 150 mm (0.035 x 3 x 6 in) Cold Rolled Steel Panel

3.1.2 VOLUMETRIC TEST METHODS (METHOD #2)

a. Sealer to be tested
b. Mechanical Convection Oven
c. 500 mL graduated cylinder (50 mm (2.0 in) diameter)
d. Three count 15 mL (0.5 oz) seamless containers with 0.25 mm (0.010 in) diameter wire
e. 0.9 x 300 x 300 mm (0.035 x 12 x 12 in) Cold Rolled Steel Panel

3.1.3 VERTICAL EXPANSION TEST METHODS (METHOD #3)

a. Sealer to be tested
b. Mechanical Convection Oven
c. Six count 0.9 x 100 x 300 mm (0.035 x 4 x 12 in) Cold Rolled Steel Panels
d. Six count 32 mm Wide Spring Clips

3.2 Water Absorption

a. Sealer to be tested
b. Mechanical Convection Oven
c. Analytical Balance (0.001 g accuracy)
d. 0.9 x 25 x 62 mm (0.035 x 1 x 2.5 in) Aluminum Coupons without wire
e. 0.9 x 300 x 300 mm (0.035 x 12 x 12 in) Cold Rolled Steel Panel

4. Gravimetric Expansion Procedure (Method #1)

4.1 Fabricate a small platform, from a 75 x 150 x 0.9 mm (3 x 6 x 0.035 in) steel panel, that will support a 150 mL beaker full of water as shown in Figure 1 (exact dimensions will vary depending on the model of balance used). The positioning of the platform and beaker should be arranged to allow complete freedom of movement of the pan.

4.2 Individually identify each of three 0.9 x 25 x 62 mm (0.035 x 1 x 2.5 in) aluminum coupon assemblies, as shown in Figure 2, and determine the dry weight of each panel (W1) to the nearest milligram (0.0001).

4.3 Determine the wet weight of each coupon assembly (W2) to the nearest milligram (0.0001) after suspending each coupon in water as in Figure 3, making sure the entire coupon is submerged.

4.4 The volume of each coupon (V1) in milliliters is equal to the difference between the dry and wet weights divided by the specific gravity of water, 1 g/mL

$$V1 = \frac{W1(mg) - W2(mg)}{1\ g/mL} \quad \text{(Eq. 1)}$$

4.5 Apply a semi-circular bead of sealer, approximately 10 mm (0.39 in) in diameter, down the center of each panel.

4.6 Trim the ends of each bead leaving a 38 mm (1.5 in) length of sealer centered on each coupon as shown in Figure 4.

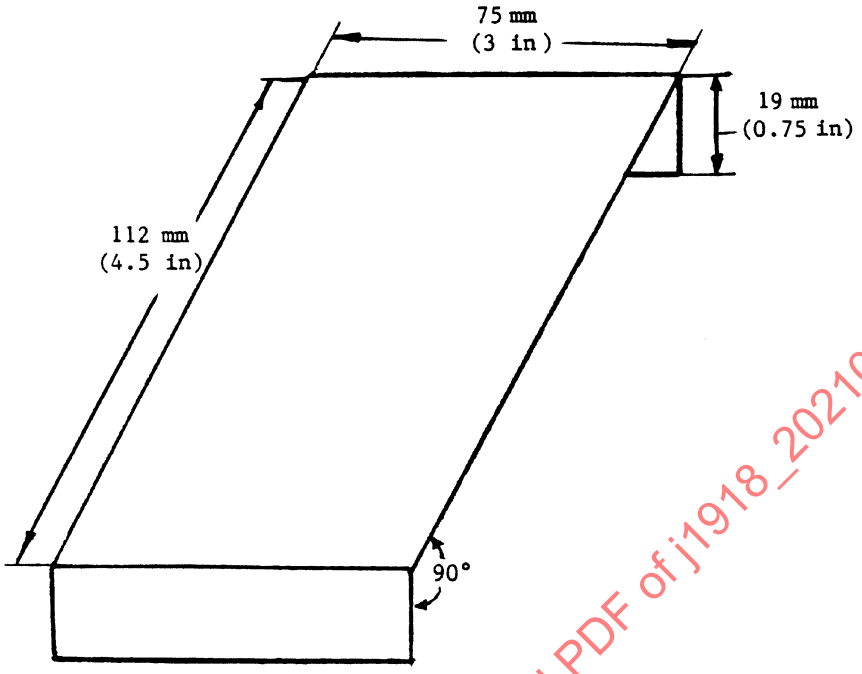

FIGURE 1—PLATFORM PANEL

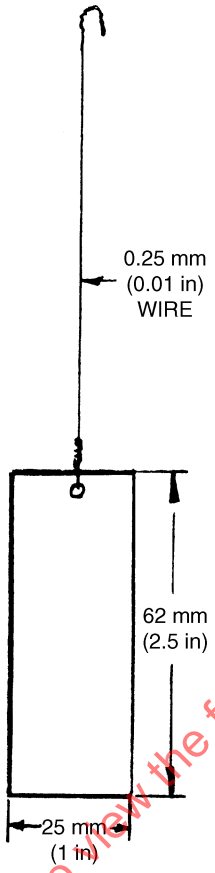

FIGURE 2—COUPON ASSEMBLY

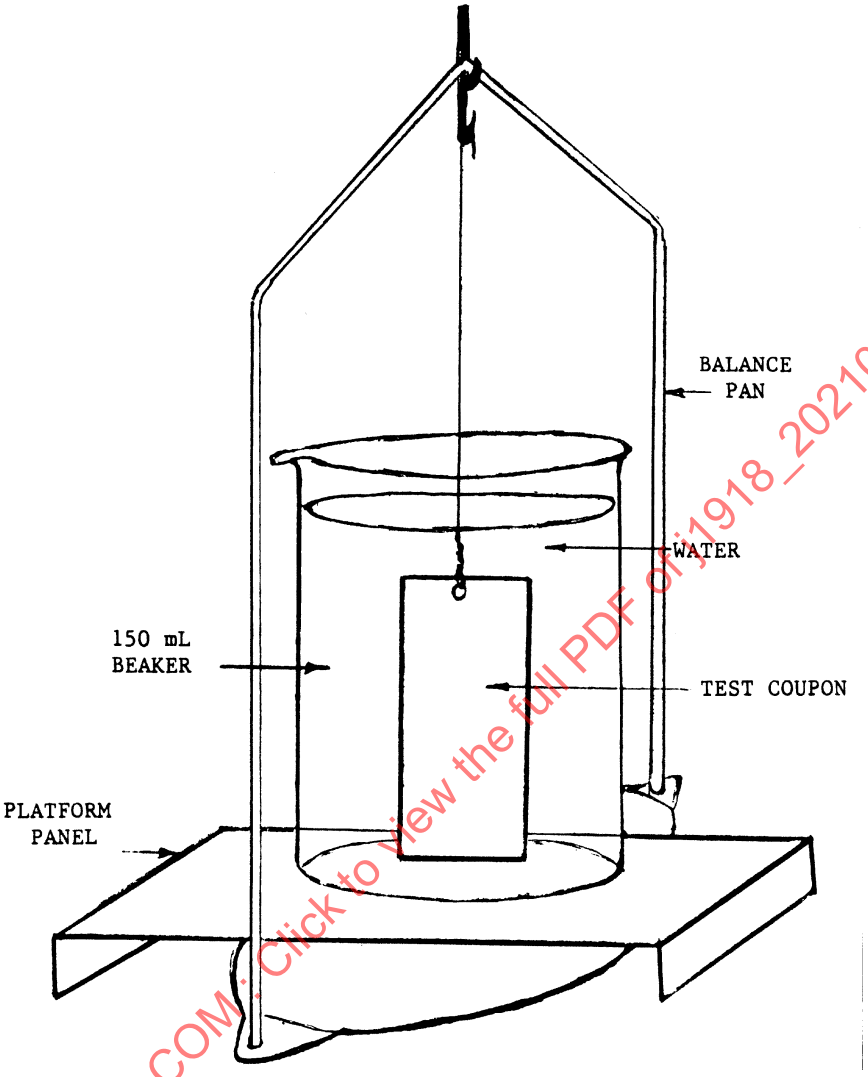

FIGURE 3—ANALYTICAL SCALE SET-UP

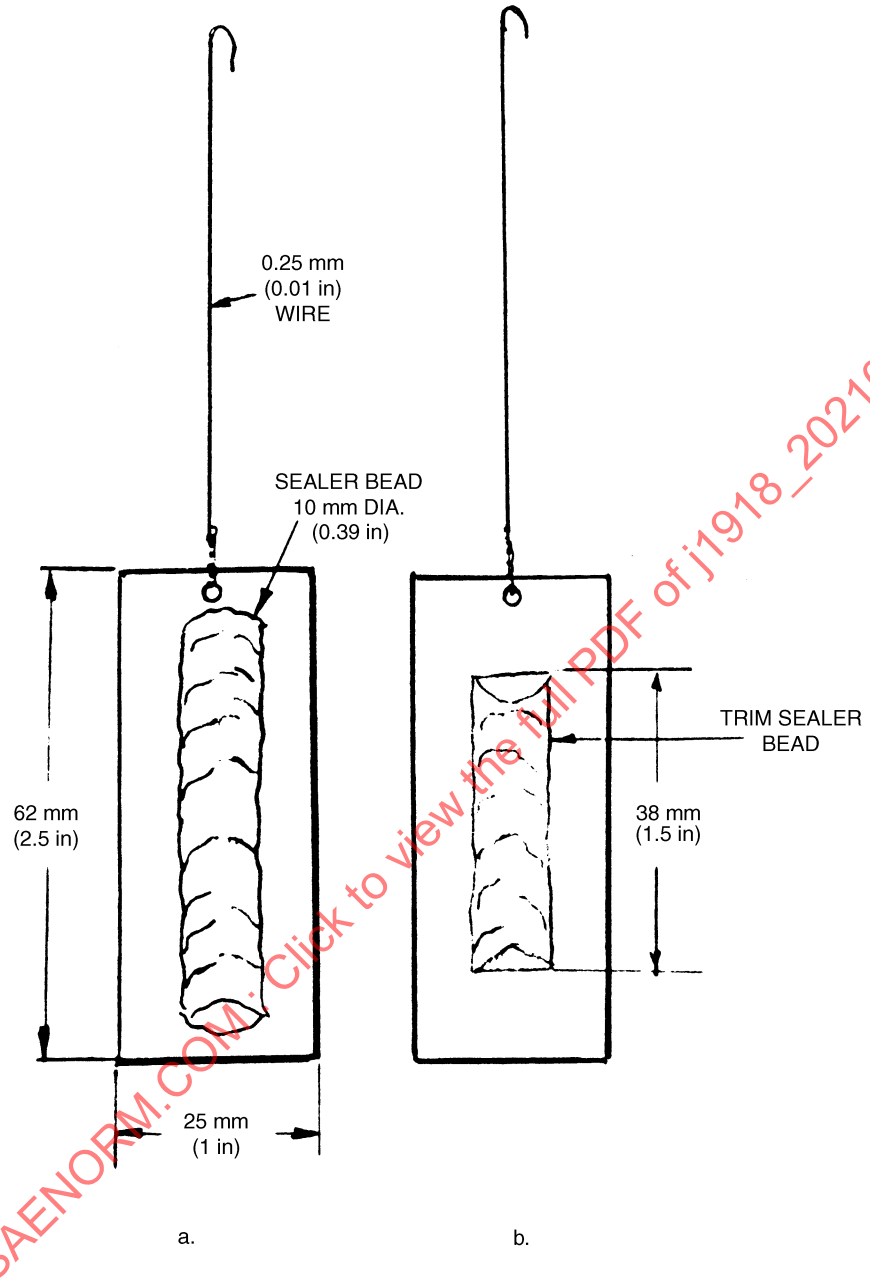

FIGURE 4—GRAVIMETRIC EXPANSION SAMPLE AND COUPON GEOMETRY

4.7 Determine the unexpanded sealer volume (V2) for the three marked and sealer coated coupons by weighing the assemblies dry (W3) and wet (W4) with weights reported in milligrams using the procedure described in 4.2 through 4.3 where,

$$V2(mL) = \left(\frac{[W3(mg) - W4(mg)]}{1\ g/mL}\right) - V1(mL) \quad \text{(Eq. 2)}$$

4.8 Place the sealer coupons horizontally in the center of a 300 x 300 x 0.9 mm (12 x 12 x 0.035 in) panel.

4.9 Place the panel, with sealer coupons, in the center of a mechanical convection oven and bake in the horizontal position for the specified time at the specified temperature.

4.10 Allow the coupons to cool to room temperature 23 °C ± 2 °C (73 °F ± 4 °F).

4.11 Determine the expanded sealer volume (V3) for the three marked, coated, and baked coupons by weighing the expanded sealer panels dry (W5) and wet (W6) with the weights reported in milligrams using the procedure described in 4.2 through 4.3 where,

$$V3(mL) = \left(\frac{[W5(mg) - W6(mg)]}{1\ g/mL}\right) - V1(mL) \quad \text{(Eq. 3)}$$

4.11.1 If the sealer expansion is great enough to float the coupon assembly, a weight large enough to overcome the buoyancy of expansion, is added to each of a second set of uncoated coupons and the steps 4.1 through 4.11 are repeated.

4.12 Calculate the volume change in the cured sealer as a percentage of the original uncured volume as follows,

$$\text{Percentage Volume Change} = \left(\frac{V3(mL)}{V2(mL)}\right) - 1 \times 100 \quad \text{(Eq. 4)}$$

4.13 Calculate the average expansion of the three coupons and report the results.

5. Volumetric Expansion Procedure (Method #2)

5.1 Fill a 500 mL graduated cylinder to the 400 mL mark (V1) with water and record the volume.

5.2 Mark and individually submerge the 15 mL containers and record the graduated cylinder volume levels (V2) in mL.

5.3 Determine the volume of the empty container (V3) by the following formula:

$$V3(mL) = V2(mL) - V1(mL) \quad \text{(Eq. 5)}$$

5.4 Fill each container with the sealer to be tested, being careful not to create any air pockets.

5.5 Fill the graduated cylinder to the 400 mL mark with water and record the volume (V1) in mL.

5.6 Submerge the individually marked sealer filled containers and record the graduated cylinder volume levels (V4) in mL.

5.7 Determine the volumes of the containers and uncured sealer (V5) by the following formula:

$$V5\,mL = V4(mL) - V1(mL) \quad \text{(Eq. 6)}$$

5.8 Place the sealer containers in the center of a 300 x 300 x 0.9 mm (12 x 12 x 0.035 in) panel.

5.9 Place the panel, with the sealer containers, in the center of a mechanical convection oven and bake in the horizontal position for the specified time at the specified temperature.

5.10 Allow the containers to cool to room temperature 23 °C ± 2 °C (73 °F ± 4 °F).

5.11 Fill the graduated cylinder to the 400 mL mark with water and record the volume (V1) in mL.

5.12 Submerge the individually marked, expanded sealer filled containers and record the graduated cylinder volume levels (V6) in mL. If the expanded sealer and container float, use a straightened paper clip to force the can beneath the water and record the level. (See Figure 5.)

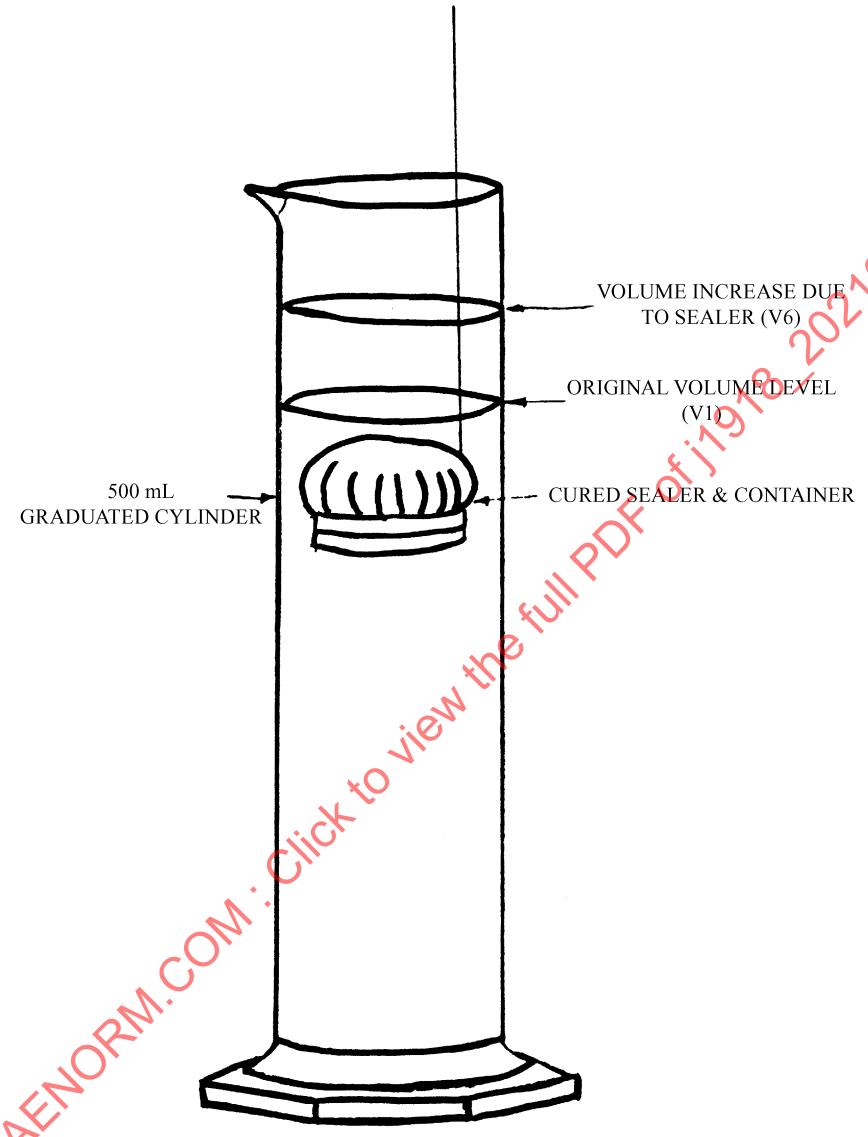

FIGURE 5—VOLUMETRIC EXPANSION SAMPLE EVALUATION

5.13 Determine the volume of the container and expanded sealer (V7) by the following formula:

$$V7(mL) = V6(mL) - V1(mL) \quad \text{(Eq. 7)}$$

NOTE—After the V6 measurement, remove the expanded material and inspect for voids.

5.14 Calculate the volume change in the sealer as a percentage by the following formula:

$$\%\ \text{Volume Change} = \left(\frac{V7(mL) - V5(mL)}{V5(mL) - V3(mL)}\right) \times 100 \quad \text{(Eq. 8)}$$

5.15 Calculate the average expansion of the three containers and report the results.

6. Vertical Expansion Procedure (Method #3)

6.1 Take three 0.9 x 100 x 300 mm (0.035 x 4 x 12 in) panels and fabricate a 90 degree bend, 25 mm long, at one end of each panel as in Figure 6.

6.2 To each fabricated panel apply a 6 x 200 mm semi-circular or, as specified, bead of sealer lengthwise down the center of each panel as shown in Figure 7.

6.3 Attach a straight 0.9 x 100 x 300 mm (0.035 x 4 x 12 in) panel to the top of the first panel securing the two at the narrow end by means of a spring clip as in Figure 8.

6.4 Record the thickness of the unexpanded sealer (T1) in millimeters.

6.5 Place the three assemblies horizontally in the center of a mechanical convection oven and bake the assemblies at the specified temperature for the specified time.

6.6 Allow the panels to cool to room temperature 23 °C ± 2 °C (73 °F ± 4 °F).

6.7 Measure and record the maximum height of the expanded sealer (T2) in millimeters for each assembly. (See Figure 9.)

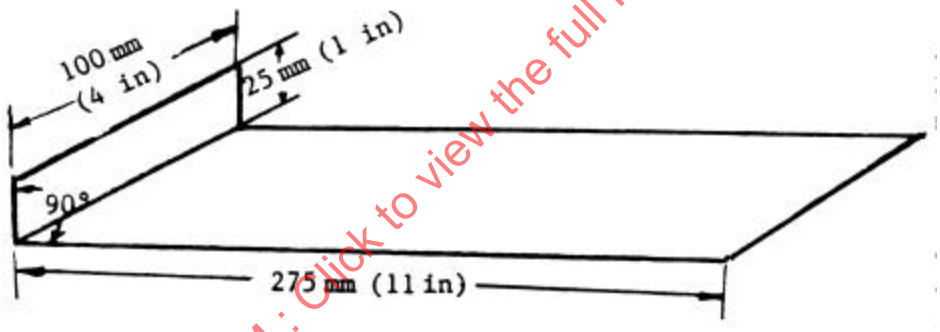

FIGURE 6—VERTICAL EXPANSION SUBSTRATE GEOMETRY

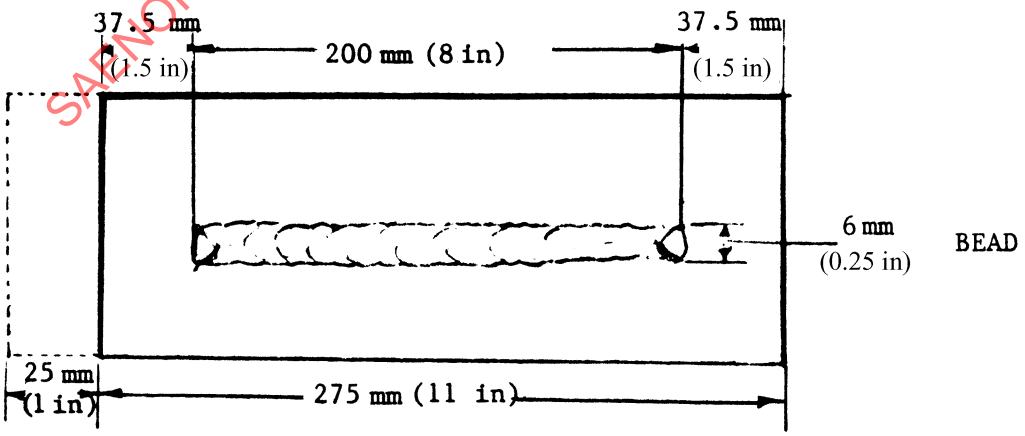

FIGURE 7—VERTICAL EXPANSION SAMPLE/SUBSTRATE GEOMETRY

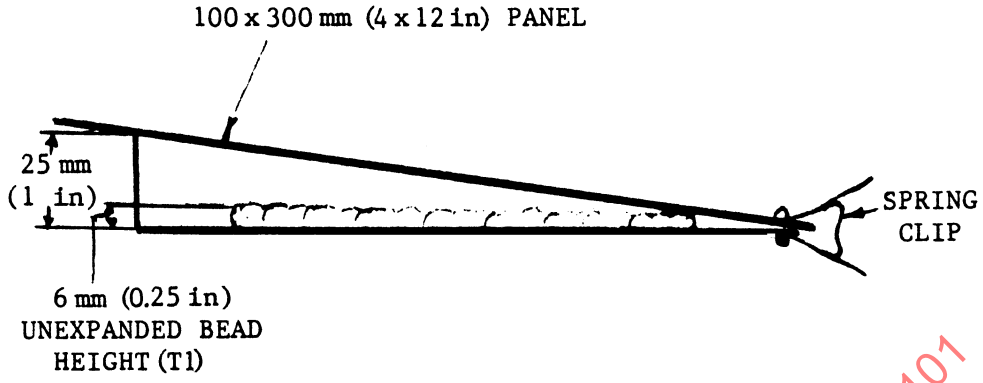

FIGURE 8—VERTICAL EXPANSION PRE-BAKE SAMPLE PREPARATION

FIGURE 9—VERTICAL EXPANSION AFTER-BAKE SAMPLE PREPARATION

6.8 Calculate the maximum vertical expansion, as a percentage of the uncured sealer height, by means of the following formula:

$$\text{Percentage Vertical Expansion} = \left(\frac{T2(mm) - T1(mm)}{T1(mm)}\right) \times 100 \quad \text{(Eq. 9)}$$

6.9 Calculate the average vertical expansion of the three assemblies and report the results.

6.10 Repeat steps 6.1 through 6.9 if the expansion characteristics perpendicular to the sealed surface of a nonhorizontal assembly is desired. Bake the panels as specified rather than horizontally.

7. Water Absorption, Uncut (Method #1)

7.1 Individually identify each of three 0.9 x 25 x 62 mm (0.035 x 1 x 2.5 in) aluminum coupons and determine, on an analytical balance, the dry weights of each coupon (W1) to the nearest milligram (0.0001).

7.2 Apply a semi-circular bead of sealer, approximately 10 mm (0.39 in) in diameter, down the center of each panel.

7.3 Trim the ends of each bead leaving a 38 mm (1.5 in) length of sealer centered on each coupon.

7.4 Place the sealer coupons horizontally in the center of a 0.9 x 300 x 300 mm (0.035 x 12 x 12 in) panel.

7.5 Place the panel, with sealer coupons, in the center of a mechanical convection oven and bake in the horizontal position for the specified time at the specified temperature.