



# Standard Practice for Time-to-Failure (Creep-Rupture) of Adhesive Joints Fabricated from EPDM Roof Membrane Material<sup>1</sup>

This standard is issued under the fixed designation D 6383; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

## 1. Scope

1.1 This practice covers sample preparation temperatures, test parameters, and specimen exposure conditions that are applicable when Test Method D 5405 is used for conducting time-to-failure (creep-rupture) tests of adhesive joints fabricated from ethylene-propylene-diene terpolymer (EPDM) roof membrane material.

1.2 This practice is applicable to joints fabricated in the laboratory from EPDM roof membrane materials and adhesives received from suppliers, and to joints prepared from EPDM seams sampled from field installations.

1.3 The joints are bonded using preformed tape or liquid-based adhesives, and EPDM roof membrane materials that are non-reinforced, fabric- or scrim-reinforced, and fabric backed. Primers are also used as recommended for the specific adhesive.

1.4 This practice contains notes that are explanatory and are not part of the mandatory requirements of this practice.

1.5 The values stated in SI units are to be regarded as the standard. The inch-pound units given in parentheses are for information only.

1.6 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of the regulatory limitations prior to use.*

## 2. Referenced Documents

### 2.1 ASTM Standards:

D 907 Terminology of Adhesives<sup>2</sup>

D 1079 Terminology Relating to Roofing, Waterproofing, and Bituminous Materials<sup>3</sup>

D 5405 Test Method for Conducting Time-to-Failure (Creep-Rupture) Tests of Joints Fabricated from Nonbituminous Organic Roof Membrane Material<sup>3</sup>

### 2.2 SPRI Document:

SPRI Recommended Laboratory Test Methods for Liquid and Tape Adhesives Used to Splice Single-Ply Membranes<sup>4</sup>

## 3. Terminology

3.1 *Definitions*—For definitions of terms used in this practice, refer to Terminologies D 907 and D 1079.

### 3.2 Definitions of Terms Specific to This Standard:

3.2.1 *creep-rupture test*—a test that measures the time-to-failure of a specimen subjected to a constant load; progressive specimen deformation may also be measured.

3.2.2 *failure*—rupture of the bond resulting in complete separation of its adherends under the test conditions; or, alternatively, rupture of the membrane material away from the bonded section of the test specimen (that is, material rupture).

3.2.3 *time-to-failure*—the period of time beginning when a joint specimen is placed under load and ending when failure occurs.

## 4. Summary of Practice

4.1 Adhesive joints are prepared in the laboratory at ambient and low temperatures using tape or liquid adhesives and EPDM roof membrane material. Creep-rupture tests are then conducted in accordance with Test Method D 5405 before and after subjecting these joints to artificial exposure in the laboratory. The loads are applied in either peel or shear configurations at ambient and elevated temperatures. Table 1 summarizes the preparation temperatures, test parameters, and exposure conditions incorporated in this practice. Alternatively, adhesive joints are prepared from EPDM seams sampled from roofs in service, and then subjected directly to creep-rupture testing.

## 5. Significance and Use

5.1 An important factor affecting the performance of seams of EPDM membranes is their ability to remain bonded over the membrane's expected service life. Time-to-failure tests provide a means of characterizing the behavior of joints under constant load over time.

NOTE 1—Table 1 is based on the results of an industry government

<sup>1</sup> This practice is under the jurisdiction of ASTM Committee D-8 on Roofing, Waterproofing, and Bituminous Materials and is the direct responsibility of Subcommittee D08.18 on Nonbituminous Organic Roof Coverings.

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<sup>2</sup> *Annual Book of ASTM Standards*, Vol 15.06.

<sup>3</sup> *Annual Book of ASTM Standards*, Vol 04.04.

<sup>4</sup> Available from SPRI, 175 Highland Ave., Needham, MA 01294.

**TABLE 1 Summary of the Sample Preparation Temperature, Test Parameters, and Exposure Conditions Incorporated in the Practice**

Sample Set Number	Sample Preparation Temperature		Test Parameters					
	°C	°F	Temperature °C	Temperature °F	Loading Peel	N	Load lbf	Artificial Exposure Before Testing Conditions
1	23	73	23	73	Peel	9.8	2.2	None
2	23	73	70	158	Peel	9.8	2.2	None
3	-4	25	23	73	Peel	9.8	2.2	None
4	23	73	23	73	Peel	9.8	2.2	Heat: 90°C (194°F) for 90 days Dry heat, wet heat, and freeze-thaw cycling according to SPRI procedure
5	23	73	23	73	Peel	9.8	2.2	
6	23	73	23	73	Shear	29.4	6.6	None
7	23	73	70	158	Shear	29.4	6.6	None

consortium study on creep-rupture resistance (time-to-failure) of EPDM adhesive joints<sup>5,6</sup>. Referral to Footnotes 5 and 6 provides typical time-to-failure data, developed under the conditions in Table 1, for EPDM joints fabricated in the laboratory with nonreinforced EPDM roof membrane material, butyl-based tapes, and liquid adhesives. It is noted that the peel load specified in this practice is 9.8 N (2.2 lbf). The peel load under which the tests described in Footnotes 5 and 6 were conducted was 9.3 N (2.1 lbf). A load of 9.8 N (2.2 lbf) corresponds to 1 kgf (2.2 lbf), and dead weights of 1-kg (2.2-lbm) mass are available through laboratory equipment supply houses. Similarly, a load of 29.4 N (6.6 lbf) corresponds to a dead weight of 3-kg (6.6-lbm) mass.

5.2 Time-to-failure tests complement other mechanical tests such as strength for characterizing joints of EPDM roof membranes, and can be incorporated in specifications for adhesives for joining EPDM roof membrane material.

5.3 This practice, which is specific to EPDM joints, complements Test Method D 5405 that provides general requirements for the preparation and creep-rupture testing of joints fabricated from any nonbituminous organic roof membrane material.

5.4 Laboratory experience in conducting time-to-failure tests of joints EPDM roof membranes has shown that specimens are less creep-resistant under peel loading than under shear loading. Consequently, the majority of the tests stipulated in this practice are performed under peel loading.

5.5 This practice does not develop time-to-failure data on all environmental conditions to which EPDM adhesive seams can be subjected in service.

## 6. Test Specimen

6.1 *Laboratory Specimens*—Prepare peel specimens and shear specimens as described in Section 8 of Test Method D 5405. Table 1 lists the seven sample sets for which specimens are prepared.

6.1.1 *Peel Specimen Dimensions*—The dimensions of the peel specimens shall be 125 by 25 mm (5 by 1 in.)  $\pm$  2 %. The

bond length shall be 75 mm (3 in.)  $\pm$  2 %. The bond is located at one end of the specimen.

6.1.2 *Shear Specimen Dimensions*—The dimensions of the shear specimens shall be 150 by 25 mm (6 by 1 in.)  $\pm$  2 %. The bond length shall be 25 mm (1 in.)  $\pm$  2 %. The bond is located at the center of the specimen.

6.1.3 *EPDM Surface Preparation*—Prior to bond formation, prepare the surface of the sheet material in accordance with the EPDM supplier's instructions. Where primers are incorporated in the bonding procedure, apply primers in accordance with the EPDM supplier's instructions.

6.1.4 *Temperature*—Prepare sample sets at  $23 \pm 2^\circ\text{C}$  ( $73 \pm 4^\circ\text{F}$ ) and at  $-4 \pm 2^\circ\text{C}$  ( $25 \pm 4^\circ\text{F}$ ); report the preparation temperature. Use a temperature controlled chamber or similar means, if necessary, to achieve the specified temperature regulation. Samples prepared at  $-4^\circ\text{C}$  ( $25^\circ\text{F}$ ) shall be kept at that temperature until the individual specimens are readied for testing (for example, placement in the test chamber, and other steps conducted before testing). The temperature at which specimens are readied shall be  $23 \pm 2^\circ\text{C}$  ( $73 \pm 4^\circ\text{F}$ ). The time between readying for testing and conducting the time-to-failure tests shall not exceed 24 h.

6.1.5 *Humidity*—Prepare specimens at ambient humidity; report the relative humidity during preparation. Condensation shall not be visible when preparing the specimens at the colder temperature.

## 6.2 Field Specimens:

6.2.1 Peel and shear specimens, having the dimensions indicated in 6.1.1 and 6.1.2, respectively, can be prepared from seams sampled from roofs in service.

6.2.2 Record all available pertinent information including, but not limited to, sample age, adhesive type, EPDM sheet type, and location of the roof.

## 7. Number of Test Specimens and Bonded Strength

7.1 Prepare a sufficient number of specimens to conduct both bond strength and time-to-failure tests in accordance with 9.2 of Test Method D 5405.

7.2 A minimum of eight joint specimens shall be included in the time-to-failure tests for each of the seven sample sets listed in Table 1.

NOTE 2—Sample sets having more than 8 specimens can be necessary under some test conditions. In particular, experimental designs that include probabilistic methods of data analysis can require more than 8

<sup>5</sup> Rossiter, Walter J., Jr., Vangel, Mark G., Embree, Edward, Kraft, Kevin M., and Seiler, James F., Jr., "Performance of Tape-Bonded Seams of EPDM Membranes: Comparison of the Peel Creep-Rupture Response of Tape-Bonded and Liquid-Adhesive-Bonded Seams," *Building Science Series 175*, National Institute of Standards and Technology, May 1996.

<sup>6</sup> Rossiter, Walter J., Jr., Vangel, Mark G., and Kraft, Kevin M., "Performance of Tape-Bonded Seams of EPDM Membranes: Comparison of the Creep-Rupture Performance of Tape-Bonded and Liquid-Adhesive-Bonded Samples as Affected by Test Temperature, Exposure Prior to Testing, Cold Temperature Preparation, and Shear Loading," *Building Science Series 177*, National Institute of Standards and Technology (July 1998).

specimens. Additionally, for cases where it is anticipated that times-to-failure can be relatively long (that is, greater than some months), and the test can be terminated before all specimens in the set fail (see 10.1.1), sample sets containing more than 8 specimens are recommended.

## 8. Loads

8.1 The load shall be within  $\pm 1\%$  of that specified as follows:

8.1.1 *Peel Tests*—At both 23 and 70°C (73 and 158°F), the load shall be 9.8 N (2.2 lbf).

8.1.2 *Shear Tests*—At both 23 and 70°C (73 and 158°F), the load shall be 29.4 N (6.6 lbf).

## 9. Artificial Exposure Before Conducting Time-to-Failure Tests

9.1 Sample sets 4 and 5 (see Table 1) are subjected to artificial exposure prior to conducting the time-to-failure tests.

9.1.1 *Heat Exposure*—Expose the test specimens in a forced air oven at  $90 \pm 1^\circ\text{C}$  ( $194 \pm 2^\circ\text{F}$ ) for 90 days  $\pm 1/4$ day.

9.1.2 *Dry Heat, Wet Heat, and Freeze-Thaw Cycling*—Expose the test specimens in accordance with paragraph of 5.4 of SPRI Recommended Laboratory Test Methods for Liquid and Tape Adhesives Used to Splice Single-Ply Membranes

## 10. Procedure

10.1 The procedure shall be in accordance with Section 11 of Test Method D 5405 with the following exception:

10.1.1 Conduct tests for a minimum of 60 days at which time it is determined that it is impractical to continue the tests further.

NOTE 3—The determination of whether to continue the tests can depend on the analyses and interpretation of the data, and on the judgment of the experimenter. Some shear specimens can have long times-to-failure (for example, greater than some months) under the loading conditions given in Table 1.

## 11. Report

11.1 Report the results of the time-to-failure tests in accordance with Section 12 of Test Method D 5405. Include the temperature and relative humidity at which the samples were prepared.

## 12. Keywords

12.1 adhesive testing; creep; EPDM; joints; laboratory exposure; practice; roofing; seams; test conditions; time-to-failure

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