



Standard Practice for Effect of Moisture and Temperature on Adhesive Bonds¹

This standard is issued under the fixed designation D 1151; 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 (ϵ) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the Department of Defense.

1. Scope

1.1 This practice defines conditions for determining the performance of adhesive bonds when subjected to continuous exposure at specified conditions of moisture and temperature. The performance is expressed as a percentage based on the ratio of strength retained after exposure to the original strength.

1.2 The values stated in SI units are to be regarded as the standard. The values given in parentheses are provided for information purposes only.

1.3 *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 regulatory limitations prior to use.*

2. Referenced Documents

2.1 ASTM Standards:

D 897 Test Method for Tensile Properties of Adhesive Bonds²

D 903 Test Method for Peel or Stripping Strength of Adhesive Bonds²

D 906 Test Method for Strength Properties of Adhesives in Plywood Type Construction in Shear by Tension Loading²

D 907 Terminology of Adhesives²

D 1002 Test Method for Apparent Shear Strength of Single-Lap-Joint Adhesively Bonded Metal Specimens by Tension Loading (Metal-to-Metal)²

3. Terminology

3.1 *Definitions*—Many of the terms in this practice are defined in Terminology D 907.

4. Significance and Use

4.1 This practice may be used to determine the performance, for suitable materials, in terms of any desired strength property of adhesive bonds. Test conditions of temperature and moisture only are here specified. The duration of exposure is dependent upon the nature of the adhesive and the type of specimens and

will, therefore, be covered by material specifications.

5. Apparatus

5.1 *Conditioning Cabinets or Ovens*, with temperature and humidity control.

6. Test Specimens

6.1 Prepare the test specimens in accordance with the recommendations of the manufacturer of the adhesive. The specimens should be of a suitable form and number to meet the requirements of the investigation. The specimens should conform in detail with the requirements prescribed in the ASTM test method covering the desired strength property, as listed in Section 2, and any other ASTM test method pertaining to strength properties of adhesives for the desired strength test.

6.2 Matched specimens should be selected for control and exposure treatments, the number to be fixed by the variability inherent in the method.

7. Conditioning

7.1 *Preconditioning*—Condition all specimens for 7 days at $50 \pm 2\%$ relative humidity and $23 \pm 1^\circ\text{C}$ ($73.4 \pm 1.8^\circ\text{F}$) immediately prior to exposure, or prior to testing in the case of control specimens. Prior history of the test specimens should be known and recorded.

7.2 *Exposure Conditions*—The exposure conditions should conform to one of the standard test exposures given in Table 1.

8. Procedure

8.1 Test the control specimens for strength by the appropriate test method immediately after the preconditioning period. Average the values obtained. Record this average as the *original strength* against which the strength after exposure is to be compared in calculating performance.

8.2 Subject the preconditioned specimens to the designated exposure conditions (Table 1) for the length of time prescribed by the specification for the adhesive being tested. At the end of the exposure period, test the specimens using one of the following procedures:

8.2.1 Test the specimens under conditions at which they were exposed, or

8.2.2 Condition the specimens for 4 h at $50 \pm 2\%$ relative humidity and $23 \pm 1^\circ\text{C}$ ($73.4 \pm 1.8^\circ\text{F}$) and test immediately thereafter, or

¹ This practice is under the jurisdiction of ASTM Committee D-14 on Adhesives and is the direct responsibility of Subcommittee D14.80 on Metal Bonding Adhesives.

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² *Annual Book of ASTM Standards*, Vol 15.06.

TABLE 1 Standard Test Exposures

Test Exposure Number	Temperature ^A		Moisture Conditions
	°C	°F	
1	-57	-70	as conditioned
2	-34	-30	as conditioned
3	-34	-30	presoaked ^B
4	0	32	as conditioned
5	23	73.4	50 % RH
6	23	73.4	immersed in water
7	38	100	88 % RH
8	63	145	oven, uncontrolled humidity over water ^C
9	63	145	immersed in water
10	63	145	oven, uncontrolled humidity over water ^C
11	70	158	oven, uncontrolled humidity over water ^C
12	70	158	oven, uncontrolled humidity over water ^C
13	82	180	oven, uncontrolled humidity over water ^C
14	87	188	oven, uncontrolled humidity over water ^C
15	82	180	oven, uncontrolled humidity over water ^C
16	100	212	oven, uncontrolled humidity over water ^C
17	100	212	immersed in water
18	105	221	oven, uncontrolled humidity over water ^C
19	149	300	oven, uncontrolled humidity over water ^C
20	204	400	oven, uncontrolled humidity over water ^C
21	260	500	oven, uncontrolled humidity over water ^C
22	316	600	oven, uncontrolled humidity over water ^C

^A The tolerance for test temperature shall be $\pm 1^\circ\text{C}$ or 1.8°F up to 82°C or 180°F , and $\pm 1\%$ for temperatures above 82°C or 180°F .

^B Presoaking shall consist of submerging specimens in water and applying vacuum at 51 cm (20 in.) of mercury until weight equilibrium is reached.

^C The relative humidity will ordinarily be 95 to 100 %.

8.2.3 Condition the specimens for 7 days at $50 \pm 2\%$ relative humidity and $23 \pm 1^\circ\text{C}$ ($73.4 \pm 1.8^\circ\text{F}$) and test immediately thereafter.

8.3 Average the strength values obtained and record the value as the average strength of the specimens after exposure.

NOTE 1—The conditions under which the exposed specimens are tested will depend upon the nature of the adhesive, the adherend, and the strength property being investigated. This will be prescribed by the material specifications or by written agreement between the manufacturer and purchaser of the adhesive.

9. Calculation

9.1 Calculate the performance of the adhesive under test, as follows:

$$\text{Performance } A = (A/D) \times 100, \quad (1)$$

$$\text{Performance } B = (B/D) \times 100, \quad (2)$$

or

$$\text{Performance } C = (C/D) \times 100. \quad (3)$$

where:

A = average strength when tested under the designated exposure condition in accordance with 8.2.1,

B = average strength after exposure, when determined in accordance with 8.2.2,

C = average strength after exposure, when determined in accordance with 8.2.3, and

D = original strength, determined in accordance with 8.1.

NOTE 2—Alternative methods of expressing results may be used.

10. Report

10.1 Report the following:

10.1.1 Complete identification of the adhesive tested, including type, source, manufacturer's code number, form, and method of preparation for use,

10.1.2 Bonding conditions used in preparing test specimens, and history of specimens prior to testing.

10.1.3 Description of test specimens, including materials, size, shape, and designation of ASTM test method covering the detailed requirements,

10.1.4 Average thickness of adhesive layer after formation of the joint, within 0.001 in. The method of obtaining the thickness of the adhesive layer shall be described including procedure, location of measurements, and range of measurements.

10.1.5 Test conditions used, any deviation from conditions listed in Table 1, duration of exposure, and condition of specimens at test (8.2.1 or 8.2.2).

10.1.6 Number of specimens tested, strength of each specimen, and average strength for both control and exposed specimens, including the types of failure and amounts of each type, and

10.1.7 Performance expressed as a percentage (Section 9).

11. Keywords

11.1 adhesive bonds; moisture; temperature

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