



Standard Practice for Testing Water Resistance of Coatings Using Water Fog Apparatus¹

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

1. Scope

1.1 This practice covers the basic principles and operating procedures for testing water resistance of coatings in an apparatus similar to that used for salt spray testing.

1.2 This practice is limited to the methods of obtaining, measuring, and controlling the conditions and procedures of water fog tests. It does not specify specimen preparation, specific test conditions, or evaluation of results.

NOTE 1—Alternative practices for testing the water resistance of coatings include Practices D 870, D 2247, and D 4585.

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

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

2. Referenced Documents

2.1 ASTM Standards:

- B 117 Practice for Operating Salt Spray (Fog) Apparatus²
- D 609 Practice for Preparation of Cold-Rolled Steel Panels for Testing Paint, Varnish, Conversion Coatings, and Related Coating Products³
- D 610 Test Method for Evaluating Degree of Rusting on Painted Steel Surfaces⁴
- D 714 Test Method for Evaluating Degree of Blistering of Paints³
- D 823 Practices for Producing Films of Uniform Thickness of Paint, Varnish, and Related Products on Test Panels³
- D 870 Practice for Testing Water Resistance of Coatings Using Water Immersion³

- D 1193 Specification for Reagent Water⁵
- D 1654 Test Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments³
- D 1730 Practices for Preparation of Aluminum and Aluminum-Alloy Surfaces for Painting⁶
- D 2247 Practice for Testing Water Resistance of Coatings in 100 % Relative Humidity³
- D 2616 Test Method for Evaluation of Visual Color Difference With a Gray Scale³
- D 3359 Test Methods for Measuring Adhesion by Tape Test³
- D 3363 Test Method for Film Hardness by Pencil Test³
- D 4541 Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers⁴
- D 4585 Practice for Testing Water Resistance of Coatings Using Controlled Condensation³

3. Summary of Practice

3.1 Coated specimens are placed in an enclosed chamber to permit free settling of fog on all specimens. The temperature of the chamber is usually maintained at 38°C (100°F). The exposure condition is varied by selecting the duration of the test. Water permeates the coating at rates that are dependent upon the characteristics of the coating. Any effects such as color change, blisters, loss of adhesion, softening, or embrittlement are observed and reported.

4. Significance and Use

4.1 Water can cause the degradation of coatings, so knowledge of how a coating resists water is helpful in predicting its service life. Failure in water fog tests may be caused by a number of factors, including a deficiency in the coating itself, contamination of the substrate, or inadequate surface preparation. The test is therefore useful for evaluating coatings alone or complete coating systems.

4.2 Water fog tests are used for research and development of coatings and substrate treatments, specification acceptance, and quality control in manufacturing. These tests usually result in a pass or fail determination, but the degree of failure may also be

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² *Annual Book of ASTM Standards*, Vol 03.02

³ *Annual Book of ASTM Standards*, Vol 06.01.

⁴ *Annual Book of ASTM Standards*, Vol 06.02.

⁵ *Annual Book of ASTM Standards*, Vol 11.01.

⁶ *Annual Book of ASTM Standards*, Vol 02.05.

measured. A coating system is considered to pass if there is no evidence of water-related failure after a specified period of time.

4.3 Results obtained from the use of water fog tests in accordance with this practice should not be represented as being equivalent to a period of exposure to water in the natural environment, until the degree of quantitative correlation has been established for the coating or coating system.

4.4 The test apparatus is similar to that used in Practice B 117, and the conversion of the apparatus from salt spray to water fog testing is feasible. Care should be taken to remove all traces of the salt from the cabinet and reservoir when converting from salt spray to water fog testing.

5. Apparatus

5.1 *Descriptions for the Test Chamber, Test Specimen Supports, and Fog Collecting Devices*, are listed under Apparatus Section in Practice B 117.

5.2 Unless otherwise specified, provide for continuous recording, such as a chart recorder or data logger, of the temperature within the chamber during the exposure period.

6. Test Specimens

6.1 This practice does not cover the preparation of test specimens. The substrate composition and surface preparation, specimen preparation, and the number of specimens should be agreed upon prior to testing.

NOTE 2—Applicable methods for the preparation of test panels and substrates are given in Practices D 609 and D 1730. Practices D 823 cover application techniques of the production of uniform films.

6.2 It's recommended that a control specimen of a paint with known durability be included with each test. Such control specimens can provide warning of changes in test severity in a given apparatus, and can indicate variations in test severity between different apparatuses.

6.3 It's recommended that at least two replicate specimens of each different coating be used, so as to compensate for variations between specimens and variations in test conditions within the apparatus.

7. Procedure

7.1 Fill the reservoir with reagent water conforming to Type III of Specification D 1193.

7.2 Heat the water to the desired temperature with the circulating system in operation. If no temperature is specified, heat the water to $38 \pm 2^\circ\text{C}$ ($100 \pm 4^\circ\text{F}$). Maintain the temperature throughout the test.

7.3 Support or suspend specimens 15° from the vertical, with the plane of the specimen parallel to the direction of the fog flow. Slotted wood supports are suitable for flat specimens. Each specimen shall be placed to permit unencumbered exposure to the fog. A minimum spacing between specimens of 30 mm is recommended. Arrange the specimens so that the water from one specimen does not drip on other specimens.

7.4 Place two containers within the chamber to collect fog for measurement. Use collectors that have approximately the same position within the chamber as the test specimens. Use a glass or plastic funnel with a diameter of area 80 cm^2 (area 100

mm) with the stem of the funnel extending into the collection container. Locate one container within 10 cm of the fog nozzle and the other as far as possible from the nozzle. Place the collectors so that they collect only the fog from the nozzle. Collection rates are to be measured every 24 h except on weekends. Record the collection rate in mL/h. Refer to customer specification for acceptable collection rates.

7.4.1 Use at least four collectors for cabinets that have more than one fogging nozzle. Position a collector 10 cm from each nozzle. Place the other collectors at positions as far as possible from each nozzle.

7.4.2 It is recommended to map the collection rates within the exposure zone of the cabinet once a year. Place collectors throughout the exposure zone to evaluate variations within the cabinet. Areas that are out of compliance should be taped off and specimens not tested there. Refer to manufacturer's recommendations to correct the problem.

NOTE 3—Collection rate mapping of a chamber throughout the exposure zone to ensure conformance to the collection rate requirements is recommended as a means of reducing test variability.

NOTE 4—Larger cabinets that have more than one fogging nozzle, may need more than two collectors to obtain adequate collection information. Refer to manufacturers' recommendations and customers' requirements for specific requirements.

7.5 To control for variability within the apparatus, reposition the specimens on a regular basis so that all specimens spend equivalent amounts of time in the various areas of the apparatus (front, back, left, right, and center).

7.6 Adjust the atomizing air supply so that 1.0 to 3.0 mL of water/h is collected in a collector with a diameter of 100 mm based on an average run of at least 16 h. The collection rate should be agreed upon between the customer and the supplier before starting the test. The collection rate of the water should be recorded daily.

NOTE 5—The fog rate specified in Practice B 117 is only 1.0 to 2.0 mL/h for a collector with a diameter of 100 mm.

7.7 Operate the test continuously with the test chamber closed unless otherwise specified. Short interruptions to inspect or remove specimens or to replenish the water supply are permitted, but such interruptions should occur no more than once each day.

7.8 Conclude the test after a specified period of time or after effects from exposure to water fog are observed.

7.9 Wipe the test specimens dry. Rate specimens for changes in color, blistering, etc. Evaluate specimens no less than 5 min and no more than 10 min after removal from test, as the effects from water exposure can change within a short time. Remove only as many specimens as can be rated within the specified time.

NOTE 6—The 0 to 10 scale described in the ASTM STP 500⁷ is preferred for rating. Relevant procedures for evaluating water effects are described in Test Methods D 610, D 714, D 1654, D 2616, D 3359, D 3363, and D 4541.

7.9.1 If possible, rate the specimens again after they have been removed from the test for a recovery period long enough

⁷ *Paint and Coating Testing Manual*, 14th ed., ASTM, 1995.

that moisture absorbed within the specimens dries out and the specimens reach moisture equilibrium with room air. A recovery period of 12 from 24 h is generally sufficient. The post-recovery rating allows evaluation of the permanent effects of the exposure as distinct from the transient effects, and is especially important for evaluation of color and gloss.

8. Report

8.1 Report the following information:

8.1.1 Sample identification.

8.1.2 Results of the evaluation(s).

8.1.3 Reference to Practice D 1735.

8.1.4 Hours of test duration.

8.1.5 Test temperature.

8.1.6 Rate of fog collection and pH of water collected.

8.1.7 Special conditions of test or any deviations in test procedure.

9. Keywords

9.1 adhesion; blistering; resistance-water; rust; water fog

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