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Standard Practice for Testing Water Resistance of Coatings in 100 % Relative Humidity¹

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

1. Scope*

1.1 This practice covers the basic principles and operating procedures for testing water resistance of coatings by exposing coated specimens in an atmosphere maintained at 100 % relative humidity so that condensation forms on all surfaces of test specimens.

1.2 This practice uses the technique of creating a slight temperature differential within the exposure area to form condensation on the coated specimens. As the warmer saturated air passes the cooler specimens, water is deposited onto the specimens in the form of condensation.

1.3 This practice places the entire specimen in the exposure area allowing condensation to form on all surfaces. This makes this practice suitable for flat panels as well as large or 3D objects. This practice differs from other methods where condensation is only formed on the front coating surface, while the back surface is outside the exposure area. Other tests may also deposit water droplets on the surface but where the source is not from condensation (for example, water spray).

NOTE 1—Alternative practices for testing the water resistance of coatings include Practices [D870](#), [D1735](#), and [D4585](#).

1.4 This practice is limited to the methods of obtaining, measuring, and controlling the conditions and procedures of tests conducted in 100 % relative humidity. It does not specify specimen preparation, or evaluation of results.

1.5 The values stated in SI units are to be regarded as the standard. The values 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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

¹ This practice is under the jurisdiction of ASTM Committee [D01](#) on Paint and Related Coatings, Materials, and Applications and is the direct responsibility of Subcommittee [D01.27](#) on Accelerated Testing.

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1.7 This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.

2. Referenced Documents

2.1 ASTM Standards:²

- [D609 Practice for Preparation of Cold-Rolled Steel Panels for Testing Paint, Varnish, Conversion Coatings, and Related Coating Products](#)
- [D610 Practice for Evaluating Degree of Rusting on Painted Steel Surfaces](#)
- [D714 Test Method for Evaluating Degree of Blistering of Paints](#)
- [D823 Practices for Producing Films of Uniform Thickness of Paint, Coatings and Related Products on Test Panels](#)
- [D870 Practice for Testing Water Resistance of Coatings Using Water Immersion](#)
- [D1193 Specification for Reagent Water](#)
- [D1654 Test Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments](#)
- [D1730 Practices for Preparation of Aluminum and Aluminum-Alloy Surfaces for Painting](#)
- [D1735 Practice for Testing Water Resistance of Coatings Using Water Fog Apparatus](#)
- [D2616 Test Method for Evaluation of Visual Color Difference With a Gray Scale](#)
- [D3359 Test Methods for Rating Adhesion by Tape Test](#)
- [D3363 Test Method for Film Hardness by Pencil Test](#)
- [D4541 Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers](#)
- [D4585 Practice for Testing Water Resistance of Coatings Using Controlled Condensation](#)

² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at www.astm.org/contact. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

*A Summary of Changes section appears at the end of this standard

3. Summary of Practice

3.1 Coated specimens are placed in an enclosed chamber containing a heated, saturated mixture of air and water vapor. The temperature of the chamber is usually maintained at 38 °C (100 °F). At 100 % relative humidity (RH), a very small temperature difference between the specimen and the surrounding vapor causes the formation of condensation on the specimens. 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, blistering, 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 for assessing how it will perform in actual service. Failure in tests at 100 % relative humidity may be caused by a number of factors including a deficiency in the coating itself, contamination of the substrate, or inadequate surface preparation. This practice is therefore useful for evaluating coatings alone or complete coating systems.

4.2 Tests at 100 % relative humidity are used for specification acceptance, quality control, and research and development for coatings and substrate treatments. Some tests are used for a pass or fail determination at an arbitrary time. A coating system is considered to pass if there is no evidence of water-related failure after a period of time. Other tests are used to monitor degree of failure as a function of exposure time.

4.2.1 Arbitrary pass/fail levels and the test durations required are typically set in other material specific test methods. Users of this practice alone may use the known performance of the controls to set test end points. Another option is to continue the test until all specimens have failed, and use the time to reach failure as a way to differentiate performance.

4.3 Results obtained from the use of 100 % humidity 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 chamber can be a small laboratory cabinet or a room large enough to hold an automobile or a truck. Some automobile manufacturers test completed vehicles in rooms maintained at 100 % relative humidity. Corrosion tests can be conducted, as the condensate dripping off the test articles is not recirculated.

5. Apparatus

5.1 *Test Chamber*, constructed of corrosion-resistant materials with supports for the test specimens.

5.2 *Source of Heated Water Vapor* can be created by one of the following methods:

5.2.1 *Heated Water Tank*, within the test chamber, a water supply, and a water level control.

5.2.2 *Water Vapor (Steam) Generator*, located outside the test chamber, a water supply, and a means of introducing the vapor to the test chamber.

5.3 *Thermostatic Control*, for the water heater with the sensor located adjacent to the specimen holders, or a means of controlling volume of steam.

5.4 *Thermometer*, with sensor located adjacent to the specimen holders.

5.5 Diagrams and details of the apparatus are shown in **Appendix X1**.

6. Test Specimens

6.1 The type and number of test specimens to be used, as well as the criteria for the evaluation of the test results, shall be defined in the specifications covering the material or product being exposed or shall be mutually agreed upon between the purchaser and the seller.

NOTE 2—Applicable methods for the preparation of test panels and substrates are given in Practices **D609** and **D1730**. Practices **D823** cover application techniques for the production of uniform films.

6.2 It is recommended that a control specimen of a coating with known durability and similar failure type 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. Best practice is to use two different control specimens, one with known relatively poor performance, and one with known relatively good performance. The use of control specimens with known performance can also be used to determine the duration of the test that is required to produce meaningful results.

6.3 It is recommended that at least two replicate specimens of each different coating be used, so as to compensate for variations between specimens and potential variations in test conditions with the device. If more than one replicate specimen is exposed, place the replicates in different locations in the exposure area.

7. Procedure

7.1 Generate the saturated water vapor with reagent water conforming to at least the requirements of Type IV of Specification **D1193**.

7.2 Unless otherwise specified, adjust the temperature of the saturated air and water vapor mixture so that the air temperature next to the test specimens is 38 °C. During equilibrium operation, the temperature of the sensor used to measure the air next to the specimens can vary by a maximum of ± 2 °C from the desired temperature. If a temperature set point different from 38 °C is used, it must be included in the Test Report.

7.2.1 The temperature of the water vapor will typically be the same or higher than the air temperature next to the specimens. This is a requirement in order for this procedure to work correctly. The temperature of the water in the vapor generation is not set by this practice but water vapor temperatures that are greater than 38 °C tend to make condensation more uniform over the test specimens.

NOTE 3—Due to heat loss to the specimens and the walls of the chamber where a heated water tank is used, the temperature of the water in the tank will be above the temperature of the air and water vapor mixture.