



Designation: ~~D1014-02~~ Designation: D 1014 – 09

Standard Practice for Conducting Exterior Exposure Tests of Paints and Coatings on Metal Substrates¹

This standard is issued under the fixed designation D 1014; 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 covers procedures to be followed for direct exposure of exterior paints and coatings to the environment when applied to metal surfaces. When originators of a weathering test have the actual exposure conducted by a separate agency, the specific conditions for the exposure of test and control specimens should be clearly defined and mutually agreed upon between all parties.

1.2 Experience indicates that the metal used as a test substrate has a significant effect upon weathering results. The purpose of this practice is to define specific steel and other metal surfaces to be used for testing in order to minimize this source of variability.

~~1.3 The values stated in SI units are to be regarded as the standard.~~

1.3 The values stated in SI units are to be regarded as the standard. The values given in parenthesis 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 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:²

A 36/A 36M [Specification for Carbon Structural Steel](#)

A 283/A 283M [Specification for Low and Intermediate Tensile Strength Carbon Steel Plates](#)

B 209 [Specification for Aluminum and Aluminum-Alloy Sheet and Plate](#)

B 449 [Specification for Chromates on Aluminum](#)

D 523 [Test Method for Specular Gloss](#)

D 609 [Practice for Preparation of Cold-Rolled Steel Panels for Testing Paint, Varnish, Conversion Coatings, and Related Coating Products](#)

D 610 ~~Test Method-Practice~~ [for Evaluating Degree of Rusting on Painted Steel Surfaces](#) [1731666e/astm-d1014-09](#)

D 660 [Test Method for Evaluating Degree of Checking of Exterior Paints](#)

D 661 [Test Method for Evaluating Degree of Cracking of Exterior Paints](#)

D 662 [Test Method for Evaluating Degree of Erosion of Exterior Paints](#)

D 714 [Test Method for Evaluating Degree of Blistering of Paints](#)

D 772 [Test Method for Evaluating Degree of Flaking \(Scaling\) of Exterior Paints](#)

D 823 ~~Practices for Producing Films of Uniform Thickness of Paint, Varnish, and Related Products on Test Panels~~⁵

~~D1186 Test Methods for Nondestructive Measurement of Dry Film Thickness of Nonmagnetic Coatings Applied to a Ferrous Base~~³ [Practices for Producing Films of Uniform Thickness of Paint, Varnish, and Related Products on Test Panels](#)

D 1212 [Test Methods for Measurement of Wet Film Thickness of Organic Coatings](#)

~~D1400 Test Method for Nondestructive Measurement of Dry Film Thickness of Nonconductive Coatings Applied to a Nonferrous Metal Base~~⁵ [1654 Test Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments](#)

D 1729 [Practice for Visual Appraisal of Colors and Color Differences of Diffusely-Illuminated Opaque Materials](#)

D 1730 [Practices for Preparation of Aluminum and Aluminum-Alloy Surfaces for Painting](#)

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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² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* Vol 01.04, 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.

- ~~D 2200 Pictorial Surface Preparation Standards for Painting Steel Surfaces~~⁶ Practice for Use of Pictorial Surface Preparation Standards and Guides for Painting Steel Surfaces
- D 2201 Practice for Preparation of Zinc-Coated and Zinc-Alloy-Coated Steel Panels for Testing Paint and Related Coating Products
- D 2244 Practice for Calculation of Color Tolerances and Color Differences from Instrumentally Measured Color Coordinates
- D 2616 Test Method for Evaluation of Visual Color Difference With a Gray Scale
- D 2803 Guide for Testing Filiform Corrosion Resistance of Organic Coatings on Metal
- D 3359 Test Methods for Measuring Adhesion by Tape Test
- ~~D 4214 Test Methods for Evaluating the Degree of Chalking of Exterior Paint Films~~⁵ Test Methods for Evaluating the Degree of Chalking of Exterior Paint Films
- ~~D 7091 Practice for Nondestructive Measurement of Dry Film Thickness of Nonmagnetic Coatings Applied to Ferrous Metals and Nonmagnetic, Nonconductive Coatings Applied to Non-Ferrous Metals~~
- E 41 Terminology Relating to Conditioning
- E 1347 Test Method for Color and Color-Difference Measurement by Tristimulus ~~(Filter)~~ Colorimetry
- G 7 Practice for Atmospheric Environmental Exposure Testing of Nonmetallic Materials
- G 113 Terminology Relating to Natural and Artificial Weathering Tests of Nonmetallic Materials
- G 141 Guide for Addressing Variability in Exposure Testing ~~on~~ of Nonmetallic Materials
- G 147 Practice for Conditioning and Handling of Nonmetallic Materials for ~~natural~~ Natural and Artificial Weathering Tests
- 2.2 Other Standard:
- SSPC Method 1 Test Panel Preparation Method No 1, Uncontaminated Rusted Steel SSPC³

3. Terminology

3.1 *Definitions*—The definitions given in Terminologies E 41 and G 113 are applicable to this practice.

4. Significance and Use

4.1 The procedures described in this practice are intended to aid in evaluating the performance of coatings on various metal panels including either new or ~~previously~~ rusted steel.

4.2 The relative durability of paints in outdoor exposures can be very different depending on the location of the exposure because of differences in solar radiation, time of wetness, temperature, pollutants, and other factors. Therefore, it cannot be assumed that results from one exposure in a single location will be useful for determining relative durability in a different location. Exposures in several locations with different climates which represent a broad range of anticipated service conditions are recommended.

4.2.1 Because of year-to-year climatological variations, results from a single exposure test cannot be used to predict the absolute rate at which a material degrades. Several years of repeat exposures are needed to get an “average” test result for a given location.

4.2.2 Solar radiation varies considerably as function of time of year. This can cause large differences in the apparent rate of degradation in many polymers. Comparing results for materials exposed for short periods (less than one year) is not recommended unless materials are exposed at the same time in the same location.

4.3 The Significance and Use in Practice G 7 addresses many variables to be considered in exterior exposure tests. Guide G 141 provides more information on variability in weathering testing.

5. Materials Used for Test Specimens

5.1 A minimum of two and preferably four test specimens shall be used to evaluate the performance of any paint system.

5.2 The surface preparation shall be the same for all test panels in the test program unless surface preparation is one of the variables to be evaluated. Surface preparation shall be essentially identical for all test panels, as the thoroughness of preparation may directly determine the performance life of the applied coating system.

5.3 *Steel Panels*—Unless otherwise specified, fabricate steel test panels from the same material over which the coating is expected to perform in-service, when the exact composition of the substrate is known. Any of the following surfaces may be used.

5.3.1 *Abrasive Blasted Steel Plate*—The steel plate shall conform to Specification A 36/A 36M or Specification A 283/A 283M/~~A283M~~. The minimum thickness shall be ~~in. (1.6 mm)~~ 1.6 mm (1/16 in.). The minimum size shall be 375 by 6 in. (75150 mm (3 by 150 mm) 6 in.). Burrs and sharp projections shall be removed from the edges by filing. The test panels shall be freed of oil by suitable grease-removing solvents in accordance with Procedures B, C, or D of Practice D 609. Unless otherwise specified and agreed upon, the surface shall be blasted to meet the requirements of Standard D 2200, Sa 2 1/2 .

5.3.2 *Rusted Surfaces*—Hot rolled steel angle or plate, or both, are useful for determining the performance of paints applied to structures that cannot be thoroughly cleaned of rust and corrosion products. The steel angle and plate shall conform to Specification A 283/A 283M/~~A283M~~. The steel angles shall be at least 4100 by 4100 by ~~in. (1003.2 mm (4 by 1004 by 3.2 mm) 1/8 in.)~~ in cross

⁶ Annual Book of ASTM Standards, Vol 02.02.

³ Available from Society for Protective Coatings (SSPC), 40 24th St., 6th Floor, Pittsburgh, PA 15222-4656, <http://www.sspc.org>.

section and ~~42 in. (300 mm)~~300 mm (12 in.) in length. The minimum size of the steel plate shall be ~~4100~~ by ~~6 in. (100150 mm)~~ (4 by ~~150 mm~~)6 in.) with a minimum thickness of ~~in. (1.6 mm)~~1.6 mm ($\frac{1}{16}$ in.). Burrs and sharp projections shall be removed from the edges by filing. The test pieces shall be freed from oil by the use of suitable grease-removing solvents in accordance with Procedures B, C, or D of Practice D 609. Those persons desiring to test coatings over rusty or slightly rusted surfaces (Note 1) should refer to Standard Practice D 2200, select the degree of rusting desired from the rust grades given, and utilize the degree of surface preparation that can be accomplished in the field or on the job.

5.3.2.1 When evaluating performance over rusty surfaces, it is recommended that ~~test specimens~~substrates be pre-corroded (weathered) in the same environment in which they will be ultimately be exposed. SSPC Method 1 describes this pre-aging procedure. Artificial rusting is permitted but conditions used must be stated in the test report.

NOTE 1—The environment in which the steel is rusted prior to painting has considerable influence on the performance of paint applied to such steel.

5.3.3 *Cold-Rolled Steel Strip*—Cold-rolled steel strip has a slightly roughened surface free from mill scale and rust, and is useful for checking the relative performance of paints on a clean, uniform surface. The steel strip shall conform to one of the types described in Practice D 609. The panels shall be not less than ~~4100~~ by ~~6 in. (100150 mm)~~ (4 by ~~150 mm~~)6 in.) in size and it is recommended that all edges shall be smooth and uniformly rounded. The metal panels shall be prepared by the agreed upon procedure (A, B, C, or D) in Practice D 609.

5.3.4 *Galvanized Steel*—When galvanized steel panels are used, prepare test specimens according to Practice D 2201.

5.4 After surface preparation, steel panels shall be prime coated as soon as possible to prevent flash rusting or deposit of any foreign contaminant on the cleaned surface. After surface preparation, if the panels are stored prior to coating, precautions must be taken to preserve the clean surface.

5.5 *Aluminum Panels*—Use aluminum panels that have the same alloy, heat treatment, and surface treatment representative of the aluminum substrate to which the coating may be applied in field use. Aluminum alloys and heat treatments are described in Specification B 209. Typical aluminum alloys used for testing coatings are 6061, 5052, and 3024. The minimum thickness shall be ~~0.020 in. (0.5 mm)~~0.5 mm (0.020 in.). The minimum size shall be ~~375~~ by ~~6 in. (75150 mm)~~ (3 by ~~150 mm~~)~~6 in.~~

5.5.1 Aluminum panels are typically prepared with a conversion coating to promote coating adhesion and to prevent corrosion of the aluminum. Chromate conversion coatings are described in Specification B 449. Non-chrome conversion coatings may also be used if agreed upon by all interested parties. Follow Practices D 1730 when preparing aluminum and aluminum alloy test specimens.

6. ~~Painting Test Specimens~~ Test Specimens

6.1 Apply all coatings in strict accordance with the coating manufacturer's written recommendations. If known, the method of application expected for the production work on the job should also be used for test panel application.

6.2 If the method of application is unknown, select one of the following (Note 2):

Automatic Spray Machine

Automatic Dip Coater

Manual Spray Application

Motor Driven Blade Applicator

Brush Application

Roller Coating

Curtain Coating

NOTE 2—Details for the application of paint are given in Practices D 823.

6.2.1 Powder coating application using techniques such as fluid bed dip or electrostatic fluid bed may also be used where appropriate.

6.3 Measure and record the film thickness of each coat in accordance with ~~Test Methods D 1186~~Method D 7091 ~~or D 1400~~. If the panel is covered by rust and mill scale, these methods will be less accurate, as they are influenced by the surface characteristics of this base metal. In such cases, approximation can be made by wet film thickness measurements in accordance with Test Methods D 1212, or the amount of paint applied to a known area can be weighed and the average dry film thickness computed.

6.4 Allow the proper drying time between coats for multiple paint systems and before exposure as required by the coating's manufacturer and include in the test record.

6.5 Paint the back and edges of all test specimens with the same systems as that tested on the front of each panel. This painting provides considerable information on the behavior of paint systems on the reverse side. Back and edge painting may also provide "insulating" properties that allow metal panels to be mounted on metal racks.

6.5.1 The edges of steel panels may be coated or wrapped to prevent rusting.

6.6 The test specimens may be scribed to base metal prior to exposure. Unless otherwise specified, scribe panels according to Test Method D 1654.

6.7 Unless otherwise specified, follow the procedures described in Practice G 147 for labeling, shipping, and conditioning / handling of test specimens.