Designation: D6294/D6294M – 13

# Standard Test Method for Corrosion Resistance of Ferrous Metal Fastener Assemblies Used in Roofing and Waterproofing[1]

This standard is issued under the fixed designation D6294/D6294M; 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.

## 1. Scope

1.1 This test method covers components of ferrous metal fastener assemblies, excluding those of stainless steel, such as fasteners, stress plates, and batten bars used in low slope roofing and waterproofing, to a sulfurous acid environment. This test method evaluates relative corrosion resistance of the components by determination of percentage of rust or white rust.

1.2 The components may or may not have a surface treatment applied.

1.3 A limiting factor is the subjectiveness when determining actual percentage of rust or white rust corrosion.

1.4 Other performance characteristics of ferrous metal components such as abrasion resistance of barrier coatings are not evaluated in this method.

1.5 This test method was developed based on Practice G87.

1.6 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard.

1.7 *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]

D16 Terminology for Paint, Related Coatings, Materials, and Applications

D1079 Terminology Relating to Roofing and Waterproofing

G15 Terminology Relating to Corrosion and Corrosion Testing (Withdrawn 2010)[3]

G87 Practice for Conducting Moist $SO_2$ Tests

## 3. Terminology

3.1 *Definitions:*

3.1.1 For definitions of terms used in this test method, see Terminology D1079, G15, and D16.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *barrier*—any material limiting passage through itself of solids, liquids, semi-solids, gases, vapors, or forms of energy such as ultraviolet light.

3.2.2 *surface treatment*—a process by which the surface of the ferrous metal component is treated with a barrier coating to inhibit corrosion. Examples of barrier coatings for ferrous metal components include galvanization, zinc plating with or without yellow or clear chromate sealer, cadmium, mechanical zinc plating and organic or inorganic polymers.

## 4. Summary of Test Method

4.1 This test method exposes ferrous metal specimens to 15 or 30 (24) h cycles consisting of the following:

4.1.1 Eight (8) h exposure to the sulfur dioxide atmosphere in a closed chamber.

4.1.2 An intermediate step of rinsing with distilled water, and

4.1.3 Sixteen (16) h of drying under vented conditions at controlled temperature and humidity.

4.2 After drying, the test specimens are visually examined to evaluate the percentage of rust or white rust that formed on the surface.

4.3 The total surface area of the components exposed in the chamber is 0.5 ± 0.1 $m^2$ [775 ± 155 $in.^2$].

[1] This test method is under the jurisdiction of ASTM Committee D08 on Roofing and Waterproofing and is the direct responsibility of Subcommittee D08.20 on Roofing Membrane Systems.

Current edition approved May 1, 2013. Published June 2013. Originally approved in 1998. Last previous edition approved in 2009 as D6294 – 98 (2009)E01. DOI: 10.1520/D6294_D6294M-13.

[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* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] The last approved version of this historical standard is referenced on www.astm.org.

## 5. Significance and Use

5.1 It is important to evaluate the corrosion resistance of ferrous metal components used in low-slope roofing and waterproofing because they provide integrity and securement of other system components, such as insulation and membranes. Corrosion of ferrous metal components may result in their early deterioration and may lead to roofing or waterproofing system failure.

5.2 Results from testing ferrous metal components in an acidic atmosphere serve as an indication of the relative corrosion resistance of such components, coated or uncoated, to the environment of the test chamber. The results are not to be construed as a general guideline to the corrosion resistance of such components in other environments or in usage that may be conducive to corrosion.

5.3 Moist air containing sulfur dioxide quickly produces easily visible corrosion on many ferrous metals. It is therefore a test medium suited to detect pores or other sources of weakness in protective barrier coatings.

5.4 This test method applies primarily to evaluating the effectiveness of barrier coatings to provide general corrosion protection under test conditions. It is not intended to evaluate the resistance of the components to specific corrosion mechanisms such as crevice, galvanic, or stress corrosion.

5.5 This test method does not address abrasion resistance of barrier coatings when the fasteners are driven through above roof deck components, such as an existing built-up roof or insulations, or both.

5.6 Only the above deck portion of fasteners subjected to this test method is evaluated.

## 6. Apparatus

6.1 The apparatus required for evaluating the corrosion resistance of the components consists of a test chamber[4] having an internal capacity of 300 L [10.6 $ft^3$], a supply of sulfur dioxide with metering device, specimen supports, provisions for heating the chamber, and necessary means of control. The size and detailed construction of the apparatus shall be in accordance with Section 4 of Practice G87.

## 7. Reagents

7.1 The reagents, (that is, sulfur dioxide and water), their purity, and the means for introducing the sulfur dioxide into the test chamber shall be in accordance with Section 7 of Practice G87.

## 8. Test Specimen

8.1 Select the number of test specimens such that the total combined exposed surface area of the specimens at any one time shall be 0.5 ± 0.1 $m^2$ [755 ± 155 $in.^2$].

8.2 It is allowable to mix the type of ferrous metal components (that is, fasteners, stress plates, an batten bars) in the test chamber, provided that the different components do not have vastly different resistance to corrosion under test conditions. The different types of components that may be evaluated in the chamber simultaneously are to be agreed upon between the laboratory and client requesting the test.

NOTE 1—The laboratory may have to conduct preliminary cycling tests to estimate the relative resistance of each component.

NOTE 2—Specimens may be produced by the laboratory showing 10, 15, 20, and 30 % rust or white rust surface corrosion to be used as controls to aid in the test result evaluation in accordance with 10.1.3 and 11.1.6.

8.3 To obtain quantitative corrosion-rate data, only ferrous metal components with similar reactivities should be included in a test run.

8.4 *Roof Fastener Test Specimens:*

8.4.1 Fasteners of any length may be tested according to this method. The length is to be agreed upon between the laboratory and client.

8.4.2 Roof fasteners are evaluated in this method in relation to deck materials into which they are expected to be installed in service. For purposes of this test method, these deck materials are structural concrete, lightweight insulating concrete, cementitious wood fiber, gypsum, metal, and wood. Prepare the fastener test specimens as follows:

8.4.3 *Fasteners for Concrete Decks:*

8.4.3.1 Use nominal 20.7 MPa [3000 $lb/in^2$] 75 mm [3 in.] minimum thickness concrete deck that has cured a minimum of 28 days. Install the fastener, in accordance with the manufacture's specifications, a minimum of 25 mm [1 in.] ± 10 % into the deck.

8.4.3.2 Use a separate hole location on the deck sample(s) for each fastener.

8.4.4 *Fasteners for Lightweight Insulating Concrete Decks:*

8.4.4.1 Use 75 mm [3 in.] minimum thickness nominal 480 $kg/m^3$ [30 pcf] lightweight insulating concrete deck that has cured a minimum 28 days. Install the fastener, in accordance with the manufacture's specifications, a minimum of 25 mm [1 in.] ± 10 % into the deck.

8.4.4.2 Use a separate hole location on the concrete deck sample(s) for each fastener.

8.4.5 *Fasteners for Cementitious Wood Fiber Decks:*

8.4.5.1 Use 75 mm [3 in.] minimum thickness cementitious wood fiber deck. Install the fastener, in accordance with manufacture's specifications, a minimum of 25 mm [1 in.] ± 10 % into the deck.

8.4.5.2 Use a separate hole location on the deck sample(s) for each fastener.

8.4.6 *Fasteners for Gypsum Decks:*

8.4.6.1 Use 75 mm [3 in.] minimum thickness poured gypsum deck that has cured a minimum of 28 days to a maximum 90 days. Install the fastener, in accordance with the manufacture's specifications, a minimum of 25 mm [1 in.] ± 10 % into the deck.

8.4.6.2 Use a separate hole location on the deck sample(s) for each fastener.

8.4.7 For the decks referenced in 8.4.3 through8.4.6 remove the fastener from the deck using care by breaking away the

[4] The sole source of supply of the apparatus known to the committee at this time is Most Associates, 114 Waters Edge Drive. Jupiter, FL 33477, and Atotech USA, 20026 Progress Drive, Strongville, OH 44136. If you are aware of alternative suppliers, please provide this information to ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee,[1] which you may attend.

deck without damage to the section of the fastener not embedded in the deck.

8.4.8 For 8.4.3 through 8.4.6 install the fastener in a pre-drilled plastic block such that the section previously driven into the deck is not exposed. As an option and for non screw type fasteners, the fasteners may be hung from a glass rod with nylon wire tied to the glass rod and directly under the fastener head.

8.4.9 *Fasteners for Metal Decks:*

8.4.9.1 Use a nominal 75 by 75 mm [3 by 3 in.] metal deck coupon[5] having the following characteristics: 22 gage metal roof stock SS Grade 80, painted, and cut edges are to be protected with paraffin wax, 2 mm [1⁄16 in.] ± 10 % from the steel coupon edges.

8.4.9.2 Using a variable speed screw gun, drive a fastener a minimum of 13 mm [0.5 in.] ± 10 % to a maximum of 19 mm [0.75 in.] ± 10 % into the metal coupon. For non screw type fasteners, drive the fasteners in accordance with the manufacture's specifications a minimum of 13 mm [0.5 in.] ± 10 % to a maximum of 19 mm [0.75 in.] ± 10 % into the metal coupon.

8.4.10 *Fasteners for Wood Decks:*

8.4.10.1 Use nominal 19 mm [0.75 in.] exterior grade plywood. Using a variable Speed screw gun, drive a fastener 25 mm [1 in.] ± 10 % into the plywood. For non screw type fasteners, drive fasteners in accordance with the manufacture's specifications a minimum of 13 mm [0.5 in.] ± 10 % to a maximum of 25 m [1 in.] ± 10 % into the deck.

8.4.10.2 Remove the fastener from the plywood by breaking away the plywood without damage to the section of the fastener not embedded into the plywood.

8.4.10.3 Install the fastener in a predrilled plastic block such that the section previously driven into the plywood is not exposed. As an option and for non screw type fasteners, the fasteners may be hung from a glass rod with nylon wire tied to the glass rod and directly under the fastener head.

8.5 *Roof Stress Plate Test Specimens*—Stress plates shall be used as supplied.

8.6 *Roof Batten Bar Test Specimens*—Batten-bar specimens shall be cut to a length of 150 ± 2 mm [6 ± 1⁄16 in.].

## 9. Position of Specimens During Test

9.1 Place the test specimens in the cabinet so that no part of any specimen is within 20 ± 2 mm [0.78 in. ± 10 %] of another, or within 100 ± 10 mm [3.9 in. ± 10 %] of the walls or the ceiling, or within 200 ± 20 mm [7.9 in. ± 10 %] of the surface of the water in the base of the chamber.

9.2 Arrange the specimens so that moisture which may condense on any of them or their supports will not fall on the other specimens placed at lower levels.

9.3 Unless otherwise agreed upon, the angle of inclination of test surfaces to the vertical is optional. However, a near vertical orientation (0° to 10° from the vertical) is suggested.

[5] The sole source of supply of the apparatus known to the committee at this time is Wheeling Corrugated, 1134 Market Street Wheeling, WV 26003. If you are aware of alternative suppliers, please provide this information to ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee,[1] which you may attend.

## 10. Procedure

10.1 The procedure shall be conducted according to Section 9 of Practice G87 with the following exceptions or additional requirements.

10.1.1 Introduce 2 ± 0.2 L [0.5 gal ± 10 %] of sulfur dioxide into the chamber through the inlet pipe.

10.1.2 One test cycle is approximately 24 h of alternating exposure to the sulfur dioxide environment for 8 ± 0.25 h, an intermediate step of rinsing (see 10.1.3) with a minimum of 1000 mL of clean distilled water at 30 ± 8°C [86 ± 14°F], followed by drying in the ambient temperature inside the chamber for 16 ± 0.25 h. For purpose of this test method ambient atmosphere is a temperature in the range of 20 to 30°C [68 to 86°F] and a relative humidity below 75 % (± 10 %).

10.1.3 Each individual component is rinsed by a gentle back and forth motion while the component is immersed in the water.

NOTE 3—Rinsing for 15 to 30 s is intended to remove staining which is not part of corrosion.

10.1.4 After rinsing and the test samples have been allowed to dry, visually estimate the percent of rust or white rust surface corrosion. As an aid, test samples may be compared to control specimens which may be produced by the laboratory showing 10, 15, 20, 30 % rust or white rust surface corrosion.

## 11. Report

11.1 Report the following information:

11.1.1 Record the date the test commenced and the date the test ended.

11.1.2 Record complete identification of specimens tested, including number of specimens, type, source, and manufacturer.

11.1.3 Identify any surface treatment applied to specimens tested.

11.1.4 Report any surface protection applied to bare edges of specimens tested.

11.1.5 Identify whether the test was run for 15 or 30 cycles.

11.1.6 Report findings in terms of percentage of rust or white rust, or both, on the specimens tested.

11.1.6.1 *On Ferrous Metal Fasteners Driven into a Metal Deck Coupon*—Report only the percentage of rust or white rust, or both, showing in the area of the fastener above the metal deck coupon into which the fastener was driven for testing.

11.1.6.2 *On Ferrous Metal Fasteners Driven into Concrete*—Report the percentage of rust or white rust, or both, showing in the area of the fastener above the concrete.

11.1.6.3 *On Ferrous Metal Fasteners Driven into Lightweight Insulating Concrete*—Report the percentage of rust or white rust, or both, showing in the area of the fastener above the lightweight insulating concrete.

11.1.6.4 *On Ferrous Metal Fasteners Driven into Cementitious Wood Fiber*—Report the percentage of rust or white rust, or both, showing in the area of the fastener above the cementitious wood fiber.

11.1.6.5 *On Ferrous Metal Fasteners Driven into Gypsum*—Report the percentage of rust or white rust, or both, showing in the area of the fastener above the gypsum.

11.1.6.6 *On Ferrous Metal Fasteners Driven into Plywood*—Report the percentage of rust or white rust, or both, showing in the area of the fastener above the plywood.

11.1.6.7 *On Ferrous Metal Stress Plates*—2 ± 0.2 mm [1⁄16 in. ± 10 %] from the outside perimeter of the specimen plate.

11.1.6.8 *On Ferrous Metal Batten Bars*—2 ± 0.2 mm [1⁄16 in. ± 10 %] from each side edge.

## 12. Precision and Bias

12.1 The precision and bias of results obtained with this test method depends upon the type of specimen used and cannot be generalized.

## 13. Keywords

13.1 barrier coatings; corrosion; corrosion resistance; fasteners; metal; rust; white rust