



Designation: F2832 – 11 (Reapproved 2021)

Standard Guide for Accelerated Corrosion Testing for Mechanical Fasteners¹

This standard is issued under the fixed designation F2832; 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 guide covers test procedures for performing accelerated tests to evaluate relative corrosion resistance of various coatings applied to mechanical fasteners. Corrosion mechanisms such as general and crevice corrosion may be evaluated with this method. Test duration may be selected to achieve any desired level of corrosion exposure and provides a frame of reference to determine relative coating resistance to corrosion. Fasteners tightened to a desired tension and subjected to this test procedure may be evaluated to simulate a variety of service conditions. Without large amounts of accumulated field results, it is difficult to relate test duration or the number of test cycles to actual service life for a given application.

1.2 This standard is not intended to cover tests of driven fasteners such as nails, staples, screws and lag bolts.

1.3 *Units*—The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.5 *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

A480/A480M Specification for General Requirements for

Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip

B117 Practice for Operating Salt Spray (Fog) Apparatus

B605 Specification for Electrodeposited Coatings of Tin-Nickel Alloy

D1193 Specification for Reagent Water

F1470 Practice for Fastener Sampling for Specified Mechanical Properties and Performance Inspection

F1789 Terminology for F16 Mechanical Fasteners

G1 Practice for Preparing, Cleaning, and Evaluating Corrosion Test Specimens

2.2 *ASME Standard*:³

ASME B18.12 – Glossary of Terms for Mechanical Fasteners

2.3 *IFI Standards*⁴

IFI-170 – Accelerated Corrosion Test for Mechanical Fasteners

3. Terminology

3.1 Definitions for many of the terms used in this standard are included in Terminology F1789 and ASME B18.12.

3.2 *Definitions of Terms Specific to This Standard*:

3.2.1 *cycle*—a series of events scheduled over a 24-hour period

3.2.2 *phase*—a test period which has elapsed for 8 cycles.

3.2.3 *test duration*—a series of cycles as defined in Section 4.

4. Test Duration

4.1 Test duration is specified as A, B, C, D or E in accordance with Table 1.

4.2 A typical cycle is shown in Table 2.

5. Apparatus and Materials

5.1 Coupons 25.4 mm wide and 50.8 mm long having a thickness selected from Table 3 shall be used. Dimensional tolerances of Specification A480/A480M shall apply. Coupons

¹ This guide is under the jurisdiction of ASTM Committee F16 on Fasteners and is the direct responsibility of Subcommittee F16.01 on Test Methods.

Current edition approved Dec. 1, 2021. Published January 2022. Originally approved in 2011. Last previous edition approved in 2016 as F2832– 11(2016). DOI: 10.1520/F2832–11R21

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 Available from American Society of Mechanical Engineers (ASME), ASME International Headquarters, Two Park Ave., New York, NY 10016-5990, http://www.asme.org.

⁴ Available from Industrial Fasteners Institute (IFI), 6363 Oak Tree Blvd. Independence, OH 44131 http://www.indfast.org.

TABLE 1 Test Duration

Test Duration	Number of Cycles
A	8
B	16
C	40
D	80
E (# of cycles) ^A	>80

^A For special applications as agreed between supplier and purchaser.

shall have a plain finish and be manufactured from AISI-1008 steel grade. Coupons shall be included with fasteners to be tested to verify that uniform amounts of corrosion have been produced by tests. Refer to Fig. 1, Fig. 1 (a) and Fig. 1(b) and Table 3. Inclusion of a metal loss coupon assists in making comparisons from one test to another and allows one to quantify a repeatable test.

5.2 A fog humidity cabinet shall be used in which salt mist applications are coupled with high humidity and moderately high temperature. Water fog or visible water droplets on parts being tested shall be continuous after equilibrium is reached. Dry-off may be sequenced manually or automatically.

5.3 Racks suitable for supporting bolt or screw assemblies shall be agreed upon between supplier and purchaser. Test results shall always state materials used for racks during testing. Nylon or other suitable nonmetallic washers shall be installed to prevent bolt or screw heads or test coupons from contact with test racks. See Fig. 1 and 7.8.

6. Salt Mist Application and Dry-off

6.1 Salt solution shall conform to requirements of Table 4. Solutions shall be sprayed by nozzles to provide a mist such that test fasteners and coupons are thoroughly wet and dripping when examined visually. Solution collection rates shall conform to Practice B117. Salt accumulations shall have been rinsed away during the salt solution spray application.

6.2 For the drying part of a cycle, a dry-off environment area shall be maintained with sufficient air circulation to assure uniform temperature and shall allow thorough drying of tested fasteners and coupons. Temperature and humidity conditions are defined in Table 4.

7. Test Procedure

7.1 Fasteners to be tested with salt spray, shall be sampled in accordance with Practice F1470, Sample Level B.

7.2 Each fastener to be tested shall be installed through its corresponding rack using nonmetallic washers as to maintain a minimum of 5 mm spacing between underside of the head and surface of the rack. The washers for any testing protocol shall be identical. Fig. 1(a) and Fig. 1(b) provide an illustrative representation. Holes in test racks shall be offset to avoid dripping from one test fastener onto another. Fastener load shall be achieved through finger tightening (Fig. 1 illustrates

the assembly). If higher loads or proof load tightening is required then the load level and method of tightening shall be by agreement between supplier and purchaser.

7.3 Coupons to be tested shall be permanently identified by numbers stamped onto the surface.

7.4 Coupons to be used shall be cleaned with a methanol or acetone solution and weighed prior to use. A coupon's weight in ± 0.5 -mg shall be recorded for comparison with its weight after testing in accordance with Table 2.

7.5 Coupons as shown in Fig. 1(a) shall be installed by drilling a hole to accept a nonmetallic hex fastener. Coupons shall be raised above coupon racks by two nonmetallic washers to expose both sides of coupons to the test environment. A minimum of 5 mm shall be provided for spacing between coupons and test rack surfaces. Fixtures shall be modified as necessary to maintain isolation from rack materials while creating and maintaining the required fastener tensions.

7.6 Dry off shall consist of exposure to high temperature, low humidity air in accordance with Table 4 for three hours.

7.7 Test coupon(s) shall be removed and analyzed after dry-off in each phase. Each coupon shall be cleaned in accordance with the procedures described in Practice G1.

7.8 For corrosion products that are tightly adhered to the fastener specimen, cleaning by mechanically abrading the surface before chemical cleaning will help remove the adherent corrosion products. Vigorous mechanical cleaning may result in the removal of some coating or base metal; therefore, care should be exercised when using mechanical cleaning techniques. Mechanical cleaning should be used only when other methods have failed to provide adequate removal of corrosion products on the coupons. After a final phase, coupon mass loss shall be evaluated based on Table 3. Prior to completion of a final testing phase, mass loss may be linearly extrapolated based on percent of the overall test completed.

8. Report

8.1 Reported test results shall include:

- 8.1.1 Name of testing agency,
- 8.1.2 Date(s) and place of testing,
- 8.1.3 Testing schedule as to number of cycles,
- 8.1.4 Identification, all materials for coupons,
- 8.1.5 Materials of construction for racks,
- 8.1.6 Identification, materials and coatings of fasteners,
- 8.1.7 Installation torques or tensions involved,
- 8.1.8 Condition of coupons,
- 8.1.9 Mass loss of coupons, net and percent, and
- 8.1.10 Condition of the fasteners, including section loss, estimated percent surface corrosion, timing of on-set, or photographs as agreed with purchaser.

9. Keywords

- 9.1 corrosion; crevice; testing

TABLE 2 Typical Schedule

Time ^A	Duration Hrs	Event
6 a.m.	8	Salt mist application (in ambient environment.)
2:00 p.m.	8	8 hour humidity cabinet exposure including 1 hour progression to wet conditions.
10:00 p.m.	8	8 hour environmental exposure including 3 hours progression to dry conditions.
Weekends		Ambient environment

^A Times shown are illustrative. A test cycle may be started at any time and follow the order shown in the table. The events for a 24 h period complete one cycle. Ambient is specified in **Table 4**. Duration times are ± 5 minutes.

TABLE 3 Coupon Mass Loss Target Range

Initial Coupon Thickness mm	Test Duration mg of Mass Loss				
	A	B	C	D	E
0.79	828–1228	1496–1896	3210–3810	6038–6638	See ^A
1.59	874–1274	1574–1974	3378–3978	6345–6945	

^A The corrosion rate (mass loss) is in linear relation with the number of test cycles. This linear relation can be used to calculate the mass loss for the number of cycles different than the test cycles corresponding to test durations shown in **Table 3**. Values in **Table 3** are only applicable to Standard Test Procedure. Mass loss for test duration E(# of Cycles) is a function of the number of the cycles agreed upon.

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