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Standard Test Method for Sandwich Corrosion Test[1]

This standard is issued under the fixed designation F1110; 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 U.S. Department of Defense.

1. Scope

1.1 This test method defines the procedure for evaluating the corrosivity of aircraft maintenance chemicals, when present between faying surfaces (sandwich) of aluminum alloys commonly used for aircraft structures. This test method is intended to be used in the qualification and approval of compounds employed in aircraft maintenance operations.

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

1.3 *This standard may involve hazardous materials, operations, and equipment. 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.* Specific hazard statements appear in Section 9.

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D1193 Specification for Reagent Water

D1748 Test Method for Rust Protection by Metal Preservatives in the Humidity Cabinet

G46 Guide for Examination and Evaluation of Pitting Corrosion

2.2 *Industry Standards:*[3]

SAE-AMS-QQ-A-250/4 Al Alloy 2024, Plate and Sheet

SAE-AMS-QQ-A-250/5 Al Alloy Alclad 2024, Plate and Sheet

SAE-AMS-QQ-A-250/12 Al Alloy 7075, Plate and Sheet

SAE-AMS-QQ-A-250/13 Al Alloy Alclad 7075, Plate and Sheet

2.3 *Military Specification:*

MIL-A-8625 Anodic Coatings for Aluminum and Al Alloys[4]

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *sandwich corrosion test*—a comparative accelerated environmental test of the corrosivity of liquid or solid materials present between faying surfaces of structural aluminum alloys commonly used in aerospace construction.

4. Summary of Test Method

4.1 Aluminum coupons having clad or anodized nonclad surfaces are sandwiched together with a filter paper saturated with the test material between the coupons. The sandwiched coupons are cycled between warm ambient air and warm humid air for 7 days. The coupons are then inspected to determine whether corrosion more severe than that caused by reagent water has occurred on the surfaces exposed to the test material. This test method is used for solutions of dry granular material or for liquid materials.

5. Significance and Use

5.1 The data generated by this test method shall be used to determine whether aircraft structural aluminum alloys are liable to be corroded or damaged by application of the test material during routine maintenance operations.

5.2 Interpretation of the sandwich corrosion test results is based on a comparison of the appearance of faying surfaces of three sets of coupons. One set of test coupons is exposed with reagent water only in the faying surfaces, to establish the baseline (controls) against which the panels exposed to the test material are compared. Disregard corrosion at cut edges of the test coupons.

5.3 The relative corrosion severity rating system is provided in order to allow a numerical classification of the test results and to eliminate the necessity for elaborate weight loss measurements. Pitting corrosion, which is rated 4—extensive (severe) corrosion, may involve only a negligible weight loss.

[1] This test method is under the jurisdiction of ASTM Committee F07 on Aerospace and Aircraft and is the direct responsibility of Subcommittee F07.07 on Qualification Testing of Aircraft Cleaning Materials.

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

[3] Available from Society of Automotive Engineers (SAE), 400 Commonwealth Dr., Warrendale, PA 15096-0001.

[4] Available from Department of Defense Single Stock Point (DODSSP); http://dodssp.daps.dla.mil

5.4 Relative corrosion severity rating system:

Appearance/Corrosion:
0—No visible corrosion and no discoloration present
1—Very slight corrosion or very slight discoloration, and/or up to 5 % of area[A] corroded
2—Discoloration and/or up to 10 % of area[A] corroded
3—Discoloration and/or up to 25 % of area[A] corroded
4—Discoloration and/or more than 25 % of area[A] corroded, and/or pitting present

[A] "Area" refers to area under the filter paper, or if no filter paper is used, the area where the test material was applied.

6. Interferences

6.1 It is possible that tap water containing large amounts of dissolved solids, especially chlorides, will cause relative severe corrosion of the aluminum control panels. For this reason, reagent water is specified. For comparative purposes, a set of aluminum test panels, with the locally available tap water applied to the filter paper, is sometimes run along with the reagent water panels.

6.2 Filter paper made from glass fibers is not recommended since, in practice, corrosion of the control panels has often been found.

7. Apparatus

7.1 *Humidity Test Cabinet,* as specified in Test Method D1748 or equal, capable of maintaining 95 to 100 % relative humidity at 37.7 ± 1°C (100 ± 2°F).

7.2 *Oven,* forced air circulation, capable of maintaining 37.7 ± 1°C (100 ± 2°F).

7.3 *Microscope,* binocular, 10× to 40×.

8. Reagents and Materials

8.1 *Purity of Water*—Unless otherwise indicated, references to water shall be understood to mean reagent water as defined by Specification D1193, Type IV.

8.2 *Aluminum Alloy Coupons:*

8.2.1 Aluminum alloy coupons shall conform to the following industry standards:

SAE-AMS-QQ-A-250/4, 2024-T3 nonclad
SAE-AMS-QQ-A-250/5, 2024-T3 Alclad
SAE-AMS-QQ-A-250/12, 7075-T6 nonclad
SAE-AMS-QQ-A-250/13, 7075-T6 Alclad

8.2.2 *Coupon Size*—The recommended coupon size 50 by 100 by 1.0 to 1.5 mm (2 by 4 by 0.04 to 0.06 in.) has been found to provide suitable results for comparative tests. Smaller sizes are not recommended, because of the increased variations due to edge effects. Larger coupons are acceptable, but the space requirements for testing and storage shall be taken in consideration.

8.3 Unless otherwise specified, anodize the nonclad coupons in accordance with Military Specification MIL-A-8625, Type 1 (Chromic Acid) followed by a hot water seal.

8.4 *Filter Paper*—Use Whatman No. 5 or equal filter paper made from cellulose, 11 or 13 cm. Filter paper is not required when the material being tested is a solid. In case no filter paper is used, the area covered by the test material shall also be approximately 25 by 75 mm (1 by 3 in.).

9. Hazards

9.1 The materials used for aircraft maintenance sometimes contain flammable solvents, strong acids or alkalis, or other toxic compounds. Take suitable precautions to prevent personal injury from these hazards. When the composition of the test material is not known, consult the manufacturer to determine whether any hazards exist.

9.2 Exercise special care in handling the chromic acid solution, specified in 8.3, for its etching properties.

10. Sampling

10.1 Agitate or thoroughly mix the test material to assure uniformity. Where dilution of the material is required, use reagent water or the solvent specified by the product manufacturer. Apply sufficient test material to saturate the area between the metal coupons.

11. Test Specimen

11.1 Prepare three sets of test panels. A test panel set shall consist of eight individual test coupons, sandwiched together in pairs of coupons of the same alloy and the same surface treatment, to provide four test coupon sandwiches for each test condition. Identify each coupon by impression stamping or other suitable permanent method.

11.2 Clean the panels by solvent wiping, or vapor degreasing. Do not use acid or caustic cleaners. Remove ink stamped markings from the panels. Do not use abrasive materials to clean the panels.

11.3 Prepare the test panel sets as follows for each alloy:

11.3.1 One set for the compound to be tested at use dilution,

11.3.2 One set for the compound to be tested in concentrated form and

11.3.3 One set for controls using reagent water.

12. Preparation of Apparatus

12.1 Verify that the humidity cabinet is operating at the specified temperature and humidity.

12.2 Verify that the oven is operating at the specified temperature, with air circulation.

13. Calibration and Standardization

13.1 Since the test coupons include controls for comparative purposes, no special calibration or standardization procedures are required.

14. Conditioning

14.1 Conditioning of the test materials or the sets of prepared test coupons is not required. Thoroughly agitate the test sample before application to the test coupons.

14.2 Allow the anodized panels to age for a period of at least 48 h prior to exposure.

15. Procedure

15.1 Assemble the cleaned panels into three identical groups each having four different sets of panels suitably

identified by permanent marking. Each panel set shall consist of two individual coupons of the same alloy and the same surface treatment.

15.2 Cut a piece of cellulose filter paper to approximate 25 by 75 mm (1 by 3 in.). Fit this piece over one of the coupons. Add the test solution at the use concentration to the paper until saturated. Cover the wet paper with the second coupon of the sandwich pair. Each sandwich shall be held together with waterproof tape, with no more than a 25 mm (1 in.) piece of tape, maximum width 20 mm (0.8 in.), on each of two opposite sides. Repeat the operation for each of the coupon sets in the group. This test may be omitted if the test material is to be used in the concentrated form only. See 8.4 for deletion of the filter paper.

15.3 Prepare a second group of panels as outlined in 15.2 except apply the material to be treated in the concentrated as-received condition, without dilution by water or solvents. (Not applicable to dry granular materials.)

15.4 Prepare a third group of panels, as outlined in 15.2, except apply reagent water only to the filter paper between the panels.

15.5 During each test day, expose the panels in the oven for 8 h followed immediately by exposure in the humidity cabinet. Preferably start the alternating exposure periods on a Monday morning with the initial exposure in the oven. Over the following weekend, the coupons are to be left in the humidity cabinet. Maintain the humidity cabinet at 37.7 ± 1°C (100 ± 2°F) and 95 to 100 % relative humidity. Maintain the oven at 37.7 ± 2.8°C (100 ± 5°F). Expose each set of panels individually, not stacked, in a horizontal position. After exposure, rinse the panels in warm tap water, and scrub lightly with a soft nonmetallic bristle brush. Rinse with reagent water in accordance with Specification D1193, Type IV at room temperature. After drying, examine each panel under 10× magnification, and rate each set according to the scale in 5.4.

16. Interpretation of Results

16.1 Compare the corrosion rating on the set of panels from the first and second groups with those from the third, Reagent water, control group. Any corrosion in excess of that shown by group 3 shall be cause for rejection. Give pitting corrosion of any panel a severity rating of 4. Disregard any corrosion at the edges of the panel. Compare only those surfaces which were under the filter paper, unless no filter paper has been used. In this case, the rating is to be determined on the areas which have been in direct contact with the test material. Pitting is defined in Guide G46.

17. Report

17.1 Prepare a report certifying that the test has been run in accordance with this test method and listing the exact conditions of the test as performed. Tabulate the corrosion rating of all test panels used in the test, and state whether the test compound is considered to be acceptable from a sandwich corrosion standpoint.

18. Precision and Bias

18.1 No statement is made about either the precision or bias of this test method since the result merely states whether there is conformance to the criteria for success specified in the accompanying material or process specification of the material being tested, or both.

19. Keywords

19.1 aircraft maintenance chemicals; aluminum structural aircraft alloys; faying surfaces; sandwich corrosion

APPENDIX

(Nonmandatory Information)

X1. RECOMMENDED PANEL IDENTIFICATION, TABULATION OF RESULTS, AND EXPOSURE SCHEDULE

X1.1 *Panel Identification:*

X1.1.1 *Test Material Diluted to Use Concentration:* A-1 2024-T3 Nonclad Anodized
A-2 2024-T3 Alclad
A-3 7075-T6 Nonclad Anodized
A-4 7075-T6 Alclad

X1.1.2 *Test Material in Concentrated, As-Received Condition:* B-1 2024-T3 Nonclad Anodized
B-2 2024-T3 Alclad
B-3 7075-T6 Nonclad Anodized
B-4 7075-T36 Alclad

X1.1.3 *Specification D1193, Type IV Control:* C-1 2024-T3 Nonclad Anodized
C-2 2024-T3 Alclad
C-3 7075-T6 Nonclad Anodized
C-4 7075-T6 Alclad

X1.2 *Tabulation of Results:*

X1.2.1 See Fig. X1.1 for a recommended form for tabulation of results.

X1.3 *Exposure Schedule:*

X1.3.1 See Table X1.1 for a recommended exposure schedule.

NOTE 1—Record pitting corrosion separately, if present.

	Alloy			
Condition	1	2	3	4
A—Diluted				
B—Concentrate				
C—Specification D1193, Type IV				

FIG. X1.1 Recommended Tabulation of Results

TABLE X1.1 Recommended Exposure Schedule[A]

Step	Exposure Time,[B] h ± ½	Conditions	
		Temperature °C (°F)	Relative Humidity, %
1	8	37.7 (100)	Ambient
2	16	37.7 (100)	95–100
3	8	37.7 (100)	Ambient
4	16	37.7 (100)	95–100
5	8	37.7 (100)	Ambient
6	16	37.7 (100)	95–100
7	8	37.7 (100)	Ambient
8	16	37.7 (100)	95–100
9	8	37.7 (100)	Ambient
10	64	37.7 (100)	95–100

[A] The sequence of steps is optional except tests shall be started on odd numbered steps.
[B] Total testing time is 168 h.