

SAE-ARP1512

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AEROSPACE
RECOMMENDED
PRACTICE

ARP 1512A

Issued 7-15-77
Revised 10-1-83CORROSION OF ALUMINUM ALLOYS BY AIRCRAFT MAINTENANCE CHEMICALS
Sandwich Test

1. **SCOPE:** This recommended practice defines a procedure for evaluating the corrosive effects of aircraft maintenance chemicals on aluminum alloys under conditions of intimate contact by visual comparison with control specimens.
2. **APPLICABLE DOCUMENTS:**
 - 2.1 **Aerospace Material Specifications:** Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096.

AMS 2470 - Anodic Treatment, Aluminum Alloys, Chromic Acid Process
AMS 4037 - Aluminum Alloy Sheet and Plate, 4.4Cu - 1.5Mg - 0.60Mn (2024; -T3 Flat Sheet, -T351 Plate)
AMS 4041 - Aluminum Alloy Sheet and Plate, Alclad, 4.4Cu - 1.5Mg - 0.60Mn (Alclad 2024-T3 Flat Sheet, -T351 Plate)
AMS 4045 - Aluminum Alloy Sheet and Plate, 5.6Zn - 2.5Mg - 1.6Cu - 0.26Cr (7075-T6)
AMS 4049 - Aluminum Alloy Sheet and Plate, Alclad, 5.6Zn - 2.5Mg - 1.6Cu - 0.26Cr (Alclad 7075-T6 Sheet, -T651 Plate)
 - 2.2 **ASTM Publications:** Available from American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.

ASTM D1193 - Reagent Water
ASTM D1748 - Rust Protection by Metal Preservatives in the Humidity Cabinet
 - 2.3 **U.S. Government Publications:** Available from Commanding Officer, Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, PA 19120.
 - 2.3.1 **Federal Specifications:**

QQ-A-250/4 - Aluminum Alloy 2024, Sheet and Plate
QQ-A-250/5 - Aluminum Alloy Alclad 2024, Sheet and Plate
QQ-A-250/12 - Aluminum Alloy 7075, Sheet and Plate
QQ-A-205/13 - Aluminum Alloy Alclad 7075, Sheet and Plate

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ARP 1512A

2.3.2 Military Specifications:

MIL-A-8625 - Anodic Coatings for Aluminum and Aluminum Alloys

3. SUMMARY OF RECOMMENDED PRACTICE: Aluminum alloy coupons having clad or anodized non-clad surfaces are sandwiched together with a filter paper saturated with the test material between the coupons. The coupons are cycled between warm ambient air and warm humid air for seven days. The coupons are then inspected to determine whether corrosion more severe than that caused by synthetic tap water has occurred on the surfaces exposed to the test material. The test may be used for solutions of dry granular material, for solids, or for liquid materials.

4. SIGNIFICANCE:

- 4.1 Data generated by this practice shall be used to determine whether aircraft structural aluminum alloys are susceptible to corrosion or damage by application of aircraft maintenance chemicals during routine maintenance operations.
- 4.2 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 only synthetic tap water in the faying surfaces to establish the baseline (controls) against which the panels exposed to the test material are compared. Corrosion at cut edges of the test coupons should not be considered.
- 4.3 A 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.
- 4.4 The synthetic tap water control panels will normally have a corrosion severity of "0" or "1" with an occasional severity of "2". The anodized panels are readily discolored, but not corroded, by tap water. In terms of surface area covered by white corrosion products of aluminum the following criteria may be applied:
- 0 - No corrosion
 - 1 - Up to 5% of the surface area corroded
 - 2 - 5 up to 10% of the surface area corroded
 - 3 - 10 up to 25% of the surface area corroded
 - 4 - 25% and greater surface area corroded
5. DEFINITION OF SANDWICH CORROSION TEST: A comparative accelerated environmental test of the corrosivity of liquid or solid materials on structural aluminum alloys commonly used in aerospace construction.

ARP 1512A**6. INTERFERENCES:**

- 6.1 Tap water containing large amounts of dissolved solids, especially chlorides, may cause relatively severe corrosion of the aluminum control panels. For this reason a synthetic tap water is specified. For comparative purposes, a set of aluminum test panels, with the locally available tap water applied to the filter paper, may be run along with the synthetic tap water panels.
- 6.2 Under certain conditions cellulose filter paper may react with the aluminum test panels and change the test results. Filter paper made from glass fibers is available and should be used except for fluoride-containing compounds.

7. APPARATUS:

- 7.1 Humidity test cabinet conforming to ASTM D1748 or equivalent, capable of 95 - 100% relative humidity at $38^{\circ}\text{C} \pm 1$ ($100^{\circ}\text{F} \pm 2$).
- 7.2 Forced air circulation oven capable of $38^{\circ}\text{C} \pm 3$ ($100^{\circ}\text{F} \pm 5$).
- 7.3 Binocular microscope, 10 - 40X magnification.

8. MATERIALS:

- 8.1 Aluminum Alloy Test Coupons: Shall be fabricated from the following aluminum alloys:

AMS 4037 or QQ-A-250/4, 2024-T3
AMS 4041 or QQ-A-250/5, Alclad 2024-T3
AMS 4045 or QQ-A-250/12, 7075-T6
AMS 4049 or QQ-A-250/13, Alclad 7075-T6

- 8.1.1 Recommended coupon size is 0.040 - 0.060 x 2 x 4 in. (1.00 - 1.50 x 50 x 100 mm). The coupon size 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 should be considered.
- 8.2 Coupons of Other Alloys: When the effect of aircraft maintenance chemicals on alloys other than aluminum must be determined, coupons of the size defined in 8.1.1 may be used. Test coupon materials should conform to a standard specification. Sufficient coupon material should be obtained to permit several complete tests to be performed on the same lot of alloy.
- 8.3 Filter Paper: Shall be Whatman GFA or equivalent filter paper made from glass fibers, 11 or 13 cm in diameter. Filter paper will not be required when the material being tested is a solid. Filter paper should not be used with highly viscous materials containing fluorides.

ARP 1512A

8.4 Anodize: The 2024-T3 and 7075-T6 non-clad aluminum alloy coupons shall be anodized in accordance with AMS 2470 or MIL-A-8625, Type 1 (Chromic Acid process).

8.5 Synthetic Tap Water: Prepare a solution of synthetic tap water, using reagent water conforming to ASTM D1193, Type III, and analytical reagent-grade chemicals as follows:

AR Calcium Acetate, $\text{Ca}(\text{C}_2\text{H}_3\text{O}_2)_2 \cdot 2\text{H}_2\text{O}$ 0.20 g $\pm$ 0.005

AR Magnesium Sulfate, $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$ 0.15 g $\pm$ 0.005

AR Sodium Chloride, NaCl 0.12 g $\pm$ 0.005

8.5.1 Dilute to one litre with reagent water conforming to ASTM D1193, Type III. The pH of the water shall be 6.5 - 7.5. The pH of the synthetic tap water solution shall be approximately 6.8 or within the range 6.5 - 7.5.

9. TEST SPECIMEN AND SAMPLE PREPARATION:

9.1 Sets of test panels as in 13.2, 13.3, and 13.4 shall be prepared. A set of test panels shall consist of 8 individual test coupons, sandwiched together in pairs of coupons of the same alloy and the same surface treatment, to provide 4 test coupon sandwiches for each test condition. Identify each coupon by impression stamping or other suitable permanent method.

9.2 The panels shall be cleaned by solvent wiping or by vapor degreasing. Acid or caustic cleaners shall not be used. Ink stamped markings shall be removed from the panels. Do not use abrasive materials to clean the panels.

9.3 The test panel sets for each alloy shall be prepared as follows:

9.3.1 One set with compound to be tested at use dilution.

9.3.2 One set with compound to be tested in concentrated form.

9.3.3 One set (control set) with synthetic tap water.

10. PREPARATION OF APPARATUS:

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

10.2 Verify that the forced air circulation oven is operating at the specified temperature with proper air circulation.

11. CALIBRATION AND STANDARDIZATION: Since the test coupons include controls for comparative purposes, no special calibration or standardization procedures are required.

ARP 1512A**12. CONDITIONING:**

- 12.1 Conditioning of the test materials or the sets of prepared test coupons is not required. The test sample shall be thoroughly agitated before application to the test coupons.
- 12.2 The anodized panels shall be allowed to age at room temperature for not less than 48 hr prior to exposure.

13. PROCEDURE:

- 13.1 Assemble the cleaned panels into identical groups with each group having four different sets of panels suitably identified by permanent marking. Each set of panels shall consist of two individual coupons of the same alloy and the same surface treatment.
- 13.2 Cut a piece of glass fiber filter paper to the approximate size of the coupons. 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. 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 only in the concentrated form. See 8.3 for deletion of the filter paper.
 - 13.2.1 Repeat the test of 13.2 using a new set of test panels without the use of glass fiber filter paper unless filter paper was deleted under the requirements of 8.3.
- 13.3 Prepare a group of panels as outlined in 13.2, except that the material to be tested shall be applied in the concentrated, as-received condition, without dilution by water or solvents. This test is not applicable to dry granular materials.
- 13.4 Prepare a group of panels as outlined in 13.2, except that only synthetic tap water shall be applied to the filter paper between the panels.
- 13.5 The panels shall be exposed for $8 \text{ hr} \pm 0.25$ in the circulating-air oven maintained at $38^{\circ}\text{C} \pm 3$ ($100^{\circ}\text{F} \pm 5$) and then shall be placed for $16 \text{ hr} \pm 0.25$ in a humidity cabinet maintained at $38^{\circ}\text{C} \pm 1$ ($100^{\circ}\text{F} \pm 2$) and 95 - 100% relative humidity. The period of exposure should preferably be started on a Monday morning in the oven and continue alternating between air and humidity cycles for 7 days. The coupons should be left in the humidity cabinet over the following weekend to complete the 7-day test. Each set of panels shall be exposed individually, not stacked, in a horizontal position. After exposure, the panels shall be rinsed thoroughly in warm tap water and scrubbed lightly with a soft non-metallic bristle