



Standard Specification for Low Volatile Organic Compound (VOC) Corrosion-Inhibiting Adhesive Primer for Aluminum Alloys to Be Adhesively Bonded¹

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This standard has been approved for use by agencies of the Department of Defense.

1. Scope

1.1 This specification covers pigmented, sprayable, low volatile organic compound (VOC) corrosion-inhibiting adhesive primers for use on aluminum alloys that are to be adhesively bonded in the fabrication of panels for tactical shelters. When applied to a properly prepared surface of aluminum alloy, the primer imparts corrosion resistance and forms a surface suitable for structural bonding and for coating with shelter paint finishes.

1.2 The values stated in SI units are to be regarded as standard. The values given in parentheses are mathematical conversions to inch-pound units that are provided for information only and are not considered standard.

1.3 *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

- B117 Practice for Operating Salt Spray (Fog) Apparatus
- B209 Specification for Aluminum and Aluminum-Alloy Sheet and Plate
- D1002 Test Method for Apparent Shear Strength of Single-Lap-Joint Adhesively Bonded Metal Specimens by Tension Loading (Metal-to-Metal)
- D3167 Test Method for Floating Roller Peel Resistance of Adhesives

¹ This specification is under the jurisdiction of ASTM Committee E06 on Performance of Buildings and is the direct responsibility of Subcommittee E06.53 on Materials and Processes for Durable Rigidwall Relocatable Structures.

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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.

E864 Practice for Surface Preparation of Aluminum Alloys to Be Adhesively Bonded in Honeycomb Shelter Panels

E865 Specification for Structural Film Adhesives for Honeycomb Sandwich Panels

E874 Practice for Adhesive Bonding of Aluminum Facings to Nonmetallic Honeycomb Core for Shelter Panels

2.2 *Federal Specifications:*³

QQ-A-250/8d Aluminum Alloy 5052 H34 Plate and Sheet

QQ-A-250/11d Aluminum Alloy 6061 T6 Plate and Sheet

2.3 *Government Document:*⁴

Rule 1124 Aerospace Assembly and Component Manufacturing Operations, South Coast Air Quality Management District

3. Materials and Manufacturer

3.1 The primer shall be a pigmented liquid composed of a modified epoxy phenolic or other resin system compounded to be spray-applied to produce a continuous, uniform coating without dilution.

4. Physical Properties

4.1 The uncured primer shall be tested as specified in 5.1 and meet the requirement of Table 1.

4.2 *Properties of Cured Film*—When applied and cured in accordance with 5.1.8, the cured film shall meet the requirements of Tables 2 and 3 when tested as specified in 5.2 and 5.3.

4.3 *Storage Stability*—Primer stored in accordance with 5.1.3 shall meet the requirements for normal- and low-temperature floating roller peel in Table 3 when cured in accordance with 5.1.8 and tested as specified in 5.3.7 and 5.3.8.

4.4 *Shelf Life*—The shelf life of the primer at $25 \pm 7^\circ\text{C}$ ($77 \pm 12^\circ\text{F}$) shall be at least four days. After four days, when tested according to 5.1.4, the primer shall meet the requirements for

³ Available from Standardization Documents Order Desk, DODSSP, Bldg. 4, Section D, 700 Robbins Ave., Philadelphia, PA 19111-5098, <http://dodssp.daps.dla.mil>.

⁴ Available from South Coast Air Quality Management District, 21865 Copley Dr. Diamond Bar, CA 91765, <http://www.aqmd.gov>.

TABLE 1 Physical Properties of Uncured Liquid Polymer

Test	Requirement
Solids content, %	Report only
Ash content, %	Report only
Color	Easily visible film
VOC content	250 g/L max

TABLE 2 Physical Property of Cured Film on Primed Surfaces

Test	Requirement
Smooth uniform coating	0.0025 to 0.010 mm (0.0001 to 0.0004 in.) ± 15 % coefficient of variation

TABLE 3 Physical Properties of Bonded Specimens

Test	Requirements (min)
Normal-temperature lap shear, 24°C (77°F), MPa (psi)	20.0 (2903)
Low-temperature lap shear, -55°C (-67°F), MPa (psi)	20.0 (2903)
High-temperature lap shear, 93°C (200°F), MPa (psi)	13.0 (1890)
Humidity exposure lap shear, 93°C (200°F), MPa (psi)	8.0 (1161)
Salt spray exposure lap shear, 35°C (95°F), MPa (psi)	16.0 (2322)
Normal-temperature floating roller peel strength, 24°C (75°F), N/m (lbf/in.)	4400 (25.1)
Low-temperature floating roller peel strength, -55°C (-67°F), N/m (lbf/in.)	2625 (15.0)

normal- and low-temperature floating roller peel in [Table 3](#) when cured in accordance with [5.1.8](#) and tested as specified in [5.3.7](#) and [5.3.8](#).

4.5 Film Thickness—The average, minimum, and maximum film thicknesses shall be between 0.0025 and 0.010 mm (0.0001 and 0.0004 in.) ± 15 % coefficient of variation. At least five thickness readings shall be made with no more than one in any 645 mm² (1 in.²) area.

4.6 VOC Content—The volatile organic compound (VOC) is any volatile compound containing the element of carbon, excluding methane, carbon monoxide, carbon dioxide, carbonic acid, metallic carbides or carbonates, and ammonium carbonates, as stated in [Rule 1124](#). The VOC content shall meet the requirement in [Table 1](#) when determined in accordance with [5.1.9](#).

5. Test Methods

5.1 Uncured Primer:

5.1.1 Solids Content—Determine the solids content by heating a 2-g sample of thoroughly mixed primer in an ignition-loss crucible with cover at 121 ± 5°C (250 ± 9°F) for not less than 90 min. Cool the crucible to room temperature in a desiccator. Weighings before and after heating shall be accurate to ±0.001 g. Calculate the mass of solids remaining as a percentage of the initial sample mass as follows:

$$\text{Percent solids content} = \frac{\text{mass of nonvolatile residue}}{\text{initial sample mass}} \times 100 \quad (1)$$

5.1.2 Ash Content—Place the crucibles containing the solids content samples in a furnace at 565 ± 28°C (1050 ± 82°F) for not less than 60 min. Cool the crucible to room temperature in a desiccator. Weighings before and after heating shall be accurate to ±0.001 g. Calculate the ash content remaining as a percentage of the solids content as follows:

$$\text{Percent ash content} = \frac{\text{mass of ash residue}}{\text{mass of nonvolatile residue}} \times 100 \quad (2)$$

5.1.3 Storage Stability—Store a sample of the primer for three months from the date of manufacture at a temperature recommended by the manufacturer. The stored sample shall meet the requirements for normal- and low-temperature floating roller peel in [Table 3](#) when cured in accordance with [5.1.8](#) and tested as specified in [5.3.7](#) and [5.3.8](#).

5.1.4 Shelf Life—Store a sample of the primer for four days at 25 ± 7°C (77 ± 13°F). The aged sample shall meet the requirements for normal- and low-temperature floating roller peel in [Table 3](#) when cured in accordance with [5.1.8](#) and tested as specified in [5.3.7](#) and [5.3.8](#).

5.1.5 Film Thickness—The cured primer film thickness shall be determined with a eddy-current instrument as specified in [5.2.2](#).

5.1.6 Color—During spray application, there shall be a discernible color change for the primer thickness specified in [4.5](#).

5.1.7 Sprayability—The primer shall be capable of being readily applied in accordance with the manufacturer's instructions to all test panels of either 6061 T6 or 5052 H34 aluminum alloy (Fed. Spec. [QQ-A-250/11d](#) or [QQ-A-250/8d](#), respectively, or Specification [B209](#)) and cleaned in accordance with Practice [E864](#) for each of the tests described in [5.1.8-5.3.8](#).

5.1.8 Curing Properties—Test the cured film for the ability to meet the requirements listed in [Tables 2 and 3](#). Spray the primer onto the test panels and air dry at least 20 min at 24 ± 5°C (77 ± 9°F); then heat in air for 65 ± 5 min at 121 ± 5°C (250 ± 9°F).

5.1.9 VOC Content—The grams of VOC per litre of primer, less water and exempt compounds per [Rule 1124](#), shall be determined by the adhesive primer manufacturer in accordance with [Rule 1124](#) and meet the requirement for VOC content in [Table 1](#).

5.2 Cured Film:

5.2.1 Test Panels and Panel Preparation—Test panels shall be either 6061 T6 or 5052 H34 bare aluminum alloy (Fed. Spec. [QQ-A-250/11d](#) or [QQ-A-250/8d](#), respectively, or Specification [B209](#)) and cleaned in accordance with Practice [E864](#).

5.2.2 Smooth Uniform Coating—Clean a 30- by 30-cm (12- by 12-in.) panel, spray to a primer thickness as specified in [4.5](#), and cure as specified in [5.1.8](#). Determine the primer thickness with a Fisher isoscope MP2-T3.3B (or equivalent) calibrated with standards between 0.0025 and 0.010 mm (0.0001 and 0.0004 in.). The primer thickness shall meet the requirements in [4.5](#) and [Table 2](#).

5.2.3 Pencil Hardness—Determine the pencil hardness of the cured film using the following procedure:

5.2.3.1 Preparation of Pencils—Prepare a set of drawing pencils ranging in hardness from 6B to 5H by stripping the wood away from the end approximately 10 mm (3/8 in.) without damaging the lead. Square the tip of the lead by holding the pencil in a vertical position and moving the lead back and forth over 400-grit or finer abrasive paper. Square the tip of the lead after each trial.

5.2.3.2 Procedure—Place a test panel with the cured primer applied in a horizontal position. Push pencils of increasing

hardness at a 45° angle into the coated surface of the panel until one is found that will cut or scratch the coating. Use the number of this pencil to express the primer hardness.

5.2.4 Environmental Resistance Test—Clean three test panels for each test described in **5.2.5-5.2.7** approximately 76 by 127 mm (3 by 5 in.) in accordance with **5.2.1**. Apply the primer and cure in accordance with **4.5** and **5.1.8**. The primed panels shall be subjected to the environments specified in **5.2.5-5.2.7** and there shall be no cracking, no blistering, and a minimum pencil hardness of 4H.

5.2.5 Water Resistance—Immerse the panels with the cured primer coating in distilled water for seven days at $24 \pm 3^\circ\text{C}$ ($75 \pm 5^\circ\text{F}$) and then expose to 95 to 100 % relative humidity at $50 \pm 3^\circ\text{C}$ ($121 \pm 5^\circ\text{F}$) for 30 days. After exposure the panels shall meet the requirements in **5.2.4**, and there shall be no loss of adhesion as described in **5.2.8**.

5.2.6 Heat Resistance—Heat test panels prepared as in **5.2.4** at $120 \pm 3^\circ\text{C}$ ($248 \pm 5^\circ\text{F}$) for 70 h. After exposure the panels shall meet the requirements in **5.2.4**, and there shall be no loss of adhesion as described in **5.2.8**.

5.2.7 Corrosion Resistance—Scribe test panels prepared in accordance with **5.2.4** through the coating to the base metal with two diagonal scribe marks extending from corner to corner and then expose them to 5 % salt fog in accordance with Practice **B117** for 40 days. After exposure the panels shall meet the requirements in **5.2.4**, and there shall be no undercutting of the primer along the scribe lines.

5.2.8 Loss of Adhesion:

5.2.8.1 Thoroughly dry the panel by wiping with a clean dry cheesecloth. Conduct the test at 20 to 27°C (68 to 81°F).

5.2.8.2 Scribe two parallel scratches 25 mm (1 in.) apart through the coating down to the metal with a sharp edged scribe.

5.2.8.3 Apply a strip of 25-mm (1-in.) wide masking tape (not more than five months old from date of manufacture) across the scratches at 90° to the scribe lines in the panel area to be tested. Press the tape down using two passes of a 2-kg (4.4-lb) rubber-covered roller approximately 90 mm (3.5 in.) in diameter by 44.5 mm (1.75 in.) in width. The durometer of the roller surface shall be 70 to 80 Shore A.

5.2.8.4 As an alternative to **5.2.8.3**, the tape shall be pressed down by rolling the tape roll along the strip of applied tape using a firm hand pressure of approximately 2 kg (4.4 lb).

5.2.8.5 Remove the tape in one abrupt motion perpendicular to the panel. No primer shall be removed from the panel, other than that previously removed during the scribing procedure in **5.2.8.2**.

5.3 Bonding Property Tests:

5.3.1 Preparation of Test Specimens—Prepare five specimens in accordance with Practice **E864** for each of the tests in **Table 3**. The lap shear specimens shall be in accordance with Test Method **D1002** and the peel specimens in accordance with Test Method **D3167**. The adherents shall be of either 6061 T6 or 5052 H34 aluminum alloy (Fed. Spec. **QQ-A-250/11d** or **QQ-A-250/8d**, respectively, or Specification **B209**). Apply the primer and allow to air dry for not less than 20 min at $25 \pm 5^\circ\text{C}$

($78 \pm 9^\circ\text{F}$); follow by heating at $121 \pm 5^\circ\text{C}$ ($250 \pm 9^\circ\text{F}$) for 65 ± 5 min. Bond and cure in accordance with Specification **E865**.

5.3.2 Normal-Temperature Lap Shear—Subject each specimen to a lap shear test at $25 \pm 3^\circ\text{C}$ ($77 \pm 5^\circ\text{F}$) in accordance with Test Method **D1002**.

5.3.3 Low-Temperature Lap Shear—Test each specimen in accordance with Test Method **D1002** for low-temperature lap shear at $-55 \pm 3^\circ\text{C}$ ($-66 \pm 5^\circ\text{F}$). Bring the temperature of the specimen to $-55 \pm 3^\circ\text{C}$ ($-66 \pm 5^\circ\text{F}$) as indicated by a thermocouple at the bond area and stabilize for 10 min prior to test. The test chamber used to test the specimens shall be stabilized at the test temperature for at least 45 min prior to testing.

5.3.4 High-Temperature Lap Shear—Test each specimen in accordance with Test Method **D1002** for high-temperature lap shear at $93 \pm 3^\circ\text{C}$ ($200 \pm 5^\circ\text{F}$). Bring the temperature of the specimen to $93 \pm 3^\circ\text{C}$ ($200 \pm 5^\circ\text{F}$) as indicated by a thermocouple at the bond area and stabilize for 10 min prior to test. The test chamber used to test the specimens shall be stabilized at the test temperature for at least 45 min prior to testing.

5.3.5 Humidity Exposure Lap Shear—Test each specimen in accordance with Test Method **D1002** at $93 \pm 3^\circ\text{C}$ ($200 \pm 5^\circ\text{F}$) for lap shear strength after two weeks exposure at 95 ± 5 % relative humidity at $71 \pm 3^\circ\text{C}$ ($160 \pm 5^\circ\text{F}$). After removing the specimens from the humidity cabinet, place them and a wet paper towel in a sealed plastic bag. Bring the temperature of the specimen to $93 \pm 3^\circ\text{C}$ ($200 \pm 5^\circ\text{F}$) as indicated by a thermocouple at the bond area. Stabilize the specimen 2 min prior to test. Test the specimens within 24 h after removal from the humidity cabinet. The test chamber used to test the specimens shall be stabilized at the test temperature for at least 45 min prior to testing.

5.3.6 Salt Spray Exposure Lap Shear—Test each specimen in accordance with Test Method **D1002** after exposure for two weeks to salt spray using 5 % NaCl solution at $35 \pm 1^\circ\text{C}$ ($95 \pm 2^\circ\text{F}$) in accordance with Practice **B117**.

5.3.7 Normal-Temperature Floating Roller Peel Strength—Test each specimen in accordance with Test Method **D3167**. The test temperature shall be $25 \pm 3^\circ\text{C}$ ($77 \pm 5^\circ\text{F}$).

5.3.8 Low-Temperature Floating Roller Peel Strength—Test each specimen according to Test Method **D3167**. The test temperature shall be $-55 \pm 3^\circ\text{C}$ ($-66 \pm 5^\circ\text{F}$) as indicated by a thermocouple attached to the thin member. Stabilize the specimen at the test temperature for 10 min prior to test. The test chamber used to test the specimens shall be stabilized at the test temperature for at least 45 min prior to testing.

6. Report

6.1 The report shall include the following information:

6.1.1 Complete identification of the adhesive used to obtain the physical properties of bonded specimens including source, the manufacturer's code number, and date of manufacture; and

6.1.2 Failure mode of bonded specimens used to obtain the physical properties.

7. Inspection

7.1 *Responsibility for Inspection*—Unless otherwise specified in the contract or purchase order, the supplier is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract or order, the supplier may use any facilities suitable for the performance of inspection requirements specified herein unless disapproved by the purchaser. The purchaser has the right to perform any of the inspections described in this specification where such inspections are necessary to assure compliance with the requirements.

7.2 *Classification of Inspections*—The inspection requirements specified herein are classified as follows:

7.2.1 Qualification inspection (see 7.3) and

7.2.2 Incoming shipment inspection (see 7.4).

7.3 *Qualification Inspection*:

7.3.1 *Qualification Test*—Adhesive primers in Section 5 that have previously passed the tests, but have subsequently been modified in any manner, must be tested against this specification and shown to meet its requirements.

7.3.1.1 *Instruction Sheet*—A dated, coded, and titled instruction sheet outlining instructions for use of the adhesive primer shall be supplied by the manufacturer. Two copies of these instructions shall be forwarded with the test report (see 7.3.2) when requesting qualification. In addition, a copy of the instruction sheet shall accompany each shipment of the adhesive primer. At the option of the purchaser, the tests specified in Section 5 may be repeated at any time on material previously found satisfactory.

7.3.2 *Test Report*—In addition to the test specimens cited herein, the manufacturer shall furnish a dated and numbered report certified by notarized affidavit giving the results of all tests listed in Section 5. The individual and average values for the tests shall be reported. The test report shall cover all requirements of Section 4. Exact information as to how the individual specimens are fabricated including materials, component material preparation, and their processing into samples as well as complete testing information for each test, such as test apparatus, crosshead speeds, etc., shall be reported. The report shall certify that the application of the primer conformed to the description given in the instruction sheet.

7.4 *Purchaser and Supplier Acceptance Tests*—The inspection of each incoming lot of adhesive primer purchased under this specification shall consist of the following:

7.4.1 *Normal-Temperature Lap Shear*—In accordance with 5.3.2,

7.4.2 *Normal-Temperature Floating Roller Peel*—In accordance with 5.3.7,

7.4.3 *Solids Content*—In accordance with 5.1.1, and

7.4.4 *Inhibitor Content*—In accordance with 5.1.2.

8. Packaging and Identification

8.1 *Packaging*—The product shall be packaged in airtight containers suitable for storage at 3°C (37°F).

8.2 *Identification*—Each container shall be identified with the following information on durable labels, using clearly legible characters that will not be obliterated by normal handling:

8.2.1 Primer, adhesive, corrosion-inhibiting,

8.2.2 Date of manufacture (month and year),

8.2.3 Manufacturer's name and address,

8.2.4 Manufacturer's product trade name,

8.2.5 Manufacturer's product type designation,

8.2.6 Manufacturer's batch/lot designation,

8.2.7 Perishable, ship and store according to manufacturer's recommendations (do not freeze),

8.2.8 Appropriate materials safety data sheets (MSDS), and

8.2.9 Manufacturer's certification that the batch and lot meet the requirements of this specification. See Practice E874.

8.3 *Packing*—The individual containers shall be packed in an exterior shipping container capable of protecting the product and maintaining the required temperature during transit.

8.4 *Exterior Marking*—Each exterior shipping container shall be legibly marked as in 8.2, plus:

8.4.1 ASTM designation (this specification number),

8.4.2 Contract number,

8.4.3 Date of shipment,

8.4.4 Warranty date, and

8.4.5 Quantity.

8.5 *Containers*—Containers shall be prepared for shipment in accordance with commercial practice to assure carrier acceptance and safe transportation to point of delivery. Packaging shall conform to carrier rules and regulations applicable to the mode of transportation. In addition to the exterior marking in 8.4, the exterior container shall be marked to comply with ICC regulations applicable to the mode of transportation.

9. Keywords

9.1 adhesive bond; corrosion-inhibiting primer; film adhesive; low VOC; relocatable shelters

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