Designation: E1826 – 23

Standard Specification for Low Volatile Organic Compound (VOC) Corrosion-Inhibiting Adhesive Primer for Aluminum Alloys to Be Adhesively Bonded in Honeycomb Shelter Panels[1]

This standard is issued under the fixed designation E1826; 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 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 after SI units 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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.4 *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]

B117 Practice for Operating Salt Spray (Fog) Apparatus

B209/B209M 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

E631 Terminology of Building Constructions

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

E1749 Terminology Relating to Rigid Wall Relocatable Shelters

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. Terminology

3.1 *Definitions*—For definitions of general terms related to building construction used in this specification, refer to Terminology E631, and for general terms related to rigid wall relocatable shelters, refer to Terminology E1749.

4. Materials and Manufacturer

4.1 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.

[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.

[3] Available from DLA Document Services, Building 4/D, 700 Robbins Ave., Philadelphia, PA 19111, http://quicksearch.dla.mil.

[4] Available from South Coast Air Quality Management District (AQMD), 21865 Copley Dr., Diamond Bar, CA 91765, http://www.aqmd.gov.

5. Physical Properties

5.1 The uncured primer shall be tested as specified in 6.1 and meet the requirement of Table 1.

5.2 *Properties of Cured Film*—When applied and cured in accordance with 6.1.8, the cured film shall meet the requirements of Tables 2 and 3 when tested as specified in 6.2 and 6.3.

5.3 *Storage Stability*—Primer stored in accordance with 6.1.3 shall meet the requirements for normal- and low-temperature floating roller peel in Table 3 when cured in accordance with 6.1.8 and tested as specified in 6.3.7 and 6.3.8.

5.4 *Shelf Life*—The shelf life of the primer at 25 °C ± 7 °C (77 °F ± 12 °F) shall be at least four days. After four days, when tested according to 6.1.4, the primer shall meet the requirements for normal- and low-temperature floating roller peel in Table 3 when cured in accordance with 6.1.8 and tested as specified in 6.3.7 and 6.3.8.

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

5.6 *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 6.1.9.

6. Test Methods

6.1 *Uncured Primer:*

6.1.1 *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 °C ± 5 °C (250 °F ± 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:

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

6.1.2 *Ash Content*—Place the crucibles containing the solids content samples in a furnace at 565 °C ± 28 °C (1050 °F ± 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:

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

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 mm to 0.010 mm (0.0001 in. 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)

6.1.3 *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 6.1.8 and tested as specified in 6.3.7 and 6.3.8.

6.1.4 *Shelf Life*—Store a sample of the primer for four days at 25 °C ± 7 °C (77 °F ± 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 6.1.8 and tested as specified in 6.3.7 and 6.3.8.

6.1.5 *Film Thickness*—The cured primer film thickness shall be determined with a eddy-current instrument as specified in 6.2.2.

6.1.6 *Color*—During spray application, there shall be a discernible color change for the primer thickness specified in 5.5.

6.1.7 *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/B209M) and cleaned in accordance with Practice E864 for each of the tests described in 6.1.8 – 6.3.8.

6.1.8 *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 °C ± 5 °C (77 °F ± 9 °F); then heat in air for 65 min ± 5 min at 121 °C ± 5 °C (250 °F ± 9 °F).

6.1.9 *VOC Content*—The grams of VOC per litre of primer, less water and exempt compounds in accordance with 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.

6.2 *Cured Film:*

6.2.1 *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/B209M) and cleaned in accordance with Practice E864.

6.2.2 *Smooth Uniform Coating*—Clean a 30 cm by 30 cm (12 in. by 12 in.) panel, spray to a primer thickness as specified in 5.5, and cure as specified in 6.1.8. Determine the primer thickness with a Fisher isoscope MP2-T3.3B (or equivalent) calibrated with standards between 0.0025 mm and 0.010 mm (0.0001 in. and 0.0004 in.). The primer thickness shall meet the requirements in 5.5 and Table 2.

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

6.2.3.1 *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 (⅜ 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.

6.2.3.2 *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.

6.2.4 *Environmental Resistance Test*—Clean three test panels for each test described in 6.2.5 – 6.2.7 approximately 76 mm by 127 mm (3 in. by 5 in.) in accordance with 6.2.1. Apply the primer and cure in accordance with 5.5 and 6.1.8. The primed panels shall be subjected to the environments specified in 6.2.5 – 6.2.7 and there shall be no cracking, no blistering, and a minimum pencil hardness of 4H.

6.2.5 *Water Resistance*—Immerse the panels with the cured primer coating in distilled water for seven days at 24 °C ± 3 °C (75 °F ± 5 °F) and then expose to 95 % to 100 % relative humidity at 50 °C ± 3 °C (121 °F ± 5 °F) for 30 days. After exposure the panels shall meet the requirements in 6.2.4, and there shall be no loss of adhesion as described in 6.2.8.

6.2.6 *Heat Resistance*—Heat test panels prepared as in 6.2.4 at 120 °C ± 3 °C (248 °F ± 5 °F) for 70 h. After exposure the panels shall meet the requirements in 6.2.4, and there shall be no loss of adhesion as described in 6.2.8.

6.2.7 *Corrosion Resistance*—Scribe test panels prepared in accordance with 6.2.4 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 6.2.4, and there shall be no blistering, cracking or substrate degradation more than 3 mm from scribe mark.

6.2.8 *Loss of Adhesion:*

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

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

6.2.8.3 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.

6.2.8.4 As an alternative to 6.2.8.3, 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).

6.2.8.5 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 6.2.8.2.

6.3 *Bonding Property Tests:*

6.3.1 *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/B209M). Apply the primer and allow to air dry for not less than 20 min at 25 °C ± 5 °C (78 °F ± 9 °F); follow by heating at 121 °C ± 5 °C (250 °F ± 9 °F) for 65 min ± 5 min. Bond and cure in accordance with Specification E865.

6.3.2 *Normal-Temperature Lap Shear*—Subject each specimen to a lap shear test at 25 °C ± 3 °C (77 °F ± 5 °F) in accordance with Test Method D1002.

6.3.3 *Low-Temperature Lap Shear*—Test each specimen in accordance with Test Method D1002 for low-temperature lap shear at −55 °C ± 3 °C (−66 °F ± 5 °F). Bring the temperature of the specimen to −55 °C ± 3 °C (−66 °F ± 5 °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.

6.3.4 *High-Temperature Lap Shear*—Test each specimen in accordance with Test Method D1002 for high-temperature lap shear at 93 °C ± 3 °C (200 °F ± 5 °F). Bring the temperature of the specimen to 93 °C ± 3 °C (200 °F ± 5 °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.

6.3.5 *Humidity Exposure Lap Shear*—Test each specimen in accordance with Test Method D1002 at 93 °C ± 3 °C (200 °F ± 5 °F) for lap shear strength after two weeks exposure at 95 % ± 5 % relative humidity at 71 °C ± 3 °C (160 °F ± 5 °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 °C ± 3 °C (200 °F ± 5 °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.

6.3.6 *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 °C ± 1 °C (95 °F ± 2 °F) in accordance with Practice B117.