



Designation: ~~E865~~—~~12~~ E865 – 20

## Standard Specification for Structural Film Adhesives for Honeycomb Sandwich Panels<sup>1</sup>

This standard is issued under the fixed designation E865; 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 ( $\epsilon$ ) 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 film adhesives for bonding of honeycomb sandwich panels. The adhesives are used for new production or depot repair. The adhesives shall be suitable for forming bonds that can withstand long exposures to temperatures from  $-55$ – $55$  °C to  $93$ °C ( $-67$ 93 °C ( $-67$  °F to  $200$ °F) $200$  °F) and also withstand the combinations of stress, temperature, and relative humidity expected to be encountered in service. The adhesives shall be used for bonding aluminum alloy facing to nonmetallic core, edge attachments, and other components of a sandwich panel.

1.2 The values stated in SI units are to be regarded as the standard where only SI units are given or where SI units are given first followed by inch-pound units; where inch-pound units are given first followed by SI units, the inch-pound units are to be regarded as the 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:<sup>2</sup>

- B117 Practice for Operating Salt Spray (Fog) Apparatus
- B209 Specification for Aluminum and Aluminum-Alloy Sheet and Plate
- C297/C297M Test Method for Flatwise Tensile Strength of Sandwich Constructions
- D1002 Test Method for Apparent Shear Strength of Single-Lap-Joint Adhesively Bonded Metal Specimens by Tension Loading (Metal-to-Metal)
- D1781 Test Method for Climbing Drum Peel for Adhesives
- D2919 Test Method for Determining Durability of Adhesive Joints Stressed in Shear by Tension Loading
- 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

<sup>1</sup> 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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<sup>2</sup> 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.

**E866** Specification for Corrosion-Inhibiting Adhesive Primer for Aluminum Alloys to Be Adhesively Bonded in Honeycomb Shelter Panels

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

**E1091** Specification for Nonmetallic Honeycomb Core for Use in Shelter Panels

**E1749** Terminology Relating to Rigid Wall Relocatable Shelters

**E1826** Specification for Low Volatile Organic Compound (VOC) Corrosion-Inhibiting Adhesive Primer for Aluminum Alloys to Be Adhesively Bonded

2.2 *Federal Specifications:*<sup>3</sup>

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

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

NOTE 1—Copies of specifications, standards, drawings, and publications required by suppliers in connection with specific purchases shall be obtained from the purchaser or as directed by his contracting officer.

### 3. Terminology

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

### 4. Ordering Information

4.1 *Procurement Documents*—Purchasers shall select any of the desired options offered herein and the procurement documents shall specify the following:

4.1.1 Title, number, and date of this specification;

4.1.2 Adhesive type and code number;

4.1.3 Amounts and unit quantities of adhesives required;

4.1.4 Length, width, and film weight of adhesive;

4.1.5 Curing conditions;

4.1.6 Level of packaging and packing required; and

4.1.7 Whether or not qualification (see **4.2**) is necessary.

4.2 *Qualification*—In the case of adhesives for which the purchaser requires qualification, comprehensive testing in accordance with Section **6** shall be performed and documented in a test report.

### 5. Requirements

5.1 *Material*—The adhesive shall be thermosetting and, when tested using the tests described in Section **6**, shall meet the strength and durability requirements of this specification. The adhesive shall not have a deleterious effect on the metal surfaces being bonded over the range of temperatures at which the adhesives will be used.

5.2 *Form and Film Weight*—The adhesive shall be film form and shall consist either entirely of adhesive or of a carrier impregnated with adhesive. The film weight shall be within the range specified in **Table 1**.

5.3 *Appearance*—The adhesive film shall be uniform in appearance. It shall be of a uniform coating that is free of streaks and color variations.

<sup>3</sup> Available from Standardization Documents Order Desk, DODSSP, Bldg. 4, Section D, DLA Document Services, Building 4/D, 700 Robbins Ave., Philadelphia, PA 19111-5098, <http://www.dodssp.daps.mil>; 19111, <http://quicksearch.dla.mil>.

**TABLE 1 Physical Requirements for the Film Adhesive**

Test	Requirement <sup>A</sup>
Film weight, kg/m <sup>2</sup> (lb/ft <sup>2</sup> )	0.405 to 0.480 (0.083 to 0.100)
Normal-temperature lap shear, MPa (psi)	20 (2903)
High-temperature lap shear, MPa (psi)	
<del>60 °C (140 °F)</del>	<del>20 (2903)</del>
60 °C (140 °F)	20 (2903)
<del>93 °C (199 °F)</del>	<del>13 (1888)</del>
93 °C (199 °F)	13 (1888)
Low-temperature lap shear, MPa (psi)	20 (2903)
Humidity exposure lap shear, MPa (psi)	5 (723)
Salt spray exposure lap shear, MPa (psi)	16 (2322)
Normal-temperature floating roller peel, N/m (lbf/in.)	4400 (25.1)
Low-temperature floating roller peel, N/m (lbf/in.)	2625 (15.0)
Dead load stress durability, h:	
<del>40 % of 60 °C (140 °F) failure stress</del>	<del>40</del>
40 % of 60 °C (140 °F) failure stress	40
<del>30 % of 60 °C (140 °F) failure stress</del>	<del>540</del>
30 % of 60 °C (140 °F) failure stress	540
<del>20 % of 60 °C (140 °F) failure stress</del>	<del>1500</del>
20 % of 60 °C (140 °F) failure stress	1500
Normal-temperature climbing drum peel, N-m/m (lbf-in./in.)	36 (8)
High-temperature climbing drum peel, N-m/m (lbf-in./in.)	18 (4)
Flatwise tensile strength, MPa (psi)	2.1 (306)
Storage life test	<sup>B</sup>

<sup>A</sup> Except for film weight, values stated are the minimal to be met by the averages of the results for the specimens tested.

<sup>B</sup> The storage life at the maximum recommended temperature and under the recommended storage conditions shall be stated in the instructions.

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5.4 *Qualification*—At the option of the purchaser, the adhesive may be required to be a product (see 7.3) for listing on the applicable qualified products list at the time set for opening of bids. The qualification shall only apply to the formulation on which qualification tests have been made. Any changes by the manufacturer, such as the adding of fillers, changing the carrier, changing the method of manufacture, or changing the mass per unit area, shall be cause for designating the adhesive as a new product. The new product shall be given a new code number and shall not be approved until it has been shown to meet the requirements of the specification.

#### 5.5 Working Characteristics:

5.5.1 *Application*—The adhesive shall be suitable for application to metal facings and core materials in accordance with the manufacturer’s instructions at temperatures between ~~18 °C and 30 °C (65 °F and 85 °F)~~ 18 °C and 30 °C (65 °F and 85 °F) and at relative humidities of up to 50 %.

5.5.2 *Curing*—The time, temperature, and pressure used to cure the adhesive shall be within the range specified herein.

5.5.2.1 *Curing Time and Temperature*—The adhesive shall meet the requirements of this specification when cured for not longer than 1 h at a bond line temperature not exceeding ~~145 °C (293 °F)~~ 145 °C (293 °F).

5.5.2.2 *Curing Pressure*—In the preparation of specimens fabricated for qualification, the pressure required for curing the adhesive shall not be less than 140 kPa (20 psi) nor more than 350 kPa (50 psi).

5.6 *Storage Life*—The adhesive manufacturer shall determine the maximum temperature and the storage period at this temperature (from date of manufacture) for which the adhesive, when stored in airtight containers or wrapped in suitable vapor barriers, will retain its ability to meet the strength requirements specified in Table 1. These storage conditions shall be stated in the instruction sheet (see 7.3.1.1).

5.7 *Mechanical Properties*—The average mechanical properties of the adhesive shall meet the requirements of Table 1.

## 6. Test Methods

6.1 *Qualification Tests*—For qualification, the adhesive shall be tested using the tests described in this section. Shear tests shall be performed in accordance with Test Method **D1002**.

6.2 *Preparation of Test Specimens*—Prepare at least ten specimens for each separate test except as otherwise specified in the individual test methods. The metal bonded shall be 6061T6 or 5052H34 aluminum alloy (Federal Specification QQ-A-250/11d or QQ-A-250/8d, respectively, or Specification **B209**) cleaned as described in Practice **E864** and at the purchasers option, primed in accordance with Specification **E866** or Specification **E1826**. Time and temperature of curing of the adhesive shall be in accordance with the adhesive manufacturer's most recent recommendation. Test panels or specimens, or both, other than the breakaway type shall be cut in such a manner that minimum vibration or heat is generated during the cutting operation.

6.3 *Normal-Temperature Lap Shear*—Subject specimens to a lap shear test at normal temperature  $25 \pm 2 \text{ } ^\circ\text{C}$  ( $77 \text{ } ^\circ\text{C}$  ( $77 \text{ } ^\circ\text{F} \pm 5 \text{ } ^\circ\text{F}$ )).

6.4 *High-Temperature Lap Shear*—Test specimens at  $60 \pm 3 \text{ } ^\circ\text{C}$  ( $140 \text{ } ^\circ\text{C}$  ( $140 \text{ } ^\circ\text{F} \pm 5 \text{ } ^\circ\text{F}$ )) and  $93 \pm 3 \text{ } ^\circ\text{C}$  ( $200 \text{ } ^\circ\text{C}$  ( $200 \text{ } ^\circ\text{F} \pm 5 \text{ } ^\circ\text{F}$ )). Bring the specimen to temperature as indicated by a thermocouple at the bond area and stabilize for 10 min just prior to test. Stabilize the chamber used to test the specimens at the test temperature for 45 min prior to testing.

6.5 *Low-Temperature Lap Shear*—Test specimens at  $-55 \pm 3 \text{ } ^\circ\text{C}$  ( $-67 \text{ } ^\circ\text{C}$  ( $-67 \text{ } ^\circ\text{F} \pm 5 \text{ } ^\circ\text{F}$ )). Bring the specimen to temperature as indicated by a thermocouple at the bond area and stabilize for 10 min just prior to test. Stabilize the chamber used to test the specimens at the test temperature for 45 min prior to testing.

6.6 *Humidity Exposure Lap Shear*—Test lap shear specimens at  $93 \pm 3 \text{ } ^\circ\text{C}$  ( $200 \text{ } ^\circ\text{C}$  ( $200 \text{ } ^\circ\text{F} \pm 5 \text{ } ^\circ\text{F}$ )) after 2 weeks' exposure to  $95 \pm 5 \%$  relative humidity and  $93 \pm 3 \text{ } ^\circ\text{C}$  ( $200 \text{ } ^\circ\text{C}$  ( $200 \text{ } ^\circ\text{F} \pm 5 \text{ } ^\circ\text{F}$ )). Bring the specimen to temperature as indicated by a thermocouple at the bond area and test within 2 min. The test chamber used to test the specimens shall be stabilized at the test temperature for at least 45 min prior to testing. Start the test of each humidity exposure lap shear test specimen no later than 30 min after removing it from the humidity chamber.

6.7 *Salt Spray Exposure Lap Shear*—Test specimens in accordance with the salt spray test of Practice **B117** for 2 weeks' exposure to salt spray using 5 % NaCl solution at  $35 \pm 3 \text{ } ^\circ\text{C}$  ( $95 \text{ } ^\circ\text{C}$  ( $95 \text{ } ^\circ\text{F} \pm 5 \text{ } ^\circ\text{F}$ )).

6.8 *Normal-Temperature Floating Roller Peel*—Test specimens at normal temperature  $25 \pm 2 \text{ } ^\circ\text{C}$  ( $77 \text{ } ^\circ\text{C}$  ( $77 \text{ } ^\circ\text{F} \pm 5 \text{ } ^\circ\text{F}$ )) in accordance with Test Method **D3167**.

6.9 *Low-Temperature Floating Roller Peel*—Test each specimen at  $-55 \pm 3 \text{ } ^\circ\text{C}$  ( $-67 \text{ } ^\circ\text{C}$  ( $-67 \text{ } ^\circ\text{F} \pm 5 \text{ } ^\circ\text{F}$ )). Bring the specimen to temperature as indicated by a thermocouple at the bond area and stabilize for 10 min just prior to testing. Stabilize the chamber used to test the specimen at the test temperature for 45 min prior to testing.

6.10 *Dead Load Stress Durability*—Test the specimens in accordance with Test Method **D2919**. Maintain the conditions of the test chamber at  $60 \pm 3 \text{ } ^\circ\text{C}$  ( $140 \text{ } ^\circ\text{C}$  ( $140 \text{ } ^\circ\text{F} \pm 5 \text{ } ^\circ\text{F}$ )) and  $95 \pm 5 \%$  relative humidity.

6.11 *Normal-Temperature Climbing Drum Peel*—Test five specimens (constructed using a  $50\text{-mm}$  ( $2\text{-in.}$ )  $50\text{ mm}$  ( $2\text{ in.}$ ) deep core, Type IV of Specification **E1091**, and  $0.5\text{-mm}$  ( $0.02\text{-in.}$ )  $0.5\text{ mm}$  ( $0.02\text{ in.}$ ) skins) in the "L" direction for peel strength in accordance with Test Method **D1781** using the load correction described in 8.1.2 of that method. Make an autographic recording of force versus head movement. Test the specimen at normal temperature  $25 \pm 2 \text{ } ^\circ\text{C}$  ( $77 \text{ } ^\circ\text{C}$  ( $77 \text{ } ^\circ\text{F} \pm 5 \text{ } ^\circ\text{F}$ )) and at a relative humidity of  $50 \pm 10 \%$ .

6.12 *High-Temperature Climbing Drum Peel*—Test five specimens (constructed using a  $50\text{-mm}$  ( $2\text{-in.}$ )  $50\text{ mm}$  ( $2\text{ in.}$ ) deep core, Type IV of Specification **E1091**, and  $0.5\text{-mm}$  ( $0.02\text{-in.}$ )  $0.5\text{ mm}$  ( $0.02\text{ in.}$ ) skins) in accordance with 6.11, except stabilize the test temperature at  $93 \pm 3 \text{ } ^\circ\text{C}$  ( $200 \text{ } ^\circ\text{C}$  ( $200 \text{ } ^\circ\text{F} \pm 5 \text{ } ^\circ\text{F}$ )) for 10 min as determined by a thermocouple adjacent to the specimen skin. The test chamber used to test the specimens shall be stabilized at the test temperature for at least 45 min prior to testing.

6.13 *Flatwise Tensile Strength*—Test five specimens (constructed using  $50\text{-mm}$  ( $2\text{-in.}$ )  $50\text{ mm}$  ( $2\text{ in.}$ ) deep core, Type IV of