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Designation: E874 – 04

Standard Practice for Adhesive Bonding of Aluminum Facings to Nonmetallic Honeycomb Core for Shelter Panels[1]

This standard is issued under the fixed designation E874; 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 Department of Defense.

1. Scope

1.1 This practice describes the materials, processes, and quality controls to be used in the manufacture of adhesive-bonded, aluminum-faced, nonmetallic-honeycomb-core sandwich panels for tactical shelters.

1.2 The values stated in inch-pound units are to be regarded as the standard. The values given in parentheses are for information only.

1.3 *This standard does not purport to address 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]

B209 Specification for Aluminum and Aluminum-Alloy Sheet and Plate

C297/C297M Test Method for Flatwise Tensile Strength of Sandwich Constructions

D1781 Test Method for Climbing Drum Peel for Adhesives

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

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

E990 Specification for Core-Splice Adhesive for Honeycomb Sandwich Structural Panels

E1091 Specification for Nonmetallic Honeycomb Core for Use in Shelter Panels

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

2.2 *Military Standards:*

MIL-STD-105 Sampling Procedures and Tables for Inspection by Attributes[3]

MIL-STD-907B Military Standard Engineering and Design Criteria for Rigid Wall Shelters[3]

2.3 *Federal Standards:*

Fed. Std. No. 209 Clean Room and Work Station Requirements, Controlled Environment[4]

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *excessive corrosion*, *n*—surface corrosion that is not removed by cleaning as described in Practice E864.

3.1.2 *gouge*, *n*—a surface defect in which material has been removed and that causes a decrease in strength in a highly stressed area.

3.1.3 *nominal pressure*, *n*—the intended operating pressure.

3.1.4 *nominal temperature*, *n*—the intended operating temperature.

3.1.5 *tapping test*, *n*—a nondestructive evaluation procedure for detecting panel delamination in which the outer skin of the panels is tapped with a hammer or coin.

3.1.5.1 *Discussion*—Changes in acoustic emissions resulting from tapping can be associated with delamination and nondelaminated sections of panel.

4. Significance and Use

4.1 The formation of reproducible, durable-adhesive bonds in structural units requires great care in the selection of materials, the preparation of the surfaces of the parts to be bonded, and the performance of the steps in the bonding process. Experience has shown that adhesive bonding carried out in accordance with this practice produces relatively reproducible bonds.

[1] This practice 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 Ridgewall 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] Copies of specifications, standards, and drawings required by the manufacturer in conjunction with specific procurements, or information about appropriate sources of these documents, should be obtained from the purchaser.

[4] Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5098.

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5. Facilities

5.1 *Panel-Assembly-Layup Area*—The panel-assembly-lay-up area is an enclosed, environmentally controlled area that is continuously controlled for temperature, relative humidity, and concentration of airborne particles. The environmentally controlled area shall be maintained at a temperature of 75 ± 10°F (24 ± 6°C) and not more than 50 % relative humidity. The temperature and relative humidity shall be recorded continuously. All incoming and recirculated air shall be filtered to control airborne particles. The air handling equipment shall provide at least five air changes per hour in the environmentally controlled area. The filters shall ensure that the particle count within the environmentally controlled area will not exceed 200 000 particles/ft^3 (7×10^6 particles/m^3) of size 1 µm and larger. The air pressure differential between the environmentally controlled area and adjacent areas shall be monitored continuously and recorded at least twice weekly. The air pressure in the environmentally controlled area shall be maintained above that of adjacent areas by a minimum of 0.015 in. H_2O (3.7 Pa). The particle count shall be monitored in accordance with Fed. Std. No. 209. The recorders shall be calibrated every six months. The environmentally controlled area shall be conspicuously identified at all entrances as *limited access.* Unnecessary traffic within the environmentally controlled area shall not be permitted. Eating and smoking within the environmentally controlled area shall not be permitted and the environmentally controlled area shall be so posted. All materials, tools, and equipment used in the environmentally controlled area shall be clean, low shed, and free of lint, oil, and grease. The application of oil, grease, mold release agents, or other possible contaminants within the environmentally controlled area shall be prohibited. The interior, exposed surfaces of the environmentally controlled area shall be non-shedding and easily cleaned. The floor shall be sealed and cleaned daily to minimize dust generation. No preparations such as insertion of foam into honeycomb core, or cleaning other than by filtered vacuum, shall take place in the environmentally controlled area. No core cutting shall be allowed in the environmentally controlled area other than that required for integral-panel cutouts involving total thickness of the core to precut skin openings, core repair, or minor trimming.

5.2 *Primer Application Area*—The primer-application area shall be separated from the cleaning tanks, manufacturing area, and other areas of potential contamination. All air furnished to this area shall be filtered, and compressed air used shall be oil-free.

6. Apparatus

6.1 *Pressure Equipment*—Pressure equipment for bonding of shelter panels shall be large enough to permit the bonding of the total panel in one step. The manufacturer shall provide calibration and test data demonstrating that the temperature on the two facings of press platens during lamination will be equal and uniform within 4 % of their nominal temperature. The pressure equipment used for curing the panels shall be capable of applying greater than 20 psi (138 kPa) and 300°F (150°C) over the entire panel surface. Platens shall be flat to within 0.002 in./ft (0.17 mm/m). The pressure equipment shall be equipped with temperature and pressure recorders and controls that accurately control heat-up rate, pressure application, dwell time, cool down (when required), and pressure removal. The pressure equipment shall also be equipped with suitable devices (for example, caul sheets) that facilitate moving the panel layup into the press without misaligning the layup.

6.1.1 *Calibrations, Temperature and Pressure Requirements, and Controls*—Gages shall be calibrated every six months by an accredited independent laboratory or by the manufacturer if approved by the purchaser. The latest calibration certificate shall be attached to the equipment near each gage. It shall be demonstrated that the actual bonding pressure is within 10 % of the nominal pressure. It shall also be demonstrated that the average temperatures of the top and bottom panel facings during the bonding process are equal and uniform to within 4 % of the nominal temperature. Thermocouples placed at each corner and at the center of each facing shall be used to demonstrate the uniformity of the temperature. Compliance of the equipment with these requirements shall be verified at intervals not exceeding six months. A permanent record of the pressure, time, and temperature measurements during bonding shall be maintained. All calibrations must be traceable to the National Institute of Standards and Technology (NIST)[5].

6.2 *Testing Equipment*—The supplier shall have available sufficient testing equipment to ensure that all process-control specimen preparation and testing required by this practice can be accomplished without unnecessarily delaying production. All calibrations of test equipment required by this practice shall be traceable to NIST.

7. Materials

7.1 Materials shall be as specified herein or as specified in the contract. All materials shall be stored and handled in such manner as to provide adequate protection against degrading environments and mechanical damage.

7.2 *Aluminum:*

7.2.1 *Facings*—The facings shall be aluminum alloy conforming to Specification B209 and shall be certified as complying with the alloy, temper, and thickness requirements of the shelter specification. Facings shall be free of excessive corrosion, oil canning (snap-buckling), dents, gouges, or other defects that may adversely affect the structural integrity of a bonded panel. The manufacturer's certification or reports of tests for mechanical properties and chemical composition shall be included with each shipment.

7.2.2 *Preparation of Aluminum-Alloy Parts for Bonding*—The aluminum-alloy parts used in the manufacture of honeycomb panels shall be prepared for bonding in accordance with Practice E864.

7.3 *Honeycomb Core*—The honeycomb-core material shall be as specified in the shelter specification and shall meet the requirements of Specification E1091. It shall be stored in its shipping container in a segregated area away from traffic congestion until processing for panel layup.

[5] Available from National Institute of Standards and Technology (NIST), 100 Bureau Dr., Stop 3460, Gaithersburg, MD 20899-3460.

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