



Standard Practice for Surface Preparation and Structural Adhesive Bonding of Precured, Nonmetallic Composite Facings to Structural Core for Flat Shelter Panels¹

This standard is issued under the fixed designation E 1307; 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 covers the materials, processes, and quality controls to be used in the manufacture of durable adhesive bonded, nonmetallic faced, flat sandwich panels for rigid wall relocatable shelters.

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

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:

C 297 Test Method for Tension Strength of Flat Sandwich Constructions in Flatwise Plane²

E 865 Specification for Structural Film Adhesives for Honeycomb Sandwich Panels³

E 990 Specification for Core-Splice Adhesive for Honeycomb Sandwich Shelter Panels³

E 1091 Specification for Nonmetallic Honeycomb Core for Use in Shelter Panels³

E 1749 Terminology Relating to Rigid Wall Relocatable Shelters³

2.2 Federal Standard:

FED STD 209 Clean Room and Work Station Requirements⁴

2.3 Military Standard:

MIL-S-8802 Sealing Compound, Temperature-Resistant, Integral Fuel Tanks and Fuel Cell Cavities, High-Adhesion⁴

2.4 Military Handbook:

MIL-Handbook 337 Adhesive Bonded Aerospace Structures⁴

3. Terminology

3.1 Definitions of Terms Specific to This Standard:

3.1.1 *nominal pressure*—the intended operating pressure.

3.1.2 *nominal temperature*—the intended operating temperature ($^{\circ}\text{C}$ or $^{\circ}\text{F}$).

4. Significance and Use

4.1 Durable adhesive bonds of composite laminates can be obtained reliably only through proper selection and careful control of the materials used and the steps in the bonding process. The preparation of the composite laminates to obtain surfaces with appropriate characteristics is a critical step. Improper surface preparation can produce seemingly acceptable bonds that can degrade rapidly with time. This practice describes how properly prepared surfaces can be obtained.

4.2 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, the fit of parts, and the performance of the steps in the bonding process. Experience has shown that adhesive bonding carried out in accordance with this practice produces reproducible bonds.

5. Materials

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

5.2 *Composite Reinforcement and Resin*—The composite reinforcement and resin shall meet the requirements specified in the procurement document.

¹ This practice is under the jurisdiction of ASTM Committee E-6 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 *Annual Book of ASTM Standards*, Vol 15.03.

³ *Annual Book of ASTM Standards*, Vol 04.11.

⁴ Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094, Attn: NPODS.

5.3 *Peel Ply Fabric*—A nonreusable peel ply shall be used. Closely woven fabric of nylon, polyester, or glass has been found suitable. The peel ply fabric must be compatible with the manufacturing process.

5.4 *Preured Facings*—The facings shall be certified as complying with the reinforcement, resin binder, resin content, and thickness requirements of the procurement document. Facings shall be free of defects that may adversely affect the structural integrity of the bonded panel.

5.5 *Core*—The core material shall be as specified in Specification E 1091 or the procurement document and shall meet the requirements of the applicable document.

5.6 *Structural Film Adhesive*—The adhesive shall conform to the requirements of Specification E 865. It shall be stored in accordance with the manufacturer's recommendations.

5.7 *Core Splice Adhesive*—The core splice adhesive shall conform to the requirements of Specification E 990. It shall be stored in accordance with the manufacturer's recommendations.

6. Facilities

6.1 *Panel Assembly Layup Area*—The panel assembly layup area is an enclosed, environmentally controlled area (ECA) that is continuously controlled for temperature, relative humidity, and concentration of airborne particles. The ECA shall be maintained at a temperature of $24 \pm 6^\circ\text{C}$ ($75 \pm 10^\circ\text{F}$) 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 ECA. The filters shall ensure that the particle count within the ECA will not exceed 7×10^6 particles per cubic metre (200 000 particles per cubic foot) of size $1 \mu\text{m}$ and larger. The air pressure differential between the ECA and adjacent areas shall be monitored continuously and recorded at least twice weekly. The air pressure in the ECA shall be maintained above that of adjacent areas by a minimum of 50 Pa (0.015 in. Hg). The particle count shall be monitored in accordance with FED STD-209. The recorders shall be calibrated every six months. The ECA shall be conspicuously identified at all entrances as "Limited Access". Unnecessary traffic within the ECA shall not be permitted. Eating and smoking within the ECA shall not be permitted and the ECA shall be so posted. All material, tools, and equipment used in the ECA shall be clean, low shed, and free from lint, oil, and grease. The use and application of oil, grease, mold release agents, or other possible contaminants within the ECA shall be prohibited. The interior, exposed surfaces of the ECA shall be nonshedding and easily cleaned to minimize dust generation. Any particle-generating preparations such as removal of peel ply, insertion of foam into honeycomb core, or cleaning must be accompanied by filtered vacuum when performed in the ECA.

7. Equipment

7.1 *Platen Press*—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 140 kPa (20 psi) and 150°C (300°F) over the entire panel surface. Platens shall be flat to within 0.17 mm/m (0.002 in./ft). 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.

7.1.1 *Calibrations, Temperature, and Pressure Requirements and Controls*—Gages shall be calibrated at least 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 within 150 mm (6 in.) of 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 compliance checks shall be maintained. All calibrations must be traceable to the National Institute of Standards and Technology.

7.2 *Autoclave*—The autoclave equipment for bonding shelter panels shall be large enough to permit the bonding of entire shelter panel assemblies in one step. The autoclave shall be equipped with vacuum gages and temperature and pressure recorders that accurately control heat-up rate, pressure application, dwell time, cool down, and pressure removal. Vacuum venting facilities shall be provided. The autoclave equipment used for curing the panels shall be capable of applying greater than 140 kPa (20 psi) and 150°C (300°F). The manufacturer shall provide calibration and test data demonstrating that the temperature was maintained within 4 % of the nominal temperature and the pressure was maintained within 10 % of the operating pressure.

7.3 *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. All calibrations of test equipment required by this practice shall be traceable to the National Institute of Standards and Technology (NIST).

8. Preparation of Composite Facings

8.1 The composite reinforcement, number of plies, resin, and cure cycle shall meet the requirements as specified in the shelter specification.

8.2 *Peel Ply*—A peel ply shall be included as the surface layer for the side of the preured skin that will be later bonded. The peel ply shall extend past all edges.