



Designation: E1556 – 20

Standard Specification for Epoxy Resin System for Composite Skin, Honeycomb Sandwich Panel Repair¹

This standard is issued under the fixed designation E1556; 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 the requirements for an epoxy resin system intended for the repair of sandwich panels for durable, rigidwall, relocatable structures. It must be usable in a field environment and shall not require the use of special equipment such as autoclaves or presses. The epoxy system covered by this specification shall be usable for simultaneous impregnation of a wet-layup composite skin and bonding of that skin to a substrate honeycomb core. The material shall withstand exposure to temperatures from $-54\text{ }^{\circ}\text{C}$ to $93\text{ }^{\circ}\text{C}$ ($-65\text{ }^{\circ}\text{F}$ to $199\text{ }^{\circ}\text{F}$) and high relative humidity, and also the combination of stress, temperature, and relative humidity that are expected to be encountered in service.

1.2 The values stated in SI units are to be regarded as 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 standard.

1.3 The following safety hazards caveat refers only to the test methods described in this specification. *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 Recom-*

mendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.

2. Referenced Documents

2.1 ASTM Standards:²

[C297/C297M Test Method for Flatwise Tensile Strength of Sandwich Constructions](#)

[D792 Test Methods for Density and Specific Gravity \(Relative Density\) of Plastics by Displacement](#)

[D2344/D2344M Test Method for Short-Beam Strength of Polymer Matrix Composite Materials and Their Laminates](#)

[D2584 Test Method for Ignition Loss of Cured Reinforced Resins](#)

[D2734 Test Methods for Void Content of Reinforced Plastics](#)

[D3165 Test Method for Strength Properties of Adhesives in Shear by Tension Loading of Single-Lap-Joint Laminated Assemblies](#)

[E631 Terminology of Building Constructions](#)

[E1091 Specification for Nonmetallic Honeycomb Core for Use in Shelter Panels](#)

[E1749 Terminology Relating to Rigid Wall Relocatable Shelters](#)

2.2 Military Specification:³

[MIL-I-24768 Insulation, Plastic, Laminated, Thermosetting, Glass-Cloth, Epoxy-Resin](#)

2.3 Military Standards:³

[MIL-STD-129 Military Marking for Shipping and Storage](#)

[MIL-STD-1916 DOD Preferred Methods for Acceptance of Product](#)

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.

Current edition approved Sept. 1, 2020. Published October 2020. Originally approved in 1993. Last previous edition approved in 2012 as E1556 – 12. DOI: 10.1520/E1556-20.

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>.

TABLE 1 Property Requirements for 24 h, 23 °C Cure

Property	Test Condition	Number of Specimens	Average Must Exceed		Minimum Must Exceed, ^A	
			MPa	(psi)	MPa	(psi)
Tensile Lap Shear Strength in accordance with 8.2.1 , 8.3.1	23 °C (73 °F), dry	5	6.9	(1000)	5.85	(850)
Apparent Horizontal Shear Strength in accordance with 8.2.2 , 8.3.2	23 °C (73 °F), dry	5	15.5	(2250)	13.15	(1910)

^A All specimens tested must exceed these minimum values.

TABLE 2 Tensile Lap Shear Strength Requirements (See [8.3.1](#))

Test Condition	Number of Specimens	Average Must Exceed		Minimum Must Exceed, ^A	
		MPa	(psi)	MPa	(psi)
–40 °C (–40 °F), dry	5	13.8	(2000)	11.7	(1700)
23 °C (73 °F), dry	5	13.8	(2000)	11.7	(1700)
93 °C (200 °F), wet ^B	5	6.9	(1000)	5.9	(850)

^A All specimens tested must exceed these minimum values.

^B Wet = tested immediately after 30 days' exposure to 60 °C (140 °F) and 95 to 100 % R.H.

TABLE 3 Apparent Horizontal Shear Strength Requirements

Test Condition	Number of Specimens	Average Must Exceed		Minimum Must Exceed, ^A	
		MPa	(psi)	MPa	(psi)
23 °C (73 °F), dry	5	31.0	(4500)	26.3	(3820)
93 °C (200 °F), wet ^B	5	13.8	(2000)	11.7	(1700)

^A All specimens tested must exceed these minimum values.

^B Wet = tested immediately after 30 days exposure to 60 °C (140 °F) and 95 to 100 % R.H.

TABLE 4 Flatwise Tensile Strength Requirements

Test Condition	Number of Specimens	Average Must Exceed		Minimum Must Exceed, ^A	
		MPa	(psi)	MPa	(psi)
–40 °C (–40 °F), dry	5	2.8	(406)	2.4	(345)
23 °C (73 °F), dry	5	2.8	(406)	2.4	(345)
80 °C (176 °F), wet ^B	5	1.38	(200)	1.17	(170)

^A All specimens tested must exceed these minimum values.

^B Wet = tested immediately after 30 days exposure to 60 °C (140 °F) and 95 to 100 % R.H.

2.4 Commercial Standard:⁴

[SAE-AMS-C-9084 Cloth, Glass, Finished for Epoxy Resin Laminates](#)

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. Physical Requirements

4.1 Working Characteristics:

4.1.1 *Application*—The components of the epoxy resin shall be readily hand-mixed to a smooth consistency suitable for application. It shall be uniform and free of lumps. The resin components, once mixed, shall not settle out. The epoxy material shall be suitable for the wet-layup impregnation of SAE-AMS-C-9084 glass cloth and for application to core materials over the temperature range of 16 °C to 38 °C (60 °F to 100 °F) and at relative humidities of 30 to 75 %.

4.1.2 *Application Life*—The application life of a 200 g kit of the mixed epoxy system shall be at least 60 min when tested in accordance with [4.1.5](#). The epoxy shall be considered to have reached the end of its application life when the viscosity of this 200 g quantity of mixed adhesive exceeds 20 000 centipoise.

4.1.3 *Curing*—The epoxy system shall be capable of curing at 23 °C ± 2 °C (73 °F ± 4 °F) in 7 days, or for no longer than 3 h at a temperature of 60 °C to 66 °C (140 °F to 151 °F), with a curing pressure not to exceed 14 psig. In a 23 °C ± 3 °C cure, the curing pressure is not required to be maintained after the first 24 h. In a 23 °C ± 2 °C cure, the epoxy material shall develop the property levels listed in [Table 1](#) within the first 24 h of cure (see [8.3.5](#)). In order to meet the requirements of this specification, the property levels listed in [Tables 2-4](#) must be achieved with the 7-day cure at 23 °C ± 2 °C (73 °F ± 4 °F).

4.1.4 *Storage Life*—The storage life period of the two parts of the epoxy resin system, when stored in airtight containers at 23 °C (73 °F), shall be at least 12 months from the date of shipment when tested in accordance with [8.3.5](#).

4.1.5 *Viscosity*—The viscosity of a 200 g kit of the mixed resin system shall be determined at 23 °C ± 2 °C (73 °F ± 4 °F) using a Brookfield viscometer with a No. 3 spindle at

⁴ Available from Society of Automotive Engineers (SAE), 400 Commonwealth Dr., Warrendale, PA 15096-0001, <http://www.sae.org>.

20 rpm. A viscosity curve shall be determined by taking a reading immediately after mixing, and every 5 min thereafter until the viscosity exceeds 20 000 centipoise. The viscosity immediately after mixing shall not exceed 14 000 centipoise.

4.2 *Mechanical Properties*—Mechanical properties of test specimens prepared and tested as specified in Section 8 shall meet the respective requirements listed in Tables 2-4.

4.3 *Instruction Sheet*—The manufacturer shall provide a dated, coded, and titled instruction sheet outlining instructions for use of the epoxy system in impregnating and bonding SAE-AMS-C-9084 glass composite skins to honeycomb cores (Specification E1091, Types I or II). These instructions shall be supplied by the manufacturer with the test report when requesting qualification (see 7.3) and also with each shipment of epoxy material (see 10.2). The following information shall be included:

4.3.1 All of the information listed in 6.3.1 – 6.3.11.

4.3.2 The application life of the mixed epoxy system at 23 °C ± 2 °C (73 °F ± 4 °F) and 38 °C ± 2 °C (100 °F ± 4 °F).

4.3.3 Mixing instructions shall be stated in detail for the epoxy resin system in the particular container supplied.

4.3.4 Application, impregnating, and curing instructions, including the spreading method, thickness range, and temperature/relative humidity working limitations.

4.3.5 Material Safety Data Sheets and necessary safety precautions to be observed throughout all operations.

4.3.6 Any other pertinent information relative to the use and storage of the two-part system (resin and curing agent) package (see 10.2).

5. Significance and Use

5.1 Epoxy resin systems used in the repair of composite skin sandwich panels for durable, rigidwall, relocatable shelters must have a combination of mechanical property levels and environmental resistance that will assure long-term durability of the skins and the skin-to-core adhesive bonds when exposed to severe climatic exposures. In addition, these epoxy materials must have processability characteristics that permit their use in a variety of repair scenarios and environments.

5.2 *Intended Use*—Epoxy systems conforming to this specification are intended for use in the repair of honeycomb panels at the maintenance field level. The material is intended for use with SAE-AMS-C-9084 glass cloth.

5.2.1 This is a procurement control document for the procurement of the epoxy system and designers shall be aware that the test values specified herein are based upon tests performed with specific glass-resin composite adherends and shall not be used for design data.

5.2.2 Epoxy systems covered by this specification are not intended for use in production bonding of sandwich construction.

6. Material and Ordering Information

6.1 *General Description*—The material shall be a two-part thermosetting epoxy system containing no asbestos, which shall not have a deleterious effect on the components being

impregnated and bonded. It shall have physical characteristics that meet the requirements of Sections 4 and 7.

6.1.1 *Formulation Changes*—The epoxy material shall be approved only for the formulation that has passed the qualification tests and shall be used by the fabricator as approved. Any changes by the manufacturer, such as the adding or changing of pigments, hardeners, or fillers, or changes in the type or method of manufacture, changes in formulation of the basic resin, or any other changes, shall be cause for designating the adhesive as a new product that shall not be considered approved. The changed epoxy resin system shall be given a new code number and shall be resubmitted for approval under this specification. A new instruction sheet for this reformulated material shall be submitted by the manufacturer to the qualifying activity for approval (see 4.3 and 11.2.2.3).

6.1.2 *Identification of Product*—The manufacturer shall identify each epoxy resin system submitted under this specification according to the type of container furnished for it (see Section 10). In addition, the manufacturer shall designate each epoxy system by a trade name and code number that shall be used to identify it.

6.2 *Qualification*—In the case of epoxy systems for which the purchaser requires qualification, comprehensive testing in accordance with Section 8 shall be performed and documented in a test report.

6.3 *Procurement Documents*—Procurement documents shall specify the following:

6.3.1 Title, number, and date of this specification,

6.3.2 Epoxy resin system type and manufacturer's trade name,

6.3.3 Date of manufacture,

6.3.4 Manufacturer's name and address,

6.3.5 Manufacturer's batch/lot designation,

6.3.6 Contract number,

6.3.7 Date of shipment,

6.3.8 Expiration dates when stored at 23 °C ± 2 °C (73 °F ± 4 °F),

6.3.9 Manufacturer's recommended storage temperature,

6.3.10 Quantity required, and

6.3.11 Manufacturer's certification that the batch and lot meet the requirements of this specification.

7. Quality Assurance Provisions

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 purchase order, the supplier is permitted to use any facility suitable for the performance of the inspection requirements specified herein, unless disapproved by purchaser. The purchaser reserves the right to perform any of the inspections set forth in the specification where such inspections are required to ensure that supplies and services conform to prescribed requirements.

7.2 *Classification of Tests*—The inspection and testing of the epoxy system shall be classified as qualification tests (see 7.3) and quality conformance tests (see 7.4).