Designation: D3841 – 21

An American National Standard

Standard Specification for Glass-Fiber-Reinforced Polyester Plastic Panels[1]

This standard is issued under the fixed designation D3841; 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 classification, materials of construction, workmanship, minimum physical requirements, and methods of testing glass-fiber reinforced polyester plastic panels intended for use in construction. Panels for specialized or unique applications have the potential to require values significantly above or below those stated in this specification. Recommended practices for certain specific applications are included as Appendix X1. This specification is not intended to restrict or limit technological changes affecting performance when those changes are agreed upon between the purchaser and the seller.

1.2 Supplementary information on chemical resistance, resistance to heat, and installation practices are provided in Appendix X1.

1.3 The classification of these plastic panels into types based on relative response to a laboratory test shall not be considered a fire hazard classification.

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

1.5 The text of this standard references notes and footnotes which provide explanatory material. These notes and footnotes (excluding those in Tables and Figures) shall not be considered as requirements of this standard.

1.6 *Fire properties are determined by using laboratory flammability tests (Test Methods D635, D1929, and E84).*

1.6.1 This standard is used to measure and describe the response of materials, products, or assemblies to heat and flame under controlled conditions, but does not by itself incorporate all factors required for fire hazard or fire risk assessment of the materials, products or assemblies under actual fire conditions.

1.6.2 Fire testing is inherently hazardous. Adequate safeguards for personnel and property shall be employed in conducting these tests.

1.7 The following precautionary caveat pertains only to the test method portion, Section 8 of this specification. *This specification 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 specification to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

NOTE 1—There is no known ISO equivalent to this standard.

1.8 *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]

D570 Test Method for Water Absorption of Plastics
D618 Practice for Conditioning Plastics for Testing
D635 Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position
D638 Test Method for Tensile Properties of Plastics
D696 Test Method for Coefficient of Linear Thermal Expansion of Plastics Between −30°C and 30°C with a Vitreous Silica Dilatometer
D790 Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials
D883 Terminology Relating to Plastics
D1435 Practice for Outdoor Weathering of Plastics
D1494 Test Method for Diffuse Light Transmission Factor of Reinforced Plastics Panels
D1600 Terminology for Abbreviated Terms Relating to Plastics
D1929 Test Method for Determining Ignition Temperature of Plastics
D3892 Practice for Packaging/Packing of Plastics

[1] This specification is under the jurisdiction of ASTM Committee D20 on Plastics and is the direct responsibility of Subcommittee D20.24 on Plastic Building Products.

Current edition approved May 1, 2021. Published May 2021. Originally approved in 1980. Last previous edition approved in 2016 as D3841 – 16. DOI: 10.1520/D3841-21.

[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.

***A Summary of Changes section appears at the end of this standard**

D4364 Practice for Performing Outdoor Accelerated Weathering Tests of Plastics Using Concentrated Sunlight
E72 Test Methods of Conducting Strength Tests of Panels for Building Construction
E84 Test Method for Surface Burning Characteristics of Building Materials
E631 Terminology of Building Constructions
E831 Test Method for Linear Thermal Expansion of Solid Materials by Thermomechanical Analysis
E903 Test Method for Solar Absorptance, Reflectance, and Transmittance of Materials Using Integrating Spheres
E972 Test Method for Solar Photometric Transmittance of Sheet Materials Using Sunlight
E1084 Test Method for Solar Transmittance (Terrestrial) of Sheet Materials Using Sunlight
E1175 Test Method for Determining Solar or Photopic Reflectance, Transmittance, and Absorptance of Materials Using a Large Diameter Integrating Sphere
G147 Practice for Conditioning and Handling of Nonmetallic Materials for Natural and Artificial Weathering Tests
G151 Practice for Exposing Nonmetallic Materials in Accelerated Test Devices that Use Laboratory Light Sources
G155 Practice for Operating Xenon Arc Light Apparatus for Exposure of Non-Metallic Materials

3. Terminology

3.1 *General*—For definitions of terms used in this specification relating to plastics, refer to Terminology D883. For abbreviations used in this specification relating to plastics, refer to D1600. For definitions of terms in this specification relating to building constructions, refer to Terminology E631.

4. Classification

4.1 Light transmitting panels covered by this specification are divided into two types, based on relative response to a laboratory flammability test:

4.1.1 *Type CC1.*

4.1.2 *Type CC2.*

NOTE 2—Types CC1 and CC2 are classifications incorporated in the major model building codes. Panels used in other applications are also classified by major model building codes in accordance with appropriate chapters of those codes.

4.2 These types are further subdivided in accordance with 7.8 by grades based on relative response to weathering tests:

4.2.1 *Grade 1*—Weather resistance.

4.2.2 *Grade 2*—General purpose.

4.3 Within the classification of type and grade of plastic panel described in this specification are commercial products with the following variations as agreed upon between purchaser and supplier:

4.3.1 *Size (Length and Width)*—The most common nominal sizes currently available are 26 to 60 in. (66.0 to 152.4 cm) in width, and 6 to 16 ft (1.8 to 4.9 m) in length. Corrugated panels, to approximately 40 ft (12.2 m), and flat sheet in coils of longer lengths, are generally available.

4.3.2 *Surface Treatments*—Some manufacturers offer special surface treatments of various types for the purpose of improving durability. Individual suppliers can provide details.

4.3.3 *Light Transmission*—Refer to manufacturers' literature for range of transmission available.

4.3.4 *Solar Energy Transmission*—Refer to manufacturers' literature for range of transmission available.

4.3.5 *Color*—Refer to manufacturers' literature for range of colored products available.

4.3.6 *Load Deflection*—Refer to manufacturers' literature for load and deflection data on specific profiles.

4.3.7 *Weight Per Square Foot or Thickness*—Panels are generally designed and sold by weight per square foot, the most common of which are 4 through 12 oz (1.2 through 3.7 kg/m^2). Other weights are available. Flat sheet is potentially designated and sold by either weight (as indicated above) or thickness, the most common of which are 0.030 through 0.125 in. (0.76 through 3.2 mm), as measured in accordance with 8.4.1. Other thicknesses are available.

NOTE 3—Besides standard profiles, special or custom profiles may be developed.

5. Materials

5.1 The polyester resin used in the panels shall be a thermosetting styrenated and acrylated polyester resin composed of polymeric esters in which the recurring ester groups are an integral part of the main polymer chain. The resin shall be reinforced with glass fibers. The polyester resin is permitted to contain additives for various purposes, such as additives to provide low smoke density or high fire retardancy, catalyst residues, stabilizers, pigments, dyes, and fillers.

6. Workmanship, Finish, and Appearance

6.1 The panels will conform to the specific dimensions of the profile being produced and shall be fully cured. Panels shall not contain visual cracks, resin voids, foreign inclusions, or surface wrinkles that would impair the proper nesting of the corrugated panels, alter the specific dimensions of the panels, or otherwise affect their serviceability.

7. Physical Requirements

7.1 *Size (Length and Width)*—Tolerance on nominal length and width shall be ±0.25 in. (±6 mm) measured in accordance with 8.2. Panels exceeding 16 ft in length shall have a length tolerance of +0.75 −0.125 in. (+19 −3.2 mm).

7.2 *Squareness*—Panels shall be within 0.125 in. (3.2 mm) of square when measured in accordance with 8.3.

7.3 *Weight*—Tolerance on the specified weight of all panels shall be ±10 % when determined in accordance with 8.4.

7.3.1 *Thickness*—When a thickness requirement is specified for flat panels in place of standard weight per square foot, the tolerance shall be ±10 % when determined in accordance with 8.4.1.

7.4 *Profile*—The pitch and depth of the corrugations shall have the following tolerances: *Pitch* ±0.0625 in. (±5.2 mm) per square foot when measured in accordance with 8.5, and *Depth* ±0.0625 in. when measured in accordance with 8.6.

7.5 *Color*—Color shall be uniform throughout the sheet when examined in accordance with 8.7.

7.6 *Light Transmission*—The nominal light transmission factor shall have a tolerance of ±4 % from the nominal factor specified by purchaser when determined by Test Methods D1494 or E972.

7.7 *Solar Energy Transmission*—The nominal solar energy transmission shall be a tolerance of ±4 % from the nominal transmission specified by the purchaser when determined by Test Methods E903; E1084; or E1175. Measurements made using E903 are to be integrated for air mass 1.5.

7.8 *Weather Resistance*—Panels are classified for Weather Resistance as Grade 1 or 2 based upon the exudation or lack of exudation of glass fibers from the panels' surfaces when tested in accordance with Practice D1435.

7.9 *Coefficient of Linear Thermal Expansion*—The linear thermal expansion of panels shall not exceed values specified in Table 1 when tested in accordance with Test Methods D696 or E831.

7.10 *Impact Resistance*—Refer to X1.4.

7.11 *Load-Deflection Properties*—The load-deflection characteristics of a corrugated or ribbed panel shall be determined in accordance with 8.9.

7.12 *Rate of Burning or Extent and Time of Burning, or Both*—Panels shall be classified as CC1 or CC2 when tested in accordance with Test Method D635 and when tested in the thickness intended for use as follows:

7.12.1 *CC1*—Plastic panels which have a burning extent of 1.0 in. (25.4 mm) or less.

7.12.2 *CC2*—Plastic panels which have a burning rate of 2.5 in. (63.5 mm)/min or less.

7.13 *Ignition Properties*—All panels shall have a minimum self-ignition temperature of 650°F (343°C) when tested in accordance with Test Method D1929.

7.14 Physical properties as shown in Table 1 shall be determined in accordance with methods specified in 8.11.

7.15 Panels shall have the following flame spread index and smoke developed index when tested in accordance with Test Method E84.

TABLE 1 Physical Properties[A]

Property	Value[B]	ASTM Test Method
Water absorption, max	1 %	D570
Tensile strength, min	7000 psi (48.3 MPa)	D638
Coefficient of linear thermal expansion, max	2.5×10^{-5} in./in./°F (4.5×10^{-5} cm/cm/°C)	D696 or E831
Flexural strength, min	14 000 psi (96.6 MPa)	D790
Flexural modulus, min	500 000 psi (3447.5 MPa)	D790

[A]The values reflect the minimum performance criteria for the most common applications. Specialized applications occasionally will require values significantly higher or lower than those stated here. For example, it is possible that flat sheet formulated for interior use as wall liners will have lower modulus values in order to achieve the flexibility required for applications of the panels to irregular substrates.
[B] These values are approximate. For specific product values refer to the manufacturers' published literature. All published physical property data shall report the test methods used to obtain the specific data.

7.15.1 Class A – flame spread index: 25, smoke developed index: 450

7.15.2 Class B – flame spread index: 75, smoke developed index: 450

7.15.3 Class C – flame spread index: 200, smoke developed index: 450

8. Test Methods

8.1 *Conditioning*—Condition the test specimens in accordance with Procedure A of Method D618 where conditioning is required.

8.2 *Length and Width*—Lay the panel on a flat, smooth surface and measure with a steel tape. Measure the length on the two sides and the center to the nearest 0.03125 in. (0.8 mm), and average the three measurements. Measure the width on the projected width at each end and in the center to the nearest 0.03125 in., and average the three measurements.

8.3 *Squareness*—Any type jig that has two rails perpendicular to one another, each of length at least equal to the length of the side of the panel in contact with the rail, is acceptable for use to determine squareness. Place the panel in the jig so that the longest edge of the panel touches the horizontal rail along its entire length, and the vertical (short edge) touches the vertical rail at some point along its entire length. Measure the gap between the vertical rail and the short edge of the panel at the corner opposite the one touching the rail. Measure to the nearest 0.03125 in. (0.8 mm). Rotate the panel 180° and repeat the test.

8.4 *Weight*—Weigh the panel on a scale accurate to ±1 %. Calculate the area on the basis of length and width measurements made in accordance with 8.2. Calculate the weight in ounces per square foot (or kilograms per square metre).

8.4.1 *Thickness*—Make thickness measurements on flat panels every 4 in. (101.6 mm) across the width of the panel, at both ends, with a micrometer incorporating an anvil no less than 0.375 in. (9.5 mm) in diameter and accurate to 0.001 in. (0.3 mm). Average the individual measurements in order to determine the panel's nominal thickness.

8.5 *Pitch*—The pitch of a profile of a panel is the average distance from the crest of one corrugation to the crest of an adjacent corrugation or, in the case of ribbed panels, the distance from the center of one rib to the center of the next adjacent rib. Determine the crests of the corrugations or ribs by placing a metal straightedge crosswise on the panel so that it touches the crests. Measure to within ±0.0625 in. (±5.2 mm/m)/ft (304.8 mm) of panel width and divide by the number of pitches to obtain an average pitch value.

8.6 *Depth*—The depth of the corrugation is the vertical distance between the plane of the crests and the upper side of the sheet at the bottom of the valley. Make ten depth measurements, five at each end, to the nearest 0.03125 in. (0.76 mm) with a depth micrometer on each specimen and average the results.

8.7 *Color*—Examine the panel visually from a distance of 10 ft (3 m) for color uniformity by viewing. Minor differences

in intensity of the color due to the uneven dispersion of the glass fibers in the resin shall not be cause for rejection.

8.8 *Weather Resistance*—Expose specimens in accordance with the procedures of Practice D1435.

NOTE 4—Practices G155 or D4364 contain methods for interim evaluation of weather resistance.

8.8.1 *Exposure Conditions—Outdoor*—Outdoor exposure in accordance with Practice D1435 is required. Sample specimens shall be at least 1 ft^2 (929 cm^2) in size. Expose the samples without backing at 45° from the horizontal, facing South. The duration of exposure shall be 924 ± 12 MJ/m^2, of total ultraviolet radiation (295 to 385-nm wavelength region).

8.8.1.1 *Cleaning*—After each 308 ± 4-MJ/m^2 total ultraviolet radiant exposure increment, the right half of each specimen shall be washed. Use deionized water to rinse the area to be washed as thoroughly as possible to remove loose surface deposits to avoid unnecessary abrasion. Saturate a clean, soft cotton cloth with a 0.05 % solution (by volume) of a mild detergent (Note 6) and deionized water and gently rub over the rinsed area. Continue the procedure until all surface deposits have been removed. While washing, the cotton cloth must frequently be rinsed in and saturated with a 0.05 % solution (by volume) of a mild detergent (Note 6) and deionized water to avoid specimen damage due to abrasive particles, which are picked up and retained by the cloth from the specimen (Note 7). After washing, pat the area dry with a clean, soft cotton cloth. (See Note 5.)

8.8.1.2 If instrumentation is not available for measuring total ultraviolet as required in 8.8.1, expose materials for three calendar years. Conduct the procedure required in 8.8.1.1 each calendar year.

NOTE 5—Other materials such as natural or synthetic sponge or chamois skin may be used.

NOTE 6—Mild detergents are suitable.

NOTE 7—A surface film generated by cleaning with a detergent solution may affect instrumental and visual grading. Care must be taken to ensure that any film caused by the solution is rinsed away with clean tap water prior to drying.

8.8.2 *Exposure Conditions—Accelerated*—The following artificial accelerated exposure test can be used to evaluate the relative durability of glass-fiber-reinforced plastic materials. The most meaningful comparisons are made between materials exposed at the same time in the same device.

8.8.2.1 *Xenon Arc Using Practice G155*—Equip and operate the apparatus as specified as follows, and test the specimens for a minimum of the stated radiant exposure:[3]

Filter	Daylight
Irradiance level	0.70 ± 0.02 W/(m^2 . nm) at 340 nm
Program	90 min light only followed by 30 min light with front spray
Black panel temperature	70 ± 2°C
Relative humidity	60 ± 10 %
Spray water	deionized
Radiant exposure	3570 ± 36 kJ/(m^2 . nm) at 340 nm

8.8.2.2 Fresnel-reflecting concentrator as in Practice D4364, shall be employed using spray Cycle 1. Specimens shall be exposed for a minimum of 924 ± 12 MJ/m^2 of total ultraviolet radiation (295 to 385-nm wavelength region).

8.8.3 *Grading Specimens*—Following exposure and after cleaning as specified in 8.8.1.1, examine each specimen for the external appearance of glass fibers on the surface of the panels as distinguished from any prominence of fibers under the surface resin.

8.8.3.1 Specimens without any exposed glass fibers following exposure are to be classified as Grade 1. Specimens with exposed glass fibers are classified as Grade 2 (see 4.2).

8.8.4 *Color Change*—Color change in weathered panels is not considered in determining panel grade. However, any color change that does occur provides an indication of a particular color's performance in actual application. Consult the manufacturer for specific information regarding a particular color.

8.8.5 *Light Transmission*—Light transmission values are not part of the panel grading criteria.

NOTE 8—However, it is possible that light transmission values following weathering may be of significant importance in certain applications. If needed, consult manufacturers' literature for specific data.

8.9 *Load Deflection (L/D) Properties*—Use Method E72 (chamber method) to determine these properties.

8.9.1 Values for maximum positive and negative loads can be obtained by Method E72. Panels are inverted for negative testing. Test reports shall indicate the panel profile tested, the panel weight in ounces per square foot (or kilograms per square metre), and the span length.

8.9.2 Install panels on the test frame exactly as recommended by the manufacturer for appropriate application. Recommended fastener spacing shall be included in the test report.

8.9.3 Report positive and negative load values in pounds per square foot (kilograms per square metre).

8.9.4 Deflection data shall be reported in inches per pound per square foot (kilograms per square metre) of load.

8.9.5 *Span Deflection Relationship*—L/D shall not be less than 20 for vertical applications or less than 40 for roof applications.

8.10 *Burning Characteristics*—Determine burning characteristics in accordance with Test Method D635, except that six specimens shall be tested from different parts of panels. For corrugated and ribbed panels, take two specimens from crests, two from sides of valleys, and two from valleys. Average the results.

[3] The positive and negative deviations included with the specified set points for irradiance, temperature and relative humidity are maximum allowable operational fluctuations during equilibrium conditions. They do not imply that the user is allowed to program a set point higher or lower than that specified. If the operational fluctuations are greater than the maximum allowable after the equipment has stabilized, discontinue the test and correct the cuase of the problem before continuing