



Standard Specification for Glass-Fiber-Reinforced Polyester Plastic Panels¹

This standard is issued under the fixed designation D 3841; 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 approval. 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 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 may 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 *Laboratory flammability tests (Test Methods D 635, D 1929, D 2843, and E 84) applicable to this standard should be used to measure and describe the properties of materials, products, or assemblies in response to heat and flame under controlled laboratory conditions and should not be used to describe or appraise the fire hazard or fire risk of materials, products, or assemblies under actual fire conditions. However, results of these tests may be used as elements of a fire risk assessment which takes into account all of the factors which are pertinent to an assessment of the fire hazard of a particular end use.*

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 are no ISO standards covering the subject matter of this specification.

2. Referenced Documents

2.1 ASTM Standards:

D 570 Test Method for Water Absorption of Plastics²

D 618 Practice for Conditioning Plastics for Testing²

D 635 Test Method for Rate of Burning and/or Extent and Time of Burning of Self-Supporting Plastics in a Horizontal Position²

D 638 Test Method for Tensile Properties of Plastics²

D 696 Test Method for Coefficient of Linear Thermal Expansion of Plastics between -30°C and 30°C with a Vitreous Silica Dilatometer²

D 790 Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials²

D 883 Terminology Relating to Plastics²

D 1435 Practice for Outdoor Weathering of Plastics²

D 1494 Test Method for Diffuse Light Transmission Factor of Reinforced Plastic Panels²

D 1600 Terminology for Abbreviated Terms Relating to Plastics²

D 1929 Test Method for Ignition Properties of Plastics³

D 2843 Test Method for Density of Smoke from the Burning or Decomposition of Plastics³

D 3892 Practice for Packaging/Packing of Plastics⁴

D 4364 Practice for Performing Accelerated Outdoor Weathering of Plastics Using Concentrated Natural Sunlight⁴

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.

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² Annual Book of ASTM Standards, Vol 08.01.

³ Annual Book of ASTM Standards, Vol 08.02.

⁴ Annual Book of ASTM Standards, Vol 08.03.

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

- E 72 Method for Conducting Strength Tests of Panels for Building Construction⁵
- E 84 Test Method for Surface Burning Characteristics of Building Materials⁵
- E 424 Test Method for Solar Energy Transmittance and Reflectance (Terrestrial) of Sheet Materials⁶
- E 631 Terminology of Building Constructions⁷
- E 831 Test Method for Linear Thermal Expansion of Solid Materials by Thermomechanical Analysis⁷
- E 903 Test Method for Solar Absorptance, Reflectance and Transmittance of Materials Using Integrating Spheres⁸
- E 972 Test Method for Solar Photometric Transmittance of Sheet Materials Using Sunlight⁸
- E 1084 Test Method for Solar Transmittance (Terrestrial) of Sheet Material Using Sunlight⁸
- E 1175 Test Method for Determining Solar or Photopic Reflectance, Transmittance and Absorptance of Materials Using a Large Diameter Integrating Sphere⁸
- G 26 Practice for Operating Light-Exposure Apparatus (Xenon-Arc Type) With or Without Water for Exposure of Nonmetallic Materials⁷

3. Terminology

3.1 *General*—Definitions are in accordance with Terminology D 883 and E 631 and abbreviations with Terminology D 1600 unless otherwise indicated.

3.2 *Definitions of Terms Specific to This Standard: Description of Term Specific to This Standard:*

3.2.1 *limited flammability*—less response to fire than general purpose material when tested under laboratory conditions.

NOTE 2—Limited flammability is considered a fire hazard classification (see 1.3 and 1.6).

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*—Limited flammability.

4.1.2 *Type CC2*—General purpose.

NOTE 3—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 may be further subdivided 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/m²). Other weights are available. Flat sheet may be 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.

4.3.8 *Profile, Pitch and Depth*—In addition to standard profiles, special or custom profiles may be developed as agreed upon between the buyer and the seller.

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 may contain additives for various purposes, such as additives to provide low smoke density or high fire retardancy, catalyst residues, stabilizers, pigments, dyes, fillers, and reinforcing fiber or filaments. For material specifications of other types of fiberglass reinforced plastics, consult the manufacturers' literature.

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 specified by the purchaser 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 $\pm 10\%$ when determined in accordance with 8.4.

⁵ Annual Book of ASTM Standards, Vol 04.07.

⁶ Discontinued—Replaced by E 903 and E 1084.

⁷ Annual Book of ASTM Standards, Vols 08.03 and 14.02.

⁸ Annual Book of ASTM Standards, Vol 12.02.

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 $\pm 10\%$ 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 as specified by the purchaser and 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 $\pm 4\%$ from the nominal factor specified by purchaser when determined by Test Methods D 1494 or E 972.

7.7 *Solar Energy Transmission*—The nominal solar energy transmission shall be a tolerance of $\pm 4\%$ from the nominal transmission specified by the purchaser when determined by Test Methods E 424, Method B; E 903; E 1084; or E 1175. Measurements made using E 903 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 exposure or lack of exposure of glass fibers on the panels' surface when tested in accordance with Practice D 1435.

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 D 696 or E 831.

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 as agreed upon between the purchaser and the seller when 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 D 635 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.

NOTE 4—These requirements are intended only to differentiate between

limited flammability panels and general purpose panels.

7.13 *Ignition Properties*—All panels shall have a minimum self-ignition temperature of 650°F (343°C) when tested by Test Method D 1929.

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 a smoke density rating no greater than 450 when tested in accordance with Test Method E 84, or a smoke density rating no greater than 75 when tested in accordance with Test Method D 2843 in the thickness intended for use.

8. Test Methods

8.1 *Conditioning*—Condition the test specimens in accordance with Procedure A of Method D 618 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, may be used 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 $\pm 1\%$. 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)/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.

TABLE 1 Physical Properties^A

| Property | Value ^B | ASTM Test Method |
|--|---|------------------|
| Water absorption, max | 1 % | D 570 |
| Tensile strength, min | 7000 psi (48.3 MPa) | D 638 |
| Coefficient of linear thermal expansion, max | 2.5×10.5 in./in./°F (4.5 cm/cm/°C) | D 696 or E 831 |
| Flexural strength, min | 14 000 psi (96.6 MPa) | D 790 |
| Flexural modulus, min | 500 000 psi | D 790 |

^A The values reflect the minimum performance criteria for the most common applications. Specialized applications may require values significantly higher or lower than those stated here. For example, flat sheet formulated for interior use as wall liners may 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.

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 D 1435. For interim evaluation of weather resistance, the accelerated methods in Practices G 26 or D 4364, Procedure B may be used.

8.8.1 *Exposure Conditions—Outdoor*— Outdoor exposure in accordance with Practice D 1435 is required. Sample specimens should be at least 1 ft²(929 cm²) in size. Expose the samples without backing at 45° from the horizontal, facing South. The duration of exposure shall be 924 ± 12 MJ/m², of total ultraviolet radiation (295 to 385-nm wavelength region).

8.8.1.1 *Cleaning*—After each 308 ± 4-MJ/m² total ultraviolet radiant exposure increment, the left one half of each specimen shall be washed. Use clean, clear tap 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 cloth⁹ with clean, clear tap 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 clean water to avoid specimen damage due to abrasive particles which are picked up and retained by the cloth from the specimen. After washing, pat the area dry with a clean, soft cotton cloth. Clear tap water may not remove the maximum amount of surface deposits. If necessary, a 5:95 solution of a mild liquid detergent (see Note 6) and clean tap water may be used. If the solution is used, extra care must be taken to ensure that any film caused by the solution is rinsed away prior to drying. A surface film generated by cleaning with a detergent solution may affect instrumental and visual grading.

NOTE 5—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. Timing exposures on a calendar basis must be agreed upon by all interested parties.

NOTE 6—Mild detergents are suitable.

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 G 26, Method A, Apparatus Types AH or BH With Controlled Irradiance Capability*—Equip and operate the apparatus as specified as follows, and test the specimens for a minimum of the stated radiant exposure:

| | |
|-------------------------|---|
| Filter combination | borosilicate inner and outer |
| Irradiance level | 0.35 W/m ² /340 nm |
| Program Cam No. 162 | 90 min light only followed by 30 min light with front spray |
| Black panel temperature | 70 ± 2°C |
| Relative humidity | 60 ± 5 % |

⁹ Rymplecloth purified wiping cloth available from American Fiber & Finishing, P.O. Box 3881, Boston, MA 02241 has been found suitable. Other materials such as natural or synthetic sponge or chamois skin may be used.

| | |
|------------------|-------------------------------------|
| Spray water | deionized |
| Spray nozzle | F-80 |
| Radiant exposure | 4500 ± 45 kJ/m ² /340 nm |

8.8.2.2 *Xenon Arc Using Practice G 26, Method A, Apparatus Types AH or BH Without Controlled Irradiance Capability*—Equip and operate the apparatus as specified in 8.8.2.1, except specimens shall be tested for a minimum of 3600 h. The irradiance level shall be maintained by manual wattage adjustment. The suggested wattage settings for each exposure interval of a 6500-W (see Note 8) xenon burner tube based upon the average performance of xenon burner tubes with borosilicate filters in Test Method A are as follows:

| Time, light on hours of use | Power, W min |
|--------------------------------|-----------------|
| 0 to 20 | 5500 |
| 20 to 100 | 6000 |
| 100 to 200 | 6200 |
| 200 to 500 | 6500 |
| 500 to 1000 | 7000 |
| 1000 to 1500 | 7500 |
| 1500 to 2000 | 8500 |
| 2000 and over | |

NOTE 7—Xenon burner tubes other than 6500-W are not recommended for this procedure.

NOTE 8—Exposure of 3600 h in accordance with the table of wattage adjustments in 8.8.2.2 does not guarantee a radiant exposure equivalent to 4500 kJ/m²/340 nm when operating with controlled irradiance.

8.8.2.3 *Fresnel-reflecting concentrator* as in Practice D 4364, Procedure B, shall be employed using spray Cycle 1. Specimens shall be exposed for a minimum of 924 ± 12 MJ/m² 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. However, light transmission values following weathering may be of significant importance in certain applications. When required, consult manufacturers' literature for specific data.

8.9 *Load Deflection (L/D) Properties*— Use Method E 72 (chamber method) to determine these properties.

8.9.1 Values for maximum positive and negative loads can be obtained by Method E 72. 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 nor less than 40 for roof applications.

8.10 *Burning Characteristics*—Determine burning characteristics in accordance with Test Method D 635, except that six specimens should 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.

8.11 *Physical Properties*—Determine physical properties in accordance with Test Methods D 570, D 638, D 696, and D 790. Test Method E 831 may be used as an alternative to Test Method D 696.

8.11.1 Test Method D 638 shall be performed on Type 1 specimens at 0.20 in./min testing speed.

8.11.2 Test Method D 790 shall be performed on “sheet” specimens, using Method 1, Procedure A at an L/D ratio of 16 to 1.

9. Retest and Rejection

9.1 If any failure occurs, the panels may be retested to establish conformity in accordance with agreement between the purchaser and the seller.

10. Inspection

10.1 Inspection of the panel shall be made as agreed upon between the purchaser and the seller as part of the purchase contract.

11. Certification

11.1 Manufacturers shall supply certification of compliance with this specification in the form of a statement appended or affixed to invoices, or of labels affixed to panels or to wrappings, or of other means agreed to between the buyer and the seller. In any form, the certification shall state, as follows:

11.1.1 The name of the manufacturer,

11.1.2 The fact of conformance with this specification by number designation: ASTM D 3841,

11.1.3 The nominal weight per square foot (square metre) or nominal thickness,

11.1.4 Type, and

11.1.5 Grade.

12. Packaging and Package Marking

12.1 *Packaging*—The panels shall be packed in containers so constructed as to assure acceptance by common or other carrier for safe transportation to the point of delivery.

12.2 *Marking*:

12.2.1 Shipping containers shall be marked as agreed upon between the purchaser and the seller.

12.2.2 Labels on individual panels shall include Specification D 3841, type, and grade.

APPENDIX

(Nonmandatory Information)

X1. SUPPLEMENTARY INFORMATION

X1.1 *Chemical Resistance*—Generally, glass fiber-reinforced plastic panels will provide satisfactory service for long periods of time. However, exposure to chemical atmospheres may cause greater color degradation and greater fiber exposure than exposure to normal outdoor conditions. Since it is impossible to describe all of the conditions of exposure to chemical atmospheres, it is recommended that specific exposure conditions be discussed with the panel manufacturer prior to purchase.

X1.2 *Resistance to Hail*—The impact of hail stones or projectiles of similar size and velocity may cause localized, visible dislocations of reinforcing fibers and some limited flaking of the resin on the interior panel surface, known in the trade as “stars” or “starring.” Such markings generally constitute no more than an appearance blemish and in the absence of actual panel penetration that would permit leakage of water,

will not materially affect the performance of the panels in terms of physical properties, light transmission, or weather resistance.

X1.3 *Installation Practice*—The method of installation has a bearing on the performance of the panel in use, which is of special importance regarding weatherproof installation and spans. Consult the manufacturers’ recommendations for their products. See also “Recommended Installation Practice for Fiberglass Reinforced Panels.”¹⁰

X1.4 Work is presently underway to select the optimum test method for impact resistance.

¹⁰ This document was developed by the Fiberglass Reinforced Panel Council of The Society of the Plastics Industry, Inc., in March 1972, and may be obtained from SPI, Inc., Composites Institute, 355 Lexington Ave., New York, NY 10017.

SUMMARY OF CHANGES

Committee D-20 has identified the location of the following changes to this standard since the last issue that may impact the use of this standard.

(1) Added ISO equivalency statement.

(2) Added new Paragraph 1.5 regarding notes.

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