



Designation: ~~C1349~~—~~10~~ **C1349** – 17

Standard Specification for Architectural Flat Glass Clad Polycarbonate¹

This standard is issued under the fixed designation C1349; 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.

1. ~~Scope~~ Scope*

1.1 This specification covers the quality requirements for cut sizes of glass clad polycarbonate (GCP) for use in buildings as security, detention, hurricane/cyclic wind-resistant, ~~and~~ blast and ballistic-resistant glazing applications.

1.2 Optical distortion and the evaluation thereof are not currently within the scope of the standard. Mockups are recommended as a method to evaluate glass. (See [Appendix X3](#).)

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

1.4 *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.*

1.5 *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 Reference to these documents shall be the latest revision unless otherwise specified by the authority applying this specification.

2.2 *ASTM Standards:*²

C162 Terminology of Glass and Glass Products

C1036 Specification for Flat Glass

C1048 Specification for Heat-Strengthened and Fully Tempered Flat Glass

C1172 Specification for Laminated Architectural Flat Glass [C1349-17](#)

C1376 Specification for Pyrolytic and Vacuum Deposition Coatings on Flat Glass [5-02164f7bc0dc/astm-c1349-17](#)

C1422 Specification for Chemically Strengthened Flat Glass

C1503 Specification for Silvered Flat Glass Mirror

D256 Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics

D543 Practices for Evaluating the Resistance of Plastics to Chemical Reagents

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

D648 Test Method for Deflection Temperature of Plastics Under Flexural Load in the Edgewise Position

D790 Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials

D792 Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement

D1003 Test Method for Haze and Luminous Transmittance of Transparent Plastics

D1005 Test Method for Measurement of Dry-Film Thickness of Organic Coatings Using Micrometers

D1044 Test Method for Resistance of Transparent Plastics to Surface Abrasion

D3763 Test Method for High Speed Puncture Properties of Plastics Using Load and Displacement Sensors

E308 Practice for Computing the Colors of Objects by Using the CIE System

¹ This specification is under the jurisdiction of ASTM Committee C14 on Glass and Glass Products and is the direct responsibility of Subcommittee C14.08 on Flat Glass. Current edition approved Oct. 1, 2010; April 15, 2017. Published November 2010; June 2017. Originally approved in 1996. Last previous edition approved in 2004; 2010 as ~~C1349—04~~; C1349 – 10. DOI: [10.1520/C1349-10](#); [10.1520/C1349-17](#).

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

E1886 Test Method for Performance of Exterior Windows, Curtain Walls, Doors, and Impact Protective Systems Impacted by Missile(s) and Exposed to Cyclic Pressure Differentials

E1996 Specification for Performance of Exterior Windows, Curtain Walls, Doors, and Impact Protective Systems Impacted by Windborne Debris in Hurricanes

F1233 Test Method for Security Glazing Materials And Systems

F1642 Test Method for Glazing and Glazing Systems Subject to Airblast Loadings

F1915 Test Methods for Glazing for Detention Facilities

2.3 *ANSI Standard:*

Z97.1 Safety Glazing Materials Used in Buildings—Safety Performance Specifications and Methods of Tests³

2.4 *Federal Document:*

CPSC 16 CFR 1201 Consumer Product Safety Commission Safety Standard for Architectural Glazing Materials⁴

2.5 *UL Standards*⁵

UL 752 Standard for Bullet Resisting Materials

UL 972 Standard for Burglary Resisting Glazing Materials

3. Terminology

3.1 *Definitions:*

3.1.1 Refer to the terminology in the ASTM standards referenced in 2.2, as appropriate.

3.1.2 *blemishes in flat glass*—refer to Specification **C1036**, as appropriate.

3.1.3 *blemishes in polycarbonate*—refer to **Appendix X1**.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *adhesion chips*—glass particles or crystalline material that is permanently bonded to the surface of a lite.

3.2.2 *aliphatic polyether urethane*—a thermoplastic interlayer required to bond polycarbonate lite to polycarbonate or glass lite to glass.

3.2.3 *asymmetrical construction*—see *non-symmetrical*.

3.2.4 *blow-in*—a separation of glass or polycarbonate and interlayer at or close to the laminate edge.

3.2.5 *boil (bubble)*—a gas pocket in the interlayer material or between the glass or polycarbonate and the interlayer.

3.2.6 *bond*—adhesion of the glass or polycarbonate ply to the interlayer.

3.2.7 *bow and warp*—*bow*—a curve, bend, or other deviation from flatness.

3.2.8 *carbon specks*—flakes of carbon inherent in the manufacturing and extrusion of polycarbonate sheets.

3.2.9 *crizzle*—an imperfection in the form of a multitude of fine surface ~~fractures~~ fractures (also known as “crazing”).

3.2.10 *deflection temperature*—the softening temperature as determined by applying heat and load to a material.

3.2.11 *delamination*—a condition in which one or more of the lites of glass or polycarbonate loses the bond between the glass or polycarbonate lite and the interlayer.

3.2.12 *discoloration*—~~areas that are blushed, whitish, or yellow in appearance.~~ a visibly noticeable color change (from original) in the appearance of a material.

3.2.13 *distortion*—the inability to see an image clearly; the image is twisted out of natural shape.

3.2.14 *edge boil*—see *boil*.

3.2.15 *elongation*—the increase in length of a material that has been stretched.

3.2.16 *flammability rating*—the rate of burn; a CC-1 rating is based on a rate of burn less than one in./min.

3.2.17 *flexural modulus*—the stiffness/rigidity of a material as determined by bending the material at stresses less than that required to produce permanent deformation.

3.2.18 *fuse*—see *adhesion chips*.

3.2.19 *glass clad polycarbonate (GCP)*—one or more lites of flat glass bonded with an aliphatic urethane interlayer to one or more sheets of extruded polycarbonate in a pressure/temperature/vacuum laminating process.

3.2.20 *hair*—~~a thin filament resembling thread or animal hair.~~ slender, pigmented filament from human or animal epidermis or other thread-like filament.

3.2.21 *haze*—the percentage of transmitted light that, in passing through a specimen, deviates from incident beam by forward scattering.

³ Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036.

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

⁵ Available from Underwriters Laboratories (UL), Corporate Progress, 333 Pfingsten Rd., Northbrook, IL 60062.

3.2.22 *inside dirt*—foreign material trapped inside the laminate.

3.2.23 *instrumented dart*—a test evaluating the puncture properties of plastics over a range of test velocities.

3.2.24 *interlayer*—~~a material developed specifically for bonding glass lites to glass lites, polycarbonate to polycarbonate, or glass and polycarbonate lites together.~~ layer or multiple layers of material acting as an adhesive between lites of glass which add(s) additional performance to the finished product, for example, impact resistance, solar control, acoustical insulation, color, design, or combinations thereof.

3.2.25 *izod milled notch*—a test evaluating the resistance of plastics to breakage by flexural shock. The notch in the izod specimen serves to concentrate the stress, minimize plastic deformation, and direct the fracture to the part of the specimen behind the notch.

3.2.26 *laminate*—see *glass clad polycarbonate*.

3.2.27 *lint*—short fibers of yarn or fabric trapped within the laminate.

3.2.28 *lite*—lite (or light)—an assembly of glass—a panel or sheet of glass or a panel or sheet of glass clad polycarbonate.

3.2.29 *mismatch*—misalignment of the edges of two or more plies of glass or polycarbonate.

3.2.30 *non-symmetrical*—an assembly for which the thickness and types of glass, polycarbonate, and interlayer are not the same about the thickness center.

3.2.31 *offset*—~~a mismatch of the edges of two or more glass or polycarbonate plies as part of the design of the glass lites that are intentionally not aligned in a laminate.~~

3.2.32 *ply*—one sheet or panel of glass or polycarbonate in a laminate.

3.2.33 *PVB*—a polyvinyl butyral interlayer used to bond glass to glass.

3.2.34 *scratch*—damage on a glass or polycarbonate surface in the form of a line caused by the relative movement of an object across and in contact with the surface.

3.2.35 *scuff*—see *streak*.

3.2.36 *separation*—see ~~delamination~~*delamination*.

3.2.37 *short interlayer*—a condition of the laminate in which the interlayer does not extend to the edge.

3.2.38 *specific gravity*—the ratio of a given volume of a material to the weight of an equal volume of water at standard conditions.

3.2.39 *streak*—a noticeably visible deviation on/in the laminating ~~directional~~ blemish or discoloration on or in the laminated unit.

3.2.40 *surfaces*—surfaces of glass and polycarbonate faces are counted from the exterior (threat) to the interior (protected). If a laminate of glass-interlayer-polycarbonate-interlayer glass is used as an example, the No. 1 surface is the surface that is to the exterior; the Nos. 2 and 3 surfaces are the next glass and polycarbonate surfaces, respectively, separated by and bonded to the interlayer material; the Nos. 4 and 5 surfaces are the following polycarbonate and glass surfaces, respectively, that are separated by and bonded to the interlayer; the No. 6 surface is the surface that is to the interior.

3.2.41 *symmetrical*—an assembly for which the thickness and types of glass, polycarbonate, and interlayers are the same about the thickness center.

3.2.42 *tabor abrasion*—a measure of the effect of a specific type of abrasion; the change in percent haze is measured for transparent materials, and weight loss is measured for opaque materials.

3.2.43 *template*—a pattern used as a guide to define the overall size and shape of a cut lite.

3.2.44 *tensile strength*—the load that causes a material to break during elongation/stretching.

3.2.45 *unlaminated area*—an area of the ~~laminate~~ glass clad polycarbonate that failed to laminate during the laminating process. This blemish is discernible due to the textured appearance of the interlayer material.

4. Classification

4.1 *Kinds*—Glass clad polycarbonate furnished under this specification shall be of the following kinds, as specified:

4.1.1 *Kind GCP, Single Core (SC)*—Glass clad polycarbonate consisting of one or more lites of flat glass bonded with an aliphatic urethane interlayer to one sheet (single core) of polycarbonate in a pressure/temperature/vacuum laminating process.

4.1.2 *Kind GCP, Multiple Core (MC)*—Glass clad polycarbonate consisting of one or more lites of flat glass bonded with an aliphatic urethane interlayer to more than one sheet (multiple core) of polycarbonate in a pressure/temperature/vacuum laminating process.

4.1.3 *Kind GCP, Others (O)*—glass clad polycarbonate constructions not covered by 4.1.1 or 4.1.2.

5. Ordering Information

5.1 *Procurement Information*—Purchasers should select the applicable options permitted in this section and include the following information in procurement documents:

- 5.1.1 Title, number, and date of this specification;
- 5.1.2 Kind of GCP, as referred to in this specification (see Section 4);
- 5.1.3 Edgework requirements (see 8.2);
- 5.1.4 Overall nominal thickness of the GCP, including the nominal thickness and treatment of glass plies and the nominal thicknesses of the polycarbonate and interlayer material;
- 5.1.5 Nominal length and width of the GCP;
- 5.1.6 Blueprint, drawing, template, orientation, or other information useful to the manufacturer regarding installation of the product;
- 5.1.7 Color or tint of the GCP laminate (tinted glass, interlayer, polycarbonate, or combinations);
- 5.1.8 Required minimum visible light transmittance of the laminate;
- 5.1.9 Mockup requirements (See 8.6–Flatness, Table 1 and Appendix X3.)
- 5.1.10 Security and safety standards or regulations to which the laminate must conform (see 7.1 – 7.8)
- 5.1.11 Schedule requirements; and
- 5.1.12 All other standards to which the laminate must conform.

5.2 *Packaging Requirements*—Glass and polycarbonate packaging and protection will be standard manufacturer’s practices unless otherwise specified. Consult manufacturers before specifying.

6. Other Requirements

- 6.1 Annealed glass plies should conform to the requirements of Specification C1036.
- 6.2 Heat-strengthened or fully tempered glass plies shall conform to the requirements of Specification C1048.
- 6.3 Pyrolytic and vacuum deposition coated glass plies shall conform to the requirements of Specification C1376.
- 6.4 Chemically strengthened glass plies shall conform to the requirements of Specification C1422.
- 6.5 Silvered mirror glass plies shall conform to the requirements of Specification C1503.
- 6.6 Polycarbonate sheets shall conform to the requirements of Appendix X1.
- 6.7 The aliphatic polyether urethane interlayer shall conform to the requirements of Appendix X2.
- 6.8 The polyvinyl butyral interlayer shall conform to the manufacturer’s specifications.
- 6.9 Laminates GCPs specified for security glazing shall meet the applicable requirements of the security glazing standards (see 7.1).
- 6.10 Laminates GCPs specified for safety glazing shall meet the requirements of the specified safety glazing standards (see 7.2).
- 6.11 Verify compatibility of all materials in the glazing pocket including, but not limited to, primers, sealants, agents, or solvents used to clean or prepare frame materials prior to installation using testing protocol of practice B—Mechanical Stress and Reagent Exposure in Practice D543.
- 6.12 Test protocols shall include evaluation of polycarbonates under stress. Test samples are to be 1/8 in. (3 mm) polycarbonate strips 1 in. (25 mm) wide by 12 in. (305 mm) long bent to a 10 in. (254 mm) base dimension in the strain jig.

7. Test Methods

- 7.1 *Security Tests*—Test and interpret in accordance with tests required by specific jurisdictions, as applicable.
- 7.2 *Impact Test for Safety Glazing*—Test and interpret in accordance with ANSI Z97.1 or CPSC 16 CFR 1201, or both, as applicable.

TABLE 1 Maximum Allowable Overall Bow and Warp^{ABC}

| Longest Edge Dimension, in. (mm) | Maximum Allowable Bow and Warp, in. (mm) |
|-------------------------------------|--|
| 0 to 18 (0 to 460) | 3/32 (2.4) |
| Over 18 to 36 (over 460 to 910) | 3/16 (4.8) |
| Over 36 to 48 (over 910 to 1220) | 1/4 (6.4) |
| Over 48 to 60 (over 1220 to 1520) | 5/16 (7.9) |
| Over 60 to 96 (over 1520 to 2440) | 1/2 (12.5) |

^A The above table is for GCP of any overall thickness having glass on both sides.
^B For GCP with glass on both sides in a strip condition or for GCP with glass on one side and exposed polycarbonate on the opposing side in a nonstrip condition, the overall bow and warp is to be multiplied by 1.5. Strip condition is defined as a GCP product with a long side to short side ratio of 4 to 1 or greater.
^C For GCP with glass on one side and exposed polycarbonate on the opposing side in a strip condition, the overall bow and warp is to be multiplied by 2.0.