Designation: C1349 – 17

Standard Specification for Architectural Flat Glass Clad Polycarbonate[1]

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*

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, 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
C1376 Specification for Pyrolytic and Vacuum Deposition Coatings on Flat Glass
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
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

[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.

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[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**

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 Tests[3]

2.4 *Federal Document:*

CPSC 16 CFR 1201 Consumer Product Safety Commission Safety Standard for Architectural Glazing Materials[4]

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 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*—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 (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*—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 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.

3.2.22 *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 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 (or light)*——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*—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*.

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

[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.

3.2.38 *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 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 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.

TABLE 1 Maximum Allowable Overall Bow[A,B,C]

Longest Edge Dimension, in. (mm)	Maximum Allowable Bow 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.

6.9 GCPs specified for security glazing shall meet the applicable requirements of the security glazing standards (see 7.1).

6.10 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 ⅛ 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.

7.3 *Test for Missile Impact and Cyclic Pressure*—Test and interpret in accordance with Test Method E1886 and Specification E1996.

7.4 *Test for Security Glazing*—Test and interpret in accordance with Test Method F1233.

7.5 *Test for Glazing Subject to Airblast Loading*—Test and interpret in accordance with Test Method F1642.

7.6 *Test for Detention Glazing*—Test and interpret in accordance with Test Method F1915.

7.7 *Test for Bullet Resisting Glazing*—Test and interpret in accordance with Standard UL 752.

7.8 *Test for Burglary Resisting Glazing*—Test and interpret in accordance with Standard UL 972.

7.9 *Size*—Measure length and width from edge to edge, including flares, mismatch, or offset.

7.10 *Overall Bow*—Place sample glass in a freestanding vertical position, with the longest edge resting on blocks at the quarter points. With the laminate in this position, place a straightedge across the concave surface, parallel to and within 1 in. (25.4 mm) of the edge, and measure the maximum deviation with a taper or feeler gauge. A dial indicator may also be used.

7.11 *Visual Inspection*—Place the specimen in a vertical position. The viewer shall look through the specimen, using daylight without direct sunlight, or using a background light suitable for observing the blemishes. View at 36 in. (914 mm) except where specified otherwise in Table 2.

7.12 *Transmittance*—Using Practice E308, measure transmittance by illuminating each laminated specimen at normal incidence with the light having the spectral composition of the International Commission on Illumination (CIE), illuminate C. Measure the ratio of transmittance to incident luminous flux by calculating from the spectral distribution of illuminate C as defined by Practice E308.

8. Fabrication Requirements

8.1 *Dimensional Fabrication*—All dimensional fabrication, such as cutting to overall dimensions, edgework, drilling, notching, grinding, sandblasting, and etching, on laminates incorporating heat-strengthened, chemically strengthened, or

TABLE 2 Maximum Allowable Glass Clad Polycarbonate Blemishes

Blemish[A]	Single Polycarbonate Core				Multiple Polycarbonate Core			
	Less than 25 ft² (2.5 m²)		25 to 50 ft² (2.5 to 4.7 m²)		Less than 25 ft² (2.5 m²)		25 to 50 ft² (2.5 to 4.7 m²)	
	Central,[B] in. (mm)	Outer,[B] in. (mm)	Central,[B] in. (mm)	Outer,[B] in. (mm)	Central,[B] in. (mm)	Outer,[B] in. (mm)	Central,[B] in. (mm)	Outer,[B] in. (mm)
Bubbles	1/16 (1.6)	3/32 (2.4)	3/32 (2.4)	1/8 (3.2)	3/32 (2.4)	1/8 (3.2)	1/8 (3.2)	3/16 (4.8)
Blow-in; edge boil	N/A	3/8 (9.5)	N/A	3/8 (9.5)	N/A	3/8 (9.5)	N/A	3/8 (9.5)
Fuse	1/32 (0.8)	1/16 (1.6)	1/16 (1.6)	3/32 (2.4)	1/16 (1.6)	3/32 (2.4)	3/32 (2.4)	5/32 (4.0)
Hair, lint (single strand)	light intensity[C]	medium intensity[D]	light intensity[C]	medium intensity[D]	medium intensity[D]	medium intensity[D]	medium intensity[D]	medium intensity[D]
Inside dirt (dirt spot)	1/16 (1.6)	3/32 (2.4)	3/32 (2.4)	5/32 (4.0)	3/32 (2.4)	5/32 (4.0)	1/8 (3.2)	3/16 (4.8)
Lint, areas of concentrated lint	light intensity[C]	light intensity[D]	light intensity[C]	light intensity[C]	light intensity[C]	light intensity[C]	light intensity[C]	light intensity[D]
Delamination, discoloration	none	none	none	none	none	none	none	none
Short interlayer; unlaminated area chip	N/A	3/8 (9.5)	N/A	3/8 (9.5)	N/A	3/8 (9.5)	N/A	3/8 (9.5)
Scuff, streak	light intensity[C]	medium intensity[D]	light intensity[C]	medium intensity[D]	light intensity[C]	medium intensity[D]	medium intensity[D]	medium intensity[D]
Scratches (white)[E]	light intensity[C]	medium intensity[D]	light intensity[C]	medium intensity[D]	light intensity[C]	medium intensity[D]	medium intensity[D]	medium intensity[D]
Carbon specks	1/16 (1.6)	1/16 (1.6)	1/16 (1.6)	1/16 (1.6)	1/16 (1.6)	1/16 (1.6)	1/16 (1.6)	1/16 (1.6)
Crizzle	none	none	none	none	none	none	none	none

[A] All imperfections noted, with the exception of carbon specks, should be separated by a minimum of 12 in. (305 mm).
[B] The central area is an area formed by an oval or circle whose axes or diameters, when centered, do not exceed 80 % of the overall dimension. The outer area is the area outside of the central area.
[C] Light intensity: barely noticeable at 36 in. (914.4 mm).
[D] Medium intensity: noticeable at 36 in. (914.4 mm) but not at 11 ft (3352.8 mm).
[E] Hairline scratches are acceptable not to exceed 4 in. (101.60 mm) in length.

fully tempered glass must be performed prior to strengthening or tempering. In addition, custom drilling of any GCP, including speakholes and pass-through holes, may invalidate performance capabilities and is not recommended.

8.2 *Edge:*

8.2.1 Most GCP laminates incorporate heat-strengthened, chemically strengthened, or fully tempered glass. Additional edgework after strengthening or laminating compromises edge strength and is, therefore, not recommended (also see 8.1). Some mismatch can be expected with these laminates.

8.2.2 For GCPs made with annealed glass, an edge shall be cut, sawed, ground, sanded to remove sharp edges only, seamed, beveled, or mitered, as specified.

8.3 *Marking:*

8.3.1 Each laminate shall bear the trademark or name of the GCP manufacturer unless otherwise specified.

8.3.2 GCP intended for safety glazing applications specified by building codes shall be marked permanently with the name or trademark of the GCP manufacturer and the designation of the applicable safety glazing standard.

8.4 *Thickness*—As there are many possible makeups for GCP, it is essential that the specifier consult with the GCP manufacturer for the minimum and maximum thicknesses for each makeup specified. Typical thicknesses are tabulated in Table 3.

8.5 *Mismatch, Length, and Width:*

8.5.1 The maximum allowable mismatch is 3⁄16 in. (4.8 mm). The length and width tolerances of symmetrical laminates shall be in accordance with Table 4 when measured from edge to edge, including flares, mismatches, or offsets.

8.5.2 For non-symmetrical laminates and large or small sized laminates, contact the GCP manufacturer for length and width tolerances.

8.6 *Flatness:*

8.6.1 Because of the nature of the processes used in manufacturing heat-strengthened, rolled, tempered, or wired glass, these glasses may not be as flat as annealed or chemically strengthened transparent glass. The deviation from flatness of GCP depends on the glass type, thickness, width, length, laminating process, and other factors. The overall bow of GCP, determined by measuring the greatest distance from a straight edge placed parallel to and within 1 in. (25.4 mm) of the edge of the GCP, shall not exceed the values given in Table 1.

8.6.2 Localized warp (as defined in Specification C1048) for rectangular GCP shall not exceed 1⁄16 in. (1.6 mm) in any 12 in. (305 mm) span of edge.

8.7 *Blemishes*—Maximum allowable laminating process blemishes shall not be greater than those listed in Table 2. Inspection should be in accordance with Paragraph 7.12 of Specification C1172. For the quality specification for the individual glass plies, polycarbonate, and aliphatic urethane, refer to Specification C1036, Specification C1048 (if applicable), Specification C1376, Appendix X1, and Appendix X2.

8.8 *Haze*—This value shall not exceed 2.5 %, as measured per Test Method D1003.

TABLE 3 Nominal Thickness

Nominal Construction, in.	in. (mm)	Minimum Thickness, in. (mm)	Maximum Thickness, in. (mm)
7⁄16	0.458 (11.63)	0.426 (10.82)	0.508 (12.9)
9⁄16	0.576 (14.63)	0.532 (13.51)	0.638 (16.21)
11⁄16	0.715 (18.16)	0.658 (16.71)	0.791 (20.09)
13⁄16	0.794 (20.17)	0.684 (17.37)	0.824 (20.93)
15⁄16	0.862 (21.89)	0.79 (20.07)	0.954 (24.23)

9. Keywords

9.1 flat glass; glass clad polycarbonate; institutional glazing; laminated glass; polycarbonate; security glazing

TABLE 4 Size Tolerances

Laminate Construction	in. (mm)
2 and 3 ply	±1⁄8 (±3)
4 or more ply	±3⁄16 (±4.8)

APPENDIXES

(Nonmandatory Information)

X1. SPECIFICATION FOR EXTRUDED POLYCARBONATE SHEET USED IN TRANSPARENT COMPOSITE STRUCTURES

X1.1 Scope

X1.1.1 This specification covers clear and tinted transparent polycarbonate sheet material suitable for composite laminates using interlayers for adhesion. The polycarbonate sheet thickness range is from 0.060 to 0.500 in. (1.5 to 12.7 mm).

X1.1.2 *Classification*—The polycarbonate sheet shall be of the following types:

(1) Type I—Standard ultraviolet (UV) stabilized polycarbonate; or

(2) Type II—Hard-coated, abrasion-resistant, or mar-resistant UV stabilized polycarbonate.

X1.2 Physical Property Values

X1.2.1 Specimens are prepared from polycarbonate sheet materials and shall display typical property values, as specified in Table X1.1, when tested as specified by the applicable procedure.

TABLE X1.1 Physical Property Values[A]

Property	Typical Values	Test Method
Specific gravity	1.19 to 1.21	D792
Tensile strength	9000 psi	D638
Elongation	80 %	D638
Flexural modulus	340 000 psi	D790
Impact strength Izod milled notch	16 ft lb/in. of notch	D256
Instrumented dart	600 in. lb	D3763
Deflection temperature under load (264 psi)	265°F	D648
Flammability rating	CC-1	D635
Taber abrasion[B] 100 cycles, CS-10F wheel 500 g	<1.5 % (change in haze)	D1044

[A] Values listed in this table represent typical numbers for ⅛ in. (nominal) thickness specimens.
[B] For Type II sheet.

X1.3 Appearance

X1.3.1 Internal dirt, contamination, and embedded particulates shall be no greater than 1/16 in. (1.6 mm) in diameter. No more than six defects in any 1 ft^2 area and no more than an average of two defects per ft^2 over the whole sheet. Defects smaller then 1/32 in. (0.8mm) are not counted except that they shall not be grouped in an objectionable pattern as to impair or distort vision.

X1.3.2 Internal bubbles or voids shall not be noticeable from a distance of 36 in. (914 mm).

X1.3.3 Visually apparent blemishes, such as roll skip, die lines, and surface defects, are not allowable when viewed under the following conditions:

(1) Sheet shall hang vertically in front of a bank of fluorescent lights spaced 6 to 12 in. (152 to 305 mm) away;

(2) Discrepancies shall not be noticeable from a distance of 36 in. (914 mm).

X1.3.4 Thickness and light transmission of clear polycarbonate (measured as instructed in Test Method D1003) is shown in Table X1.2.

TABLE X1.2 Thickness and Light Transmission of Clear Polycarbonate

Nominal Gauge, in. (mm)[A]	Minimum Thickness, in. (mm)	Maximum Thickness, in. (mm)	Light Transmission Minimum
0.060	0.054	0.066	87 %
0.093	0.084	0.102	86 %
0.118 (3.0)	0.106 (2.7)	0.130 (3.3)	86 %
0.125	0.113	0.138	85 %
0.117 (4.5)	0.159 (4.05)	0.195 (4.95)	84 %
0.220	0.198	0.242	82 %
0.236 (6.0)	0.212 (5.4)	0.260 (6.6)	82 %
0.250	0.225	0.275	81 %
0.375	0.338	0.413	78 %
0.500	0.450	0.550	75 %

[A] Metric is given only when an equivalent metric thickness is produced.

X1.3.5 *Haze* (measured in accordance with Test Method D1003)—The maximum haze value is 2 % for all thicknesses.

X1.3.6 *Chemical Resistance*—For a specific sealant compatibility or chemical resistance, please contact the polycarbonate sheet manufacturer.

X2. SPECIFICATION FOR ALIPHATIC POLYETHER URETHANE FOR USE IN FLAT GLASS CLAD POLYCARBONATE

X2.1 The following guidelines are offered as recommendations for specifying polyurethane interlayer for use in GCP composite structures:[6]

X2.1.1 *Type*—The recommended type of interlayer is aliphatic polyether.

X2.1.2 *Light Transmission*—The light transmission should be a minimum of 85 % when measured by Test Method D1005 as laminated between two ⅛-in. (3.2-mm) thickness glass plies with a film of 0.050 in. (1.3 mm).

X2.1.3 *Haze*—The haze should be limited to 1 % when measured by Test Method D1005 on a film thickness of 0.050 in. (1.3 mm).

X2.1.4 *Gauge Variation*—A gauge variation of ±10 % of the nominal thickness is acceptable. This is measured every inch, and variation is not to exceed 0.002 in. (0.05 mm) per lineal inch anywhere along the sheet.

X2.1.5 *Ultimate Tensile Strength*—The ultimate tensile strength shall be 3000 psi, as a minimum, when measured by Test Method D1005.

X2.1.6 *Ultimate Elongation*—The ultimate elongation shall be 300 %, as a minimum, when measured by Test Method D1005.

X2.2 For a specific sealant compatibility or chemical resistance, please contact the polyurethane resin manufacturer.

[6] Measurements are for specimens at 23 ± 2°C.

X3. GLASS CLAD POLYCARBONATE SELECTION

X3.1 *Visual Mockups*—Viewing full-size mockups under typical site conditions and surrounding landscape is highly recommended for evaluation of reflected and optical distortion.

SUMMARY OF CHANGES

Committee C14 has identified the location of selected changes to this standard since the last issue (C1349 – 10) that may impact the use of this standard. (Approved April 15, 2017.)

(1) The specification has been updated to align with changes in Specifications C1172 and C1048 (in other words, the deletion of "and warp" and definitions in accordance with Specification C1172.