



Designation: C1172 – 19

Standard Specification for Laminated Architectural Flat Glass¹

This standard is issued under the fixed designation C1172; 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 of flat laminated glass consisting of two or more lites of glass bonded with an interlayer material for use in building and related applications.

1.2 Depending on the number, thickness, and treatment of lites, and the number and thickness of interlayers, the glass shall be laminated for applications including, but not limited to, safety, security, detention, hurricane/cyclic-wind resistance, blast resistance, bullet resistance, sound reduction, and decorative glazing.

1.3 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 X1](#).)

1.4 The dimensional values, except thickness designations, stated in inch-pound units are to be regarded as the standard. The values in parentheses are for information only.

1.5 The following safety hazards caveat pertains only to the test method portion, Section 7, of this specification: *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.6 *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](#)
- [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](#)
- [E308 Practice for Computing the Colors of Objects by Using the CIE System](#)
- [E413 Classification for Rating Sound Insulation](#)
- [E903 Test Method for Solar Absorptance, Reflectance, and Transmittance of Materials Using Integrating Spheres](#)
- [E1332 Classification for Rating Outdoor-Indoor Sound Attenuation](#)
- [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](#)
- [E2395 Specification for Voluntary Security Performance of Window and Door Assemblies with Glazing Impact](#)
- [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](#)
- [F3006 Specification for Ball Drop Impact Resistance of Laminated Architectural Flat Glazing](#)
- [F3007 Test Method for Ball Drop Impact Resistance of Laminated Architectural Flat Glass](#)

2.3 ANSI Standard:

- [Z97.1 Safety Glazing Materials Used in Buildings—Safety Performance Specifications and Methods of Tests³](#)

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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.

³ Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, <http://www.ansi.org>.

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

2.4 *Federal Document*:⁴

CPSC 16CFR1201 Consumer Product Safety Commission
Safety Standard for Architectural Glazing Materials

2.5 *National Institute of Justice (NIJ) Standard*:⁵

NIJ 0108.1 Ballistic Resistant Protective Materials

2.6 *UL Standards*:⁶

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 Terminology C162, Specifications C1036 or C1048, as appropriate.

3.1.2 *blemishes in flat glass*—Refer to Specifications C1036 or C1048, as appropriate.

3.2 *Definitions of Terms Specific to This Standard*:

3.2.1 *adhesion chips*—See *fuse*.

3.2.2 *blow-in*—a separation of glass and interlayer at or close to the laminate edge caused by penetration of the autoclaving medium into the edge during manufacturing.

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

3.2.4 *covered edge*—the peripheral area of the laminate covered by the channel or sash when installed.

3.2.5 *delamination*—a condition in which separation has occurred between the glass lite(s) and the interlayer.

3.2.6 *discoloration*—a visibly noticeable color change (from original) in the appearance of a material.

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

3.2.8 *edge boil*—See *boil (bubble)*.

3.2.9 *exposed edge*—the peripheral area of the laminate exposed to the environment after installation.

3.2.10 *fuse*—a glass particle or crystalline material that is permanently bonded to a surface of a lite.

3.2.11 *hair*—a slender, pigmented filament from human or animal epidermis or other thread-like filament.

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

3.2.13 *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.

3.2.14 *laminated glass*—an assembly consisting of two or more lites of glass, conforming to Specifications C1036 or C1048, that are bonded together by interlayer material.

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

3.2.16 *lite or light*—a panel or sheet of glass or a panel or sheet of laminated glass.

3.2.17 *mismatch*—misalignment of the edges of two lites of glass, when laminated.

3.2.18 *offset*—glass lites that are intentionally not aligned in a laminate.

3.2.19 *rub*—abrasion of a glass surface producing a frosted appearance; also known as a scuff.

3.2.20 *separation*—an area of the laminate that has become delaminated (see *delamination*).

3.2.21 *shiner*—an area on a glass edge that has not been ground or polished.

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

3.2.23 *streak*—a noticeably visible directional blemish or discoloration on or in the laminated unit.

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

3.2.25 *unlaminated area*—an area of the laminate that failed to flow, develop acceptable optics, achieve adhesion, or combinations thereof during the laminating process. This blemish may be discernible due to a texture, haze, or other change in appearance.

4. Classification

4.1 *Type*—Laminated flat glass furnished under this specification shall be of the following types, as specified:

4.1.1 *Type I - Laminated Glass*—An assembly consisting of two or more lites of glass, conforming to Specifications C1036 or C1048, that are bonded together by interlayer material.

4.1.2 *Type II - Laminated Safety Glass*—An assembly of two or more lites of flat glass, conforming to Specifications C1036 or C1048, that are bonded together by interlayer material that meet the requirements of ANSI Z97.1 or CPSC 16CFR1201. In the case of breakage, the interlayer serves to retain the glass fragments, limit the size of the opening and reduce the risk of cutting or piercing injuries.

4.2 *Application*—The following terms are designed to guide the user to the appropriate inspection charts and requirements. The glazing can usually, but not always, be viewed in transmittance and reflectance.

4.2.1 *Laminated Proximate Glazing*—Glazing used in an installation in which the lower edge of the glazing is a maximum of 6 ft (1.8 m) above the walking surface. The glazing is usually vertical, however, may also be sloping in or out from the vertical plane. The glazing can be approached within 10 ft (3 m) or less (if distance is greater than 10 ft (3 m) see *Laminated Overhead Glazing*). Interior decorative glazing will be judged according to laminated vertical glazing criteria.

4.2.2 *Laminated Overhead Glazing*—Glazing used in an installation in which the lower edge of the glass is more than 6 ft (1.8 m) above a walking floor level or cannot be approached within 10 ft (3 m). The glazing is usually sloping from the vertical plane, however, may also be vertical. Sloped

⁴ Available from U.S. Consumer Product Safety Commission (CPSC), 4330 East West Hwy., Bethesda, MD 20814, <http://www.cpsc.gov>.

⁵ Available from National Institute of Justice (NIJ), 810 7th St., NW, Washington, DC 20531, <http://www.ojp.usdoj.gov/nij>.

⁶ Available from Underwriters Laboratories (UL), 333 Pfingsten Rd., Northbrook, IL 60062-2096, <http://www.ul.com>.

glazing is considered any glazing that slopes more than 15° from the vertical in any direction.

4.2.3 *Laminated Spandrel Glazing*—Glazing used in an installation in which the glazing is only viewed in reflection from the building’s exterior. The glazing is usually installed vertically, however, may be at a slope to the vertical plane. Laminated spandrel glazing shall be inspected using the criteria of laminated proximate glazing or laminated overhead glazing as defined in 4.2.1 or 4.2.2.

5. Ordering Information

5.1 Purchasers should select the preferred options permitted in this specification and include the following information in procurement documents:

- 5.1.1 Title, number, and date of this specification.
- 5.1.2 Type of laminated flat glass as referred to in this specification (see Section 4).
- 5.1.3 Edgework requirements (see 8.2).
- 5.1.4 Thickness requirements:
 - 5.1.4.1 Thickness designation of each individual lite of glass to be used in the laminate.
 - 5.1.4.2 Thickness designation of individual interlayer(s) used in the laminate.
 - 5.1.4.3 Overall nominal thickness of the laminate.
- 5.1.5 Nominal length and width of the laminate.
 - 5.1.5.1 Blueprint, drawing, template, configuration specification, or other forms of information which detail overall size, configuration, and orientation.
- 5.1.6 *Types*—Color, tint, coating, decorative effect, and strength of each individual lite of glass.
- 5.1.7 Color, tint, type, formation, and decorative effect of the interlayer.
- 5.1.8 The luminous transmittance of the laminate (see 7.13).
- 5.1.9 Safety standards or regulations to which the laminate must conform.
- 5.1.10 All other standards as specified.

5.2 *Packaging Requirements*—Glass packaging and protection will be standard manufacturer practice unless otherwise specified. Consult manufacturer before specifying.

6. Other Requirements

- 6.1 Annealed glass lites shall conform to the requirements of Specification C1036 for the incorporated glass type.
- 6.2 Chemically strengthened glass lites shall conform to the requirements of Specification C1422.
- 6.3 Heat strengthened or fully tempered glass lites shall conform to the requirements of Specification C1048.
- 6.4 Mirror glass lites shall conform to the requirements of Specification C1503.
- 6.5 Pyrolytic and vacuum deposition coated glass lites shall conform to the requirements of Specification C1376.
- 6.6 Solar and optical properties to be as specified.
- 6.7 Solar heat gain coefficient to be as specified.
- 6.8 Sound transmission to be as specified in accordance with Classifications E413 or E1332.

6.9 Spandrel glass lites shall conform to the requirements of Specification C1048 for the incorporated glass type.

- 6.10 Visible reflection to be as specified.
- 6.11 Visible transmittance to be as specified.
- 6.12 U-factor to be as specified.
- 6.13 UV transmittance to be as specified.

7. Test Methods

7.1 *Impact Test for Safety Glazing*—Test and interpret in accordance with ANSI Z97.1 or CPSC 16CFR1201, or both, as applicable.

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

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

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

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

7.6 *Test for Bullet Resisting Glazing*—Test and interpret in accordance with specified standards such as Test Method F1233, NIJ 0108.1, and Standard UL 752.

7.7 *Test for Burglary Resisting Glazing*—Test and interpret in accordance with specified standards such as, but not limited to: Test Method F1233, NIJ 0108.1, and UL 972.

7.8 *Test for Impact Performance*—Test and interpret in accordance with Specifications E2395 and F3006, and Test Method F3007.

7.9 Color to be measured in accordance with Practice E308 using Illuminant C or D65.

7.10 *Overall Bow*—Place sample glass in a free-standing 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 gage. A dial indicator may also be used.

7.11 *Size*—Measure length and width from edge to edge, including flares, mismatch, or offset (see 8.5).

7.12 *Visual Inspection*—All visual inspections shall be made with 20/20 vision (normal or corrected eye). The viewer shall look at the sample at an angle of 90° (perpendicular) to the surface using the following lighting unless otherwise specified: daylight (without direct sunlight) or other uniform diffused background lighting that simulates daylight, with a minimum luminance of 160 fc (1700 lx) measured at the surface of the glass facing the light source.

7.12.1 *Laminated Proximate Glazing*—Inspect glazing in the vertical position at a distance of 39 in. (1 m). If a blemish is readily apparent under these viewing conditions, refer to Table 1 for acceptable criteria.