Designation: ~~C1464 – 16~~ C1464 – 21

Standard Specification for Bent Glass[1]

This standard is issued under the fixed designation C1464; 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 requirements for bent glass used in general building construction, furniture, display, and various other non-automotive applications.

1.2 The ~~dimensional values,~~ values stated in SI units are to be regarded as ~~the~~ standard. The values given in parentheses after SI units are provided for information ~~only.~~only and are not considered standard.

1.3 The following safety hazards caveat pertains only to the test method portion, Section ~~7~~8, 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~~ safety, health, and ~~health~~environmental practices and determine the applicability of regulatory limitations prior to use.*

1.4 *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]

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~~C1422/C1422M Specification for Chemically Strengthened Flat Glass

2.2 *ANSI ~~Standard~~Standard:*[3]

~~ANSI Z 97.1~~ANSI-Z97.1 Safety Glazing Materials Used in ~~Buildings—Safety~~ Buildings - Safety Performance Specifications and Methods of Test

2.3 *Federal ~~Document:~~Standard:*[4]

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

3. Terminology

3.1 *Definitions:*

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[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 ~~May 1, 2016~~Sept. 1, 2021. Published ~~June 2016~~November 2021. Originally approved in 2000. Last previous edition approved in ~~2006~~2016 as ~~C1464 – 06 (2011).~~C1464 – 16. DOI: ~~10.1520/C1464-16.~~10.1520/C1464-21.

[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.

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

[4] Available from ~~the Superintendent of Documents,~~ U.S. Government Printing Office, ~~Washington, DC 20402.~~Superintendent of Documents, 732 N. Capitol St., NW, Washington, DC 20401-0001, http://www.access.gpo.gov.

3.1.1 Refer to Terminology C162, Specifications C1036, ~~C1422~~C1422/C1422M, C1376, and C1172, as appropriate.

3.1.2 ~~*Blemishes*~~*blemishes in* ~~*Flat Glass—*~~*flat glass—*~~Refer~~refer to Specifications C1036, C1048, ~~C1422~~C1422/C1422M, C1376, and C1172, as appropriate.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *arc*—see *girth*.

3.2.2 *bend axis*—the imaginary pivot point around which a radius sweeps, and which may be extended along a line, to further describe how a surface is being shaped.

3.2.3 *bend profile*—a profile of the curvature taken at a cross section of the shape perpendicular to the bend axis.

3.2.4 *bent glass*—flat glass that has been shaped while hot into a body having curved surfaces.

3.2.5 *chord*—a straight line segment that joins two points of an arc.

3.2.6 *complex bend*—a profile shape composed of curvature not easily defined by multiple radii that can result in a bent shape on one or more axis, typically defined by model or ~~mold.~~mold; see Fig. 1.

3.2.7 *compound bend*—a profile shape composed of curvature of more than one ~~radii,~~radius, curved on two or more axes.

3.2.8 *concave surface*—the curved major surface closest to an imaginary center point of a circle.

3.2.9 *convex surface*—the curved major surface farthest away from an imaginary center point of a circle.

3.2.10 *craze*—the splitting or bunching of a coating resulting from pivot of the major glass surfaces about the centerline as the glass is bent, and which is a function of the properties of the coating, thickness of glass, and the tightness of curvature.

3.2.11 *crossbend*—deviation from a straight edge along a line perpendicular to the curvature measured on the concave side.

3.2.12 *cylindrical bend*—a profile shape composed of a single curvature with a constant radius and no straight sections, all curved on a single axis.

3.2.13 *degree of angle*—the angular measurement of a segment of a curve.

3.2.14 *depth*—on a circular bend, the distance from the midpoint of a chord to the arc measured along its radius perpendicular to the circumference.

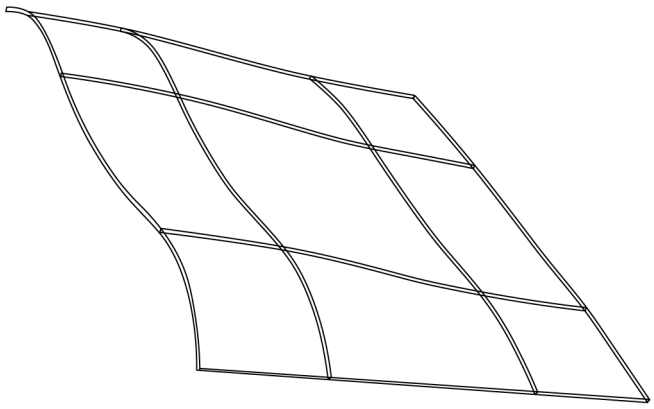

FIG. 61 Complex Bend

3.2.15 *elliptical bend*—a curved profile shape composed of two or more tangential radii on a single axis.

3.2.16 *girth*—the distance around the concave or convex surface measured perpendicular to the height including any flats.

3.2.17 *height*—the length measurement of the edge perpendicular to the horizontal arc or girth.

3.2.18 *multiple bend*—a profile shape composed of a curvature of two or more radii, all curved on a single axis, with at least two of the curvatures possibly separated by a flat (plane) area, and with or without one or more additional flat (plane) areas tangent to the curvatures.

3.2.19 *pock marks*—process surface ~~blemishs~~blemishes that consist of small, shallow areas, circular in shape, on the surface of the glass.

3.2.20 *ring marks*—process surface ~~blemishs~~blemishes that consist of shallow marks typically running along the perimeter of the glass surface.

3.2.21 *rotation*—a condition where vertical edges (perpendicular to arc) are not parallel to bending axis.

3.2.22 *serpentine bend*—profile shape composed of concave and convex curvatures of one or more radii on a single axis with or without flat areas tangent to the curvatures.

3.2.23 *shape*—contoured form including curvature, arc(s), and even flats.

3.2.24 *single bend*—a profile composed of a single radius curved on a single axis, possibly with one or two flat (plane) areas tangent to the curvature.

3.2.25 *spherical*—a profile shape composed of curvature of one radius, curved on more than two axes.

3.2.26 *twist*—one or more of the corners of the glass are not in the same plane.

4. Classification

4.1 *Kinds*—Bent glass furnished under this specification shall be of the following kinds, as ~~specified:~~specified (see Note 1):

NOTE 1—Not all configurations or combinations are possible. Consult with the fabricator or manufacturer before specifying.

4.1.1 *Kind BA*—Bent glass shall be annealed flat glass, either transparent, patterned, coated, or wired glass in accordance with the applicable requirements of Specification C1036, C1048, or C1376 as further processed to conform with the requirements hereinafter specified for bent glass.

4.1.2 *Kind BCS*—Chemically strengthened bent glass shall be flat glass, either transparent or patterned, in accordance with the applicable requirements of Specification C1036, as further processed to conform with the requirements hereinafter specified for bent glass and then in accordance with the applicable requirements of Specification ~~C1422~~C1422/C1422M for chemically strengthened flat glass.

4.1.3 *Kind BFT*—Fully tempered bent glass shall be flat glass, either transparent coated or patterned, in accordance with the applicable requirements of Specification C1036, and C1376 if applicable, as further processed to conform with the requirements hereinafter specified for bent glass and then in accordance with the applicable requirements of Specification C1048 for fully tempered glass.

4.1.4 *Kind BHS*—Heat-strengthened bent glass shall be flat glass, either transparent coated or patterned, in accordance with the applicable requirements of Specification C1036, and C1376 if applicable, as further processed to conform with the requirements hereinafter specified for bent glass and then in accordance with the applicable requirements of Specification C1048 for heat-strengthened glass.

4.1.5 *Kind BL*—Laminated bent glass shall be flat glass, either transparent coated or patterned, in accordance with the applicable requirements of Specification C1036, and C1376 if applicable, as further processed with the requirements hereinafter specified for bent glass and then in accordance with the applicable requirements of Specification C1172 for laminated glass.

4.1.6 *Kind BX*—Bent glass with miscellaneous combinations not previously combined.

~~NOTE 1—Not all configurations or combinations are possible. Consult with the fabricator or manufacturer before specifying.~~

5. Significance and Use

5.1 The user may have quality and/or fabrication requirements that are different than those of the standard. It is important to discuss these requirements with the fabricator prior to ordering the glass.

5.2 Tolerances for one-of-a-kind, low volume bent glass versus high production bent glass products may be different. Glazing conditions will affect these tolerances, such as free standing and glued in place applications. The cumulative effect of tolerances on the glass and system shall be considered.

5.3 Optical quality depends on the glass type. Overall thickness, tightness of radius can influence visual appearance. Single axis bends compared to compound or complex shapes with or without tangential flats will introduce the risk of distortion, which becomes compounded when laminated or combined into insulating glass units.

6. Ordering Information

NOTE 2—The user shall discuss quality requirements that fall outside of this standard with the fabricator prior to ordering.

6.1 Purchasers should include the following information in procurement documents:

6.1.1 Title, number, and date of this specification.

6.1.2 Kind of bent glass as referred to in this specification (see Section 4).

6.1.3 Fabrication requirements (see Section ~~6~~7).

6.1.4 *Thickness Requirements:*

6.1.4.1 Overall thickness designation.

6.1.4.2 Thickness of individual lites in the laminate.

6.1.4.3 Interlayer type and thickness.

6.1.5 Interlayer type and ~~color~~color.

6.1.6 Nominal height, width, radius (see definitions and Figs. 1-~~6~~6).

6.1.6.1 Black-line or blue-line prints, drawing, template, configuration, specification, or other forms of information which detail glass type, overall size, type of bend, and ~~orientation~~orientation.

~~5.1.7 Safety standards or regulations to which the glass must conform, be labeled, or both.~~

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

6.1.8 Products specifying coated glass should consult with the coating manufacturer for coating orientation requirements.

6.2 *Marking:*

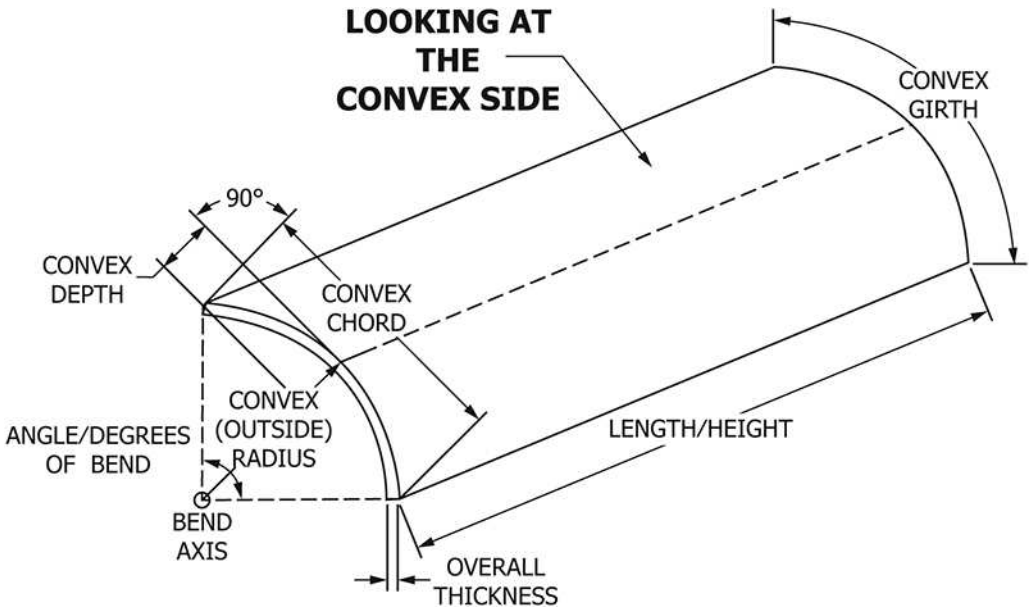

FIG. ~~1~~2 Cylindrical Bend

~~*A* = outside radius,~~
~~*B* = chord,~~
~~*C* = height,~~
~~*D* = girth, and~~
~~*E* = depth.~~

6.2.1 Each bent glass product, as supplied by the manufacturer, shall bear the manufacturer's name, or trademark, or both, unless otherwise specified.

6.2.2 Bent glass intended for safety glazing applications specified by building codes, shall be permanently marked as required by the applicable safety glazing standard.

7. Fabrication Requirements

7.1 Cutting to overall dimensions, edgework, drilled holes, notching, grinding, sandblasting, and etching are permissible.

7.1.1 When the glass is specified as chemically strengthened, heat-strengthened, or fully tempered, the fabrication processes in ~~6.1~~7.1 must be completed prior to the strengthening process.

7.2 Glass intended for safety glazing applications as specified by the purchaser, federal regulation or building codes shall be marked or labeled in accordance with the applicable safety glazing standard.

7.3 *Thickness Tolerances*—Thickness shall be in accordance with the thickness requirements of Specifications C1036 and C1172.

7.4 *Dimensional Tolerances:*

7.4.1 Height shall not exceed the deviations shown in Table 1.

7.4.2 Shape ~~Accuracy~~accuracy and ~~Crossbend~~cross-bend shall not exceed the tolerances shown in Table 2.

7.4.3 Twist shall not exceed the tolerances shown in Table 3.

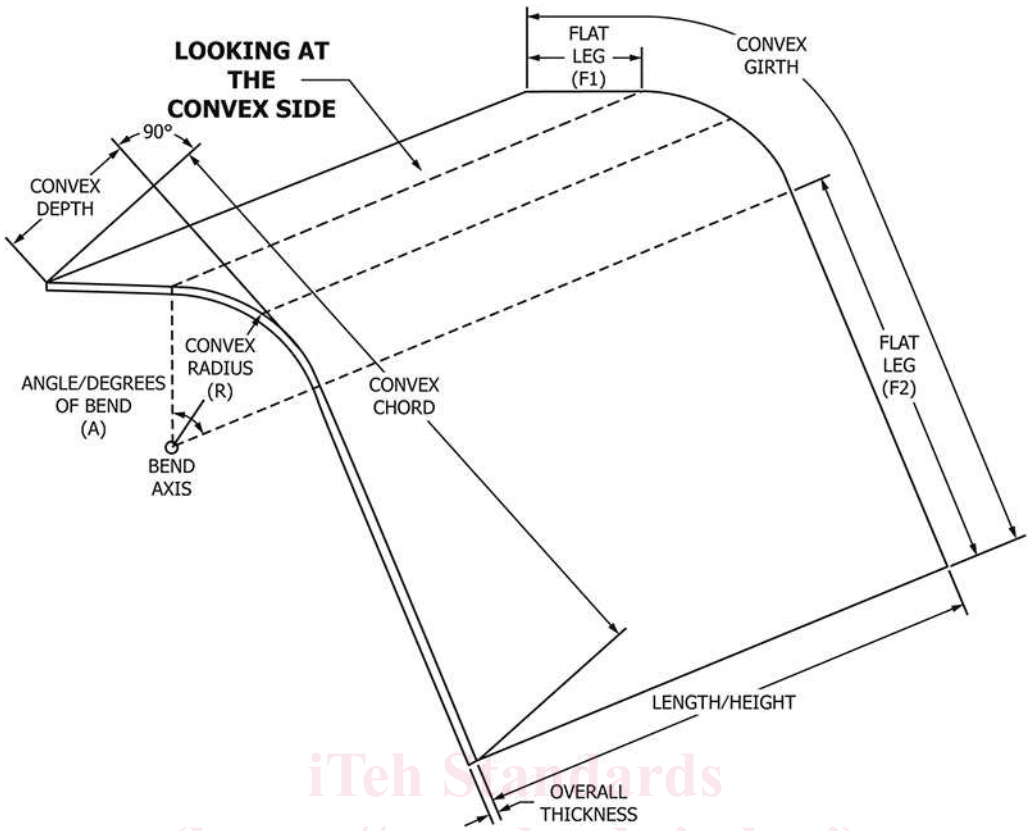

FIG. 23 Single Bend

~~*F1* = straight leg dimension,~~
~~*F2* = straight leg dimension,~~
~~*A* = degree of angle,~~
~~*R* = radius of curve, and~~
~~*L* = length.~~

7.5 *Blemishes*—For blemishes, refer to Specifications C1036 for annealed glass, C1172 for laminated glass, and C1376 for coated glass.

7.5.1 Pock marks shall not exceed 1.6 mm (1⁄16 in.) in the central portion of the glass and 2.4 mm (3⁄32 in.) in the outer area (see 8.4).

7.5.2 ~~Pock~~Ring marks shall not exceed 1.6 mm (1⁄16 ~~in.)~~ in.) in the central portion of the glass and 2.4 mm (3⁄32 ~~in.)~~ in.) in the outer area (see~~7.3.4~~8.4). See Note 3 and Note 4.

NOTE 3—The central area is considered to form an oval or circle centered on the lite whose axes or diameters do not exceed 80 % of the overall dimension. The remaining area is considered the outer area.

NOTE 4—Separated by at least 305 mm (12 in.).

~~6.5.2 Ring marks shall not exceed 1.6 mm (1⁄16 in.) in the central portion of the glass and 2.4 mm (3⁄32 in.) in the outer area (see 7.3.4). See Note 2 and Note 3.~~

7.6 *Distortion*—~~This standard~~Design professionals should discuss options with the fabricator to minimize perceived distortions prior to specifying. The observation of full-scale mock-ups viewed as similar to the final installed conditions is highly

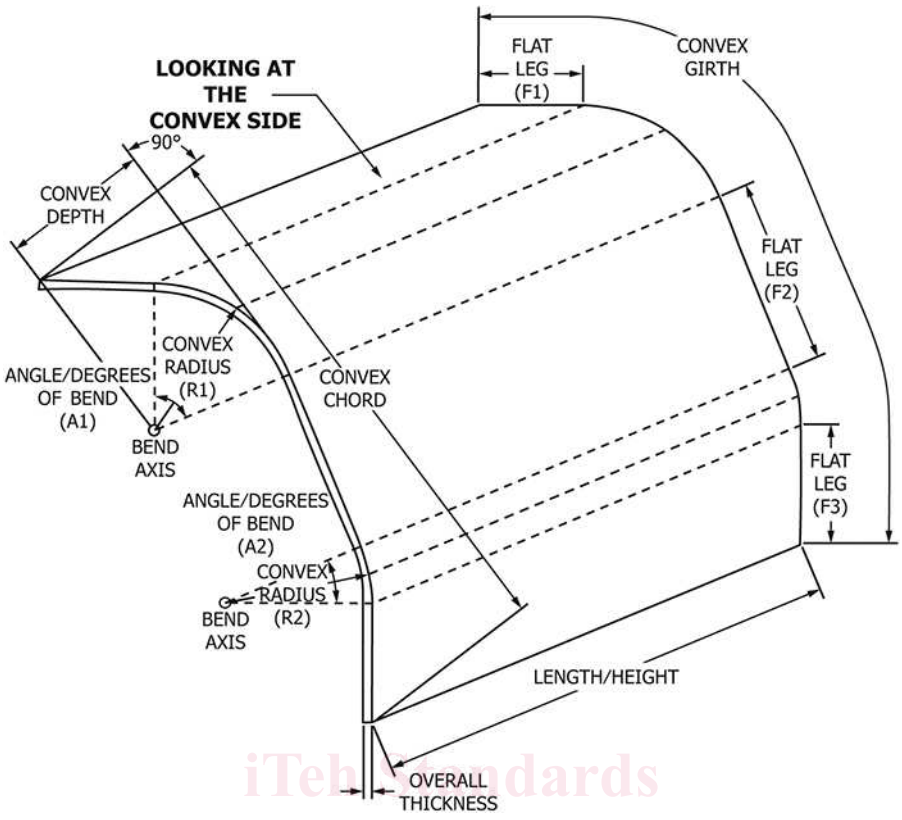

FIG. 34 Multiple Bend

~~*F1, F2, F3* = straight leg dimensions,~~
~~*A1, A2* = curve angles,~~
~~*R1, R2* = curve radii, and~~
~~*L* = length.~~

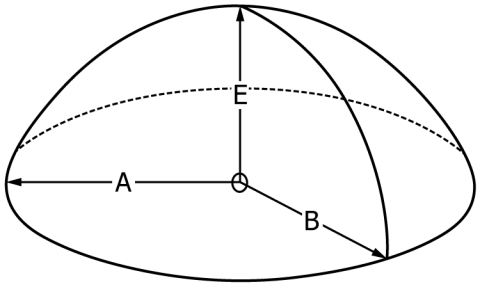

FIG. 45 Spherical (A, B and E are equal)

A = outside radius,
B = secondary radius, and
E = depth.

recommended. This specification addresses flat glass that is hot formed by ~~mechanical~~ automated, mechanical, or gravity actions at temperatures exceeding the softening point of glass to induce a permanent shape. The original flatness and surface quality will be altered in ~~the forming process where the~~ all heat-forming process. The softened glass stretches ~~and or contacts the~~ or deforms