Designation: ~~C1036 – 16~~ C1036 – 21

Standard Specification for Flat Glass[1]

This standard is issued under the fixed designation C1036; 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.

This standard has been approved for use by agencies of the U.S. Department of Defense.

1. Scope

1.1 This specification covers the requirements for annealed, monolithic flat soda-lime glass supplied as cut sizes or stock sheets.

1.2 This specification is focused upon the quality of flat glass as produced. The specification is applicable for laboratory and field evaluation only to the extent that such evaluation can be carried out in accordance with the test method(s) prescribed herein.

1.3 This specification covers the quality requirements of flat, transparent, clear, low-iron, and tinted glass. This glass is intended to be used primarily for architectural glazing products ~~including:~~ such as coated glass, insulating glass units, laminated glass, mirrors, ~~spandrel glass, or similar uses.~~and spandrel glass.

NOTE 1—Reflective distortion is not addressed in this specification.

1.4 This specification covers the quality requirements of patterned or wired glasses intended to be used primarily for decorative and general glazing applications.

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

1.6 *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.*

1.7 *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:~~Standard:*[2]

C162 Terminology of Glass and Glass Products

2.2 *NFRC Standard:*[3]

NFRC 300 Test Method for Determining the Solar Optical Properties of Glazing Materials and Systems

[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.

[3] Available from National Fenestration Rating ~~Council, 84884 Georgia Ave., Suite 320, Silver Spring, MD 20910.~~Council (NFRC), 6305 Ivy Ln., Suite 140, Greenbelt, MD 20770, http://www.nfrc.org.

3. Terminology

~~3.1 *Definitions*—For additional definitions of terms, refer to Terminology C162.~~

3.1 *Definitions:*

3.1.1 For additional definitions of terms, refer to Terminology C162.

3.2 *Definitions of ~~Terms Specific to This Standard:~~Key Terms:*

3.2.1 *associated distortion, n*—alteration of viewed images caused by variations in glass flatness or inhomogeneous portions within the glass.

3.2.2 *bevel, n*—angled surface at the edge of a lite of glass.

3.2.3 *blemish, n*—imperfection in the body or on the surface of the glass; for the purpose of this specification, blemishes are divided into two ~~categories:~~categories; blemishes not specifically mentioned shall each be compared to the blemish that they most closely resemble.

3.2.3.1 *linear blemish, n*—scratches, rubs, digs, and other similar imperfections, which may be straight or curved in ~~nature. If~~nature; if curved, the length of such a blemish is to be measured from end to end along the curve.

3.2.3.2 *point blemish, n*—crush, knots, dirt, stones, gaseous inclusions, tin drip, and other similar imperfections.

3.2.4 *bow, n*—~~a condition in which~~ the deviation in flatness of a lite of ~~flat glass departs from a true plane.~~glass, expressed over the entire width or length dimension of the lite or over a smaller, local span.

3.2.5 *chip, n*—indentation in the glass edge as a result of breakage of a small fragment; chips fall into two categories:

3.2.5.1 *shell chip, n*—any chip other than a v-chip.

3.2.5.2 *v-chip, n*—a chip forming an acute angle, located at the edge(s) of a glass lite and which may cause a crack in the glass.

3.2.6 *chip depth, n*—measured distance of a chip from the ~~face of the glass~~ glass surface into the thickness.

3.2.7 *chip ~~length~~ , length, n*—maximum distance parallel to the edge of the glass from one edge of a chip to the other.

3.2.8 *chip width, n*—maximum perpendicular distance from the edge of the glass to the inner edge of the ~~chip.~~chip, as measured on the glass surface.

3.2.9 *clear glass, n*—glass formulated to have transmittance in the visible spectrum greater than 82 % (reference to NFRC 300 measurement method) at a standard thickness of 6 mm (¼ in.) with lack of color as compared to tinted glass of the same thickness.

3.2.10 *crush, n*—pitted condition with a dull appearance.

3.2.11 *cut size, n*—glass ordered cut to its final intended size.

3.2.12 *dig, n*—a deep scratch in the glass surface.

3.2.13 *dirt, n*—small particle of foreign matter embedded in the surface of flat glass.

3.2.14 *fire crack, n*—small, sometimes microscopic fissure in the edge of wired or patterned glass.

3.2.15 *flare, n*—protrusion on the glass edge or corner of an otherwise rectangular surface.

3.2.16 *gaseous inclusion, n*—round or elongated bubble in the glass.

3.2.17 *knot, n*—inhomogeneity in the form of a vitreous lump.

~~3.2.17 *line, n*—fine cords or string, usually on the surface of flat glass.~~

3.2.18 ~~*low iron*~~ *low-iron glass, n*—glass formulated to have transmittance in the visible spectrum higher than that of clear glass of the same ~~thickness.~~thickness; edge color can vary, so the glass manufacturer should be consulted regarding an application where edge color is an aesthetic consideration.

3.2.19 *patterned glass, n*—rolled flat glass having a pattern on one or both surfaces.

3.2.20 *ream, n*—linear distortion as a result of non-homogeneous layers of flat glass.

3.2.21 *rub, n*—abrasion of a glass surface producing a frosted appearance.

3.2.22 *scratch, n*—an abrasion of a glass surface in the form of a curved line, a straight line, or both.

~~3.2.23 *shell chip, n*—circular indentation in the glass edge as a result of breakage of a small fragment.~~

3.2.23 *stock sheets, n*—glass ordered in sizes intended to be cut to create final or cut size (that is, uncuts, intermediates, jumbos, and lehr ends).

3.2.24 *stone, n*—crystalline inclusion in glass.

3.2.25 *string, n*—straight line or curled ~~line, usually~~ blemish, usually on the surface, often resulting from slow ~~solution~~melting of a large grain of sand or foreign material.

3.2.26 *tin drip, n*—droplet of oxidized tin that falls onto, and bonds to, the top surface of float glass within the tin bath.

3.2.27 *tinted glass, n*—glass formulated to have a uniform color throughout the glass, often with the purpose of reducing ~~glare (visible transmittance),~~ one or more of the following: glare, solar heat gain, or ~~visible/ultraviolet~~ultraviolet (UV) transmittance.

~~3.2.28 *v-chip, n*—v-shaped imperfection in the edge of the glass lite.~~

3.2.28 *vision interference angle, n*—viewing angle at which distortion in transmission first appears (see 6.1.2~~Fig. 2).~~).

3.2.29 *wired glass, n*—flat glass with a layer of wire mesh embedded in the glass.

4. Classification and Intended Use

NOTE 2—When referencing this specification, the user ~~shall~~should indicate the title and ~~date~~edition of the specification, and the type, class, quality (including cut-size or stock sheets), size, and thickness of the ~~glass.~~glass as appropriate.

4.1 *Types, Classes, Qualities, Forms, ~~Qualities,~~ Finishes, Meshes, and ~~Finishes—~~Patterns*—Glass shall be of the following types, classes, qualities, forms, ~~qualities,~~ finishes, meshes, and ~~finishes,~~patterns as specified:

4.1.1 *Type I—Transparent Flat Glass: Class ~~1—Clear,~~ 1—Clear and Low-iron, or Class 2—Tinted:*

~~**TABLE 1 Type I, Class 1 and 2 Quality and Use**~~

~~Quality~~	~~Typical Use~~
~~Quality Q1 (cut-size or stock sheets)[A]~~	~~Production of high-quality mirrors.~~
~~Quality Q2 (cut-size or stock sheets)~~	~~Production of general use mirrors and other applications.~~
~~Quality Q3 (cut-size or stock sheets)~~	~~Production of architectural glass products including coated, heat treated, laminated, and other select glass products.~~
~~Quality Q4 (cut-size or stock sheets)~~	~~General glazing applications.~~

~~[A] For Class 2 Tinted, there is no Quality Q1 available~~

See Table 1.

4.1.2 *Type ~~I—Patterned~~II—Wired and ~~Wired~~Patterned Flat Glass Class ~~1—Clear,~~ 1—Clear and Low-iron, or Class 2—Tinted:*

~~**TABLE 2 Type II, Class 1 and 2 Quality and Use**~~

~~Quality~~	~~Typical Use~~
~~Quality Q5~~	~~Applications in which design and aesthetic characteristics are major considerations.~~
~~Quality Q6~~	~~Applications in which functional characteristics are a consideration and blemishes are not a major concern.~~
~~Form~~	~~Description~~
~~Form 1~~	~~Wired glass, polished both sides~~
~~Form 2~~	~~Wired glass, patterned surfaces~~
~~Form 3~~	~~Patterned glass~~
~~Finish~~	~~Description~~
~~Finish 1 (F1)~~	~~Patterned one side~~
~~Finish 2 (F2)~~	~~Patterned both sides~~
~~Mesh~~	~~Description~~
~~Mesh 1 (M1)~~	~~Diamond~~
~~Mesh 2 (M2)~~	~~Square~~
~~Mesh 3 (M3)~~	~~Parallel strand~~
~~Mesh 4 (M4)~~	~~Special~~
~~Pattern~~	~~Description~~
~~Pattern 1 (P1)~~	~~Linear~~

TABLE 1 Type I, Class 1 and 2 Quality and Use

Quality	Typical Use
Quality-Q1 (cut-size or stock sheets)	Production of high-quality mirrors.
Quality-Q2 (cut-size or stock sheets)	Production of general use mirrors and other applications.
Quality-Q3 (cut-size or stock sheets)	Production of architectural glass products including coated, heat treated, laminated, and other select glass products.
Quality-Q4 (cut-size or stock sheets)	General glazing applications.

~~TABLE 2 Continued~~

~~Quality~~	~~Typical Use~~
~~Pattern 2 (P2)~~	~~Geometric~~
~~Pattern 3 (P3)~~	~~Random~~
~~Pattern 4 (P4)~~	~~Special~~

See Table 2.

5. Requirements

5.1 *Requirements for Type I (Transparent Flat Glass):*

5.1.1 *Edge Requirements*—Edges of glass shall be supplied as ~~specified:~~specified. Chips on the glass edges shall be viewed at close proximity (12 in.) without magnification, using localized lighting.

NOTE 3—Glass edges are typically supplied as factory cut. Optional edge work can be specified as seamed, ground, polished, beveled, mitered, or other, as arranged with the manufacturer. ~~See manufacturer's literature for more information.~~

5.1.1.1 *Shell Chips*—Shell chips are permitted within the requirements shown in Table 3, as long as there are no associated cracks, detectable without magnification, as viewed from the edge.

5.1.1.2 ~~*V-Chips*—~~*V-chips*—Visible V-chips are not permitted. ~~(See 6.1.1 for viewing criteria.)~~

5.1.2 *Dimensional Tolerances*—Tolerances for length, width, squareness, and thickness for rectangular shapes shall be in accordance with Table 4. Nonrectangular shapes shall use the same thickness tolerances in Table 4. For linear ~~straight line~~ dimensions of nonrectangular shapes, the length and width requirements in Table 4 shall be used. For curvilinear dimensions of nonrectangular shapes, tolerances shall be as agreed upon by the involved parties.

TABLE 2 Type II, Class 1 and 2 Quality and Use

Quality	Typical Use
Quality-Q5	Applications in which design and aesthetic characteristics are major considerations.
Quality-Q6	Applications in which functional characteristics are a consideration and blemishes are not a major concern.
Form	**Description**
Form 1	Wired glass, polished both sides
Form 2	Wired glass, patterned surfaces
Form 3	Patterned glass
Finish	**Description**
Finish 1 (F1)	Patterned one side
Finish 2 (F2)	Patterned both sides
Mesh	**Description**
Mesh 1 (M1)	Diamond
Mesh 2 (M2)	Square
Mesh 3 (M3)	Parallel strand
Mesh 4 (M4)	Special
Pattern	**Description**
Pattern 1 (P1)	Linear
Pattern 2 (P2)	Geometric
Pattern 3 (P3)	Random

TABLE 3 Allowable Shell Chip Size and Distribution for Cut Size and Stock Sheet Qualities of Type 1—Transparent Flat Glass

Description	Q1	Q2	Q3	Q4
Chip depth	Chip depth ≤ 25 % of glass thickness	Chip depth ≤ 50 % of glass thickness	Chip depth ≤ 50 % of glass thickness	Chip depth ≤ 50 % of glass thickness
Chip width[A]	Chip width ≤ 25 % of glass thickness or 1.6 mm (1/16 in.) whichever is greater	Chip width ≤ 50 % of glass thickness or 1.6 mm (1/16 in.) whichever is greater	Chip width ≤ glass thickness or 6 mm (1/4 in.) whichever is greater	Not limited
Chip length[A]	Chip length ≤ 2 times the chip width[B]	Chip length ≤ 2 times the chip width[B]	Chip length ≤ 2 times the chip width[B]	Not limited

[A] For stock sheets, there is no limit for chip width and length.
[B] For a chip located at the corner of a cut size, the chip length shall not exceed the allowable chip width.

TABLE 4 Dimensional Tolerances for Rectangular Shapes of Type 1—Transparent Flat Glass

Nominal Designation		Thickness Range				Length and Width Tolerance[A]				Squareness (D1–D2)			
SI Designation, mm[B]	Traditional Designation	mm		in.		Cut Size		Stock Sheet		Cut Size		Stock Sheet	
		min	max	min	max	± mm	(± in.)	± mm	(± in.)	mm	(in.)	mm	(in.)
1.0	micro-slide	0.79	1.24	0.031	0.049	1.6	(1/16)	6.4	(1/4)	2.0	(5/64)	3.0	(1/8)
1.5	photo	1.27	1.78	0.05	0.07	1.6	(1/16)	6.4	(1/4)	2.0	(5/64)	3.0	(1/8)
2	picture	1.80	2.13	0.071	0.084	1.6	(1/16)	6.4	(1/4)	2.0	(5/64)	3.0	(1/8)
2.5	single	2.16	2.57	0.085	0.101	1.6	(1/16)	6.4	(1/4)	2.0	(5/64)	3.0	(1/8)
2.7	lami	2.59	2.90	0.102	0.114	1.6	(1/16)	6.4	(1/4)	2.0	(5/64)	3.0	(1/8)
3[C]	double, 1/8 in.	2.92	3.40	0.115	0.134	1.6	(1/16)	6.4	(1/4)	2.0	(5/64)	3.0	(1/8)
4	5/32 in.	3.78	4.19	0.149	0.165	1.6	(1/16)	6.4	(1/4)	2.0	(5/64)	3.0	(1/8)
5	3/16 in.	4.57	5.05	0.18	0.199	1.6	(1/16)	6.4	(1/4)	2.0	(5/64)	3.0	(1/8)
6	1/4 in.	5.56	6.20	0.219	0.244	1.6	(1/16)	6.4	(1/4)	2.0	(5/64)	3.0	(1/8)
8	5/16 in.	7.42	8.43	0.292	0.332	2.0	(5/64)	6.4	(1/4)	2.8	(7/64)	6.0	(1/4)
10	3/8 in.	9.02	10.31	0.355	0.406	2.4	(3/32)	6.4	(1/4)	3.4	(1/8)	6.0	(1/4)
12	1/2 in.	11.91	13.49	0.469	0.531	3.2	(1/8)	6.4	(1/4)	4.5	(11/64)	10.0	(3/8)
16	5/8 in.	15.09	16.66	0.595	0.656	4.0	(5/32)	6.4	(1/4)	5.7	(7/32)	12.0	(1/2)
19	3/4 in.	18.26	19.84	0.719	0.781	4.8	(3/16)	6.4	(1/4)	6.8	(1/4)	14.0	(9/16)
22	7/8 in.	21.44	23.01	0.844	0.906	5.6	(7/32)	6.4	(1/4)	7.9	(19/64)	16.0	(5/8)
25	1 in.	24.61	26.19	0.969	1.031	6.4	(1/4)	6.4	(1/4)	9.0	(11/32)	18.0	(3/4)

[A] Length and width of cut size and stock sheets of flat glass include flares and bevels.
[B] These designations apply only to ASTM International and may not reflect other international standards.
[C] Within the ~~3.0~~ 3 mm designation there are some applications that may require different thickness ranges such as DST. (Typical minimum thickness for DST is 0.120 in.)

5.1.3 *Blemishes*—Allowable blemishes are addressed in Section 6 and in Tables 5-7.

NOTE 4—In addition to the point blemishes allowed in accordance with Table 5, rejectable point blemishes are allowed in Stock Sheets up to the limits shown in Table 6.

5.1.4 *Uniformity*—For glass with a thickness of 6 mm (1/4 ~~in.)~~ in.) or less, the glass shall not vary in thickness more than 0.1 mm (0.004 in.) over a 100 mm (4 in.) length.

5.1.5 *Distortion*—Reams, strings, ~~lines,~~ and other allowable distortion (in transmission) are addressed in Section 6 and Table 8.

5.1.6 *Squareness*—The squareness requirements ~~for cut glass~~ are shown in 6.1.4 and Table 4.

TABLE 5 Allowable Point Blemish Size and Distribution For Cut Size Qualities[A]

Blemish Size mm (in.)[B,C,D]	Q1 Quality 1	Q2 Quality 2	Q3 Quality 3	Q4 Quality 4
< 0.50 (0.02)	Allowed[E]	Allowed[E]	Allowed	Allowed
≥ 0.50 < 0.80 ≥ (0.02) < (0.03)	Allowed with a minimum separation of 1500 mm (60 in.)[F]	Allowed with a minimum separation of 600 mm (24 in.)[F]	Allowed	Allowed
≥ 0.80 < 1.20 ≥ (0.03) < (0.05)	None allowed	Allowed with a minimum separation of 1200 mm (48 in.)[F]	Allowed	Allowed
≥ 1.20 < 1.50 ≥ (0.05) < (0.06)	None allowed	Allowed with a minimum separation of 1500 mm (60 in.)[F]	Allowed with a minimum separation of 600 mm (24 in.)[F]	Allowed
≥ 1.50 < 2.00 ≥ (0.06) < (0.08)	None allowed	None allowed	Allowed with a minimum separation of 600 mm (24 in.)[F]	Allowed
≥ 2.00 < 2.50 ≥ (0.08) < (0.10)	None allowed	None allowed	None allowed	Allowed with a minimum separation of 600 mm (24 in.)[F]
≥ 2.5 ≥ (0.10)	None allowed	None allowed	None allowed	None allowed

[A] Table values are for ~~6.0~~6 mm (¼ in.) and less. For glass thicker than ~~6.0~~6 mm (¼ in.) and less than or equal to ~~12.0~~12 mm (½ in.), ~~they may contain~~ proportionally larger blemishes ~~for~~ are permitted but with the same minimum separation distances. (For example, a ~~12 mm~~ 12 mm Q3 sample with a blemish size of ≥ ~~3.0 < 4.0 mm, the allowable minimum separation would be 600 mm.)~~ 3 mm < 4 mm and minimum separation of 600 mm would be allowed.) Table 5 does not apply to glass thicker than ~~12.0~~12 mm (½ in.). Allowable blemishes for glass thicker than ~~12.0~~12 mm (½ in.) shall be determined by agreement between the buyer and the seller.
[B] See 6.1.1.1 for detection of point blemishes.
[C] See 6.1.1.2 for measurement of point blemishes.
[D] For Q1 and Q2 only, the blemish size includes associated distortion (see 6.1.1.2).
[E] Provided that normally allowable blemishes do not form a cluster that is detectable at 1800 mm (6 ft).
[F] See 6.1.1.4 for minimum blemish separation.

TABLE 6 Point Blemishes Allowed for Stock Sheets

~~Glass Area~~	~~Rejectable Point Blemishes Allowed per Sheet~~
Glass Area	Rejectable Point Blemishes Allowed per Sheet
If glass area < 7 m^2 (75 ft^2)	One rejectable point blemish
~~If glass area ≥ 7 m^2 (75 ft^2) but < 14 m^2 (150 ft^2)~~	~~Two rejectable point blemishes~~
If glass area ≥ 7 m^2 (75 ft^2), but < 14 m^2 (150 ft^2)	Two rejectable point blemishes
If glass area ≥ 14 m^2 (150 ft^2)	Three rejectable point blemishes

5.1.7 *Bow*—The deviation in flatness of a cut size and stock sheet shall be maximum 2.6 mm per linear meter of span length (0.031 in. per linear foot of span length). See Appendix X1.

5.2 *Requirements for Type II ~~(Patterned~~(Wired and ~~Wired~~Patterned Flat Glass):*

5.2.1 *Wired (Forms 1 and 2):*

5.2.1.1 *Form 1 (Polished Both Sides)*—Glass may contain waviness that does not interfere with vision normal to the surface.

5.2.1.2 *Form 1 ~~&~~and 2 (Patterned One or Both Sides)*—Glass shall not contain visible fire cracks.