



## Standard Specification for Flat Glass<sup>1</sup>

This standard is issued under the fixed designation C 1036; 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 approval. A superscript epsilon ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

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

### 1. Scope

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

1.2 This 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, and tinted glass. This glass is intended to be used primarily for architectural glazing products including: coated glass, insulating glass units, laminated glass, mirrors, spandrel glass, or similar uses.

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 in SI units are to be regarded as the standard. The values given in parentheses are for information only.

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 and health practices and determine the applicability of regulatory limitations prior to use.*

### 2. Referenced Documents

2.1 *ASTM Standards:*<sup>2</sup>

**C 162** Terminology of Glass and Glass Products

2.2 *NFRC Standard:*<sup>3</sup>

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

### 3. Terminology

3.1 *Definitions*—For additional definitions of terms, refer to Terminology **C 162**.

3.2 *Definitions of Terms Specific to This Standard:*

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:

3.2.3.1 *linear blemish, n*—scratches, rubs, digs, and other similar imperfections.

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

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

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

3.2.6 *chip width, n*—perpendicular distance from the edge of the glass to the inner edge of the chip.

3.2.7 *crush, n*—lightly pitted condition with a dull gray appearance.

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

3.2.9 *dig, n*—deep, short scratch.

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

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

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

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

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

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

<sup>1</sup> 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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<sup>2</sup> For referenced ASTM standards, visit the ASTM website, [www.astm.org](http://www.astm.org), or contact ASTM Customer Service at [service@astm.org](mailto:service@astm.org). For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

<sup>3</sup> National Fenestration Rating Council, 84884 Georgia Ave., Suite 320, Silver Spring, MD 20910.

**TABLE 1 Allowable Shell Chip Size and Distribution (Type I Glass) for Cut Size and Stock Sheet Qualities**

Description	Q1	Q2	Q3	Q4
Chip depth	Chip depth $\leq$ 25 % of glass thickness	Chip depth $\leq$ 50 % of glass thickness	Chip depth $\leq$ 50 % of glass thickness	Chip depth $\leq$ 50 % of glass thickness
Chip width <sup>A</sup>	Chip width $\leq$ 25 % of glass thickness or 1.6 mm ( $\frac{1}{16}$ in.) whichever is greater	Chip width $\leq$ 50% of glass thickness or 1.6 mm ( $\frac{1}{16}$ in.) whichever is greater	Chip width $\leq$ glass thickness or 6 mm ( $\frac{1}{4}$ in.) whichever is greater	Not limited
Chip length <sup>A</sup>	Chip length $\leq$ 2 times the chip width	Chip length $\leq$ 2 times the chip width	Chip length $\leq$ 2 times the chip width	Not limited

<sup>A</sup> Chip width and length are not applicable to stock sheets.

**TABLE 2 Dimensional Tolerance for Rectangular Shapes of Type 1 Transparent, Flat Glass<sup>A</sup>**

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

<sup>A</sup> Length and width of cut size and stock sheets of flat glass include flares and bevels.

<sup>B</sup> These designations apply only to ASTM International and may not reflect other international standards.

<sup>C</sup> Within the 3.0 designation there are some applications that may require different thickness ranges such as DST. (Typical minimum thickness for DST is 0.120 in.)

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

3.2.17 *ream*, *n*—linear distortion as a result of nonhomogeneous layers of flat glass.

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

3.2.19 *scratch*, *n*—damage on a glass surface in the form of a line caused by the movement of an object across and in contact with the glass surface.

3.2.20 *shell chip*, *n*—circular indentation in the glass edge as a result of breakage of a small fragment out of an otherwise regular surface.

3.2.21 *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).

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

3.2.23 *string*, *n*—straight or curled line, usually resulting from slow solution of a large grain of sand or foreign material.

3.2.24 *tinted glass*, *n*—glass formulated to have a uniform color throughout the glass, with the purpose of reducing glare, solar heat gain, or visible/ultraviolet (UV) transmittance.

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

**TABLE 3 Allowable Point Blemish Size and Distribution For Cut Size Qualities<sup>A</sup>**

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

<sup>A</sup> Table values are for 6.0 mm (¼ in.) and less. For glass thicker than 6.0 mm (¼ in.) and less than or equal to 12.0 mm (½ in.), they may contain proportionally larger blemishes for the same minimum separation distances. (For example, a 12-mm Q3 sample with a blemish size of ≥ 3.0 < 4.0 mm, the allowable minimum separation would be 600 mm.) **Table 3** does not apply to glass thicker than 12.0 mm (½ in.). Allowable blemishes for glass thicker than 12.0 mm (½ in.) shall be determined by agreement between the buyer and the seller.

<sup>B</sup> See 6.1.1.1 for detection of point blemishes.

<sup>C</sup> See 6.1.1.2 for measurement of point blemishes.

<sup>D</sup> For Q1 and Q2 only, the blemish size includes associated distortion (see 6.1.1.2).

<sup>E</sup> Provided that normally nondetectable blemishes do not form a cluster that is detectable at 1800 mm (6 ft).

<sup>F</sup> See 6.1.1.4 for minimum blemish separation.

**TABLE 4 Point Blemishes Allowed for Stock Sheets**

Glass Area	Point Blemishes Allowed
If glass area < 7 m <sup>2</sup> (75 ft <sup>2</sup> )	Allowable blemishes per <b>Table 3</b> PLUS one rejectable point blemish
If glass area ≥ 7 m <sup>2</sup> (75 ft <sup>2</sup> ) but < 14 m <sup>2</sup> (150 ft <sup>2</sup> )	Allowable blemishes per <b>Table 3</b> PLUS two rejectable point blemishes
If glass area ≥ 14 m <sup>2</sup> (150 ft <sup>2</sup> )	Allowable blemishes per <b>Table 3</b> PLUS three rejectable point blemishes

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 in- cluding coated, heat treated, laminated, and other select glass products.
Quality-Q4 (cut-size or stock sheets)	General glazing applications.

3.2.26 *vision interference angle, n*—angle at which distortion in transmission first appears (see **Fig. 1**).

3.2.27 *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 indicate the title and date of the specification and the type, class, quality (including cut-size or stock sheets), size, and thickness of the glass.

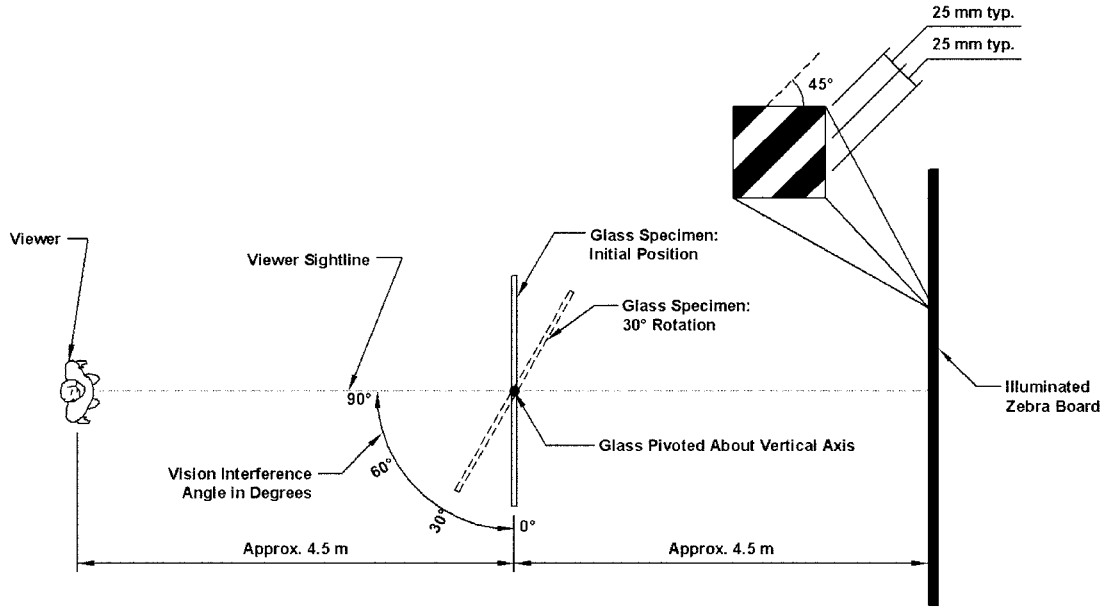
4.1 *Types, Classes, Forms, Qualities, and Finishes*—Glass shall be of the following types, classes, forms, qualities, and finishes, as specified:

4.1.1 *Type 1—Transparent Flat Glass:*

4.1.1.1 *Class 1—Clear:*

#### 4.1.1.2 *Class 2—Tinted:*

Quality	Typical Use
Quality-Q1	Not available.
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 in- cluding coated, heat treated, laminated, and other select glass products.
Quality-Q4 (cut-size or stock sheets)	General glazing applications.



**FIG. 1 Vision Interference Angle Procedure**

**TABLE 5 Allowable Linear Blemish Size and Distribution for Cut Size and Stock Sheet Qualities**

Linear Blemish Size <sup>A</sup> Intensity Length	Q1 Quality 1 Distribution	Q2 Quality 2 Distribution	Q3 Quality 3 Distribution	Q4 Quality 4 Distribution
Faint ≤ 75 mm (3 in.)	Allowed with a minimum separation of 1500 mm (60 in.)	Allowed with a minimum separation of 1200 mm (48 in.)	Allowed	Allowed
Faint > 75 mm (3 in.)	None allowed	None allowed	Allowed	Allowed
Light ≤ 75 mm (3 in.)	None allowed	Allowed with a minimum separation of 1200 mm (48 in.)	Allowed	Allowed
Light > 75 mm (3 in.)	None allowed	None allowed	Allowed	Allowed
Medium ≤ 75 mm (3 in.)	None allowed	None allowed	Allowed with a minimum separation of 600 mm (24 in.)	Allowed
Medium > 75 mm (3 in.)	None allowed	None allowed	None allowed	Allowed
Heavy ≤ 150 mm (6 in.)	None allowed	None allowed	None allowed	Allowed with a minimum separation of 600 mm (24 in.)
Heavy > 150 mm (6 in.)	None allowed	None allowed	None allowed	None allowed

<sup>A</sup> See 6.1.1.3 for detection of linear blemishes.

### 4.1.2 Type II—Patterned and Wired Flat Glass:

#### 4.1.2.1 Class 1—Clear

#### 4.1.2.2 Class 2—Tinted:

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
Pattern 4 (P4)	Special

## 5. Requirements

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

5.1.1 *Edge Requirements*—Edges of glass shall be supplied as specified.

NOTE 3—Edges may be supplied or specified, or both, as factory cut, seamed, ground, polished, beveled, mitered, and so forth. See manufacturers' literature for more information.

5.1.1.1 *Shell Chips*—Shell chips are permitted. (See [Table 1](#) for acceptance criteria.)

5.1.1.2 *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 2](#). Nonrectangular shapes shall use

the same thickness tolerances in [Table 2](#). For linear dimensions of nonrectangular shapes, the length and width requirements in [Table 2](#) shall be used. For nonlinear dimensions of nonrectangular shapes, tolerances shall be as agreed upon by the involved parties.

5.1.3 *Blemishes*—Allowable blemishes are addressed in [Section 6](#) and in [Tables 3-5](#).

5.1.4 *Uniformity*—For cut sizes of glass with a thickness of 6 mm (¼ 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 6](#).

5.1.6 *Squareness*—The squareness requirements for cut glass are shown in [6.1.4](#) and [Table 2](#).

5.2 *Requirements for Type II (Patterned and Wired 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 2 (Patterned One or Both Sides)*—Glass shall not contain fire cracks.

5.2.1.3 *Dimensional Tolerances*—Tolerance for length, width, and thickness shall be in accordance with [Table 7](#).

5.2.1.4 *Wire and Mesh*—Diameter of wires shall be from 0.43 to 0.64 mm (0.017 to 0.025 in.). Discoloration and slight distortion of wire are permissible. Wired glass may contain numerous gaseous inclusions along the wire.

(1) *Mesh M1*, diamond shall be welded. Opening in the mesh shall not exceed 32 mm (1¼ in.) between wire intersections measured across diagonal corners of the diamond.

(2) *Mesh M2*, square shall be welded. Opening in the mesh shall not exceed 16 mm (⅝ in.) between wire intersections measured along a side of the square.

(3) *Mesh M3*, parallel strand, spacing shall be as specified.

(4) *Mesh M4*, as specified.

#### 5.2.2 *Patterned (Form 3):*

5.2.2.1 *Dimensional Tolerances—Finishes F1 and F2, Patterns P1, P2, P3, and P4*—Tolerances for Patterns P1 and P2 for length, width, and thickness shall be in accordance with [Table 8](#). Check with the manufacturer for thickness and dimensional tolerances on random Pattern P3 and special Pattern P4.

5.2.2.2 *Blemishes*—Allowable blemishes are addressed in [Section 6](#) and in [Table 9](#).

5.2.2.3 Patterned glass shall not contain fire cracks.

#### 5.2.2.4 *Surface Pattern:*

(1) *Quality Q5*—Surface pattern shall be clear, sharp, defined, and free of obvious disfiguration that affects the appearance of the pattern.

(2) *Quality Q6*—Surface pattern shall be free of large areas of blemishes. Scattered areas of non-uniform surface and scattered surface blemishes are permissible.

NOTE 4—Patterned glass can vary slightly in both configuration and color from run to run.

**TABLE 6 Allowable Distortion (Type I Glass) for Cut Size and Stock Sheet Qualities<sup>A</sup>**

	Q1	Q2	Q3	Q4
Allowable Vision Interference Angle <sup>B</sup>	≥ 60°	≥ 50°	≥ 35°	≥ 25°

<sup>A</sup> [Table 6](#) does not apply to glass thicker than 6.0 mm (¼ in.). Allowable distortion for glass thicker than 6.0 mm (¼ in.) shall be determined by agreement between the buyer and the seller.

<sup>B</sup> See [6.1.2](#) (and [Fig. 1](#)) for determining the vision interference angle.

**TABLE 7 Thickness and Tolerance for Wired Glass<sup>A</sup>**

SI Designation mm	Traditional Designation in.	Thickness Range mm		Thickness Range in.		Length and Width Tolerance	
		min	max	min	max	± mm	(± in.)
6	¼	6.4	7.6	0.252	0.299	4.8	(¾/16)
10	⅜	8.76	10.03	0.303	0.390	4.8	(¾/16)

<sup>A</sup> While the designation in millimetres and inches (traditional designation) are the same as shown in Table 2, actual wire glass thickness is greater than nonwire glass.

**TABLE 8 Thickness and Tolerance for Patterned Glass**

Designation (mm)	Traditional Designation	Thickness Range mm		Thickness Range in.		Length and Width Tolerance	
		min	max	min	max	± mm	(± in.)
2	Picture	1.80	2.14	0.071	0.084	1.6	(¼/16)
2.5	Single	2.15	2.90	0.085	0.114	1.6	(¼/16)
3	Double ⅛ in.	3.00	3.61	0.118	0.142	1.6	(¼/16)
4	⅜ in.	3.62	4.37	0.143	0.172	1.6	(¼/16)
5	⅜ in.	4.39	5.42	0.173	0.213	1.6	(¼/16)
5.5	⅞ in.	5.43	5.90	0.214	0.232	2.4	(¾/32)
6	¼ in.	5.70	7.60	0.224	0.299	3.2	(⅜/16)
8	⅜ in.	7.61	9.10	0.300	0.358	4.0	(⅝/32)
10	⅜ in.	9.11	10.70	0.359	0.421	4.8	(¾/16)
12	½ in.	11.50	13.00	0.453	0.512	4.8	(¾/16)

## 6. Test Methods

### 6.1 Test Methods for Type I Glass (Transparent Flat Glass):

6.1.1 *Viewing Conditions for Blemish Detection*—All visual inspections shall be made with 20/20 vision (naked eye or corrected). Place samples in the vertical position at the distance as specified in the sections following. The viewer shall look through 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 1700 lux (160 foot-candles) measured at the surface of the glass facing the light source. See Fig. 2.

6.1.1.1 *Blemish Detection for Point Blemish (Knots, Dirt, Stones, Crush, Gaseous Inclusions, and Other Similar Blemishes)*—Place samples at a distance of approximately 1 m (39 in.) from the viewer. If a blemish is detected, refer to Tables 3 and 4 for evaluation criteria.

6.1.1.2 *Point Blemish Measurement*—Point blemish size shall be determined by measuring the maximum length and perpendicular width of the blemish and calculating the average of the two dimensions. The allowable blemish sizes listed in Table 3 include associated distortion for Q1 and Q2, but Q3 and Q4 do not include associated distortion.

6.1.1.3 *Detection for Linear Blemishes (Scratches, Rubs, Digs, and Other Similar Blemishes)*—Place samples approximately 4 m (160 in.) from the viewer. The viewer shall move towards the specimen until a blemish is detected (if any). The distance from the viewer to glass surface when the blemish is first detectable is defined as the detection distance. Blemish

intensity is determined by comparing the detection distance to the blemish intensity chart in Table 10. Refer to Table 5 for evaluation criteria.

6.1.1.4 *Blemish Distribution*—To determine the separation between blemishes (see Table 3 and Table 5), measure the distance between the two closest points of the blemishes. The minimum separation distance between blemishes is determined by the minimum separation required for the larger of the two blemishes.

6.1.2 *Ream, Strings, Lines, and Distortion*—(See Fig. 1.) Place sample, with the direction of the draw oriented vertically, at a distance of approximately 4.5 m (15 ft) from a zebra board with a measured illumination of 215 lux (20 foot-candles) minimum with 25-mm (1-in.) black-and-white diagonal stripes. Start with the glass sample parallel with the zebra board (identified as 0°) and perpendicular with the viewer's line of sight. Rotate the specimen clockwise from zero until it reaches the angle at which the distortion appears and report that angle as the vision interference angle. Refer to Table 6 for evaluation criteria. If the direction of draw cannot be determined, then the sample shall also be viewed turning the sample 90° and evaluated as stated above. The lower of the two interference angles measured shall be used to compare to the evaluation criteria in Table 6.

6.1.3 *Dimensional Measurements*—To measure the length and width of cut size and stock sheets of flat glass, measure the perpendicular distance from edge to edge, including flares and bevels.

**TABLE 9 Allowable Blemish Size and Distribution for Cut Size and Stock Sheet Patterned Glass<sup>A</sup>**

Blemish Size <sup>B,C,D</sup> mm (in.)	Q5 Quality 5	Q6 Quality 6
< 2.50 (0.10)	Allowed	Allowed
≥ 2.50 < 4.00 ≥ (0.10) < (0.16)	Allowed with a minimum separation of 600 mm (24 in.)	Allowed with a minimum separation of 600 mm (24 in.)
≥ 4.00 < 6.00 ≥ (0.16) < (0.24)	Allowed with a minimum separation of 1200 mm (48 in.)	Allowed with a minimum separation of 1200 mm (48 in.)
≥ 6.00 < 8.00 ≥ (0.24) < (0.31)	Allowed with a minimum separation of 1500 mm (60 in.)	Allowed with a minimum separation of 1500 mm (60 in.)
≥ 8.00 < 10.00 ≥ (0.31) < (0.39)	Allowed with a minimum separation of 1500 mm (60 in.)	Allowed with a minimum separation of 1500 mm (60 in.)
≥ 10.00 < 15.00 ≥ (0.39) < (0.59)	Allowed with a minimum separation of 1500 mm (60 in.)	Allowed with a minimum separation of 1500 mm (60 in.)
≥ 15.00 < 19.00 ≥ (0.59) < (0.75)	Not allowed	Allowed with a minimum separation of 1500 mm (60 in.)
> 19.00 (0.75)	Not allowed	Not allowed

<sup>A</sup> Table values are for 6.0 mm (¼ in.) and less. For glass thicker than 6.0 mm (¼ in.) and less than or equal to 12.0 mm (½ in.), they may contain proportionally larger blemishes for the same minimum separation distances. (For example, a 12-mm Q5 sample with a blemish size of ≥ 20.0 < 30.0 mm, the allowable minimum separation would be 1500 mm.) **Table 9** does not apply to glass thicker than 12.0 mm (½ in.). Allowable blemishes for glass thicker than 12.0 mm (½ in.) shall be determined by agreement between the buyer and the seller.

<sup>B</sup> See 6.1.1.1 for detection of point blemishes.

<sup>C</sup> See 6.2.3 for measurement of point blemishes.

<sup>D</sup> Blemishes not specifically mentioned shall be compared to the blemish they most closely resemble.

**TABLE 10 Blemish Intensity Chart**

Detection Distance	Blemish Intensity
Over 3.3 m (132 in.)	Heavy
3.3 to 1.01 m (132 to 40 in.)	Medium
1 to 0.2 m (39 to 8 in.)	Light
Less than 0.2 m (8 in.)	Faint

6.1.4 *Squareness Measurement*—After measuring the length and width for compliance with dimensional tolerance, measure the length of both diagonals (corner to corner). The difference in length between the two diagonals (D1–D2) shall not exceed the limits set forth in **Table 2**.

6.1.5 *Solar/Optical Properties*—If specified, the reflectance and transmittance of glass are to be determined in accordance with **NFRC 300**.

6.2 *Test Methods for Type II Glass (Wired or Patterned Glass)*:

6.2.1 *Associated Distortion and Blemish Appraisal*—Because of the variety of uses of patterned and wired glass, specific inspection guidelines are beyond the scope of this specification. Check with the manufacturer for more information.

6.2.2 *Dimensional Measurements*—To measure the length and width of cut size and stock sheets of flat glass, measure the perpendicular distance from edge to edge, including flares and

bevels. Measurements taken at any point shall meet the tolerance requirements of **Table 7** or **Table 8**, or both.

6.2.3 *Point Blemish Measurement*—Point blemish size shall be determined by measuring the maximum length and perpendicular width of the blemish and calculating the average of the two dimensions. The allowable blemish sizes listed in **Table 9** do not include associated distortion.

6.2.4 *Solar/Optical Properties*—For patterned and wired glass, consult with the manufacturer when the solar and optical properties are required.

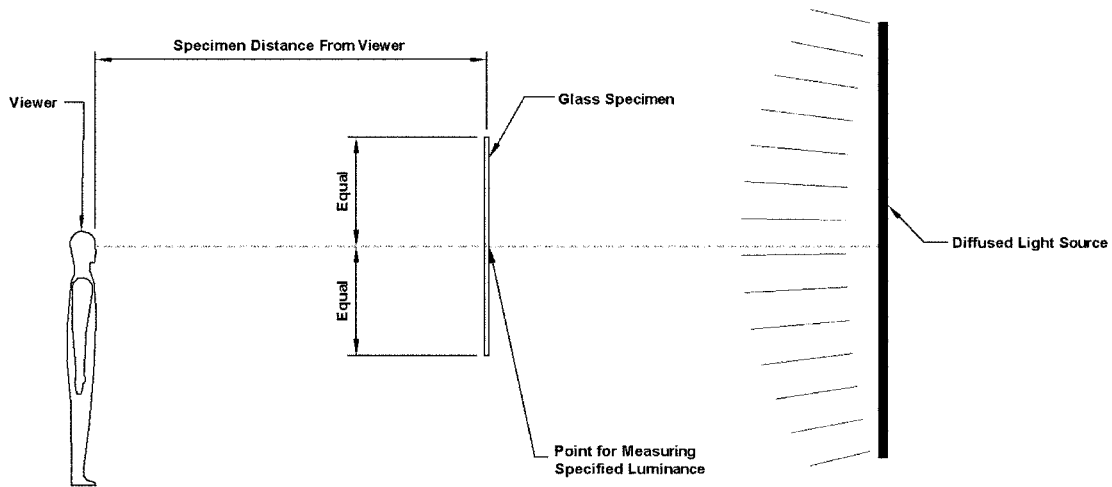
6.2.5 *Measuring the Thickness of Patterned Glass*—The thickness of patterned glass shall be determined by measuring high point to high point to the precision and accuracy in **Table 8**, using a measuring device with 19-mm (¾-in.) diameter or greater contact surfaces. As an alternate method, the thickness may be measured using two bars with flat and parallel surfaces 75 mm (3 in.) long or greater × 6 mm (0.25 in.) wide or greater × 6 mm (0.25 in.) thick or greater.

## 7. Package Marking

7.1 Each package of glass shall be identified by the manufacturer and include the manufacturer's name or trademark, nominal thickness, and place of manufacture.

## 8. Keywords

8.1 architectural glass; flat glass; glazing; patterned glass; tinted glass; transparent glass; wired glass



**FIG. 2 Viewing Conditions for Blemish Detection**

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