



# Standard Specification for Glasses, Portlight, Circular, Fully Tempered<sup>1</sup>

This standard is issued under the fixed designation C 1443; 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 ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

## 1. Scope

1.1 This specification covers the requirements for circular, fully tempered, high clarity, flat glasses used for portlight applications.

1.2 The dimensional values stated in English units are to be regarded as standard. The values given in parentheses are for information only.

1.3 The following safety hazard caveat pertains only to the test method portion, Section 11, 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 and health practices and determine the applicability of regulatory limitations prior to use.*

## 2. Referenced Documents

### 2.1 ASTM Standards:

C 162 Terminology of Glass and Glass Products<sup>2</sup>

C 1036 Specification for Flat Glass<sup>2</sup>

C 1048 Specification for Heat-Treated Flat Glass—Kind HS, Kind FT Coated and Uncoated Glass<sup>2</sup>

C 1279 Test Method for Non-Destructive Photoelastic Measurement of Edge and Surface Stresses in Annealed, Heat Strengthened, and Full Tempered Glass<sup>2</sup>

### 2.2 ANSI Standard:

ANSI Z1.4 Sampling Procedures and Tables for Inspection by Attributes (DOD Adopted)<sup>3</sup>

## 3. Terminology

3.1 *Definitions*—For definitions of terms used in this specification, refer to Terminology C 162 and also Specifications C 1036 and C 1048 and Test Method C 1279.

## 4. Classification

4.1 Glasses covered by this specification shall be of the following types, as specified (see 5.1):

4.1.1 *Type I*—Plain edges, both faces polished,

4.1.2 *Type II*—Plain edge, one face polished, opposite face frosted,

4.1.3 *Type III*—Rabbeted edge, both faces polished, or

4.1.4 *Type IV*—Rabbeted edge, one face polished, opposite face frosted.

## 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 portlight glasses, as requested (see 4.1),

5.1.3 Dimensions of portlight glasses (see 8.1 and 9.3), and

5.1.4 Type, class, and quality of glass (see Specification C 1036) and heat treatment (see Specification C 1048).

5.2 *Samples*—If samples are to be supplied with bids, they should be specifically requested in the invitation for bids and the particular purpose to be served by the bid sample should be clearly stated.

## 6. Materials and Manufacture

6.1 *Material*—The glass used shall be glazing quality, float glass in accordance with the requirements for Specification C 1036, Type I, Class 1, quality q<sup>3</sup> or higher, if required, and heat-treated Specification C 1048, kind FT.

6.2 *Marking*—Specimens shall exhibit the words “fully tempered” approximately 1/2 in. (12.7 mm) from the edge by means of etching or sand blasting. Marking shall be done before heat treating.

## 7. Other Requirements

7.1 *Breaking Strength*—Glasses shall exhibit satisfactory resistance to breakage (see 11.1.2.1).

7.2 *Surface and Edge Compression*—Type I and III glasses shall have a surface compression of not less than 10 000 psi or an edge compression of not less than 9700 psi (see 11.1.1.2).

7.3 *Clarity*—When glasses are tested (see 11.1.2.3), black and white lines of the clarity target shall be definitely distinguishable for all parts of the critical area.

7.4 *Warpage*—Glasses shall not exhibit more than 1/32 in. (0.8 mm) warpage along any line on either face (see 11.1.2.3).

## 8. Dimensions

8.1 The dimensions of the specimens shall be as specified in 5.1. The thickness of a circular glass specimen shall not vary more than 1/32 in. (0.8 mm) between any two points on its periphery. Dimensional tolerances for circular cut glasses shall not exceed values specified in Table 1 and Specification

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<sup>2</sup> *Annual Book of ASTM Standards*, Vol 15.02.

<sup>3</sup> American National Standards Institute (ANSI), Inc., 11 W. 42nd St., New York, NY 10036.

**TABLE 1 Permitted Tolerances**

Dimension	Tolerance, $\pm$ in. ( $\pm$ mm)
Diameter	$\frac{1}{16}$ (1.6)
Depth of rabbet	$\frac{1}{32}$ (0.8)

C 1036.

## 9. Finish and Appearance

9.1 *Finish*—Glasses shall be finished by grinding to the tolerances specified in 8.1. Edges shall be ground, with corners chamfered  $\frac{1}{16}$  in. (1.6 mm).

9.2 *Types II and IV*—The designated faces of the glasses shall be uniformly frosted by sand blasting or etching.

9.3 *Types III and IV*—The edges of the glasses shall be rabbeted. The depth of the rabbet in the horizontal direction and in the vertical direction shall be specified by the purchaser (see 5.1.3). Depth dimensions for the rabbet shall be accurate to within  $\frac{1}{32}$  in. (0.8 mm) when measured from the edge and from the face of the glass. One edge of the rabbet shall be perpendicular to the face of the glass and the other edge of the rabbet shall be perpendicular to the edge of the glass such that the angle formed by the faces of the rabbet is  $90 \pm 2^\circ$ .

## 10. Sampling

10.1 *Inspection Lot*—For purposes of inspection, a lot shall consist of not more than 1000 specimens which shall be of a single thickness, produced in a single plant and offered for delivery at one time.

10.1.1 *Sampling for Visual and Dimensional Examinations*—Samples shall be selected in accordance with the procedures of ANSI Z1.4 at inspection Level II for examination in accordance with 11.1.1.1.

10.1.2 *Sampling for Surface and Edge Stress*—Samples shall be selected at random in accordance with Table 2 for examination in accordance with 11.1.1.2. When a lot contains fewer than seven glasses, or when a special use (see 5.1) requires protection against defects, the sample shall consist of all specimens in the lot. Where the lot consists of between 7 and 50 glasses, the sample shall consist of 6 specimens. Where the lot consists of between 51 and 100 glasses, the sample shall consist of 14 specimens. Lots containing more than 100 glasses

**TABLE 2 Sampling for Surface and Edge Stress Examination and Tests**

Lot Size	Sample Size	Allowable Number of Failures for Surface and Edge Stress Examination	Allowable Number of Failures for Tests (Load, Clarity, Warpage)
1-6	all	none	none
7-50	6	none	load <sup>A</sup>
...	...		clarity: none <sup>B</sup>
51-100	14	none	warpage: none <sup>C</sup>
101-1000	10		load <sup>A</sup>
			clarity: none <sup>B</sup>
			warpage: none <sup>C</sup>

<sup>A</sup>See 11.1.2.1.

<sup>B</sup>Supplier may, at his option, test all remaining glasses in the lot for clarity in accordance with 11.1.2.2 and all glasses that pass shall be considered acceptable.

<sup>C</sup>Supplier may, at his option, test all remaining glasses in the lot for warpage in accordance with 11.1.2.3 and all glasses that pass shall be considered acceptable.

shall be evaluated by means of a sample of 10 specimens. Samples from lots consisting of more than 6 glasses shall contain a representative variety of types and diameters.

10.1.3 *Sampling for Test*—Sampling for all tests to be performed on specimens shall be in accordance with 10.1.2.

## 11. Inspection, Acceptance and Rejection

11.1 *Responsibility*—The supplier is responsible for inspection of cut specimens unless otherwise specified in the contract or purchase order. Two forms of inspection are required: examination and test.

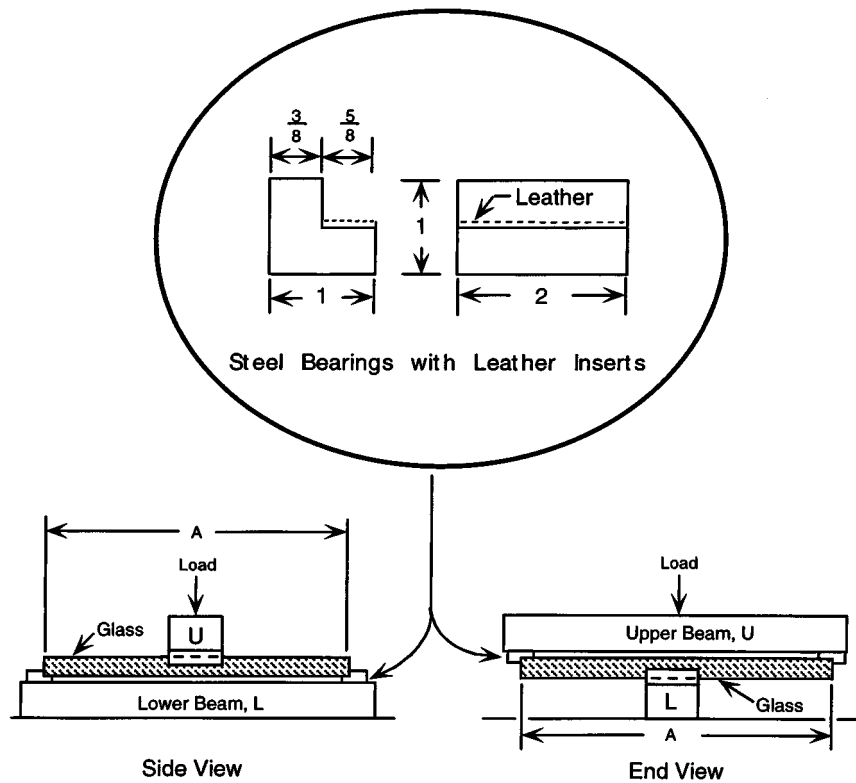
11.1.1 *Examination*—Inspection by examination shall consist of determining compliance with visual and dimensional requirements.

11.1.1.1 *Visual and Dimensional Examinations*—All specimens of a sample size selected in accordance with 10.1.1 shall be examined to verify conformance to all of the requirements which do not involve tests or polariscopic examination. The lot shall be accepted if all of the specimens in the sample (see 10.1.1) conform to visual requirements of Section 6.2 and Section 9 and dimensional requirements of Section 8. The lot shall be rejected if any of the specimens in the sample fail to conform to these requirements. If the lot is rejected on the basis of visual and dimensional examination, the supplier may at his option examine all remaining specimens of the lot to determine conformance with visual and dimensional requirements. Any of the specimens of the lot that comply with the visual and dimensional requirements shall be considered acceptable, subject to conformance with polariscopic examination requirements and test requirements.

11.1.1.2 *Surface and Edge Stresses, (Type I and Type III Glasses)*—All specimens of a sample size selected in accordance with 10.1.2 shall be subjected to surface or edge stress examination (see 7.2) to determine if they are fully tempered. It is suggested that Type III glasses be tested for surface stress. Test Method C 1279 is recommended for testing edge and surface stresses. If any glass specimen from a sample undergoing surface and edge stress examination does not meet the required values (see 7.2), the lot shall be rejected in accordance with criteria given in Table 2.

11.1.2 *Test Acceptance or Rejection*—Inspection by test shall consist of load, clarity, and warpage tests.

11.1.2.1 *Load Test*—All specimens of a sample size selected in accordance with 10.1.3 shall be tested under a load applied without shock using the jig illustrated in Fig. 1. Each of the specimens shall be placed centrally between the upper and lower steel beams which should be perpendicular as shown in side and end views, respectively. The steel bearings supporting the specimen shall be spaced on Dimension A so that the specimen has a clearance of  $\frac{1}{16}$  in. (1.6 mm) at either side. Each bearing shall have a leather insert approximately  $\frac{1}{8}$  in. (3.2 mm) thick over the entire surface between steel and glass. Type III and IV specimens shall be tested with the large diameter down, and the bearings against the bottom face shall extend approximately  $\frac{1}{2}$  in. (12.7 mm) within the circle of the smaller diameter. The rate of loading shall be  $0.1 \pm 0.0005$  in. ( $2.54 \pm 0.0127$  mm) per min. When all specimens in a lot are to be tested, each specimen shall be loaded to the value shown in Table 3. (Other values may be obtained, if needed, by linear



All dimensions are in inches.  
 FIG. 1 Load Apparatus (see 11.1.2.1)

TABLE 3 Load When All Samples in a Lot Are to be Tested

Diameter	Load, lb (kg) for Given Thickness, in. (mm)							
	1/4 (6.4)	3/8 (9.5)	1/2 (12.7)	5/8 (15.9)	3/4 (19.1)	7/8 (22.2)	1 (25.4)	1 1/4 (31.8)
6 (152.4)	790 (358.3)	1720 (780.2)	2980 (1351.7)	4570 (613.1)	6480 (2939.3)	8690 (3941.7)	11 220 (5089.3)	17 190 (7797.3)
8 1/2 (215.9)	710 (322.1)	1550 (703.1)	2690 (1220.2)	4120 (553.5)	5840 (2649.0)	7830 (3551.6)	10 110 (4585.8)	15 490 (7026.1)
12 1/2 (317.5)	600 (272.2)	1310 (594.2)	2280 (1034.2)	3490 (469.1)	4940 (2240.7)	6640 (3011.9)	8570 (3887.3)	13 120 (5951.1)
16 (406.4)	520 (235.9)	1140 (517.1)	1970 (893.6)	3020 (405.3)	4280 (1941.4)	5740 (2603.6)	7410 (3361.1)	11 350 (5148.3)
20 (508)	440 (199.6)	960 (435.4)	1670 (757.5)	2560 (343.6)	3620 (1642.0)	4860 (2204.5)	6270 (2844.0)	9610 (4359.0)
25 1/2 (647.7)	350 (158.8)	770 (349.3)	1330 (603.3)	2030 (273.6)	2880 (1306.3)	3870 (1755.4)	4990 (2263.4)	7650 (3470.0)

interpolation between the nearest values shown in the table.) Specimens not damaged shall be accepted. Each specimen in the sample size selected in accordance with 10.1.3 shall be load tested to the corresponding value shown in Table 3. If no specimen breaks, the lot shall be accepted. If one of the specimens breaks the entire lot shall be load tested by the method specified above and specimens not damaged by that test will be accepted. Lots containing more than 100 specimens shall be evaluated by testing a sample of 10 specimens selected

in accordance with 10.1.3. The sample shall be evaluated by determining whether the breaking load of each specimen in the sample falls above or below the corresponding values shown in Table 4. (Other values may be obtained, if needed, by linear interpolation between the nearest values shown in the table.) If the breaking loads of the specimens are greater than or equal to the specified value, the lot shall be accepted. If the breaking load of the specimens is less than the specified value, the lot shall be rejected, but the manufacturer shall have the option of

TABLE 4 Load for a Sample of 10 Samples from a Lot Consisting of More Than 100 Samples

Diameter	Load, lb (kg) for Given Thickness, in. (mm)							
	1/4 (6.4)	3/8 (9.5)	1/2 (12.7)	5/8 (15.9)	3/4 (19.1)	7/8 (22.2)	1 (25.4)	1 1/4 (31.8)
6 (152.4)	1043 (473.1)	2265 (1027.4)	3926 (1780.8)	6015 (2728.4)	8524 (3866.4)	11 440 (5189.1)	14 768 (6698.7)	22 621 (10 260.7)
8 1/2 (215.9)	940 (426.4)	2042 (926.2)	3539 (1605.3)	5422 (2459.4)	7688 (3487.2)	10 312 (4677.4)	13 312 (6038.2)	20 391 (9249.2)
12 1/2 (317.5)	797 (361.5)	1729 (784.3)	2997 (1359.4)	4592 (2082.9)	6508 (2747.9)	8734 (3961.7)	11 275 (5114.3)	17 271 (7834.0)
16 (406.4)	688 (312.1)	1495 (678.1)	2592 (1175.7)	3971 (1801.2)	5628 (2552.8)	7553 (3426.0)	9750 (4422.5)	14 936 (6774.9)
20 (508)	583 (264.4)	1266 (574.2)	2195 (995.6)	3364 (1525.9)	4767 (2162.3)	6397 (2901.6)	8259 (3746.2)	12 650 (5737.9)
25 1/2 (647.7)	464 (210.5)	1008 (457.2)	1747 (792.4)	2677 (1214.3)	3794 (1720.9)	5091 (2309.2)	6573 (2981.5)	10 068 (4566.8)

testing such sample of the lot by the method specified above and samples not damaged in that test shall be accepted. Appendix X1 provides rationale for proof load testing.

11.1.2.2 *Clarity Test (Type I and Type III Glasses)*—All specimens of a sample selected in accordance with 10.1.3 shall be tested for clarity. The deterioration of the clarity of target lines due to placing the sample in a light path shall be observed through a suitable telescope. The target shall consist of two sets of alternating black and white lines of equal width oriented so that the lines of the two sets are mutually perpendicular. The target to telescope distance shall be at least 20 ft (6.1 m). The telescope shall have a magnifying power of at least 10X, and the test aperture shall be  $\geq \frac{1}{2}$  in. (12.7 mm) diameter. If the width of any of the lines is greater than 0.001 75 in. multiplied by the distance in feet between the target and the objective of the telescope, the lot shall be rejected in accordance with criteria given in Table 2. For example, if the distance between the target and the objective of the telescope is 20.0 ft (6.10 m) the width of any line shall not exceed 0.035 in. (0.889 mm). The sample shall be held normal to the axis of the line of sight of the telescope, and shall be located immediately in front of the telescope objective. The sample shall be moved within the plane defined by the two parallel surfaces separated by the thickness of the glass so as to survey the critical area, covering at least 30 % of this area. The critical area is the central portion of the glass, exclusive of a rim area which extends inward 1 in.

(25.4 mm) from the edge for specimens not over 10 in. (254.0 mm) diameter, and exclusive of areas which extend inward  $1\frac{1}{2}$  in. (38.1 mm) in any direction from tong marks, if tong marks are present.

11.1.2.3 *Warpage Test*—All specimens of a sample selected in accordance with 10.1.3 shall be tested for warpage. The annular ring method shall be used to determine warpage. The testing apparatus shall consist of an upper and lower annular ring, whose outside diameter shall exceed the diameter of the glass to be tested by  $\frac{1}{2}$  in. (12.5 mm), the inner diameter being  $2\frac{1}{2}$  in. (63.5 mm) less than the outer diameter. The surface with which the glass comes in contact shall be within  $\frac{4}{1000}$  in. (0.1016 mm) of a mechanical plane surface. The lower annular ring shall be placed on a level horizontal surface. The glass to be tested shall be laid centrally on the annular ring. The top annular ring shall be centrally placed on top of the glass. If at any location the variation in clearance between the plane surface of the annular rings and the surface of the glass exceeds  $\pm \frac{1}{32}$  in. ( $\pm 0.8$  mm) when determined with a feeler gage, the lot shall be rejected in accordance with criteria given in Table 2.

## 12. Keywords

12.1 breakage strength; flat glass; portlight; proof load; tempered glass

## APPENDIX

### (Nonmandatory Information)

#### X1. RELIABILITY OF PROOF LOAD TESTING

X1.1 The sampling specified (see Section 10) is based primarily on the load test specified in 11.1.2.1. The load test is a reliable method for determining whether circular glass is properly heat treated. The results of load testing (to breaking) of 209 samples were analyzed by the method of least squares. The samples were selected from the regular production of two manufacturers and ranged from 6 to  $25\frac{1}{2}$  in. (152.4 to 647.7 mm) diameter and  $\frac{1}{4}$  to  $1\frac{1}{4}$  in. (6.4 to 31.8 mm) thick. Tests were conducted at different laboratories. The median breaking load was found to be given by the empirical equation:

$$L = 21990 T^{1.9115} (0.9593)^D \quad (X1.1)$$

where:


$L$  = median breaking load, lb;

$T$  = thickness, in.; and

$D$  = diameter, in.

For example, if the thickness of the sample is  $\frac{1}{4}$  in. (6.4 mm), and the diameter of the sample is 6 in. (152.4 mm), the median breaking load,  $L$ , is 1210 lb (549 kg).

X1.1.1 The standard deviation of the data was of the order of 22 % of the median. The indicated distribution of breaking strengths is such that approximately 2.3 % of specimens tested may be expected to fail at loads of less than 65 % of the median if the production standard represented by the above samples is maintained. The median strength given by X1.1 is over five times the median strength of annealed plate glass. For lots of less than 101 samples, the breaking strength as determined in this specification is at least equal to 65 % of the average median given by Eq X1.1 above. When a lot consists of between 101 and 1000 specimens, a sample of 10 specimens is tested to determine whether the breaking strength is at least equal to 86 % of the average median given by Eq X1.1. Since a satisfactory lot will be rejected approximately 1 % of the time on the basis of tests of such a sample, the manufacturer is given the option of testing every glass to 65 % of the median given by the Eq X1.1. This method of testing large lots means that the worst possible average percent defective is 5.5 %, regardless of the size of the lots sampled.

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