



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

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### 1. Scope

1.1 This specification covers the requirements for silvered flat glass mirrors of rectangular shape supplied as cut sizes, stock sheets or as lehr ends and to which no further processing (such as edgework or other fabrication) has been done.

1.2 This specification covers the quality requirements of silvered annealed monolithic clear and tinted flat glass mirrors up to 6 mm (1/4 in.) thick. The mirrors are intended to be used indoors for mirror glazing, for components of decorative accessories or for similar uses.

1.3 This specification does not address safety glazing materials nor requirements for mirror applications. Consult model building codes and other applicable standards for safety glazing applications.

1.4 Mirrors covered in this specification are not intended for use in environments where high humidity or airborne corrosion promoters, or both, are consistently present (such as swimming pool areas, ocean-going vessels, chemical laboratories and other corrosive environments).

1.5 The dimensional values stated in metric units are to be regarded as the standard. The inch-pound units given in parentheses are for information only.

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

### 2. Referenced Documents

2.1 Reference to these documents shall be the latest issue unless otherwise specified by the authority applying this specification:

#### 2.2 ASTM Standards:

B 117 Practice for Operating Salt Spray (Fog) Apparatus<sup>2</sup>

C 162 Terminology of Glass & Glass Products<sup>3</sup>

C 1036 Specification for Flat Glass<sup>3</sup>

E 903 Test Method for Solar Absorptance, Reflectance and

### Transmittance of Materials Using Integrating Spheres<sup>4</sup>

### 3. Terminology

3.1 *Definitions*—Refer to Terminology C 162 and the standards referenced in 2.2 as appropriate.

3.1.1 *blemishes*—an imperfections in the body or on the surface of the mirror. For the purpose of this specification blemishes are divided into 2 categories:

3.1.1.1 *point blemishes*—knots, dirt, stones, gaseous inclusions (seeds and bubbles), tin particles, crush and other similar imperfections.

3.1.1.2 *linear blemishes*—scratches, rubs, digs and other similar imperfections.

3.1.2 *chip*—an imperfection on the edge of a mirror lite due to breakage of a small fragment out of an otherwise regular surface.

3.1.2.1 *shell chip*—a circular indentation in the mirror edge due to breakage of a small fragment.

3.1.2.2 *v-chip*—a V-shaped chip indentation in the mirror edge due to breakage of a small fragment.

3.1.2.3 *chip width*—the perpendicular distance from the edge of the mirror to the inner edge of the chip.

3.1.2.4 *chip length*—the distance, parallel to the edge of the mirror, from one edge of a chip to the other.

3.1.2.5 *chip depth*—the measured distance of a chip from the face of the mirror into the thickness.

3.1.3 *clean cut edge*—natural cut edge of mirror without further fabrication.

3.1.4 *cluster*—a group of not less than 3 point blemishes separated by not more than 50 mm (2 in.).

3.1.5 *crush*—a lightly pitted area in the glass surface resulting in a dull gray or white appearance over the region.

3.1.6 *dig*—deep, short scratch in the glass surface.

3.1.7 *dirt*—a small particle of foreign material imbedded in the glass surface.

3.1.8 *edge corrosion*—change in the color or level of reflectance along the mirror edge as a result of degradation of the silver coating from external sources.

3.1.9 *edgework*—fabrication of the mirror edge beyond the original clean-cut condition.

3.1.10 *flare*—a protrusion on the edge of a lite of mirror.

3.1.11 *gaseous inclusion*—(also known as *seed* or *bubble*) a round or elongated bubble at the surface (open) or within the

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<sup>2</sup> Annual Book of ASTM Standards, Vol 03.02.

<sup>3</sup> Annual Book of ASTM Standards, Vol 15.02.

<sup>4</sup> Annual Book of ASTM Standards, Vol 12.02.

body thickness leaving a cavity in the mirror.

3.1.12 *knot*—an inhomogeneity in the form of a vitreous lump in the mirror.

3.1.13 *mirror cut size*—mirrors intended for final use in the size ordered (i.e. mirrors not intended for recutting).

3.1.14 *mirror Lehr end*—mirrors intended for recutting by the user into smaller sizes where it is expected that some material may be lost in cutting due to blemishes and edge quality.

3.1.15 *mirror stock sheet*—mirrors intended for architectural use and where trimming will be required.

3.1.16 *rub*—an abrasion of the mirror surface producing a frosted appearance.

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

3.1.18 *silver coating*—the metallic silver coating in a silvered mirror product.

3.1.19 *silvered mirror*—mirror product fabricated through the application of metallic silver and protected by a mirror backing paint.

3.1.20 *spot silver fault*—a small area at which the silver coating is partially or entirely absent.

3.1.21 *stone*—a crystalline inclusion in the mirror.

3.1.22 *visible clouding*—a frosted appearance in the reflected image from a silvered mirror.

**4. Classification and Intended Use**

4.1 *Grades*—Mirrors furnished under this specification shall be of the following grades, as specified.

4.1.1 *Mirror Cut Size*—Mirrors intended for final use in the size ordered (that is, mirrors not intended for recutting).

4.1.2 *Mirror Stock Sheet*—Mirrors intended for architectural use and where trimming will be required.

4.1.3 *Mirror Lehr End*—Mirrors intended for recutting by the user into smaller sizes where it is expected that some material may be lost in cutting due to blemishes and edge quality.

4.2 *Qualities*—Mirrors furnished under this specification shall be of the following qualities, as specified.

4.2.1 *Mirror Select Quality*—(Usually available in 6 mm (1/4 in.) clear mirror only.) Recommended or intended or both, for use in visually demanding applications requiring minimal distortion and blemishes.

4.2.2 *Mirror Glazing Quality*—Recommended or intended or both, for general use where limited levels of minor blemishes or distortion, or both are acceptable.

4.3 *Color*—The glass substrate may be clear or tinted.

4.3.1 *Clear Glass Mirrors*—Mirrors made with clear (untinted) glass.

4.3.2 *Tinted Glass Mirrors*—Mirrors made with tinted (colored) glass. Intended for use primarily in decorative applications where diminished light reflectance is not a concern. A variety of tinted glass substrates are available. The specific tint desired should be specified by the purchaser and is subject to availability. Not all grades or qualities may be available in tinted glass mirror.

NOTE 1—Actual color or shade of tinted glass mirror may vary from

manufacturer to manufacturer and from batch to batch.

4.4 *Thickness*—Mirrors are available in the following standard nominal thicknesses:

Designation	Thickness		Intended use Recommended application
	(Traditional designation)	Maximum recommended surface area per cut size piece	
2.5 mm	(single)	Up to .5 sq. m. (5 sq.ft.)	Utility mirrors where distortion and blemishes are not a major concern
3.0 mm	(double or 1/8 in.)	Up to .75 sq. m. (7.5 sq.ft.)	Mirror components and other general use applications
4.0 mm	(5/16 in.)	Up to 1 sq. m. (10 sq.ft.)	Mirror components and other general use applications
5.0 mm	(3/16 in.)	Up to 3 sq. m. (32 sq. ft.)	Architectural use and other applications where optical quality is a major concern
6.0 mm	(1/4 in.)	Up to 3 sq. m. (32 sq. ft.)	Architectural use and other applications where optical quality is a major concern

**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 Grade of mirror (see 4.1).
- 5.1.3 Quality of mirror (see 4.2).
- 5.1.4 Color of mirror (see 4.3).
- 5.1.5 Thickness of mirror.
- 5.1.6 Nominal length and width.

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

**6. Requirements**

6.1 *Reflectance Requirements*—When measured in accordance with Test Method 7.1, reflectance shall not be less than the following:

- 6.1.1 For clear glass mirrors—minimum visible light reflected = 83 %.
- 6.1.2 For tinted glass mirrors—minimum visible light reflected = (T)<sup>2</sup> (where T = the visible light transmission value for the glass substrate in its unsilvered state.)

6.2 *Coating Requirements:*

6.2.1 *Appearance of Silver Coating*—When inspected in accordance with Test Method 7.2, the silver coating shall be free of visible blemishes.

6.2.2 *Coating Resistance Requirements*—When tested in accordance with Test Method 7.3 mirrors shall meet the requirements shown in Table 6.

6.3 *Blemish Limits*—Blemishes, other than visible blemishes in the silver coating, are permitted within the following limits.

6.3.1 *Blemish Limits for Mirror Cut Size and Mirror Stock Sheet Grades:*

6.3.1.1 *Point Blemish Limits*—When inspected in accordance with Test Method 7.4.1 point blemishes shall be within the limits shown in Table 2.

**TABLE 1 Dimensional Tolerances for Mirror Cut Size, Mirror Stock Sheet and Mirror Lehr End Grades**

Thickness Designation Metric (Traditional)	Thickness Range <sup>A</sup>	Thickness Range <sup>A</sup>		Squareness Max. D1-D2 mm (inches)	Length and Width <sup>B</sup> Cut Size ± mm (± in.)	Tolerance Stock Sheet & Lehr End ± mm (± in.)
		mm min max	(inches) min max			
2.5 mm	(Single)	2.16 to 2.57	(0.085 to 0.101)	2.0 (5/64)	1.6 (1/16)	6.4 (1/4)
3.0 mm	(Double-1/8 in.)	2.92 to 3.40	(0.115 to 0.134)	2.0 (5/64)	1.6 (1/16)	6.4 (1/4)
4.0 mm	(3/32 in.)	3.78 to 4.19	(0.149 to 0.165)	2.0 (5/64)	1.6 (1/16)	6.4 (1/4)
5.0 mm	(3/16 in.)	4.57 to 5.07	(0.180 to 0.199)	2.0 (5/64)	1.6 (1/16)	6.4 (1/4)
6.0 mm	(1/4 in.)	5.56 to 6.20	(0.219 to 0.244)	2.0 (5/64)	1.6 (1/16)	6.4 (1/4)

<sup>A</sup> The mirror shall not vary in thickness more than 0.1 mm (.004 in.) over a 100 mm (4 in.) area.

<sup>B</sup> Length and width of mirrors include flares and bevels.

**TABLE 2 Allowable Point Blemish Size and Distribution for Mirror Cut Size and Mirror Stock Sheet Grades of Mirrors**

Blemish Size <sup>A</sup>	Mirror Select Quality (usually available in 6 mm (1/4 in.) clear mirror only)		Mirror Glazing Quality		Mirror Stock Sheet (usually available in 6 mm (1/4 in.) clear mirror only)	
	Mirror Cut Size <sup>B</sup>		Mirror Glazing Quality		Mirror Stock Sheet	
	Central <sup>C</sup>	Outer <sup>C</sup>	Central <sup>C</sup>	Outer <sup>C</sup>	Mirror Select Quality	Mirror Glazing Quality
< 0.30 mm (<.012 in.)	Allowed with a minimum separation of 300 mm (12 in.)	Allowed with a minimum separation of 300 mm (12 in.)	Allowed <sup>D</sup>	Allowed <sup>D</sup>	Allowed <sup>D</sup>	Allowed <sup>D</sup>
≥ 0.30 mm < 0.50 mm (≥.012 in. <.02 in.)	Allowed with a minimum separation of 600 mm (24 in.)	Allowed with a minimum separation of 300 mm (12 in.)	Allowed with a minimum separation of 300 mm (12 in.)	Allowed with a minimum separation of 300 mm (12 in.)	Allowed with a minimum separation of 1200 mm (48 in.)	Allowed <sup>D</sup>
≥ 0.50 mm < 0.80 mm (≥.02 in. <.032 in.)	None Allowed	Allowed with a minimum separation of 900 mm (36 in.)	None Allowed	Allowed with a minimum separation of 300 mm (12 in.)	None Allowed	Allowed with a minimum separation of 600 mm (24 in.)
≥ 0.80 mm < 1.20 mm (≥.032 in. <.047 in.)	None Allowed	None Allowed	None Allowed	Allowed with a minimum separation of 1500 mm (60 in.)	None Allowed	Allowed with a minimum separation of 1200 mm (48 in.)
≥ 1.20 mm < 1.50 mm (≥.047 in. <.059 in.)	None Allowed	None Allowed	None Allowed	None Allowed	None Allowed	Allowed with a minimum separation of 1500 mm (60 in.)
≥ 1.50 mm (≥.059 in.)	None Allowed	None Allowed	None Allowed	None Allowed	None Allowed	None Allowed

<sup>A</sup> See 7.4.1 for detection, 7.4.1.1 for measurement and 7.4.3 for distribution of point blemishes.

<sup>B</sup> See 4.4 for maximum recommended surface area per cut size piece.

<sup>C</sup> The central area is considered to form a square or rectangle defined by the center 80 % of the length and 80 % of the width dimensions centered on a lite of mirror. The remaining area is considered the outer area.

<sup>D</sup> Provided that clusters are not formed.

**TABLE 3 Allowable Point Blemish Size and Distribution For Mirror Lehr End Grade**

NOTE—Follow the requirements for the appropriate Quality (Mirror Select Quality or Mirror Glazing Quality) for Mirror Stock Sheet in Table 2 with the following additional details for Mirror Lehr End Requirements:

If mirror area < 7 m<sup>2</sup> (75 SF)—one rejectable defect allowed  
 If mirror area ≥ 7 m<sup>2</sup> (75 SF)—two rejectable defects allowed

6.3.1.2 *Linear Blemish Limits*—When inspected in accordance with Test Method 7.4.2 linear blemishes shall be within the limits shown in Table 4.

6.3.2 *Blemish Limits for Mirror Lehr End Grade:*

6.3.2.1 *Point Blemish Limits*—When tested in accordance with Test Method 7.4.1 mirrors shall meet the quality requirements shown in Tables 2 and 3.

6.3.2.2 *Linear Blemish Limits*—When tested in accordance with Test Method 7.4.2 mirrors shall meet the quality requirements shown in Table 4.

6.4 *Edge Quality Requirements*—Edges shall be clean cut. (Types and qualities of edgework are not within the scope of

this specification. Consult manufacturer before specifying.)

6.4.1 *Shell Chips*—Shell chips are permitted in the edges of clean cut mirror as long as they do not exceed the acceptance criteria shown in Table 5.

6.4.2 *V-Chips*—V-Chips are not permitted.

6.5 *Dimensional Tolerances:*

6.5.1 *Thickness*—When measured at any point throughout the sheet, tolerances for thickness (including uniformity of thickness) of mirrors shall be in accordance with Table 1.

6.5.2 *Length and Width*—When measured in accordance with Test Method 7.5, tolerances for length and width of mirrors shall be in accordance with Table 1.

6.5.3 *Squareness*—When measured in accordance with Test Method 7.6, tolerances for squareness of mirrors shall be in accordance with Table 1.

6.6 *Distortion Requirements*—Limited levels of distortion are inherent in flat glass mirrors and are permitted, provided that the glass used in manufacturing the mirrors conforms to the following limits.

6.6.1 *Distortion Limits for Mirror Select Quality Mirrors*—

**TABLE 4 Allowable Linear Blemish Size and Distribution for Mirror Cut Size, Mirror Stock Sheet and Mirror Lehr End Grades of Mirrors**

Linear Blemish Size Blemish Intensity <sup>b</sup>	Blemish Length	Mirror Cut Size <sup>a</sup>		Mirror Stock Sheet and Lehr End			
		Mirror Select Quality (usually available in 6 mm (1/4 in.) clear mirror only)	Mirror Glazing Quality	Mirror Select Quality (usually available in 6 mm (1/4 in.) clear mirror only)		Mirror Glazing Quality	
				Central <sup>c</sup>	Outer <sup>c</sup>	Central <sup>c</sup>	Outer <sup>c</sup>
Faint	≤75 mm (3 in.)	Allowed <sup>d</sup>	Allowed <sup>d</sup>	Allowed <sup>d</sup>	Allowed <sup>d</sup>	Allowed <sup>d</sup>	Allowed <sup>d</sup>
	>75 mm (3 in.)	None allowed	Allowed <sup>d</sup>	Allowed <sup>d</sup>	Allowed <sup>d</sup>	Allowed <sup>d</sup>	Allowed <sup>d</sup>
Light	≤75 mm (3 in.)	None allowed	Allowed with a minimum separation of 600 mm (24 in.)	Allowed with a minimum separation of 600 mm (24 in.)	Allowed with a minimum separation of 600 mm (24 in.)	Allowed with a minimum separation of 600 mm (24 in.)	Allowed with a minimum separation of 600 mm (24 in.)
	>75 mm (3 in.)	None allowed	None allowed	None allowed	Allowed with a minimum separation of 600 mm (24 in.)	None allowed	Allowed with a minimum separation of 600 mm (24 in.)
Medium	≤75 mm (3 in.)	None allowed	None allowed	None allowed	Allowed with a minimum separation of 1200 mm (48 in.)	None allowed	Allowed with a minimum separation of 1200 mm (48 in.)
	>75 mm (3 in.)	None allowed	None allowed	None allowed	None allowed	None allowed	None allowed
Heavy	≤75 mm (3 in.)	None allowed	None allowed	None allowed	Allowed with a minimum separation of 1200 mm (48 in.)	None allowed	Allowed with a minimum separation of 1200 mm (48 in.)
	>75 mm (3 in.)	None allowed	None allowed	None allowed	None allowed	None allowed	None allowed

  

Blemish Intensity Chart	
Over 1.5 m (60 in.)	Heavy
1.5 m (60 in.) to 0.6 m (24 in.)	Medium
.6 m (24 in.) to 0.2 m (8 in.)	Light
Less than 0.2 m (8 in.)	Faint

<sup>a</sup> See 4.4 for maximum recommended surface area per cut size piece.

<sup>b</sup> See 7.4.2 for detection and 7.4.3 for distribution of linear blemishes.

<sup>c</sup> The central area is considered to form a square or rectangle defined by the center 80 % of the length and 80 % of the width dimensions centered on a lite of mirror. The remaining area is considered the outer area.

<sup>d</sup> Provided that clusters are not formed.

**TABLE 5 Allowable Chip Size For Mirror Cut Size, Mirror Stock Sheet and Mirror Lehr End Grades**

Description	Mirror Cut Size	Mirror Stock Sheet	Mirror Lehr End
Chip Depth	Chip depth ≤25 % of mirror thickness	Chip depth ≤50 % of mirror thickness	Chip depth ≤50 % of mirror thickness
Chip Width <sup>a</sup>	Chip width ≤25 % of mirror thickness or 1.6 mm (1/16 in.) whichever is greater	Chip width ≤50 % of mirror thickness or 1.6 mm (1/16 in.) whichever is greater	
Chip Length <sup>a</sup>	Chip length ≤2 times the chip width	Chip length ≤2 times the chip width	

<sup>a</sup> Chip Width and Length are not applicable to Mirror Lehr End.

**TABLE 6 Resistance Criteria for Mirror Coating**

Test Procedure	Test Method Ref. #	Allowable Limits	
		Spot Faults	Edge Corrosion
Salt Fog Resistance	7.3	Max 5 faults of which: up to 2 of <3.0 mm (1/8 in.) diameter up to 5 of ≤0.5 mm (0.020 in.) diameter	Max. 3 mm (.118 in.) from edge into face of mirror

Glass used in the manufacture of Mirror Select Quality mirrors shall conform to the allowable distortion limits cited in Specification C 1036 for Q1 quality glass.

6.6.2 *Distortion Limits for Mirror Glazing Quality Mirrors*—Glass used in the manufacture of Mirror Glazing Quality mirrors shall conform to the allowable distortion limits cited in Specification C 1036 for Q2 quality glass.

6.7 *Fabrication Requirements*—Mirrors may be further fabricated using a variety of cutting, edging, and decorating processes. These processes are not covered within the scope of this specification and must be agreed upon between buyer and seller.

## 7. Test Methods

7.1 *Test Method for Reflectance*—Reflectance shall be measured in accordance with Test Method E 903.

7.2 *Test Method for Appearance of Silver Coating*—Place samples in a vertical position at a distance of approximately 1 m (39 in.) from the viewer. The viewer shall, with normal 20/20 vision (naked eye or corrected), inspect the reflective surface of the sample at an angle of 90° perpendicular to the surface using daylight (without direct sunlight) or other uniform diffused background lighting that simulates daylight.

7.3 *Coating Resistance Evaluation*—Coating resistance

shall be measured in accordance with Practice B 117 (Standard Method of Salt Spray Testing) except that the salt solution shall be prepared by dissolving  $20 \pm 1$  parts of mass sodium chloride to  $80 \pm 1$  parts water. Test specimens shall measure  $150 \times 150$  mm ( $6 \times 6$  in.). The period of exposure shall be 300 h. In evaluating test specimens at the end of the test, the viewing distance shall be approximately 450 mm (18 in.) with normal 20/20 vision (naked eye or corrected) so that illumination and viewing angles are opposing at approximately  $45^\circ$ . Illumination shall approximate two 40-watt fluorescent tubes at a distance of 1200 to 1500 mm (4 to 5 ft). Refer to Table 6 for evaluation criteria.

**7.4 Test Methods for Blemish Evaluation**—All visual inspections for blemishes are to be made with normal 20/20 vision (naked eye or corrected).

**7.4.1 Blemish Detection for Point Blemishes (Knots, Dirt, Stones, Gaseous Inclusions, Tin Particles, Crush and Other Similar Blemishes)**—Place samples in a vertical position at a distance of approximately 1 m (39 in.) from the viewer. The viewer shall look at the sample at an angle of  $90^\circ$  perpendicular to the surface using daylight (without direct sunlight) or other uniform diffused background lighting that simulates daylight. If a blemish is detected, measure in accordance with 7.4.1.1 and refer to Tables 2 and 3 for evaluation criteria.

**7.4.1.1 Point Blemish Measurement**—Point blemish size shall be determined by measuring the length and width of the blemish (including associated distortion) and calculating the average of the two dimensions ( $(\text{Length} + \text{Width}) / 2$ ). The allowable blemish sizes are listed in Tables 2 and 3.

**7.4.2 Detection For Linear Blemishes (Scratches, Rubs, Digs and Other Similar Blemishes)**—Place samples in a vertical position to the viewer. The viewer shall stand approximately 4 m (13 ft) from the samples and look at the samples at

an angle of  $90^\circ$  perpendicular to the surface using daylight (without direct sunlight) or other uniform diffused background lighting that simulates daylight. The viewer shall move towards the samples until a blemish is detected (if any). The distance from the viewer to the mirror surface when the blemish is first detectable is defined as the detection distance. Refer to Table 4 for evaluation criteria.

**7.4.3 Blemish Distribution**—In order to determine the allowable separation between blemishes (see Table 2 and Table 4), measure the distance between the two closest points of the blemishes. The allowable separation distance between blemishes is determined by the minimum separation of the larger of the two blemishes.

**7.5 Dimensional Measurements**—To measure the length and width of cut and stock sizes of mirrors, measure the perpendicular distance from edge to edge, including flares. Measurements taken at any point shall fall within the tolerance limits set forth in Table 1.

**7.6 Squareness Measurement**—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 1.

## 8. Marking

8.1 Each package of mirror shall bear a label, affixed by the manufacturer, giving the manufacturer's name or trademark, grade of mirror, quality of mirror, color, nominal thickness, quantity, dimensions, and place of manufacture.

## 9. Keywords

9.1 flat glass; glazing; mirror; reflectance; reflective coating; silvered

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