QUALITY SPECIFICATIONS

BRIN NORTHWESTERN GLASS FAB ST. GERMAIN'S GLASS HEARTLAND GLASS

www.bringlass.com

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Scope

This document defines the quality standards, tolerances, and appearance criteria for glass and metal products manufactured by Brin Glass Company (dba Northwestern Glass Fab) and its subsidiaries (St. Germain's Glass, Heartland Glass). Refer to the appropriate section of this document for the product being inspected.

These specifications are based on widely accepted industry standards that apply to glass and metal products used in windows, doors, skylights, and architectural glazing applications. See references provided at the end of this document for more information. As a company that aims to provide high-quality products and services to our customers, our intention is for all specifications in this document to meet or exceed industry standards.

Product specifications outsourced from 3rd party vendors may vary from the specifications detailed in this document. Please speak with your Brin Glass Company sales representative regarding outsourced product specifications prior to ordering.

INSTRUCTIONS FOR FIGURE 1 VIEWING CONDITIONS FOR BLEMISH DETECTION:

- Inspection lighting should be daylight (without direct sunlight) or uniform diffused background lighting with a minimum luminance of 1700 lux (160 foot-candles) and a maximum of 2500 lux (230 foot-candles) measured at the center of the glass surface. No direct sunlight or other direct lighting should be used in transmission or reflection to inspect for blemishes
- As you use the FIGURE 1 inspection criteria, begin viewing at the maximum specified viewing distance for the product and applicable blemish. Progress sequentially to each of the shorter distances noted (if applicable).
- Visual inspections should be made with 20/20 vision. Glass should be vertical, and viewer should be positioned perpendicular to the glass surface at a 90° angle
- Viewing conditions are based on *ASTM C1036 6.1.1 Viewing Conditions for Blemish Detection*. These inspection methods are widely accepted across the architectural glass industry and are intended to simulate how glass is commonly viewed while in service

(FIGURE 1) Viewing Conditions for Blemish Detection

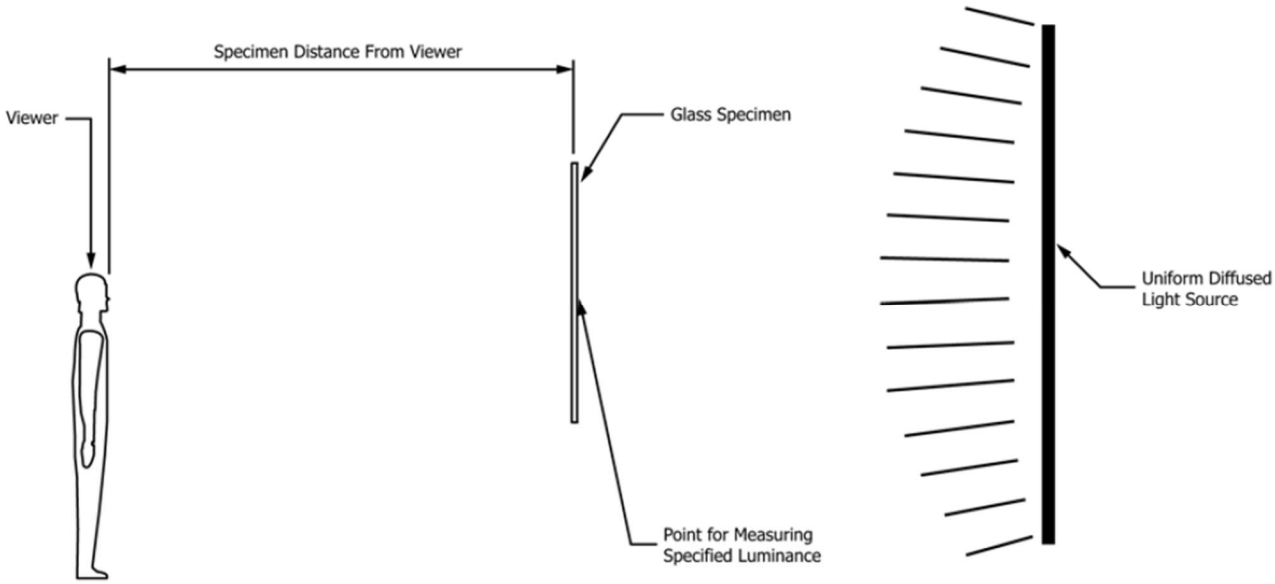


FIG. 1 Viewing Conditions for Blemish Detection

Quality Specifications for:

FLAT GLASS

This section covers the appearance criteria and tolerances specific to monolithic flat glass supplied as cut-to-size with clean cut or seamed edges, or as stock sheets. This includes flat, transparent, clear, low-iron, and tinted glass. These specifications can also apply to individual lites of flat glass that are part of a larger assembly, such as insulated glass or laminated glass. These specifications are based on ASTM C1036 Standard Specification for Flat Glass, Quality 3 (Q3) or better for cut-to-size glass, and Quality 4 (Q4) or better for stock sheets.

INSTRUCTIONS FOR LINEAR BLEMISH INSPECTION:

- To determine linear blemish intensity, start inspection at **10'** per viewing conditions described in FIGURE 1
- Progress sequentially to each of the shorter distances noted until the blemish is readily apparent. This is the detection distance
- Compare blemish to the length and separation criteria for allowable blemishes at that intensity

Linear Blemish *(scratch, rub, dig or similar imperfections – see p. 24 for examples)*		
BLEMISH INTENSITY	**DETECTION DISTANCE**	**LINEAR BLEMISH TOLERANCE** *(clean cut or seamed edge)*
Heavy	10'	None allowed
Medium	3'	Allowed if ≤ 3" length with a minimum separation of 24"
Light	8"	Allowed
Faint	Less than 8"	Allowed

STOCK SHEET tolerance =	No heavy blemishes allowed. Medium blemishes less than 3" long are allowed.

INSTRUCTIONS FOR POINT BLEMISH INSPECTION:

- Inspect for point blemishes at **3'** per viewing conditions described in FIGURE 1. All point blemishes not readily apparent at this distance are allowed
- Point blemish size = (width + length) / 2
- Point blemish size for this inspection does not include any associated distortion

Point Blemish *(seed, dirt, or similar imperfections – see p. 25 for examples)*	
POINT BLEMISH SIZE	**POINT BLEMISH TOLERANCE** *(clean cut or seamed edge)*
< 1/32"	Allowed
1/32" – 1/16"	Allowed with a minimum separation of 24"
>1/16"	None allowed

STOCK SHEET tolerance =	Point blemishes 1/16" and under are allowed without restriction. (2) point blemishes > 1/16" allowed per stock sheet.

Chip Tolerance *(on clean cut or seamed edges - see p. 25 for chip visual aids)*			
GLASS THICKNESS	**CHIP DEPTH max (50% of glass thickness)**	**CHIP WIDTH max**	**CHIP LENGTH max**
3/32”	3/64”	1/8”	1/4”
1/8”	1/16”	1/8”	1/4”
5/32”	5/64”	5/32”	1/2"
3/16”	3/32”	3/16”	
1/4”	1/8”	1/4"	
3/8”	3/16”	1/4"	
1/2"	1/4"	1/4"	
3/4"	3/8”	1/4"	
Stock Sheet	≤ 50% of glass thickness	Not Limited	Not Limited

- No V-chips are allowed
- Corner chips fall under size tolerance allowances
- Edge seaming maximum width: follow chip width specifications

Dimensional Size Tolerance *(on clean cut or seamed edges – including flares)*		
GLASS THICKNESS	**WIDTH and LENGTH**	
	CLEAN CUT or SEAMED EDGE	**STOCK SHEET**
3/32” – 1/4”	1/16”	1/2"
3/8”	3/32”	1/2"
1/2"	1/8”	1/2"
3/4"	3/16”	1/2"
CUSTOM SHAPE 99s (customer provided pattern): Add ± 1/16” to all size tolerances		

Squareness Tolerance		
GLASS THICKNESS	*(measured diagonally corner to corner)*	
	CLEAN CUT or SEAMED EDGE	**STOCK SHEET**
3/32” – 1/4”	5/64”	N/A
3/8”	1/8”	N/A
1/2"	11/64”	N/A
3/4"	1/4"	N/A

Quality Specifications for:

EDGEWORK & FABRICATION

This section covers the appearance criteria and tolerances specific to glass with edgework and other fabrication processes, such as holes, notches, and cut-outs. These specifications are based on ASTM C1036 Standard Specification for Flat Glass, Quality 2 (Q2) or better, and ASTM C1048 Standard Specification for Heat-Strengthened and Fully Tempered Flat Glass Section 7, Properties and Fabrication of Heat-Treated Glass.

INSTRUCTIONS FOR LINEAR BLEMISH INSPECTION:

- To determine linear blemish intensity, start inspection at **10'** per viewing conditions described in FIGURE 1
- Progress sequentially to each of the shorter distances noted until the blemish is readily apparent. This is the detection distance
- Compare blemish to the length and separation criteria for allowable blemishes at that intensity

Linear Blemish *(scratch, rub, dig or similar imperfections – see p. 24 for examples)*		
BLEMISH INTENSITY	**DETECTION DISTANCE**	**LINEAR BLEMISH TOLERANCE** *(glass with edgework or other fabrication)*
Heavy	10'	None allowed
Medium	3'	None allowed
Light	8"	Allowed if ≤ 3" length with a minimum separation of 48"
Faint	Less than 8"	Allowed

INSTRUCTIONS FOR POINT BLEMISH INSPECTION:

- Inspect for point blemishes at **3'** per viewing conditions described in FIGURE 1. All point blemishes not readily apparent at this distance are allowed
- Point blemish size = (width + length) / 2
- Point blemish size for this inspection includes any associated distortion

Point Blemish *(seed, dirt, or similar imperfections – see p. 25 for examples)*	
POINT BLEMISH SIZE	**POINT BLEMISH TOLERANCE** *(glass with edgework or other fabrication)*
< 1/64"	Allowed without restriction
1/64" – 1/32"	Allowed with a minimum separation of 24"
>1/32" – 1/16"	Allowed with a minimum separation of 60"
>1/16"	None allowed

Dimensional Size Tolerance *(glass with edgework or other fabrication)*		
GLASS THICKNESS	**WIDTH and LENGTH**	**SQUARENESS** *(measured diagonally corner to corner)*
3/32" – 1/4"	1/16"	5/64"
3/8"	1/16"	5/64"
1/2"	3/32"	1/8"
3/4"	1/8"	11/64"
CUSTOM SHAPE 99s (customer provided pattern): Add ± 1/16" to all size tolerances		

POLISHED and GROUND Edgework:

- Edge chips: not allowed if visible from **3'** when viewed per FIG. 1
- Corner chips: not allowed if visible from **5'** when viewed per FIG. 1
- Polish or grind marks: not allowed if visible from **5'** when viewed per FIG. 1
- Shiners/skips: not allowed

HOLES:

- Hole diameter: ± 1/16"
- Hole center from specified edge: ± 1/16"
- Between hole centers: ± 1/16"
- Chips / flakes at unpolished hole edges: 1/16" maximum width

NOTCHES & CUTOUTS:

- Glass edge to notch edge: ± 1/16"
- Notch edge to notch edge: ± 1/16"
- Notch center from specified edge: ± 1/16"
- Chips / flakes at unpolished edges: 1/16" maximum width
- Notch / cutout size tolerance for glass thickness 1/2" or less: ± 1/16"
- Notch / cutout size tolerance for glass thickness greater than 1/2": ± 1/8"

BEVELS:

- Bevel width: ± 1/16"
- Bevel parallel with glass edge: ± 1/32"
- Corner match: ± 1/8" on 90° angle, ± 1/4" on non 90° angle
- Edge thickness: ± 1/32"

WATERJET Edgework:

- No quality criteria. Not intended as an exposed edge. See: HOLES; NOTCHES & CUTOUTS for location and chip tolerances

SEAMED Edgework:

- No quality criteria. Not intended as an exposed edge. See: FLAT GLASS section for tolerances

LAMINATED GLASS Edgework:

- Interlayer edge defect tolerance: 1/32"

Quality Specifications for:

MIRROR

This section covers the appearance criteria and tolerances specific to silvered flat glass mirrors supplied as cut-to-size with clean cut or seamed edges, or as stock sheets. For mirror edgework and fabrication tolerances, see EDGEWORK & FABRICATION section. These specifications are based on ASTM C1503 Standard Specification for Silvered Flat Glass Mirror, Mirror Glazing Quality or better.

INSTRUCTIONS FOR LINEAR BLEMISH INSPECTION:

- To determine linear blemish intensity, start inspection at **10'** per viewing conditions described in FIGURE 1
- For mirror inspection per FIGURE 1, a viewing angle of **±10 degrees** is allowable
- Inspect the mirror while moving towards it until a blemish is readily apparent (if any). This is the detection distance
- Compare blemish to the length and separation criteria for allowable blemishes at that intensity

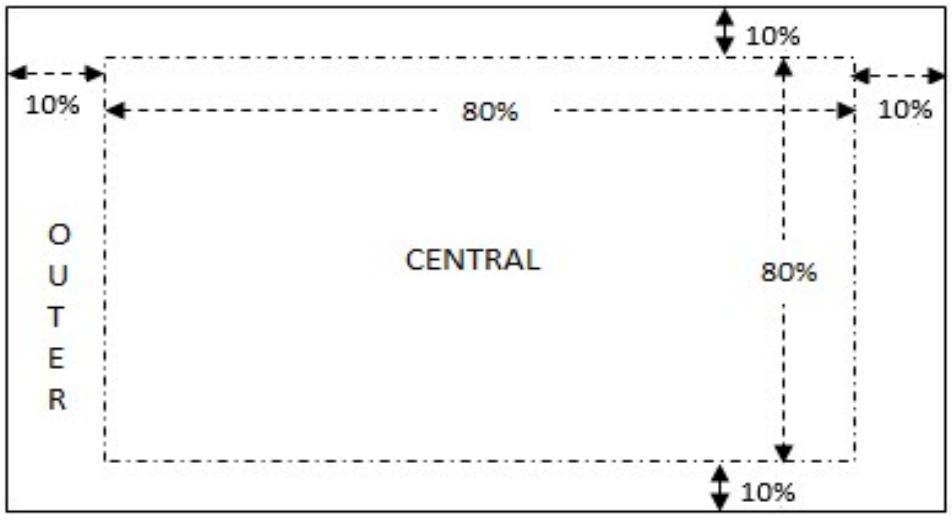
Linear Blemish *(scratch, rub, dig or similar imperfections – see p. 24 for examples)*		
BLEMISH INTENSITY	**DETECTION DISTANCE**	**LINEAR BLEMISH TOLERANCE** *(clean cut or seamed edge)*
Heavy	Over 5'	None allowed
Medium	5' to 24"	None allowed
Light	24" to 8"	Allowed if ≤ 3" length with a minimum separation of 24"
Faint	Under 8"	Allowed

Linear Blemish – STOCK SHEET			
BLEMISH INTENSITY	**DETECTION DISTANCE**	**CENTRAL**	**OUTER**
Heavy	Over 5'	None allowed	Allowed if ≤ 3" length with a minimum separation of 48"
Medium	5' to 2'	None allowed	Allowed if ≤ 3" length with a minimum separation of 48"
Light	24" to 8"	Allowed if ≤ 3" length with a minimum separation of 24"	Allowed with a minimum separation of 24"
Faint	Less than 8"	Allowed	Allowed

INSTRUCTIONS FOR POINT BLEMISH INSPECTION:

- Inspect for point blemishes at **3'** per viewing conditions described in FIGURE 1. For mirror inspection per FIG. 1, a viewing angle of **±10 degrees** is allowable. All point blemishes not readily apparent at this distance are allowed
- Determine defect location: CENTRAL or OUTER viewing area
- Point blemish size = (width + length) / 2
- Point blemish size for this inspection includes any associated distortion

Point Blemishes for Mirror *(seed, dirt or similar imperfections – see p. 25 for examples)*			
SIZE	**CENTRAL**	**OUTER**	**STOCK SHEET**
< .30mm (.012") (1/84")	Allowed (no clusters)	Allowed (no clusters)	Allowed (no clusters)
≥ .30mm - <.50mm (≥ .012" - < .02") (≥ 1/84" - < 1/50")	Allowed with a minimum separation of 12"	Allowed with a minimum separation of 12"	Allowed (no clusters)
≥ .50mm - <.80mm (≥ .02" - < .032") (≥ 1/50" - < 1/32")	None allowed	Allowed with a minimum separation of 12"	Allowed with a minimum separation of 24"
≥ .80mm - < 1.20mm (≥ .032" - < .047") (≥ 1/32" - < 3/64")	None allowed	Allowed with a minimum separation of 60"	Allowed with a minimum separation of 48"
≥ 1.20mm - <1.50mm (≥ .047" - <.059") (≥ 3/64" - < 1/16")	None allowed	None allowed	Allowed with a minimum separation of 60"
≥ 1.50mm (≥ .059") (≥ 1/16")	None allowed	None allowed	None allowed



Silver Film Blemish
Allowed if not readily apparent from **3'** per viewing conditions in FIG. 1, **±10 degrees**

Chip Tolerance *(on clean cut or seamed edges) (see p. 25 for chip visual aids)*			
GLASS THICKNESS	**CHIP DEPTH max (25% of mirror thickness)**	**CHIP WIDTH max**	**CHIP LENGTH max**
3/32"	3/128"	1/16"	1/8"
1/8"	1/32"		
5/32"	5/128"		
3/16"	3/64"		
1/4"	1/16"		
Stock Sheet	≤ 50% of mirror thickness	Not Limited	Not Limited

- No V-chips allowed
- Corner chips fall under size tolerance allowances
- Edge seaming maximum width: follow chip width specifications

Dimensional Size Tolerance		
MIRROR THICKNESS	**WIDTH and LENGTH**	
	CLEAN CUT or SEAMED EDGE	**STOCK SHEET**
3/32" – 1/4"	1/16"	1/4"

Squareness Tolerance		
MIRROR THICKNESS	*(measured diagonally corner to corner)*	
	CLEAN CUT or SEAMED EDGE	**STOCK SHEET**
3/32" – 1/4"	5/64"	N/A

Quality Specifications for:

TEMPERED GLASS

This section covers the appearance criteria, tolerances, and design recommendations that are specific to fully tempered glass of all types. These specifications meet or exceed ASTM C1048 Standard Specification for Heat-Treated and Fully Tempered Flat Glass.

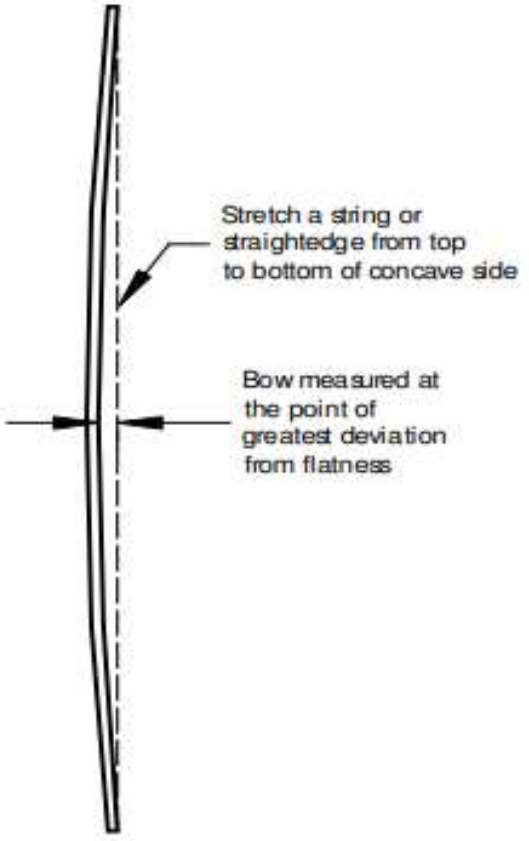
BOW & WARP Tolerance:

Bow and warp in tempered glass is the curvature across the entire specified dimension of the lite of glass. The processes used in manufacturing tempered glass cause it to be not as flat as annealed glass. The deviation from flatness depends on thickness, width, length, and other factors. In general, greater thickness yields flatter glass.

To determine if glass is within allowable limits for bow and warp, use the following test method.

Test Method:

1. Place glass in a freestanding vertical position, resting on blocks at the quarter points.
2. Place a straight edge across the concave side, parallel to and within 1" of the glass edge. If a straight edge is impractical, a string may be stretched around the glass within 1" of the glass edge.
3. Measure the widest gap with a feeler gauge or other measuring device.
4. Refer to Bow and Warp Maximum Limits table.



Bow & Warp Maximum Limits										
	EDGE DIMENSIONS IN INCHES (WIDTH/LENGTH OF GLASS)									
	0-24	24-36	36-48	48-60	60-72	72-84	84-96	96-108	108-120	120-132
GLASS THICKNESS										
1/8"	1/8"	1/8"	3/16"	1/4"	5/16"	3/8"	-	-	-	-
5/32"	1/8"	1/8"	3/16"	1/4"	5/16"	3/8"	7/16"	-	-	-
3/16"	1/8"	1/8"	3/16"	1/4"	9/32"	11/32"	7/16"	9/16"	11/16"	-
1/4"	1/16"	3/32"	1/8"	5/32"	3/16"	7/32"	11/32"	7/16"	9/16"	11/16"
3/8"	1/16"	1/16"	1/16"	3/32"	1/8"	5/32"	3/16"	1/4"	13/32"	15/32"
1/2" & UP	1/32"	1/16"	1/16"	1/16"	3/32"	1/8"	5/32"	7/32"	11/32"	13/32"

LOCALIZED BOW & WARP:

Localized bow and warp for rectangular glass should not exceed 1/16” over any 12” span.

DISTORTION:

Tempered glass is made by heating glass in a furnace, followed by a rapid cooling with air. The original flatness of the glass is modified by the heat treatment, which can cause reflected images to appear distorted. This is a normal part of the heat-treating process and is not considered a defect. Regardless of glass flatness, the degree of distortion perceived is largely due to the characteristics or symmetry of the object(s) being reflected.

Any requirements for distortion, roller wave, consistent furnace orientation, or distortion measurement must be disclosed at quotation and prior to order.

Size Recommendations for Tempered Glass

INSULATED GLASS

TABLE 1: Recommended maximum length for TEMPERED insulated glass. Limitations are based on manufacturing and safe handling limits. IGUs that exceed these recommendations are not covered by warranty for bow and warp.

Table 1- INSULATED GLASS (TEMPERED)	
GLASS THICKNESS	MAXIMUM LENGTH
1/8"	80”
5/32"	90”
3/16"	100”
1/4"	128"

FIXED INTERIOR MONOLITHIC GLASS

The fixed panels of interior glass partitions mounted or restrained on only two sides (top and bottom) require special design considerations. These recommendations address an issue of concern in these applications that has frequently occurred. Glass held on only two sides is much more flexible than glass supported on all four sides. Some installations have been under-designed and installed with inadequate glass thickness. This can result in excessive glass deflection under indoor loads caused by stack action, HVAC changes, doors to the outdoors opening and closing, and people pushing or leaning on the glass.

Glass that is too thin can tremble, shimmer or deflect excessively, even though the tempered glass meets design probability of breakage requirements. As the unsupported span or height of the glass panels increases, the glass thickness must also increase to maintain a reasonable stiffness.

TABLE 2: Recommended MINIMUM thickness for tempered glass used in butt-glazed (vertical edges unsupported) fixed interior glass panels mounted or restrained at top and bottom only.

Table 2 – FIXED INTERIOR GLASS PANELS (TEMPERED)	
Unsupported span from top to bottom of glass	**Recommended minimum thickness of TEMPERED glass**
Up to 5’	1/4"
5’ – 8’	3/8”
8’ – 10’	1/2"
10’ – 14’	3/4"
Over 14’	Contact Sales

CAUTIONS:
Structural joints or permanently clipping adjacent panels do not add to the structural strength or rigidity of the assembly, and do not permit reduction of the recommended thicknesses shown in TABLE 2.

Open narrow joints between butt-glazed glass panels may catch or pinch fingers. The best preventative is to avoid open joints by filling them with silicone. An alternative is to install permanent clamps approximately every four feet to couple the adjoining panels together. This helps prevent relative movement between panels. The gap between panels with unfilled joints should be such that fingers cannot be inserted and trapped.

FIXED EXTERIOR MONOLITHIC GLASS

For outdoor applications of butt-joint glazing, with higher design wind loads than indoor applications, similar under-designed use of glass have also occurred. To address such applications, use ASTM E1300 “Standard Practice for Determining the Minimum Thickness of Annealed Glass Required to Resist a Specified Load”.

MONOLITHIC SWINGING DOORS

Door sizes need to be limited due to glass flexibility and hardware limitations. Closers and pivots have weight limitations. Doors that are too wide are difficult to control in windy conditions and may exceed hardware limits. Full rails, top and bottom are recommended for larger door sizes.

Table 3 recommends the maximum interior swing door sizes using various glass and hardware options. These maximum sizes consider both the hardware manufacturer's design limitations and glass deflection considerations.

Table 3. Guidelines for Interior Swinging Door Sizes

Entrances utilizing non-structural interlayers and/or exterior door applications are dependent on numerous factors impacting the intended design of the entrance. These types of entrances should be reviewed by qualified individuals or manufacturers with engineering capabilities.

Fully Tempered and Tempered Laminated Glass							
		R/R (Full Rails)			P/P (Patch Fittings) and/or P/R (Rail Combinations)		
Glass Thickness **Glass Weight**		**10 mm (3/8 in.) [5 lb/sf]**	**12 mm (1/2 in.) [6.4 lb/sf]**	**19 mm (3/4 in.) [9.8 lb/sf]**	**10 mm (3/8 in.) [5 lb/sf]**	**12 mm (1/2 in.) [6.4 lb/sf]**	**19 mm (3/4 in.) [9.8 lb/sf]**
Concealed Overhead Closer *(200 lb max typically)*	Width	914 mm (36")	1067 mm (42")	914 mm (36")	914 mm (36")	1067 mm (42")	914 mm (36")
	Height	2134 mm (84")	2743 mm (108")	2134 mm (84")	2134 mm (84")	2591 mm (102")	2134 mm (84")
	Glass Weight	(105 lbs.)	(202 lbs.)	(206 lbs.)	(105 lbs.)	(191 lbs.)	(206 lbs.)
Floor Closer	Width	914 mm (36")	1219 mm (48")	1219 mm (48")	914 mm (36")	1067 mm (42")	914 mm (36")
	Height	2134 mm (84")	2743 mm (108")	3048 mm (120")	2134 mm (84")	2591 mm (102")	2473 mm (108")
	Glass Weight	(105 lbs.)	(230 lbs.)	(392 lbs.)	(105 lbs.)	(191 lbs.)	(265 lbs.)

SLIDING DOORS

Tempered sliding glass doors can be utilized in slider door systems using either floor mounted or top mounted rollers. The weight of the sliding doors can be supported by rollers on a floor track or suspended from rollers in an overhead track.

The size and weight limitations for sliding doors are largely dependent on the type of hardware used. Your sales representative can assist you with choosing the correct hardware and other design considerations for your sliding glass door application.

Fixed Monolithic Glass and Swinging Door information and recommendation excerpts from NGA (National Glass Association with GANA) Heavy Glass Door Design Manual, 2021 edition. For full details, this manual is available on the NGA website, www.glass.org.

Quality Specifications for:

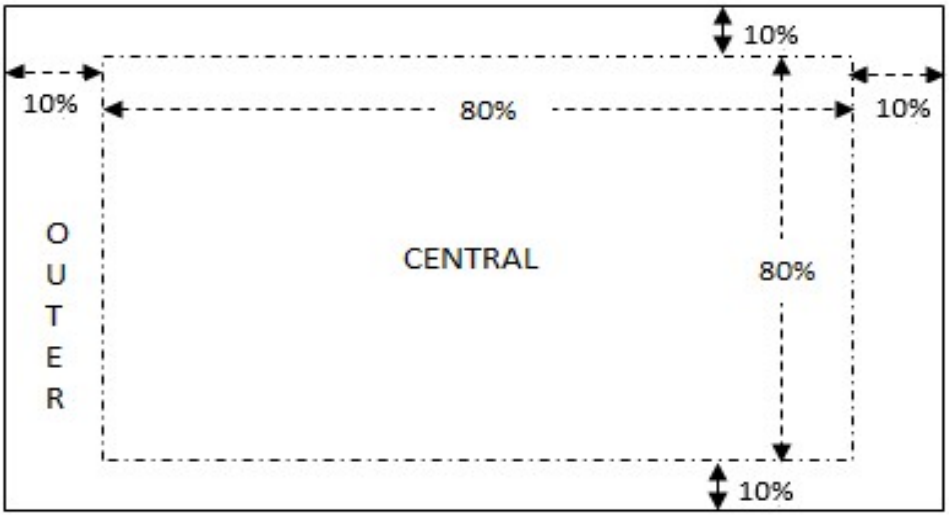
LAMINATED GLASS

This section covers the appearance criteria and tolerances for flat laminated glass consisting of two or more lites of glass bonded with an interlayer material. These specifications are based on ASTM C1172 Standard Specification for Laminated Flat Glass.

The criteria covered in this section are applicable to any perceived blemishes in the interlayer material and/or in between the lites of glass themselves. For any perceived blemish on/in each individual lite of glass, see FLAT GLASS section. For edgework and fabrication tolerances, see EDGEWORK & FABRICATION section.

INSTRUCTIONS FOR LAMINATING PROCESS BLEMISH INSPECTION:

- Inspect for blemishes at **3'** per viewing conditions described in FIGURE 1. All blemishes not readily apparent at this distance are allowed
- Determine glass surface area (ft^2)
- Determine defect location:
  CENTRAL or OUTER viewing area
- Evaluate blemish according to the LAMINATING PROCESS BLEMISHES table below in accordance with the following criteria and definitions:
  - *Light intensity*= barely noticeable at 3'
  - *Medium intensity*: noticeable at 3' but not at 10'
  - Laminates with more than 2 lites of glass may contain proportionally more blemishes



LAMINATING PROCESS BLEMISHES *maximum allowable*	Up to 25 ft²		25ft² +		Stock Sheet	
	Central	Outer	Central	Outer	Central	Outer
Short Interlayer, Chip*, Un-laminated Area	-	1/4"	-	1/4"	-	1/4"
Inside dirt (dirt spot)	1/16"	3/32"	3/32"	5/32"	1/8"	3/16"
Separation, Discoloration	none	none	none	none	none	none
Boil	1/16"	3/32"	1/8"	3/16"	1/4"	1/4"
Blow-in or Edge Boil	-	1/4"	-	1/4"	-	5/16"
Fuse	1/32"	1/16"	1/16"	3/32"	3/32"	5/32"
Hair or Lint	light intensity	medium intensity	light intensity	medium intensity	medium intensity	medium intensity
Lint- areas of concentrated lint	light intensity	medium intensity	light intensity	medium intensity	medium intensity	medium intensity
Scuff or Streak	light intensity	medium intensity	medium intensity	medium intensity	medium intensity	medium intensity
ALL BLEMISHES NOTED MUST BE SEPERATED BY A MINIMUM OF 12"						

* Missing corner chips of maximum 1/4" allowed on 1 lite of laminate only. 2nd lite must meet appropriate width and length tolerances.

Dimensional Size Tolerance *(including mismatch)*			
TOTAL LAMINATE THICKNESS	Up to 25 ft²	Over 25 ft²	STOCK SHEET
	CLEAN CUT or SEAMED EDGE	CLEAN CUT or SEAMED EDGE	
≤ 1/4"	± 1/16"	+ 3/32" , - 1/16"	± 1/2"
> 1/4" - 1/2"	+ 1/8" , - 1/16"	+ 5/32" , - 1/16"	± 1/2"
> 1/2"	± 1/8"	+ 5/32" , - 1/8"	± 1/2"
SQUARENESS TOLERANCE *(measured diagonally)*	± 3/16"	± 3/8"	N/A

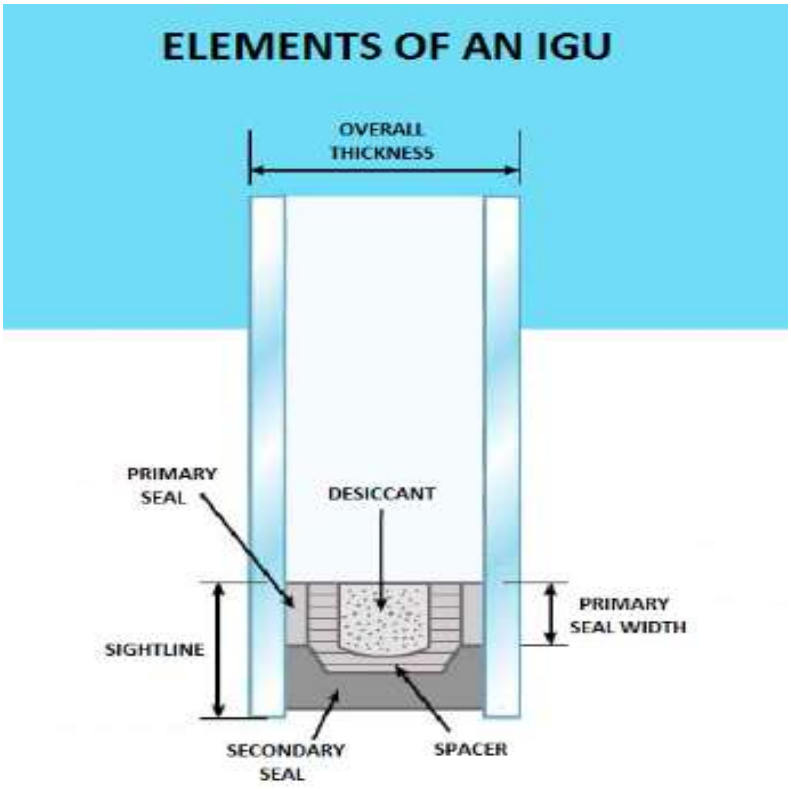
Thickness Tolerance (all sizes) = ± 1/32"

Quality Specifications for:

INSULATED GLASS

This section defines the appearance criteria and tolerances that apply to dual sealed Insulated Glass Units (IGUs). These specifications are based on IGCC (Insulating Glass Certification Council) and IGMA (Insulating Glass Manufacturers Alliance) quality assurance procedures, guidelines and specifications, and ASTM E2190 Standard Specification for Insulating Glass Unit Performance and Evaluation.

For any perceived blemish on the exterior surface of and/or within each individual lite of glass or interlayer, see the applicable section of this document for the individual lite (FLAT GLASS, LAMINATED GLASS, etc.)



PRIMARY SEAL *(butyl, PIB, polyisobutylene)*

PLACEMENT:
Primary seal should not be exposed at any point along the outer edge of the IGU. Primary seal is allowed to enter the air space of the IGU if it does not exceed overall sightline specification.

SEAL WIDTH:
A minimum primary seal width of 1/16” is allowed for a maximum total length of 8” for the entire IGU. The minimum primary seal width for the rest of the IGU is 1/8”.

GAPS:
No gaps or skips are allowed in the primary seal.

DEBRIS:
Minor debris is permitted in the primary seal, but seal width and gap requirements must be met.

SECONDARY SEAL *(silicone or polyurethane)*

COVERAGE:
Secondary seal must cover the entire outer surface of the spacer. The outer surface of the spacer should not be exposed or visible at any point.

SEAL THICKNESS:
The minimum fill thickness of the secondary seal is 1/16”, as measured from the outer surface of the spacer to the thinnest point of the secondary seal.

SEAL OVERFILL:
Up to 3/32” of overfill is allowed from the glass edge.

VOIDS:
Voids or separations between primary and secondary seal are permitted to a maximum width of 1/16” by a maximum length of 6” with gaps separated by at least 16”.

CORNER VOIDS:
Up to 3/32” from the primary seal edge to the continuation of the secondary seal.

DEBRIS:
Minor debris is permitted in secondary seal, but seal thickness, coverage, and void requirements must be met.

SIGHT LINE

DEFINITION:
The sight line is defined as the perimeter area of the IGU that contains the primary seal, secondary seal, and spacer. The sight line is measured from the outside edge of the glass (largest lite) to the inside edge of the sight line (spacer or primary seal).

STANDARD SIGHT LINE SIZE TOLERANCES:

- Aluminum spacer: 9/16” max, 5/16” min
- Super Spacer: 1/2" max, 3/8” min

SIGHT LINE EDGE DELETE for SOFT COAT LOW-E IGUs:

- 1/2" max, 3/8” min

EXTERIOR GLASS SURFACE CLEANLINESS

WITHIN SIGHT LINE:
Up to 1/64” of excess sealant on the outer surface of each pane of glass within the sight line of the IGU is allowed.

DAYLIGHT OPENING:
Daylight opening is defined as the central glass area between the sight lines of the IGU that is looked through unobstructed.

Minor glass surface obstructions in the daylight opening (fingerprints, smudges, etc.) that are easily removed with common glass cleaning methods (glass cleaner, isopropyl alcohol, etc.) are allowed.

SIZE TOLERANCES

OVERALL (OA) THICKNESS TOLERANCE:
(multiple configurations default to larger tolerance)

Standard: + 1/32” / -1/16”

IGUs with ¼” glass: + 1/32” / -3/32”
IGUs with patterned, laminated, or wire glass: ± 1/16”

IGUs with 3/16” mill spacer using 3/32” glass: ± 1/16”
IGUs with 3/16” mill spacer using 1/8” or thicker glass: + 3/32” / -1/16”

Triple pane IGUs: ± 1/16”
Triple pane IGUs using 3/16” mill spacer: + 1/8” / -1/16”

WIDTH AND HEIGHT TOLERANCE:

IGUs with:
Both Width and Height Dimension < 80”: ± 1/16”
1 or more Width or Height Dimension ≥ 80”: + 1/8 / - 1/16”
Laminated or Wire glass: + 1/8 / - 1/16”
Custom shape 99 glass (customer provided pattern): ± 1/8”
Edgework on 1 or more lites: ± 1/8”

SQUARENESS TOLERANCE:
± 1/4”

GRID PLACEMENT and SQUARENESS TOLERANCE:
± 1/16”

BLEMISH TOLERANCES

VISUAL OBSTRUCTIONS (INTERNAL):

INSTRUCTIONS FOR VISUAL OBSTRUCTION INSPECTION:

- Inspect for visual obstructions inside the IGU at **3'** per viewing conditions described in FIGURE 1. All visual obstructions not readily apparent at this distance are allowed
- For any perceived blemish on the exterior surface of and/or within each individual lite of glass or interlayer, see the applicable section of this document for the individual lite (FLAT GLASS, LAMINATED GLASS, etc.)
- Visual obstructions inside the IGU may include, but are not limited to water spots, adhesive residue, fingerprints, dirt/debris, desiccant dusting
- If readily apparent, compare to size and separation criteria below:

Internal Visual Obstructions *(water spots, adhesive residue, fingerprints, etc.)*	
VISUAL OBSTRUCTION SIZE	**VISUAL OBSTRUCTION TOLERANCE**
< 1/32"	Allowed
1/32" – 1/16"	Allowed with a minimum separation of 24"
>1/16"	None allowed

BOW & WARP:

See TEMPERED GLASS section for tempered IGU bow and warp tolerances.

Quality Specifications for:

METAL FABRICATION

This section covers the tolerances and appearance criteria specific to metal shop fabrication.

Fabrication Guidelines:

- Metal will be built to Tubelite specifications
- Framing with screw spline joints will be assembled
- Framing with shear blocks will be fabricated and shipped KD
    - Exception: Door jambs with shear blocks will be assembled

Dimensional Size Tolerance:

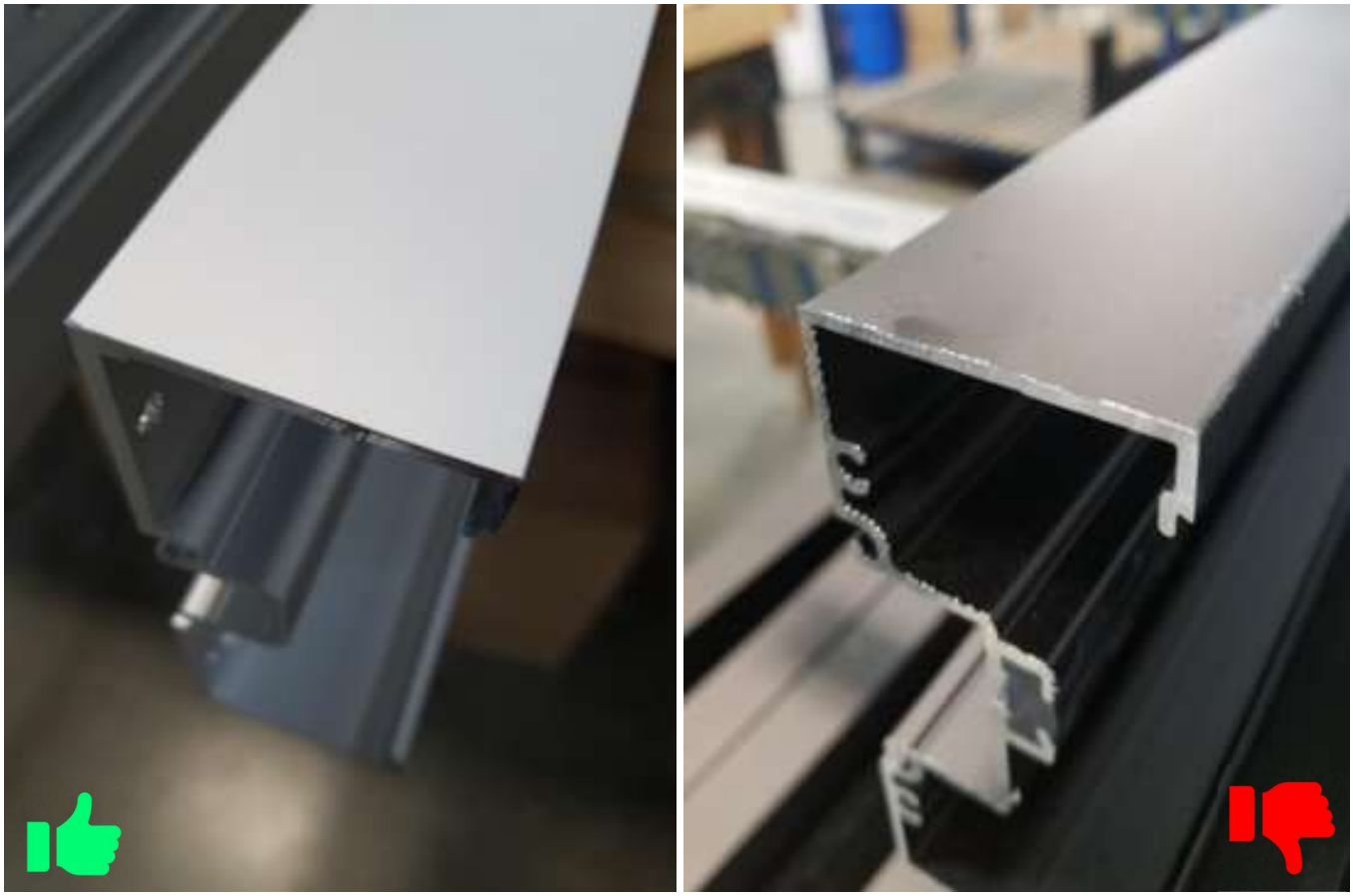
- Frame dimension size:
    - up to 120": ± 1/16"
    - 120"-200": ± 1/8"
    - Add ± 1/16" each additional 100"

Joints:

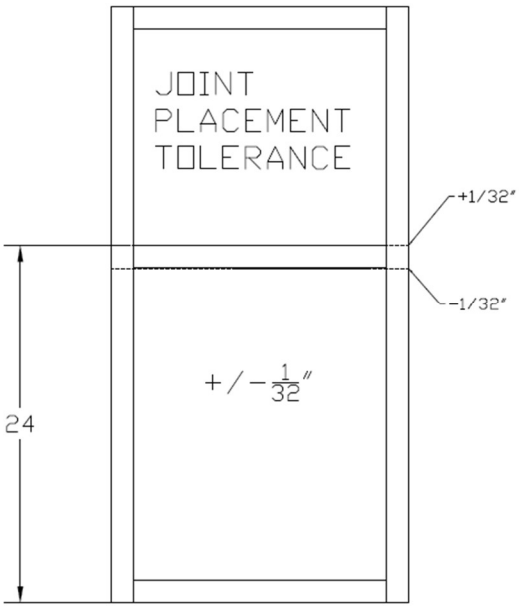
- Joints should be visibly flush
- Joints should be tight. No daylight visible
- No excess silicone should be present

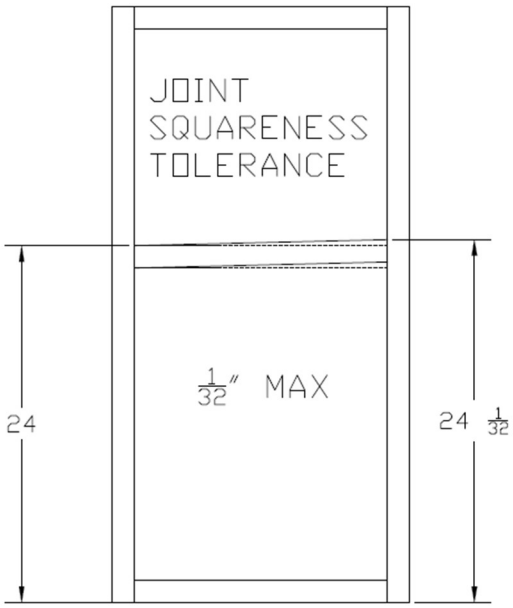
Joints (continued):

- Cut ends should be filed/deburred



- Joint placement tolerance: ± 1/32”
- Joint squareness tolerance: 1/32” max





Hardware:

- Installed hardware should be tight to metal surface
- Hinges, mortise locks, etc. should be visibly flush
- Hardware placement tolerance: ± 1/16”
- Handles, panics, etc. should be straight
    - Tolerance: 1/16” out of square max

Screws:

- Frame screws should be tight to metal surface
- Hardware screws should be tight and flush or slightly countersunk to metal surface

Terminology

associated distortion—alteration of viewed images caused by variations in glass flatness or inhomogeneous portions within the glass
bevel—angled surface at the edge of a lite of glass
blemish—imperfection in the body or on the surface of the glass
blow-in—a separation of glass and interlayer at or close to the laminate edge
boil —a bubble or gas pocket in the interlayer material or between the glass and interlayer
bow— the deviation in flatness of a lite of glass, expressed over the entire width or length dimension of the lite or over a smaller, local span
chip- indentation in the glass edge as a result of breakage of a small fragment
chip depth —measured distance of a chip from the glass surface into the thickness
chip length—maximum distance parallel to the edge of the glass from one edge of a chip to the other
chip width—maximum perpendicular distance from the edge of the glass to the inner edge of the chip
clam— see shell chip
clear glass—glass formulated to have transmittance in the visible spectrum greater than 82 % at a standard thickness of 6 mm (1⁄4 in.) with lack of color as compared to tinted glass of the same thickness
cluster—a group of not less than (3) point blemishes separated by not more than 50 mm (2 in.)
crush—pitted condition with a dull appearance
cut size —glass ordered cut to its final intended size
delamination—a condition in which one or two of the lites of glass loses the bond between the glass lite and the interlayer
dig—a deep scratch in the glass surface
direct lighting- lighting in which the greater part of the light goes directly from the source to the area lit
dirt—small particle of foreign matter embedded in the surface of the glass
discoloration- a visibly noticeable color change (from original) in the appearance of a material
edge boil—See boil
flare—protrusion on the glass edge or corner of an otherwise rectangular surface
fuse—a glass particle or crystalline material that is permanently bonded to a surface of a lite
hair—a slender, pigmented filament from human or animal epidermis or other thread-like filament
inside dirt—foreign material trapped inside the laminate
interlayer—a layer or multiple layers of material acting as an adhesive between lites of glass which adds additional performance to the finished product
KD— (knock down) product supplied unassembled, with all components needed for assembly
laminated glass—an assembly consisting of two or more lites of glass that are bonded together by interlayer material
linear blemish—scratch, rub, dig or other similar imperfection, which may be straight or curved in nature. If curved, the length of such a blemish is to be measured from end to end along the curve
lint—short fibers of yarn or fabric trapped within the laminate
lite or light—a panel or sheet of glass
low iron glass—glass formulated to have transmittance in the visible spectrum higher than that of clear glass of the same thickness
mismatch— misalignment of the edges of two lites of glass when laminated
oyster— see shell chip
point blemish—seed, dirt, crush, stone, or other similar imperfection
rub—abrasion of a glass surface producing a frosted appearance
scratch—an abrasion of a glass surface in the form of a curved line, a straight line or both

scuff—see streak
seed- round or elongated bubble in the glass
separation-- an area of the laminate that has become delaminated (see *delamination*)
shell chip — any chip other than a v-chip
shiner—an area on a glass edge that has not been ground or polished
short interlayer—a condition of the laminate in which the interlayer does not extend to the edge
silver film blemish—visible clouding, spot silver faults and other similar imperfections of the silver coating
skip— see shiner
spot silver fault—a small area at which the silver coating is partially or entirely absent
stock sheet—glass ordered in sizes intended to be cut to create final or cut size
stone—crystalline inclusion in glass
streak—a noticeably visible deviation on or in the laminating unit
tinted glass—glass formulated to have a uniform color throughout the glass, with the purpose of reducing glare (visible transmittance), solar heat gain or ultraviolet (UV) transmittance
unlaminated area—an area of the laminate that failed to laminate during the lamination process. This blemish may be discernable due to the textured appearance of the interlayer material
v-chip— *a chip forming an acute angle, located at the edge(s) of a glass lite and which may cause a crack in the glass*
visible clouding—a frosted appearance in the reflected image from a silvered mirror
visual obstruction-- anything located inside the sealed insulated glass unit that unintentionally and materially inhibits a person's view through the glazed daylight opening from either interior-to-exterior or exterior-to-interior, when inspected in accordance with FIGURE 1

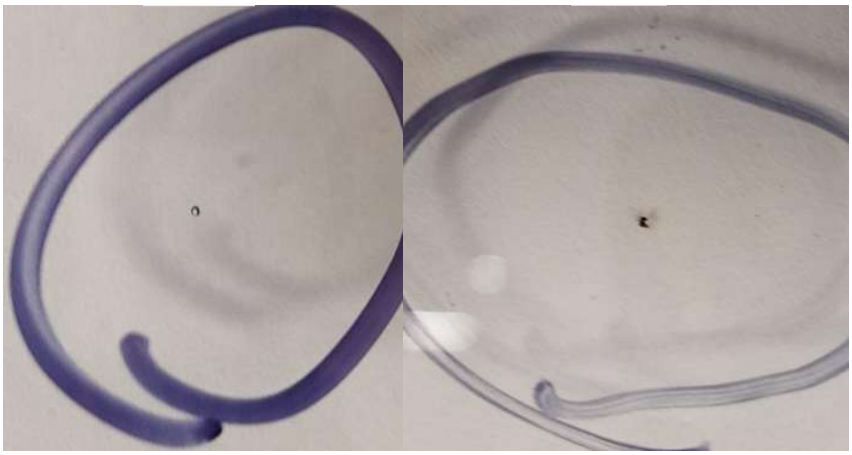
Visual Aids

LINEAR BLEMISHES-

scratch ***rub*** ***dig***

POINT BLEMISHES-

seed ***dirt***

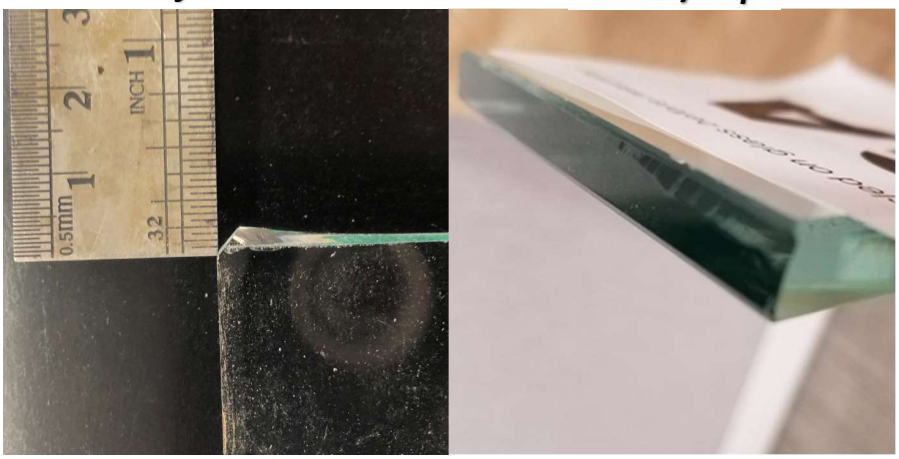


CHIPS-

shell chip ***v-chip*** ***chip dimensions***

EDGE DEFECTS-

flare ***shiner/skip***



References

ASTM C1036 Standard Specification for Flat Glass
ASTM C1048 Standard Specification for Heat-Strengthened and Fully Tempered Flat Glass
ASTM C1172 Standard Specification for Laminated Architectural Flat Glass
ASTM C1503 Standard Specification for Silvered Flat Glass Mirror
ASTM E2190 Standard Specification for Insulating Glass Unit Performance and Evaluation
IGMA TB-1200 Guidelines for Insulating Glass Dimensional Tolerances
IGMA TB-1250 PIB Primary Sealant in Insulating Glass Units
IGMA TM-1300 Design Considerations for Multiple-Cavity IG Units
IGMA TM-1500 Guidelines to Reduce Instances of Thermal Stress
IGMA TM-3100 Voluntary Guidelines for the Identification of Visual Obstructions in the Air Space if Insulating Glass Units
IGMA TM-4000 Insulating Glass Manufacturing Quality Procedure Manual
IGMA TM-4100 Preventing Insulating Glass Failures
NGA with GANA Heavy Glass Door Design Manual

REVISION TABLE			
Revision	*Description*	*Date*	*Initials*
1.0	Production release – “NWGF Quality Specifications”	3/25/19	EM
1.1	First revision – General release	5/22/19	EM
1.11	Added Table of Contents	5/30/19	EM
1.12	Revised IG OA tolerances	6/5/19	EM
1.13	Added Super Spacer standard sightline, Wire glass in IG OA	10/16/19	EM
1.2	Added Section “Metal Fabrication”	10/9/20	EM
1.21	Added IG low-e (272) edge delete tolerance	10/16/20	EM
1.22	Updated page references, add edge defect visual aids	12/1/20	EM
2.0	Update to reflect reference revisions (C1036, C1172, Heavy Glass Door Design manual). Clarify viewing conditions and instructions for blemish inspection. Visual obstructions in IGUs defined. Format changes. References added. FLAT GLASS linear blemish tolerance modified to match ASTM C1036 Q3 specification	4/9/25	EM
2.1	Document revised to include Brin, St. Germain’s, Heartland	1/6/26	EM