Tolerance Standard

1. ASTM Applied Standards

a) Acceptability

A3 Glass Fabricator's annealed laminated or flat tempered laminated glass products offer extraordinary optical qualities that meet or exceed the following industry-recognized standards as guidelines for acceptability:

1. ANSI Z97.1 - American National Standard for Glazing Materials Used in Buildings - Safety Performance Specifications and Methods of Test
2. ASTM C162 - Standard Terminology of Glass and Glass Products
3. ASTM C1036 (Q3) - Standard Specification for Flat Glass
4. ASTM C1048 - Standard Specification for Heat-Treated Flat Glass
5. ASTM C1172 - Standard Specification for Laminated Architectural Flat Glass
6. ASTM E2188 - Standard Test Method for Insulating Glass Unit Performance

The tolerances and specifications are strongly considered as general guidelines for acceptability/approval. In some instances, the specified tolerances may appear exaggerated when viewing from a certain angle. It may be possible to reduce these tolerance levels but not all the time. Unusual shapes may cause various tolerance levels to be increased.

A lite of glass manufactured by A3 Glass Fabricator that falls within the tolerance levels explained in the following pages are acceptable and will not be objected by any customer or the customer's customer. **b) Mock-ups**

It is advised to have a mock-up fabricated first in order to make a more informed decision concerning any known limitations, tolerances or standards stated in this document. A3 Glass Fabricator also advises that the mock-up should be put at the job site in the same conditions as the future job.

2. Glass Dimensional Tolerances

a) Dimensions

Based on glass thickness according to ASTM C1036 – Standard Specification for Flat Glass, Table 2 (Dimensional Tolerance for Rectangular Shapes of Type 1 Transparent, Flat Glass):

Glass Thickness	Tolerance
3/16" (5mm)	±1/16"
1/4" (6mm)	±1/16"
3/8" (9mm)	±3/32"
1/2" (12mm)	±1/8"
3/4" (19mm)	±3/16"

Figure 1 Dimensional Tolerance

b) Twisting / Squareness

± 1/16″ per 39″ (2mm per 1m) (Figure 2)

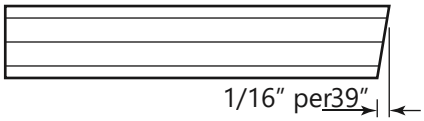


Figure 2

c) Edge types

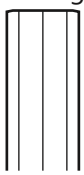
When the glass is scored and broken out from the stock sheet:

I. The edges are extremely sharp

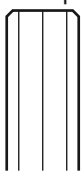
ii. They are not aesthetically pleasing to the eye and can be irregular

iii. The finish may hide micro fissures that when heated inside the oven may cause breakage

The following processes are used to fix the previous issues from above (Figure 3):



Seamed edge
(Using a belt sander)



Flat polish or flat ground edge
(using a polishing machine)

Figure 3

To flat polish an edge is to execute a 45° chamfer (arris) on both sides (front face and back face); the dimensional tolerance for the chamfer width is ±1/32″ (Figure 4)

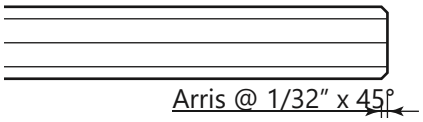


Figure 4

d) Edge straightness/bow on heat treated glass

Based on size and thickness of glass, according to ASTM C1048 - Standard Specification for heat treated flat glass, Figure 5 (overall bow and warp, maximum)

Tolerance Standard

						Edge Dimension						
	0-20″	>20-35″	>35-47″	>47-59″	>59-71″	>71-83″	>83-94″	>94-106″	>106-118″	>118-130″	>130-146″	>146-158″
Nominal Thickness Designation						Maximum Bow						
3/16″	.12	.16	.20	.28	.35	.47	.5	.67	.75	—	—	—
1/4″	.08	.12	.16	.2	.28	.35	.47	.55	.67	.75	.83	.94
3/8″	.08	.08	.08	.16	.2	.24	.28	.35	.47	.55	.67	.75
1/2-3/4″	.04	.08	.08	.08	.16	.2	.2	.28	.39	.47	.55	.67

Figure 5

e) Edge alignment

Alignment for edges on laminated or insulated units is ±1/8″ (Figure 6)

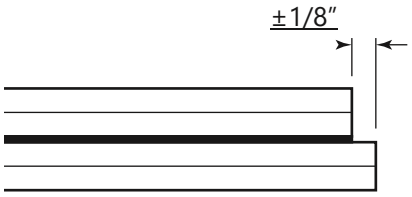


Figure 6

f) Hole alignment and distance tolerances

Hole placement: ± 1/16″

Hole alignment: (laminated units) (Figure 7) ± 1/8″

Hole dimensions: according to ASTM C1048 ± 1/32″ ±1/8″

Figure 7

f) O overall thickness tolerance

In monolithic products per ASTM 1036, for laminated or insulated glass units, the final overall thickness of the insulated unit is not something that can be controlled precisely. All units have a +/- thickness tolerance that is generated by the primary glass manufacturer and accepted by ASTM 1036. In addition, the interlayers have a thickness variance due to the lamination process and the air spacers have their own thickness tolerance. A3 Glass Fabricator will offer the specified components and therefore any variance in unit overall thickness will not be cause for rejection.

h) Edge color

The edges of the glass may exhibit different colors depending on many factors, including the thickness, the size of the glass, the lighting conditions, the edge of finish type, and even materials within the glass composition. As the glass gets thicker and larger in dimensions, the green cast of the glass will become darker. Low iron glass will have the same effect.

I) Tight angles (angles smaller than 35º)

Tight/acute corners with angles smaller than 35º will require a flattened tip of about 3/8" to 5/8" to prevent breakage during tempering. (Figure 8)

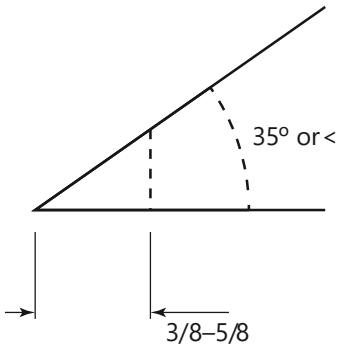


Figure 8

Heat Treated Lites: Tempered, Heat Strengthened

a) Distortion in flat glass lites

A3 Glass Fabricator's internal standards for flatness in tempered glass lites are limited to a .006" differential as measured with a roller-wave gauge. There will be some roll distortion that exists in all heat strengthened and tempered glass lites, and the viewing angle will exaggerate these effects.

The term "distortion" applies to specific dimensions and overall depths ranging from the height of the 'peaks' as measured to the lowest point in the 'valleys' on the finished glass surface that are created by the rollers of the furnace.

b) Iridescence

According to ASTM C1048 "A strain pattern also known as iridescence is inherent in all heat strengthened and fully tempered glass. This strain pattern may become visible under certain lighting conditions. It is a characteristic of heat-treated glass and should not be mistaken as discoloration or non-uniform tint or color, or a defect on the glass. The strain pattern does not affect any physical properties or performance values of the glass

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c) Birefringence

A rainbow type strain, or pattern known as birefringence, might be visible on heat treated glass or on any laminated product when annealed, under certain types of indirect lighting or when viewing the glass at an angle approximately 45º or more. This phenomenon occurs very rarely but all heat-treated glass will show it under specific lighting conditions. It is not considered a defect, discoloration or a non-uniform tint or color, but is characteristic of this type of glass.

d) Heat marks in heat treated glass

The heat-treating process can cause certain small marks on the glass surface. They are very similar to fine salt grains, and they usually will show when viewing glass at an angle and/or against a bright background. They are more visible in thicker and larger lites, especially when they weigh more than 300 pounds. Glass 3/4" thick will always show these marks.

e) Spontaneous breakage

Tempered glass may suffer spontaneous breakage due to nickel sulfide inclusions. Such a defect originates at the float glass manufacturing process and cannot be controlled or detected by the primary glass producers or A3 Glass Fabricator. In applications where safety is critical such as skylights and handrails, A3 Glass Fabricator recommends the use of tempered laminated glass.

As a way to reduce the possibility of spontaneous breakage, but never eliminate it, we off the heat soak test to any tempered glass type at any additional cost. The customer specifically needs to request this process.

f) Tempered glass breakage pattern

Tempered glass may break for various reasons, including damage to the glass during installation into a framing system, installation of the framing system in a way which places undue stress on the glass, damage from an impact of some kind, and other various reasons. These circumstances can sometimes cause glass to break after a period of time, not immediately. In addition, while tempered glass typically into small pieces, when following the breaking procedure described in 16 CFR 1201, it is possible that some longer, thinner pieces will be present, as the procedure indicates the following: "When breakage occurs, what appear to be the largest particles shall be selected within 5 minutes subsequent to the test and shall weigh no more than the equivalent weight of 10 square inches of the original specimen."

A breakage pattern with some longer, thinner pieces does not necessarily indicate a problem with the glass itself or the tempering process. This is particularly accentuated when the glass is laminated.

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Insulated Glass Units

a) Distortion, surface bow

The air sealed within an insulated glass unit will respond to the gas laws of physics the moment the unit is sealed. These laws govern the volume of gas as it relates to changes in temperature and pressure. As the sealed-in air is heated or cooled, it expands or contracts in volume. As the barometric pressure falls and rises, it likewise expands and contracts. This causes the two lites to bow away from and toward each other. As a result, objects viewed in reflection will be distorted. The amount of distortion depends upon the amount of deviation from flatness and the pattern of movement of the objects viewed. There is no known method by which the identical internal volume, air temperature and pressure can be achieved in each and every insulated unit for a specific project and still have the advantages of a sealed unit. Distortion will also be evident in the units with heat treated glass and from unequal glazing pressures around the perimeter (reference GANA glazing manual-11 design considerations).

An insulated glass unit that is composed of heat treated laminated lites will, in most cases, enhance the glass surface to accentuate levels of bow or warp and roller distortion that in non-laminated insulated glass units may not be considered objectionable.

b) Standard sealant depth/sight line

A3 Glass Fabricator's standard secondary sealant depth will always be flush to the two edges of glass to prevent the two lites from possible separation.

c) Primary sealant thickness

Minimum primary sealant thickness is 1/8".

d) Primary sealant creep in

M maximum primary sealant "creep in" 3/32". The "creep in" may not necessarily follow a continuous or even line or pattern, it may show up in spots.

e) Edge finish aesthetics

The sealant prevents the insulated glass unit from condensation and structural failure; it is not intended to be an aesthetically pleasing product. We do not recommend the use of insulated glass units with the edges exposed or in a special visual edge application. The primary and secondary sealant may show small spots or stains along its surface, particularly noticeable when using gray sealants. Silicone may also exhibit areas with slightly different hues due to the application process, it could be noticeable when the depth of the sealant is above a quarter of an inch. Both conditions do not compromise the structural performance of the silicone.

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In addition, the aesthetic qualities of the edge finish of insulated glass units will be those that are consistently manufactured by our equipment and may vary in uniformity of edge finish and appearance. None of the above-described aesthetic conditions are considered defects and therefore will not be a cause for rejection.

f) Space splices

The spacer in an insulated glass unit will not be a continuous bar; the metal spacer in an insulated glass unit will be spliced at different positions. The number of joints or splices will differ from unit to unit and cannot be predetermined. The splices are a part of the process of making an insulated glass unit and therefore are not a reason to reject any unit.

g) Glazing sealants used

Our insulated glass units are sealed with Dow Corning 982, General Electric IGS3723/IG3733 silicone, or Sika Sikasil IG-25.

Customers must ensure that any building materials that come in contact with the sealant that we use will be compatible. A3 Glass Fabricator will not be responsible to the insulated glass unit if it fails due to this warning.

Soft Coated Low E Products

a) Shell life and timely ordering

This coated glass has a shell life or roughly three months. A3 Glass Fabricator stores this glass and will manufacture it in a timely basis for the customer but if the customer is late on getting the final glass sizes us to us the responsibility and cost falls onto the customer if the product fails due to expiration.

b) Edge deletion

The coating will be removed from all edges of the glass to properly insulate it. This is not a feature that can be ignored.

I) Appearance

It will be uneven in appearance, showing scratched areas and different uneven patterns.

ii) Dimensions

It will have an estimated standard depth of 3/8"–1/2". The edge deletion is allowed to infringe the sight line up to 1/8". It is visible at close inspection.

iii) Hues

It may show a purple to red iridescent like hue or pattern. This is an intrinsic result of the process.

c) Color uniformity

Glass and film products that are coated may unexpectedly yield slight differences as reflected in color or intensity of light transmittance or reflectance or both. These almost unperceivable differences are no cause for rejection.

Non-uniformity in coated and/or laminated glass products can be defined by using DE*CMC as defined by ASTM Test Method D 2244 for CMC. Allowable DE*CMC for exterior reflectance shall be less than four and a half within a lite or between adjacent lites to a reference target sample by using the aforementioned industry standards as outlined in Measuring Color Uniformity Guidelines.

Design professionals and building owners should be aware that certain fenestration glazing products incorporating coated glass and or film products will yield minor color differences when used in adjacent vision and spandrel area conditions and when used in laminated glass constructions or on different glass thickness.

d) Color shift when laminating

When using a Low-E or reflective coating embedded within a laminate and placed in contact with the interlayer, the refractive index of the coating is changed and will result in a perceived color shift that is generally red/purple.

e) Heat

Soft coated Low-E products will considerably lower the amount of incoming solar heat into a building while allowing a great amount of visible light in. This does not mean that all of the incoming heat will be completely eliminated.

6. Laminated Glass

a) Sealants to use when glazing and grouting handrail

Neutral silicones are typically compatible with laminated glass. If further details are required as to which silicone to use, please contact your sealant supplier, or give A3 Glass Fabricator a call.

Do not use industry standard grout for handrails as this may cause the unit to fail, either in separation with the interlayer fractures in the glass. Sealants, gaskets, and wedges are the best use, especially for exterior conditions, for the glass and base shoe. The use of any unauthorized sealant or grout will void all written, verbal and/or implied warranties.

b) Translucent/colored interlayers aesthetics

When using colored interlayers, they may show some bands of dark or clear color, it is not a defect but a characteristic of this product as long as the color differential is not larger than the allowed Delta E 4.5.

c) Edge stability

Over time, if the edges of laminated glass are exposed, small air pockets could appear. This is not a cause for rejection of the unit so long as it is not larger than 5/16" from the edge.

d) Color uniformity

Non-uniformity in laminated glass products can be defined by using DE*CMC as defined by ASTM Test Method D 2244 for CMC. Allowable DE*CMC for exterior reflectance shall be less than four and a half within a lite or between adjacent lites to a reference target sample by using the aforementioned industry standards as outlined in Measuring Color Uniformity Guidelines.

Perceived color or lighting transmission differences when placing the glass in front of lights and using it as a lighting device will not be subject to reject the product. The only accepted method to measure color in uniformity is by using a spectrophotometer under lighting conditions as prescribed in ASTM 1048 or 1172.

7. Spandrel or Painted Glass

a) Mockups

It is advised to have a mock-up fabricated first in order to make a more informed decision concerning any known limitations, tolerances or standards stated in this document. A3 Glass Fabricator also advises that the mock-up should be put at the job site in the same conditions as the future job.

b) Color uniformity

The opacity of A3 Glass Fabricator's spandrel may vary slightly due to minor variations in paint thickness and/or viewing angles. Non-uniformity can be defined by using DE* CIELAB as defined by ASTM Test Method D2244 for CIELAB Allowable DE* CIELAB for exterior reflectance shall be less than four and a half within a lite or between adjacent lites to a reference target sample.

Perceived color or lighting transmission differences when placing the glass in front of lights and using it as a lighting device will not be subject to reject the product. The only accepted method to measure color uniformity is by using a spectrophotometer under lighting conditions as described in ASTM 1048 or 1172.

c) Spandrel inspections

Industry standards detail that the finished lite should be viewed from a distance of 15 feet and under natural daylight conditions.

i) Opaque and non-vision areas background

These lites are not intended for use in applications that are positioned against incoming light transmission, as the light and any pinholes, lack of paint uniformity, or other inherent qualities of the product will be noticeably visible.

ii) Pinholes

When viewing spandrel under the conditions described above, reflected pinholes and scratches are not considered defects if they are unobtrusive.

iii) Color variation

Color and reflectance may vary when viewed under a uniform, opaque background. This is not considered a defect unless the color variance is above Delta E 4.5.

6. General Inspection

Industry standards (ASTM) clearly specify that the finished monolithic, laminated, or insulated glass units are to be visually inspected from a distance of 10 feet and at a viewing angle of 90 degrees to the said glass product, which has been placed against a bright and uniformly colored opaque background and viewed in a natural daylight setting.

Once this criteria is in place, standards for acceptability to tempered/annealed laminated glass, insulated glass units are as follows:

a) Bubbles

Per ASTM C1172 Table 1, if there should appear an air bubble or other such impurity that is readily apparent, then the following criteria applies in determining acceptability: Air bubbles larger than 1/4" in diameter are not allowed in any part of the glass area. Blow in or short interlayer larger than 1/4" is not allowed, unless the glass is captured by more than 1/4".

b) Blemishes

Per ASTM C1172 Table 1, blemish is a defect found on the glass surface between the laminate and the glass. Blemishes up to 1/32" **are** allowed unless there is blemish accumulation. In 80 percent of the central glass area, up to three blemishes no larger than 3/16" per 10 square feet are allowed, unless there is a blemish accumulation. In the outer 20 percent, up to four blemishes no larger than 3/16" per 10 square feet are allowed.

Per ASTM C1172 Table 1, areas of concentrated lint or interlayer scuff streak are allowed when they are barely noticeable at 3 feet. Hair is allowed if not noticeable at 11 feet.

Blemish accumulation happens when more than ten blemishes are located within a circle no larger than 8 inches in diameter.

c) Edges and chips

The edges must be free of excess EVA. Our tolerance for edge EVA cleanliness is a maximum 1/16" EVA protuberance. EVA cleanliness around the edges of holes will be such that it does not interfere with the customer's hardware.

Chips on the edges are allowed when the edges are captured, and the chips are not visible through the glass surface once the glass is installed. When the edges are not captured, one chip per every three feet measuring less than 3/8" in length and 1/16" in width is allowed if it is not visible through the glass surface.

d) Scratches

Per ASTM C1036 (Q3), all glass products are to be inspected from a distance of 10 feet. Visible scratches of up to 3 inches in length, visible from this distance, are not allowed with a minimum separation of 24". Concentrated scratches or abraded areas are not allowed. Any scratch that is not visible from 10 feet even if larger than the mentioned sizes will not be a cause for rejection.

7. Logos

A non-removable, white/frost ceramic frit Crystal Glass (dba: A3 Glass Fabricator) logo is stamped on all heat-treated glass that we fabricate in order to comply with ASTM and other international codes. We may be able to accommodate special logo requests; however, failure to place and/o0r write the logo exactly as specified, even when stamping it is not required, will not be a cause to reject the glass.

8. Receipt of Goods

Within five consecutive days from delivery reported by our drivers or a freight company of the glass panels, every individual lite included in that delivery must be carefully inspected. This is to ensure that the pieces were manufactured according to the specifications detailed in the A3 Glass Fabricator order confirmation. A3 Glass Fabricator will not accept any claims after this five-day period.

9. Storage and handling

All glass products must be stored in a secure, low moisture/dry location, preferably a climate-controlled environment. Care should also be taken to immediately clean off any foreign materials, liquids or gasses that may happen to spill, fall, or otherwise come into contact with the glass. Liquids, even water or water vapor, will stain the glass if not cleaned quickly. This may even occur during transit, so it is very important to review your products carefully upon receipt.

At no time should metal, any sharp or hard objects be allowed near the glass as this may cause scratches or cause the glass to break.

Acid etched or sandblasted glass should not have anything touch the exposed etched surface. If it does remove the foreign object immediately and clean the area using glass cleaner or denatured alcohol. If this is not done in a timely manner the decorative surface may be permanently damaged.

A3 Glass Fabricator will not be held liable for any damage resulting in negligence on the customer's behalf.

10. Installation

Glass installation, measurements (dimensions), shop drawings, and structural calculations are the sole responsibility of the customer.
A3 Glass Fabricator is solely responsible in manufacturing its products according to the A3 Glass Fabricator order confirmation. A3 Glass Fabricator is not responsible for any design, calculations, specifications, measurements, and installation details, knowledge of product final application and proper use, details, and effects of prior designs other than its own manufacturing processes.

A3 Glass Fabricator will not perform any project revisions or glass calculations and will manufacture the order understanding that the customer comprehends that it is their sole responsibility to perform structural and load calculations and install the glass in a way that will serve its intended purpose safely and long lasting.

The frame where the glass is to be installed must be clean and free of liquids and debris, equipped with functioning weep holes, to allow for excess moisture drainage, and should be well-finished according to the manufacturer's original standards.

Any failure to comply with this will void the warranty.

11. Regular Care and Maintenance

Regular cleaning and maintenance will help conserve the brilliance of glass, maximize heat reflecting properties and provide greater long-term value. A3 Glass Fabricator will not be held responsible for any negligence in the cleaning process.

12. Warranties

Standard warranties are available upon request. They are valid from the date the product is manufactured.