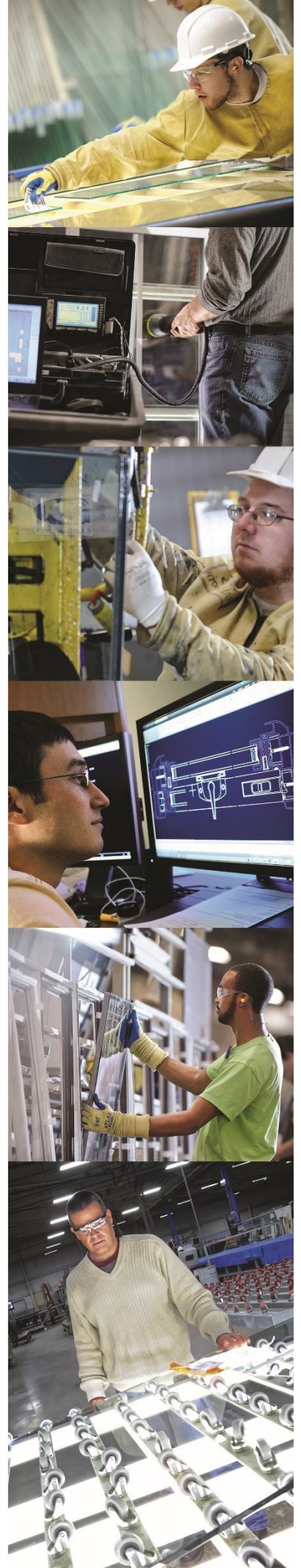


ClimaGuard Products User's Guide

What you need to know about fabricating
our products in North America



Guardian Climaguard Introduction

Guardian Climaguard glass products help to make homes energy efficient, beautiful, comfortable and safe. It's glass that delivers true performance from Guardian Glass, one of the world's largest manufacturers of float glass, fabricated glass and mirrors for commercial and residential applications. Guardian glass engineers and technologists work with window makers to help develop windows that are energy-efficient, reduce sound transfer, and provide protection, privacy, beauty and more.

Guardian Climaguard products in North America are available in 2.3 mm to 5.0 mm glass thickness and are strictly limited to residential applications as defined by the *International Residential Code®* (IRC®). The IRC defines a residential construction as single-family houses, two-family houses (duplexes) and buildings consisting of three or more townhouse units. All buildings within the scope of the IRC are limited to three stories above grade plane. For example, a four-story single-family house would fall within the scope of the *International Building Code®* (IBC®), not the IRC. Therefore, any construction that falls outside the scope of the IRC, even if residential in nature, would also fall outside the scope and coverage of the Guardian Climaguard® Limited Warranty. For those projects, Guardian suggests the use of our commercial SunGuard® product line.

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1. Product Configurations

1.1 Low-E Coating Configurations

Guardian Climaguard® coated glass products utilize low emissivity (Low-E) coatings having layer stack designs that offer superior spectral performance. Annealed products and heat-treatable companion products are available for most coatings. The fabricator is responsible to ensure that the correct product is used for the needed application. The fabricator is also responsible to ensure that the coated surface is positioned in the Insulating Glass Unit (IGU) in accordance with the configurations and requirements listed below.

Table 1 indicates the product types and recommended coated surface position configurations for Climaguard® products.

Table 1 - Climaguard® Low-E Coated Glass Products			
Product	Recommended Coated Surface Position in a Double-Pane IGU	Annealed	Heat-Treatable
Climaguard 80/70	#2 or #3 Surface	X	
Climaguard 72/57	#2 or #3 Surface	X	
Climaguard 70/36	#2 Surface	X	
Climaguard 62/27	#2 Surface	X	
Climaguard 55/27	#2 Surface	X	
Climaguard 53/23	#2 Surface	X	
Climaguard 80/70 AT	#2 or #3 Surface	X	X
Climaguard 72 HT	#2 or #3 Surface		X
Climaguard HT	#2 Surface		X
Climaguard 62 HT	#2 Surface		X
Climaguard 55 HT	#2 Surface		X
Climaguard 53 HT	#2 Surface		X
Climaguard IS-20	#4 Surface	X	X
<ol style="list-style-type: none"> 1. Recommended surface positions are based on double-pane IGU. 2. Products that are listed as Annealed must never be heat-treated, and products listed as Heat-Treatable (HT) must never be used in the annealed state. AT products may be used in the annealed or heat-treated state. 3. Heat-Treatable (HT) products are designed to be similar in appearance and performance to their Annealed companion products. 4. IS-20 annealed is max size 60"x96" and HLR 802 AT is max size 96"x130. 5. A mock-up is highly recommended if coated surface position is different from the list above. 			

1. Guardian requires that all Climaguard® products (except for Climaguard® IS glass) be used in a sealed IGU with the coated surface facing the sealed air space or in an approved monolithic laminated configuration. Climaguard® coated glass products (except for Climaguard® IS glass) must not be used in monolithic vision applications.
2. Coated surface location must be identified and properly positioned prior to assembly into an IGU or laminated glass configuration. Care must be taken to identify the coated surface in laminated glass configurations in which the coating is in contact with the polyvinyl butyral (PVB) interlayer, as commercially available coating detectors are incapable of identifying the location of the coated surface once the glass has been laminated.
3. Under different lighting and glazing conditions slight differences in reflected color may be apparent.
4. Guardian advises against positioning a Low-E coating on the center lite (surfaces #3 or #4) of a triple-pane IGU, unless the center lite is heat treated. Positioning a Low-E coating on either surface of the center lite will result in a buildup of heat and potential breakage due to high amounts of stress. Refer to the Guardian Performance Calculator for specific guidance.

1.2 Laminated Glass Configurations

Special care must be taken during the fabrication of laminated products to avoid coating damage and ensure successful lamination. Climaguard® HT products must be tempered or heat strengthened prior to laminating. Laminated Climaguard products can be configured two ways: with the coated surface *exposed* (facing and in contact with air) or with the coated surface *embedded* (facing and in direct contact with the PVB interlayer).

1. Climaguard® products may be used in *exposed* laminated configurations with the coating facing the air space in the final IGU assembly. Laminated lites with a coating on an exposed surface must be insulated within 72 hours of lamination.
2. Embedding a Climaguard® coating against the PVB interlayer is **not recommended**. Please contact a Guardian representative for further information. In such applications:
 - The U-value will be exceptionally high due to conductive heat transfer within the laminated lite, effectively negating the purpose of a Low-E coating and reducing total insulating performance. Guardian can assist its customers in predicting thermal performance based on the application.
 - There **will be a color shift that may be objectionable and may not be consistent lite to lite** as compared to coatings positioned on surface #2 of a typical double-pane IGU configuration.
 - Embedded coatings must not be used in residential curtain walls, true divided lites or butt glazed window applications.
 - All embedded coatings must be edge deleted, whether used in an IGU or monolithic application.

1.3 Acid Etched Glass Configurations

SatinDeco® acid etched glass can be used either monolithically or in an IGU in combination with other Climaguard® coated glass products to produce a unique look to meet a variety of aesthetic design objectives. The etched surface can be positioned as any surface of the IGU except for surface #1. Guardian does not offer Low-E coatings on SatinDeco® glass.

SatinDeco® glass is also available as a double-sided etched product on both clear and low iron glass. The double-sided etched products can only be used as a #3/#4 surface product in a standard IGU configuration.

When processing SatinDeco® glass, Guardian recommends that you test all optical sensors associated with the processing equipment before starting production.

Glass processing equipment commonly utilizes optical sensors to guide placement and fabrication of glass lites. Due to the diffusive properties of the etched surface of SatinDeco® glass, some optical sensors may not have sufficient sensitivity to function properly. If the performance of optical sensors is affected in a way that compromises safety, the use of the affected equipment should be suspended pending resolution of the issue and confirmation that fabrication of SatinDeco® glass can proceed in a safe manner.

Contact the manufacturer of the affected equipment regarding adjustment or replacement options.

2. Handling, Receiving and Storage Procedures

2.1 General Information

Prior to fabrication, a Guardian Field Customer Engineer (FCE) must conduct a certification audit of the customer's facility. The Guardian Climaguard® Limited Warranty is void if the fabricator does not hold a current Guardian certification.

Handling, cutting, washing and heat treating must be done in accordance with certain requirements to prevent damage to the coated surface prior to all fabrication. Processing Climaguard® glass products with the coating facing down will damage the coating.

Sharp objects such as nails, screws, razor blades, steel wool, etc., can scratch and damage the coating and must not be used on coated products. Blades or other scrapers must never be used to scrape material off the coated surface, as it may damage the coating and the glass.

Proper handling, receiving and storage are critical to the long-term performance of Guardian Residential glass products.

1. The maximum product shelf life for all as-coated (annealed or tempered glass that was coated after tempering by Guardian) Guardian Residential coated glass products is six months from the time of receipt from Guardian. This time frame is based on testing under normal plant conditions. It will vary if the glass is stored in an environment with high temperature and high humidity. Climaguard® IS glass is the only exception as it does not have a defined shelf life. Rotate stock to use the oldest product first. (First In, First Out).
2. Climaguard® heat-treatable products supplied with Temporary Protective Film (TPF) can be handled and fabricated similarly to standard clear float glass, provided that the TPF remains on the coated surface. For as-coated Climaguard® products (or Climaguard® heat-treatable products where the TPF has been removed), the fabricator must follow the precautions outlined in this User's Guide.
3. The coated surface must always face up (away from conveyor rolls, felt covers or roller balls) during fabrication to avoid the possibility of glass splinters and chips scratching the glass surface. In the case of doubled-sided products with coatings on both surfaces of the glass, the coating designated for surface #4 (IS-20) may be processed facing down. This practice allows for the coating on the opposing side to face up and away from the conveyor rolls.
4. Contact with the coated surface must be avoided during fabrication. Contact must be made from the edges or with the uncoated surface of the lite as shown in image 1. Never palm coated glass. The coating must not be handled with bare hands. Clean dry gloves must be worn when handling Climaguard® products.
5. Glass should always be unloaded under dry indoor conditions. Glass must always be protected from the elements (e.g., rain, snow, splashing water, etc.). The glass must be removed from the front of the container. Avoid sliding or rubbing one pane of glass against another.
6. If suction cup equipment is utilized, it must be properly maintained for pressure and alignment to the drop table. The following procedures are mandatory when using suction cup equipment when handling Guardian Residential glass products:
 - If suction cups must contact the coated surface during movement of the individual lites, they must be clean and dry.
 - The minimum number of suction cups must be used to safely move the product.
 - If suction cup frames are used to move and position lites on a tilt table, the drop height must be minimized to eliminate any sliding of the cups against glass. All glass must be aligned to have no more than a +1/4 in. (+6 mm) difference between the edge of the glass and the drop table.

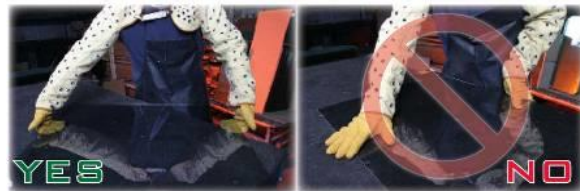


Image 1 - Proper handling of coated glass.

7. Guardian recommends that glass be placed on racks for movement to the next process after cutting. The preferred method of separation is foam-covered cork tabs with the static foam side facing the coated surface or with poly foam strips/sheets.

- If A-Frames are used, like sizes must be stacked together.
- Different sizes must be separated by cork or foam tabs, or poly foam strips (see “INTERLEAVING MATERIALS” in this User’s Guide for more information on glass separation when transporting).
- Harp racks should be avoided when handling Guardian Residential coated glass products, however, if they must be used:
 - Harp racks must be clean and well maintained.
 - Avoid sliding the coated surface against the harp cords.
 - Never put more than one lite per slot.
 - ClimaGuard® HT products must not be placed into harp racks without TPF.



Image 2 – Harp rack

8. Glass must be stored in a dry environment protected from direct weather or chemical exposure. Guardian Residential glass products must not be stored outdoors. Do not store products within 50 ft. (15.25 m) of glass washers, outside doors or corrosive chemical storage areas. Contact with corrosive chemicals that could damage the glass or coatings (e.g., concrete, plaster, building runoff) must be avoided. Due to the solar absorbing characteristics of coated glass products, glass stored in shipping containers or stacked in a group may experience thermal breakage if exposed to direct sunlight.
9. Guardian Residential glass products are shipped on racks or packed in cases and are labeled with Guardian production/identification tags. ClimaGuard® heat-treatable products may be shipped with TPF. All Guardian product and case tags must remain with the original packaging. Lites must always remain traceable to original Guardian case tags.
10. Pin racks should not be used for storage of Guardian Residential coated glass products.
11. ClimaGuard® HT products must be insulated or laminated within 72 hours of heat treatment.
12. ClimaGuard® 80/70 and HiLightR 802 must be insulated or laminated within 120 hours of heat treatment.

2.2 Interleaving Materials

Guardian Residential glass products must never be stored or transported without proper separation between lites. Glass to glass contact can lead to abrasion, which can cause damage to the coating.

Table 2 – Interleaving Materials	
Recommended	Not Recommended
<ul style="list-style-type: none"> • Foam Pads • Cork Pads (static foam against coating) • Polyfoam Sheets¹ • Lucite Beads 	<ul style="list-style-type: none"> • Newsprint • Silver Saver and Kraft Papers • Cardboard • Powder Separators Containing Acid² • Nut Powders
<p>1. Care must be taken when using polyfoam sheets. They must never be dragged across the coated surface.</p> <p>2. Powder separators containing acid are not recommended for use with ClimaGuard® products.</p>	

After tempering ClimaGuard® heat-treatable products, the glass temperature must be below 49 °C (120 °F) prior to packing or storing on racks.

2.3 Guardian Gasket Rack

1. The Guardian Gasket Rack is a secure and protective racking system for monolithic tempered glass. The Gasket Rack includes a vinyl gasket that is slid into a mating aluminum extrusion, on the base and back of an “L-shaped” rack, shown in Image 3. When two gaskets are positioned adjacent to each other, an opening is formed that allows for the insertion of a monolithic glass lite.



Image 3 - Gasket Rack



Image 4 - Loaded Gasket Rack

2. The gasket is designed such that two hinges open to accept the incoming glass. The slots are numbered (Image 7), and they alternate in color between white and beige (Image 5) in order to provide a visual indication of proper alignment between the vertical and horizontal slots. Once the glass is inserted, the hinges close and the glass is held firmly in place.



Image 5 - View looking at glass inserted in gasket.

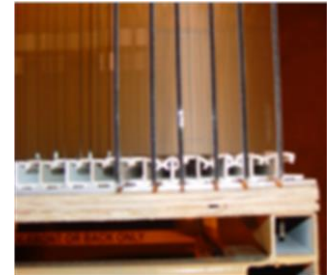


Image 6 - View looking down at gasket with glass inserted.

2.4 General Specifications

1. When unloaded, the rack is 47 in. w x 52.75 in. d x 69.25 in. high and weighs 266 lbs. Maximum total glass weight should not exceed 4000lbs. 3 mm-6 mm (.125 in. - .25 in.) monolithic glass thickness range. Minimum glass size is 15 in. x 15 in. and the maximum glass size is 40 in. x 80 in. with 60 numbered slots for monolithic glass lites.



Image 7 - Numbered slots in Gasket Rack

2. A pole is positioned in a holder on the back of each rack (Image 8). The pole is intended to be used to insert or remove glass when the adjacent lites limit direct access.
3. 48 in. long forks are required to move rack or dolly with fork truck. Racks are not intended for side-picking with a fork truck. Lift from the front or back of the rack only.
4. Load configuration for transport in a truck - 2 wide by 10 deep (43 ft. 11 ½ in. long) or 11 deep (48 ft. 4 ¼ in. long). Racks are intended to be loaded with the back of the rack facing toward the front of the truck.



Image 8 - Location of pole

5. A roll around dolly is available as an option with this rack (Image 9). The dolly is used to facilitate rack movement throughout the plant. The rack is placed on top of the dolly with a fork truck. Once securely in place, the dolly enables the rack to be safely moved without the use of a fork truck (Image 10).
6. The dolly consists of swivel casters with brakes that freely allow the cart to be positioned as needed. The dolly is 47.5 in. x 53.25 in. x 13 in. high and weighs 250 lbs.



Image 9 - View of the dolly without the Gasket Rack.



Image 10 - View of the dolly with the gasket rack.

2.5 Gasket Rack Loading Procedure

1. When inserting glass into the Gasket Rack:
 - Always use appropriate personal protective gear before handling glass.
 - Insert the front edge of each glass lite into the desired numbered slot on the bottom of the Gasket Rack.
 - Pivot the front edge of glass lite within the slot while lifting and sliding the lite into and toward the back of the Gasket Rack.
 - As the lite reaches the back of the rack, align the lite with desired numbered vertical slot, and slide the lite into place.
 - To fully seat the glass lite into the gasket, gently push the glass as deeply into the slot as the gasket will allow. It is critical each lite is fully seated in the horizontal and vertical gaskets.
 - After the Gasket Rack is fully loaded, glass separator gaskets (Image 11) are attached to maintain separation between individual lites and to stabilize the full rack of glass.



Image 11 – View of glass separator gasket.



Image 12 – View of glass separator gasket in position.

- Apply separators to separate each lite and prevent contact during handling (Image 12).
- Separators will slide over edge of glass of two adjacent lites holding them in position.
- Separators are to be placed on top of lite on free corner and in middle of lite.
- Install separators at one-fourth the length of the side (at $\frac{1}{4}$ points).
- Separators are to be saved and reused until they no longer fit snug.
- Separator placement is required to prevent movement of glass during handling and shipment, which causes glass damage.

2.6 Replacement Parts

1. Gasket material will eventually wear and needs to be replaced. Useful life will be determined by use. Users should inspect the entire rack on a frequent basis for worn or broken parts. Any parts showing wear should be replaced to maintain effective operation.
2. Replacement parts are available by contacting the Guardian Customer Engineering Group. All pricing must be confirmed at the time of order placement. Prices are subject to change and do not include shipping charges.



Image 13 – Replacement parts

3. Coating Detection

1. Detection of the coated surface is a critical step in correctly processing ClimaGuard® glass. The user must establish which surface has been coated:

- When opening incoming packaging. (Packing tags will indicate the orientation of the coated surface within the packaging; however, formal detection using one of the methods outlined may be needed).
- When moving material and before any subsequent processing of the glass.

2. Common methods available for detection of the Low-E coating include:

Commercial Coating Detector

- Guardian recommends a coating detector that does not utilize metal contacts. Metal contacts can scratch the coating if applied to the coated surface. Guardian products with a single coating may use standard coating detectors. EDTM of Toledo, Ohio offers a variety of coating detectors via their website www.edtm.com.
- To ensure proper identification and fabrication, double-sided products require the use of a special dual coating detector. Guardian recommends the EDTM Reflex detector (#RX 1550). (Image 15)

Ohm Meter Detector

- Set an Ohm meter (Image 16) on a high resistance setting (i.e., R x 10,000). Contact the glass surface (near the extreme edge only) with the positive and negative terminals approximately 1 in. (25 mm) apart.
- A meter reading registers if the terminals are contacting the coated surface. No reading registers if they are contacting the uncoated surface.
- When using this method, care must be taken to avoid scratching the coated surface.

NOTE: Sputter coated films do not have the surface roughness of pyrolytic films and cannot be easily felt. Touching the coated surface with bare hands or with gloves is not a reliable method to detect the coated surface. Skin oils are difficult to remove and can damage the coated surface after prolonged exposure.



Image 14 – Low-E surface detector



Image 15 – EDTM Reflex detector



Image 16 – Ohm meter

3.1 Coating Visual Inspection - Central Viewing Area

1. When viewed against a bright uniform background, Guardian Residential glass products must meet or surpass the guidelines outlined in this section.
2. Guardian Residential glass products that undergo further fabrication must be inspected in transmission and in reflection prior to each step in the fabrication process and after final fabrication.
3. The inspection criteria outlined in this User Guide apply to stock sheets, finished cut size, or Guardian supplied finished cut size lites. However, the Central Viewing Area limitation does not apply to stock sheets.

4. The area of most importance during visual inspection is the Central Viewing Area. The Central Viewing Area is defined by 80% of the length and 80% of the width dimensions centered on a lite of glass. The remaining area is considered the outer area. An example of the Central Viewing Area of a lite that is 100 in. by 40 in. (2540 mm x 1016 mm) is shown in Image 17.

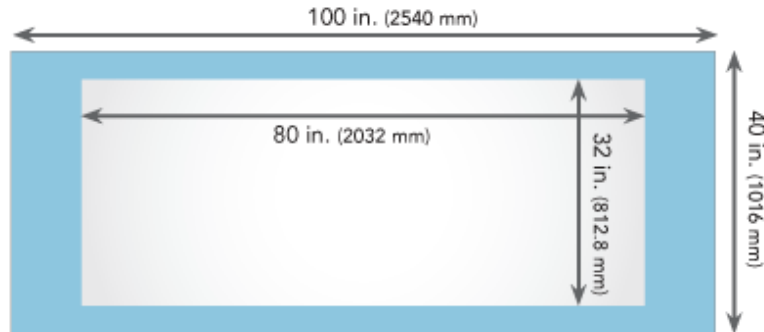


Image 17 – Central Viewing Area

5. A diffused light source allows the fabricator the ability to simulate normal daylight conditions. The light source is essential when inspecting Guardian Residential coated glass products in transmission and reflection – Image 18.



Image 18 – Solid backgrounds to simulate outdoor reflected color (Black) and transmission color (White)

6. The inspection guidelines for visible defects are outlined below per ASTM C 1376:
- Pinholes, blemishes and clusters* (in transmission):
 - Pinholes or blemishes up to 1/16 in. (1.5 mm) are acceptable.
 - Clusters of pinholes or blemishes within the Central Viewing Area that are readily apparent from 10 ft. (3 m) are not acceptable.
 - Clusters greater than 1/32 in. (0.82 mm) and visible from 10 ft. (3 m) are acceptable only outside the Central Viewing Area.

* When inspecting for pinholes or blemishes, a cluster is defined as 2 or more pinholes or blemishes up to 1/16 in. (1.5 mm) each that are clearly apparent and located in an area of 3 in. (76 mm) diameter per ASTM C 1376. Inspections should be performed consistently throughout each stage of fabrication process.

3.2 Visual Inspection - Scratches (In Transmission)

When viewed from a distance of 10 ft. (3 m) visible scratches longer than 2 in. (50 mm) within the Central Viewing Area are not acceptable per ASTM C 1376.



Image 19 – Visual Inspection of transmission (light source behind glass)

3.3 Visual Inspection - Uniformity (In Reflection)

When viewed from a distance of 10 ft. (3 m) or greater, coated glass may exhibit slightly different hue or color that may not be apparent in hand samples.



Image 20 – Visual Inspection of reflection (light source behind or above inspector)

4. Cutting

1. Proper cutting is crucial to the overall performance of any type of glass. A clean edge when cutting is extremely important in reducing breakages and maintaining the inherent strength of the glass.
2. Cutting should be done with coated side UP. If, as in the case of double-sided glass, such as HiLightR 802, the IS side faces down.
3. Cutting should only take place on firm supportive surfaces (tables) in order to provide a constant pressure. Cutting tables with limited pressure control may experience poor score depth, or a “skipping” of the cutting wheel, and result in excessive chipping of the cut edge; proper pressure is key to reducing “skipping” and poor score depth.
4. Maintaining an undamaged cutting wheel is also significant importance in determining edge quality. Damaged or worn wheels, caused by broken glass, may increase the odds of lower quality edges. Irregularities in the cut edge will reduce the overall break strength of the glass, and therefore should be minimized.
5. ClimaGuard® heat-treatable glass products are supplied with TPF:
 - TPF should remain on the coated surface during cutting.
 - Do not require cutting fluid when cutting through the TPF surface.
 - Results from Guardian research indicate that a coarse ground cutting wheel is optimal for cutting the TPF and scoring the glass consistently with a clean edge. Guardian recommends cutting wheels produced by Bohle and MacInnes Tool Corporation.
 - Suggested cutting parameters for TPF are included in Table 3. Cutting speed affects pressure and each may need to be altered to achieve the best possible cut.



Image 21 – Side profile of a typical uncoated glass cut edge.

of



Image 22 – Glass cut at the same cutting wheel angle, speed, and head pressure as in Image 21, but with poor score depth.

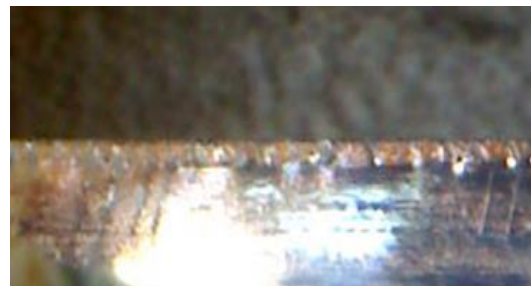


Image 23 – Glass cut at higher head pressure to achieve adequate score depth with wheel skip marks visible on the cut edge.

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Table 3 - TPF Cutting Parameters

Glass Thickness	3 mm	4 mm	5 mm	6 mm
Wheel Angle	128°	134°	134-136°	138 - 145°
Wheel Diameter	4.1 mm	4.1 mm	4.1 mm	4.1 mm
Pressure	1.3 bar (19 psi)	1.4 bar (20 psi)	1.5 bar (22 psi)	1.8 bar (26 psi)

5. For other Guardian Residential glass products (or for ClimaGuard HT products where the TPF has been removed):
- The cutting table surface must be cleaned frequently.
 - Guardian recommends that no contact other than the cutting wheel be made with the coated surface during cutting.
 - Glass must be moved from the cutting table to the rack one lite at a time as shown. All effort should be made to not touch the coated surface.

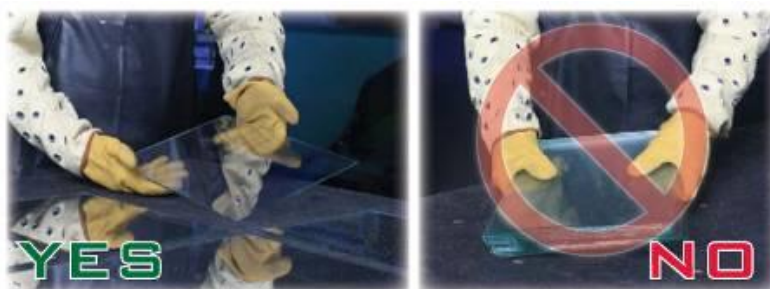


Image 24 – Proper handling of cut parts

- Only approved cutting fluids are to be used with Guardian Residential products. Cutting fluid must be used in moderation to ensure evaporation without leaving residue that could contaminate the glass washer. Refer to Table 4.

Table 4 - Guardian Approved Cutting Fluids	
<ul style="list-style-type: none"> • ACECUT 5503 • ACECUT 5929 • COOL-CUT • Cleancut, Rocol Lubricants • CR Laurence W 410 • CR Laurence Evaporating Oil, V020 • GAI Cutting Oil • GLASOL GB • ILOFORM 7425, Castrol Industrial NA 	<ul style="list-style-type: none"> • GC 110E, GlassChem • GC 120E, GlassChem • LamSon Oil A-233-A • Mineral Spirits • Perfect Score HP 5503 • Process 485, J&S Chemical Corporation • ShellSol D60 • SOGEVER 1100 FG • SOGEVER 1200 FG

5. Edge-Deletion and Sealants

5.1 Sight Line and Edge Deletion Methods

1. Edge deletion is intended to remove a band of coating that is equal to the sight line. For residential applications, edge deletion is recommended for optimal adhesion between the glass and the sealant. The fabricator is responsible for setting an acceptable tolerance for the edge-deletion band when edge-deleting a coated product. An edge-deletion band greater than the sight line will result in an encroachment into the vision area of the unit. Alternatively, an edge-deletion band that is too narrow could result in poor adhesion or sight line discoloration.
2. For Climaguard® heat-treated products requiring edge deletion, automated edge deletion on a cutting line or an insulating glass line is preferred.
3. If edge deletion is done with manual (hand-style) grinding equipment, care must be taken to ensure that the deletion is complete and consistent.

5.2 Edge-Deletion

1. Climaguard® products are designed for use in either annealed or heat-treated states. Edge-deletion requirements for the two conditions vary based on the product and application, as defined below.
2. Standard (non-heat treatable) Climaguard® products manufactured by Guardian can be insulated without edge deletion in annealed applications utilizing the list of tested sealants in Table 5 “Guardian Approved Sealants” (Section 5.4).
3. Standard (non-heat treatable) Climaguard® products manufactured by Guardian that have been coated after tempering by Guardian can also be insulated without edge deletion utilizing the list of tested sealants in Table 5.
4. All Climaguard® HT products must be edge deleted.
5. Climaguard® IS products do not require edge deletion.
6. Edge deletion of all Climaguard® coated glass products is required when using sealants not on the approved list.
7. All embedded coatings (facing the PVB) in a lamination must be edge deleted, whether in a monolithic application or as part of an IGU assembly.
8. The fabricator bears responsibility with the design and testing of the window frame to ensure that an adequate weep system and setting blocks are included. A good drainage and isolation system allows for the proper and expedient evacuation of liquids away from the exposed edge while minimizing the contact between the IGU and the substance. Acidic substances such as brick wash have the potential to cause harm to several window components, such as hardware, sealants, and Low-E coatings. Windows should be masked off and brick wash should be properly diluted and applied per manufacturer instructions. If these conditions cannot be met, coatings should be proactively edge deleted to minimize potential damage to the coating or IGU.
9. Regardless of the approach used, fabricators must assure that edge deletion completely removes the conductive silver layer(s) of the coating, that the width of the deletion doesn’t encroach into the vision area (sight line) of the unit and that the deletion band is aesthetically acceptable for structural glazing applications if applicable.

5.3 Standard Edge Deletion Procedure

Edge deletion can be accomplished through three different methods. In all cases, the fabricator must ensure that the edge deletion is complete and consistent. The options are:

- Using in-line CNC edge deletion at the cutting table or prior to the IGU assembly step.
 - Using a standalone table, available from various suppliers.
 - Using hand-held edge deletion tools.
1. The coated surface must always be edge-deleted face up (away from conveyor rolls, felt covers or roller balls). It is also important to verify the coated surface with a coating detector to make sure that the coated side is the side being edge-deleted (Image 25).
 2. Determine the sight line for the units being manufactured and the tolerance required. For example, the sightline is approximately ½ in. (12 mm) in the example shown in Image 26. Use an edge-deletion wheel such as 3M Part#03991 8 in. OD x ½ in. W x 3 in. ID SST. Actual width of wheel will vary depending upon edge deletion/sight line width desired. Remove the coating by grinding the edge completely and continuously using automated or manual grinding equipment.
 3. To determine whether the coating has been completely removed from the edge, the edge-deleted area must be tested with an ohmmeter as shown in Image 27. The ohmmeter must show no reading, which indicates complete removal of the coating. If the ohmmeter shows a reading, edge deletion is incomplete.
 4. Glass must be handled from the edges only during the edge deletion process. Care must be taken to avoid touching or palming the coated surface.



Image 25 – Low-E coating detector

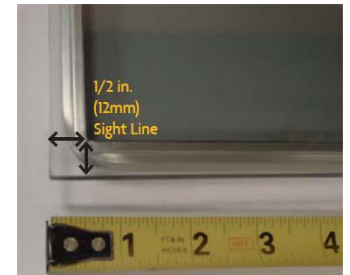


Image 26 – Sight line edge deletion



Image 27 – Ohm meter

With Temporary Protective Film:

1. Post-heat-treatment automated edge deletion on the IGU line is recommended for coated glass with TPF, as the approach addresses edge deletion at the final step in the fabrication process.
2. Manual table and hand-style edge deletion may also be performed post-furnace. For best results, Guardian recommends a 3M part #03991 edge deletion wheel.
3. Edge deletion through the TPF performed at the automated cutting system is also recommended, and can achieve good results using one of the following practices:
 - Cutting equipment manufacturers are now developing new technologies and upgrading current systems to perform edge deletion through the TPF. For more information on qualifying systems please consult the automated cutting table manufacturer.
 - Cutting systems equipped with automated edge deletion, but that may not qualify for OEM upgrade, may be a candidate for the Guardian Temporary Protective Film Debris Removal System (also called Guardian TPF DRS). The upgrade incorporates a higher capacity vacuum system for the removal of most debris generated during the deletion phase. Generally, installation is completed over a 3-day period by a contracted firm.
 - Edge deletion through the TPF at the cutting table may be performed without capital investment or modifications. By slowing the edge deletion bridge speed to approximately 10 meters / minute (± 1 meter / minute), and slightly increasing the head's down force, edge deletion can be performed. However, TPF debris will accumulate on the cutting table surface. Regular cleaning of the cutting table's surface will be required with this approach. The OEM vacuum system should be disconnected, as the debris will quickly overwhelm the canister.

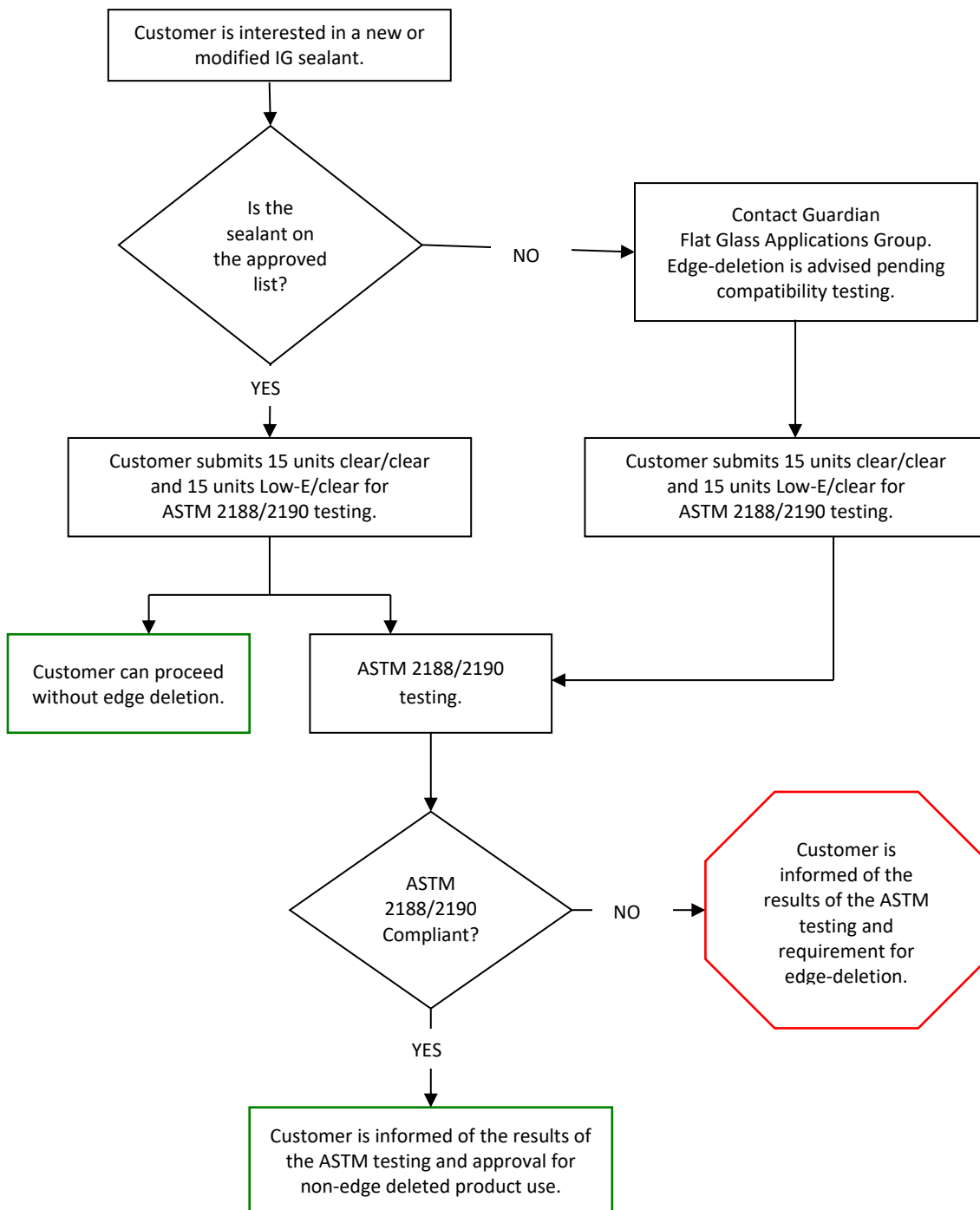
5.4 Sealant Guidelines

IGU sealants utilize different chemical formulations to achieve the desired adhesion and cure-time objectives. These chemicals may compromise the metallic layers that comprise Low-E coatings. For this reason, only approved sealants listed in Table 5 “Guardian Approved Sealants” should be used with non-edge deleted ClimaGuard® products. All HT products must be edge deleted.

Table 5 - Guardian Approved Sealants	
Manufacturer	Product / Series
ADCO	2000 HS; 3070 HS
Bostik	3190; 5192; 5197; 9190
Delchem	D2000
Dow-Corning	982; 3362, HV, HVGR
Edgetech	Super Spacer
Fenzi	Thiover
GE	IGS 3713; IGS 3723 B; IGS 3733 A; SGS 4400
HB Fuller	HL-5130; 5140; 5160; HL-5143AM; HL-5144; HL-5145; HL-5153; HM1081 A; HM-1091; UR-5100; Naftotherm BU-TPS
Kommering	GD 116; 667, 667NA
TruSeal	JS794; Duraseal; Duralite; Swiggle

5.5 Sealant Evaluation Process

Please contact your local Guardian Field Customer Engineer or the Guardian Flat Glass Applications group if you need assistance with testing of sealants not listed in Table 5. Guardian will arrange testing of any specific sealants currently used in manufacturing an IGU upon request. Normal testing takes 18-20 weeks to complete once the units are received by Guardian. See below for a flow chart depicting the sealant evaluation process.



6. Seaming



Image 28 – TPF though seaming operation

1. With TPF:

- TPF should remain on the coated surface during the seaming process.
- Dry seaming is the preferred and recommended method of seaming.
- Wet seaming, especially with excessive coolant, may dislodge the edges of the film.
- The optimal seaming belt roughness range is 100–120 grit.

2. Without TPF:

- The seaming table surface must be cleaned frequently.
- Contact with the coated surface must be avoided during seaming. Contact must be made from the edges or with the uncoated surface of the lite.

7. Washing

Guardian Residential products must be washed immediately after any edge grinding, polishing, seaming or other fabrication steps. If lubricants or coolants are used in processing, the resulting glass grit slurry may be highly alkaline (pH of 8.0 or higher) and will damage the glass and coating if not removed promptly.

1. Proper setup of the washer is critical for all glass products, especially coated glass. Due to a contrast in light transmission, damage caused by the brushes that may not be visible in non-coated glass, can be seen in coated glass.
2. Low-E brushes are required for washers processing Climaguard® products. Brushes must not be damaged or worn and must be adjustable and positioned to minimize contact with the coated surface. Low-E brushes are specified as brushes having the following characteristics:
 - Bristle diameter between 0.006 - 0.008 in. (0.15 - 0.20 mm)
 - Made from 6-6 Nylon or similar “soft” material that has high water absorption.
 - Trim height of 2 - 2 ³/₈ in. (50 - 60 mm)
 - Uniform density.
3. When spot cleaning of the coated or uncoated surface is required, use mild, fast-drying household glass cleaners. Dab or blot the surface with a clean, soft cloth to remove any excess cleaning solution. Do not wipe the coated surface, as this may damage the coating. Approved cleaners are:
 - General purpose cleaners such as Windex® or equivalent.
 - A mixture of approximately 10% ammonia and 90% tap water.
 - A mixture of approximately 50% isopropyl alcohol and 50% tap water.
4. With TPF:
 - TPF should remain on the coated surface during the washing process.
 - Standard float-glass washer settings may be utilized on products with TPF.
 - TPF should remain on the surface during post-washing transport when the washer is not directly in line with the furnace entry conveyor.

7.1 Pre-Rinse

1. A pre-rinse section that sprays clean water prior to entry into the primary wash section is effective in removing any separator powders, loose dirt and glass grinding residual.
2. A pre-rinse section is also effective in reducing washer maintenance and will reduce contamination of the primary wash section.

7.2 Washer Operation

1. Detergent wash water tank temperature must be maintained between 49-60°C (120-140°F) during operation.
2. Brushes should be positioned to minimize contact with the coated surface.
3. Do not stop the glass beneath rotating washer brushes. Prolonged contact with the brushes will result in damage to the glass and coating.



Image 29 – Water tank temperature reading

7.3 Washer Maintenance

1. Frequent cleaning of the washer assembly is recommended as detailed in the washer manufacturer's operating manual.
2. Worn or improperly adjusted brushes will cause coating damage or improper cleaning.

3. Steam cleaning of rolls and brushes can help assure removal of scale and residue buildup.
4. Avoid steam cleaning bearings and joints where released grease may contaminate the washer.
5. Separator curtains inside the washer must be checked and adjusted so they don't contact the glass surface.
6. Brushes and pinch rolls must be adjusted to accommodate the specific glass thickness being processed.
7. Cleaning agents used in the maintenance of glass washers (e.g., acids or alkaline solutions) must be thoroughly removed from the system before washing.

7.4 Detergent & Rinse

1. The wash and rinse water spray bars must be directed into the brushes for uniform distribution.
2. Spray tubes must be periodically inspected to ensure even flow. Plugged holes must be opened.
3. Guardian does not recommend detergents because hot water is the preferred method for cleaning glass. However, if detergents are used they must be formulated for machine washing and used in moderation. Too much detergent can cause difficulty in rinsing, resulting in scale buildup on the brushes or pinch rolls. Low phosphate, liquid detergents dissolve best.
4. Wash and rinse water pH levels must be monitored to stay within the 6-8 pH range.
5. The wash and rinse tanks must have a slight overflow to ensure removal of foreign materials.
6. At minimum, wash and rise tanks must be drained and cleaned daily.
7. Normal tap water is suitable for use in washing and rinsing. Special de-ionization (DI) or reverse osmosis (RO) systems are not required unless they are necessary for pH control.
8. Avoid abrasive cleaners (e.g., Ajax®, Comet®, Soft Scrub®, rouge, Lime-A-Way®, cerium oxide) or non-detergent cleaners (e.g., vinegar, citric acid).

7.5 Rinse Water Blow-off

1. Make necessary adjustments to pinch rolls and air knives to assure total removal of rinse water, per OEM instructions.
2. Any washer blow-off streaks that remain on the coated surface of the glass can be baked-in during tempering or bending and become permanent.
3. ClimaGuard® Low-E coatings are somewhat hydrophilic, meaning that water tends to spread out across the surface of a lite during the washing process.

8. Heat-Treating

1. The following guidelines apply to Climaguard® products that are designated as “Heat-Treatable” in Table 1 (on page 3).
 - Coated glass products must be insulated within 72 hours following heat-treatment by a certified fabricator.
 - Climaguard® 80/70 must be insulated within 120 hours following heat-treatment by a certified fabricator.
2. Guardian requires edge deletion for all heat-treatable coatings.
3. It is the responsibility of the fabricator to assess application specific details involving thermal stress, wind load, and all other building code compliance considerations and requirements.
4. All Climaguard® coated glass products are sold to Guardian Certified Fabricators only and must not be resold to non-certified fabricators unless the glass is sealed in an IGU.
5. Climaguard® HT coated glass products in the annealed (as-coated) state must never be fabricated into an IGU without first being heat-treated.

8.1 Tempering Overview

1. After tempering, the coated lites must be separated using interleaving. Glass temperature must be less than 49 °C (120 °F) prior to packing to minimize distortion and reduce the risk of thermal damage to the coating. Lower temperatures with extended cycle times provide the best optics.
2. Guardian recommends that all fabrication processes for Climaguard® HT products be performed in one facility. However, if tempered products must be shipped for insulating, an Insulating Notification Tag should be used indicating an “insulate by” date.
3. Climaguard® heat-treatable coated products must not be re-heat-treated after the initial tempering.

8.2 General Furnace Setups

1. Because of the improved solar performance characteristics of Guardian’s Residential coatings, furnace operations (including setup parameters and residence times) are of critical importance when processing heat-treatable coated glass products. True heat convection results in the most uniform heat saturation and in superior heat treatment for Climaguard® HT coated glass products.
2. Climaguard® HT products are designed to reflect and/or absorb solar energy. In much the same way, radiant energy produced by a tempering furnace is reflected away from and/or absorbed by these coatings during the heat-treatment process. As a result, adjustments must be made to the furnace profile and conveyor speed.
3. To obtain the best optics, a uniform heat saturation of the product must be achieved. Uniform heat saturation is often difficult to obtain with standard radiant furnaces. However, by introducing convection air during heat treatment, through the use of aspirators, the furnace’s energy is distributed in a more uniform manner. In addition, convection air improves a furnace’s efficiency, and in turn increases yields. Other furnace functions such as the ability to control individual heating elements (top-and-bottom or side-to-side) allow the fabricator greater flexibility when developing heat-treatment profiles.
4. Furnace settings established for colored glass products or high-performance Low-E coatings can be used as a starting point when heat-treating Climaguard® HT products.
5. As a rule, furnace temperatures must be decreased and the furnace residence time must be increased in relation to the improvement in solar or thermal properties of the glass being heat-treated.

6. Furnaces used to temper Climaguard® HT coated glass must have aspiration. A true convection furnace will provide the best results. SO₂ (Sulfur Dioxide) must not be used when tempering Guardian Residential glass products. Guardian requires that the use of SO₂ be discontinued a minimum 30 minutes prior to running these products. The set-point temperature of the furnace must be at or below 699°C (1290°F).
7. It is not possible to make accurate product setup recommendations that will apply to every type of furnace available. Table 6 “Thermal Exposure Cycle Time” lists general operational ranges for Climaguard® HT coated products by furnace type:
 - Type 1 relates to a full convection furnace that delivers convection air at the furnace operating temperature on both the top and bottom surfaces of the glass.
 - Type 2 relates to a furnace that has enhanced aspiration, with automatic control of pressure, and the ability to supply convection air by zone or area.
8. Climaguard IS can be used annealed or tempered. Furnace settings will be closer to uncoated glass. Please contact a Field Customer Engineer for furnace settings for double-sided product.

Table 6 - Thermal Exposure Cycle Time						
Coating	Temperature Range (HT and HS)	Cycle Time in Seconds per mm of Glass Thickness by Furnace Type			Convection Pressure & Duty Cycle (Note 2)	HS Quench Rates (Note 3)
		Type 1	Type 2	Type 3		
Climaguard HT products	670°C–700°C (1238°F–1292°F)	39 sec/mm (±10 sec)	55 sec/mm (±10 sec)	70 sec/mm (±10 sec)	1.3–2.75 bar (20–40 psi)	0.5 in.–1.0 in. of H ₂ O
1. Thermal exposure will vary broadly based on the temperature threshold and efficiency of the furnace. 2. Cold aspiration is listed. Convection is best utilized during the first 50% of the duty cycle. Hot fans, or true convection, may be used during the entire duty cycle. 3. Tempered (HT) glass must meet ASTM and ANSI standards for safety glass and must meet Guardian’s requirements for roll wave and flatness.						

8.3 Temporary Protective Film (TPF) Guidelines

1. TPF is a full-coverage, low-adhesive recyclable tape that is available on residential heat-treatable coatings.
2. TPF protects the coated surface from mechanical damage often experienced during general fabrication and enhances the product’s environmental stability, significantly increasing fabricator yields. TPF provides protection for the coated surface; however, Climaguard® products must always be run with the coated side up.
3. TPF is fabricator friendly and can be easily removed from the glass prior to heat treatment. The film requires no special setups and can be disposed of in a variety of ways.
4. Climaguard® HT coated glass products are available with TPF on the coated surface. TPF will significantly increase fabrication yields while stabilizing the coated surface during storage.
5. TPF is a polyethylene (PET) polymer sheet that is applied directly to the coated surface by Guardian during the manufacturing process. The adhesive used in the TPF is low tack and leaves no residue on the coated surface, resulting in the cleanest pre-furnace condition possible. TPF is provided with color in the film for easy product identification.

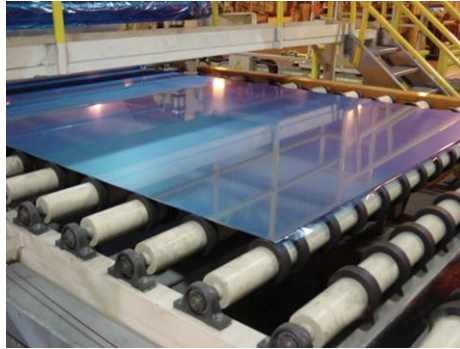


Image 30 A & B – TPF Applicator

6. TPF should remain on the coated surface through the pre-tempering furnace fabrication processes. The **TPF MUST BE REMOVED** prior to entering into the furnace. It must never be allowed to enter the tempering furnace.
- If TPF has remained on the surface of the glass through all fabrication steps and removed just prior to the furnace, the surface should be clean and free from all contaminants.
 - In instances where the TPF has been removed during fabrication, surface contaminants (e.g., fingerprints, water streaks, cutting oil residues, cooling lubricants used in grinding and hole-drilling, etc.) will adhere to the coated surface and affect the visual appearance. All surface contaminants must be fully removed before tempering.
 - Do not try to start the removal of the TPF with bare hands or gloves. Removal is simplified with the use of double-sided tape and/or a tacky roller. Start at the corner of the lite and lift towards the center of the glass once contact is made with the film.
 - Once the edge of the film is a safe distance from the surface of 2–3 in. (50–76 mm), removal by hand can be performed if there is no direct contact with the surface of the glass.

8.4 Quality Inspection

A visual inspection in both transmission and reflection of tempered glass must be done regularly and in accordance with Guardian quality standards.

Bow, warp, roll wave and surface pressure are important data that must be checked and recorded on a regular basis to assure compliance with Guardian's Residential certification program.

A subtle change in outdoor reflected color and visible light reflectance and transmission may occur after tempering ClimaGuard® products. This minor variation is due to the tempering process and is within the normal production tolerance of coated annealed glass.

Glass not meeting these quality guidelines must not be processed further.

8.5 Zebra Board Visual Inspection

Zebra boards must also be used in visual inspection of glass after heat treatment. Zebra boards are 4 ft. x 8 ft. (1.12 m x 2.24 m) panels with 2 in. (50 mm) thick white-and-black stripes across the panel at a 45 degree angle. Examples of using a zebra board for distortion measurement are shown in Images 31 and 32.

1. Zebra boards provide a subjective means of viewing distortion in reflection. Zebra boards are normally mounted post-furnace and in a vertical plane to the glass. Distortion is viewed at a 45 degree angle as the glass passes under the board. Fabricators must categorize and grade levels of optical distortion.
2. Zebra boards may also be mounted off-line in combination with an inspection table. Once properly graded, fabricators must restrict the level of optical distortion exiting their facility. Examples of differing levels of optical distortion are displayed in the subsequent section.

8.6 Optical Distortion

A number of conditions may contribute to optical distortion. Manufacturing shortfalls, glazing errors, or unequal pressures within an IGU can further contribute to distortion. Minimizing optical distortion caused by the heat-treatment process will greatly enhance the appearance of the final product.



Image 31 – Zebra board mounted on-line



Image 32 – Zebra board mounted off-line

Image 33 Series – Differing Levels of Optical Distortion as Viewed Using a Zebra Board



Image 33 A

Heavily distorted substrate—
overexposure to extreme heat.

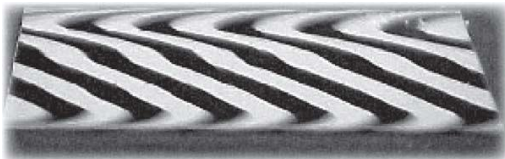


Image 33 B

Optics are slightly improved;
however, heavy edge-lift remains.

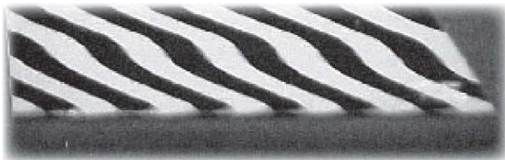


Image 33 C

Edge-lift has diminished somewhat.
Substrate is beginning to flatten.

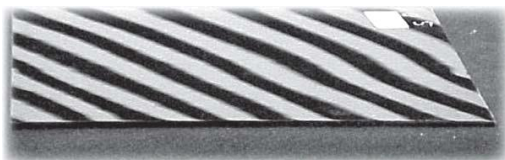


Image 33 D

Substrate is flatter. Overall
reflective properties have improved.



Image 33 E

Distortion is greatly minimized.
Reflection of zebra-board stripes
appears straight and true.

8.7 Roll Distortion Measurement

1. Factors such as extreme heat, overexposure, deformed ceramic conveyor rolls, non-uniform heat saturation, and other factors will contribute to optical distortion. A roll distortion gauge provides the fabricator a tool for monitoring peak-to-valley distortion levels produced during heat treatment. Roll distortion gauges and zebra boards are required for the successful completion of the process for Guardian's Residential certification. The fabricator must develop in-house specifications for acceptable levels of roll wave.
3. A common roll distortion gauge is shown in Image 34 and 35. The roll distortion gauge is passed over the uncoated surface or bottom side of the glass. The gauge may be used on both the X and Y dimensions.

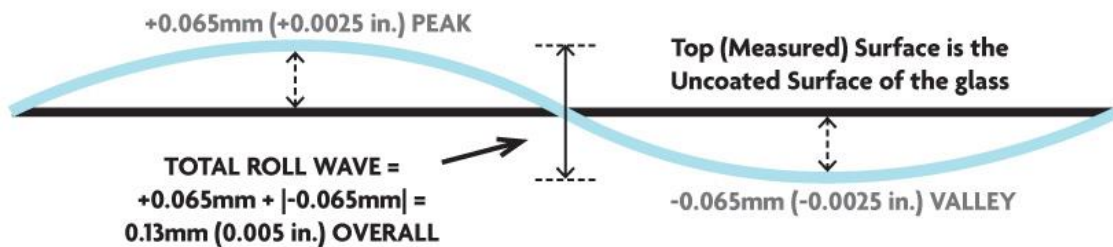


Image 36 – Target roller wave



Image 35 – Roll distortion gauge

4. Passing the gauge over the surface allows for peak-to-valley measurements. Extremes in roll wave, center, and edge kink will be determined during this measurement (Image 35).



5. Guardian recommends a target roll wave of 0.13 mm (0.005 in.) with a maximum measured roll wave of 0.25 mm (0.010 in.) for any application using Guardian Residential glass. Fabricators are urged to develop tighter in-house specifications for maximum roll wave. These specifications should be based on both furnace capabilities and aesthetic expectation for the product. The level of distortion must not exceed that depicted in the zebra board picture labeled Image 33D.

8.8 Required Quality Systems and Equipment

1. Quality control and properly maintained equipment are critical for any heat-treating process. Quality systems, inspection areas, and related quality measurement equipment must be in place before any heat treatment of Guardian's heat-treatable coated glass products.
2. Guardian endorses the latest edition of the following industry standards and specifications:
 - ASTM C 1048 • ASTM C 1036 • ANSI Z97.1 • CAN/CGSB-12.1 • 16 CFR 1201

3. A polariscope or GASP (Grazing Angle Surface Polarimeter), shown in Image 37, is a very effective instrument in determining the degree of residual stress in glass. The GASP allows for an accurate, non-destructive analysis of both heat-strengthened and tempered products. It does not replace the standard weighted piece method that is used for tempered products per ANSI Z97.1, yet provides a secondary method to verify residual stress (surface) with a defined number as described in ASTM C 1048.
4. As described in ASTM C 1048, localized warp may be determined with the use of a straight edge spanning the concave surface. The glass can be measured with a feeler gauge or dial indicator in combination with a straight edge. See ASTM C 1048 for warp tolerances. Guardian recommends using half of the ASTM guideline as an in-house tolerance.
5. A tape measure is necessary to confirm overall length, width, and square-ness (Image 38). A micrometer (Image 39) is necessary to confirm substrate thickness. A scale (also shown in Image 38) is required for weighing “dice” samples after break-testing tempered product (Image 40 A & B).



Image 37 – GASP
(Glazing Angle Surface Polarimeter)



**Image 38 – Tape measure,
scale and feeler gauge**

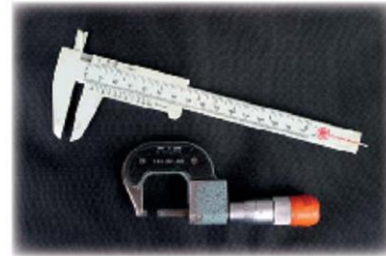


Image 39 – Micrometers

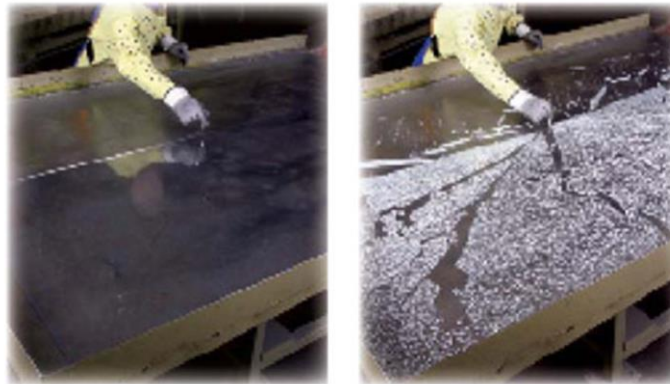


Image 40 A & B – Break-testing tempered glass

6. The thermal reflective properties of ClimaGuard® HT coated products will render top mounted measuring devices inaccurate. Adjustments to the emissivity settings of top mounted radiant pyrometers will be required. Even with correct adjustments, top mounted pyrometers can be inaccurate. Surface temperatures are best measured from the bottom (uncoated side) of the product.

8.9 Heat-Treatment Certification

1. A certification audit will be conducted at all fabricators working with Guardian Residential products. The audit will consist of a low-level production simulation consisting of the lite sizes and quantities outlined in Table 7 below.

Table 7 - Guardian Low-Level Production Simulation Requirements		
Number of Lites to Be Run	Size of Lites	Stock Sheets Required
4	Tempered 72 in. x 84 in. (1829 mm x 2438 mm)	2
4	Tempered 46.25 in. x 75.125 in. (1175 mm x 1908 mm)	2
8	Tempered 24 in. x 36 in. (610 mm x 914 mm)	2

2. The low-level production simulation must be successfully accomplished within one hour and is designed to ensure that the fabricator's process is optimized for consistent quality output across a range of sizes.
3. The customer may use the drops after cutting the trial-sized lites to prepare for the audit, but the actual production run must take place in the presence of a Guardian FCE and utilize the sizes indicated.

9. Laminating

9.1 General Guidelines

The instructions in this section will focus on the technique of bonding a polyvinyl butyral (PVB) interlayer between two pieces of glass under heat and pressure to form a bonded laminate. Laminated lites with a coating on an exposed surface must be insulated within 72 hours of lamination. Guardian has limited experience with the use of liquid resins in laminating Guardian's Residential glass products and requires that they be used with caution. **Compatibility testing must be performed before using resin products.**

1. Multiple-layer PVB constructions require slower line speeds to properly de-air.
 - One-layer PVB laminate has two surfaces to de-air.
 - Two-layer PVB laminate has four surfaces to de-air and requires a slower nip speed.
 - Three-layer PVB laminate has six surfaces to de-air, requiring the lowest nip speed.
2. ClimaGuard® products can be incorporated into a laminated glass unit using one of the following configurations:
 - The coating facing the airspace of an IGU (also known as an “exposed” application) - The exposed construction (Image 41) is the most challenging construction from which to obtain sufficient PVB temperature, as radiant energy is reflected off the top surface. Increase the top heat percentage to “full” to overcome heat energy being reflected away by the coating. Decrease the bottom heat percentage to harmonize bottom-surface temperatures to top. Otherwise, bottom PVB temperature will overheat, resulting in trapped air. Adjust line speed to achieve proper target nip temperature of 52-74 °C (125-165 °F).

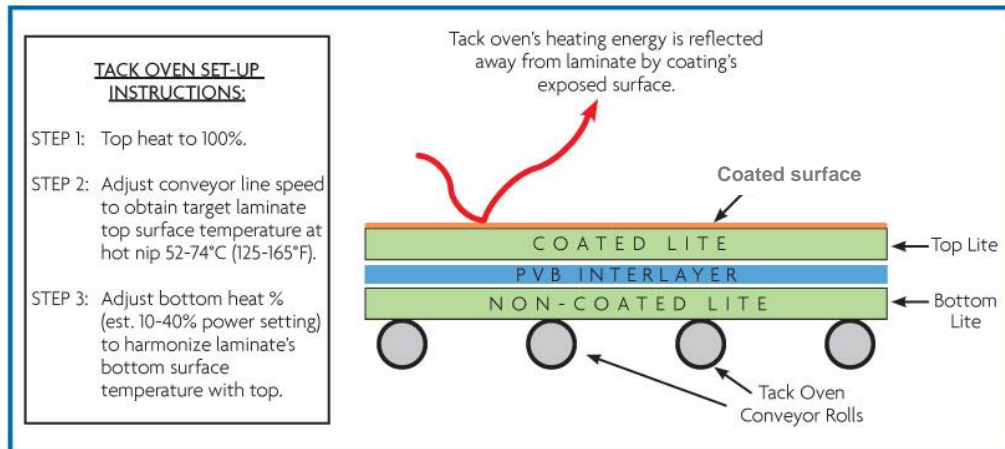


Image 41 – Laminate construction for exposed coating

- The PVB sheet facing the coated surface (also known as an “embedded” application) - The embedded construction (Image 42) makes it easier to obtain sufficient PVB temperature, as heat penetrates the body of the top lite. In this construction, the coating reflects the oven's energy back through the body of the glass. Hence, the top PVB surface receives the majority of its heat from conduction. Increase the top heat percentage, biasing to a higher percentage than the bottom. Decrease the bottom heat percentage to harmonize bottom surface temperature to top. Otherwise, the bottom PVB temperature will overheat, resulting in trapped air. Adjust the line speed to achieve proper target nip temperature of 52-74 °C (125-165 °F). **Note:** The use of ClimaGuard® products embedded against the interlayer is **not recommended**. ClimaGuard® products used in an embedded configuration must be edge deleted. Please see section 9.5, Table 8 for more information.

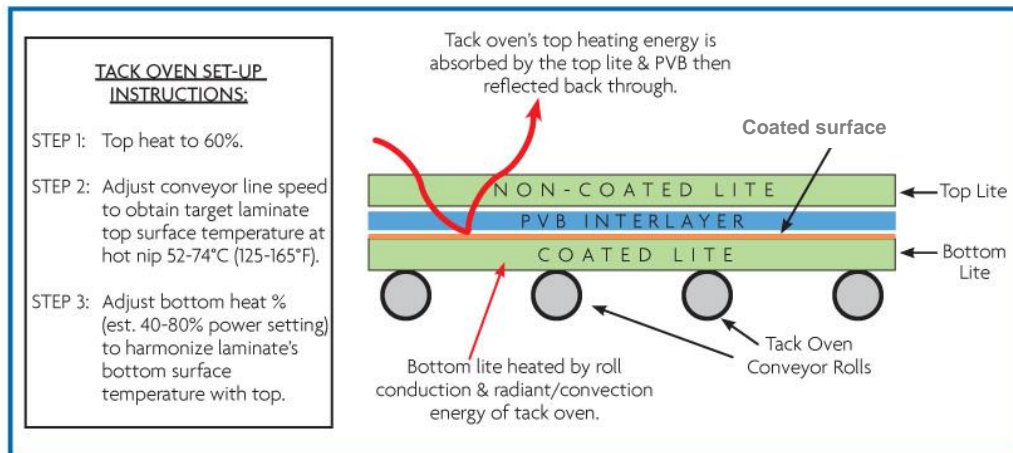


Image 42 – Laminate construction for embedded coating

9.2 Clean Room, Assembly, and Trimming Operations

1. A complete visual inspection of **transmission and reflection** must be performed prior to assembly of glass and interlayer materials.
2. Assembly must be conducted in a "clean-room"-type environment. Contaminants trapped within the interior of the unit may be objectionable. Required clean-room conditions:
 - Relative humidity of 23-25% for maintaining the appropriate PVB moisture level.
 - Maintained temperature range of 15-21 °C (60-70 °F).
 - Full gowning of personnel in lint-free coveralls, gloves, shoe covers and hairnets.
3. Minimize the exposure time of cut PVB sheet(s) prior to assembly.
4. Using a sharp instrument (which should be replaced often), trim excess material with even pressure, taking care not to pull the PVB or chip the edges of the glass.

9.3 Tack Oven and Nip Roll Operations

1. The roll-body surfaces of the nip rolls must be clean and capable of applying uniform pressure. Perform a complete **visual inspection of reflection** after assembling glass and interlayer materials to inspect for any damage the nip roll might have caused to the coated surface. Cold and hot nip rolls must be clean and free of debris when processing Guardian Residential coated glass products. Take care to minimize contact with the coated-surface after the nip roll and prior to racking for the autoclave.
2. Adjust line speed and/or tack oven controls to achieve proper laminate temperature at nip roll temperature of 52-74 °C (125-165 °F) using a "contact style" temperature-measuring device.
3. Tack oven and hot nip roll temperatures must be monitored when processing Guardian Residential coated glass products. Bias temperature settings to equalize top and bottom surface temperatures of the laminate.
4. Proper tack oven/nip operations will result in the laminate having a homogeneous grayish color appearance throughout the laminate as it exits the final nip roll assembly with a clear perimeter border and no air entrapment or tracking.

9.4 Autoclave Operations

1. Due to the reflective properties of Climaguard® products, a slightly longer autoclave residence (balance or hold) time may be required when laminating these products. A minimum of 30 minutes hold or balance time is required after both set-points are reached; ensuring that the PVB interlayer has achieved proper autoclave temperature. The required temperature set-point is between 137-143 °C (280-290 °F). The required pressure set-point is between 11.3-12.1 bar (165-175 psi). Use autoclave cycles that are typical for processing clear-on-clear glass of same thicknesses and size.
2. Each laminate must be separated by an appropriate air space to ensure proper heat transfer. Do not drag interlayer (PVB) material across coating.
3. Pressure must be released when the laminate temperature is below 49 °C (120 °F). Otherwise “champagne bubbles” may appear around the perimeter of laminates when removed from autoclave.
4. Climaguard® coated glass products are not pressure sensitive and will not be harmed by the atmosphere within a well-maintained autoclave.
CAUTION: Use of clean/dry compressed air is mandatory along with ensuring the autoclave is free from plasticizer residue.
5. Coated surface location must be identified and properly positioned prior to assembly into an IGU or laminated glass configuration. Extra care must be taken to identify the coated surface in laminated glass configurations in which the coating is in contact with the PVB interlayer, as commercially available coating detectors are incapable of identifying the location of the coated surface once the glass has been laminated.
6. For all coatings, the PVB or liquid resin will cause a color shift that may be objectionable. Guardian recommends mock-up approval for all laminated glass configurations.
7. Bow and warp of heat-treated glass that will be subsequently used in laminated configurations must be carefully controlled (per ASTM 1048 or better) to ensure proper adhesion between the glass and PVB interlayer.
8. To minimize the potential for voids and air pockets when laminating heat treated glass, thicker interlayer material may be required to compensate for thermally induced glass distortion.
 - Fabricators should submit fully fabricated samples to PVB manufacturer for quality review prior to offering laminated product for sale. Periodic re-submission of laminated glass samples to PVB manufacturer is strongly advised.
 - Fabricators must be certified by Guardian prior to processing any Guardian Residential glass products in laminated form.
 - Laminated Guardian Residential glass products must meet all standard clear/clear laminated requirements of:
 - 16 CFR 1201 - Safety Standard for Architectural Glazing Materials
 - ASTM C 1172 - Standard Specification for Laminated Architectural Flat Glass
 - Z97.1-1984 (R1994) - A.N.S. for Safety Glazing Materials Used in Buildings – Safety Performance Specifications and Methods of Test
9. For applications that include laminated and non-laminated coated glass, Guardian recommends that a full-size mock-up be approved prior to high volume fabrication. As with any laminated application, the edges of the Climaguard® glass laminated unit must not be exposed to prolonged contact with moisture or any incompatible sealant.

9.5 Edge Deletion Requirements in Laminated Configurations

1. All Climaguard® products embedded (facing the PVB) in a lamination must be edge deleted, whether used in a monolithic lamination or IGU application.

Table 8 - Edge-Deletion Requirements for ClimaGuard® Products In Laminated Glass Configurations.		
Coating	Laminated Glass with Coating Facing IGU Airspace (Exposed)	Laminated Glass with Coating Facing Interlayer (Embedded)
ClimaGuard 80/70	Not Required ¹	Required ²
ClimaGuard 72/57	Not Required ¹	Required ²
ClimaGuard 70/36	Not Required ¹	Required ²
ClimaGuard 62/27	Not Required ¹	Required ²
ClimaGuard 55/27	Not Required ¹	Required ²
ClimaGuard 53/23	Not Required ¹	Required ²
ClimaGuard 80/70 AT	Required	Required ²
ClimaGuard HT	Required	Required ²
ClimaGuard 72 HT	Required	Required ²
ClimaGuard 62HT	Required	Required ²
ClimaGuard 55 HT	Required	Required ²
ClimaGuard 53 HT	Currently in Testing	
¹ Not required with Guardian approved sealants when fabricated in the as-coated condition (annealed or temper-coat by Guardian).		
² Embedding coatings in laminated glass is not recommended, however if used embedded all edges must be edge deleted.		

9.6 Glazing Inspection and Quality Standards

Table 9 - ASTM C1172-03 – Maximum Allowable Laminating Process Blemishes						
Blemish	Up to 25 ft. ² (2.5 m ²)		25 - 75 ft. ² (2.5-7.0 m ²)		Over 75 ft. ² (7.0 m ²)	
	Central	Outer	Central	Outer	Central	Outer
Boil (bubble)	1/16 (1.6)	3/32 (2.4)	1/8 (3.2)	3/16 (4.8)	1/4 (6.4)	1/4 (6.4)
Blow-in	n/a	CE: 1/4 (6.4) EE: 1/32 (0.8)	n/a	CE: 1/4 (6.4) EE: 1/16 (1.6)	n/a	CE: 5/16 (8.0) EE: 3/32 (2.4)
Fuse	1/32 (0.8)	1/16 (1.6)	1/16 (1.6)	3/32 (2.4)	3/32 (2.4)	5/32 (4.0)
Hair, lint (single strand)	light intensity	medium intensity	light intensity	medium intensity	medium intensity	medium intensity
Inside Dirt	1/16 (1.6)	3/32 (2.4)	3/32 (2.4)	5/32 (4.0)	1/8 (3.2)	3/16 (4.8)
Lint	light intensity	light intensity	light intensity	light intensity	light intensity	light intensity
Separation	none	none	none	none	none	none
Short Interlayer	n/a	CE: 1/4 (6.4) EE: 1/16 (1.6)	n/a	CE: 1/4 (6.4) EE: 1/32 (0.8)	n/a	CE: 1/4 (6.4) EE: 1/4 (6.4)
Interlayer scuff	light intensity	light intensity	light intensity	light intensity	light intensity	light intensity
<ol style="list-style-type: none"> 1. Inspection must be performed with the glazing system in vertical orientation 2. Central area is defined by an oval/circle, whose axis when centered, is <80% of the overall dimension 3. Outer area is defined as the area outside of the central area 4. CE: covered edge of glass bite 5. EE: exposed edge (if CE or EE is unknown use CE tolerance) 6. Light intensity: barely noticeable at 36 in. (914.4 mm) but not at 11 ft. (3,352.8 mm) 7. Medium intensity: noticeable at 36 in. (914.4 mm) but not at 11 ft. (3,352.8 mm) 8. All imperfections noted should be separated by a minimum of 12 in. (305 mm) 						

10. Insulating

10.1 Assembly

1. ClimaGuard® coated glass products must be insulated with the coating facing inward, toward the hermetically sealed unit, unless specifically stated otherwise.
2. The framing system holding the glass must be designed to support the IGU without applying undue dead load, twisting, or other mechanical or thermal stress loads. Refer to the “Framing” section in the Insulating Glass Manufacturers Alliance (IGMA) guide for detailed information on Glass Support.
3. If applicable, a thermal or mechanical press should be used according to the fabrication guidelines provided by the IGU system supplier. Equipment must be leveled and capable of maintaining a uniform pressure across the IGU. Equipment must follow the OEM requirements for installation and operation.
4. Guardian does not recommend the use of breather tubes for pressure relief of IGUs. Instead, the thinner inside-diameter capillary tubes are to be used if needed, and it is recommended that such tubes are crimped within one day (24 hours) of delivery to the point of final installation.
 - Capillary tubes should be less than or equal to 0.021 in. (0.5 mm) ID and greater than 12 in. length.
 - Capillary tubes should be located on a vertical edge 6 - 10 in. from the upper corner of the IGU, as determined based on final installed orientation.
 - Capillary tubes may be left open provided the unit passes frost point testing. Failure of a unit to achieve -40 °C (-40 °F) or below in frost point testing using ASTM E 576 indicates seal failure or excess moisture in the unit and voids the Guardian ClimaGuard® Limited Warranty, per its terms.
5. Desiccants must be stored in a cool and dry location per the OEM recommendations. The following recommendations are only to be used as general guidelines:
 - For standard molecular sieve, only the two long sides of the spacer frame should be filled.
 - Fill only one long leg and one short leg when the long side is greater than 2.5 times the length of the short side. You should consult the OEM's specifications for the recommended method. Overfilling with desiccant could cause premature unit failure. Guardian approves the use of a desiccated matrix when backed up with an approved secondary seal.
 - Guardian recognizes that the useful life of any absorbent is reduced by excessive exposure to the atmosphere, and that daily testing of inventory is required. Fabricators must contact the desiccant OEM for the approved test kit and method.
6. Spacers must be applied in such a way as to ensure good adhesion to the substrate. Guardian requires that the spacer be applied uniformly to the sightline to prevent sag or bow. Any bow or sag in the sightline will be objectionable to the viewer.
 - Spacer systems must be cut, bent or otherwise shaped in accordance with the OEM's recommendations. The spacer must be clean and free of contaminants. The spacer must be positioned in such a way that it maintains its original shape with no deformation. Corners or joints must be continuous, with no gaps or breaks.
7. Two-part sealants require regular testing to confirm proper sealant characteristics. Guardian recommends a butterfly and stick life test in accordance with IGMA guidelines. The butterfly test ensures proper sealant mix and the stick life test confirms the expected sealant cure time. Refer to IGMA quality control guidelines for test specifics.
 - One-part sealants must be tested per the OEM recommendations.

8. The space between the back of the spacer and the edge of the glass must be filled completely, with no voids, air pockets, or bubbles. Guardian recommends that the secondary seal be flush with the edge of the glass to prevent excessive sealant buildup, which could cause problems with sticking to the packaging material and/or unit-to-unit bonding in the container.
 - Guardian recommends a vertical application of the secondary seal on oversized units (>45 ft.²) to prevent collapse of IGU.
9. A sealed IGU will always display reflective object distortion because weather, wind, and glazing will produce ever changing pressure loads that differ from the pressure locked-in during the manufacturing process. For specific information regarding IGU construction modifications, refer to the “Making a Difference in Glass Deflection/Image Distortion” section in the IGMA technical binder.
10. IGUs must be designed to withstand the specified loads and to meet relevant building code, fire, and safety requirements. The ASTM E1300 standard gives a procedure to select appropriate glass thickness and type for any given probability of breakage under wind and snow loads. When using heat absorbing or reflective glasses a thermal stress analysis should be made for the particular shadows, frame type and glazing location involved.
11. All fabricators should maintain third-party certification for all IGUs it produces, including separate certifications for all spacer and sealant combinations, configurations, and separate manufacturing locations. Fabricators should never label an IGU with certification credentials, unless the particular IGU is currently certified. Certification programs are administered through the Insulating Glass Certification Council (IGCC) and Associated Laboratories Inc., among others.
12. Guardian approves the usage of inert gases such as argon, xenon and krypton. Drilling, filling and plugging the IGU’s filler ports must be done in accordance with the spacer OEM recommendations. The end result must be a hermetically sealed IGU.
13. Completed IGUs should always be fabricated into finished window units as soon as is practical. This will minimize the potential for misalignment of lites prior to full sealant cure or damage to exposed glass edges.

11. Quality Criteria

11.1 Coated Glazing Inspection and Quality Standards

Table 10 - Quality Specifications for Coated Vision Glass		
Blemish	Central Area	Outer Area
Pinhole	1/16 in. (1.6 mm) Max	3/32 in. (2.4 mm) Max
Spot	1/16 in. (1.6 mm) Max	3/32 in. (2.4 mm) Max
Coating Scratch	2 in. (50 mm) max length	3 in. (75 mm) max length
Mark/Contaminant	2 in. (50 mm) max length	3 in. (75 mm) max length
Coating Rub	Not Allowed	Length + width not to exceed ¾ in. (19 mm)
Crazing	Not Allowed	Not Allowed
Corrosion	Not Allowed	Not Allowed

1. These specifications apply to cut size glass only.
 2. The glass shall be inspected, in transmission, at a distance of 10 ft. (3 m) at a viewing angle of 90 degrees to the specimen against a bright uniform background. If a blemish is visible, the above criteria apply.
 3. Central area is defined by a square/rectangle, defined by 80% of the length and 80% of the width dimensions centered on a lite of glass.
 4. Outer area is defined as the area outside of the central area.
 5. No more than two clearly apparent blemishes are allowed in a 3 in. (75 mm) diameter circle and no more than five readily apparent blemishes are allowed in a 12 in. (300 mm) diameter circle.

11.2 Industry Endorsements

Guardian endorses the latest edition of the following industry standards and specifications:

- ASTM C 1048 *Standard Specification for Heat-Treated Flat Glass*
- ASTM C 1172 *Standard Specification for Laminated Architectural Flat Glass.*
- ASTM C 1376 *Standard Specification for Pyrolytic and Vacuum Deposition Coatings on Glass*
- ASTM E 576 *Standard Test Method for Frost/Dew Point of Sealed Insulating Glass Units in the Vertical Position*
- ASTM E 1886 *Standard Test Methods for Glazing, Shutters and Doors Impacted by Missiles and Cyclic Pressures*
- ASTM C 1996 *Standard Specification for Impacts from Wind-Borne Debris in Hurricanes*
- ASTM F 521 *Standard Test Methods for Bond Integrity of Transparent Laminates*
- ASTM F 588 *Standard Test Methods for Forced-Entry Resistance*
- ASTM F 1233 *Standard Test Methods for Security Glazing Materials and Systems*
- ASTM F 1642 *Standard Test Methods for Glazing and Systems subjected to Air Blast Loadings*
- Dade County, FL Comprehensive Building Code for Resistance to Windborne Debris from Hurricanes
- SCCI_STD 12 (Southern Building Code Congress International)
- TDI 1-98 (Texas Department of Insurance) – Gulf Coastal Regions
- ANSI Z 97.1 *Safety Glazing Materials Used in Buildings, Safety Performance Specifications and Methods of Test*
- CPSC 16/CFR 1201 *Safety Standard for Architectural Glazing Materials*
- NIJ 0108.01 *National Institute of Justice Ballistic Performance*
- GSA TS01-2003 *Air Blast Resistance*
- GANA Laminated Glass Design Guide

12. Glass Cleaning Procedures

The purpose of this section is to provide guidance to consumers on proper glass cleaning procedures for windows containing Guardian Residential glass. These recommendations apply specifically to the glass portion of the window unit. Consumers should consult the window manufacturer for guidance on cleaning window frame and hardware components.

12.1 Glass Cleaning

1. Cleaning the glass of common surface debris, such as fingerprints, dust, and typical environmental deposits can be easily accomplished with common household glass cleaners.
2. Stubborn marks left on the glass, such as crayons, adhesives, and artificial snow, may be difficult to remove with typical glass cleaners, and may require an alternative cleaning method.
3. Stickers, tape, and other adhesives may be removed with a mild solvent based cleaner. Refer to cleaning solvent manufacturer for use on glass surfaces. Examples of products advertised for use on glass include:
 - Goo Gone® by the Homax Group
 - Turtle Wax® Label and Sticker Remover
4. Crayons, artificial snow, bird droppings, and other stubborn deposits can be removed by using a mild abrasive cleaner on the affected area. The abrasives within these cleaning compounds vary greatly, and harsh abrasives could scratch the glass surface. Recommended mild abrasive cleaners are:
 - Turtle Wax® Premium Polishing Compound (liquid)
 - Sparkle® SP101 Cleaner and Stain Remover
5. Certain common materials and chemicals may come into contact with the glass that, although apparently removed with common household cleaners, may reappear as an irregular pattern in condensation or dew that may form on the glass surface. This irregular condensation mark is the result of a change in the surface energy of the glass when contacted by the material. Examples include materials introduced to the glass during manufacture of the window, installation of the window, as well as everyday use of the window. Some of these materials include: rubber gloves, suction cups, silicone lubricants, cleaning fluids, markers, and stains left by hard water. This resultant change in surface energy does not alter the performance of the glass, and may be easily removed by cleaning with one of the mild abrasive cleaners listed above.
6. When using any of the cleaners or chemicals outlined above, take care not to allow contact between the cleaning solution and other components of the window, unless otherwise permitted by the window manufacturer. Always obey the safety recommendations of the manufacturer of the cleaning product.
7. There are certain items that should never be used to clean glass, as they may scratch the glass, stain the glass, or pose a safety risk. These items include razor blades and other sharp objects, steel wool, sandpaper, abrasive pads, acids or bases, undiluted or improperly diluted brick wash.

12.2 Exposure to Corrosive Cleaning Solutions

Corrosive cleaning detergents that may come into contact with windows during post-installation construction clean-up may cause corrosion of glass and Low-E coatings. These detergents are commonly referred to as “brick wash” and failure to follow the detergent manufacturer’s recommendations for the protection of other surfaces when applying the detergent solution can cause serious damage to windows and IGUs and void the glass warranty.

1. This warning specifically applies to detergents containing concentrated levels of chemicals in three categories: acidic (such as hydrofluoric, hydrochloric, or muriatic acid solutions), alkaline (sodium hydroxide and others), and organic (solvents, such as benzene). Due to the aggressively corrosive effect of brick wash solutions such as those falling into these categories, the use of brick wash is listed as an exclusion to most window manufacturers’ limited warranties.
2. The improper use of brick wash may result in damage to exposed and unexposed window system components. Unexposed window components are often compromised as brick wash breaches the glazing bead and is passed through the weep system of the window. This exposure may be the result of the original application of brick wash or as a result of secondary exposure when the window surface is re-wetted by rain water or during future window cleaning.
3. Guardian’s Science and Technology Center has performed extensive analysis of IGUs taken from windows that have been exposed to brick wash. Failures were noted at a higher rate in IGU configurations that included spectrally selective Low-E glass. Further analysis of spectrally selective IGU failures was performed to determine the root cause of the higher failure rate. Using Energy Dispersive X-Ray (EDX) analysis, high levels of chlorine were identified within the Low-E coating. The chlorine trace is a by-product of the hydrochloric acid component in the brick wash solution. Coating exposure to hydrochloric acid at high concentration levels was determined to be a primary catalyst for IGU failures. Edge deletion of the Low-E coating was found to reduce the potential for IGU failure in the presence of brick wash; however, it did not eliminate the potential for failure at higher brick wash volume levels and concentrations.
4. The Guardian Climaguard® Limited Warranty specifically prohibits exposure to certain types of detergents, whether such detergents are used in the fabrication of Climaguard® products or during the installation or use of any product containing Guardian Residential products.

Guardian Climaguard® Limited Warranty

Guardian warrants, to its immediate customer only, that Climaguard coated glass products (the “Products”) manufactured by Guardian will not contain manufacturing defects that result in visible deterioration in the coating:

- For ten (10) years from the date of original Product shipment by Guardian, when glazed as a component of a hermetically sealed insulating glass unit (“IG unit”) with the coated surface of the Product facing the interior airspace of the IG unit or in exposed applications that Guardian has specifically approved for designated Products; or
- For five (5) years from the date of original Product shipment by Guardian, when laminated with the coating facing the PVB if Guardian has specifically approved the Product for laminated applications.

Guardian is not responsible for any warranties that its customer provides to subsequent customers or other end users of the Product.

To make a claim under this Limited Warranty, Guardian’s customer must (a) notify Guardian of any alleged defect promptly in writing at the plant from which the purchase was made (see www.guardianglass.com for plant locations) and (b) provide Guardian an opportunity to inspect the Product before its removal from any IG unit, end product, or installation/glazing system. If a Product fails to conform to this Limited Warranty, Guardian’s liability is limited, at Guardian’s exclusive option, to Guardian replacing the Product without charge at the original point of delivery or, in the alternative, refunding 100% of the original net selling price to its customer. This Limited Warranty does not cover labor or any other replacement, installation, or fabrication costs. The warranty period for any replacement Product supplied under this Limited Warranty extends only to the remaining warranty period on the original Product.

CONDITIONS THAT WILL VOID THIS LIMITED WARRANTY:

1. The Product is broken or fractured.
2. The Product is stored, processed, installed, cleaned, or otherwise handled contrary to Guardian’s written instructions and published User’s Guides, Product Application Notes, or other guidelines, which are incorporated by reference into this Limited Warranty, or to applicable industry standards.
3. The Product is discarded or destroyed before reasonable opportunity for inspection by Guardian.
4. The Product is installed in an IG unit in which the seal has failed.
5. The Product is incorporated into a laminated glass unit that has delaminated.
6. The Product is damaged not due to any fault of Guardian, including for example by abnormal weather conditions; faulty installation, building construction or building design; exposure to acids, alkalis, or incompatible cleaning materials such as corrosive or abrasive compounds; or contact with abrasive items whether inside an IG unit (i.e., muntin bars, Venetian blinds, etc.) or outside (i.e., razor blades, scrapers, or metallic objects).

EXCEPT FOR THE EXPRESS LIMITED WARRANTY DESCRIBED ABOVE, THERE ARE NO EXPRESS OR IMPLIED WARRANTIES OF ANY KIND AND THERE ARE NO WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE WITH RESPECT TO THE PRODUCT OR ANY PART OR COMPONENT THEREOF AND NO WARRANTY SHALL BE IMPLIED BY OPERATION OF LAW OR OTHERWISE. IN NO EVENT SHALL GUARDIAN BE LIABLE TO ANY PERSON OR ENTITY FOR INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES OR CHARGES FOR ANY REASON, EVEN IF SUCH DAMAGES OR CHARGES ARE FORESEEABLE OR GUARDIAN HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES OR CHARGES.

No variation or change from this Limited Warranty will be binding upon Guardian unless made in writing specifically referencing this Limited Warranty and signed by an officer of Guardian.

It is the sole responsibility of the fabricator to adequately inspect Guardian Residential coated glass products before each step of fabrication and prior to shipment and installation. Inspection must be done in accordance with the criteria described in this User's Guide. Guardian will not assume responsibility for any claims if the product is fabricated contrary to these written instructions, damaged in fabrication and handling due to improper storage or installation. Guardian reserves the right to inspect any product claimed to be defective.

Authorized Customer Representative	Guardian Glass
SIGNATURE	SIGNATURE
PRINT NAME	PRINT NAME
COMPANY	COMPANY
TITLE	TITLE
DATE	DATE