GUARDIAN®
GLASS

GUARDIAN SELECT®
FABRICATOR

SunGuard® Product User Guide

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GENERAL FABRICATION OVERVIEW

To ensure the quality processing of SunGuard® products, all SunGuard coated glass products are sold only to Guardian Select® Fabricators and must not be resold to non-certified fabricators or distributors.

Strict adherence to all applicable fabrication guidance is required, with internal staff training programs appropriately implemented. Adherence to fabrication guidance is a condition of the SunGuard Limited Warranty and helps to ensure a quality finished end-product.

The Certification Process

Each Guardian Select Fabricator has successfully passed a thorough certification process including an initial business review by Guardian's Territory Sales Manager (TSM) and a robust onsite operational audit by a Guardian Field Service Engineer (FSE). Ongoing certification remains contingent upon successful cyclical recertification audits. Guardian Select Fabricators are expected to sustain strong leadership in maintaining process control, delivering quality products, achieving customer satisfaction, and continuously innovating for ever-strengthened performance. Compliance with the guidance of all equipment and material suppliers, and with the guidance of prominent industry organizations such as the National Glass Association (NGA) and Fenestration and Glazing Industry Alliance (FGIA), is expected. For more information on the certification process or criteria, please contact your TSM or FSE.

- Table A lists the products most often used during fabricator certifications. At the discretion of the FSE, other products may be used.

Table A — Test Products Typically Used for Fabricator Certifications

Product Line(s)	Common Test Products	Other Products Covered by Test Products
SuperNeutral®	SN 68 HT or SN 54 HT	SNX 62/27, SNX 62/27 HT, SNX 51/23, SNX 51/23 HT, SN 68, SN 68 HT, SN 54 HT, SNE 50/25 HT, SNR 35 HT, SNR 43 HT and SNR 50 HT
High Performance and Solar Control	AG 43	Neutral 78/65, Neutral 50, Neutral 40, AG 50, and Silver 20

SunGuard® Coated Products and General Information

SunGuard products fall into 3 fabrication categories:

- **Annealed (AN) products cannot be heat-treated. The coating will be damaged in the heat-treating process**.
- **Heat-Treatable (HT) products must be heat-treated. They are designed to match the appearance of the same product in its annealed (AN) version**.
- **Annealed or Heat-Treatable (AT) products may be used as either as annealed or as heat-treated glass, depending upon project requirements.** The heat-treated product will match the appearance of the annealed product.

Table B — SunGuard® Coated Glass Products

Product	Type	AN	HT	AT
SNX 62/27	SuperNeutral®	X		
SNX 51/23	SuperNeutral	X		
SN 68	SuperNeutral	X		
SN 54	SuperNeutral	X		
SNX 62/27 HT	SuperNeutral		X	
SNX-L 62/34 HT	SuperNeutral		X	
SN 68 HT	SuperNeutral		X	
SNX 51/23 HT	SuperNeutral		X	
SN-L 68 HT	SuperNeutral		X	
SN 54 HT	SuperNeutral		X	
SNR 35 HT	SuperNeutral		X	
SNR 43 HT	SuperNeutral		X	
SNR 50 HT	SuperNeutral		X	
SNE 50/25 HT	SuperNeutral		X	
IS 20	Interior Surface		X	
Neutral 78/65	High Performance			X
Neutral 50	High Performance			X
Neutral 40	High Performance			X
AG 50	High Performance			X
AG 43	High Performance			X
Silver 20	Solar Control			X

Section 1 : GENERAL FABRICATOR GUIDELINES

1.1 General Fabricator Information

1.1.1 All fabrication of SunGuard® products must occur within the same facility.

1.1.2 **SunGuard products are designed for commercial applications**. A "commercial application" is defined as any building beyond the scope of residential construction as defined by the International Residential Code® (IRC®). Examples of commercial applications include, but are not limited to, public facilities, office buildings, retail facilities, high-rise apartments and condominiums, hotels, and residential applications that fall outside of the IRC® definition of residential construction.

1.1.3 SunGuard products may be implemented for residential construction (and are appropriate for high-end residences, as well as for curtain walls or other traditionally commercial glazing features when implemented within residential structures). Guardian's ClimaGuard® (residential) products are not recommended for commercial applications.

1.1.4 SunGuard products must not be used in monolithic applications except where specifically permitted within this publication. See Table 1-1 for further guidance on permitted coating surface placements.

1.1.5 It is the responsibility of the fabricator to identify, understand, and properly address the specific attributes of the project application including, but not limited to:

- **Public Safety**
- **Load Resistance**
- **Deflection Control**
- **Aesthetics**
- **Acoustic Performance**
- **Code Compliance**
- **Thermal Stress Management**
- **Energy Performance**
- **Material Compatibility**
- **Long-term Durability**

1.1.6 **The coated surface must always face away (upward) from contacting elements** — such as conveyor rolls, suction cups, felt covers, roller balls, and furnace rolls — during fabrication to avoid the possibility of glass splinters or chips scratching the coating.

1.1.7 IS 20 may face downward, touching contacting elements, when frit is applied to the reverse side of the lite.

1.1.8 Follow all instructions supplied by the manufacturers for any equipment or materials used in the handling, processing, or implementation of SunGuard products. Any conflicts between those instructions and Guardian's policies should be brought to Guardian's immediate attention for resolution.

1.1.9 **The fabricator should determine whether the glass must be heat-treated to meet the project requirements.** In most cases, tinted substrates and coatings with reflective properties will require heat treatment to avoid thermal stress breakage. See Section 9: Heat-Treating for additional information.

1.1.10 Heat-treated SunGuard® products are required to be hermetically sealed within insulating glass units within a short timeframe to ensure optimal quality (see Table 9-1).

1.1.11 **Guardian recommends that units be glazed with a consistent coated surface orientation throughout a project.** There may be a noticeable color shift when comparing units having the coating on the 2nd surface and units having the coating on the 3rd surface.

1.1.12 Fabrication should take place with the tin sides of the fabricated lites positioned in a consistent manner between assemblies to support uniform aesthetics of the installed glazing.

1.1.13 Inspection and quality control procedures must be performed after each step in the fabrication process, as outlined in the SunGuard® certification checklist.

1.2 Permitted Surface Placements

1.2.1 Table 1-1 and Table 1-2 present permitted coating surface placements of SunGuard® products in a double-glazed IG unit.

Table 1-1 — Permitted Coating Surface Placements in a Non-Laminated Double-Pane IG Unit

Acceptable surface placement.
Acceptable surface placement with qualifications noted.
Prohibited surface placement.

Product	Surface #2	Surface #3	Surface #4
SNX 62/27 & SNX 62/27 HT	Yes	Yes (1)(2)(3)	No
SNX-L 62/34 HT	Yes	Yes	No
SNX 51/23 & SNX 51/23 HT	Yes	No	No
SN 68 & SN 68 HT	Yes	Yes (2)	No
SN-L 68 HT	Yes	Yes	No
SN 54 & SN 54 HT	Yes	No	No
SNE 50/25 HT	Yes	No	No
SNR 35 HT	Yes	No	No
SNR 43 HT	Yes	No	No
SNR 50 HT	Yes	No	No
Neutral 78/65	Yes	Yes	No
Neutral 50	Yes	No	No
Neutral 40	Yes	No	No
AG 50	Yes	No	No
AG 43	Yes	No	No
Silver 20 (4)	Yes	No	No
IS 20 (5)	Yes	Yes	Yes (6)

(1) SNX 62/27 HT can be used on surface #3 without the need of a tinted outboard lite or a supplementary #2 surface coating ONLY if the coating was produced in the Carleton, MI facility. If SNX 62/27 HT is coated at another Guardian facility footnote 2 applies.
(2) A tinted outboard lite, or a supplementary #2 surface coating facilitating an overall minimum outward reflectivity of 20%, is recommended.
(3) The annealed and heat-treatable versions of the coating may not be mixed.
(4) Silver 20 may be used in a monolithic glazing on the #2 surface, provided it is fully protected by a compatible ceramic frit or silicone paint. Full-size mockups should be reviewed. Coated then heat-treated lites should not be mixed with heat-treated then coated lites, in the same project, due to variations in outdoor reflected color and light reflectance.
(5) SunGuard® IS 20 may be implemented on the #2 surface of monolithic single-pane glazing.
(6) For applications in which structural silicone sealants, structural glazing tapes, or other structural adhesives will be in contact with the IS 20 coated glass surface, please contact your Regional Technical Advisor (RTA) about compatibility considerations.

Double-Glazed Insulating Glass Unit

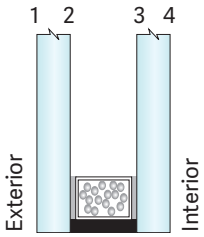


Figure 1-1

1.2.2 The guidance given in Table 1-1 can be extended to more complex glazing configurations. Please contact your Regional Technical Advisor (RTA) for assistance on coating placement in more complex glazings.

1.2.3 The guidance in Table 1-1 applies similarly to laminated IG units, provided coatings are embedded consistent with the guidance given in Table 1-2.

Table 1-2 — Permitted Coating Surface Placements in a Laminated Single-Pane Glazing Configuration

Acceptable surface placement.
Acceptable surface placement with qualifications noted.
Prohibited surface placement.

Product	Surface #2	Surface #3	Surface #4
SNX 62/27 & SNX 62/27 HT	No	No	No
SNX-L 62/34 HT	Yes	Yes	No
SNX 51/23 & SNX 51/23 HT	No	No	No
SN 68 & SN 68 HT	No	No	No
SN-L 68 HT	Yes	Yes (1)	No
SN 54 & SN 54 HT	No	No	No
SNE 50/25 HT	No	No	No
SNR 35 HT	No	No	No
SNR 43 HT	No	No	No
SNR 50 HT	No	No	No
Neutral 78/65	No	No	No
Neutral 50	No	No	No
Neutral 40	No	No	No
AG 50	No	No	No
AG 43	No	No	No
Silver 20	Yes (2)	No	No
IS 20	No	No	Yes (3)

(1) A tinted outboard ply is required.
(2) A full-scale mockup is advised. AN and HT mixes are not recommended.
(3) Contact your Regional Technical Advisor (RTA) for material compatibility in Structural Silicone Glazed (SSG) applications and condensation considerations.

Laminated Glass

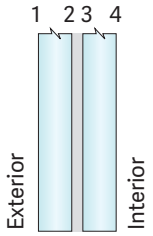


Figure 1-2

1.2.4 When two coatings are used in a single unit, a full-size mockup is recommended to ensure that the overall aesthetic is consistent with the expectations of the project team.

1.2.5 There may be a noticeable color shift when comparing units having the coating on the 2nd vs. 3rd surface for both laminated and non laminated units. Units having the coating on the 2nd surface and 3rd surface should not be mixed in the same project without mockup approval.

1.2.6 The most common placement of coatings within triple-pane glazing are on the #2 and #5 surfaces. Except Neutral 78/65, Guardian does not recommend other coatings on the #4 surface due to potential cumulative color variance and heat buildup within the unit. Please review Guardian's Expert Series on triple pane glazing located here for more information

1.2.7 Please contact your Regional Technical Advisor (RTA) with additional questions on coating placement.

Section 2: RECEIVING, STORAGE AND HANDLING

2.1 Receiving, Storage and Handling Guidelines

2.1.1 Proper receiving, storage, and handling are critical to the long-term performance of SunGuard® products.

2.1.2 **All SunGuard product and case tags must remain with the original packaging**. SunGuard products are shipped on racks or packed in cases and are labeled with Guardian production/identification tags. Lites must always be traceable to the original Guardian case tags. Pin racks must not be used for storage of SunGuard® products.

2.1.3 **SunGuard products must be unloaded under dry, indoor conditions and always protected from direct weather** – including, but not limited to, rain, snow, splashing water, and chemical exposure. If wet and/or damaged glass is received, delivery must be immediately rejected, the carrier contacted, and Guardian notified of the wet shipment and/or damage.

2.1.4 SunGuard products should not be stored within 50 ft. (15 m) of glass washers, outside doors, or corrosive chemical storage areas. Contact between glass and potentially damaging or corrosive materials must be avoided.

2.1.5 Because of the solar-absorbing characteristics of SunGuard products, glass stored in shipping containers or stacked in a group may experience thermal breakage if exposed to direct sunlight.

2.1.6 SunGuard product stock should be rotated so that the oldest supply is always used first ("first in - first out").

2.1.7 **Contact between lites must always be avoided**. When SunGuard products are stored prior to fabrication or being transported between fabrication processes, contact between lites should be avoided by means of approved separators (see Table 2-1).

2.1.8 Avoid abrasion when handling SunGuard products.

2.1.8.1 If suction cup equipment is utilized in removing glass from storage, it must be properly maintained for the appropriate pressure and cup cleanliness must be maintained. If suction cups contact coated surfaces, the cups must be clean and dry, and only the minimum number of cups safely necessary must be used. Rolling blocks, as needed, should be implemented when moving glass. Glass edges should not be permitted to contact frames or other hard surfaces during fabrication.

2.1.8.2 If suction cup frames require manual operation, proper technique is required to reduce the risk of coating abrasion. Suction cups cannot drag across the coated surface when engaging or releasing the lites.

2.1.8.3 Guardian recommends the use of suction cup covers.

2.1.8.4 Suction cup covers should be changed periodically and if they become dirty to avoid damage to the glass coating.

2.1.9 Touching coated surfaces must be avoided during fabrication.

2.1.9.1 **Clean, dry gloves must be worn.** Glass should never be handled with bare hands.

2.1.9.2 **Lites should be handled by the edges, or the uncoated surface**, as shown in Image 2-1. The coated glass surface should never be touched (with the exception of IS 20).

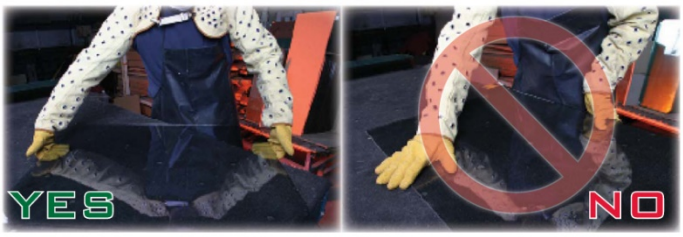


Image 2-1

2.1.9.3 Razor blades, steel wool, or other materials with an elevated potential to cause surface damage should not be used on any coated glass surfaces.

2.1.10 **Lites must be placed correctly on appropriate racks** when equipment-assisted movement is required between processes which are not directly in line.

2.1.10.1 If A-Frames are used, like sizes must be stacked together.

2.1.10.2 Different sizes must be separated by physical separators such as foam tabs or polyfoam strips.

2.1.11 **Harp racks present a scratch hazard to SunGuard® products and are not recommended.** If harp racks are used, the fabricator assumes all responsibilities for scratches and damage to the coated surface. The following precautions are recommended if the fabricator chooses to accept the risks:

2.1.11.1 Keep harp racks clean and well maintained.

2.1.11.2 Avoid sliding coated surfaces against the harp cords.

2.1.11.3 Never put more than one lite in a slot.

2.1.11.4 Modify the racks to create a sloped bottom (such as a mild left-to-right downward slope as viewed from the front of the rack), to allow the uncoated glass surfaces to lean against the harp cords.

2.2 Shelf Life

2.2.1 The maximum product shelf life for all SunGuard® products prior fabrication is six months from the date of Guardian's delivery to the customer, based upon testing under normal plant conditions. This shelf life will be shortened if SunGuard products are stored in an environment with high temperature and/or high humidity. Additional timeframe limitations associated with heat-treating SunGuard products are presented in Section 9: Heat-Treating.

2.3 Separators

2.3.1 SunGuard products must never be stored or transported without proper separation between lites. Glass-to-glass contact will cause scratches and damage the coated surfaces.

Table 2-1 — Separating Materials

Recommended	Not Recommended
Cork Pads (Static Foam against Coating) Foam Pads Lucite® Beads Polyfoam Sheets* Silver Saver®	Cardboard Newsprint Nut Powders Powder Separators Containing Acid Kraft Papers
* Care must be taken when using these sheets. They must never be dragged across coated surfaces.	

2.3.2 **Separating materials must not be used on hot glass.** After heat treatment of SunGuard products, the glass temperature must be maintained below 122°F (50°C) at the cooling section exit. Use of separators on hot glass can result in permanent marks on the glass.

2.4 Thick Glass Handling

2.4.1 Thick glass (also referred to as "heavy glass") is defined as glass that is 8 mm or greater in thickness. Since weight increases significantly as glass thickness increases, special handling is required. Table 2-2 shows the relationship between thickness and weight of glass.

Table 2-2 — Effect of Glass Thickness on Weight

Nominal Thickness	Size	Area	Approximate Weight	Approximate Increase
6mm	60" X 80" (1524 mm X 2032 mm)	33 ft^2 (3.1 m^2)	102 lb. (46 kg)	-
8mm	60" X 80" (1524 mm X 2032 mm)	33 ft^2 (3.1 m^2)	136 lb. (62 kg)	33% (vs. 6 mm)
10mm	60" X 80" (1524 mm X 2032 mm)	33 ft^2 (3.1 m^2)	170 lb. (77 kg)	67% (vs. 6 mm)
Note: Glass weights can be calculated using a unit weight of 156 pounds per cubic foot (2500 kilograms per cubic meter).				

2.4.2 **The ability to fabricate thick glass should be evaluated before accepting orders.** To accommodate the weight of thick glass, it may be necessary to add mechanical lifts in areas of the plant where lifting is otherwise manually conducted.

2.4.3 Existing vacuum-assist frames should be checked to ensure that they can support the weight of the glass. If the glass is too heavy, hazardous situations may arise for personnel, equipment and inventory.

2.4.4 Conveyors should also be evaluated to ensure they are designed to support the weight of the glass. Drive motors should be evaluated to ensure they can support the starting torque and amperage requirements.

2.4.5 **Glass washers on all processes must be adjusted prior to handling heavy glass.** While some washers have automatic thickness adjustments, most will require manual adjustments. If the washer is not properly adjusted to the correct glass thickness, the product may be damaged or improperly cleaned.

2.5 Jumbo Glass Handling

2.5.1 Guardian jumbo glass can have dimensions up to 130” x 240” (3300 mm x 6100 mm).

2.5.2 **The ability to handle jumbo glass should be evaluated before accepting orders.** Both the size and weight of Jumbo glass must be considered when determining if modifications will be required to existing equipment.

2.5.3 **All handling requirements for SunGuard® coated products apply to Jumbo glass**. After cutting, the lites are handled the same as any other SunGuard coated product.

Section 3: TEMPORARY PROTECTIVE FILM (TPF)

3.1 TPF Introduction

3.1.1 "Temporary Protective Film" (TPF) is a recyclable polyethylene (PE) full coverage tape commonly provided on heat treatable double-silver and triple-silver SunGuard® coated glass surfaces.

3.1.2 TPF is applied to AG 43, AG 50 and Silver 20 products except for those products produced in the Kingsburg, CA facility.

3.1.3 The bonding agent of TPF is a low-tack pressure-sensitive adhesive (PSA).

3.1.4 TPF protects the coated surface from environmental and mechanical damage often experienced during shipment and general fabrication. The use of TPF can significantly increase fabricator yields.

3.1.5 TPF can be easily removed from the glass prior to heat treatment and can be disposed of in a variety of ways.

3.2 TPF Precautions

3.2.1 Guardian Glass with TPF must be processed with the TPF side facing up.

3.2.2 TPF should remain on the coated surface through cutting, edgework, and washing. TPF must be removed prior to the glass entering the tempering furnace.

CAUTION

3.2.3 TPF must never be allowed to enter the tempering furnace.

Image 3-1

3.3 TPF Cutting

3.3.1 TPF should remain on the coated surface during cutting.

3.3.2 Minimal amounts of cutting fluid should be used when cutting through the TPF surface as excess fluid can cause the TPF to lift.

3.3.3 Results from Guardian research indicate that a coarse ground cutting wheel is optimal for cutting TPF and scoring the glass consistently with a clean edge.

3.3.4 See Section 5: Cutting for recommended wheel diameter, cutting angle, and pressures.

3.4 TPF Seaming

3.4.1 TPF is strongly recommended to remain on the coated surface during the seaming process.

3.4.2 Dry seaming is the preferred and recommended method of seaming.

3.4.3 Wet seaming, especially with excessive coolant, may dislodge the edges of the film.

3.4.3.1 In the event the glass is wet seamed, the glass should be washed before the seaming slurry can dry and the seaming slurry should be completely removed.

3.4.4 The optimal seaming belt roughness range is 120 - 150 grit.

3.5 TPF Edge Deletion

3.5.1 Edge deletion on Guardian glass with TPF can be performed either pre or post heat treatment. See Section 7: Edge Deletion for further information.

3.6 TPF Removal

3.6.1 Do not try to start the removal of TPF with bare hands or gloves.

3.6.2 Removal is simplified with the use of doubled-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.

3.6.3 Once the edge of the film is at a safe distance from the surface (2” - 3” (50 - 76 mm)), the film can be removed by hand.

Image 3-3 – Removal of TPF

3.7 TPF disposal

3.7.1 The polyethylene (PE) TPF can potentially be recycled directly.

3.7.2 TPF that remains on the surface of cullet must be recycled as contaminated cullet, just as any low-e coated glass. Contact your recycler about disposal options.

3.7.3 Though not preferable, TPF can normally be disposed of in landfills. Refer to local waste disposal codes regarding landfill disposal of TPF.

Section 4: COATED SURFACE DETECTION

Detection of the coated surface is a critical step in correctly processing SunGuard® products. To ensure proper fabrication, the user must establish which surface has been coated when opening incoming packaging.

Sputter-coatings do not have the surface roughness of pyrolytic coatings and cannot be easily detected by contact with gloves or bare hands. Skin oils are also difficult to remove and may damage the coated surface with prolonged exposure.

Packing tags indicate the orientation of the coated surface within the packaging, however, formal detection by one of the methods outlined below is necessary prior to moving and subsequently processing the glass.

Care must be taken to avoid scratching the glass, especially if the coating detector utilizes metal contacts.

4.1 Coating Detectors

4.1.1 Detectors, such as the one pictured in Images 4-1 and 4-2, may be obtained from EDTM at www.edtm.com.

4.1.2 An ohmmeter, shown in Image 4-3, measures electrical resistance. The coated surface of a glass lite is highly conductive because of its metallic content, while the uncoated surface will have much greater resistance.

4.1.2.1 Set the ohmmeter on a high-resistance setting (e.g., RX 10,000).

4.1.2.2 Contact the glass surface near the extreme edge, with the positive and negative terminals of the detector positioned approximately 1” (25 mm) apart.

4.1.2.3 If a reading registers, the terminals are contacting the coated surface. Otherwise, they are not.

Image 4-3 – Low E Surface Detector

Image 4-3 – EDTM Reflex Detector

Image 4-3 – Ohmmeter

Section 5: CUTTING

This section refers to the correct procedures and materials for cutting all SunGuard® products.

5.1 General Cutting Guidelines

5.1.1 The surface of the cutting table must be frequently cleaned to remove contaminants and other potential sources of damage to the glass.

5.1.2 The coated surface of the glass must always face upward, with the exception that IS 20 may face down when frit is applied to the reverse side of the lite.

5.1.3 Table 5-1 presents a list of approved cutting fluids. Additional fluids may be tested and approved upon request. Please contact your FSE for additional information. Cutting fluid must be used in moderation.

Table 5-1 — Approved Cutting Fluids

Manufacturer	Cutting Oil
Bohle	ACECUT 5503, ACECUT 5929, V52, V55 & V59
Aull Technology, Inc.	GC120E & GC110E
Sogelub	SOGEVER 1100 FG & SOGEVER 1200 FG
C.R. Laurence Co., Inc.	V020 & W410GL
	Mineral Spirits
Salem	STM Cut 8 & STM Cut 14
Lamson Oil Company	FormAll 2330
Rocol	RTD Cleancut
Shell Chemicals	ShellSo D60
Perfect Score Technologies	HP-5503
GAI	GAI Cutting Oil
Walter Surface Technologies	COOLCUT
Fuchs	GLASOL GB
Castrol	Castrol Iloform 7425
Magnus	MagSlip 2100-E
J&S Chemical	Process 485
H.B. Fuller	HL-147

Note: All product and company names are trademarks™ or registered® trademarks of their respective holders and are not trademarks of Guardian Glass. Guardian's use of the product and company names above does not imply any affiliation with or endorsement by the owners of or manufacturers of these products for the uses described by Guardian.

5.1.4 Glass must be moved from the cutting table to the rack one lite at a time, as shown below. The coated surface must not be handled directly (with the exception of IS 20).

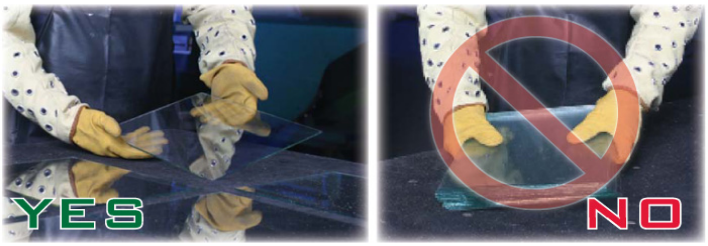


Image 5-1 – Glass Handling

5.1.5 Glass must be placed on racks for movement to the next process after cutting unless the subsequent processes are directly inline.

5.2 TPF Cutting

5.2.1 TPF must face up and remain on the coated surface during cutting.

5.2.2 Minimal amounts of cutting fluid should be used when cutting through the TPF surface as excess fluid can cause the TPF to lift.

5.2.3 Using a coarse ground conventional cutting wheel when cutting glass with TPF typically, will produce a clean edge. Guardian recommends wheels produced by Bohle and MacInnes Tool.

5.2.4 Suggested TPF cutting parameters with a conventional coarse ground wheel are in Table 5-2 below:

Table 5-2 — TPF Cutting Parameters

Glass Thickness	Wheel Angle	Wheel Diameter	Pressure
6 mm	135 - 145°	4.1 mm	26 psi (1.8 bar)
8 mm	148°	4.1 mm	41 psi (2.8 bar)
10 mm	148°	5.6 mm	43 psi (3.0 bar)
Note: Cutting speed affects pressure, and adaptation may be necessary to achieve the best possible cuts.			

5.2.5 Some fabricators have found improved results when cutting through TPF with the use of specialty serrated cutting wheels. For example, MDI Penett 60/130 or 60/140, or the Bohle Cutmaster Platinum 135 to 145 degree cutting wheel.

5.3 Thick Glass Cutting

5.3.1 When cutting heavy glass, a different cutting wheel angle and/or cutting wheel pressure will usually be required. Generally, a lower angle cutting wheel and increased cutting pressure are necessary for thick glass. The cutting table manufacturer may be a source of advice if the plant operators are not experienced in cutting thick glass.

Section 6: SEAMING

6.1 General Seaming Guidelines

6.1.1 The surface of the seaming table must be frequently cleaned.

6.1.2 The coated surface of the glass must always face upward (with the exception of IS 20).

6.1.3 Guardian recommends that seaming be performed on both annealed and HT SunGuard® coated products for safety and handling purposes.

Section 7: EDGE DELETION

7.1 Edge Deletion

7.1.1 Guardian requires all SunGuard® SuperNeutral® and High Performance coated glass products to be edge deleted. Edge deletion facilitates adhesion to sealants, prevents corrosion, and improves aesthetics and durability.

7.1.2 Silver 20 and IS 20 coated glass can be fabricated without edge deletion — contact your Regional Technical Advisor (RTA) for guidance on compatibility considerations associated with structural silicone sealants, structural glazing tapes, and related features.

7.1.3 The National Glass Association (NGA) Glass Informational Bulletin (GIB) "Guidelines for the Appearance of Insulating Glass Unit Edges in Commercial Applications", states the following:

"Edge deletion is typically targeted to end in the primary sealant. The primary sealant in the edge deleted area will be a different color than the primary sealant in the coated area. The color and degree of color difference will depend on the coating and the edge deletion process. These primary sealant color differences may be significant but are not a cause for rejection. Viewing mock-ups is strongly recommended."

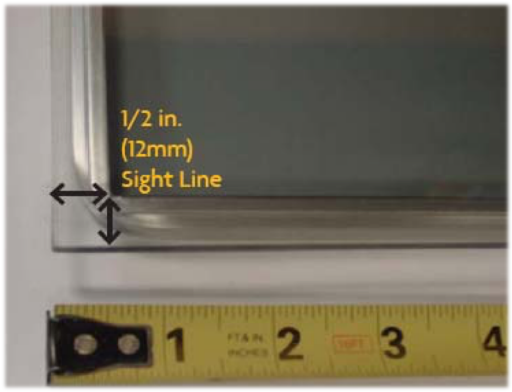


Image 7-1 – Sightline Edge Deletion

NGA's GIB: "Guidelines for the Appearance of Insulating Glass Unit Edges in Commercial Applications" is copyrighted by the National Glass Association, 800 SW Jackson St, Suite 1500, Topeka, KS 66612. A copy of the complete publication may be obtained from NGA's Online Publication Store at: https://www.techstreet.com/standards/guidelines-for-the-appearance-of-insulating-glass-unit-edges-in-commercial-applications-glass-information-bulletin-id-02-0315?product_id=1921032. For structurally glazed applications, edge deletion which extends beyond the sightline and encroaches into the vision area will be visible when looking outward through the glazing from the inside of the building.

7.1.4 SunGuard products can be edge-deleted in one pass (excluding offsets) when the guidelines in this document are followed and when the correct edge deletion wheel is used.

7.1.5 Edge deletion will be easier if the coating is in the annealed state, whether edge-deleted on a cutting system or by using an edge deletion table. Once the coating is processed through the tempering furnace, it will require more aggressive measures (such as increased machine force, increased residence time, and/or specific wheels).

7.1.6 The surface to be edge deleted must always face upward.

7.1.7 Edge deletion should preferably be performed with an automated process or with an edge deletion table. If edge deletion is performed with a manual grinding tool, care must be taken to ensure that the edge deletion is adequate.

7.1.8 Using automated or manual equipment, the coated edge of the glass must be ground until the conductive silver layers have been removed. A constant fluid motion will produce the best results. The downward pressure must be firm enough to remove the coating without being so firm as to result in a bind between the wheel and the glass surface.

7.1.9 When edge deleting SunGuard® SNX 51/23 HT, SN 54 HT, and SNR 43 HT following heat treatment and on a vertical IG line, Salem Distributing Company, Inc. Part #W8B82 with a 1/2" sightline is recommended to facilitate single-pass edge deletion.

7.1.10 The fabricator is responsible for setting an acceptable tolerance for the edge deletion band when edge deleting a coated product. An advance review of edge deletion samples by the end customer may help to prevent misunderstandings about the edge deletion appearance.

7.1.11 Edge deletion may be performed by a variety of methods if the conductive silver layers are completely removed by the process. Please see Table 7-1.

Table 7-1 — Typical Edge Deletion Methods

Edge Deletion Method	Performed Pre vs. Post Heat Treatment (HT)	Recommended Edge Deletion Wheel Types	Comments
Standalone Horizontal Table	Pre or Post HT	1) Pre-HT: 3M Scotch-Brite™ SST Deburring or Equivalent Wheel 2) Post HT: Salem Distributing Part #W8B82 Wheel with ½" Sightline or Equivalent Wheel	Standalone tables may yield inconsistent deletion widths. Multiple passes may be required.
Handheld Tool	Pre or Post HT	Call Resources Unlimited Co., Inc. at (734) 654-9728 to order replacement wheels.	Handheld tools may yield inconsistent edge deletion widths.
Incorporation into Horizontal CNC Cutting Tables	Pre HT	3M Scotch-Brite™ SST Deburring or Equivalent Wheel	-
In-line with Automated Horizontal Seaming Lines	Pre HT	3M Scotch-Brite™ SST Deburring or Equivalent Wheel	These systems often involve two separate wheels which produce an X and Y axis deletion.
Incorporation into Vertical Insulating Line	HT Coatings Post HT and AN Coatings In-line	1) Pre-HT: 3M Scotch-Brite™ SST Deburring or Equivalent Wheel 2) Post HT: Salem Distributing Part #W8B82 Wheel with ½" Sightline or Equivalent Wheel	Traverse speeds, wheel condition, and downward force must be properly managed for optimal deletion.

7.1.12 To determine whether the conductive layers have been removed from the deleted band, the edge-deleted area must be tested for electrical conductivity with an approved 'contact' style low-e coating detector or ohmmeter. The device should be used to confirm the absence of the conductive coating, including any residue.

Image 7-2 – Low-E Coating Detector

7.1.13 The operator must also perform regular visual inspections for coating residue and reflective appearance. Upon viewing the edge of the coated lite in reflection residual coating is generally visible under typical lighting conditions.

7.1.14 Remaining non-conductive residue may result in some reflective color differences but has not been found to affect the performance of sealant adhesion or the service lives of IG units.

7.1.15 Proper maintenance is critical for adequate edge deletion, regardless of the edge deletion equipment.

Image 7-3 – Ohmmeter

7.1.16 Periodic dressing of the edge deletion wheel is necessary to ensure successful coating removal while avoiding damage to the glass substrate. The required dressing frequency depends on the wheel pressure, grinding speed, and coating. A glazed wheel surface indicates that dressing is needed.

7.1.17 Edge deletion wheel dressing may be accomplished by holding a wire brush perpendicular to the wheel as shown in Image 7-4. The wire brush will clean coated material from the wheel's surface. The wheel should be turned on, and the wire brush lightly set against the surface until the glaze is removed.

Image 7-4 – Simplified Wheel Dressing with a Wire Brush on a Horizontal Table. Note: The protective shroud has been removed for visual clarity only.

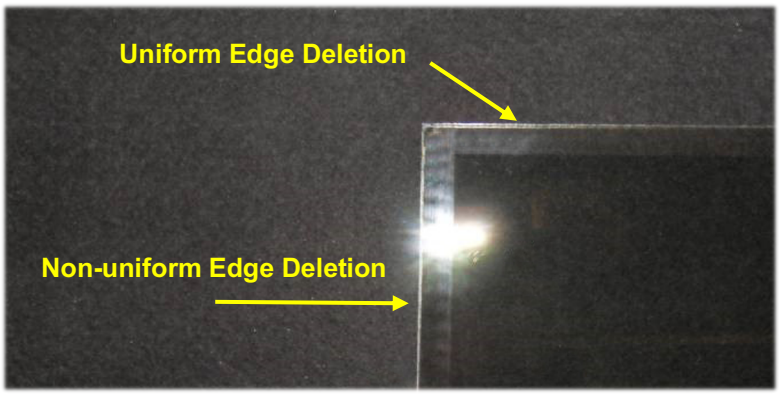


Image 7-5 – Uniform and Non-uniform Edge Deletion

7.2 TPF Edge Deletion

7.2.1 Post-heat-treatment automated edge deletion on the IG line may be performed for TPF coated glass, as the approach addresses edge deletion at the final step in the fabrication process after the TPF has been removed.

7.2.2 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.

7.2.3 Edge deletion through TPF performed at the automated cutting system may also be performed with good results provided one of the following practices is followed:

7.2.3.1 Cutting equipment manufacturers are developing new technologies and upgrading current systems to perform edge deletion through TPF. For more information on qualifying systems please consult the automated cutting table manufacturer.

7.2.3.2 Edge deletion through TPF at the cutting table may be performed without capital investment or modifications. By slowing the edge deletion bridge speed to approximately 20 meters / minute (± 1 meter / minute), and slightly increasing the head's downward 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.

7.2.4 Regardless of the approach used, fabricators must assure that the 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. For specific information regarding automated edge-deletion systems, when the edge-deletion process is integrated with the glass-cutting operation, please contact your Guardian Field Service Engineer.

7.3 Edge Deletion of Offset IG Units

7.3.1 When fabricating offset IG units (for instance, IG units implemented at butt-glazed corners), edge deletion as appropriate must extend from the offset edge to the primary sealant. Multiple passes may be necessary.

7.3.2 Offset IG units may implement various sightline widths. Consequently, the edge-deletion bands may correspondingly vary. Band widths of 1" to 3" are commonly encountered.

7.3.3 Consistent with the previous discussion, acceptable offset edge deletion requires the complete and verified removal of all conductive material, and the fulfillment of all applicable aesthetic requirements. The deletion band should exhibit a generally uniform appearance when viewed vertically in reflection at a distance of 10' (3 meters), though some remaining

non-conductive coating residue may be present without necessarily cause for visual rejection. Such residue will not affect the sealant performance or IG unit durability. See Image 7.6.

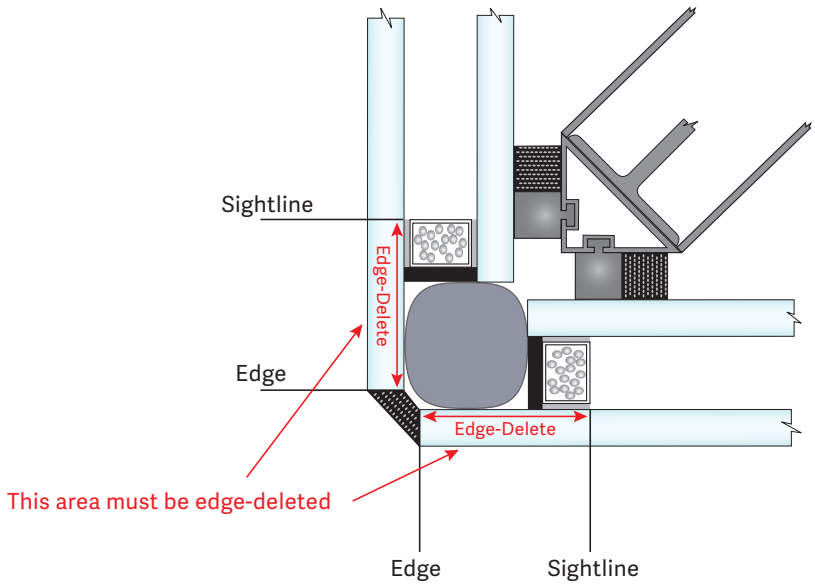


Image 7-6 - Edge Deletion at Corner Connection of Offset IG Units

7.4 Laminated Glass Edge Deletion

7.4.1 The previously presented edge deletion guidelines also apply to coated laminated glazing applications, whether the coating is exposed (not in direct contact with the interlayer material) or embedded (in direct contact with the interlayer material). Only SunGuard® SNX-L 62/34 HT, SN-L 68 HT (specially sourced as the embeddable version of the product), and Silver 20 are permitted in embedded laminated make-ups, subject to the qualifications presented within this document.

7.4.2 As with any laminated glazing assembly, the edges of a SunGuard product laminated glazing assembly must not be exposed to prolonged contact with moisture, silicone, or any material for which incompatibility issues may arise.

7.4.3 A minimum ½” edge deletion width should be implemented unless both of the following conditions are met in relationship to a reduced edge deletion width:

7.4.3.1 Compatibility testing validates that all of the non-glass components in contact with, as well as in the immediate vicinity of, the interlayer material are compatible with one another and are compatible in combination with the interlayer material.

7.4.3.2 The fabricator can reliably implement the reduced edge deletion width.

Section 8: WASHING

Washing must take place immediately after any edge grinding, polishing, seaming, or related processes and immediately prior to tempering, laminating, IG unit assembly, or related processes. Washers must be maintained per the OEM's recommendation.

8.1 Washing

8.1.1 The coated surface of a lite must always face up to avoid the possibility of glass splinters or chips scratching the coating (except for IS 20).

8.1.2 The top surface of the lite must not be touched when loading or unloading the washer. Contact must only be made with the bottom surface or edges of the lite, as shown below.

Image 8-1 – Proper handling practices for SunGuard® products

8.1.3 Proper setup of the washer is critical for all glass products, and particularly low e coated glass. Brush-induced damage that may not be visible in uncoated glass may be evident in coated glass.

8.1.4 Low e brushes are required for washers processing SunGuard® products. The brushes must be adjustable and must be positioned to minimize contact with the coated surface. The brushes must not be damaged or worn. The following specifications apply:

8.1.4.1 The upper brush bristles must have a standard diameter of 0.006 - 0.008".

8.1.4.2 The bottom brush bristles must have a standard diameter of 0.008 - 0.010".

8.1.4.3 All bristles must be made of 6-12 crimped Nylon or similar soft material with high water absorption.

8.1.4.4 Allow brushes to soak for approximately 10 minutes after restarting the washer from an extended shut-down period.

8.1.4.5 All bristle lengths must be 2 - 2⅜"and of uniform density.

8.1.5 When spot cleaning 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 surface, as this may damage the coating. Any of the following may be used:

- General-purpose cleaners, such as original Windex® or equivalent products.
- A mixture of approximately 10% ammonia and 90% tap water.
- A mixture of approximately 50% isopropyl alcohol and 50% tap water.

8.1.6 Glass washers on all processes must be adjusted prior to handling heavy glass. While some washers have automatic thickness adjustments, most will require manual adjustments. If the washer is not properly adjusted to the correct glass thickness, the coating and substrate may be damaged.

8.2 Pre-Rinse Section

8.2.1 A pre-rinse section that sprays clean water prior to entry into the primary wash section can be effective in removing separator powders, loose dirt, and other residual material, helping to reduce contamination and maintenance of the primary wash section.

8.3 Washer Operation

8.3.1 For horizontal washers the wash water tank temperature must be maintained between 120-140°F (49--60°C) during operation. For vertical washers the wash tank temperature must be maintained between 110 – 140°F (43–60°C). The water and tanks must exhibit a relatively neutral pH of 6 to 8. The glass should not be stopped beneath the rotating washer brushes. Prolonged contact with the brushes will result in damage to the glass and the coating.

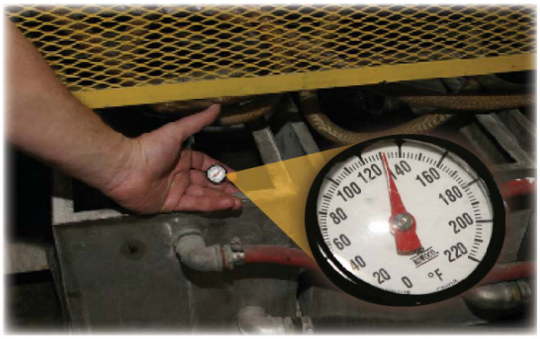


Image 8-2 – Measurement of Water Temperature

8.4 Washer Maintenance

8.4.1 Frequent cleaning of the washer assembly is required, as detailed in the washer manufacturer's operating manual. Worn or improperly adjusted brushes will result in improper cleaning and can cause coating damage.

8.4.2 Steam cleaning of rolls and brushes can help to facilitate removal of residue and scale. Bearings and joints should not be steam cleaned where released grease may contaminate the washer.

8.4.3 Separator curtains inside the washer must be checked and adjusted so that they do not contact the glass surface. Brushes and pinch rolls must be adjusted to accommodate the specific glass thickness being processed.

8.4.4 Cleaning agents used in the maintenance of glass washers (such as acids or alkaline solutions) must be thoroughly removed from the system before washing SunGuard® products.

8.5 Wash and Rinse

8.5.1 The wash and rinse water spray bars must be directed into the brushes for uniform distribution. Spray tubes must be periodically inspected to ensure even flow. Plugged holes must be opened.

8.5.2 Guardian does not recommend detergents. Hot water is usually sufficient to clean SunGuard products. If detergents are used, they must be formulated for machine washing of low-e coated glass and must be used only in moderation. Excessive detergent can result in rinsing difficulties, with scale buildup on brushes and pinch rolls. Low phosphate liquid detergents dissolve best.

CAUTION

8.5.3 Never use detergents when washing laminated glass, as the interlayer adhesion may be adversely affected.

8.5.4 The wash cycle should be followed by a cool water rinse.

8.5.5 Wash and rinse water pH levels must be monitored to stay within a pH range of 6 to 8.

8.5.6 The wash and rinse tanks must have a slight overflow to facilitate the removal of foreign materials. At a minimum, the wash and rinse tanks must be drained and cleaned daily.

8.5.7 Normal tap water is suitable for use in washing and rinsing. Special deionization (DI) or reverse osmosis (RO) systems are not required unless necessary for pH or TDS control.

8.5.8 Avoid commercial abrasive cleaners (such as rouge or cerium oxide), household abrasive cleaners (such as Ajax®, Comet®, Soft Scrub®, or Lime-A-Way®), and non-detergent cleaners (such as vinegar or citric acid).

8.6 Rinse Water Blow-off

8.6.1 Make necessary adjustments to pinch rolls and air knives to assure total removal of rinse water, consistent with the instructions from the OEM. Any washer blow-off streaks that remain on a coated glass surface can be permanently baked in place during heat treatment. Standing water can also become trapped during the laminating process.

8.6.2 Glass should not stop until completely out of the washer and blow off sections. Stopping in the blow off section can lead to uneven drying and subsequent blow off streaks.

Section 9: HEAT-TREATING

9.1 Heat-Treating General Overview

9.1.1 The selection between an annealed or heat-treatable version of a coating depends upon whether heat-treatment is necessary for the installed application. The fabricator should determine whether the glass must be heat-treated to meet the project requirements.

9.1.1.1 In most cases, tinted substrates and coatings with reflective properties will require heat treatment to avoid thermal stress breakage.

9.1.1.2 Other factors, including but not limited to tinted glass; large glazing assembly sizes; light-colored framing members; partial shading; edge damage during shipping, handling, or installation; and service in climates with elevated solar exposure or severe temperature fluctuations can significantly increase the possibility of thermal breakage.

9.1.1.3 If heat treatment is necessary, heat-treatable products must be used or the glass must be heat-treated prior to coating. Heat-treated SunGuard® products are required to be hermetically sealed within insulating glass units within a short timeframe to ensure optimal quality (see Table 9-1).

9.1.2 Full convection furnaces yield the most uniform heat saturation and best heat treatment results for SunGuard heat-treatable coated glass products.

9.1.3 SunGuard heat-treatable coated glass products are designed to be heat treated only one time. If SunGuard coated glass is sent through the furnace more than one time, Guardian's SunGuard Limited Warranty will be voided.

9.1.4 Due to the energy performance characteristics of Guardian's SunGuard coatings, furnace operations (including setup parameters and residence times) are of critical importance when processing heat-treatable SunGuard products.

9.1.5 Quality systems, inspection areas, and related quality measurement equipment must be in place before any heat treatment of the SunGuard® heat-treatable series of coated glass products. Please see Section 14: Quality Inspection for additional information.

9.1.6 All fabricators performing tempering have been required to maintain certification through the Safety Glazing Certification Council (SGCC) effective as of December 31, 2016. Related information is available at www.sgcc.org. Evidence of current certifications must be provided as part of the Select Fabrication audit.

9.1.7 Heat-treatable SunGuard® products have IG unit fabrication timeframe requirements following heat treatment, as presented in Table 9-1.

Table 9-1 — SunGuard Post Heat-Treatment Insulation Timeframe Requirements*			
Product	**Type**	**Insulation Within 5 Days**	**Insulation Within 72 Hours**
SNX 62/27 HT	SuperNeutral®		X
SNX-L 62/34 HT	SuperNeutral		X
SNX 51/23 HT	SuperNeutral		X
SN 68 HT	SuperNeutral		X
SN-L 68 HT	SuperNeutral		X
SN 54 HT	SuperNeutral		X
SNE 50/25 HT	SuperNeutral		X
SNR 35 HT	SuperNeutral		X
SNR 43 HT	SuperNeutral		X
SNR 50 HT	SuperNeutral		X
Neutral 78/65	High Performance	X	
Neutral 50, Neutral 40	High Performance	X	
AG 50, AG 43	High Performance	X	
Silver 20	Solar Control	X	
*These timeframes are inclusive of the heat soaking process as applicable.			

9.2 TPF removal

9.2.1 TPF must be removed before the glass enters the furnace.

9.2.2 Do not try to start the removal of TPF with bare hands or gloves

9.2.3 Removal is simplified with the use of doubled-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.

9.2.4 Once the edge of the film is a safe distance from the surface (2-3” (50-76 mm)), removal by hand can be performed.

9.2.5 Polyethylene (PE) TPF is recyclable

9.3 Heat Treatment Fundamentals

9.3.1 Heat-strengthened glass is recommended when heat treatment is necessary for thermal stress management, unless tempered glass is specifically required otherwise (such as to satisfy safety glazing requirements involving ANSI Z97.1 and CPSC 16 CFR 1201, compensate particularly elevated thermal stresses, or achieve load resistance requirements).

9.3.2 Heat treatment of low-e coated glass is generally more challenging than that of other types of glass. A well-maintained furnace with a high level of convection is typically needed to properly heat-treat sputter-coated low-e glass products.

9.3.3 SunGuard® products are designed to reflect and/or absorb solar energy. Consequently, tempering furnace profile and conveyor speed adjustments are necessary to compensate the reflection and/or absorption of radiant furnace energy by these coatings during the heat treatment process.

9.3.3.1 As a rule, furnace temperatures must be decreased, and residence times increased in relation to the improvement in energy performance properties of the products being processed (see Table 9-2).

9.3.4 To obtain the best optics, **uniform heat saturation of the product must be achieved**, which is often difficult with standard radiant furnaces. By introducing convection air during heat-treatment — using aspirators or convection nozzles — heat can be more uniformly distributed. Convection air also improves operational efficiency, increasing yields. Other furnace functions, such as the ability to control individual heating elements (top-and-bottom or side-to-side) offer enhanced flexibility in developing heat-treatment profiles.

9.3.5 **Surface temperatures should be measured from the bottom, uncoated surface of the glass.** The thermal-reflective properties of SunGuard products will render most top-mounted temperature measuring devices inaccurate, especially if they are not equipped with emissivity correction.

9.3.5.1 Some pyrometers are equipped with software capable of adjusting the pyrometer's emissivity and can accurately read surface temperatures.

9.3.6 Whenever possible, lites must be processed so that roll wave will appear horizontal, parallel to the base dimension of the installed glazing.

9.4 General Furnace Set ups

While this publication does not present SunGuard product setup recommendations specific to every particular furnace (please consult your FSE for more detailed guidance), Table 9-2 presents general operational ranges for the SunGuard® products on the basis of 3 general furnace types:

- Type 1 is 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 is a furnace with enhanced aspiration, automatic control of pressure, and the ability to supply convection air by zone or area.
- Type 3 is a radiation furnace with a basic aspiration system installed, and typically no aspiration control except for pressure.

Table 9-2 — Furnace Operational Ranges for SunGuard® Heat-Treatable Coated Glass Products

Product Family	Coating	Thermal Exposure Cycle Time (1) Furnace Type and Efficiency Times Given in Seconds per mm Glass Thickness			Temperature Range (HS and FT)	Convection Pressure and Duty Cycle (2)	HS Quench Rate (3)	FT Quench Rate (4)
		Type 1	Type 2	Type 3				
SuperNeutral®	SNX 62/27 HT	39 sec/mm (±10 sec)	55 sec/mm (±10 sec)	70 sec/mm (±10 sec)	1238°F–1292°F (670°C–700°C)	1.3–2.75 bar (20–40 psi)	0.5”–1.0” of H2O	10”–14” of H2O
	SNX-L 62/34 HT							
	SNX 51/23 HT							
	SN 68 HT							
	SN-L 68 HT							
	SN 54 HT							
	SNE 50/25 HT							
	SNR 35 HT	34 sec/mm (±10 sec)	50 sec/mm (±10 sec)	65 sec/mm (±10 sec)				
	SNR 43 HT							
	SNR 50 HT							
High Performance	Neutral 78/65	30 sec/mm (±10 sec)	45 sec/mm (±10 sec)	60 sec/mm (±10 sec)				
	Neutral 50	20 sec/mm (±10 sec)	35 sec/mm (±10 sec)	50 sec/mm (±10 sec)				
	Neutral 40							
	AG 50	35 sec/mm (±10 sec)	50 sec/mm (±10 sec)	65 sec/mm (±10 sec)				
	AG 43							
Solar Control	Silver 20	19 sec/mm (±10 sec)	28 sec/mm (±10 sec)	40 sec/mm (±10 sec)				
Interior Surface	IS 20	18 sec/mm (±10 sec)	32 sec/mm (±10 sec)	38 sec/mm (±10 sec)				

(1) Thermal exposure will vary broadly based on the temperature threshold and the efficiency of the furnace. Exceeding a thermal exposure of 80 seconds per millimeter of glass will cause objectionable haze on any SNX HT offering.
(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) Heat-strengthened (HS) glass must meet ASTM standards for surface stress and must meet Guardian’s requirements for roll wave and flatness.
(4) Fully tempered (FT) glass must meet ASTM and ANSI standards for safety glass and must meet Guardian’s requirements for roll wave and flatness.

9.5 Heat Treatment Processing

9.5.1 The coated substrate must be thoroughly cleaned prior to heat treatment, as contaminants may cause damage.

9.5.2 The coated surface of the glass must always face upward (with the exception of IS 20 when ceramic frit has been applied to the reverse side).

9.5.3 To minimize distortion and reduce the risk of thermal damage to the coating, furnace temperatures should be decreased as far as possible. Lower temperatures with extended cycle times provide the best optics. The furnace operating temperature set point must not exceed 1292°F (700°C) during heat treatment.

9.5.4 Except for IS 20 coated glass, the use of SO_2 (sulfur dioxide) must be discontinued a minimum of 30 minutes prior to running SunGuard® products and must not be used when processing the products.

9.5.5 Full convection processes are recommended to improve the furnace efficiency and to support the finished optical quality of the glass. Furnaces without some level of convection may not be successful in heat-treating SunGuard double- and triple-silver coatings.

9.5.6 SunGuard Solar Control and High-Performance coatings absorb significant amounts of energy. Adequate gaps between batches must be provided to allow for thermal recovery of the furnace.

9.5.7 After heat treatment of SunGuard products, the glass temperature must be maintained below 122°F (50°C) at the cooling section exit. Use of separators on hot glass can leave permanent marks on the glass.

9.6 Heat-Treatment Certification

9.6.1 A certification audit will be conducted at all fabricators working with Guardian heat-treatable SunGuard products. The audit will consist of a low-level production simulation consisting of the lite sizes and quantities outlined in Table 9-3.

Table 9-2 — Guardian Low-Level Production Simulation Requirements

Number of Lites to Be Run	Sizes of Lites	Stock Sheets Required
1	Heat-Strengthened 72” x 96” (1829 mm x 2438 mm)	1
3	Heat-Strengthened 46 1/4” x 75 1/8” (1175 mm x 1908 mm)	1
6	Heat-Strengthened 24” x 36” (610 mm x 914 mm)	1
1	Tempered 72” x 96” (1829 mm x 2438 mm)	1
3	Tempered 46 1/4” x 75 1/8” (1175 mm x 1908 mm)	1
6	Tempered 24” x 36” (610 mm x 914 mm)	1

9.6.2 The low-level production simulation must be successfully accomplished within one hour and is designed to confirm that the fabricator's process is optimized for consistent quality output across a range of sizes.

9.6.3 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 FSE and utilize the indicated sizes.

9.6.4 If the fabricator does not have a reliable quality system in place to inspect the glass before and after heat treatment, the Guardian FSE can provide a suitable final quality check inspection system.

9.7 Heat Treatment Inspection

9.7.1 A visual inspection of both transmission and reflection of heat-treated glass must be performed regularly and in accordance with Guardian quality standards. Please refer to Section 14: Quality Inspection for additional information.

9.8 Thick glass Heat-Treatment

9.8.1 Heat-treating thick glass will generally provide better optics (less roll wave distortion) than thin glass. A thorough evaluation of the tempering furnace capabilities and the operators' skills should be conducted prior to accepting projects with heat-treated heavy glass.

9.8.2 Any furnace issues with thick uncoated glass will be magnified with thick coated glass.

9.8.3 When heat-strengthening heavy low-e coated glass, flatness may be challenging to maintain during the cooling stage. As air is added to facilitate flatness, care should be taken so the glass does not exceed allowable surface compression for heat strengthened glass. The furnace quench must be in optimal working condition to successfully heat-strengthen heavy coated glass. Strain patterns (also known as "anisotropy" or "iridescence") are generally more visible on thick glass than on thinner glass.

Section 10: BENDING

Heat-Treatable versions of SunGuard® Solar, High Performance, SuperNeutral® and Interior Surface (SunGuard IS 20) coated glass products can be bent provided the guidelines presented here are followed. To maintain aesthetics and ensure superior performance, special care must be taken during the fabrication of these products. Following the requirements that are noted here will reduce the chances of damage to the coating during the bending process. Failure to adhere to these guidelines may void the warranty.

10.1 Prerequisites for Bending

10.1.1 Guardian Field Service Engineering must conduct a certification visit at the customer's fabrication facility prior to initiating any bending operation. Because every application is different, each circumstance must be independently evaluated.

10.1.2 Full-size mockups of the bent glazing should be produced, reviewed and approved in writing by all key parties prior to accepting any project to ensure the suitability of the coating for the intended use.

10.1.3 Projects involving glazing with a concave shape as viewed from the exterior of the building should be carefully reviewed to mitigate the potential for issues of concentrating reflected energy.

10.1.4 In preparing the glass for entry into a bending furnace, the coated substrate must be machine washed with the coating facing up and away from conveyor rolls or mold surface.

10.1.5 Washed glass must be totally dry and free of fingerprints and other contaminants. Note: Inspection of the coated glass following the washing process is required. Fine scratches produced by washing will be further enhanced during the bending process.

10.1.6 Due to extended exposure to heat and risk for subsequent color shift SNX 62/27 HT, SNX 51/23 HT and SNX-L 62/34 HT are not approved for bent annealing. However, they are approved for bent tempering and heat-strengthening.

10.2 Bent Annealing

CAUTION

10.2.1 Temporary Protective Film (TPF) must be removed just prior to bending the glass.

10.2.2 Release agents such as a combination of talc powder and isopropyl alcohol may be used during the bending process. However, post-bend residual release agents must be removed using a clean, soft cloth saturated with mixture of ammonia and water. Fire retardant blankets may be used at the glass to mold interface.

10.2.3 During the sag bending process, glass temperature must not exceed 1120°F (605°C) and the ambient temperature must be at or below 1166°F (630°C). If this temperature is exceeded, coating degradation may occur. Note: The thermal reflective properties of

SunGuard® Solar, High Performance, SuperNeutral® and Interior Surface (IS 20) coated glass products will render top-mounted measuring devices inaccurate.

10.2.4 Do not attempt to press bend the shape. Rather, allow for sag to occur once the coated glass is thermally softened.

10.2.5 Once the bending process is complete, the glass must be immediately brought down to a temperature of 970°F (521°C), from which the slow annealing cycle may begin. Test cuts of the substrate should be performed to assure proper annealing.

10.2.6 Radical bends may cause stretch marks or “crazing” to occur in the coating.

10.2.7 Surface orientation is determined by the shape of the mold. (See Images 10-1 and 10-2)

10.2.8 Avoid placing the coating down against the mold surface. If bending doublets, the coated lite must be on top and its surface away from the clear uncoated mate.

10.2.9 The bent annealed coated glass must be hermetically sealed within an insulating glass or laminated unit within 72 hours of bending. Failure to seal the coated surface may result in oxidation of the film.

10.2.10 The recommended glazing configuration places the coating in compression.

10.2.10.1 When viewing from the exterior of the project, SunGuard coatings are typically applied to the second surface of a convex unit.

10.2.10.2 In some cases, third surface applications are requested on concave units.

10.2.10.3 Please see Tables 1-1 and 1-2 for allowable surface placement of coatings and other considerations.

10.3 Bent Tempering and Heat Strengthening

10.3.1 SunGuard High Performance, SuperNeutral® HT and SNX HT coated glass products *require* edge deletion prior to bending, insulating or laminating. For more information on edge deletion, review Section 7: Edge Deletion. Bent glass applications may require the use of a hand-held deletion tool. Unlike a fixed device, the hand-held tool will allow the operator to follow the contour of the bend.

10.3.2 SunGuard Solar coatings (Silver 20) and SunGuard IS 20 *do not require* edge deletion. SunGuard Solar coatings (Silver 20) must **not** be used monolithically.

10.3.3 Due to the reflective properties of SunGuard® Solar, High Performance and SuperNeutral® products, extended soak times may be necessary. As with heat treated flat glass, bent SunGuard products must conform to the optical and safety requirements set-forth by both the glass industry and Guardian Select® Fabricator program.

10.3.4 As a general rule, any radius tighter than 80” (2032 mm) must be pre-approved by Guardian.

10.3.5 Inspection of bent parts must be done in accordance with requirements found in Section 14: Quality Inspection of this document.

10.3.6 The same general handling techniques are required for heat-strengthened and tempered glass applications. However, surface pressure on the finished parts must be monitored. For information on stress measurements in bent glass, contact your FSE. For more information on heat-treating and inspection, please see Section 9: Heat-Treating of this user’s guide.

10.3.7 Strain patterns in heat treated glass may be more apparent under certain viewing conditions. The effect is enhanced during static heating and cooling. Mock-up viewings outdoors should include an evaluation for this phenomenon.

10.4 Convex and Concave Bending

10.4.1 Convex or concave applications will be determined by both the orientation of the coated surface and the mold shape.

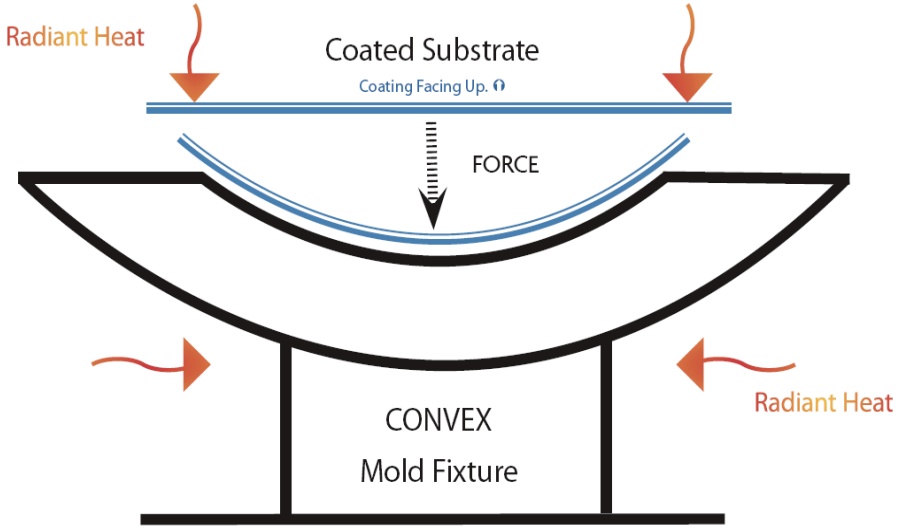


Image 10-1 – Convex Bend. Coating Facing Upward Away from Mold. Final Application Places the Coating on the #2 Surface

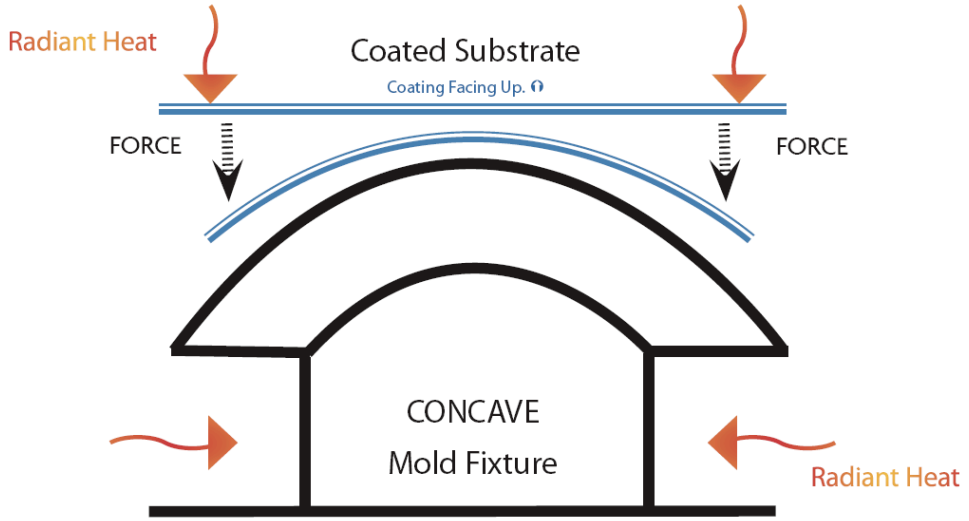


Image 10-2 – Concave Bend. Coating Facing Upward Away from the Mold. Final Application Places the Coating on the #2 Surface

10.5 Cold Bending

As an alternative to traditional sag bending where the glass is heated beyond its softening temperature, SunGuard® heat treatable products can be cold bent.

10.5.1 Before cold bending SunGuard heat treatable products:

10.5.1.1 A finite element analysis must be conducted to determine the limits of each individual component i.e.: glass, spacer, sealant, frame…etc.

10.5.1.2 Full sized mockups involving the most aggressive bend must be made and approved by all key parties.

10.5.2 SunGuard heat treatable products must be heat strengthened or tempered prior to cold bending.

10.5.3 Cold bending may be performed on individual components or IG units.

10.6 Bending Terminology

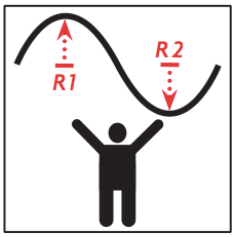
CONVEX

When viewed from the exterior, the curve bends toward the observer.

CONCAVE

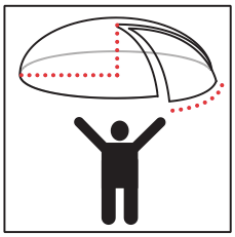
When viewed from the exterior, the curve bends away from the observer.

SERPENTINE CURVE



A condition of having concave [R1] and convex [R2] curves in the same plane.

COMPOUND CURVE



A condition having curves in horizontal and vertical planes.

CIRCUMFERENCE

The length of a curve or arc of a circle. It must be specified whether the measurement is along the exterior or interior face of the glass.

POINT OF TANGENCY

The point at which a straight line meets a curve or arc. Determination of this point is crucial for the interfacing of curved glass and metal.

TANGENT

A straight line exiting an arc or curve. Sometimes referred to as a straight leg.

RADIUS

The dimension or measurement of an imaginary line taken from the center point of a circle to the arc or circumference of the circle.

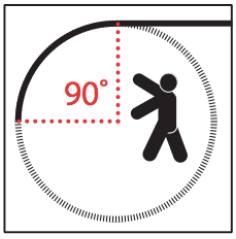
CHORD

The dimension of an imaginary straight line connecting the end points of a curve or arc. Sometimes referred to as the "point to point" dimension or measurement.

GIRTH

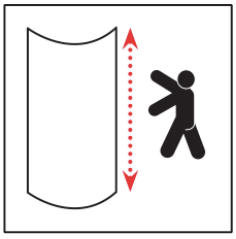
The length of a curve or arc required. The dimension or measurement of the material required if viewed in a "stretched-out" or "flattened" state. The longer girth must be specified.

DEGREE OF ARC



Every circle, regardless of radius, contains 360 degrees of curvature. The girth or arc length of curved glass can be determined when the "degree of arc" is given.

HEIGHT



The straight edge of a lite of glass as opposed to the girth dimension. Could also be referred to as the width dimension if the lite is installed in an overhead application.

RISE

In geometric terms, the rise is known as the height of the arc. While not critical when adequate information is submitted, the rise can be used in conjunction with the chord dimension to calculate an unknown radius or girth.

COMPRESSION

Pressed together, made more compact by pressure.

TENSION

Stress on a material produced by the pull of forces tending to cause extension.

Sources: GANA Glazing Manual 2004 and Webster's New World College Dictionary [4th edition].

Figure 10-3

Section 11: HEAT SOAKING

11.1 Background Information

11.1.1 Only heat-treatable (HT or AT) SunGuard® products may be heat soaked.

11.1.2 The decision to implement heat soaking should be made by those with overall project responsibility, in consideration of the specific attributes of the application, breakage risks and potential consequences, costs and schedule implications of potential replacement.

11.1.3 Architectural glass is inherently subject to potential inclusions, many of which are stable in nature. Yet there is the potential for NiS (nickel sulfide) inclusions which can cause spontaneous breakage in tempered glass. Tempered glass is heated and then quenched to develop permanent compressive surface stresses that increase the flexural load resistance of the lite. During the heating process, a β-NiS crystal may undergo a phase change to a form known as α-NiS. The α-NiS crystal is denser than the more stable β-NiS crystal and occupies a slightly smaller volume. As the glass is quenched, it conforms to the shape of the α-NiS crystal. If the α-NiS crystal later reverts to the β-NiS form, it occupies a slightly greater volume and exerts stress that may cause the glass to spontaneously break.

11.1.4 Heat soaking is a process which may expose some NiS or other inclusions that could potentially otherwise cause spontaneous breakage. The process involves placing the tempered glass inside a specially designed oven and raising the temperature to approximately 536°F (280°C) to accelerate α-NiS crystal transformations to the β-NiS form in a controlled environment.

11.1.5 While this process helps to reduce spontaneous NiS-induced breakage risks, it is not 100% effective in preventing NiS-induced breakages of installed glazing. It also adds cost and, if not properly performed, may reduce the residual compressive surface stress of the glass, and its corresponding structural capacity. As heat soaking requires an additional fabrication step, it also carries the risk of handling damage.

11.1.6 Following the heat soak process, the residual stresses within the processed glass must remain consistent with the requirements of ASTM C 1048.

11.1.7 While there is not an established North American published standard for heat soaking, the European Union has published EN 14179-2 “Glass in Buildings - Heat Soaked Thermally Toughened Soda Lime Silicate Safety Glass”.

11.1.8 Heat-strengthening greatly reduces the possibility of NiS-induced spontaneous breakage compared to tempered glass, and heat-strengthened glass is more conductive to complete post-breakage retention than is tempered glass. Heat-strengthened glass also exhibits approximately double the load capacity of otherwise equal annealed glass.

11.1.9 Heat-strengthened glass is recommended when heat treatment is necessary for thermal stress management, unless tempered glass is specifically required otherwise (such as to satisfy safety glazing requirements involving ANSI Z97.1 and CPSC 16 CFR 1201, compensate particularly elevated thermal stresses, or achieve load resistance requirements).

11.2 Heat Soaking Process Notes

11.2.1 Tempering, heat soaking, and IG assembly must be conducted at the same site.

11.2.2 Upstream processes — such as handling, cutting, seaming, washing and heat treatment — must be properly performed to prevent damage to coated surfaces prior to heat soaking.

11.2.3 The coated surface of the glass must always face upward, with the exception that IS 20 may face down when frit is applied to the reverse side of the lite.

11.2.4 Heat soaking thermocouple leads should be attached only to uncoated glass surfaces.

11.2.4.1 If breakage occurs in the heat soaking oven, adjacent lites must be closely inspected to ensure scratch-free glass.

Section 12: LAMINATING

12.1 General Information

12.1.1 Sloped and overhead glazing applications generally require laminated glazing.

12.1.2 All fabricators performing lamination have been required to maintain certification through the Safety Glazing Certification Council (SGCC) effective as of December 31, 2016. Related information is available at www.sgcc.org. Evidence of current certifications must be provided as part of the Select Fabrication audit.

12.1.3 Any SunGuard® coating may be implemented in an exposed position in a laminated glass configuration (in which the coating is not in direct contact with an interlayer material) if the coating is implemented on an approved surface in the glazing (see Table 1-1).

12.1.4 For embedded coatings (in which the coating is in direct contact with an interlayer material), the fabricator is responsible to ensure that the coated surface is positioned in accordance with approved glazing configurations. Please see Table 1-2. Coating embedment in violation of our written guidance may result in objectionable color variances within a glazing assembly, from one glazing assembly to another, and/or between coating runs, and will not be covered by our SunGuard Limited Warranty.

12.1.5 When a low-e coating is embedded, its contribution to the insulating performance of an IG unit is negated, but solar control properties remain. **As the off-angle reflected color sensitivities of low-e coatings are intensified upon embedment, written approval of representative full-scale mockups by the design team and glazing contractor are advised to ensure that all aesthetic requirements are fully satisfied.** Any exceptions to this guidance must be approved by your FSE.

12.1.6 For glazing assemblies with embedded coatings: coated glass that is subsequently heat-treated should not be mixed with heat-treated glass that is subsequently coated, as appearance variations between the differently processed products may be visually evident in the final application.

12.1.7 As Guardian has limited experience with liquid resin interlayers, complete compatibility testing is necessary in advance of their use. Guardian embeddable coatings SNX-L 62/34 HT, SN-L 68 HT, and Silver 20 are compatible with PVB (polyvinyl butyral), and ionoplast (Kuraray SentryGlas®) interlayer. Note: SN-L 68 HT must be specially sourced as the embeddable version of the product. Please contact your FSE for more information.

Table 12-1 — Guardian Approved Interlayer Materials for Embedded Coatings

Product Category	Description
PVB	Polyvinyl Butyral
SentryGlas®	Ionoplast

12.1.8 The general compatibility of certain low-e coatings to PVB and ionoplast interlayers **does not cover all specific applications.** In structural façade applications additional consideration should be given when utilizing laminated glass with low-e coatings placed facing PVB and ionoplast interlayers (e.g., SentryGlas), which may reduce its structural performance compared with uncoated laminated glass. Please contact Guardian Technical Services for further information.

12.2 Laminating Information

CAUTION

12.2.1 TPF must be removed prior to lamination.

12.2.2 Laminated glazing assemblies with multiple PVB interlayers require reduced lamination line speeds to properly de-air.

12.2.2.1 The nip roll speed must be reduced as the number of PVB interlayers in the laminated glazing assembly is increased.

12.2.2.2 As additional layers of PVB are added, the nip roll speed and pressure must be adapted.

12.2.3 A laminated glazing assembly with an exposed coating (Image 12-1) is the most challenging configuration with which to sustain a sufficient interlayer temperature, as radiant energy is reflected off the top surface of the glass:

12.2.3.1 Increase the top percentage distribution of tack oven heat to “full” to help compensate for the coating.

12.2.3.2 Decrease the bottom heat percentage distribution to harmonize the bottom and top surface temperatures. Otherwise, the interlayer underside will overheat, trapping air.

12.2.3.3 Adjust the line speed to achieve the proper target nip temperature of 125 - 165°F (52 - 74°C).

TACK OVEN SET-UP INSTRUCTIONS:

Step 1: Top heat to 100%

Step 2: Adjust Conveyor line speed to obtain target laminate top surface temperature at hot nip 125-165°F (52-74°C)

Step 3: Adjust bottom heat % (est. 10-40% power setting) to harmonize laminate’s bottom surface with top

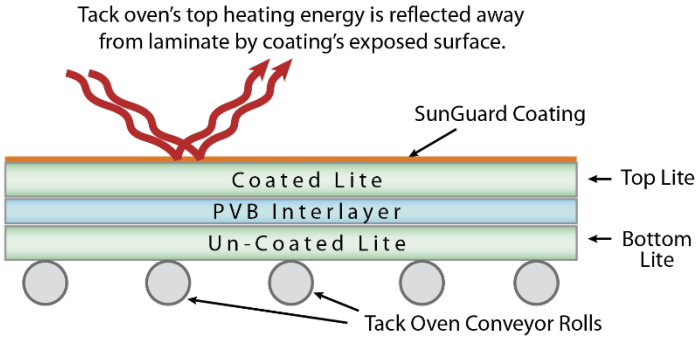


Image 12-1 –- Laminated Glazing Assembly with Exposed Coating

12.2.3.4 Reduce the nip roll pressure to the minimum level required for adequate function. If diamond pattern nip rolls are implemented, Guardian recommends switching to a solid roll. Non-solid rolls may collect particulate debris resulting in scratches or leave non-uniform imprints. Regardless of the type of roll used, the surface must be clean, and equal pressure side-to-side must be applied.

12.2.3.5 If glass breakage occurs during any step of the process, care must be taken to ensure that adjacent lites are not damaged when removing the broken glass.

12.2.3.6 After the autoclave process, coated glass must be hermetically sealed within an insulating glass unit within 72 hours.

12.2.3.7 A laminated glazing assembly with an embedded coating (Figure 12-2) is the less challenging to process than a laminated glazing assembly with an exposed coating because the PVB is less impeded from receiving heat through the upper ply of glass.

12.2.3.8 Increase the top percentage distribution of heat, and decrease the bottom percentage distribution of heat, to prevent the interlayer from overheating, resulting in trapped air.

12.2.3.9 Adjust the line speed to achieve proper target nip temperature of 125 -165°F (52 - 74°C).

TACK OVEN SET-UP INSTRUCTIONS:

Step 1: Top heat to 60%

Step 2: Adjust Conveyor line speed to obtain target laminate top surface temperature at hot nip 125-165°F (52-74°C)

Step 3: Adjust bottom heat % (est. 40-80% power setting) to harmonize laminate's bottom surface with top

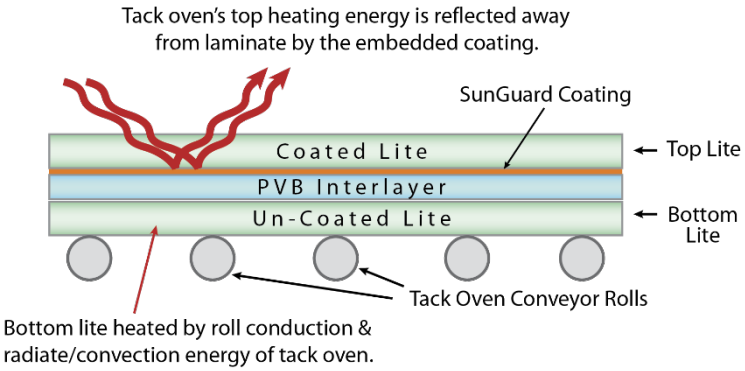


Image 12-2 – Laminated Glazing Assembly with Embedded Coating

12.3 Assembly Room Information

12.3.1 A complete visual inspection of transmission and reflection must be performed prior to assembly of laminated glazing.

12.3.2 A complete visual inspection of reflection must be performed after fabricating laminated glazing to inspect for any damage that the nip rolls might have caused to the coated surface.

12.3.3 Assembly must be conducted in a “clean room” to mitigate the potential for entrapment of visually objectionable contaminants. Temperature and humidity in the clean room must be maintained consistently with the OEM’s instructions. Personnel in the clean room must wear lint-free coveralls, gloves, shoe covers, and hairnets.

12.3.4 The nip rolls must be clean and must apply uniform pressure.

12.3.5 The exposure time of cut interlayer sheets must be minimized prior to assembly. Excess material should be trimmed using even pressure, with a frequently replaced sharp instrument, without pulling the interlayer.

12.3.6 Care must be taken to avoid contact with the coated surface after the nip roll and prior to racking the assembly for the autoclave.

12.4 Tack Oven and Nip Roll Operations

12.4.1 Adjust the line speed and/or tack oven controls to achieve a proper laminate temperature at a nip roll temperature of 125 - 165°F (52 - 74°C) using a “non-contact style” thermometer.

12.4.2 The temperature settings should be biased to equalize the top and bottom surface temperatures of the laminate.

12.4.3 Proper tack oven/nip operations will prevent air entrapment and will result in the laminate having a uniform translucent appearance upon exiting the final nip roll assembly.

12.5 Autoclaving

12.5.1 The suggested temperature set-point is 280 - 290°F (138 - 143°C).

12.5.2 The suggested pressure set-point is between 165 - 175 psi (11.4 - 12.1 bar).

12.5.3 Due to the thermal reflective properties of our coated glass products, a slightly longer autoclave residence (balance or hold) time may be required. A minimum of 30 minutes’ hold or balance time is needed after both set points are reached, ensuring that the PVB interlayer has achieved the desired temperature.

12.5.4 Space should be provided between each laminated lite to ensure uniform heat flow over the entire surface area.

12.5.5 Pressure must be released when the laminate temperature is below 120°F (49°C), otherwise “champagne bubbles” may appear around perimeter of the processed glazing.

12.5.6 SunGuard® products are not pressure sensitive and will not be harmed by the pressure within a well-maintained autoclave.

Section 13: SPANDREL

Spandrel glass is an architectural product used to cover or conceal construction materials between the floors of buildings, disguise things like arches and columns, floor slabs, and duct work. Spandrel glass can provide a complementing or contrasting look when compared to the vision glass appearance from the outside of the building.

13.1 Deco HT

Guardian Deco HT™ is a coated stock sheet that is easy to cut, fabricate and heat-treat. It uses a proprietary coating system that provides superior durability to conventional frits prior to heat-treating. During heat-treating the coating further bonds to the glass surface.

When properly heat-treated, Guardian Deco HT provides a uniform matte finish with lower gloss values than traditional frits.

See Deco HT Handling & Fabrication guide for more information on Guardian Deco HT.

13.2 Spandrel Application

13.2.1 Spandrel glass is opaque and serves to conceal non-vision areas. Secondary opacification mechanisms are necessary, as streaks and pinholes in the opacified surface may otherwise be visually evident.

13.2.2 Only heat-treated glass may be used for spandrel glazing units. Annealed glass must never be used in spandrel applications.

13.2.3 Ceramic frits and silicone paints may be applied directly only to SunGuard® Silver 20 in full-coverage, monolithic spandrel applications, as addressed in Table 1-1.

13.2.4 Ceramic frit can be applied to a glass surface opposite a SunGuard IS 20 coated surface, with the coated surface facing downward during fabrication.

13.2.5 To avoid the emergence of haze associated with a chemical incompatibility, silicone paint must not be implemented in the same sealed space of an IG unit as a coated glass surface, unless specifically authorized by your FSE and by the silicone paint manufacturer.

13.2.6 Ceramic frit and silicone paint suppliers should be contacted for their complete guidance.

13.3 Silk Screening

Please contact your FSE regarding the use of SunGuard products in silk-screened applications.

Section 14: QUALITY INSPECTION

14.1 General Information

14.1.1 Staff training, equipment maintenance, and quality control are crucial for successful, sustainable operations.

14.1.2 The complete requirements presented in applicable ASTM standards and other prominent industry publications must be implemented. Please see Section 18: Additional Publications.

14.1.3 Glass that does not meet applicable quality requirements must not be further processed.

14.2 Visual Inspection

14.2.1 As subsequently described, SunGuard® products must be visually inspected to ensure appearance acceptability prior to each fabrication operation.

14.2.2 In addition to normal in-plant quality checks, it is advisable to take production glass samples outside at regular intervals — weather permitting (in the absence of precipitation, dust, or fog) — to evaluate distortion under daylight conditions.

14.2.2.1 The glass should be placed on a rolling rack with the coated surface in the orientation that it will be installed on the project.

14.2.2.2 A piece of black felt should be draped over the rack before placing the glass on the rack to prevent scratching of the coating and to provide a dark background for outdoor inspection.

14.2.2.3 Once outside, the glass should be viewed so that distant straight objects — such as poles, power lines, building corners, and so forth — can be viewed in reflection. The more distortion present in the treated glass, the more the reflected images will change. This check must be conducted in addition to the normal quality checks such as roll wave distortion, bow, and stress.

14.3 Heat-Treatment Inspection

14.3.1 Visual inspection of both transmission and reflection of heat-treated glass must be performed regularly and in accordance with applicable standards.

14.3.2 Bow, roll wave, and surface pressure/center-punch test must be checked and recorded on a regular basis to ensure fabricator certification compliance.

14.3.3 A nondestructive means of affirming suitable residual stresses in heat-treated glass is required. Options include a GASP® Polarimeter from Strainoptics, Inc. (or equivalent device), or a SCALP-04 from GlasStress Ltd.

14.3.4 A center-punch and weight scale, as described in ANSI Z97.1, is necessary when performing center-punch testing.

14.4 Zebra Board Visual Inspection and Distortion Measurement

14.4.1 Zebra boards and roll distortion gauges are required for SunGuard® heat-treatable product certification.

14.4.2 Documentation of roll wave, center kink, and edge kink must be implemented.

14.4.3 Zebra boards must be used to visually inspect glass after heat treatment. Zebra boards are usually 4 ft. x 8 ft. (1.2 m x 2.4 m) panels with 2” (51 mm) thick black and white stripes oriented at a 45° angle.

14.4.4 Zebra boards provide a subjective means of viewing reflected distortion. They are normally vertically mounted above the line after the furnace. Distortion is viewed at a 45°angle as the glass passes beneath the board.

14.4.5 Zebra boards may also be mounted off-line in combination with an inspection table. (Image 14-1)

14.4.6 Optical distortion must be categorized and graded, and only minimal amounts of optical distortion must be permitted in finished glazing.

14.4.7 Examples of optical distortion levels are presented in the following Images 14-2 through 14-6.

Image 14-1 – Zebra Board Mounted Offline Above Inspector

Image 14-3 – Overexposure to extreme heat has yielded a heavily-distorted substrate

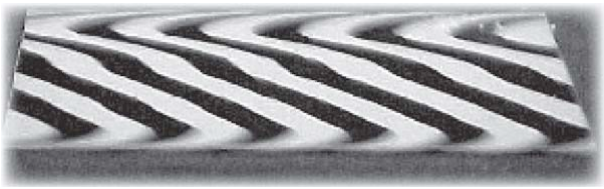


Image 14-2 – The optics are slightly improved though heavy edge lift remains

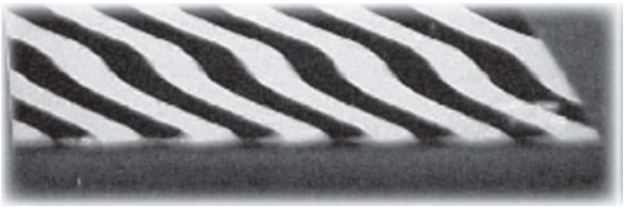


Image 14-4 – The edge-lift has further image reduced

Image 14-5 –- The substrate is flatter, and the overall reflective properties have improved

Image 14-6 – The distortion has been greatly minimized and the reflected zebra-board stripes

14.4.8 Except as noted otherwise in the project specification or specifically approved by the customer, lites must be processed so roll wave will be oriented horizontally, parallel to the base dimension of the finished unit in its installed position. If this is not possible because of the size of the glazing or other circumstances, the fabricator should bring this to the attention of the project team.

14.4.9 Fabrication factors which may contribute to distortion include excessive heat, overexposure, deformed conveyor rolls, and non-uniform heat saturation. Minimization of factory-controlled distortion is critical, as installation quality and environmental exposure also may affect the flatness of the installed glazing.

14.4.10 Distortion is more visually pronounced on highly reflective glazing than on glazing with limited outward reflectivity.

14.4.11 Heat-treated glass with an aspect ratio near one (a square-like shape) may be prone to bi-stability issues. As the glazing may exhibit a small amount of bow from its heat treatment, it may engage in seemingly spontaneous shifts of its primary span direction, with popping actions that could lead to lite-to-lite contact and subsequent glass breakage.

14.4.12 A roll distortion gauge is a tool for monitoring peak-to-valley distortions developed during heat treatment and must be implemented as outlined in ASTM C 1651.

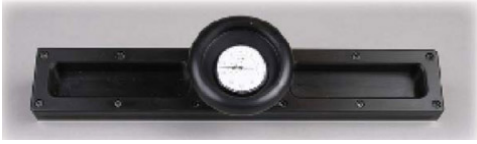


Image 14-8 – Roll Wave Distortion Gauge

Image 14-7 – Roll Wave Distortion Gauge in use

14.4.13 For all SunGuard® applications, a roll wave limit not exceeding 0.003”. (0.08 mm) should be targeted, while maintaining adherence to a maximum limit of 0.005”. (0.13 mm), over the surface of the lite, except within its leading and trailing 12”. (305 mm). More stringent internal specifications are encouraged. Center kink must not exceed 0.001”. (0.025 mm) when a roll wave gauge is passed over the surface of the glass perpendicular to its line of travel through the furnace.

14.4.14 Heat-treated glass must be conformant with the ASTM C 1048 overall bow and localized bow limits, each reduced by half (for intensified stringency).

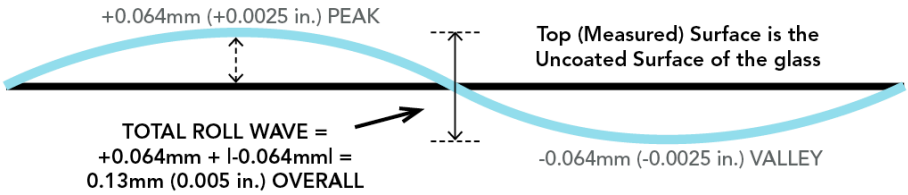


Image 14-9 - Roll Wave Measurement

14.4.15 Lites selected for quality control measurement should be viewed outdoors in reflection as possible. If it is not possible to view a lite outside, it should be viewed in reflection from as far away as possible, at least 25 ft. (7.6 m) away. Regardless of the viewing location, the lite should be examined both as it is to be installed in the building and then rotated 90°. This will enable the viewer to check for excessive roll wave or vertical distortion.

14.4.16 Online distortion measurement systems are recommended. If implemented, acceptance criteria should be set consistently with the previously outlined roll wave requirements. Examples of online systems include Osprey® by LiteSentry™ and iLooK™ by Glaston.

14.4.16.1 Maximum allowable mD ≤120 over 90% of the central vision area on the heat-treated lite

14.4.16.2 If the online detection equipment has cross dimensional distortion capabilities, a target of 100 mD or less is required and can be used in lieu of a manual reading for center kink.

Section 15: INSULATING

15.1 Fabrication

15.1.1 It is the fabricator's responsibility to identify, understand, and properly address the specific attributes of the project application including, but not limited to, code compliance, public safety, load resistance, deflection control, thermal stress management, energy performance, aesthetics, acoustic performance, material compatibility, and long-range durability.

15.1.2 The fabricator is responsible for ensuring that the coated surface(s) is/are positioned in the IG unit in accordance with approved glazing configurations. Please see Table 1-1.

15.1.3 SunGuard® coatings — except for IS 20 — must be permanently protected either by containment within a hermetically-sealed IG unit, or by embedment against an interlayer as permitted in the configurations outlined in Table 1-2 and Section 12: Laminating.

15.1.4 The coated surface of the glass must always face upward — with the exception that IS 20 may face down when frit is applied to the reverse side of the lite.

15.1.5 IG units greater than 45 ft^2 (4.2 m^2) must be vertically oriented during IG fabrication to minimize potential distortion from self-weight deflection.

15.1.6 If a thermal or mechanical press is implemented, the equipment must be leveled and must maintain uniform pressure across the IG unit.

15.1.7 Completed IG units should always be stored on a base with a slight angle so that the weight of the glass lites is evenly distributed. The front of the container or rack should be tilted and stabilized (front to back) to prevent accidental tipping of the units.

15.1.8 Advanced evaluations of IG unit gap widths are particularly important if blinds are to be installed within the sealed spaces (as contact with the coated surface(s) must be reliably avoided during fabrication, transport, installation, and all service conditions of the IG units), if the glazing must satisfy specific acoustic performance requirements, or if the glazing will exhibit a unique size or aspect ratio.

15.1.9 As very small units and long, narrow units may undergo excessive "pumping" action of the sealed air or gas in service, the sealant depth may require modification to help prevent seal failures. The sealant supplier should be consulted for specific recommendations.

15.1.10 Insulating glass third-party certification must be maintained. Certification programs are administered through the Insulating Glass Certification Council (IGCC) and Associated Laboratories, Inc., among others. Copies of current IG certifications must be supplied as part of the certification process.

15.2 Spacer and Desiccant

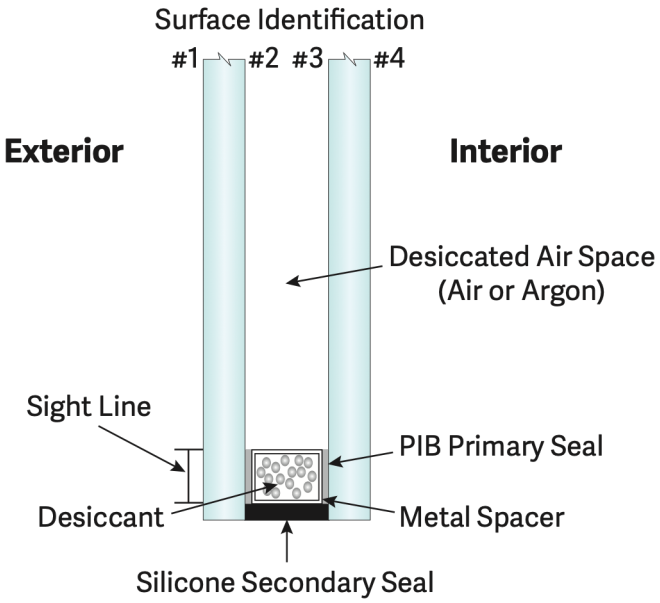


Image 15-1 – IG Unit Cutaway

15.2.1 Spacers must be clean and free of contaminants. Spacer systems must be cut and bent in accordance with the OEM's recommendations, implementing a uniform process that prevents sagging, bowing, or any other form of future deformation with visually objectionable consequences in the installed application.

15.2.2 Corners and joints must be continuous, without gaps or breaks.

15.2.3 Guardian approves the use of IG units filled with inert gases, such as argon or krypton.

15.2.4 Desiccants must be stored in a cool, dry location consistent with the OEM's recommendations. The useful life of any absorbent is reduced by excessive exposure to the atmosphere, and daily testing of inventory is required. The desiccant OEM must be contacted for the approved test kit and method.

15.2.4.1 The OEM's specifications should be reviewed for the recommended fill method. Desiccant overfilling or under-filling could cause premature unit failure.

15.2.4.2 For a standard molecular sieve, only the two long sides of the spacer frame should be filled.

15.2.4.3 When the long side of the spacer frame is more than 2.5 times the length of the short side, only one long leg and one short leg should be filled.

15.2.4.4 Warm edge spacers are approved by Guardian when backed with an approved secondary seal.

15.2.4.5 Guardian approves the use of a desiccated matrix when used in conjunction with an approved secondary seal.

15.2.4.6 Guardian does not recommend the use of breather tubes for pressure relief of IG units. Rather, capillary tubes (are defined as having an inside diameter of less than or equal to 0.021”) should be implemented if necessary.

15.2.5 Capillary tubes, if installed, will not normally affect the long-term performance of the IG unit if proper sealing guidelines are implemented at the project site. If pressure equalization valves are implemented, their use must be consistent with the recommendations of the valve manufacturer. Capillary tubes or pressure equalization valves should never be implemented with gas-filled IG units.

15.2.6 Drilling, filling, and plugging the IG unit air space filler ports must be conducted in accordance with the spacer OEM’s recommendations. The units must be permanently hermetically sealed.

15.3 Seal

15.3.1 No single-seal IG units are permitted in commercial applications without Guardian’s written authorization.

15.3.2 Polyisobutylene (PIB) is normally used as the primary seal for dual seal IG units. PIB exhibits excellent adhesion to glass and metal and has a low moisture vapor transmission rate.

15.3.3 A continuous PIB bead is required, without gaps or breaks. The PIB seal must be applied to both inside surfaces of the IG unit.

15.3.3.1 Guardian recommends that the fabricator track the sealant type and lot number through specific projects.

15.3.3.2 Two-part sealants require regular testing to confirm proper characteristics. Guardian requires that a butterfly and stick life test in accordance with FGIA guidelines be performed periodically. The butterfly test helps to verify the proper sealant mix, and the stick life test helps to confirm the expected sealant cure time. Please see FGIA’s quality control guidelines for additional information.

15.3.3.3 One-part must be tested per the OEM’s recommendations.

15.3.3.4 The space between the back of the spacer and the edge of the glass must be filled completely, without voids, air pockets, or bubbles. The secondary seal should be flush with the edge of the glass to prevent excessive buildup that could stick to the packaging material or cause unit-to-unit bonding during transport.

15.3.4 Please see Table 15-1 for Guardian-approved sealants. Additional sealants may be tested and approved upon request. Please contact your FSE for additional information.

Table 15-1 — Guardian-Approved Sealants and Related Products

Manufacturer	Product / Series	Manufacturer	Product / Series
Delchem	D-2000	H.B. Fuller	
Dow Corning®	795		HL-5130
	982		HL-5140
	3362		HL-5145
	3-0117		HL-5153
Fenzi	Hotver 2000		HL-5160
	Thiover		PU-810
GE®	IGS3713	Kommerling/Royal	Hot Melt 2000 HS
	IGS3723B		Hot Melt 3070 HS
	SSG4400 UltraGlaze®	Quanex	Super Spacer®

Note: All product and company names are trademarks™ or registered® trademarks of their respective holders and are not trademarks of Guardian Glass. Guardian's use of the product and company names above does not imply any affiliation with or endorsement by the owners of or manufacturers of these products for the uses described by Guardian.

15.4 Edge Deletion

15.4.1 When fabricating offset IG units (for instance, IG units implemented at butt-glazed corners), edge deletion as appropriate must extend from the offset edge to the primary sealant. Multiple passes may be necessary. Please see Section 7: Edge Deletion for further information.

15.5 Deflection – Horizontal IG Production Lites

15.5.1 Guardian recommends that all IG fabrication be performed on vertical, automated production lines to minimize potential distortion from self-weight deflection. Fabricators with fully horizontal insulating lines, or with vertical lines in which IG units are sealed while in the horizontal position, should be extremely cautious regarding glass deflection. During horizontal IG unit fabrication, the unsupported upper lite can sag under its own weight, yielding an observable concave, collapsed appearance of the unit in its installed state. Horizontal deflection is a function of the size and shape of the IG unit, and the weight of the glass. Square-shaped IG units are prone to greater deflections than are otherwise-equivalent rectangular IG units of the same total area.

15.5.2 As self-weight deflection during horizontal IG unit fabrication has previously been cause for rejection on project sites, Guardian requires that the coated lite be fully supported (positioned in the bottom, rather than top, position) during IG unit fabrication.

15.5.3 Quality control is the fabricator's responsibility. Deflection inspections must be conducted during the daily IG unit fabrication quality routine. In addition, representative units should be spot checked outdoors to confirm acceptable optics. The fabricator must ensure that the optical requirements of accepted projects can be satisfactorily met.

15.5.4 Guardian strongly recommends that deflections of square IG units and IG units greater than 16 ft^2 (1.5 m^2) in area be measured.

15.5.5 Deflection can be evaluated by attaching two strings diagonally across opposing corners of an IG unit to form an "X", and then measuring the out-of-plane displacement of the glass where the strings intersect. Units exhibiting any measurable gap between the string intersection and glass surface should not be shipped if any optical distortion is visibly apparent.

15.6 Thick Glass IG Units

15.6.1 It is critical to consider the weight implications of IG units with thick glass.

15.6.2 While special sealants are not necessarily required for IG units with thick glass, implemented sealants must satisfy all appropriate requirements. For instance, the sealants must accommodate the loads involved in suction cup of lifting thick glass IG units from one lite as applicable.

Section 16: THERMAL BREAKAGE

16.1 Thermal Breakage General Information

16.1.1 As warm glass expands and cool glass contracts, differential thermal loading onto glass must be addressed through provisions that appropriately mitigate the risks of breakage.

16.1.2 The following images illustrate thermal stress loading onto glazing that is captured along all its edges. The central region of the glazing is directly exposed to solar energy, and the glass heats and expands. Yet the perimeter of the glazing is shielded from solar energy, and the glass cools and contracts. If the internal stresses associated with this differential loading exceed the structural capacity of the glass, breakage will result.

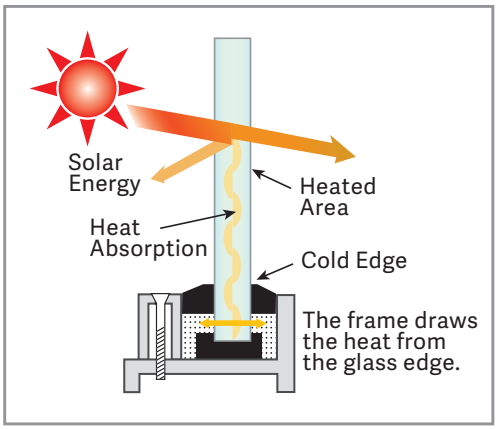


Image 16-2 – The central area of the glass is hotter than the edge

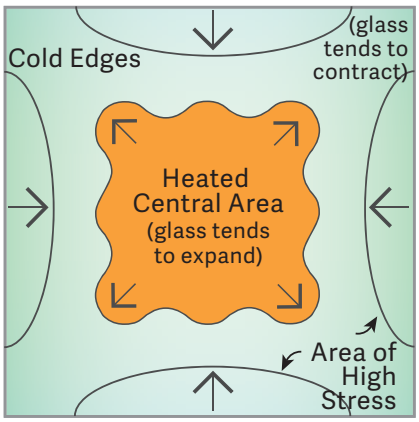


Image 16-2 – Glass expansion is restricted

16.1.3 The residual compressive surface stress of heat-treated glass helps to reduce the risks of thermal stress breakage relative to those of annealed glass.

16.1.4 Heat-strengthened glass is recommended when heat treatment is necessary for thermal stress management, unless tempered glass is specifically required otherwise (such as to satisfy safety glazing requirements involving ANSI Z97.1 and CPSC 16 CFR 1201, compensate particularly elevated thermal stresses, or achieve load resistance requirements).

16.1.5 **Thermal stress management is the fabricator's responsibility.** The discussion of the subject of thermal stress management within this publication is provided as a matter of convenience and is not an assumption of responsibility or liability for design and application choices, nor is a warranty of any kind.

16.1.6 Please contact your Regional Technical Advisor for any questions related to thermal stress management considerations.

Section 17: GLASS CLEANING RECOMMENDATIONS

Guardian supports the procedures and recommendations developed by NGA. NGA has published an Informational Bulletin titled, “Proper Procedures for Cleaning Architectural Glass Products,” to provide procedures and instructions on how to clean installed architectural glass.

Section 18: ADDITIONAL PUBLICATIONS

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

- ANSI Z 97.1 - Safety Glazing Materials Used in Buildings — Safety Performance Specifications and Methods of Test
- ASTM C 1036 - Standard Specification for Flat Glass
- ASTM C 1048 - Standard Specification for Heat-Strengthened and Fully Tempered Flat Glass
- ASTM C 1172 - Standard Specification for Laminated Architectural Flat Glass.
- ASTM C 1376 - Standard Specification for Pyrolytic and Vacuum Deposition Coatings on Flat Glass
- ASTM C 1464 - Standard Specification for Bent Glass
- ASTM C 1651 - Standard Test Method for Measurement of Roll Wave Optical Distortion in Heat-Treated Flat Glass
- ASTM E 1300 - Standard Practice for Determining Load Resistance of Glass in Buildings
- ASTM E 1886 - Standard Test Method for Performance of Exterior Windows, Curtain Walls, Doors, and Impact Protective Systems Impacted by Missile(s) and Exposed to Cyclic Pressure Differentials
- ASTM E 1996 - Standard Specification for Performance of Exterior Windows, Curtain Walls, Doors, and Impact Protective Systems Impacted by Windborne Debris in Hurricanes
- ASTM E 2188 - Standard Test Method for Insulating Glass Unit Performance
- ASTM E 2189 - Standard Test Method for Testing Resistance to Fogging in Insulating Glass Units
- ASTM E 2190 - Standard Specification for Insulating Glass Unit Performance and Evaluation
- ASTM F 521 - Standard Test Methods for Bond Integrity of Transparent Laminates
- ASTM F 1233 - Standard Test Method for Security Glazing Materials and Systems
- CAN/CGSB-12.1 - Safety Glazing
- Miami-Dade County, Florida Comprehensive Building Code for Resistance to Windborne Debris from Hurricanes
- Consumer Product Safety Commission (CPSC) 16 Code of Federal Regulations (CFR) Part 1201 Safety Standard for Architectural Glazing Materials
- International Building Code (IBC)
- GANA/NGA Glazing Manual
- GANA/NGA Engineering Standards Manual

COMMERCIAL TERMS AND CONDITIONS

The products in this publication are sold subject to Guardian's standard terms and conditions of sale and any applicable written warranties.

DISCLAIMER

The encompassed information is intended to assist in the proper application and use of Guardian SunGuard® coated glass products and does not constitute a warranty of SunGuard products for any particular purpose. The only warranty offered by Guardian on SunGuard products is Guardian's published SunGuard Series Coated Glass Limited Warranty.

Verification: The signature below verifies that the customer has read and understands the full contents of this User's Guide and all SunGuard® fabrication documents.

Required Signatures

FABRICATOR REPRESENTATIVE NAME

FABRICATOR REPRESENTATIVE SIGNATURE

TITLE

COMPANY

DATE

GUARDIAN REPRESENTATIVE NAME AND PHONE NUMBER

GUARDIAN ENGINEER SIGNATURE

Internal Change Control

Change control document	Version: December 1, 2021
SunGuard® Product User's Guide	Supersedes: October 5, 2021
	Superseded by: Jon Griggs

Reason for change

What was changed?

- Updated SNX 62/27 HT on Surface 3 allowed without tinted outboard
- Updated cutting fluids

Other Documents affected

	Author	Signature	Date
Approved:	Dale Goemaere		12/13/21
Approved:	Yuwadee Senamontree		
Approved:	Jon Griggs		12/2/21