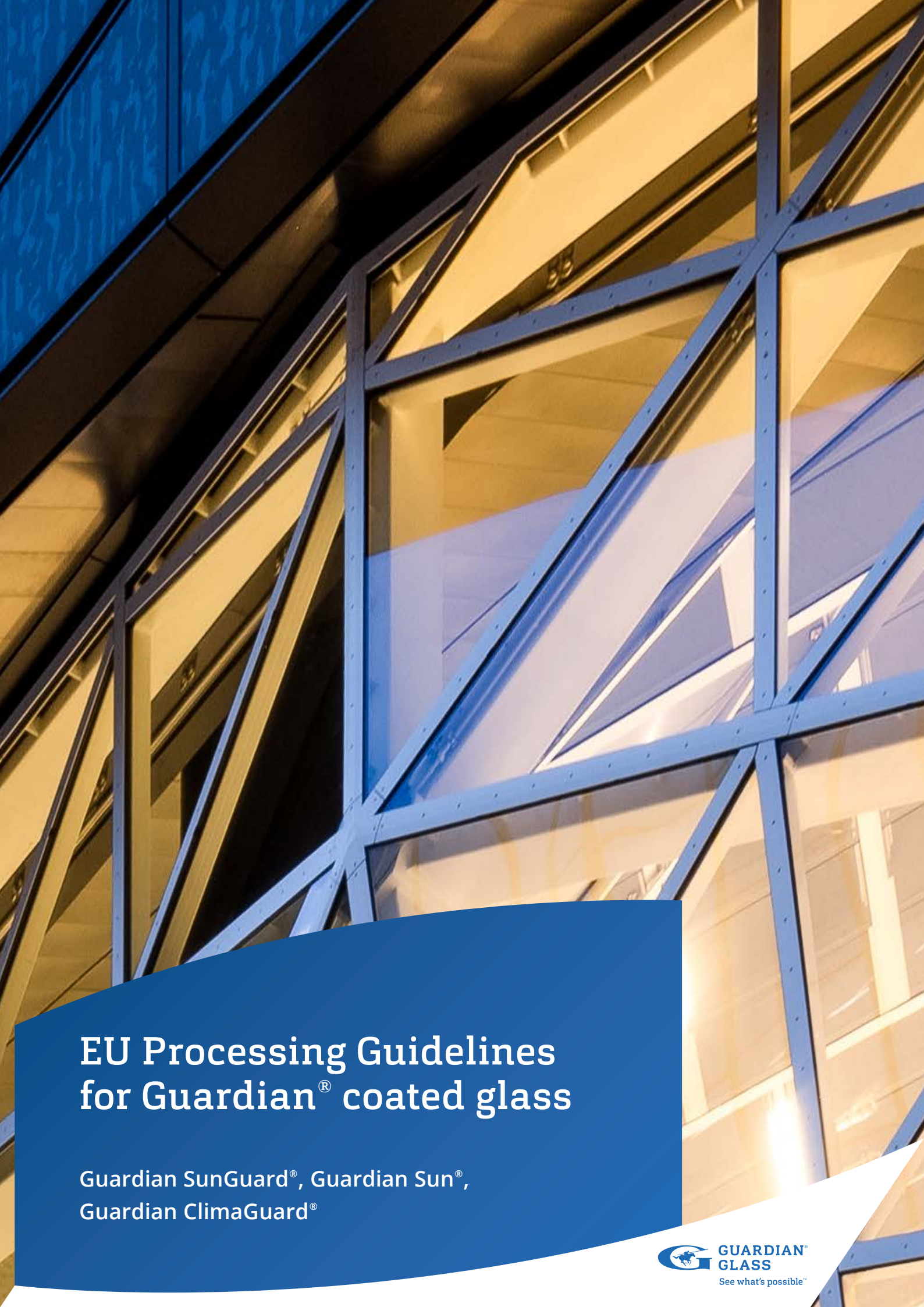

EU Processing Guidelines for Guardian® coated glass

Guardian SunGuard®, Guardian Sun®,
Guardian ClimaGuard®

GUARDIAN® GLASS
See what's possible™

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Introduction

This document, «EU Processing Guidelines for Guardian® coated glass. Guardian SunGuard®, Guardian Sun®, Guardian ClimaGuard®» provides specific instructions regarding the storage, handling and processing of the following types of Guardian coated glass: Guardian SunGuard®, Guardian ClimaGuard® and Guardian Sun®, which are needed to avoid any adverse effect on the quality of the final product.

It specifies the requirements only for SunGuard, Guardian Sun and ClimaGuard that are produced at Guardian plants in the European Union and the United Kingdom and are shipped within the territory of Europe, Turkey and Commonwealth of Independent States.

The Processing Guidelines are not intended to be a comprehensive full set of instructions but assume the processor has professional knowledge of glass processing.

As these products are complex, it is necessary to ensure that processing capabilities are checked and certified by Guardian before these products are processed for the first time. Guardian Technical Services can carry out such a certification at the processors' premises.

Non-compliance with these Processing Guidelines can lead to damage of the coated glass and will invalidate any claims made against Guardian or any product warranty. → *p.44*

The requirements for other Guardian products, for example Guardian Clarity™, Dielectric Mirror or Guardian products produced outside of the EU and the UK, are addressed in other dedicated processing, handling and maintenance Guidelines and are not the subject to the guidelines contained in this document.

For more technical information, the latest version of this document, additional Guardian Guidelines, or products requirements for other regions, please refer to *www.guardianglass.com* or contact Guardian Technical Services. → *p.44*

Reference code: Guardian_General PG_EN_1121

1. Guardian products overview

1.1. Guardian products

Guardian SunGuard®, Guardian ClimaGuard® and Guardian Sun® are high quality energy efficient magnetron coated glass products.

Guardian coated glasses are coated on to the following base glasses: *Guardian ExtraClear®*, *Guardian UltraClear®* (low-iron) and *Guardian LamiGlass®* glass.

Guardian ClimaGuard® - low-emissivity glass with a silver containing coating.
Guardian ClimaGuard® Dry - anti condensation coated glass that does not contain silver.
Guardian Sun® - low-emissivity and solar control glass glass with a silver containing coating.
Guardian SunGuard® High Performance (HP), *SuperNeutral™* (SN), *eXtra Selective* (SNX) – single, double, triple silver coated low-emissivity and solar control glass.
Guardian SunGuard® High Durable (HD) – highly durable coated solar control glass that does not contain silver, suitable for monolithic applications.
Guardian SunGuard® Solar - coated solar control glass - does not contain silver.
Guardian LamiGlass® - laminated glass produced by Guardian with PVB interlayer, can be coated with SunGuard®, ClimaGuard® or Guardian Sun®.



Use of Temporary Protective Film (TPF)

Some of Guardian coated glass is provided with a temporary protective film. The TPF is a full coverage, polyethylene-based, low adhesive foil that is applied by Guardian directly to the coated surface during the manufacturing. → p.42

The TPF preserves the coating by sealing it from contamination and protecting it from some mechanical damage during processing prior to the glass being heat treated. The adhesive used in the TPF is low tack and can be easily removed from the coated surface. The TPF must be removed completely before heat treatment. → p.24

TPF is typically applied on heat-treatable versions of SunGuard® SN HT and SunGuard® SNX HT.

The processing of Guardian coated glass with TPF has some special considerations that should be taken into account. In all cases, it is strongly recommended, whenever possible, to process the glass with the coating (or TPF) away from supportive elements. → p.10

For more information about Guardian products, please refer to *www.guardianglass.com*.

1.2. Guardian coatings orientation in the glazing

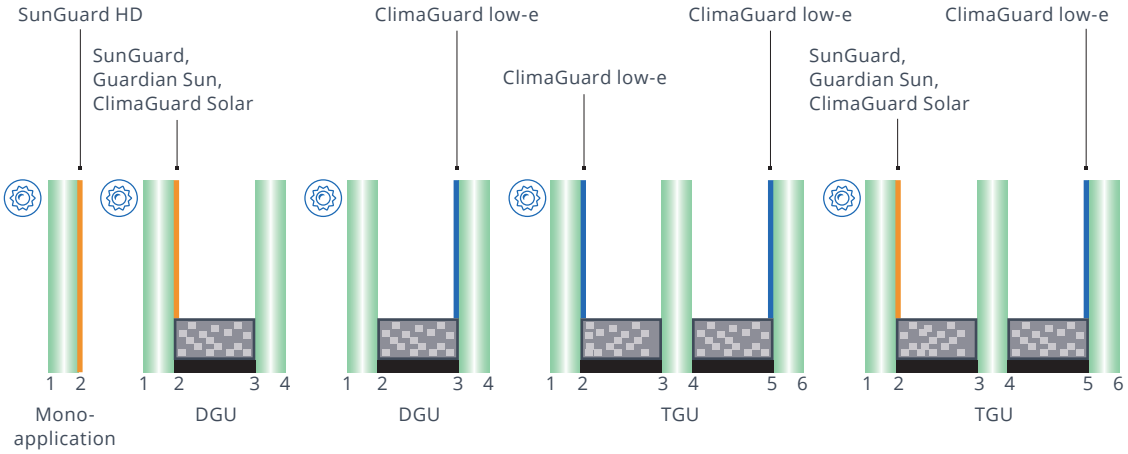
Important aspects to be considered:

Calculate glazing performance on *glassanalytics.guardian.com*

Coatings in mono-application → *p.4*

Only SunGuard HD and ClimaGuard Dry can be used exposed to the environment. All other coatings must face the cavity of an IGU. In case of laminated application please see chapter 12.3. A 'T' or 'HT' after the Guardian product name indicates that the product is a heat-treatable version. → *p.37*

Typical coating positions in architectural glass configurations. Other combinations can be used.



For information on different applications, please refer to *www.guardianglass.com* or contact Guardian Technical Services. → *p.44*

	Glass type	Mono-application / facing outside of cavity of IGU	Recommended position DGU(TGU)	Durability class acc. to EN 1096
SunGuard® HD		Allowed if exposed towards the building	2	A
SunGuard® Solar		Not allowed	2	C
ClimaGuard® Dry	+Anticondensation	Allowed	1	A
ClimaGuard® (T) except *ClimaGuard® Dry, ClimaGuard® Solar*		Not allowed	3 (2+5)	C
ClimaGuard® Solar		Not allowed	2	C
Guardian Sun® (T)		Not allowed	2	C
SunGuard® HP		Not allowed	2	C

Reference code: Guardian_General PG_EN_1121

	Glass type	Mono-application / facing outside of cavity of IGU	Recommended position DGU(TGU)	Durability class acc. to EN 1096
SunGuard® SN		Not allowed	2	C
SunGuard® SN HT		Not allowed	2	C
SunGuard® SNX		Not allowed	2	C
SunGuard® SNX HT		Not allowed	2	C

1.3. Special risks to be considered

Guardian coatings have different chemical and mechanical durability characteristics, which make the coatings suitable for use in a range of different applications. Some common aspects should be considered when the glazing is designed.

Coatings in single glazed application

Coatings allowed for use in mono-application should not be exposed to any aggressive media (e.g. chlorine in swimming pools) or mechanical impact before, during and after installation. Environmental conditions can also have adverse effects on coatings in mono-application if not routinely cleaned.

→ p.7

For more information on cleaning of final product, please refer to «Guardian. Cleaning Guidelines» on *www.guardianglass.com*.

Visual appearance

Some color difference may appear in the same type of glass types before and after processing. E.g. between annealed - heat-treated state of the same product, laminated – not laminated applications or versions of the same product mixed in a façade. Full size project mock-ups are strongly recommended.

Impact of humidity

Contact between the silver layer and humidity will lead to the corrosion (oxidation) of coatings that contain silver and will impact on the adhesion, glazing performance and aesthetics. Laminated glass with standard PVB foil must not be exposed to high moisture due to high water absorption, which can lead to delamination.

→ p.36

Material compatibility

Reaction of the coating with the sealant, glue, lamination interlayers and any other materials may attack or destroy the coating and impact on the adhesion, glazing performance and aesthetics. Compatibility of any materials in the glazing should be ensured before processing (e.g. PVB-sealant, enamel-glue, etc...). Untested material combinations must not be used.

Risk of thermal breakage

Use of some type of glass products can increase energy absorption in glazing - e.g. glass types with high energy absorption; partial or enameled panes (particularly with dark enamels) etc. High energy absorption increases a risk of thermal stress breakage and may result in the need to heat treat glazing panes.

Suitable edge processing can reduce the risk of thermal breakage in case of annealed glass use.

It is not the responsibility of Guardian to ensure that the intended application is appropriate and complies with all relevant laws, regulations, standards, codes of practices and other requirements.

Reference code: Guardian_General PG_EN_1121

2. Packaging and storage

2.1. Original packaging

SunGuard, Guardian Sun and ClimaGuard products are available in different types of packaging. For more information about thicknesses, sizes and availability, please contact Guardian Customer Service.

→ p.44

Incoming material should be inspected for damage prior to acceptance. Any issues before or after the start of processing should be reported to Guardian.

In general, the first pane in each pack is uncoated and used for protection of the adjacent coated pane. All subsequent panes will be arranged with their coated (or TPF side) in the direction of this uncoated pane, unless expressly advised by the purchasing customer.

The first pane in the pack may also be coated and reversed to face the next one. When this is the case, this first coated pane will have a special sticker on it. In the case of TPF absence, it creates a coating-coating contact; do not drag glass pane on other.

→ p.10

A special separator powder is placed between the panes to ensure good separation and prevent damage during transportation.

Guardian tags should remain with the original packaging. For best practice, tag numbers should be traceable throughout all stages of processing as well as finished goods.

2.2. Storage conditions



Exposure to high humidity will lead to coating corrosion

- Glass should be unloaded under dry, indoor conditions.
- Guardian products must not be stored outside even in case where the coating is covered by TPF.
- Where TPF is present, high humidity reduces the film's adhesion and can lead to the penetration of moisture under the TPF.
- If packs arrive cold upon delivery they must be allowed to reach ambient factory temperature before opening to avoid condensation on the glass surfaces

Warehouse requirements

- The warehouse should be well ventilated, and all glass should be rotated for production (first in, first out).
- Storage must be in a dry, warm and clean place, a suitable distance away from glass washers, external doors or any other humidity source (e.g. CNC water jet spray), without contact from any kind of chemicals, corrosive substances, cutting fluids and other chemically active materials even when TPF is used.
- To prevent condensation forming and damaging the coatings, relative humidity should not exceed 70%. Minimum temperature should not be less than 15°C.
- Glass must be stored at 3-5 degrees from the vertical.

2.3. Internal storage and transportation requirements

Standard glass transportation equipment can be used when processing Guardian coated glass.

If immediate, online full processing after opening of the pack is not possible

- All general storage recommendations should be followed during waiting time and internal transportation. → p.6
- Coated surfaces in open packs should be protected and must not be exposed during storage. Glass products allowed for use facing to atmosphere could be stored exposed.
- Sealed packs that were opened but not consumed completely must be re-sealed.
- Glass should be stacked from the largest sized panes to smallest if possible. → p.3
- Place cork pads on the edges of the glass to avoid scratching the bigger panes with the corners of the smaller panes.
- Coating-to-rack contact must be avoided. The first glass pane should be stacked with the glass side facing the rack (i.e. coating faces the operator). All other panes should be oriented the opposite way (i.e. glass side to the operator). Or the use of a protective pane against the rack prior to loading any coated products.

Separation materials

During the processing, glass-to-glass or glass-to-TPF contact must be avoided. In each case - suitable and compatible separation materials must be used between glass panes. It is preferable to use a slot-racking system designed for soft coated glass products.

The separation material should not leave any traces or marks (coated and uncoated side), nor should it be abrasive or chemically aggressive. Contact the supplier of separation materials for confirmation of the absence of the acid content.

Reference code: Guardian_General PG_EN_1121

Recommended separation materials

- Lucite powder, Separol
- Foam pads, adhesive-free cork pads (on the edges of the glass up to 10 mm)
- Smooth and soft acid-free paper, suitable foam foil, polyfoam sheets (e.g. transport of monolithic lites or tempered lites)

→ p.40

Not recommended materials

- Newsprint
- Cardboard and other hard papers
- Powder separators containing acid
- Nut powders

2.4. Guardian coated glass shelf life

Guardian glass products must be processed within the shelf life timeframes specified below. All storage conditions to apply during the shelf life. Packs that were opened but not consumed completely must be re-sealed.

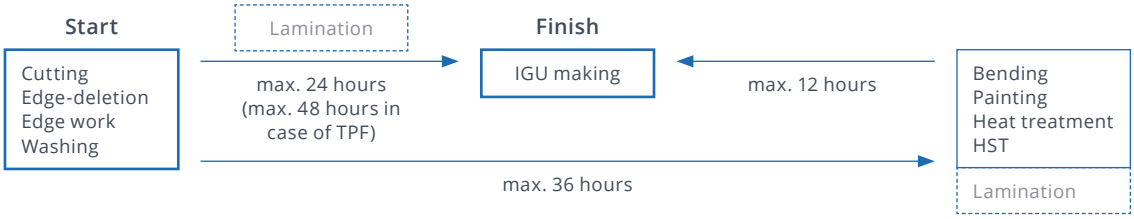
The shelf life after delivery to the first buyer from Guardian is the following:

→ p.6

SunGuard® HD *SunGuard® Solar* *ClimaGuard® Dry*	**Non-taped pack** - «open pack». Shelf life is not limited, regardless of pack being open or not. **Taped pack** - packs with desiccant protected by sealing tape. Shelf life is not limited, regardless of pack being open or not.
ClimaGuard® (except *ClimaGuard® Dry*) *Guardian Sun®* *SunGuard® HP* *SunGuard® SN* *SunGuard® SNX*	**Non-taped pack** - «open pack». Shelf life is **3 months**, regardless of pack being open or not. **Taped pack** - The ultimate shelf life is limited to 6 months, regardless of when the pack is eventually opened. From the point of opening, the shelf life is 3 months or the remainder of the ultimate shelf life, whichever is shorter.
SunGuard® SN HT *SunGuard® SNX HT*	**Non-taped pack** - «open pack». Shelf life is **3 months**, regardless of pack being open or not. **Taped pack** - The ultimate shelf life is limited to 6 months, regardless of when the pack is eventually opened. From the point of opening, the shelf life is 2 weeks or the remainder of the ultimate shelf life, whichever is shorter.

2.5. Processing time

After the start of processing, the coated glass must be processed as soon as possible within a maximum of 24 hours. If the coating is originally covered by TPF – within a maximum of 48 hours. Please bear in mind that TPF provides very limited protection from environmental humidity.



3. Handling

Standard glass handling equipment can be used when processing Guardian coated glass.

For best practice, tag numbers should be traceable throughout all stages of processing as well as finished goods.

All storage requirements must be followed during the processing. → p.7

Before starting any manipulation with the glass

- Check requirements for the exact coated Guardian product.
  Please refer to *www.guardianglass.com*. Ensure that current information is used.
- Everyone involved should be made aware about processing procedures and requirements.
- Always wear suitable personal protective equipment (clean safety gloves, safety glasses, etc.).

Any mechanical or chemical impact on coated or TPF surface can lead to coating damage

- Avoid damaging or peeling back of TPF so that the coating underneath is not exposed.
- Any marks, scratches, dirt, fluid droplets or fingerprints from gloves on the coating can lead to irreversible defects. These defects become particularly evident after heat treatment.
- The glass should be processed with the coated surface (with or without TPF) away from supportive elements.
- Avoid any contact between the coating and hard objects and equipment (glass splinters, glass edges, metallic parts, abrasive particles, etc.).
- Any appliances that come into unavoidable contact with the coatings should be cleaned frequently. Do not drag templates, measurement tools or other metal objects across the surface.
- Do not stick, glue or write on the coating with any materials (adhesive labels, wax crayons, etc.).
- Contact with the coating or TPF should be avoided with any kind of chemicals. If suitable fluids are applied, the surface should be washed immediately.
- Any impact on the edges of the glass should be avoided, as this may decrease glass durability.

The direct contact of the suction cup with the coating should be avoided whenever possible

- In case of unavoidable contact with the coating, the suction cup surface should be perfectly clean, dry and free of any lubricants.
- Do not drag suction cups on the coating surface.
- It is recommended that suitable, clean protective covers on the cups (overshoes) are used. Covers decrease the risk of presence of any abrasive or chemically active particles. The white color of the covers typically used makes it easier to visually assess their conditions.

- Covers facilitate removing of the cup and decrease the risk of scratching while attempting to remove.
- Replacing the cover rather the cup cleaning can help to optimize the process and decrease processing times.
- Be aware that the use of protecting covers reduces the weight that can be handled by the suction cups.

After certain steps of processing manual or machine cleaning of the product may become necessary. → *p.20*



The coated surface requires quality control after each processing step under suitable light conditions. → *p.43*

It is the full responsibility of the processor to ensure the quality of the final product and compatibility and suitability tests are essential in each case.

Reference code: Guardian_General PG_EN_1121

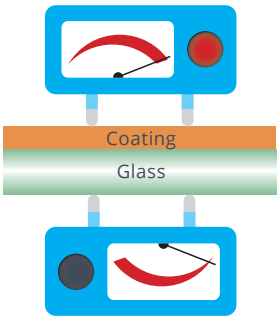
4. Identification of the coated side:

During processing, it is necessary to identify the coated side of the glass.

- Do not touch the glass surface to identify the coated side.
- Do not stick, glue or write on the coating with any materials (adhesive labels, wax crayons, etc.).

TPF presence

If TPF is present, the coated surface is fully covered by the film, TPF is never present on an uncoated surface.



Conductivity method

The majority of Guardian coatings are electrically conductive (i.e. they have low electrical resistivity). The coated surface may be identified with a commercial coating detector or ohmmeter. Use instruments within 10 mm of the edges to prevent visible damage of the coating.

The resistivity values can help to differentiate some of Guardian products but do not guarantee accurate result. If the exact Guardian product needs to be identified or in case of any doubts please refer to information on the tag or contact Guardian Technical Services.

→ p.44

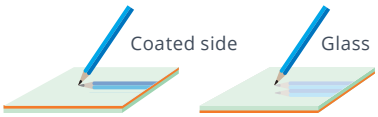
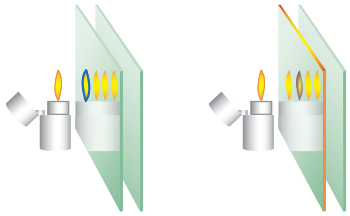


Image method

Place a pencil or similar pointed object against the surface within 10 mm of the edge to prevent visible damage of the coating. On the coated surface, a single well-defined reflected image will appear. Against the uncoated surface, two images appear.



Light Method

This method can be used to identify coating position in an IGU. Place a source of light against the surface. Reflected images will appear: the same number as the number of glass surfaces in the IGU. On the coated surface, an image with a different color or light will appear.

5. Sealant compatibility. Requirements for edge-deletion.

Any chemical processes that can occur in the zone of contact of coated glass and sealant can have a serious impact on the adhesion, glazing performance and aesthetics. For these reasons, coating edge-deletion in this zone is often required.

5.1. General conditions

Corrosion risk

Contact between the silver layer and surrounding atmosphere can lead to the corrosion (oxidation) of coatings that contain silver and impact on their adhesion, performance and aesthetics.

- Mandatory edge-deletion of coatings that contain silver is required for all applications where there is any possibility of faulty sealing or open edges. E.g. monolithic laminated glazing with the coating against PVB with the edges exposed to the atmosphere. → *p.37*
- According to European ETAG 002 Guideline, mandatory edge-deletion of coatings that contain silver is required for structural glazing applications. This applies also to standard insulating glass units where the outer pane is not mounted by profiles or any other supporting devices. The coating needs to be removed accordingly.

Possibility of reaction of the coating with the sealant

Chemical reactions may attack or destroy the coating and impact on the glass-sealant adhesion. → *p.15*

- Extensive tests have shown that for SunGuard and ClimaGuard coatings without silver layers edge-deletion is not mandatory for the range of commonly used, non-chemically active sealants. → *p.15*
- For some Guardian products that contain silver with higher chemical durability in tested glass-sealant combinations, edge-deletion may not be mandatory in some applications and conditions.
- Guardian products with silver layers installed without edge-deletion (as SunGuard HP coatings) must be protected against environmental influences accordingly under the responsibility of the processor.
- Untested combination of silver-containing coating with sealant requires mandatory edge deletion.

The coatings of the product families SunGuard HP, SunGuard Solar and SunGuard HD are compatible to 2K polysulfide, 2K polyurethane, 1K hotmelt and 2K silicone sealants for standard insulating glass applications (no structural glazing).

Reference code: Guardian_General PG_EN_1121

Following sealants were tested successfully with selected coatings according to EN 1279- 4: 2018 (Glass in building - Insulating glass units - Part 4: Methods of test for the physical attributes of edgeseal components and inserts):

- 2-component polysulfide: Fenzi Thiover, Kömmerling GD 116
- 2-component polyurethane: Kömmerling GD 677
- 1-component hotmelt: Bostik 5000
- 2-component silicone: Sika IG-25 HM+, DOWSIL 3363

According to equivalence rules of coatings detailed in Annex B of EN 1279-4:2018, the complete range of SunGuard HP, SunGuard Solar and SunGuard HD are covered by the test results.

Structural glazing

If a European certification for structural glazing according to ETAG 002-1 is required or if coatings are intended to be in contact with any silicone with structural functionality (edge seal or bonding), please contact Guardian for detailed information about suitable glass types and tested coating-sealant combinations complying with the ETAG 002-1 requirements. For more information about use of Guardian products in structural glazing according to European ETAG 002 Guideline, please refer to «Product application information. Sealant compatibility and structural glazing.» on *www.guardianglass.com*.

→ *p.44*

Full size project mock-ups are strongly recommended

Some color difference may appear between general coated area and the edges:

- On the edge deleted area visible from the outside of the building (structural glazing, steps, etc.).
- In glazing without edge-deletion "different color frame" may appear in coating-sealant contact zone.

It is the full responsibility of the processor to ensure the quality of the final product and compatibility and suitability tests are essential in each case.

5.2. Guardian System TEA

Special edge enamel technology «Guardian System TEA» can be used for structural application of heat-treatable Guardian products that contain silver. A layer of enamel is applied directly to the coating. After heat treatment, the coating is completely dissolved and only glass and enamel are left. The edge enameled surface is very mechanically and chemically stable and optically homogeneous. It provides reliable adhesion and aesthetics for structural application. «Guardian System TEA» is certified for use with various structural sealants. For more information, please contact Guardian Technical Services.

→ *p.44*

5.3. Guardian products permitted applications. Requirements for edge-deletion

Important aspects to be considered:

Check specific product requirements on *glassanalytics.guardian.com*
More information in «PAI. Sealant compatibility and structural glazing.» on *www.guardianglass.com*

Compatibility and suitability tests are required

Mock-up is recommended

Impact of humidity
→ *p.13*

SunGuard® HD	**Edge-deletion is not mandatory** → *p.13*	
SunGuard® Solar		
ClimaGuard® Dry		
ClimaGuard® Neutral 70	**Edge-deletion is not mandatory** for tested combinations → *p.13* in some cases of edge enameling; in case of «Guardian System TEA» enameling. → *p.14*	**Edge-deletion is mandatory** According to European ETAG 002 Guideline for structural glazing and IGUs with outer pane not mounted by profiles or any other supporting devices, even when using the specific enamels which normally would not require edge-deletion. In case of enameling with «Guardian System TEA» edge-deletion is not mandatory. → *p.14*
SunGuard® HP		
ClimaGuard® except *ClimaGuard® Neutral 70, ClimaGuard® Dry*	**Edge-deletion is mandatory** The coating must be completely removed from the perimeter of each finished cut size.	
Guardian Sun®		
SunGuard® SN		
SunGuard® SNX		
ClimaGuard® T	**Edge-deletion is mandatory** except in the case of «Guardian System TEA» enameling. → *p.14*	
Guardian Sun® T		
SunGuard® SN HT		
SunGuard® SNX HT		

Reference code: Guardian_General PG_EN_1121

6. Cutting and coating edge-deletion

Important aspects to be considered:

Before processing:

- Ensure safety → p.10
- More information in «PAI. Sealant compatibility and structural glazing.» on *www.guardianglass.com*

Tests required:

- Compatibility, suitability and feasibility tests with selected coating, equipment, glass geometries, cutting fluids, etc...

During and after processing:

- Internal storage → p.7
- Handling recommendation → p.10
- Avoid glass-to-glass, glass-to-TPF contact → p.7
- Keep coated surface or TPF away from supportive elements
- Respect processing time → p.9
- Conduct a quality control after each processing step
- Mock-up is recommended

6.1. General conditions

Cutting fluids on coated surface

- No fluid should remain for a long time on the coating in order to prevent chemical reaction and damage of the coating or difficulties during the washing process.
- Cutting fluids should be cleaned immediately after cutting from the surface and from the edges if needed. → p.20
- If the glass panes are stacked just after cutting, separation is needed to facilitate evaporation of the cutting fluids. → p.7

6.2. Edge-deletion

The coating should be removed using grinding equipment, wheels and technical procedures developed specifically for this purpose. For coatings not covered with TPF, manual process can also be applied.

Edge-deletion can be performed in several ways

- On the cutting table (for the coatings without TPF) → p.18
- On the cutting table (through TPF) → p.19
  - is safer for the coating, can be difficult for step glazing and small sizes
- Post-heat treatment, on the IGU production line → p.18
  - can be applied for the large step glazing
  - wave effect after heat treatment can reduce quality of edge-deletion
  - for the case of cutting trough TPF please refer to the chapter 6.4

For aesthetic reasons, Guardian recommends adopting only one way of edge-deletion process flow for the same project.
Guardian has tested a range of edge-deletion wheels. For more information on the appropriate equipment, please contact Guardian Technical Services. → p.44

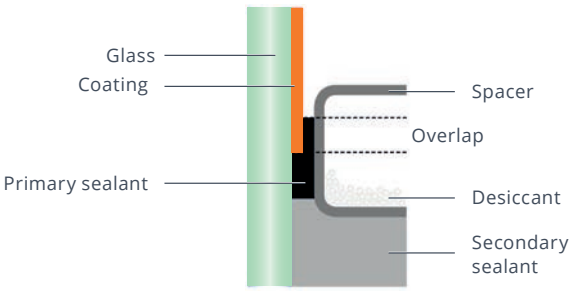
Edge-deletion area

The area of coating deletion should generally not be wider than 10 mm, as otherwise it may enter the visible area. If the sealing depth needs to be increased due to a particular application, then the width of edge-deletion of the coating must be increased accordingly.

Wider edge-deletion zone leads to the necessity to use repeated passes of the wheel, which can lead to a non-homogeneous optical appearance. «Guardian System TEA» can be used to achieve better edge quality. → p.13

Full size project mock-ups produced by the intended edge-deletion equipment are strongly recommended to evaluate the edge deleted area visible from outside of the building (structural glazing, steps, etc.).

Under extreme conditions, increased thermal dilatation due to solar energy absorption or certain shapes of the outer pane of the insulating glass can create shear tensions which can be transferred to the coating stack if the Butyl strip (primary seal) is applied completely on the coating. Guardian recommends to minimize the overlapping area whenever possible.



A coating detector or ohmmeter should be used to check whether all coating has been removed. → p.12

It is the full responsibility of the processor to ensure the quality of the edge-deletion, as well as the adhesion of sealants on edge-deleted surfaces.

Reference code: Guardian_General PG_EN_1121

6.3. Cutting of glass not covered with TPF

Avoid cutting by hand with tools such as rulers or templates. If the needs to should be cut using a template, place a protective sheet of acid-free paper between the template and the glass. → *p.7*

The cutting of Guardian LamiGlass® coated with SunGuard, ClimaGuard or Guardian Sun should be performed using a cutting table, wheels and technical procedures developed specifically for cutting of laminated glass. Coated Guardian LamiGlass® is annealed and so will be supplied without TPF.

The nature of PVB is such that it becomes stiffer as its temperature decreases, this has implications for cutting laminates and may affect the both the yield from break-out and the quality of the cut edge. Guardian LamiGlass should not be stored or cut in low temperature areas of the processing site.

Ensure that the cutting table is equipped with the facility to cut both sides of the glass. The pressure and speed should be suitably adjusted to provide a clean break with acceptable edgework.

- For soft coatings, Guardian recommends easily evaporating cutting fluids (e.g. Acecut 5250 and 5503).
- For harder coatings such as SunGuard HD and thicker glass with soft coating, medium evaporating cutting fluid (e.g. Acecut 6000) may help to achieve yielded good results for processing optimization.

6.4. Cutting through TPF without edge-deletion.

Do not remove TPF before cutting.

Some cutting fluids can lead to TPF delamination after prolonged contact.

Guardian recommends the following adjustment comparing to the cutting of the same thickness of coated glass without TPF:

- Only minimum required amounts of cutting fluid is recommended.
- Results from Guardian test research indicate that pre-facetted cutting wheel is optimal for cutting the TPF and scoring the glass consistently with a clean edge. Examples of wheels:
  - For monolithic 4 mm, 6 mm, 8 mm, 10 mm and laminated 44.x, 55.x, 66.x - prefacetted Bohle 03AP148P or MDI 60/130°
  - For monolithic 10 mm, 12 mm and 15 mm and laminated 66.x, 8.8.x - prefacetted Bohle 03AP152P or MDI 60/140°
- Wider tool angles than 145° are not recommended.

- It is recommended to start with the same cutting pressure as for normal float glass. After the first cut slightly adapt the cutting pressure if required. The cutting speed may need to be reduced to optimize the quality of the score.
- Cutting speed and pressure affect each other and some fine-tuning may be required. The stress lines that are visible after the break should be checked in order to achieve clean cut edges.

Edge-deletion should be carried out after TPF removal in accordance with the recommendation mentioned in 6.3 above. → p.24
→ p.18

6.5. Edge-deletion through TPF on the cutting table.

Do not remove TPF before edge-deletion and cutting.

Some cutting fluids can lead to TPF delamination after prolonged contact.

An upgrade to the aspiration system of the edge-deletion system is required to fully remove the residual TPF particles. For more information, please contact Guardian Technical Services and equipment vendors to perform necessary modification. → p.44

Guardian recommends the following adjustment:

- The edge-deletion wheel must always rotate against the direction of movement of the bridge/head. i.e. TPF debris is thrown «in front of» the wheel.
- It is recommended to use the maximum allowed rotation speed indicated on the wheel around 1950 RPM or 4500 RPM, depending on the wheel.
- For optimum results to obtain a clean TPF edge, it may be necessary to reduce the edge-deletion speed (bridge/head movement) to about 20-25 m/min and downward force of the edge-deletion wheel to between 1.0-3.0 bars. Edge-deletion speed and downward force affect each other, and some fine-tuning may be required.
- Guardian has tested a range of edge-deletion wheels. The best results were obtained by using the grinding wheels from company Norton, type Rapid Finish Convolute, type BearTex, company Fischler, type 3010 AE80, company Artifex, type SC 80 HT, company TYROLIT, type A1507-BE15T F. For more information about the appropriate equipment please contact Guardian Technical Services. → p.44
- Only minimum required amounts of cutting fluid are recommended.
- Once edge-deletion is completed the principled cutting parameters are the same as for float or coated glass without TPF.

7. Washing and cleaning

Important aspects to be considered:

Before processing:

Ensure safety
→ p.10

Tests required:

Feasibility tests with selected coating, equipment, etc...

During and after processing:

Internal storage
→ p.7

Handling recommendation
→ p.10

Avoid glass-to-glass, glass-to-TPF contact
→ p.7

Keep coated surface or TPF away from supportive elements

Respect processing time
→ p.9

Conduct a quality control after each processing step

Standard glass washing machines can be used when processing Guardian coated glass. However, there are specific details to be considered.

Any mechanical or chemical impact on coated or TPF surface can lead to coating damage.

- In case of jumbo with TPF if there is the overlapping zone it should be aligned perpendicular to the brushes in order to avoid damaging or peeling back of TPF so that the coating underneath does not become exposed.
- The washing machine must be checked and maintained at regular intervals to ensure it is perfectly clean and operating correctly.
- Always use clean and de-ionised water (< 30 µS) as close to neutral acidity as possible (pH 7±1). The water must not contain any cleaning agents or non-dissolved particles (such as lime).
- Abrasive cleaning agents can scratch or damage the coatings and must be avoided.

To avoid scratching of the coating (directly or through TPF):

- Standard washing machine brushes are not suitable for coatings. The brushes with Ø of bristles max. 0.15 to 0.20 mm are recommended for all Guardian coatings.
- Fixed brushes at the machine entry or exit must be adjusted to not contact the coated surface.
- The brushes should be set to a maximum 1-2 mm contact with the coated surface.
- During washing the panes must not remain stationary in the machine with the brushes revolving.
- The brushes should be cleaned frequently and have an ample supply of water; the brushes must not operate dry.

After washing

- Carry out a visual inspection in both transmission and reflection with suitable lighting.
- After washing, the coating should only be touched with suitable clean gloves.
- The glass panes must exit the washing machine completely dry, otherwise drying traces (watermarks) will remain later.
- There must not be any scratches, dirt, watermarks or residues, fluid droplets or fingerprints from gloves on the coating. Otherwise, these can lead to irreversible defects, particularly evident after heat treatment.
- TPF must remain on the coated surface during post-washing transport when the washer is not directly in line with the furnace entry conveyor. If the washer is in line, prevent water droplets getting onto the coating when the TPF is transferred to the furnace loading table.

→ p.24

Manual Cleaning

When spot cleaning of the coating is required, dab or blot the surface with a clean, soft cloth to remove any excess cleaning solution. Do not wipe the surface. Guardian recommends the use of mild fast-drying household glass cleaners, e.g. a mixture of approx. 10% ammonia and 90% water or a mixture of approx. 50% isopropyl alcohol and 50% water. You can find more information about cleaning of the glass in the final application on *https://glasstime.guardianglass.com/en/knowledge-center/standards-norms/cleaning-glass#anchorArticle*.

Do not try to wipe out the small glass particles from the surface, as these must be blown off by dry and clean air.

8. Edge processing

Important aspects to be considered:

Before processing:

Ensure safety
→ p.10

Tests required:

Feasibility tests with selected coating, equipment, etc...

During and after processing:

Internal storage
→ p.7

Handling recommendation
→ p.10

Avoid glass-to-glass, glass-to-TPF contact
→ p.7

Keep coated surface or TPF away from supportive elements

Respect processing time
→ p.9

Conduct a quality control after each processing step

Guardian products are suitable for edge grinding, polishing or seaming. Edge work can be carried out manually or on automated machines. Special care must be taken to prevent coating damage.

Suitable edge processing can reduce the risk of thermal breakage.

Any mechanical or chemical impact on coated or TPF surface can lead to coating damage

- During manual handling, as in manual seaming with a cross belt machine, contact with the coated surface should be minimized to touching the edges of the pane only.
- During automatic edge grinding, any clamping or conveyor devices must not contact coated surface (with or without TPF). Contact should be from below, on the uncoated surface, or on the edges of the pane.
- The grinding equipment should have an ample supply of clean water.
- To prevent coating or TPF damage by glass debris accumulation from either wet or dry seaming or grinding, the glass should be rinsed directly after the operation with copious amounts of water before washing directly after the edge processing operation.
- All equipment must be checked and maintained at regular intervals to ensure it is perfectly clean and operating correctly.

Special care is required when the TPF edge extends right up to the glass edge

- Attention is required, for example, when edge work should be carried out after cutting through the TPF but before TPF removal.
- Avoid damaging or peeling back of TPF so that the coating underneath does not become exposed.

- If TPF peels back in the corners or along the edges during washing/blow-drying, it is recommended to reduce air pressure in blow-dry section of washer.
- If the TPF edge is dislodged by the grinding wheels or the cross belts, Guardian recommends manual trimming to cut back the edge of the TPF. A few millimeters are sufficient and can be achieved with a suitable blade.
- For grinding glass with TPF, segmented grinding wheels (suitable for laminated glass) are recommended to avoid clogging of the grinding wheels by the TPF particles.

Reference code: Guardian_General PG_EN_1121

9. Heat treatment

Important aspects to be considered:

Before processing:

- Ensure safety → p.10
- Check requirement on *www.guardianglass.com*

Tests required:

- Compatibility, suitability and feasibility tests with selected coating, equipment, glass geometries, enamel and edge-deleted areas, separation materials, etc...

During and after processing:

- Internal storage → p.7
- Handling recommendation → p.10
- Avoid glass-to-glass, glass-to-TPF contact → p.7
- Keep coated surface or TPF away from supportive elements
- Respect processing time → p.9
- Conduct a quality control after each processing step
- Mock-up is recommended

Some of Guardian products can be heat treated for safety, load resistance, resistance to thermal breakage or for other requirements. → p.28

9.1. TPF removal

The TPF must be removed completely before heat treatment and should never be allowed into the furnace, as this would irreparably damage the coating. The TPF must be removed just before the glass is introduced into the furnace e.g. on the loading table.

The removal of the TPF is facilitated by the film's «easy-peel» effect:

- Start in a corner of the glass.
- To get a good grip of the corner of the TPF if needed, apply a strip of strongly adhesive tape on it to lift the TPF off the coated glass.
- At first peel back about 20 to 30 cm of the TPF
- Then hold the TPF tightly and pull swiftly. This 'fast pull' substantially reduces the force required to remove the film from the coated glass.





Jumbo with TPF

- To cover a whole Jumbo with TPF, two films can be overlapped and sealed with organic glue that does not hinder the «easy-peel» effect.
- Make use of the «easy-peel» effect by pulling the films back from both sides right up to the overlap area.
- After, peel the overlapping films back slowly to avoid tearing of the film due to the organic glue.
- Most of the glue is removed with the TPF, but some organic residue may remain on the coating in a strip of about 10cm width. This residue will evaporate without leaving a trace during heat treatment.
- Do not try to clean organic glue residue, unless enamel is to be applied in this area.

When spot cleaning of coating is required after TPF removal the recommendation for manual cleaning should be applied. → *p.21*

9.2. Heat treatment

Heat-treatable Guardian products can be processed as fully tempered or heat strengthened glass. The capability of equipment to process fully tempered glass does not necessarily mean it has the capability of processing into heat strengthened glass. Settings adjustment is necessary, particularly in the cooling section. → *p.28*

No cutting, edge processing or other further mechanical processing can be carried out with heat-treated glass.
Edge processing before heat treatment is required to decrease glass breakage in the furnace. → *p.22*

SO_2 (Sulphur dioxide) must not be used at any time during the heat treatment of Guardian products. The SO_2 flow must be discontinued at least 2 hours prior. Avoid any traces of SO_2 in the furnace.

If the glass panes are intended for glazing in the same project, ensure that all the panes are processed in the furnace in the same direction according to future installation. It is recommended that roller waves will be oriented horizontally on the facade.
Some color difference may be apparent between annealed & heat-treated state or different versions of the same product mixed in a facade. Full size project mock-ups are strongly recommended.

Uniform heating

Whole surface uniform heating and cooling are critical in order to obtain good optical quality of heat-treated coated glass. A non-uniform process in the furnace can lead to permanent deformations and glass breakage.

Reference code: Guardian_General PG_EN_1121

Any modification of emissivity and heat absorption of coated side (large area of edge-deletion, edge enameling, silk-screening, etc.), can lead to inhomogeneous heating of the glass in the furnace. Feasibility tests should be conducted.

Start tests with a furnace tuning proven successful for some coated products with comparable emissivity.
To check particular product emissivity, please refer to *www.guardianglass.com* and *cemarking.eu.guardian.com* (Declaration of Performance). Ensure current information is used.

Coatings with high emissivity:
Due to the low heat-reflection, SunGuard HD and ClimaGuard Dry coatings can be heat treated using similar settings to clear float glass with a slightly increased heating time.

Coatings with low emissivity:
The heat reflection of the low emissivity coating counteracts the warming of this surface by radiation. The bottom surface, without a low-e coating, absorbs the heat much more effectively and heats up quicker than the coated side. This leads to asymmetrical heating of the glass in the furnace.

As a rule, furnace temperatures should be decreased, and the furnace dip time increased in direct proportion to the emissivity of the glass being heat-treated. For coatings with lower emissivity, it is necessary to use furnaces with forced air convection. The use of forced air convection furnaces will enable improved heating control of the glass.

It is the full responsibility of the processor to ensure the quality of the final product. Set-up provided by a Guardian Technical Services specialist must be organized before first heat treatment of the glass for uncertified processing specialists.

9.3. NiS

All fully tempered glass has a risk of spontaneous breakage due to nickel sulfide inclusions (NiS). Even with the current state of the art in glass manufacturing, it is not possible to completely eliminate NiS inclusions.

Therefore, there is no warranty against breakage for NiS reason.

To decrease potential risk of spontaneous breakage of fully tempered glass in the glazing, it is strongly recommended to carry out a Heat Soak Test (HST).
According to EN 14179, the HST does not provide 100% safety regarding spontaneous breakage, as certain residual risks must be considered.

9.4. Heat Soak Test

Heat Soak Test (HST) is an offline process whereby the glass is exposed to extremely adverse conditions causing NiS to manifest and glass to break. It is performed by placing tempered glass into a specially designed, calibrated and certified HST oven. In Europe, the HST is to be carried out in accordance with EN 14179.

- After the tempering, the coated glass must be put in HST as soon as possible.
- As an additional offline handling process, HST carries extra risks of the glass scratching, abrasion, chipping and breakage.
- During the process, breakage may occur due to the presence of NiS or due to other reasons such as non-uniform heating if the HST is not conducted properly. Remaining broken glass may damage the new loads, so the HST cleaning is required to release oven for the next batch.

Recommended loading instructions, strongly impact the quality of the test:

- A clear float glass is placed first on the HST-rack. Stack order from big size panes to smaller ones if possible. The coated glasses stacked with the coating facing towards the rack (non-coated glass side to the operator).
- Glass-to-glass contact is not allowed. Minimum distance between the glass panes is 20 mm. → *p.7*
- Thermo-couples must be attached to the uncoated surface.
- The separators should ensure optimized airflow between the glass panes, without hindering the airflow itself.

The coated glass may require machine washing after HST. → *p.20*



Example
Teflon separators are placed only in the edgedeleted area without contact with the coating.

It is the full responsibility of the processor to ensure the quality of the final product and compatibility and suitability tests are essential in each case.

Reference code: Guardian_General PG_EN_1121

9.5. Guardian products permitted applications. Heat treatment

Important aspects to be considered:

Check requirement on *www.guardianglass.com*

Mock-up is recommended

Some Guardian products are produced in one version for both annealed and heat-treated applications. Others have 'T' or 'HT' versions for heat-treated application.
Annealed versions must never be heat treated. Heat-treatable versions must never be used annealed.

	Annealed application	Heat-treated application
SunGuard® HD	One version both for heat treated and annealed applications	
SunGuard® Solar		
ClimaGuard® Neutral 70		
ClimaGuard® A		
SunGuard® HP		
ClimaGuard® Dry	Not allowed	Must be heat treated in order to provide its special anti-condensation performance
ClimaGuard® except *ClimaGuard® Neutral 70, ClimaGuard® Dry*	Only annealed usage. Must never be heat treated.	Not allowed
Guardian Sun®		
SunGuard® SN		
SunGuard® SNX		
ClimaGuard® T	Not allowed	Must be heat treated
Guardian Sun® T		
SunGuard® SN HT		
SunGuard® SNX HT		

10. Enameling of coated surfaces

Important aspects to be considered:

Before processing:

Ensure safety
→ *p.10*

More information in «PAI. Ceramic print - Spandrel Glass.» on *www.guardianglass.com*

Tests required:

Compatibility, suitability and feasibility tests with selected coating, equipment, glass geometries, enamel and edge-deleted areas, paintings, etc...

During and after processing:

Internal storage
→ *p.7*

Handling recommendation
→ *p.10*

Avoid glass-to-glass, glass-to-TPF contact
→ *p.7*

Keep coated surface or TPF away from supportive elements

Respect processing time
→ *p.9*

Conduct a quality control after each processing step

Mock-up is recommended

10.1. General conditions

Enamels (ceramic paints) are applied on the glass surface and require subsequent heat treatment. During heat treatment these enamels melt and fuse permanently to the glass, forming a colored ceramic layer.

Heat-treatable Guardian products recommended for enameling are not typically supplied with TPF. For those that are, TPF removal should be carried out before enameling.
→ *p.31*
→ *p.24*

Guardian recommends the following procedures:

- The processor must follow processing instructions supplied by the enamel producer
- Minimum thickness of the wet enamel after printing with adjusted processing viscosity:
  - 70 µm by silk-screen printing
  - 90 µm by enameling with roller coating
- Complete drying through the entire thickness of the enamel must be ensured before firing.
- The final thickness of the enamel coating after firing should not be less than 30 µm.
- The ceramic frit must melt without bubbling, under normal tempering conditions for flat glass, to ensure a dense and uniform cover with minimized porosity.
- Unfavorable tempering conditions can lead to reduced quality (gloss, color, homogeneity, durability, density, adhesion) of the final product.
- Large areas of edge enameling change the heat absorption of the coated side. Particularly for coatings that contain silver, this can lead to inhomogeneous heating of the glass in the furnace with poor quality of final product or glass breakage.
→ *p.25*

Reference code: Guardian_General PG_EN_1121

Do no use untested combination of coating and enameling

There are various ceramic paints that may contain different chemicals. Reactions during firing may cause a hazy appearance or even complete destruction of the coating. Therefore, all enamels must not contain lead, cadmium, graphite, lithium, carbonate. In case where combinations are not recommended by Guardian – all necessary tests should be conducted.

Full size project mock-ups are strongly recommended.

Color deviation can appear due the contact between coating and paint.

Minimum quality control for enameled glass

- All test methods recommended by the enamel manufacturer
- Scratch resistance and adhesion (test with Erichsen-pen)
- Porosity and adhesion (iso-propanol test)
- Melting behavior and surface roughness (gloss test with gloss meter)
- Uniform and dense coverage (detection of pinholes in transmission – halogen lamp test)

For more information on the use of Guardian products in spandrel glazing, please refer to «Product application information. Ceramic print - spandrel glass.»

It is the full responsibility of the processor to ensure the quality of the final product and compatibility and suitability tests are essential in each case.

10.2. Ceramic print with FERRO System 140

Ferro and Guardian have tested «System 140» colors using recommended solvent «Medium 80 1022» or «Medium 80 1026» on Guardian SunGuard products.

The Ferro System 140 includes various types of ceramic paints, composed of partially different chemical components. In relation to the glass products indicated below, Guardian recommends the following types:

- For spandrel glass: 140 15 4001 (color similar to RAL 7031 Blue grey)
- For edge enameling: 14014 4001 (color similar to RAL 9005 Deep black)
  140 14 4011 (color similar to RAL 9005 Intensive black - more pigments)

10.3. Guardian products permitted for ceramic print on coating

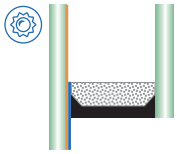
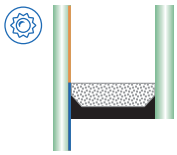
Important aspects to be considered:

- Check recommended enamel combinations for SunGuard Spandrels in «PAI. Ceramic print - Spandrel Glass.» on *www.guardianglass.com*
- Compatibility, suitability and feasibility tests are required
- Mock-up is recommended
- Potential thermal breakage risk

Various heat-treatable Guardian coatings can be printed with ceramic paints for various purposes.

For a not heat-treatable coating, ceramic printing is not allowed. → *p.28*

		SunGuard® HD except SunGuard® HD Royal Blue 20*	*SunGuard® Solar*	*ClimaGuard® Neutral 70*	*SunGuard® HP*	*Guardian Sun® T*	*SunGuard® SN HT*	*SunGuard® SNX HT*
Patterns, decorative print on the coating	1 2 3 4 Coating facing inside the cavity of IGU	Allowed The part to be covered by sealant should remain free of printed pattern, otherwise compatibility tests must be carried out.				No common approach. Tests are needed		
	1 2 3 4 1 2 Mono-application / coating facing outside of cavity of IGU	Allowed if exposed towards the building	Not allowed	Not allowed		Not allowed		
Paint covers the whole coated surface	1 2 Mono-application / glass parapet / spandrels	Allowed if exposed towards the building	Allowed if exposed towards the building. Strict quality requirements should be followed due to the high risk of corrosion	Not allowed		Not allowed		
Edge enameling in standard IGU. Covers up the spacer and the edge seal. Protects IGU sealants against UV radiation	Without edge deletion	Allowed → *p.15*	Allowed → *p.15*	Allowed → *p.15*		Not allowed, except «Guardian System TEA» enameling. → *p.14*		
	With edge deletion	Allowed → *p.15*	Allowed → *p.15*	Allowed → *p.15*		Allowed → *p.15*		

		SunGuard® HD except SunGuard® HD Royal Blue 20*	SunGuard® Solar	ClimaGuard® Neutral 70	SunGuard® HP	Guardian Sun® T	SunGuard® SN HT	SunGuard® SNX HT
Edge enameling on the outer pane in stepped IGU, structural glazing (acc. to EU ETAG 002) and IGU with outer pane not mounted by profiles or any other supporting devices	 Without edge deletion	Allowed for tested combi-nations (list by request) → *p.15*	Allowed for tested combinations (list by request)	Not allowed, except «Guardian System TEA» enameling. → *p.14*				
	 With edge deletion	Allowed → *p.15*	Allowed → *p.15*	Allowed → *p.15*		Allowed → *p.15*		

*SunGuard HD Royal Blue 20 is not allowed for any type of enameling.

10.4. SunGuard HD on surface #2 in combination to ceramic frit on surface #1

Ceramic frit on surface #1 with coating on surface #2 requires the tempering of the glass with the coating facing downwards on the rollers.

Such a special application requires additional attention and extreme care while processing due to imminent contact between the supporting elements and coated surface and is carried out fully by the processor at their own risk. The ceramic rollers of the furnace must be clean and free of dirt and the glass should not be slid over stationary machine parts (rollers, castors, etc.).

Prior to acceptance of any order, it is necessary to run preliminary feasibility tests with the selected coating and paint, using the intended production equipment, tempering conditions, glass geometries and area covered with ceramic frit.

Full size project mock-ups are strongly recommended.

It is the full responsibility of the processor to ensure the quality of the final product and compatibility and suitability tests are essential in each case.

11. Bending

Important aspects to be considered:

Before processing:

Ensure safety → p.10

Check requirement on *www.guardianglass.com*

Tests required:

Compatibility, suitability and feasibility tests with selected coating, equipment, glass geometries, bending radius, coating position, enamel and edge-deleted areas, etc...

During and after processing:

Internal storage → p.7

Handling recommendation → p.10

Avoid glass-to-glass, glass-to-TPF contact → p.7

Keep coated surface or TPF away from supportive elements

Respect processing time → p.9

Conduct a quality control after each processing step

Mock-up is recommended

For HT bending, in general, if a Guardian coating can be heat-treated it means it can also be bent. All recommendation for heat treatment should be followed. For heat-treatable Guardian products supplied with TPF, the TPF removal should be carried out before HT bending. → p.28 → p.24

For annealed gravity bending, all Guardian products based on float glass may be tested.

For cold bending all Guardian products based on float glass as well on Guardian LamiGlass® can be tested.

During the bending process, optimum results will be obtained by placing the coated pane on top of a multi-pane stack, with the coating away from supportive elements. The recommended glazing configuration places the coating in compression, in other words on the concave surface.

It is necessary to run preliminary tests prior to acceptance of any order. Minimal possible bend radius depends on processor equipment and glazing composition.
Guardian products after bending can be processed into laminated glazing. All recommendations for lamination should be followed. → p.34

Full size project mock-ups are strongly recommended.
Color deviation can appear due the view angle.

It is the full responsibility of the processor to ensure the quality of the final product and compatibility and suitability tests are essential in each case.

Reference code: Guardian_General PG_EN_1121

12. Processing to laminated glazing

Important aspects to be considered:

Before processing:

- Ensure safety → *p.10*
- More information in «PAI. Guardian SunGuard® in Laminated Glass Applications on *www.guardianglass.com*

Tests required:

- Compatibility, suitability and feasibility tests with selected coating, interlayer, equipment, glass geometries, silicons & sealants, etc...

During and after processing:

- Internal storage → *p.7*
- Handling recommendation → *p.10*
- Avoid glass-to-glass, glass-to-TPF contact → *p.7*
- Keep coated surface or TPF away from supportive elements
- Respect processing time → *p.9*
- Conduct a quality control after each processing step
- Mock-up is recommended

12.1. General conditions

There are several different ways to process Guardian products into laminated glass to achieve the desired aesthetics, safety and sound reduction performance. → *p.38*
For more information about use of Guardian products in laminated application, please refer to «Product Application Information. Guardian SunGuard® in Laminated Glass Applications.» on *www.guardianglass.com*.

In the case of laminating of heat-treatable Guardian products generally supplied with TPF, the TPF removal and heat treatment must be carried out before lamination. → *p.24*
Annealed Guardian products are normally supplied without TPF. Therefore, in this case there is no TPF present on the coating during lamination glazing production.

It is the full responsibility of the processor to run any necessary compatibility and suitability tests in each case – sealants, interlayers, etc... prior to acceptance of any order and the start of processing.
For durability tests of laminated glass please refer to EN 12543-4.
The quality needs to be checked during production on regular bases as part of a quality assurance plan.
In the case of use of organic construction materials, sealants, foils, etc., chemical plasticizers can be exchanged between the different construction components, which in turn can change the mechanical and chemical behavior of such materials, which ultimately can lead to destruction of the glazing. Without compatibility tests, the direct contact between interlayer and any sealant materials should be avoided. Some limits for usage conditions can exist

for those kinds of components, e.g. temperature. For more information, please contact the materials suppliers.

Some coating-interlayer-combinations can lead to higher solar energy absorption.
Edge working or heat treatment of the glass prior laminating reduces the risk of thermal breakage significantly. In critical cases, a thermal stress analysis is recommended.

Full size project mock-ups are strongly recommended.
Color deviation may appear in case of direct contact between coating and PVB.
Some color difference may appear between laminated – not laminated applications or versions of the same product mixed in a facade.

Laminated glass and laminated safety glass
Laminated glass product can be used in glazing for some general reasons (aesthetics, sound reduction, etc.) as well as to satisfy safety and security requirements.

In Europe, all laminated safety glass products should comply to EN 14449 «Laminated glass and laminated safety glass». To classify laminated product as safety glass, it should be certified according to EN 12543-2 «Laminated glass and laminated safety glass-Part 2: Laminated safety glass».

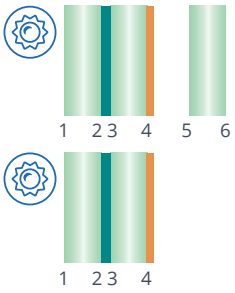
To check safety and security certification of particular Guardian LamiGlass® product manufactured by Guardian, please refer to *cemarking.eu.guardian.com* and Declaration of Performance.

Be aware that only a few glass products with coating inside the laminated pane inside can comply to EN 12543-2 «Part 2: Laminated safety glass».

It is the full responsibility of the processor to ensure the quality of the final product and compatibility and suitability tests are essential in each case.

Reference code: Guardian_General PG_EN_1121

12.2. Coating outside of laminated pane



Coated Guardian products in either the annealed state or after heat treatment can be processed into laminated cut sizes with the coating towards the outside of the laminated pane. It can be used in IGUs or mono-applications according to allowed application for coated Guardian product.

→ p.3

Annealed Guardian LamiGlass® coated with SunGuard, ClimaGuard or Guardian Sun can be used to produce different types of laminated glazing.

Mechanical impact

- Special attention needs to be paid during processing if the coating is exposed to mechanical contact - particularly if nip rolls are used for the pre-lamination process. Check for scratches, if yes – reduce the pressure of nip rolls, which should be completely clean.

→ p.10

- If vacuum bags/rings are used, then acid-free paper interlayer is required between the glass and the inside of the vacuum bag to avoid marking.

Possibility of chemical reactions

Any chemical processes that can occur on the coating or lamination foil can have a serious impact on the adhesion between glass panes and the foil, glazing performance and aesthetics. As there is no direct contact between coating and interlayer – there are no special Guardian requirements for the interlayer type, except compatibility requirements that are essential in each particular case.

Avoid using the interlayers that require extreme thermal or chemical condition during processing into laminated glass.

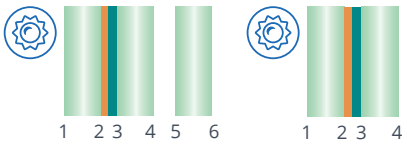
Impact of humidity and risk of corrosion

In general, edges of laminated glass with standard PVB foil must not be exposed to high moisture due to high water absorption that can lead to delamination and coating corrosion from the edges. To avoid delamination and corrosion, the glazing must be designed with appropriate level of moisture protection (hermetic glazing, sealed edges, etc.).

Guardian LamiGlass® products are produced only with PVB foils, which means that the edges must not be exposed to high moisture.

It is the full responsibility of the processor to ensure the quality of the final product and compatibility and suitability tests are essential in each case.

12.3. Coating inside of laminated pane, against PVB interlayer



Some Guardian products in some applications and conditions, in either the annealed state or after heat treatment, can be processed into laminated cut sizes with the coating inside the laminated pane, against PVB interlayer, for the use in IGU or mono-applications.

→ p.28
→ p.38

Possibility of chemical reactions

Any chemical processes that can occur in the zone of contact of coating and lamination foil can have a serious impact on the adhesion between glass panes and the foil, glazing performance and aesthetics. Reaction of the coating with the foil may attack or destroy the coating and can lead to delamination.

Without compatibility tests, the direct contact between PVB and any sealant materials should be avoided. Sealant and interlayer manufacturers provide tested combinations on request.

The IFT Guideline DI-02/1 (IFT Rosenheim 2009) provides information about test methods and visual validation.

- Guardian has not tested and therefore does not recommend the use of resins, colored PVB, structured PVB, SentryGlass, EVA foil against Guardian coatings due to the high number of different chemical compositions of those foils and therefore the high number of compatibility tests that would be required in each case.
- All necessary tests should be conducted. Do not use untested combinations of coating and interlayer.
- The manufacturer of the laminated glass with SunGuard coatings is responsible for ensuring the durability according to EN ISO 12543-4.
- Please contact Guardian for further information regarding compatibility and quality control requirements for the coated surface faced the interlayer of laminated glass.

Inside laminated coatings can have a significant color deviation compared to non-laminated glasses of the same type (especially SunGuard HP, SN and SNX coatings are critical).
The best optical appearance and highest level of durability can be achieved with the coatings of the SunGuard HD family.
In combination with multifunctional coatings only one production charge of the coated base glass should be used due to stronger requirements on color tolerances.

Reference code: Guardian_General PG_EN_1121

Inside laminated coatings lose their low emissivity properties, therefore inside laminated coated glass does not provide thermal insulation function, the U value will be the same as in the case of uncoated laminated glass.

Compatibility with PVB interlayer

- SunGuard HD and SunGuard Solar coatings are compatible with PVB interlayers and can achieve the best optical appearance and highest level of durability. Several types are certified in combination with different PVB interlayer types as laminated safety glass. Typical applications are ventilated double skin facades.
- Selected SunGuard HP coatings are compatible with PVB interlayer. Please contact Guardian for more information.
- SunGuard SN and SunGuard SNX don't have common approval from Guardian for lamination against PVB interlayer. Attractive alternatives are SunGuard HD coatings in combination with clear or solar PVB.

Impact of humidity and risk of corrosion

Contact between the silver layer and surrounding atmosphere or humidity can lead to the corrosion (oxidation) of coatings that contain silver and will impact on adhesion, performance, and aesthetics.

- Laminated glass with standard PVB foil must not be exposed to high moisture due to high water absorption that can lead to delamination and coating corrosion from the edges.
- To avoid delamination and corrosion of coatings that contain silver, the glazing must be designed with appropriate level of moisture protection (hermetic glazing, sealant edges, etc.). → p.13
- Exposure of PVB edge to the atmosphere can lead to delamination, even in case of edge-deletion.
- Laminated SunGuard HP application must ensure the proper protection of the edges against moisture impact. In other case this coating that contain silver must be edge deleted prior to inside lamination to avoid corrosion. This requires the lamination of end-size cut glass.

It is the full responsibility of the processor to ensure the quality of the final product and compatibility and suitability tests are essential in each case.

12.4 Guardian product permitted applications. Laminated glazing

Important aspects to be considered:

More information in «PAI. Guardian SunGuard® in Laminated Glass Applications.» on *www.guardianglass.com*

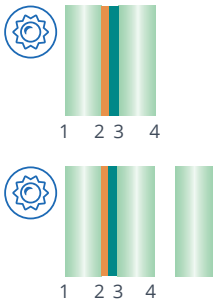
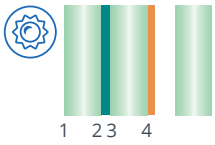
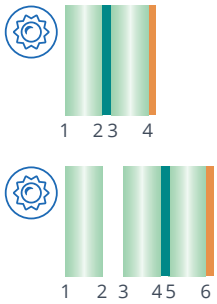
Impact of humidity
→ p.36, → p.37

Potential risk of thermal breakage

Compatibility, suitability and feasibility tests are required

Mock-up is recommended

Mono-application
→ p.4

	Coating inside the laminated pane, against PVB interlayer Direct contact between coating and interlayer, therefore, only PVB interlayer is allowed. Coating color deviations will appear.	Coating on outside of the laminated pane No contact of coating with interlayer	
	Please be aware that in case of use of PVB interlayer edge moisture protection is required (see above) → *p.27*, → *p.29*		
	 IGU, Mono-application	 Facing inside the cavity of IGU	 Mono-application / Facing outside of cavity of IGU
SunGuard® HD	Allowed	Allowed	Allowed if exposed towards the building
SunGuard® Solar			Not allowed
ClimaGuard® Dry	Not allowed	Allowed	Allowed (recommended on pos#1) → *p.3*
ClimaGuard® Neutral 70	Allowed for tested combinations. Loss of thermal insulation performance of the coating. Edge deletion is required, if the intended application does not ensure the proper edges protection against moisture impact. → *p.13*	Allowed in accordance with particular coating permitted applications → *p.3* and requirements (edge-deletion, etc.) → *p.11*	Not allowed
SunGuard® HP			
SunGuard® SN (HT)	Special approval is needed. Rather, SunGuard HD with clear / solar PVB can be used.		
SunGuard® SNX (HT)			
ClimaGuard® (T) except *ClimaGuard® Dry, ClimaGuard® Neutral 70*	Not allowed		
Guardian Sun® (T)			
Guardian LamiGlass® coated with *SunGuard®, ClimaGuard®* or *Guardian Sun®*	--	Allowed, in accordance with particular coating permitted applications → *p.3* and requirements. Please be aware that Guardian LamiGlass® is made by Guardian with PVB interlayers.	

13. Transportation of separate panes outside of processing site

All risks and additional measures that come with transportation of separate panes that are not allowed for mono-application are under the full responsibility of the initial processor.

Important aspects to be considered:

Before processing:

Ensure safety
→ p.10

Tests required:

Compatibility and feasibility tests with selected coating, packaging materials, transportation processes, etc...

During and after processing:

Internal storage
→ p.7

Handling recommendation
→ p.10

Avoid glass-to-glass, glass-to-TPF contact
→ p.7

Keep coated surface or TPF away from supportive elements

Respect processing time
→ p.9

Conduct a quality control after each processing step

- Any transportation of Guardian coated glass, except coating allowed for mono-application, outside the factory environment is strongly not recommended. → p.3
- Any subsequent processor of the glass must be informed about the special requirements of processing of Guardian coated glass and must follow all guidelines described in this document.
- Any subsequent processor must be informed about the processing time and how many hours the glass has already been in processing. → p.9

Prior to taking a decision about transporting separate panes, it is necessary to run production simulation including packaging, transport and storage of the glass with the selected coating, using the intended production equipment, packaging and separation materials and methods.

The coated surface requires quality control at the receiving site for checking any coating damage and corrosion under suitable light conditions. → p.43

General recommendations that can decisively determine the quality of the process:

- All storage and handling requirements should be followed before and during transportation, as well as during further processing. → p.6
- Any movement or rubbing of the panes against each other must be avoided during transit and loading / unloading of the glass.
- Transit and storage times should be kept as short as possible.

- Glass must be hermetically sealed within a very short time after processing.
- All recommendations for internal storage should be followed during monolithic panes packaging, as well as during further processing. → p.7
- Glass-to-glass contact must be avoided. → p.7
- If possible, a compatible protective film should be applied to the coated surface directly after heat treatment (if any) or cutting.
- The glass should be at ambient temperature when being packed.
- An uncoated cover pane should be used to protect the coatings when transporting a full or partial pack.
- The pack should be sealed around the edge with airtight tape or stretch film with suitable desiccant in the package. It will also prevent the panes from moving and sliding against each other.

An example of packaging of monolithic panes

- Dry acid-free paper is placed on the back of the rack before starting to load the glass on the rack.
- The first glass is positioned on the rack with the glass side against the paper and the rack (coating facing operator).
- Stack is ordered from big size panes to smaller ones.
- When all the glass is packed, the rack is wrapped with stretch film all around to get a solid pack.





Reference code: Guardian_General PG_EN_1121

14. Recycling and environment and safety

SunGuard, Guardian Sun and ClimaGuard do not meet the criteria for classification in any hazard class according to EU Regulation (EC) No 1272/2008 on classification, labelling and packaging (CLP) of substances and mixtures. For more information, please contact Guardian Technical Services in order to obtain voluntary product information «Article Safety Data Sheets (SDS)»

→ p.44

For more environmental information and/or to apply to sustainable building rating systems, please refer to Guardian «Environmental Product Declaration (EPD)» on *www.guardianglass.com*. It is a verified and registered document that communicates information about the lifecycle environmental impacts of products.

Guardian coated glass, as well as laminated and heat treated glass, can be shipped to central collecting points. There they are generally processed and sorted into their original pure components. The glass can be recycled. Residual fractions are preferably thermally recycled or in last resort, disposed of in landfill.



The TPF (Temporary Protective Film) is recyclable. It is recommended to collect it separately from other waste products. In case the TPF is not removed from glass trims, Guardian recommends to sort it together with the laminated glass waste stream. According to the European List of Waste Products (EWC) the code for TPF is 20.01.39 - Plastics.
For more information, please refer to and follow the local waste collection applicable regulations and guidelines.

15. Quality and Compliance Features of Coated Glass

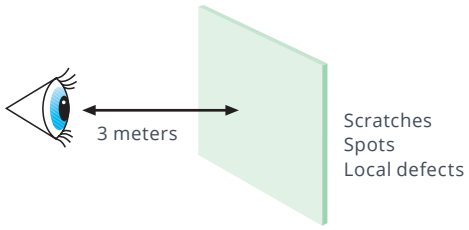
Glass products are subject to the European Construction Product Regulation No 305/2011 and must have mandatory CE Marking labelling that show compliance with the harmonized European Standards in order to be freely traded within the market of the European Economic Area. All Guardian coated glass conforms to EN 1096 «Glass in building – Coated glass». For more information about a particular product, please refer to *cemarking.eu.guardian.com*.

The glass requires a quality control after each processing step under suitable light conditions to detect as early as possible any quality deviations.

Some important examination conditions according to EN 1096-1:

Coated glass may be examined in stock size plates or in finished sizes ready for installation. The examination may be undertaken in the factory or on site when glazed.

- The pane of coated glass being examined is viewed from a minimum distance of 3 m.
- The angle between the normal to the coated surface and the light beam proceeding to the eyes of the observer after reflection or transmission shall not exceed 30°.
- The examination of the coated glass in reflection is performed by the observer looking at the side which will be the outside of the glazing.
- The examination of the coated glass in transmission is performed by the observer looking at the side which will be the inside of the glazing.



Verification

The signature below verifies that the processor has read and understands the full content of these processing guidelines: EU Processing Guidelines for Guardian® coated glass / Guardian SunGuard®, Guardian Sun®, Guardian ClimaGuard® / "Guardian_General PG_EN_1121".

Name / Signature: _____ Title: _____

Company / Stamp: _____ Date: _____

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