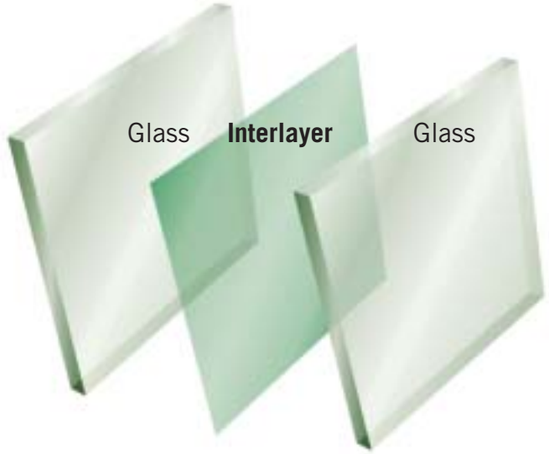
Cardinal® LG

The Glass Choice that Protects Your World

Laminated Glass Construction



Why Laminated Glass?

Life can sometimes be unpredictable. Everyone is concerned about the safety of homes and families. Unpredictable weather can cause havoc for homeowners. Today's traffic and other factors mean that the world is an increasingly noisy place.

More than anything, your customers are looking for a sense of confidence and reassurance today. Cardinal's laminated glass offers a level of security and serenity that can't be realized with ordinary glass.

How does it work? Cardinal's laminated glass consists of panes of annealed, heat-strengthened or tempered glass with one or more invisible interlayers sandwiched together to create a stronger, sturdier glass unit.

Today more architects and building professionals are turning to laminated glass. Find out why.

Storm Relief

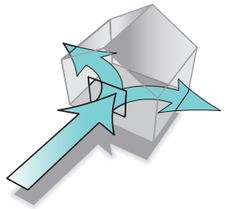
Home Safety

Sound Guard

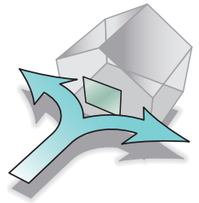
Fade Shield

Storm Relief

What's at work



If the building envelope is breached through a broken window, wind may enter the building, causing an increase in pressure that could lift the roof and push the walls outward.



Laminated glass helps to preserve the building envelope, minimizing damage by wind, rain and other elements.

Innovative design options

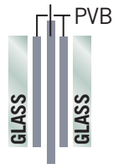
Cardinal employs multiple interlayers to meet various size and security constraints.

.090 PVB

Sea-Storm® PVB

- For small units (up to 15 ft^2)

PET w/ tabs



Sea-Storm® PET

- Tabs help keep glass in frame
- Maximum width 60"

.090 SGP®

Sea-Storm® SGP®

- 100 times as rigid as PVB
- Maximum size 72" x 120"

SGP® (SentryGlas® Plus) is a registered trademark of DuPont™ Company.

Resists Intense Impact

During windstorms and hurricanes, windborne debris is common, and following impact, windows may be subjected to sustained, gusting winds. Cardinal's SeaStorm® is crafted to offer a high level of impact resistance and remain integral in the window envelope even after glass breakage.

This is especially important in areas of extreme weather conditions. In 1992 the Gulf coast region was hit by Hurricane Andrew, which shattered countless windows with debris carried by gusting winds. Air flooded into homes, increasing the pressure inside the structure and causing buildings to collapse.

Today, local building codes increasingly require impact protection. Windows must now be able to sustain blows from a nine pound 2" x 4" traveling at 50 feet per second , or 34 miles per hour.

Sea-Storm® glass offers certified, proven impact resistance without the need for storm panels or shutters. Many other coastal areas are making local building codes tougher so that homes and other buildings can withstand environmental conditions. Cardinal LG stands ready to meet the needs and challenges of today's ever-changing building environment.

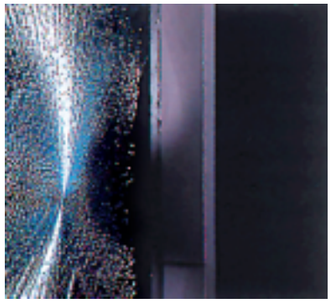
Home Safety

LG = Glass Integrity

Annealed glass breaks easily, producing long, sharp splinters.

Tempered glass shatters completely under higher levels of impact energy, and few pieces remain in the frame.

Laminated glass may crack under pressure, but tends to remain integral, adhering to the plastic vinyl interlayer.



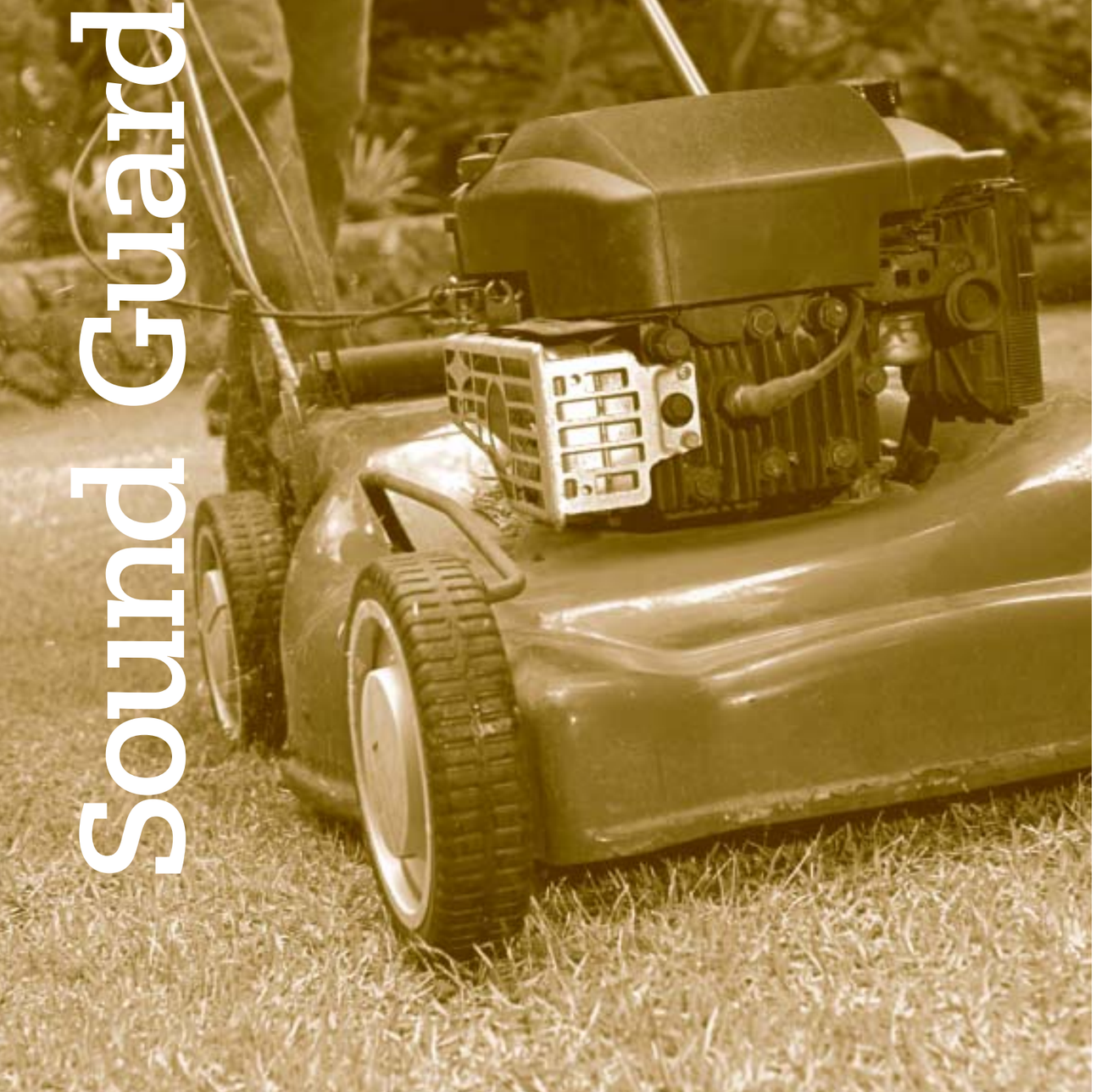
Security, Safety, and Serenity

Ordinary annealed glass breaks easily. Tempered glass, while stronger, shatters under a greater impact. But laminated glass is different.

If laminated glass is broken, the vinyl interlayer remains in the frame, with glass fragments adhering to the interlayer. This provides a strong barrier against forced entry. Furthermore, laminated glass cannot be cut from one side only, which renders glasscutters useless in the hands of would-be intruders. Cardinal LG offers an unparalleled level of harmonious tranquility for homeowners.

Cardinal's laminated glass meets rigorous industry codes, including the American Society of Testing Materials standard for preventing forced entry (ASTM F1233) and the burglary resistant guidelines issued by Underwriters Laboratories (UL972).

Each homeowner has unique needs for security. Our laminated glass is customized to meet the special requirements of any particular security application, providing the best options available.



Acoustical Properties

The superior sound-dampening effects of laminated glass are represented by the higher STC values.

Acoustic Performance	Glass Type	Threshold STC
Poor	Single pane	27
Moderate	Insulating glass	31
Better	Traditional laminated glass IG w/ 1 laminated pane	33 - 35
Best	Heavy single pane laminate IG w/ 2 laminated panes	37+

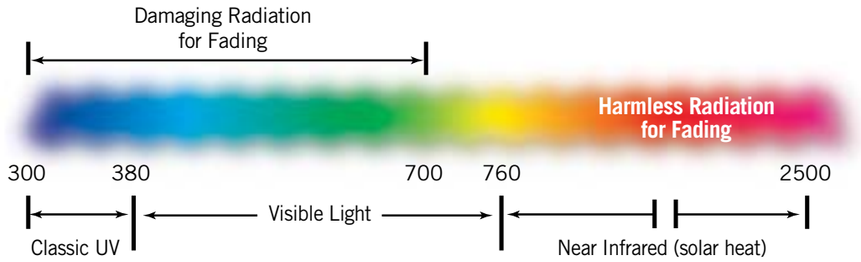
Planes, Trains and Automobiles

The world gets noisier every day. Sometimes all you want is a little peace and quiet. Laminated glass is an effective way to reduce unwanted outside noise. This is especially useful in areas near airports, industry, traffic, or wherever unpleasant sounds exist.

The American Society for Testing and Materials (ASTM) developed the sound transmission class rating (STC) to describe the sound isolation performance of materials. A higher STC rating indicates a greater sound dampening effect. Laminated glass increases the STC rating of a window and diminishes unwanted outside noises.

When combined with a hermetically-sealed IG unit, the acoustical benefits to your windows can increase. For maximum acoustical needs, Cardinal recommends a double-laminated IG unit. This will provide the greatest acoustical protection benefits along with the thermal efficiency characteristics of insulating glass.

Solar Spectrum in Nanometer (nm) Wavelengths



Solar energy transmitted through glass is categorized into three main regions: ultraviolet, visible and near infrared. Energy in the spectrum of 300 to 700 nanometers can cause fading of interior furnishings. This region includes all of the ultraviolet energy and most of the visible spectrum and is the best representation of relative fade rates. The balance of the spectrum is harmless with regard to direct fading.

Protect Your Home from Fading

Fabric, furniture and other materials fade and become discolored over time when portions of the solar energy spectrum enter a room. The potential fading reduction of solar energy through glass can be determined by a measurement called Damage Weighted Transmission (Tdw). The lower the value of Tdw the better the glass protects against fading.

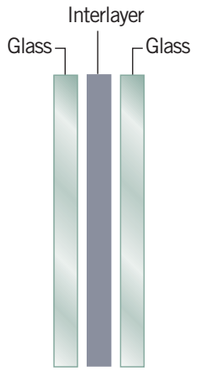
Single pane clear glass allows most of the UV and visible energy to come through into the room, offering very little protection. The Tdw of clear glass is 0.84.

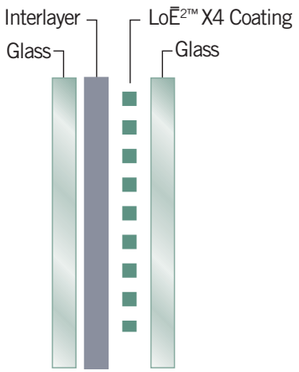
On the other hand, laminated glass provides a balance between visual aesthetics and interior protection. Laminated glass can block over 95% of the UV energy while allowing most of the visible light through. The composite performance is a Tdw of 0.66 – twice the fade protection of ordinary glass.

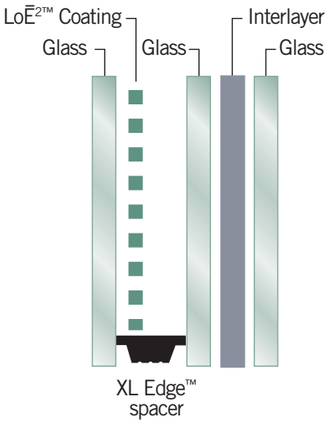
Houseplants respond only to visible light, so plant growth will not be affected when laminated glass is chosen for interior protection.

While no glass product can eliminate fading, Cardinal's laminated glass offers a clear glass appearance and enhanced protection against premature effects of faded carpeting and furniture.

Many Options







Monolithic LG

- Impact resistance
- Acoustical reduction
- Fade protection
- Optional Sea-Storm® rating

. . .with LoE²™ X4 coating

- Reduced solar heat gain (SHGC)
- Maximum fade resistance
- Optional Sea-Storm® rating

. . .with insulating glass

- Optimum performance (U-factor)
- Maximum sound control
- Optional Sea-Storm® rating

Flexible Design Choices

When combined with other technologies, the performance of laminated glass is greatly enhanced. Add our special LoE²™ coating for maximum solar heat gain protection, as well as increased fade resistance. For all around, full-year thermal performance, use laminated glass in tandem with our insulating glass system. This has the effect of augmenting the sound dampening characteristics of laminated glass, useful in areas of intense sound problems.

For whatever application you need, we have the necessary systems and processes. We can modify laminated glass to meet your requirements, rather than requiring you to make drastic changes to your window configurations in order to use it.

Conclusions

Performance Chart of Various Glass Configurations

GLASS CONFIGURATION	SOUND	FADE PROTECTION		AESTHETICS			THERMAL PERFORMANCE			
	STC	Tdw	UV	Visible light			SHGC	U-Factor	Glass Temp (F°)	
			Trans.	*Trans.*	*Reflectance*			*(Btu/hr/ft²/°F)*	*Indoor*	
					%OUT	%IN			WINTER	SUMMER
Monolithic - 1/8" thick										
3.0mm (1/8") Monolithic	27	0.84	0.71	90%	8%	8%	0.86	1.04	15	90
Laminated Monolithic - 1/4" thick										
with clear PVB (3.0mm - 0.030"- 3.0mm)	33	0.66	0.05	89%	8%	8%	0.80	1.00	17	95
with LoE² X4 coating (3.0mm - 0.030"- 3.0mm)	33	0.54	0.02	78%	8%	8%	0.59	1.00	17	101
with gray PVB (3.0mm - 0.030"- 3.0mm)	33	0.35	0.01	45%	5%	5%	0.64	1.00	17	107
Sea-Storm® (4.7 mm - 0.090" - 4.7 mm)										
with Clear PVB	35	0.59	<.01	85%	8%	9%	0.74	0.94	20	99
with LoE² X4 coating	35	0.47	<.01	72%	10%	10%	0.53	0.94	20	106
with gray PVB	35	0.29	<.01	39%	6%	5%	0.57	0.94	20	112
with gray PVB + LoE² X4 coating	35	0.23	<.01	33%	5%	8%	0.43	0.94	20	118
Insulating										
3/4" Clear IG (3.0mm - 13.0 - 3.0mm)	31	0.75	0.58	82%	15%	15%	0.78	0.48	44	90
3/4" LoE²-172 #2 (3.0mm - 13.0 - 3.0mm)	31	0.55	0.16	72%	11%	12%	0.41	0.25*	56	84
Laminated Insulating (3/4" IG)										
3.0mm - 9.8 - 1/4" Lami	35	0.60	0.04	81%	15%	15%	0.74	0.49	43	99
3.0mm - 6.5 - Sea-Storm®	34	0.54	<.01	78%	15%	15%	0.71	0.52	42	105
3.0mm LoE²-172 #2 - 9.8 - 1/4" Lami	35	0.49	0.02	71%	11%	12%	0.41	0.26*	54	89
3.0mm LoE²-172 #2 - 6.5 - Sea-Storm®	34	0.45	<.01	68%	11%	12%	0.41	0.32*	52	92

= Hurricane rated

1) All data is glass only. 2) Calculated from Window 5.2 with NFRC 100-2001 Conditions.
3) Indoor glass temperatures are for the center portion of the glass.
*U-factor assumes 90% argon fill (10% air).

The purpose of this table is to help balance the individual needs of safety, aesthetics, thermal performance and other factors. The table compares laminated glass against the performance of non-LG configurations. This represents a sample of possible configurations and merely reflects some of the major elements in glass selection.

DEFINITIONS:

Sound Transmission Class (STC) - The average value connected with the effective sound reduction of a material. The higher the number, the better a window is at reducing sound.

Fading Transmission (Tdw) - The amount of solar energy that enters a building and can cause fading of interior furnishings (spectral region is 300 to 700 nanometers). This region includes all of the ultraviolet energy and most of the visible spectrum and is the best representation of relative fade rates.

Ultraviolet Transmission (UV) - The amount of solar energy that enters a building in the invisible spectrum defined as ultraviolet (spectral region is 300 – 380 nanometers). The use of UV transmission values does not adequately represent the potential of a glass product to reduce fading.

Visible Light Transmission - The amount of solar energy that enters a building as light (spectral region is 380 – 760 nanometers).

Visible Light Reflectance – The percentage of light (spectral region is 380 – 760 nanometers) that is reflected from the glass.

Solar Heat Gain Coefficient (SHGC) - The amount of solar energy that enters a building as heat (spectral region is 300 - 2500 nanometers). The smaller the SHGC value the better the glass is at reducing air-conditioning loads.

U-factor - This represents the heat flow rate through a glazing system expressed in BTU/hr/ft²/°F, using winter weather conditions of 0°F outside and 70°F inside. The smaller the number, the better the window system is at reducing heat loss.

The Right Choice for Protection

Cardinal is committed to providing superior laminated glass to the residential window market. For window manufacturers, Cardinal has the experience and production capability to meet all of your stock and custom laminated glass needs.

The requirements for each laminated application can vary greatly. That's why we have built systems to deal with the intense demand and short lead times that have been a historical challenge with other laminated glass manufacturers. We are flexible in offering configurations that also match the need for custom shapes and sizes, as well as a variety of tints. We can provide you high quality laminated glass quickly and accurately.

For window buyers, it is very important to consider security and safety as a factor in your purchasing decisions. In order to benefit from the protection of Cardinal's line of laminated glass products, please see your building professional, architect or window manufacturer.

Working alongside you to defend the things that matter most, Cardinal's laminated glass is built to protect.

Cardinal IG
Company

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