



Safety Performance



Designing for Safety

The primary goal of safety glazing is to protect people from accidental glass impact, breakage or fallout. When broken, ordinary glass windows can cause serious injury. Laminated glass, however, can both prevent bodily injury and protect the building envelope. Safety glazing incorporating Saflex protective interlayers in a properly designed and installed system reduces the risk of injury from broken glass. Upon impact, the glass firmly bonds to the interlayer and remains in place, providing protection from dangerous flying or falling glass fragments.

Laminated glass made with Saflex interlayers is an ideal choice for applications where safety glass is required including curtain walls, overhead glazing, windows and doors, skylights, shower enclosures, railings and more.

Meeting safety codes and standards. Laminated glass made with Saflex protective interlayers effectively meets all established North American building code requirements for safety glazing. Performance requirements are determined by the particular application and the glazing area:

- › CPSC 16FR 1201 Category I Performance
- › CPSC 16FR 1201 Category II Performance criteria
- › Underwriters Laboratories' UL972 Standard for Security Glazing
- › Class 1 of the ASTM International's F1233 Security Glazing Test Standard.

Overhead and sloped glazing. Laminated glass made with Saflex interlayers can help address the special safety requirements presented by sloped and overhead glazing applications. When laminated glazing is impacted, glass fragments tend to adhere to the interlayer, helping to maintain the system's integrity. Because of these proven retention characteristics, laminated glass made with Saflex protective interlayers meets the performance requirements for sloped and overhead glazing as stated in U.S. and European model building codes.



Laminate Specification Data

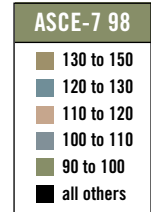
GLAZING		SAFETY		SECURITY		
Nominal Overall in. (mm)	Unit Configuration, in.	CPSC Cat. I	CPSC Cat. II	ASTM F1233	UL 972	Blast Rst.
MONOLITHIC (SINGLE LITE GLASS)						
1/4 in. (6 mm) Annealed		—	—	—	—	—
1/4 in. (6 mm) Tempered		•	•	—	—	—
LAMINATED (GLASS – SAFLEX PVB – GLASS)						
1/4 in. (6 mm)	1/8 in. – 0.015 in. – 1/8 in.	•	—	—	—	—
1/4 in. (6 mm)	1/8 in. – 0.030 in. – 1/8 in.	•	•	—	—	•
1/4 in. (6 mm)	1/8 in. – 0.060 in. – 1/8 in.	•	•	•	•	•
1/4 in. (6 mm)	1/8 in. – 0.090 in. – 1/8 in.	•	•	•	•	•



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This map indicates the wind speeds in the ASCE 7 standard that tend to govern the ASTM impact standards.



Designing for Hurricanes

Hurricane and storm protection. The severe and complex nature of hurricane winds creates special challenges for buildings. When wind-borne debris breaks glass windows and doors, the building's protective exterior "envelope" is compromised, allowing strong winds to rush into the structure. These trapped wind forces then exert upward pressure on the roof and outward pressure on exterior walls, and can eventually cause total destruction.

While no single product offers complete protection from hurricanes, typhoons and violent storms, laminated glazing using Saflex protective interlayers can be a critical first line of defense. In properly designed systems, laminated glass effectively withstands these forces to help maintain the critical exterior envelope. If broken by impact from wind-borne debris, the glass fragments bond firmly to the protective interlayer, continuing to safeguard building occupants and contents.

Properly designed window and door systems manufactured with laminated glass have proven successful in meeting major building codes and test standards such as the Florida Building Code, including the High Velocity Wind Zone (Dade County), International Building Code, American Society for Testing and Materials (ASTM) and Texas Department of Insurance. While certain other protection methods such as storm shutters also meet many standards, laminated glass using Saflex protective interlayers offers continuous passive protection to a building's structure, contents and inhabitants without the need for storing and properly installing unwieldy shutters or storm screens.

Designing for Essential Facilities: Level E Protection

While most hurricane-related building codes are designed to protect homes and businesses during a hurricane, experts still advise people to evacuate. A tough building standard known as ASTM E1996 "Level E" was designed to protect essential facilities like hospitals, emergency shelters and institutions, where the people inside usually do not have an option to evacuate. However, until now, there were few solutions available for achieving Level E. Those that were available were so costly that they were often value-engineered out of the plans.

In early 2008, Saflex introduced a hurricane interlayer system that could meet Level E in a single piece of laminated glazing. The new Saflex Level E hurricane solution uses a combination of Saflex's most powerful interlayers, laminated between two pieces of glass under heat and pressure. The resulting piece of glass looks and functions like a single piece or ordinary glass but is stronger and tougher than even standard laminated glass. It's a convenient and cost-effective for architects and building owners who demand the highest level of protection.

Find more information about designing for hurricane protection by visiting www.saflex.com/hurricane

Extreme Wind & Impact – Glass Constructions		
MISSILE	CODE/STANDARD	GLASS CONFIGURATION
Large	FBC TAS 201/3 Dade	Glass – 2.29 mm (0.090") Saflex – Glass Glass – 2.54 mm (0.100") Saflex HP – Glass Glass – 1.91 mm (0.075") Vanceva VS O2 – Glass
Large	SBCCI Apdx SSTD-12	Glass – 2.29 mm (0.090") Saflex – Glass Glass – 2.54 mm (0.100") Saflex HP – Glass Glass – 1.91 mm (0.075") Vanceva Storm – Glass
Large	ASTM E1996	Glass – 2.29 mm (0.090") Saflex – Glass Glass – 2.54 mm (0.100") Saflex HP – Glass Glass – 1.91 mm (0.075") Vanceva Storm – Glass
Small	FBC TAS 201/3 Dade	Glass – 1.52 mm (0.060") Saflex* – Glass
Small	SBCCI Apdx SSTD-12	Glass – 1.52 mm (0.060") Saflex* – Glass
Small	ASTM E1996	Glass – 1.52 mm (0.060") Saflex* – Glass

* Typical minimum gauge interlayer for indicated performance. Large missile automatically qualifies for small missile applications. Glass thickness and type determined by use of ASTM E 1300.

Designing for Earthquakes

Seismic protection. In earthquake-prone regions, glazing systems using laminated glass made with Saflex protective interlayers can provide a high degree of safety. Highly resistant to the rocking motions of an earthquake, laminated glazing systems help protect building occupants and pedestrians from injury caused by falling glass and help maintain the integrity of the building envelope to keep the structure secure and weather-tight.





Security Performance

Designing for Security

The desire for living and working in open, sunlit, glass-clad buildings has come face-to-face with the need to assure that building structures provide occupants with optimal security. Properly designed and installed laminated glazing systems made with Saflex interlayers can provide remarkable protection from forced entry, bomb blasts and ballistics.

Designing for personal and facility security. Products constructed from laminated glass are referred to as security glazing and are designed to withstand the complex dynamic structural loads resulting from intentional impact or assault. Since burglaries, forced entries or ballistic attacks are often targeted toward the easiest opportunity and lowest perceived risk, the presence of laminated security glazing made with Saflex interlayer may be enough to thwart an attack.

Laminated architectural glazing made with Saflex interlayer provides a significant improvement over monolithic glass products in resistance to forced entry and is capable of passing Underwriters Laboratory Burglary Resistance Test UL 972, ASTM F1233 Standard Test Method for Security Glazing Materials and Systems and EU norms.

Within the glazing industry, security design generally falls into three broad categories: burglary / forced entry, bomb blast, and ballistics. Each category requires special design criteria for glazing systems as detailed below.

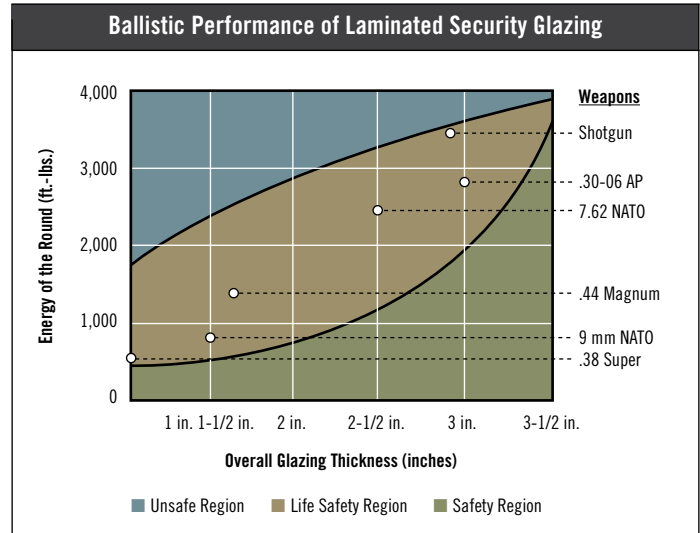
Burglary and forced entry and forced exit resistance In designing to resist burglary or forced entry, the entire glazing system – not just the glass panel – must be designed to withstand an attack. In institutional settings, laminated glass can provide the needed time delay to allow added security or authorized personnel to arrive on scene and adequately address a situation without creating potential danger for other inmates or clients. Generally, security products with the greatest overall thickness and the largest percentage of Saflex or Vanceva protective interlayers deliver the best resistance to forced entry as required by the American Society for Testing and Materials class rating ASTM F12233 Class I, II and III.

Typically, laminated glass made with Saflex protective interlayers is strong enough to deter and discourage an opportunistic, “smash-and-grab” burglar. Since laminated glass cannot be cut from only one side, even quiet glass cutters become a useless burglary tool. Standard laminated glass made with 1.52 mm thick (0.060 inch) interlayer provides significantly improved resistance to attack from handheld weapons compared to ordinary monolithic glass products – even those that are strengthened.

Designing for Security in Residential Applications Window and door systems made with Saflex interlayer are unique products that meet a range

of home safety and security standards. Made with a tough protective interlayer laminated between two sheets of glass, these window and door systems even stand up to repeated blows from bricks, bats, hammers and crowbars. Plus, they filter out up to 99% of UV rays* that can contribute to the fading and degradation of home furnishings. They also can reduce the perception of irritating outside noise up to 50% more than ordinary window glass. *Up to 380 nanometers

Ballistic protection. Security glazing incorporating the appropriate configuration of laminated glass made with Saflex interlayers offers effective ballistic protection. Constructed in multiple alternating layers of glass and interlayers, laminated glass has been shown to withstand penetration by high-velocity bullets and reduce injuries from ballistic attack – without compromising the clear-vision benefits of a glass system.



Notes: The minimum thickness of laminated security glazing required to prevent penetration of a single incoming round from a particular weapon is strongly dependent upon details of the security glazing construction, including number and thickness of individual plies, type of glass, and type and thickness of interlayer. The curve shown should be considered illustrative only. The horizontal lines indicate the energy of individual rounds fired from test weapons. The left end of each line represents an actual test point for a specimen which exhibits life safety value. Note that 1-inch thick monolithic glass, regardless of heat treatment, will not resist penetration by a single round fired from any of the weapons listed on the chart. The data presented are based on samples tested and are not guaranteed for all samples or all circumstances which may vary from those present during testing.

Bomb blast resistance. According to experts, approximately 75 percent of all damage and injury from bomb blasts results from flying and falling glass following an explosion. Security glazing using laminated glass made with Saflex interlayers substantially reduces injury, decreases the extent of damage and the cost to repair targeted and surrounding facilities, and reduces the opportunity for looting. In new building design or retrofit of existing windows, blast-resistant glazing systems withstand both the initial blast wave from the explosive event as well as debris that may impact the glazing, and reduce or eliminate flying glass to protect nearby non-targeted buildings.



Structural Performance

Designing for Structural Stability

Current architectural design trends are driving the increased use of glass in building design. As a result, architects and designers need glazing products that can help them bring more natural light into a building without sacrificing structural integrity. Laminated glass made with Saflex interlayers helps create solutions for a variety of glazing performance needs and aesthetic design goals.

Among the many demands placed on construction projects today, two basic requirements remain constant. The building and all its components must be structurally sound and must keep weather elements from entering the building. A breach in the building envelope can result in a range of undesirable and often dangerous outcomes – including internal pressure, exposure of occupants to wind and rain, damage to building contents and disruption of business. Laminated glazing systems made with tough Saflex interlayers can meet structural codes and building standards in applications such as insulated glass units, overhead glazing and glass floors.

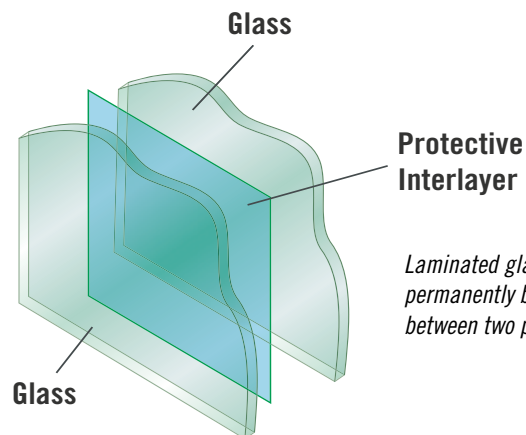
Insulating glass units. In an insulated glass unit, the lites share the load equally so long as the lites are the same type (annealed, heat-strengthened or fully tempered) and thickness, and are relatively thin. Otherwise, load sharing will be unequal and must be calculated to determine the strength of the unit. Insulating units can use laminated lites in one or both glass positions. When laminated glass is used as only one lite of an insulating system, in most applications the laminate should be placed toward the building interior. For optimum protection of occupants and passersby, the use of double laminated units should be considered.

Overhead glazing. As defined by the three model building codes, overhead glazing is glass that is positioned over space that may be occupied by humans. In these applications, the codes prescribe laminated glass for either a single lite or the lower lite in an insulating glass unit – although other products are allowed provided post-breakage controls are in place, such as mesh under tempered glass. Overhead glazing should not be exposed to the weight of a person and should be designed to discourage people from walking on glass surfaces.

Glass floors. Laminated glass floors are popular today, and calculations for floor loads can be found in the model building codes. In designing glass floors (walking surface of floors, landings, stairwells and similar locations) for human and other loads, it is generally recommended that architects and designers use the following criteria:

- Laminated glass should have a minimum of three plies and should be capable of supporting the total design load with any one ply broken.

- Surface damage caused by people or objects placed on glass can significantly reduce the strength of glass (subjecting it to breakage under subsequent loads) and should therefore be considered in the design.
- Glass floors may be subject to conditions that make them slippery or targets of high-pressure or -impact loads. The surface of the glass and the application areas should be given special consideration during design.



Additional Benefits of Laminated Glass

In addition to the proven safety and security capabilities, Saflex®, Saflex HP® and Vanceva Storm® interlayers deliver all the other benefits inherent in laminated glass:

- **Acoustic:** Reducing the transmission of unwanted sound into a building's environment.
- **Solar:** Filtering more than 99 percent of UV rays, controlling visible light radiation & reducing heat build-up & thermal stress.

In addition, Saflex interlayers are available in a range of earth- and sky-tone shades, enabling architects to specify laminated glass to match industry standard tinted glazing. Interlayers are also available in a range of translucent whites that can be used alone or combined with Saflex standard colors to create a broad array of hurricane performance and aesthetic designs.

For additional information regarding designing for safety and security protection using Saflex interlayers including technical information visit:

www.saflex.com/fabricators