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ENHANCE YOUR VISION

Security glazing

with Saflex™ PVB interlayers

EASTMAN

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A clear defense against modern threats

The trend toward using more glass for interior and exterior glazing has created visually compelling and innovative designs. But architectural glass requires special safeguards to ensure safety and performance and minimize injury and loss. That's because when ordinary glass windows break, dangerous or flying shards can result in serious injuries. Unlike monolithic glass, laminated glazing made with Saflex™ and Vanceva™ Color PVB interlayers reduce the risk of injury because glass adheres to the interlayer after impact — also protecting the building envelope.

Of course, glass isn't always broken by accidental or natural causes. Today's architects must also consider protection against manufactured and nefarious threats, such as forced entry and forced exit, ballistics and blasts.

In recent years, there has been a keen and growing interest in ways to protect people and property better, especially for educational, industrial and commercial building applications.

While no single product offers complete protection from intentional attacks, properly designed laminated glass systems made with Saflex PVB interlayers can be a critical line of defense. These strong, protective interlayers act to deter or delay attackers from gaining entry while protecting people and property from injury and damage.

Several ASTM International and industry test standards can evaluate glazing configurations with simulated burglary, forced entry, forced exit, and ballistic and bomb attacks.

- Ballistic-resistant glass laminates are normally constructed with multiple layers of glass and interlayers and tend to be greater than 30-mm (1.18-in.) thick.
- Blast-resistant glazing can be effective against common blast loads with laminates having as little as 0.76-mm (0.030-in.) Saflex Clear PVB interlayer; depending on blast loads and systems, more complex constructions may be required.
- Burglary and forced entries or forced exits commonly use repetitive blunt strikes or a combination of ballistic weakening and blunt impact attacks on the laminated glazing. These methods include reach and grab, reach for release, or full walk-through entry or exit. In reach-and-grab or reach-for-release attempts, an opening need only be big enough to allow a gloved hand to fit through and grab goods or release a latch to open a door or window. The glazing configurations needed for these types of attacks vary with the attack type but typically start with 1.52-mm Saflex Clear. Increased impact resistance requires greater thickness. Saflex composite interlayers, such as Saflex Storm PVB interlayers, allow for thinner layers to reach similar or higher performance levels of most standards.

Eastman has completed testing on various Saflex interlayer combinations according to common ASTM International security glazing standards and a nonconsensus standard, which is referenced in some parts of the industry. (See tables)

These tests are often performed by Eastman on glass only in a fixed or neutral frame. To achieve appropriate protection, the selection of the glass, glazing details and framing system are important. Glass specifiers should consider all risks, threats, vulnerabilities and facility designs to ensure optimal safety.

With regard to forced-entry attacks, refer to the following standard test results. ASTM F1233 and 5aa-1 are primarily anthropomorphically driven and, by the nature of that execution, are not as repeatable as the other tests (ASTM E2395, ASTM F3561, EN 356 and UL 972), which are mechanically driven (except level 5 of ASTM F2395).

Key benefits

- **Saflex PVB interlayer options for efficient security glazing thicknesses**
- **Configure to meet multiple forced-entry testing standards**
- **Design built-in resistance to entry or penetration in cases of man-made attacks**
- **Combine to achieve safety, structural, acoustic, solar and security performances with style**
- **Proven, durable interlayers for protective confidence in various building structures**

ASTM F3561

Standard Test Method for Forced-Entry-Resistance of Fenestration Systems After Simulated Active Shooter Attack

Active shooter glass testing consists of preweakening glazing using 10 shots with 556 M193 bullets, followed by escalating impacts with a 45-kg (100-lb) torpedo-shaped impactor. The standard consists of levels 1 through 8, with 8 being the highest. This is not a ballistic resistance test as the bullets are used to preweaken the glass and are anticipated to pass through.

Interlayer	Interlayer thickness mm (in.)	Overall laminate thickness mm (in.)	Accumulated impact energy J (ft*lbf)	ASTM F3561 level
Saflex Clear[1]	0.76 (0.030)	7.11 (0.280)	136 (100)	1
Saflex Clear[1]	1.14 (0.045)	7.49 (0.295)	136 (100)	1
Saflex Clear[1]	1.52 (0.060)	7.87 (0.310)	407 (300)	2
Saflex Storm VS	1.96 (0.077)	8.31 (0.327)	813 (600)	3
Saflex Clear[1]	2.29 (0.090)	8.64 (0.340)	813 (600)	3
Saflex Clear[1]	3.05 (0.120)	9.40 (0.370)	1356 (1000)	4
Saflex Storm VS*2	3.91 (0.154)	10.26 (0.404)	3796 (2800)	7
Saflex Clear[1]	4.57 (0.180)	10.92 (0.430)	3796 (2800)	7
Saflex Storm VS-R_{30}-VS[4]	4.67 (0.184)	11.02 (0.434)	4881 (3600)	8
Saflex Storm VS-R_{60}-VS	5.44 (0.214)	11.79 (0.464)	4881 (3600)	8

ASTM F1233

Standard Test Method for Security Glazing Materials and Systems

This test method involves the physical attack by specifically detailed assailants yielding a variety of tools that are used in a precise order to attempt entry through the glazing. The tests were run in two ways. The first included glass — not preweakened by ballistic attack — while the second included ballistically weakened glass (struck by three 9-mm bullets), followed by attacks using various tools. The tools were of the following sequence: hammer (level 1.0 – 1.1), hammer and sledge (level 1.2), CO_2 fire extinguisher (thermal/cold) (level 1.3), large sledge (level 1.4) and torch (level 1.5). Units must complete the entire sequence to pass a given level. The tables are laid out by increasing performance first followed by interlayer thickness. All glass was 3 mm (0.125 in.) annealed.

Tool attack on glazing — no ballistic weakening

Interlayer	Interlayer thickness mm (in.)	Ballistics	Level @ contraband passage	Class achieved — body passage					
				1.0	1.1	1.2	1.3	1.4	1.5
Saflex Clear[1]	1.52 (0.060)		No rating[2]	✓	✓				
Saflex Clear[1]	1.91 (0.075)		No rating	✓	✓				
Saflex Clear[1]	2.29 (0.090)		1.0	✓	✓	✓			
Saflex Storm VS	1.97 (0.077)		No rating	✓	✓	✓			
Saflex Storm VS*2[3]	3.89 (0.154)		1.2	✓	✓	✓	✓		
Saflex Clear[1]	4.58 (0.180)		No rating	✓	✓	✓	✓		
Saflex Storm VS-R_{30}-VS[4]	4.68 (0.184)		1.4	✓	✓	✓	✓	✓	
Saflex Clear[1]	6.84 (0.270)		1.4	✓	✓	✓	✓	✓	✓

Ballistic weakening prior to tool attack

Interlayer	Interlayer thickness mm (in.)	Ballistics	Level @ contraband passage	Class achieved — body passage					
				1.0	1.1	1.2	1.3	1.4	1.5
Saflex Storm VS	1.97 (0.077)		N/A (bullet)[5]	✓	✓				
Saflex Clear[1]	2.29 (0.090)		N/A (bullet)	✓	✓	✓			
Saflex Clear[1]	4.58 (0.180)		N/A (bullet)	✓	✓	✓	✓		
Saflex Clear[1]	6.84 (0.270)		N/A (bullet)	✓	✓	✓	✓		
Saflex Storm VS*2	3.89 (0.154)		N/A (bullet)	✓	✓	✓	✓	✓	

Test protocol 5AA-1

Certification standards for retrofitting and reinforcing of standard commercial entry systems, windows and glazing

This test method involves a ballistic attack using a 7.62-mm NATO projectile followed by attacks from thrown bricks, kicking and blunt tool impact. This timed test is carried out anthropomorphically. There is no mechanical impact after the ballistic rounds are fired. Time results and level of performance repeatability cannot be guaranteed due to the high variability of the test. The results are indicative of the specimens only as tested and are meant to serve as a guide. All laminates were assembled with nominal 3-mm (0.125-in.) annealed glass unless noted.

Interlayer	Interlayer thickness mm (in.)	Class achieved						
		7.62 NATO 147 grain; 5 shots	20 bricks	10 kicks	Claw hammer, wrench and lumber (2 min)	Sledge and bat (3 min)	12-lb sledge	Time (min)
Saflex Clear	2.29 (0.090)	✓	✓	✓	⊗			> 2 min
Saflex Clear[1]	4.58 (0.180)	✓	✓	✓	✓	⊗		< 5
Saflex Storm VS	1.97 (0.077)	✓	✓	✓	⊗			> 1
Saflex Storm VS*2[3]	3.89 (0.154)	✓	✓	✓	✓	⊗		< 4
Saflex Storm VS-R_{60}-VS	5.42 (0.214)	✓	✓	✓	✓	✓	⊗	> 8
Saflex Storm VS-R_{60}-VS*	5.42 (0.214)	✓	✓	✓	✓	✓	⊗	> 10
Saflex Storm VS*3	5.87 (0.231)	✓	✓	✓	✓	✓	⊗	> 7

⊗ *indicates penetration of the test object was achieved during this level.*

[1] *The performance of Saflex Clear may be indicative of the performance of other non-composite Saflex PVB interlayers. Consult your Saflex applications industry support representative for more information or visit saflex.com.*

[2] *No rating indicates contraband passage; an opening 3 mm (0.125 in.) or greater was formed before level 1.0 was achieved.*

[3] *Interlayers designated with * followed by a number indicates the number of layers, i.e., VS*2 indicates two layers of VS02.*

[4] *R with a subscript indicates a layer of Saflex Clear R series interlayer in the gauge (thousandths of an inch) indicated, i.e., R30 = Saflex Clear 0.76 mm (0.030 in.) or 30 gauge.*

[5] *N/A (bullet) indicates that a 3-mm (0.125 in.) hole was immediately present in the interlayer due to the ballistic round penetration and not rated as part of the forced entry sequence using the tools.*

ASTM E2395 and UL 972 performance

Level 5 per ASTM E2395 and compliance to UL 972 can be achieved with Saflex Clear[1] PVB interlayer in 1.52 mm (0.060 in.) or greater thickness or Saflex Storm/Secure in 1.191 mm thickness when laminated with a minimum of 3-mm (0.125-in.) annealed glass.

ASTM E2395

Standard Specification for Voluntary Security Performance of Window and Door Assemblies with Glazing Impact

This test system requires the fenestration to obtain at least a minimum rating in accordance with frame-forced entry tests ASTM F476, F588 or F842 followed by glazing impacts that are meant to simulate striking of the glazing. Repeatable impacts are done by propelling ball bearings or 2 x 4 dimensional timbers from an air cannon. The weight of the missile increases with each higher level until the 1.7-kg (4.5-lb) missile is used. To achieve the highest level (level 5), the impacts are followed by 10 strikes with a hammer in the compromised corner of the glazing.

UL 972

UL Standard for Safety for Burglary Resisting Glazing Material

This test assesses the impact resistance of glazing by multiple ball-drop impacts meant to simulate striking to gain access or entry for purposes of burglary.

EN 356

European standard glass in building security glazing — testing and classification of resistance against manual attack

Test levels P1A through P5A of this standard use a ball-drop impact, while levels P6B through P8B use a mechanized axe swing at the glass. Data are suggestive and based on experience in working with our laminating partners. Actual configurations vary based on the fabricator's assembly preference. Asymmetrical constructions may have increased performance capability over the examples shown. In no case should these configurations be offered without the proper testing and certification of the laminated glass configuration by an authorized body. The following table gives typical examples of potential configurations needed to pass various levels of EN 356; however, actual testing may vary.

EN 356 typical configurations

Interlayer	Class achieved	Thickness of interlayer between each glass layer mm (in.)	Number of glass layers			
			Glass 1	Glass 2	Glass 3	Glass 4
Saflex Clear[1]	P1A	0.38 (0.015)	3	3	–	–
	P2A	0.76 (0.030)	3	3	–	–
	P3A	1.52 (0.060)	3	3	–	–
	P4A	1.52 (0.060)	4	4	–	–
	P5A	2.29 (0.090)	4	4	–	–
	P6B	1.52 (0.060)	4	4	4	–
	P7B	2.29 (0.090)	6	6	6	–
	P8B	2.29 (0.090)	5	5	5	5

[1]*The performance of Saflex Clear may be indicative of the performance of other non-composite Saflex PVB interlayers. Consult your Saflex applications industry support representative for more information or visit saflex.com.*

All data presented are relevant for the samples tested. Variability in nonmechanical tests yields results that should be used as a guide only. Interlayers are suggested based on results of testing only laminated glass; incorporating laminated glass into window, door and skylight frames requires further testing to validate achievable performance levels of the complete system.

The architectural industry trusts Saflex and Vanceva color PVB interlayers.

Since 1937, glass fabricators have counted on Saflex for high-quality products, reliable service and expert advice to help deliver world-class technology for laminated glass. Eastman architectural glazing products include Saflex PVB interlayers for laminated glass as well as Vanceva Color PVB interlayers. Architects and engineers are taking advantage of our products, which offer structural performance, over 69,000 colors, acoustic sound reduction and solar UV protection and provide the added benefits of safety, security and weight reduction inherent to the PVB when laminated between two pieces of glass.

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AI-ARCH-14254B 9/23