Saflex™ and Vanceva™ Security Glazing meeting ASTM F1233

The trend toward using more glass in building design has created opportunities to design for enhanced performance in many areas, but a concentration on safety and security are the current focus area for this document. Laminated glass, two or more pieces of glass held together by an interlayer, has long been used as safety glazing however certain configurations are also being designed for security applications. These glass units tend to have more penetration resistance capability than basic laminated safety glass and can range in performance from simple impact to multi-assault resistant glazing.

For interior and exterior glazing, special precautions against injury and loss must be considered. That's because ordinary glass windows can result in serious injuries when broken, causing dangerous flying, or falling shards. Unlike monolithic glass, however, laminated glazing made with Saflex™ and Vanceva™ Color PVB interlayers reduce the risk of injury because glass tends to adhere to the interlayer after impact—this ability for the laminate to break but stay essentially intact also adds to protecting the integrity of the building envelope.

Of course, glass can always be broken by accidental or natural causes. However, today's building and construction professional must also consider protection against manufactured threats, such as forced-entry and forced-exit, ballistics, and blasts—whether caused by nefarious sources or combustible industrial, materials during production or transfer.

While no sole product offers complete protection from intentional attacks, laminated glass with Saflex® PVB interlayers in properly designed systems 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. In recent years, interest has continued to grow rapidly especially regarding educational, industrial, and commercial building applications.

ASTM International F1233 test standard is used to evaluate glazing configurations with simulated forced-entry, forced-exit, and ballistic type of attacks.

Burglary and forced-entry or forced-exit attacks commonly use repetitive blunt strikes or a combination of ballistic weakening, followed by the blunt impact attacks on the laminated glazing. These methods are meant to simulate reach-and-grab, reach-for-release, or full walk-through entry or exit. In reach and grab or reach-for-release attempts, an opening only needs to be big enough to allow a gloved hand to fit through with little force, thus grabbing goods or releasing 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 PVB interlayer and grow in thickness when increased impact resistance is needed. Saflex composite interlayers, like Saflex Storm PVB interlayers, are able to be used as thinner layers to reach similar or higher performance levels than Saflex Clear PVB interlayer.

Ballistic-resistant glass laminates are normally constructed with multiple layers of glass and interlayers and tend to be greater than 30 mm (1.18 inch) thick.

Eastman has completed testing on various Saflex interlayer combinations according to ASTM F1233 **Standard Test Method for Security Glazing Materials and Systems.** These tests are performed on glass only in a fixed or neutral frame and are conducted on 3 mm (0.125 inch) thick annealed glass. To achieve appropriate protection, the selection of glass, glazing details and framing system are important as the performance of the glazed system as installed is what delivers the security protection. Specific risks, threats, vulnerabilities, facility design and placement are aspects of security that also need to be considered.

ASTM F1233 outlines a series of weapons and an attack methodology which is used to evaluate the forced entry resistance of glazing. These weapons are used in a specific sequence which are described through level 1.5 in Table 1. Table 2 shows the performance of select interlayer combinations in laminated glass when tested for forced entry only (no

pre-weakening by ballistic attack). Table 3 shows the performance of select interlayer combinations in laminated glass when tested for forced-entry after ballistic weakening of the glass with 3 shots from a 9-mm handgun.

Table 1: ASTM F1233 Test Sequence through 1.5

Sequence	Test Implements	Attack	Class Achieved
1	Ball Peen Hammer	10 strikes	1.0
2	Ball Peen Hammer	10 strikes	1.1
3	1.5-in. (4-cm) Diameter Pipe/Sledge	25 strikes	1.2
4	Extinguisher, CO2	1 minute	1.3
5	Sledgehammer	25 strikes	1.4
6	Propane Torch Flame	5 minutes	1.5

Table 2: ASTM F1233 Tool attack only on glazing – no ballistic weakening

Interlayer Description	Interlayer Thickness mm (inch)	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	1.27 (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	✓	✓	✓	✓	✓	✓

[1] The performance of Saflex Clear may be indicative of the performance of other non-composite Saflex PVB interlayers. Please consult your Saflex Applications Industry Support Representative for more information or visit www.saflex.com.
[2] No rating indicates contraband passage, an opening 3 mm (0.125 inch) 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., R_{30} = Saflex Clear 0.76 mm (0.030 inch) or 30 gauge.

Table 3: ASTM F1233 Ballistic Weakening prior to tool attack

Interlayer Description	Interlayer Thickness mm (inch)	Ballistic Weakening	Level @Contraband[2] Passage	Class achieved – Body Passage					
				1.0	1.1	1.2	1.3	1.4	1.5
Saflex™ Storm VS	1.27 (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)	✓	✓	✓	✓	✓	

Keywords: ASTM F1233, Ballistically weakened, forced entry, forced exit, laminated, Saflex, Security, Vanceva.

[5] N/A (bullet) indicates that a 3 mm (0.125 inch) 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.