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This guide has been prepared as a basic introduction to security glazing. It is by no means intended to be utilized for the interpretation of building codes, regulations, or statutes governing security glazing. Information contained herein is subject to change in accordance with manufacturer's product line updates as well as building industry regulations.

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Our technical manuals are prepared as tools designed to inform our customers of technical data as it relates to our products and services. It is our goal to help you make informed decisions when designing, specifying, ordering, installing, or maintaining Stiles products.

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Introduction to Security Glazing Products

Threat Resistance, Types, Testing Requirements & Technical Considerations

The use of security glazing products are world wide. In the United States, they are evident in such facilities as prisons, detention centers, research & development centers, communication centers, banks, law enforcement centers, hospitals, testing facilities, medical laboratories, industrial and chemical manufacturing plants, safe houses, safe rooms, armored vehicles and transports etc. The continued use and growth, especially when it comes to the "type" of facility utilizing these products continues to expand and change. This is due to the expanding number of multinational corporations, government involvement's internationally, and the escalating need for security related services. There isn't a sector in the business community that does not utilize some form of security products or services.

The 70's and 80's were two decades of technological breakthroughs for the security industry. The 90's has become a decade of finding the ways and means to interface those technological wonders and their multiple generation offspring into the real world. As physical security is increased, so too does the threat. The ability to breech security increases as more facilities "harden" themselves. The quickest growing breaching device being used today on a greater scale is the explosive device. Bombs or explosive devices are more readily chosen, as they cause instant damage and injury. Couple this with two additional important elements such as: (1.) the fear factor, as bombs are easily constructed and planted, usually often undetected; and (2.) the fact that the bomber does not need to be present when it is detonated, making it the ideal weapon and/or breaching device while decreasing the likelihood of identification.

In the United States the reported bombing incidents have soared by approximately 52% since 1990. The number of reported actual working bombs has also escalated from approximately 1.4 in 5 to 4 out of every 5; either located or detonated. However, property damage and threats to window and door glass units suffer the most from bombings, approximately 60 to 83% of the damages sustained from bombings is to the glass.

THREAT EXPOSURE

There are three threats that need to be examined with regard to window glass and glazing systems.
These are: Forced Entry Attacks, Ballistic Attacks, Explosive Blast Attacks.

Forced Entry Attacks are usually attributed to burglaries. Burglaries on a commercial scale can exceed millions of dollars, especially if the lost property is proprietary in nature or research & development advances. Forced entries can be of the "smash and grab" type to more sophisticated sustained assaults by multiple attackers with varied tools, times, and abilities. Forced entry attacks are of two types: The allowable entry or opening through which the stolen property or contraband may be passed, and an entry or opening of sufficient size to allow the quick passage of an entire body.

Ballistic Attacks are solely attributed to assaults from either handguns, shotguns or rifles. Predominately handguns and shotguns. The severity of loss is enormous in two respects - loss of life and property damage. Injuries from ballistic attacks are related to two performance capabilities of the glazing. First, the ability of the glazing to prevent total penetration of the impacting projectiles and the subsequent destruction and harm. And secondly, having the appropriate glazing necessary to stop the impacting projectiles from penetrating, and not allowing excessive spall from the rear (protected) side of the glass to impale those behind it. Injuries from facial lacerations to loss of vision to death have occurred from spall.

Explosive Blast Attacks are attributed to the deliberate or intentional acts of man. However, there are also industrial and chemical explosive blasts that occur from refineries, manufacturing plants, research & development facilities etc. There are four generalized damaging effects generated from explosive blasts: The primary cause, which is the shock or initial blast wave from the explosion. The secondary cause of damage being the impact from fragments of the encasement material. Third, the hot gasses and flame that ignite fires, burn victims and its subsequent damage. The last cause is the ground vibrations or "seismic loading" caused effects similar to that produced by an earthquake. Before we examine security glazing in detail, a few elements relating to exposure need to be addressed.

Glass by its nature is very fragile. It is that way because we want to see through it. Being fragile, glass and glazing products are totally unable to resist being cracked, broken, shattered and/or penetrated, depending upon its compositional make-up. Airborne glass fragments propelled during failure of windows and doors subjected to explosive effects are known to be a major cause of injuries and death. Glass that fails to prevent the penetration of one or more projectiles during a drive-by shooting incident, is known to be another major cause of injuries and death. Glass that fails to prevent unauthorized entry is a cause of property damage, theft, as well as injuries and/or death caused by the many violent activities associated with such criminal acts. These and other incidents can either be accidental or deliberate; i.e. terrorist bomb attacks, accidental chemical or industrial explosive blasts, workplace violence, earthquakes, hurricanes or gale force winds and their subsequent damage. Even more beleaguering to most businesses besides the total monetary losses which can be an attributing cause to spiraling insurance costs, is the negative publicity of a personal fatality or injury suit, which leads to reduced activity and ultimately income.

As buildings are frequently being designed to have large expanses of glass for aesthetic reasons, the risk to life from flying glass fragments and penetration has become heightened and of greater concern. Security glass units are in the realm of physical security measures a "cost effective, continuous passive physical deterrent", which in most cases is undetected until attacked. Security and safety are important to owners, occupants and visitors of any building or facility. Today, all prudent designers and security directors pay serious attention to the specific issues of security and safety - especially to those issues which are most apparent to the users of the facilities. With respect to Safety and Security, the two are distinguished by the following definitions.

SAFETY:
Provides for the reduction of the risk or occurrence of injury, loss or death from accidental or natural causes.

SECURITY:
Provides for the reduction of the risk or occurrence of injury, loss or death from the intentional actions of man.

Security considerations pertaining to glazing systems and components are determined by three factors:

1. **FUNCTION**
2. **AESTHETICS**
3. **AFFORDABILITY**

These factors are listed in the proper order as should be with any "Life Safety" product or component.

Codes and Testing Requirements

Building codes in the United States only require that glass units used in building structures be designed for "Dead Loading". This specifically means - wind loads, snow loads and human impact loads. These vary from state to state and county to county as certain locations regulate variances from the standard Uniform Building Code.

Glass is, however, not required by code:

1. To resist any burglary attempts - Forced Entry Resistance
2. To defeat projectile penetration - Ballistic Resistance
3. To defeat and maintain integrity from explosive effects - Blast Resistance

These require independent testing laboratories test methods and standards that subject glazing to these specialized classifications of attack.

Forced Entry Testing Requirements most widely accepted are the Underwriters Laboratories UL 972 and the American Standards Testing Methods ASTM F1233. These tests evaluate impact load testing as well as blunt tool impact, sharp tool impact, thermal stress and chemical deterioration. The various testing methods account for such variable factors such as the number of persons attacking, the various tools glass used, the various techniques and methods used with the varied tools as well as their sequence. And lastly the amount of time required to thwart the attackers from gaining any entry. A newly adopted mechanical test method, F1915, evaluates detention glazing and classifies products according to 15, 30, 60 and 90 minute categories.

Ballistic Resistance Testing Requirements most widely accepted are the Underwriters Laboratories UL 752, the National Institute of Justice Standard 0108.01 and the American Standards Testing Methods ASTM F1233. These tests evaluate ballistic impacts from handguns, shotguns and rifles, in single and variable multiple shot sequences. Some testing standards allow for an accepted amount of spall and other do not. (spalling is the exit of glass toward the protected side, regardless of projectile penetration).

Explosive Blast Testing Requirements are centered around the air-blast standard. The test protocol and procedures are defined by the American Standards Testing Methods standard ASTM F1642-96. This test standard is used as it effects the whole surface area of the test specimen, and can be reproduced without substantial variances. This standard is designed to test all glass and glazing systems including those fabricated with glass, plastic, glass - clad composites, laminated glass, glass/plastic glazing materials and film-backed glass. This test is usually conducted in a shock tube, but can also be in an open-air arena capable of accommodating the detonation of the types of explosives, charge weights, peak positive pressures, incident pressures, reflected pressures, encasement materials, stand-off distances and positive phase durations. But, the open-air arena atmospheric conditions cannot be as easily regulated as in the chamber. The other advantage of the shock tube test is that you can replicate secondary rebounding pressures and durations, more commonly associated with high-rise urban environments. However, the shock tube does have limitations, it can only test to the maximum amount of peak positive pressure testing capabilities of approximately 40 P.S.I., the open air arena can detonate virtually any size charge weight, thus delivering substantially large pressures. As of the printing of this article, no set explosive charge ratings, stand-off distances, explosive types, peak positive pressures, reflected pressures or phase durations have been established for standardization ... The end users must specify their requirements and have samples tested according to the parameters acceptable to themselves.

There are other testing agencies and standards available from government, military, independent laboratories and internationally, relating to each threat. As with all tests though, you need to use those that meet your needs and requirements from a practical use and liability containment focus.

Design Considerations

In the conceptual design stage or prior to the final security glazing requirements, architectural specifications must be considered. These are:

1. Weight bearing considerations of the structures framework and wall loading limits.

2. Nominal thicknesses for a specific type of glazing. Most ballistic rated all-glass units are substantially thicker than glass-clad or polycarbonate units. However, not all threat levels can be met with certain types of glass units due to their composition and structure. Additionally, other elements of exposure affect certain types of glass units such as ultraviolet exposure, chemicals, abrasion, extreme heat & cold temperatures, excessive variances in temperatures of over 50° during the day etc.

3. Window and door frame assemblies with regard to opening & closing accessories, i.e. hinges, latches, locks etc., as well as framing composites, stainless steel, steel, etc., need to meet the new weight and nominal thickness changes. These changes will need to be considered as load stress on the glass will be transferred to the framing, through them. If fixed, blast loading is directly transferred to the framing concept of the structure. The proper balance and selection of the glazing and glazing framing systems need to meet - not exceed the capabilities of the structure. Properly selected framing and working accessories need to be selected considering these as well as the aesthetics of the building design. Most often than not, this establishes the glazing choices, then financial capabilities will decide which style and glazing make-up. Examples of varied applications within a single facility could include wide variances that prohibit the same materials throughout. Take a building that houses the following types of security glazing requirements: multi-story glazing, interior curtain walls, atriums / solariums, display cases, money exchange / transaction areas, containment areas, storefront "style" exterior windows, decorative constructions etc. If a single building housed these, the complications would rise considerably. Now consider the applications in a multi-tenant high rise, museum, high end mall / business complex, multi-field medical complex, airport, zoo etc. Each has several of the above types of glass and glazing applications to consider.

4. There are lead times to consider. Most specialty glass units require from 4 to 8 weeks to manufacture. This also depends upon quantity, sizes, special shapes etc. In addition to that you have the lead times for the assembly of the framing concepts, unless your selection requirements allow for retrofit applications without removal of the existing frames. If so, this usually requires 1 to 3 weeks. Prior to any job acceptance, shop drawings, specifications and/or blueprints will be required for detail. If they need to be completed expect 1 to 2 weeks for completion, you also need to allow for drawing review and final changes. Specialized circumstances may be considered upon types, sizes and shapes of materials for quicker times. But, not without an additional surcharge!

5. Shipping. Allow from several days to over a month. Lead times will vary according to the sizes, weights and distances of the shipment.

6. Rated components: Rated framing concepts, accessories, glass / glazing components or completed assemblies need to be specified. Especially if required for codes, ordinances, insurance etc. Most insurance underwriters do not like to provide any insurance premium reductions without the assurance of a completely rated installation. This is especially true when dealing in "Life Safety" components and assemblies. Verify before selecting. Pricing differences can vary.

7. Other code requirements such as insulating factors need not be overlooked. Insulated glass units have their own set of particulars to deal with. Avoiding such requirements is not recommended. Heating and cooling transference - loses or gains are becoming more costly. Do not throw good hard earned money after bad. Design and specify correctly the first time! Remember, you are relying upon a Life Safety Product!

8. Matching threat resistance. The glass framing concepts need to fulfill and meet the same threat resistance as the glazing. There are frames specifically designed for: Ballistic resistance for various threat levels, Forced entry resistance for various threat levels, and Blast resistance by overall make-up and installation techniques.

Security Glazing Considerations

When selecting the appropriate security glazing for your installation, whether new or retrofit, consider that in addition to your primary requirement for selecting a specific security glazing, it should also meet three equally important secondary criteria:

1. The glazing should provide for excellent optical clarity with ease of maintenance over time.

2. The glazing should withstand a secondary threat requirement totally dependent upon the type of facility, location, and environmental concerns, both natural and created, etc.

3. The glazing should provide for a "Fail Safe" condition. Different types of glass and glazing systems can be broken, cracked, shattered or penetrated. However, the security glazing should not allow for excessive loss of the glazing on the rear or protected side, nor should it expose the protected side to subsequent environmental damage by having the building envelope breached. Good security glazing once attacked, although not pleasing to the eye, should provide for a limited barrier to keep people, wind, water and the elements from entering the building. Thus, protecting equipment, fixtures, furniture, coverings, merchandise etc., within the building. This will also preclude the need for an immediate "board-up".

The following pages will outline the basic types of glass utilized for safety and security applications (with the exception of Annealed glass that has been included as a "benchmark.")

Annealed Glass

Annealed glass is not a safety or security product. Commonly referred to a "plate" glass (in 3/16" or 1/4" thicknesses, and "double-strength" or "window glass" in 1/8" and 3/32" thicknesses). The term "annealed" is derived from the manufacturing process. Annealed glass can be factory or field cut. Annealed glass poses the greatest risk of human injury of any glass type, as the glass breaks into large, jagged shards and does not remain stable in the opening after breakage occurs. Most household windows, as well as commercial storefront glass is annealed (where code dictates such).

Annealed glass is available in a vast variety of textures and colors. Stained glass also falls into the "annealed" category. Laminated safety glass is produced by securing two lites of annealed glass together with a PVB interlayer.

BREAKAGE PATTERN

BREAKS IN RANDOM, JAGGED PIECES THROUGHOUT GLASS LITE

NO SAFETY ASPECTS - GREAT POTENTIAL OF INJURY

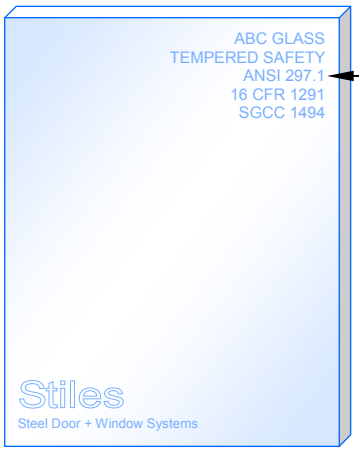
DOES NOT REMAIN IN TACT AFTER BREAKAGE

Tempered Glass

Tempered glass greatly increases impact resistance over standard annealed glass. It is about four times as strong as annealed glass. However, it is breakable. When it breaks, the surface tension created by the tempering process causes it to shatter into hundreds of small pieces, rather than the large jagged shards characteristic of annealed glass. Although it offers more breakage resistance than ordinary annealed glass, its applications have a safety rather than security orientation. Its major disadvantage is that once broken, the entire lite disintegrates.

Tempered glass can not be cut. A lite of annealed glass must first be cut to size and then tempered in a tempering furnace.

All tempered glass bears a small acid-etched label, usually found in the bottom right or left hand corner of the glass. This label, or "bug" as it is commonly called, signifies compliance to various standards. Tempered glass is used extensively in entrance doors, sidelites, shower doors, and automobile side glass. It is not required in transoms.



TEMPERED GLASS LOGO

ETCHED INTO GLASS TO SIGNIFY COMPLIANCE

FOUND IN BOTTOM CORNER OF GLASS LITES

BREAKAGE PATTERN

BREAKS IN UNIFORM, ROUNDED PIECES THROUGHOUT GLASS LITE

FAR LESS CHANCE OF INURY THAN ANNEALED GLASS

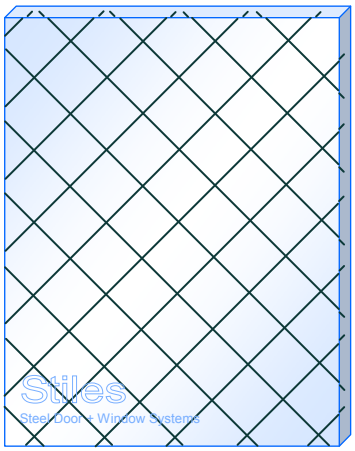
DOES NOT REMAIN IN TACT AFTER BREAKAGE

Tempered Glass Options		
STD THICKNESS	WEIGHT (lb / sq ft)	STD COLORS
1/8"	1.62	Clear Bronze Gray Blue / Blue Green Architectural Textures Patterned Glass
5/32	2.02	
3/16"	2.43	
1/4"	3.24	
5/16"	4.06	
3/8"	4.87	
1/2"	6.49	
5/8"	8.11	
3/4"	9.73	
1"	12.98	

Wire Glass

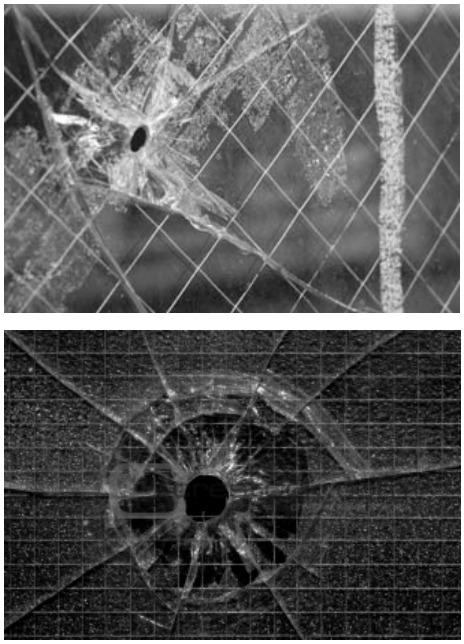
Primarily a safety product, wire glass is used extensively in fire rated doors. The wire mesh prevents the glass from shattering out of the frame during the intense heat of a fire. A disadvantage is that such lites have little or no impact resistance. This product is extremely dangerous in correctional facilities and psychiatric institutions, as it breaks easily, and, once broken, allows shards with exposed sharp wires to be used as weapons. This type of glazing does not hold up well in environmental areas that subject the glazing to heavy amounts of humidity and moisture or chemical exposure, as rust will eventual weep up the wire mesh between the laminations of the glazing, expanding and forcing outward eventually cracking the glazing. Full perimeter sealing of the glass lite during installation will prevent this type of failure.

Commonly available in 1/4" thickness, with either 1/2" or 3/4" mesh. Square or diamond wire patterns available, as is the option of either clear glass or obscure glass (smooth-rough finish). Wire glass meets the requirements of ANSI Z97.1-1984, but does not meet the impact requirements of CPSC 16 CFR 1201.



NOTE:
Due to the low impact resistance of wire glass, the 2003 IBC now has specific regulations pertaining to the use of wire glass in schools and athletic facilities, Visit www.iccsafe.org for information on the IBS.

Check your local, State, and Federal building codes prior to specifying or ordering wire glass.



BREAKAGE PATTERN

GLASS IS ANNEALED. BREAKS INTO LARGE JAGGED PIECES.

MOST GLASS PIECES REMAIN IN TACT AFTER BREAKAGE OCCURS.

Wire Glass Options		
STD. THICKNESS	DESCRIPTION	WEIGHT (lb / sq ft)
1/4"	Clear Polished Wire Glass, Square or Diamond Pattern	3.4
1/4"	Smooth-Rough Obscure Wire Glass, Square or Diamon Pattern	3.4

Heat Strengthened Glass

Heat strengthened glass increases the impact resistance over standard annealed glass, for the same given size and thickness. It is about twice as strong as annealed glass. It is more resistant to wind loading and impacts than annealed glass though less resistant than tempered. When broken, it fractures into large, jagged pieces similar to annealed glass, but normally somewhat smaller in shard size.

BREAKAGE PATTERN

SIMILAR TO ANNEALED GLASS. BREAKS INTO LARGE JAGGED PIECES.

GLASS PIECES DO NOT REMAIN IN TACT IN OPENING ONCE BREAKAGE OCCURS.

Chemically Strengthened Glass

Chemically strengthened glass increases impact resistance over standard annealed glass. It is also about 3-4 times stronger than annealed glass. However, it too is breakable. When it breaks, the surface tension created by the tempering bath process causes it to shatter into hundreds of small pieces, rather than the large jagged shards characteristic of plate glass, but larger than heat tempered glass.

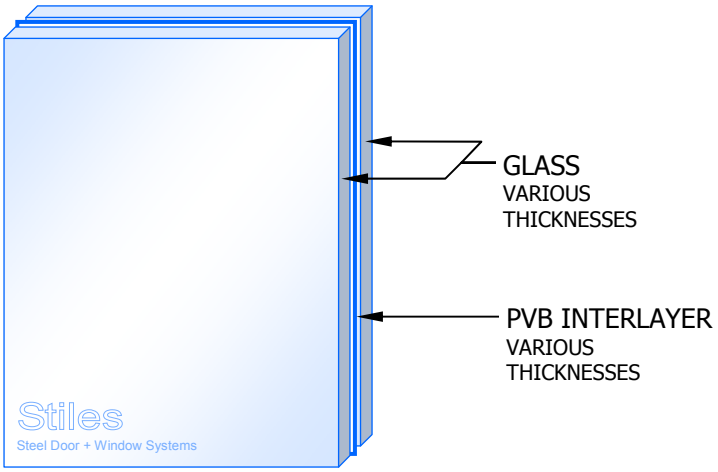
BREAKAGE PATTERN

BREAKS IN UNIFORM, ROUNDED PIECES THROUGHOUT LITE, SIMILAR TO TEMPERED GLASS.

FAR LESS CHANCE OF INURY THAN ANNEALED GLASS

Laminated Safety Glass

Used in automobile windshields, along with architectural applications. This glazing product is manufactured with either annealed and/or tempered glass and varying polyvinyl butyral (PVB) interlayers from .015 inches to .030+ inches thick. It comes in various thicknesses making it suitable for a wide variety of safety, limited security, and sound control applications.



BREAKAGE PATTERN

"COBWEB" OF BREAKS AT POINT OF IMPACT.

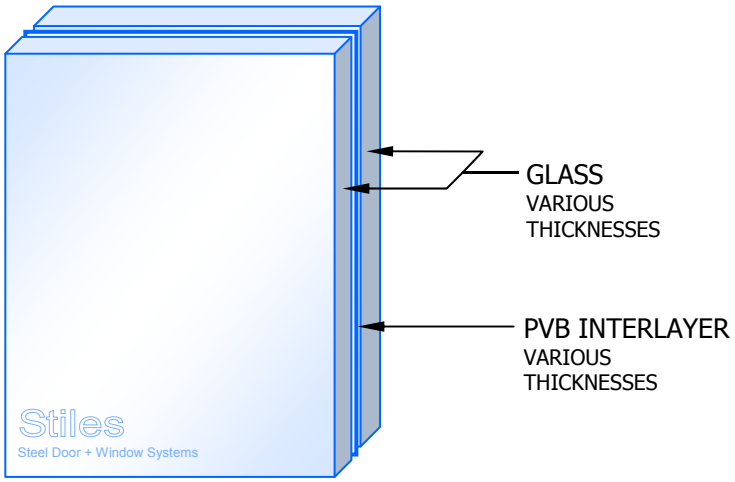
GLASS STAYS IN TACT IN OPENING DUE TO INTERLAYER.

Physical Security Options				
PROTECTION LEVEL	THICKNESS	CONFIGURATION (Glass - Interlayer - Glass)	WEIGHT (lb / sq ft)	STD COLORS
N/A	1/4"	Lami - 0.015 - Lami	2.93	Clear Bronze Gray Blue / Blue Green
N/A	1/4"	Lami - 0.030 - Lami	3.01	
N/A	1/4"	1/8" - 0.015 - 1/8"	3.33	
N/A	1/4"	1/8 - 0.030 - 1/8	3.42	
UL 972	5/16"	1/8 - 0.060 - 1/8	3.58	
UL 972	5/16"	1/8 - 0.090 - 1/8	3.75	
UL 972	3/8"	3/16 - 0.030 - 3/16	5.05	
UL 972	7/16"	3/16 - 0.060 - 3/16	5.21	
UL 972	7/16"	3/16 - 0.090 - 3/16	5.38	
UL 972	1/2"	1/4 - 0.030 - 1/4	6.67	
UL 972	9/16"	1/4 - 0.060 - 1/4	6.83	
UL 972	9/16"	1/4 - 0.090 - 1/4	7.00	
UL 972	13/16"	3/8 - 0.060 - 3/8	10.09	
UL 972	13/16"	3/8 - 0.090 - 3/8	10.26	

NOTE: 1/4" laminated safety glass does not meet UL 972 requirements.
All laminated safety glass meets CPSC 16 CFR 1201 and ANSI Z97.1
Laminated safety glass may require acid-etch labeling.

Burglar & Forced Entry Resistant Glass

Actually a thicker version of laminated safety glass, tested and rated by Underwriters Laboratories, according to standards set forth in UL 972. This glazing product is manufactured with annealed glass and varying polyvinyl butylral (PVB) interlayers from .060 inches to .090 inches thick, and is designed to prevent "smash and grab" burglaries. It does not offer prolonged physical attack resistance capabilities. Once attacked, the glass unit will become cracked and partial glass loss to either side may be noticed. The structural integrity, once the glass is cracked, becomes dependent upon the PVB interlayer composition and nominal thickness. Standard thicknesses include: 1/4", 5/16", 3/8", 7/16", 1/2", 9/16", and 13/16". Interlayer thicknesses include: 0.015", 0.030", 0.015", 0.060", and 0.090".



BREAKAGE PATTERN

"COBWEB" OF BREAKS AT POINT OF IMPACT.

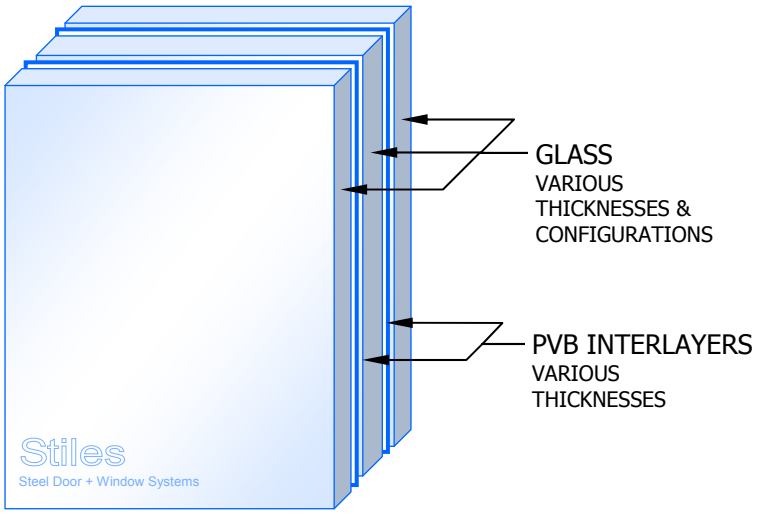
GLASS STAYS IN TACT IN OPENING DUE TO INTERLAYER.

Physical Security Options				
PROTECTION LEVEL	THICKNESS	CONFIGURATION (Glass - Interlayer - Glass)	WEIGHT (lb / sq ft)	STD COLORS
UL 972	5/16"	1/8 - 0.060 - 1/8	3.58	Clear Bronze Gray Blue / Blue Green
UL 972	5/16"	1/8 - 0.090 - 1/8	3.75	
UL 972	3/8"	3/16 - 0.030 - 3/16	5.05	
UL 972	7/16"	3/16 - 0.060 - 3/16	5.21	
UL 972	7/16"	3/16 - 0.090 - 3/16	5.38	
UL 972	1/2"	1/4 - 0.030 - 1/4	6.67	
UL 972	9/16"	1/4 - 0.060 - 1/4	6.83	
UL 972	9/16"	1/4 - 0.090 - 1/4	7.00	
UL 972	13/16"	3/8 - 0.060 - 3/8	10.09	
UL 972	13/16"	3/8 - 0.090 - 3/8	10.26	

NOTE: 1/4" laminated safety glass does not meet UL 972 requirements.
All laminated safety glass meets CPSC 16 CFR 1201 and ANSI Z97.1
Laminated safety glass may require acid-etch labeling.

Bullet Resistant All Glass Laminates

Very heavy and thick, (UL 752 listed materials are between 1-3/16” and 2-1/2" in nominal thickness), and are manufactured with multiple layers / configurations of annealed and / or tempered glass with polyvinyl butylral (PVB) interlayers from .015 inches to .090 inches thick. They can pass ballistic ratings and are not required to eliminate spall. Anti-spall film is often added to the existing already thick glazing on the rear or protected side. Once attacked the glass unit will become cracked and partial glass loss to either side may be noticed depending upon whether it is specified as non-spalling or low-spalling. Spalling is the exit of glass toward the protected side during an attack, regardless of projectile, blast, or forced entry penetration/access. Security glazing can defeat the threat and still allow spalling whether limited or not. Anti-Spalling requirements fall within two levels: Low Spalling (allowing for a limited amount of glazing loss - generally non-lethal), and non-spalling (allowing for no glazing loss within the specified threat level). The structural integrity, once the glass is cracked, becomes dependent upon the PVB interlayer composition and nominal thickness. This type of glass, once attacked with ballistic fire, offers minimal secondary security threat resistance.



BREAKAGE PATTERN

“COBWEB” OF BREAKS AT POINT OF IMPACT.

GLASS STAYS IN TACT IN OPENING DUE TO

Ballistic Options - All Glass Laminates		
UL 752 LEVEL	THICKNESS	WEIGHT (lb / sq ft)
1	1-3/16"	14.7
2	1-1/2"	19.3
3	2"	25.8
4	2"	25.8
5	2"	25.8
6	1-13/16"	22.6

Acrylic

Acrylics are lightweight synthetic materials with excellent optical clarity and a high degree of breakage resistance. They offer limited ballistic resistance. However, acrylic glazing materials are highly combustible thermoplastics, and as such, support flames and emit toxic fumes when burned. They are also extremely susceptible to a loss of clarity through scratching, gouging and (UV) ultraviolet exposure, unless "UV treated." Acrylics, once attacked, exhibit large cracking and loss of the acrylic material especially during ballistic or blast attacks. Acrylics can be laminated or installed as monolithic (single lite) glazing.

BREAKAGE PATTERN

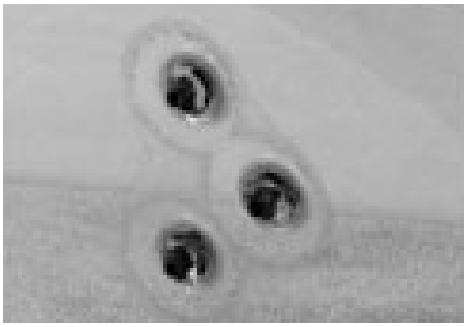
"COBWEB" OF BREAKS AT POINT OF IMPACT.

ACRYLIC DOES NOT REMAIN IN TACT AFTER BREAKAGE.

Ballistic Acrylic				
UL 752 LEVEL	THICKNESS	% LIGHT TRANSMISSION	WEIGHT (lb / sq ft)	STD COLORS
1	1-1/4"	90	7.7	Clear Bronze Gray
2	1-7/16"	90	8.6	
2	1-3/4"	90	10.8	
3	1-1/4"	85	7.7	

Polycarbonate

Polycarbonates are lightweight synthetic materials with 250 times the breakage resistance of equal thicknesses of plate glass with excellent optical clarity. They are available with Underwriters Laboratories ratings for burglar resistance or bullet resistance. Similar to acrylics, polycarbonates are susceptible to a lesser degree to scratching, gouging and yellowing from ultraviolet exposure. Mar resistant surfaces are available. They too are not fire resistant and emit toxic fumes when burned, but are much more difficult to ignite. Polycarbonates do offer the highest prolonged physical attack resistance available for glazing. Polycarbonates, once attacked, may show signs of slight de-lamination between layers directly surrounding a ballistic attack, and will encapsulate the bullet. But no other visual distortion or cracking will be evident. Forced entry attacks will show damage to the polycarbonate directly from the type of implement used, and blast attacks within the specified threat parameters will show possible signs of de-lamination, but no other signs of damage unless impacted by fragmentation or shrapnel. Sold extensively under the trade names Lexan® and Tuffak®, and others. Polycarbonate, when UV treated, will not “yellow” like many acrylics. When fired upon, bullet resistant polycarbonate will not ricochet the bullet or any bullet fragments. The bullet is captured entirely when fired at bullet resistant polycarbonate.



BREAKAGE PATTERN

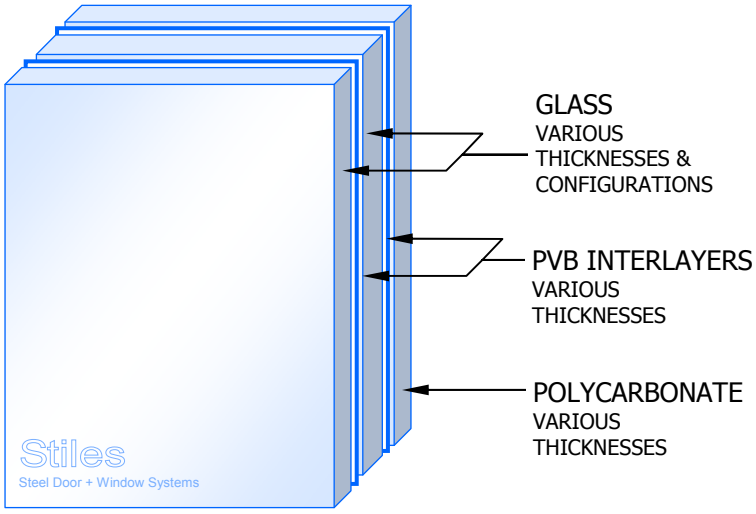
VIRTUALLY UNBREAKABLE. SCRATCHES OR DENTS. BULLETS LEAVE FLARED ENTRY POINTS - NO CRACKS.

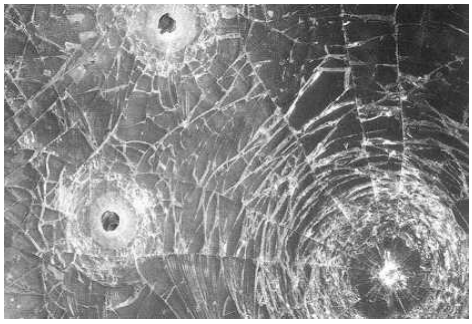
REMAINS IN TACT AFTER BREAKAGE.

Laminated Polycarbonate			
PRODUCT	UL 752 LEVEL	THICKNESS	WEIGHT (lb / sq ft)
Lexgard MP 750	1	3/4”	5.1
Lexgard MP 1000	2	1-1/16”	6.5
Lexgard XP 1250	3	1-5/16”	8.1

Glass Clad Polycarbonate

Glass Clad Polycarbonate is composite glazing made by either sandwiching a polycarbonate sheet between laminations of glass and polyvinyl butyral (PVB), or by laminating a sheet to the back side of laminated glass for forced entry resistance or as an anti-spall shield. The glass facings will exhibit cracking and some partial loss from an attack, while the polycarbonate cores will react as described in the "Polycarbonate" section.





BREAKAGE PATTERN

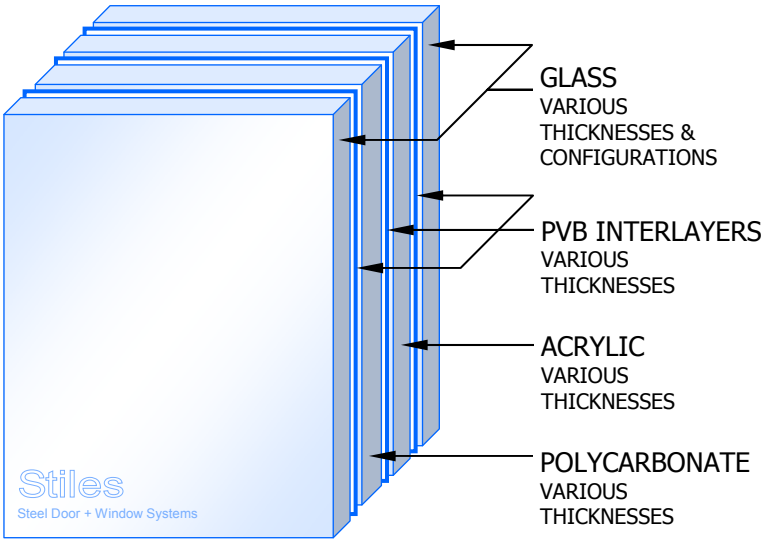
"COBWEB" OF BREAKS AT POINTS OF IMPACT.

REMAINS IN TACT AFTER BREAKAGE.

Ballistic Glass Clad Polycarbonate (With exposed polycarbonate on non-threat side)		
UL 752 LEVEL	THICKNESS	WEIGHT (lb / sq ft)
1	3/4"	7.14
2	15/16"	10.34
3	1-1/8"	12.19
4	1-1/4"	14.04
5	1-5/16"	15.89
6	1-1/4"	14.04
7	1-7/8"	22.22
8	2"	21.21

Return-Fire Composites

This is composite glazing made from a combination of glass, acrylic and polycarbonate sheets laminated together to provide for a clear glazing unit that can be utilized to return fire through the glazing as a last resort. This type of glazing will resist penetration from the threat side of the glazing, but allow for penetration of the glazing from the protected side towards the attack side with approximately a 20% loss in the exiting bullets velocity. Primarily designed for ballistic threats, this type of glazing offers additional resistance for forced entry, and explosive blast threats. Once attacked the polycarbonate, glass and acrylic act as normal depending upon the composition chosen. However, for the return fired rounds the exit facing of the glazing exhibits some loss toward the threat, otherwise subsequent attack resistance is offered by the compositions.



BREAKAGE PATTERN

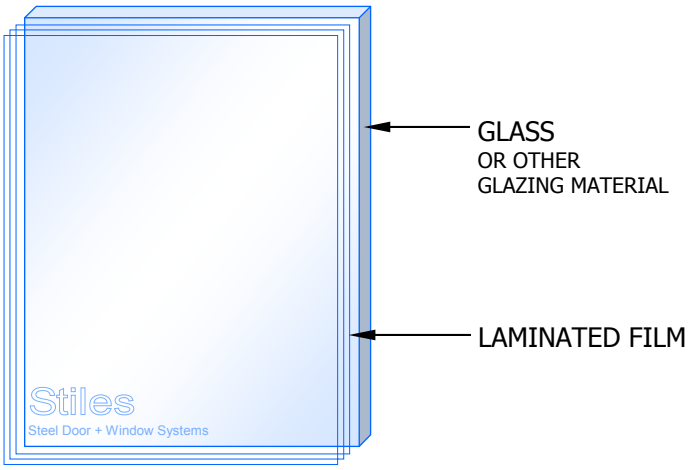
"COBWEB" OF BREAKS AT POINTS OF IMPACT.

REMAINS IN TACT AFTER BREAKAGE.

Return-Fire Ballistic Laminate Glazing			
UL 752 LEVEL	THICKNESS	% LIGHT TRANSMISSION	WEIGHT (lb / sq ft)
2	13/16"	89	4.3
2	15/16"	88	5.7
3 & 6	1-1/16"	87	6.3
7	1-5/8"	86	9.5
4 & 5	1-1/2"	75	15
8	2-5/8"	83	16

Security Laminate Films

Manufactured from several - usually three layers of polyethylene terepthalate (PET) and acrylic adhesives. The standard nominal thickness is 360 microns or 15 mil. Excellent optical clarity with a scratch resistant coating. They have ultraviolet (UV) resistance and have an Underwriters Laboratories UL 972 rating for burglar resistance. High technology security laminates offer varied explosive blast resistance on standard 1/4" inch thick annealed glass to 100 P.S.I. Dependent on the nominal thickness of the glass applied to, they offer limited ballistic resistance combined and excellent anti-spalling capabilities. They also offer tinting, coloring, solar control, EMI / RF damping and shielding and integrated alarm protection laminated inside. They are hard to ignite and are self- extinguishing when the flame is removed. Once attacked, the glazing that the laminates are attached to will crack or break according the type of glass used. Glass loss will be dependent upon the laminates adhesive elasticity and hardness capabilities. If the adhesives harden during the curing process, glass loss will be evident, if the adhesive id designed not to harden then minimal loss will be evident up to the attack threshold of the laminate. Currently forced entry is based upon the UL 972 for those certified and for explosive blast and limited ballistic resistance based upon the user required specifics, glazing and laminate composition capabilities only. The ANSI Z97 testing certifications are not for security related attacks.



BREAKAGE PATTERN

"COBWEB" OF BREAKS AT POINT OF IMPACT
(DEPENDENDING ON TYPE OF GLASS)

REMAINS IN TACT AFTER BREAKAGE.

Stiles®

Steel Door + Window Systems

UL 752 Ballistic Threat Level Chart

UNDERWRITERS LABORATORY UL 752 BALLISTIC STANDARDS					
UL752 Level	WEAPON	AMMUNITION	SHOTS	TEST CRITERIA (per UL 752 rev.10-5-05, 12" X 12" Target @ 15')	
1	 Baretta 9mm Parabellum	 9mm 124 grain FMJ	3	Velocity Shot Spacing Witness Plate Test Temp	1175 to 1292.5 ft/sec. 3 shots within 4.5" triangle .125 cardboard @ 18" from target (-26/72) 55, 72, 95, 120F
2	 .Smith & Wesson .357 Magnum	 .357 Magnum 158 grain JSP	3	Velocity Shot Spacing Witness Plate Test Temp	1250 to 1375 ft/sec. 3 shots within 4.5" triangle .125 cardboard @ 18" from target (-26/72) 55, 72, 95, 120F
3	 Colt .44 Magnum	 .44 Magnum 240 grain SWC	3	Velocity Shot Spacing Witness Plate Test Temp	1350 to 1485 ft/sec. 3 shots within 4.5" triangle .125 cardboard @ 18" from target (-26/72) 55, 72, 95, 120F
4	 M-1 Garand 30-06, .30 Caliber	 .30 cal, 30-06 180 grain JSP	1	Velocity Shot Spacing Witness Plate Test Temp	2540 to 2794 ft/sec. 1 shot, centered .125 cardboard @ 18" from target (-26/72) 55, 72, 95, 120F
5	 Heckler & Koch Model G3 7.62 X 51 NATO	 .30 cal, 7.62 NATO 150 grain FMJ	1	Velocity Shot Spacing Witness Plate Test Temp	2750 to 3025 ft/se (Parts 1-3) 1 shot, centered .125 cardboard @ 18" from target (-26/72) 55, 72, 95, 120F
6	 Baretta 9mm Parabellum	 9mm 124 grain FMJ	5	Velocity Shot Spacing Witness Plate Test Temp	1400 to 1540 ft/sec. 5 shots within a 4.5" square .125 cardboard @ 18" from target 72F
7	 Colt M16 (AR15 Semi), 5.56 X 45 NATO	 .223 cal, 5.56 NATO 55 grain FMJ	5	Velocity Shot Spacing Witness Plate Test Temp	3080 to 3388 ft/sec. 5 shots within a 4.5" square .125 cardboard @ 18" from target 72F
8	 Heckler & Koch Model G3 7.62 X 51 NATO	 .30 cal, 7.62 NATO 150 grain FMJ	5	Velocity Shot Spacing Witness Plate Test Temp	2750 to 3025 ft/sec. 5 shots within a 4.5" square .125 cardboard @ 18" from target 72F
9	 M-1 Garand 30-06, .30 Caliber	 .30 cal, 30-06, M2 AP 166 grain FMJ	1	Velocity Shot Spacing Witness Plate Test Temp	2715 to 2987 ft/sec. 1 shot, centered .125 cardboard @ 18" from target 72F
SHOTGUN SUPPLEMENT					
SG 1-8	 Benelli 12GA Shotgun	 12GA, 2.75" 437 grain Slug		Velocity Shot Spacing Witness Plate Test Temp	(Levels1-8) 1585 to 1743.5 ft/sec. (Levels 1-3 A-C) 3 shots in 4.5" triangle (Levels 4-5, Parts 1A-B) 1 shot, center (Levels 6-8, Part 1) 5 shots in 4.5" sq. .125 cardboard @ 18" from target (-26/72) 55, 72, 95, 120F (varies)
		 12GA, 2.75" 650 grain #00 Buck		Velocity Shot Spacing Witness Plate Test Temp	(1-8) 1200 to 1320 ft/sec. (Levels 1-3 2A-C) 3 shots 4.5" triangle (Levels 4-5, Parts 2A-B) 1 shot, center (Levels 6-8, Part 2) 5 shots in 4.5" sq. .125 cardboard @ 18" from target (-26/72) 55, 72, 95, 120F (varies)