Laminated security glazing and ballistic assault

"Standards and Performance”

- Presented by: Julia Schimmelpenningh

Days 2025

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Eastman

a global industry leader

- Fortune 500 global specialty materials company with 2024 revenues of ~$9.3B
- Global manufacturer and marketer of advanced materials and specialty additives
- Operates four business segments
- Global team of ~14,000
- Serving customers in >100 countries
- Applicable products: Saflex™ and Vanceva™ PVB interlayers

Session objectives

- Security glazing trends
- Overview - ASTM F3561
- Overview - ASTM F3279
- Evolutionary advances
- Summary & questions

Glass Performance Days 2025

Trends

- Social and political unrest
- Targeted attacks
- Changing how we think about buildings we spend time in
  - 90% of time spent indoors
  - How to minimize injury, damage and loss of property, and maintain facilities
- Escalating violent attacks in educational facilities over the past 10+ years
  Protective measures being specified
- Concentration on schools — but applicable to all buildings

What and why?

Risks can be associated with ordinary glass windows

Laminated glass use in natural disaster protection - demonstrated

Laminated glass has long been a security glazing solution

Accelerating use for protective glazing applications (schools, retail, office, government assaults etc.)

Glass industry has products that can help!

Additional focus on performance

New standards for glazing

New requirements for applications

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Different types of security glazing

Basic – safety glazing with glass shard retention, no immediate shatter

Enhanced – multiple intentional strikes

Forced entry – intent to create an opening for body passage

Enhanced forced entry – pre-weakened glazing prior to impacting for body passage

Ballistic – bullet resistant glazing (spall or non-spall)

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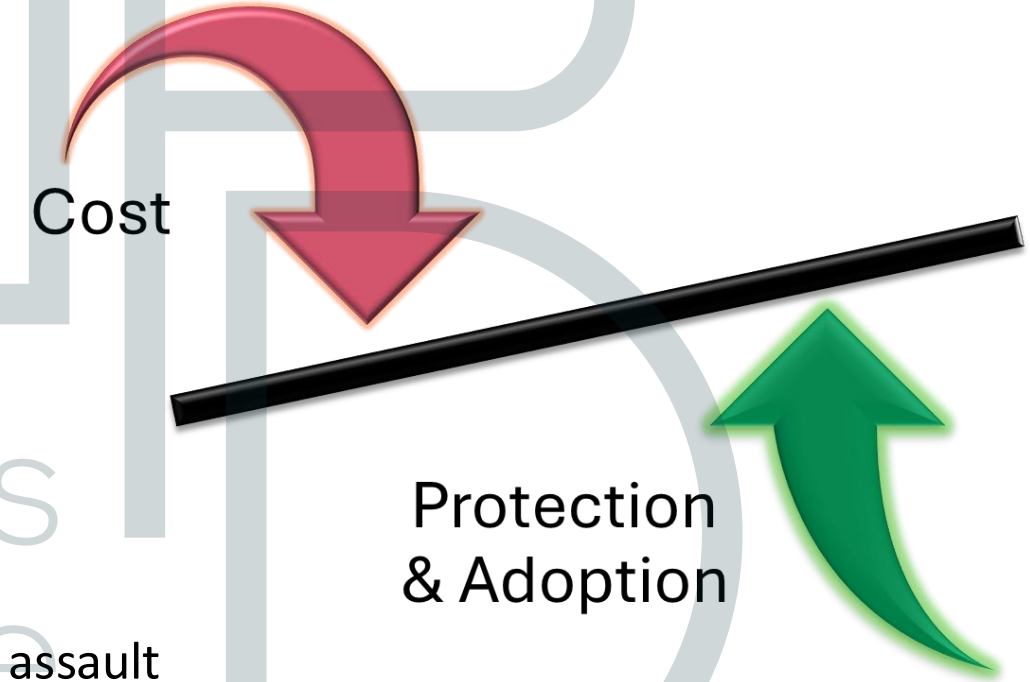
Introduction

What was needed:

- High level repeatable standards for enhanced security performance
- Protecting integrity of the building envelope
- Greater penetration resistance
- Post breakage integrity
- Simple unit to multi-assault resistant glazing
- Conventional PVB and composite PVB

What is delivered:

- Human physical and psychological comfort goals
- Two significant international standards involving ballistic assault
- Enhanced glazing that brings desired security and safety capacity plus multi-functionality



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Overview of new international security standards

ASTM F3561

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

Ballistic attack used to weaken the specimen
Impact simulates assault after the glass has been weakened as an additive attempt to gain entry

Forced entry standard – Delay | Deter Entry
NOT A BALLISTIC RESISTANT STANDARD

ASTM F3279

Standard Test method for Ballistic Resistant Security Glazing

Ballistic attack of glazing
Stop penetration of bullets
Life safety and Ocular safety spall ratings

REFERENCABLE BALLISTIC STANDARD

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Driving the development

NEED TO PROTECT PEOPLE

PROVIDE AN UNDERSTANDABLE AND COMPREHENSIVE TEST METHOD

FILL GAPS IN OBJECTIVES, TESTING AND PERFORMANCE

ENSURE REPRODUCIBILITY

STAND ALONE & UPDATED BALLISTIC STANDARD

ENOUGH LEVELS FOR RISK, THREAT, VULNERABILITY AND ECONOMIC CONSIDERATIONS

NGA BULLETIN – OUTLINING EXISTING TESTING

KNOWLEDGE THE INDUSTRY HAD PRODUCTS THAT COULD HELP

PETITION GRANTED BY ASTM FOR EMERGENCY WORK ORDER

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Development of ASTM F3561

Days 2025

June 2025

GPD Finland - jcschi@eastman.com

External Use

Active standard

Publication Number

F3561-23

Standard Test Method for

Forced-Entry-Resistance of Fenestration Systems After Simulated Active Shooter Attack

(originally published August 2022

Modified 2023

Imminent 2025)

This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.

Designation: F3561 – 22

Standard Test Method for Forced-Entry-Resistance of Fenestration Systems After Simulated Active Shooter Attack[1]

This standard is issued under the fixed designation F3561; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This test method sets forth the requirements and testing procedures to test forced-entry-resistant building components, construction components, and specialty security equipment. This test method is intended primarily for manufacturers to test and rate their windows, doors, modular panels, glazings, and similar products to ensure that all manufactured products meet the necessary requirements for forced-entry protection after sustaining an active shooter assault.

1.2 This test method is currently designed to simulate an active shooter weakening the system with repetitive shots followed by mechanically driven impact to simulate forced entry.

1.3 This test method is not to be used for ballistic resistant glazing rating. Test projectiles are permitted to perforate the entire specimen. The test projectile firings are intended to simulate actions taken by an assailant to aid in the ability to gain entry to a facility.

1.4 This is a laboratory test to be performed on full systems and therefore not applicable for field testing.

1.5 All tests are executed on the exterior surface of the fenestration.

1.6 Systems are required to be tested as complete units in a test frame or fielded conditions. Mulled systems must be tested in the mulled condition. Test results only apply to the component or system as tested. Once a system is tested and deemed to satisfy the requirements of this test method, no design change can be made without a retest except those that qualify under Annex A1 Substitution Criteria.

1.7 Components (such as glazing, door leaves, etc.) may be tested in accordance with Appendix X1, receiving a capability statement for the component, but not a system rating per this standard.

1.8 Window and door systems shall be rated to at least a minimum level of Test Methods F476, F588, or F842, or combinations thereof, as appropriate prior to commencing this test evaluation. This test does not dual certify to the above mentioned standards.

1.9 The values stated in this standard are SI units with the exception of the nominal descriptors for tools.

1.10 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.11 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

A36/A36M Specification for Carbon Structural Steel
A574 Specification for Alloy Steel Socket-Head Cap Screws
C719 Test Method for Adhesion and Cohesion of Elastomeric Joint Sealants Under Cyclic Movement (Hockman Cycle)
C1036 Specification for Flat Glass
C1048 Specification for Heat-Strengthened and Fully Tempered Flat Glass
C1135 Test Method for Determining Tensile Adhesion Properties of Structural Sealants
C1172 Specification for Laminated Architectural Flat Glass
D1415 Test Method for Rubber Property—International Hardness
D3575 Test Methods for Flexible Cellular Materials Made from Olefin Polymers
E631 Terminology of Building Constructions
E3062/E3062M Specification for Indoor Ballistic Test Ranges for Small Arms and Fragmentation Testing of

[1] This test method is under the jurisdiction of ASTM Committee F12 on Security Systems and Equipment and is the direct responsibility of Subcommittee F12.10 on Systems Products and Services.
Current edition approved Aug. 1, 2022. Published August 2022. DOI: 10.1520/F3561-22.

[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

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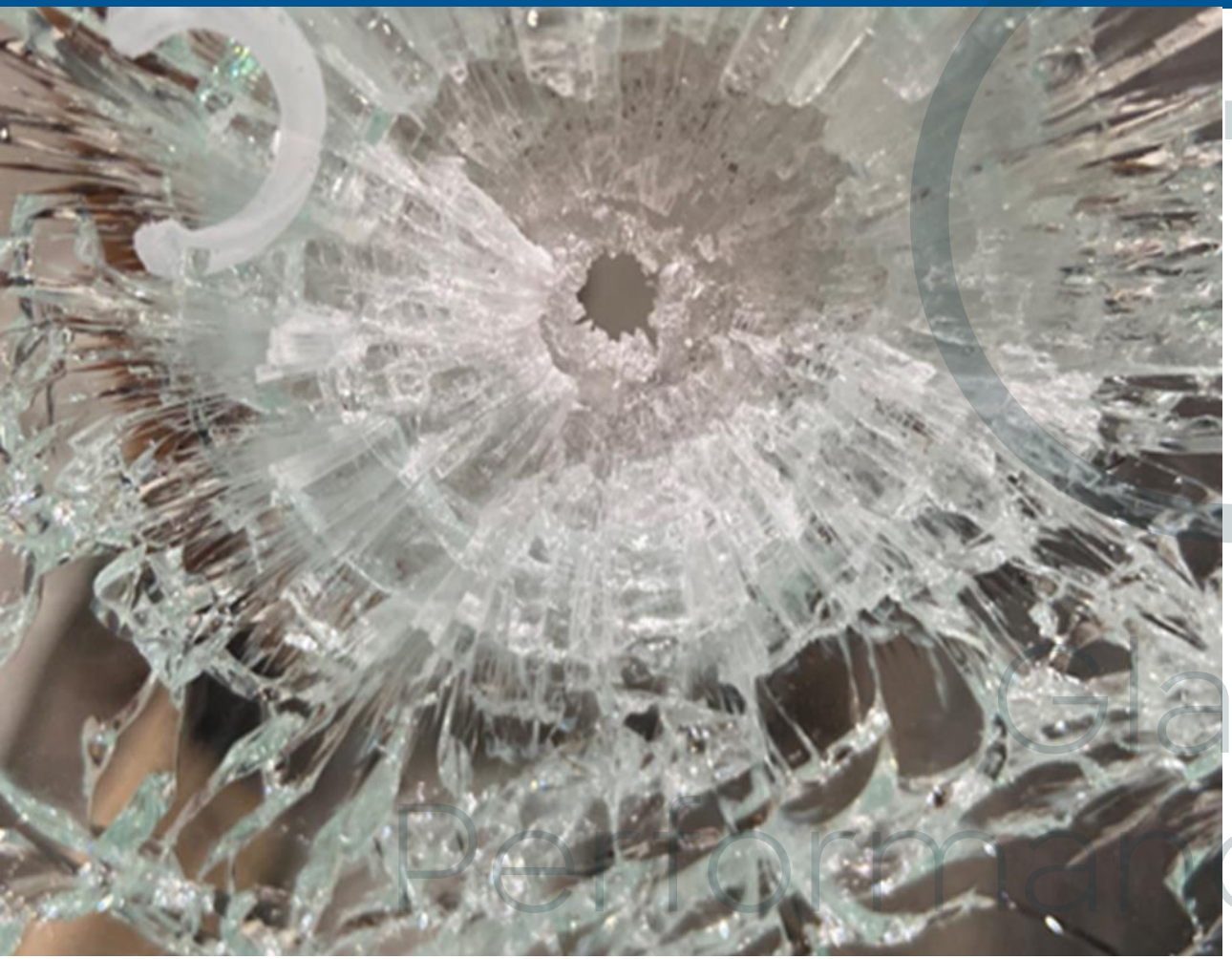
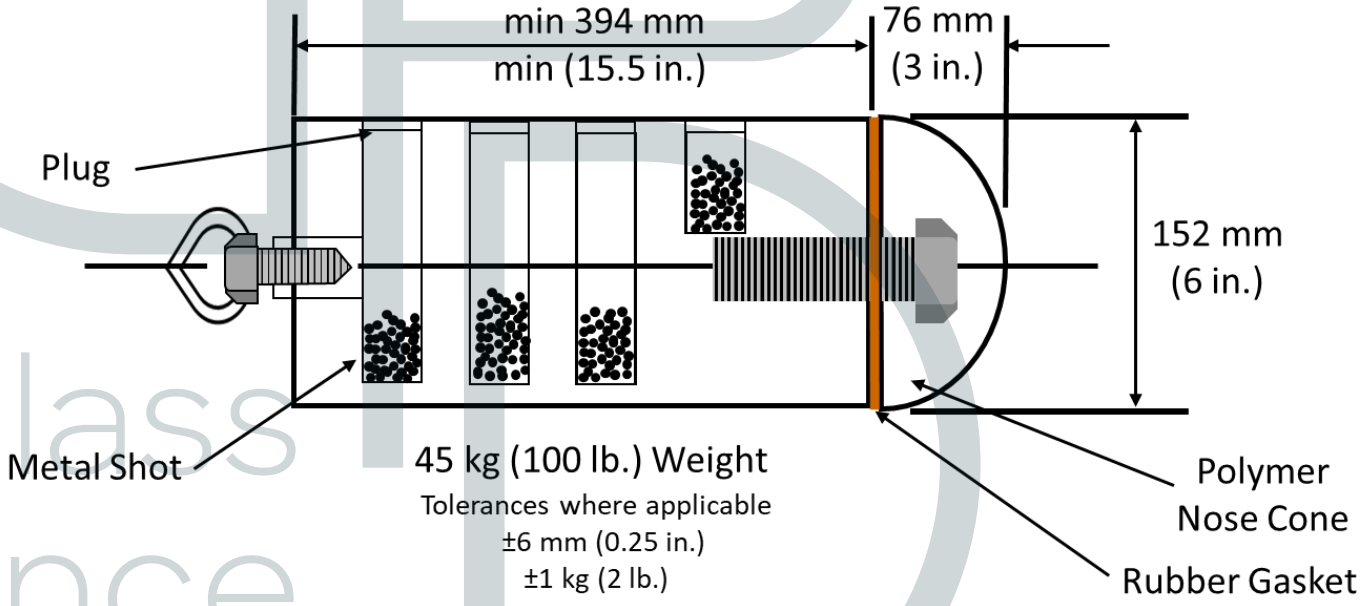
Basics



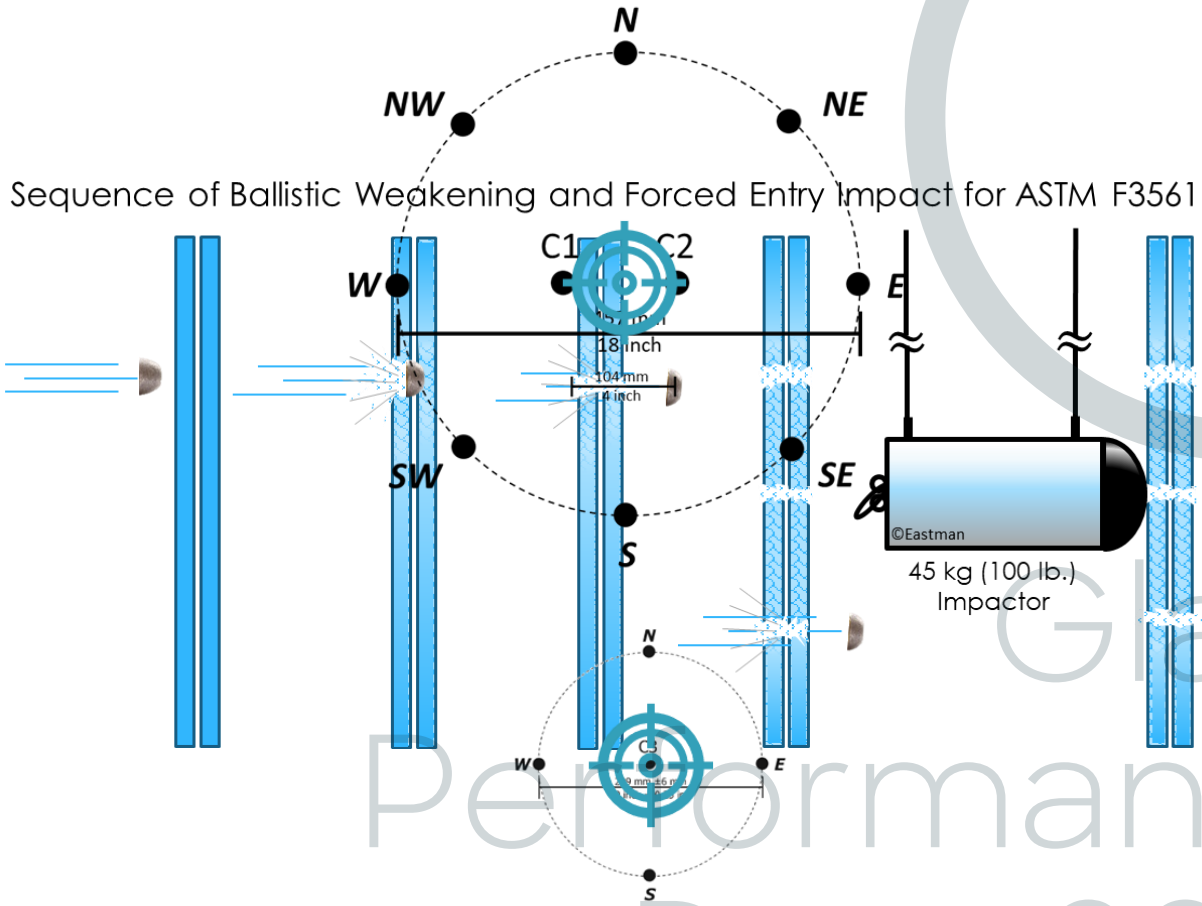
- Not a bullet resistant standard
- Systematically broken and then impacted until capability to obtain entry is achieved
- AR15 with 556 M193 ammunition
- Simulate opening generation for reach-for-release or full walk-through entry
- Gloved hand to fit through with little force, thus the 152 mm opening
- System test - not meant to certify a glazing for replacement infills

ASTM F3561 - Impactor

- Impactor from ASTM F476
- 45 kg (100 lbs.) total mass
- 80 Shore D Durometer Nose



ASTM F3561 “Active Shooter” standard



- Baseline capability of systems
- Weaken glazing with projectiles (glass and lock)
- Mechanically force entry
- Two impacts per level
- Accumulation from Level 1
- Glass “predictive” test

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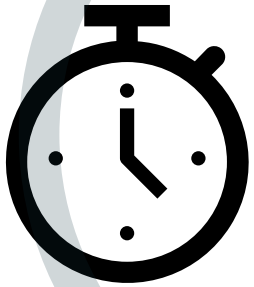
ASTM F3561 – performance level details

Level	Potential Energy		Height of Drop (H)		@ stage
	Joules (J)	ft*lb.	mm	ft	Total Force J (ft*lb.)
1	68	50	155	0.5	136 (100)
2	136	100	305	1.0	407 (300)
3	203	150	460	1.5	813 (600)
4	271	200	655	2.2	1356 (1000)
5	339	250	768	2.5	2034 (1500)
6	407	300	920	3.0	2847 (2100)
7	475	350	1076	3.5	3796 (2800)
8	542	400	1228	4.0	4881 (3600)

Why use ASTM F3561?

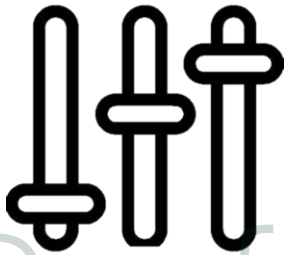
Forced entry resistance



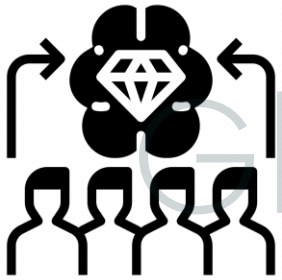
Responder enhancement

Mechanized testing

Reproducible

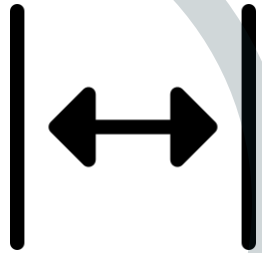


Multiple levels



International consensus

Systematic review



Fills test gaps

Laminated glass response

Glass only ratings

Days 2025

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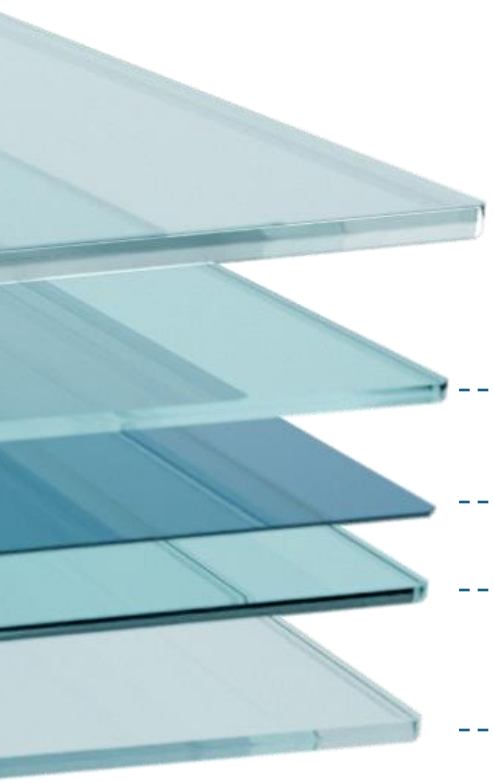
June 2025 | *GPD Finland - jcschi@eastman.com*

Testing background

- All laminates made with 3-mm annealed glass
- Laminate size 61 cm x 61 cm (24-inch x 24-inch)
- Tests stopped if edge pull out occurred
- Laminates dry glazing with pressure clamps in steel frame through level 6
- Friction gasket > level 6
- Level assigned with strictest criteria using penetration of impact nose
- Conventional and composite PVB



Glass

Skin (PVB interlayer)

Core (Tear resistant film)

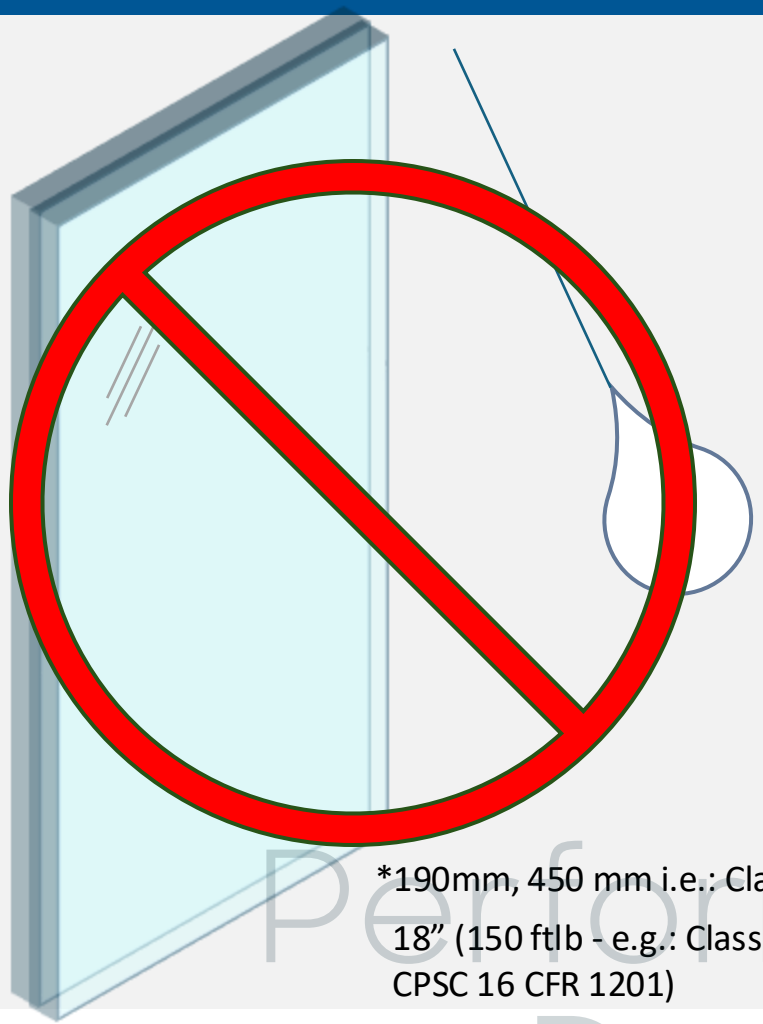
Skin (PVB interlayer)

Glass

PVB composite interlayer

- *Tri-layer designed for superior penetration resistance*
- *Increased tear resistance*
- *Post breakage enhancement*
- *Increased performance with decreased glass thickness*

Baseline

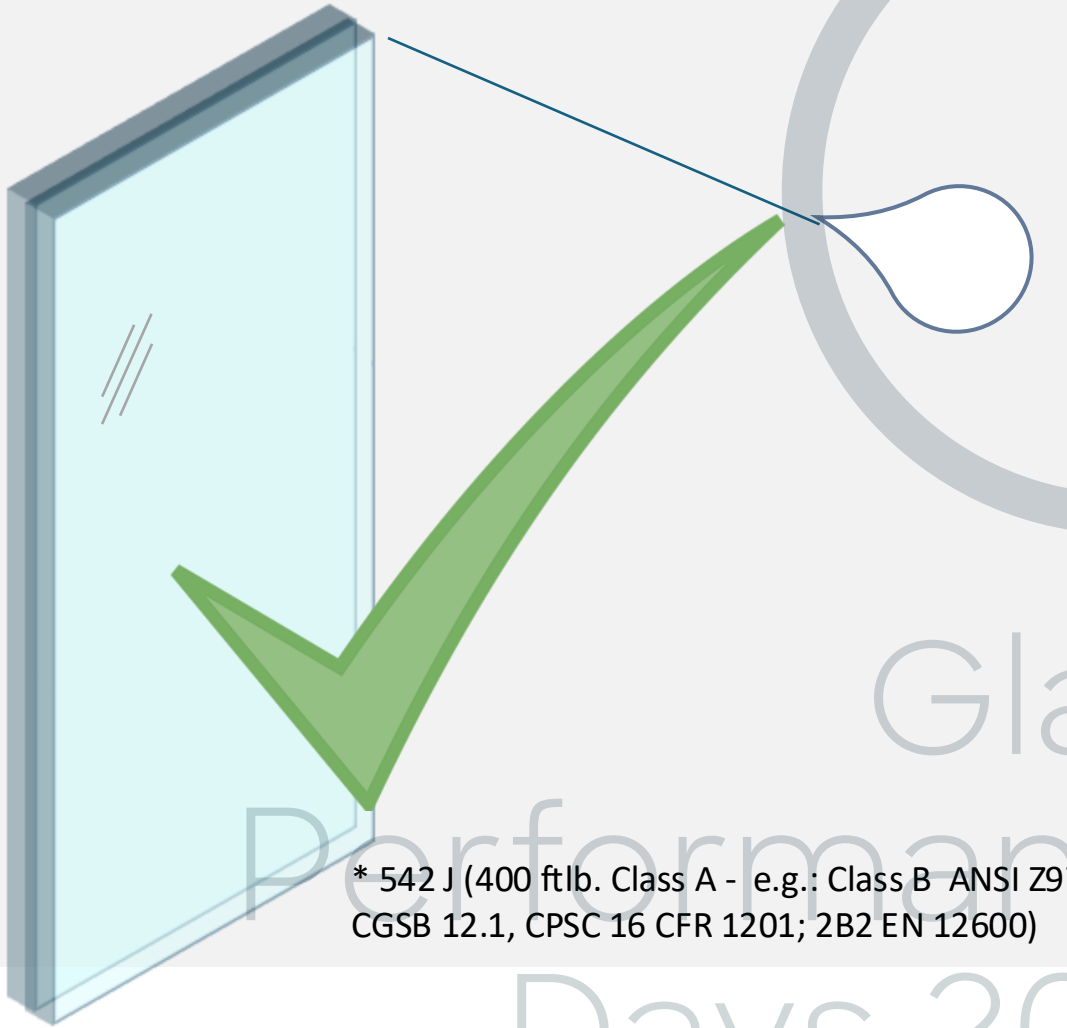


- Typically - not leveling in
- Glazings not surpassing ANSI Z97.1 Class B Type 1*
- Thin laminated glazing
- Thin films and unanchored films

*190mm, 450 mm i.e.: Class 1 or 2 EN 12600

18” (150 ftlb - e.g.: Class B ANSI Z97, CGSB 12.1, CPSC 16 CFR 1201)

First levels - typical



* 542 J (400 ftlb. Class A - e.g.: Class B ANSI Z97, CGSB 12.1, CPSC 16 CFR 1201; 2B2 EN 12600)

- "Safety glazing (Type 1)" up to typical entry level products for burglary resist level in at "Good" levels 1 – 2
- Laminated glazing
- Thicker films; anchored
- Plastic sheeting

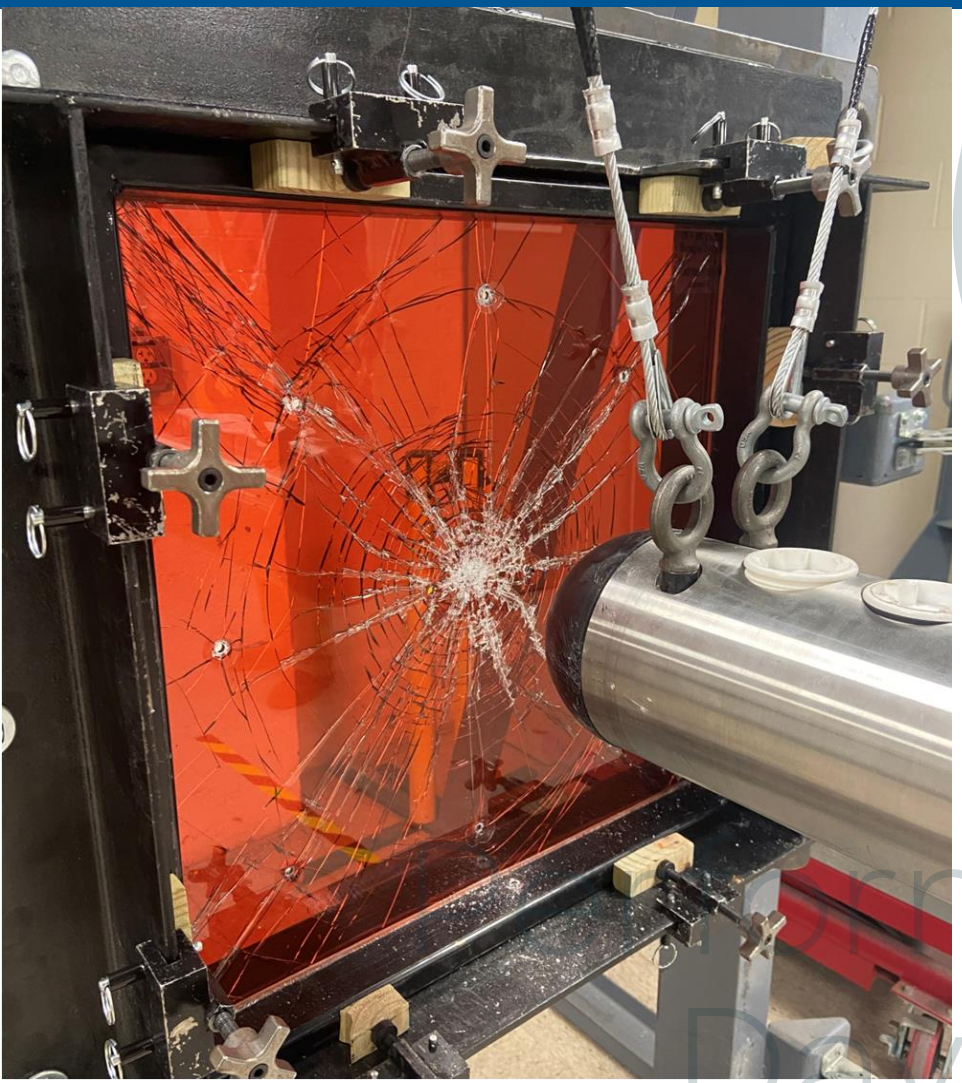
Mid levels - typical

- Glazings for ASTM E1996 Level D typically result “Better” levels 3 – 5
- EN 356 P5A – P6B
- Laminated glazing
- Thicker anchored films
- Plastic sheeting

Top Levels - typical

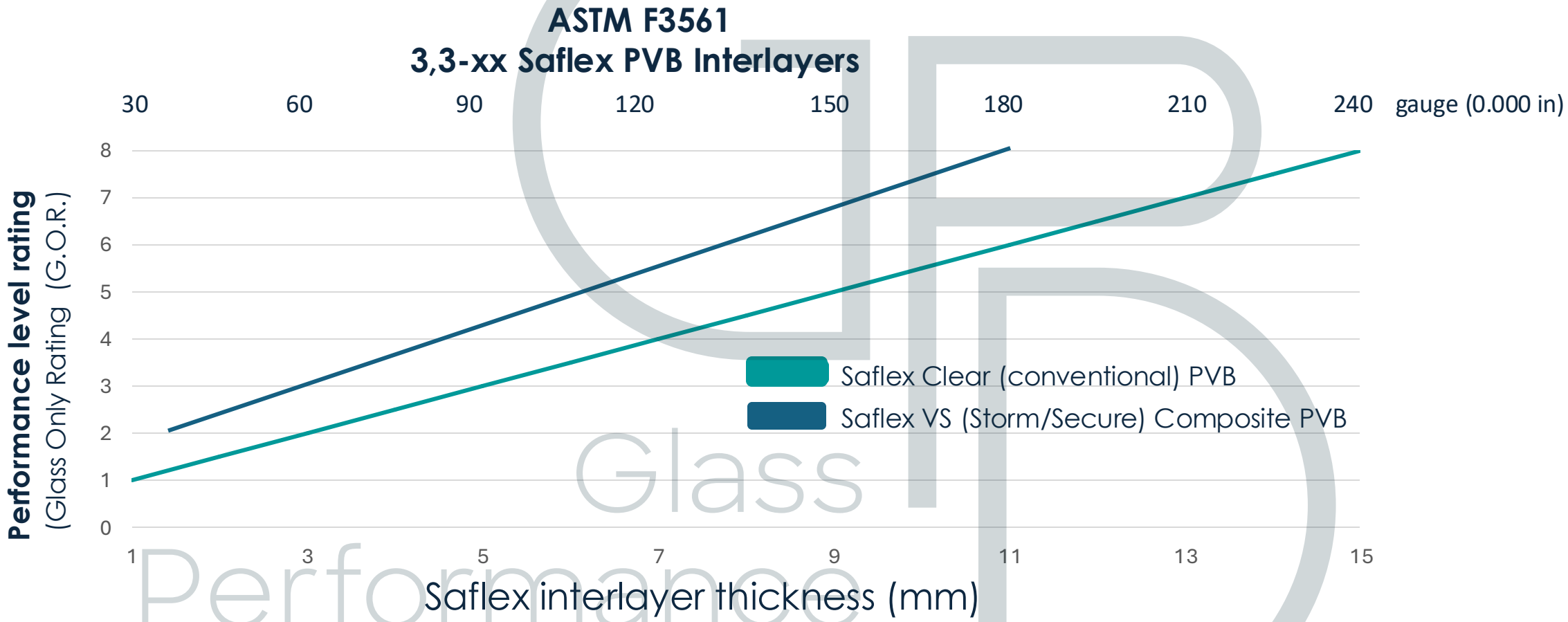
- Glazings passing ASTM E1996 Level E and/or F1233 Class 1.2+ typically result in “Best” levels 6-8
- Laminated glasses
- Thick or laminated plastic sheeting
- Filmed laminated glazings

General guidance



ASTM F3561 Level	Interpretation	Adjective
1 – 2	No immediate opening/void for arm penetration; body part impact	**Good**
3 – 5	Multiple high energy body impacts	**Better**
6 – 8	Repeated full body impacts for sustained time	**Best**

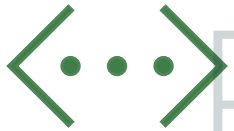
ASTM F3561 G.O.R. summary results



ASTM F3561 G.O.R. summary

- Performance Level = # layers 30g Saflex Clear
- Composite PVB (Saflex VS) interlayers perform ~1-2 Level higher than conventional (Saflex Clear) PVB

- Saflex Clear | Saflex Acoustic | Saflex FlySafe 3D | Saflex DM (HP)| Saflex Structural performed same as R series (3.70 mm (0.120 inch)



- IGU tests allow split of total interlayer

Glass only testing – F3561

Interlayer	Interlayer thickness (mm)	Overall laminate thickness (mm)	Accumulated impact energy Joules (J)	ASTM F3561 Level
Conventional PVB	0.76	7.11	136	1
Conventional PVB	1.14	7.49	136	1
Conventional PVB	1.52	7.87	407	2
PVB Composite (VS)	1.96	8.31	813	3
Conventional PVB	2.29	8.64	813	3
Conventional PVB	3.05	9.40	1356	4
PVB Composite (VS*2)	3.91	10.26	3796	7
Conventional PVB	4.57	10.92	3796	7
PVB Composite (VS-R_{30}-VS)	4.67	11.02	4881	8
PVB Composite (VS-R_{60}-VS)	5.44	11.79	4881	8

Ballistic Resistant Glazing

ASTM F3279

SAFLEX VANCEVA from Eastman

June 2025 | *GPD Finland - jcschi@eastman.com*

ASTM F3279-24

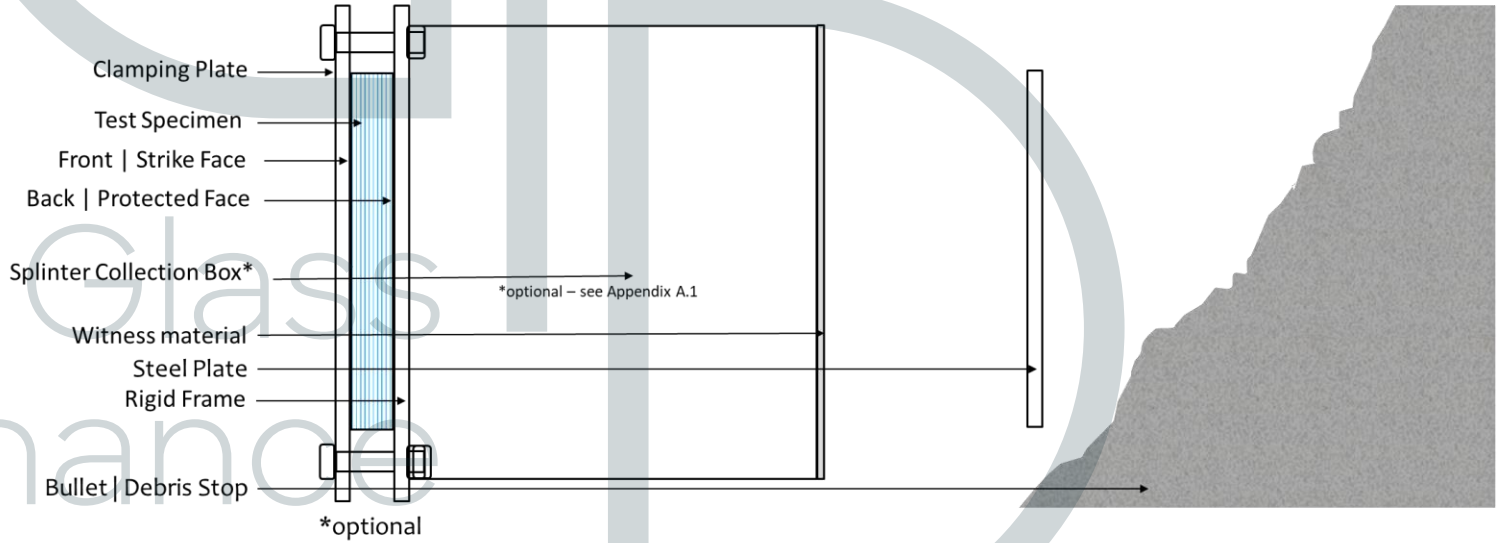
- **Standard Test method for Ballistic Resistant Security Glazing**
  - Ballistic Standard

- **Development Goals**
  - Standard alone ballistic standard for glazing
  - Spall rating levels – Life and Ocular
  - Update weapons and ammunition
- **Scope**
  - Assessing the resistance of security glazing materials against ballistic threats from various weapons and ammunition.
  - The assignment of ratings is also described:
    - Ballistic Resistance Class (BRC) relates to the distance and amount and severity of spall that comes off the glazing after testing.
    - Ballistic Test Identity (BTI) 4 segment code describing testing and performance capability of glazing configuration.
  - Unique in requirement of different size specimens based on shot patterns,
  - Provides options for test temperature based on intended use
  - Provides options in performance ratings for spall

Methodology summary

ASTM F3279

- Glazing set in test frame
- Test/qualification expectations selected
  - Weapon & Ammunition
  - Test temperature
  - Shot Pattern
  - Witness panel (BRC)
- Test executed
- Assessment/Rating (BTI)



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Weapons and ammunition

- Handguns
- Rifle
- Shotgun
- Special threats

Handgun – 6 options

Threat	Ammunition description*
H1	9mm Luger, Copper Jacket Lead Core, Round Nose (RN), Full Metal Jacket (FMJ)
H2	9mm Luger, Copper Jacket Lead Core, RN, FMJ
H3	.40 S&W, Copper Jacket Lead Core, Flat Nose (FN), FMJ
H4	.45 ACP, Copper Jacket Lead Core, RN, FMJ
H5	.357 Magnum, Copper Jacket Lead Core, JSP
H6	.44 Magnum, Copper Jacket Lead Core, SJHP

*Bullet weight and velocity included in ASTM F3279

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Rifle – 10 options

Threat	Ammunition description*
R1	5.56x45mm, M193, Copper Jacket Lead Core, FMJ
R2	5.56x45mm, Copper Jacketed Steel Tip Penetrator, Lead Core Base
R3	7.62x39mm, Mild Steel Core (Type 56) FMJ
R4	7.62x51mm, NATO Ball, Copper Plated Steel Jacket, Lead Core
R5	7.62x51mm, AP, Copper Jacketed Steel Core, FMJ
R6	.30-06 Springfield, Copper Jacketed Lead Core SP
R7	.30-06 Caliber Rifle, Copper Jacketed Steel Core, APM2, (AP)
R8	.50 caliber (12.7x99mm) Rifle, M33 Ball, Copper Jacketed steel core
R9	.50 caliber (12.7x99mm) Rifle, APM2 (AP), Copper Jacketed steel core
R10	7.62x39 mm API Round

*Bullet weight and velocity included in ASTM F3279

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Shotgun – 3 options

Threat	Ammunition description*
S1	12 ga. 70mm (2 ¾ inch), #4 Buckshot,27 Pellet, Pellet Diameter 6mm (0.24 inch)
S2	12 ga. 70mm (2 ¾ inch), 000 Buckshot, 8 Pellet, Pellet Diameter 9.14mm (0.36 inch)
S3	12 ga. 70mm (2 ¾ inch), Rifled Slug, Lead, 1oz

*Bullet weight and velocity included in ASTM F3279

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Specials – 10 + options

Threat	Ammunition description*
A1	.380 ACP, Copper Jacketed Lead Core, Round Nose, FMJ
A2	10mm, Copper Jacketed Lead Core, FMJ
A3	5.56x45mm, M855A1, Copper Jacketed Steel and Copper Core, FMJ (AIC: M855A1)
A4	7.62x39mm, Russian API, BZ
A5	7.62x51mm, M80A1, Copper Jacketed Steel and Copper Core, FMJ (AIC: M80A1)
A6	7.62x51mm, Long Range Ball, Copper Jacketed Lead Core, FMJ (AIC: M118)
A7	7.62x51mm, AP (WC Core), FMJ (AIC: M993; NAMMO AP8)
A8	7.62 x 54R Dragunov (AIC: 57-N-323S)
A9	.50 caliber (12.7x99mm) Rifle, MK263 AP
A10	Special - Handgun Ammunition, Rifle Ammunition or Fragment Simulators (FSP)[A]

*Bullet weight and velocity included in ASTM F3279

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Industry designated levels

Threat/ Performance level	Threat	Ammunition description*	Required BTI
1	H2	9mm Luger, Copper Jacket Lead Core, RN, FMJ	H2-T1-A3-2L
2	H5	.357 Magnum, Copper Jacket Lead Core, JSP	H5-T1-A3-2L
3	H6	.44 Magnum, Copper Jacket Lead Core, SJHP	H6-T1-A3-2L
4	R1	5.56x45mm, M193, Copper Jacket Lead Core, FMJ (AIC: M193)	R1-T1-C5-2L
5	R2	5.56x45mm, Copper Jacketed Steel and Lead Core, FMJ (AIC: M855)	R2-T1-C5-2L
6	R3	7.62x39mm, Mild Steel Core (Type 56) (AIC: Core Hrd:HRB 80)	R3-T1-C5-2L
7	R4	7.62x51mm, NATO Ball, Copper Jacketed Lead Core, FMJ (AIC: M80 Ball)	R4-T1-C5-2L
8	R7	.30-06 Caliber Rifle, Copper Jacketed Steel Core, APM2, (AP)	R7-T1-B3-2L
9	R9	.50 caliber (12.7x99mm) Rifle, APM2 (AP), Copper Jacketed steel core	R9-T1-S-2L

*Bullet weight and velocity included in ASTM F3279

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Test specimen size*

Number of shots	Pattern type	Test specimen minimum size	Test specimen maximum size	Witness panel size
1 (single-shot test)	S	300 mm x 300 mm (12 inch x 12 inch)	610 mm x 610 mm (24 inch x 24 inch)	610 mm x 610 mm (24 inch x 24 inch)
>1 (multi-shot test)	A, B, C, or D	510 mm x 510 mm (20 inch x 20 inch)	1067 mm x 1067 mm (42 inch x 42 inch)	At least 610 mm x 610 mm (24 inch x 24 inch)
≥1 (multi-shot test)	E	810 mm x 810 mm (32 inch x 32 inch)	1220 mm x 1220 mm (48 inch x 48 inch)	At least 810 mm x 810 mm (32 inch x 32 inch)

* Tolerances given in ASTM F3279

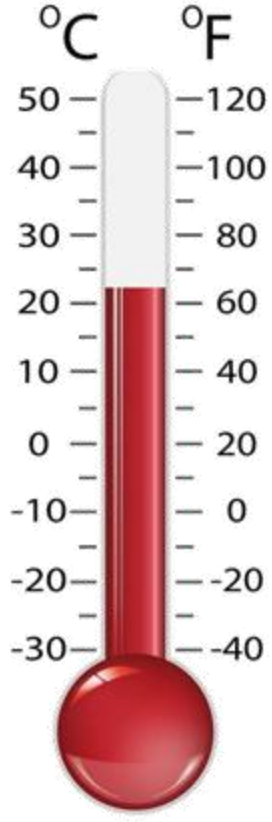
Test range distances

Test threat	Designation	Distances
Handgun, rifle and fragment simulators[a] greater than 64 grain	D1:	Muzzle to test specimen reference plane = nominally 7.6 m (25 ft.)
	D2:	Location of velocity measurement to test specimen reference plane = 3.7 m ± 25 mm (12. ft. ± 1.0 inch)
Handgun, rifle and fragment simulators 16 grain to 64 grain	D1:	Muzzle to test specimen reference plane = nominally 4.6 m (15 ft.)
	D2:	Location of velocity measurement to test specimen reference plane = 2.3 m ± 25 mm (7.5 ft. ± 1.0 inch)

[a] Fragment simulators include (1) right circular cylinders (RCCs) and (2) fragment simulating projectiles (FSPs).

Temperature

Category	Description	Conditioning temperature (± 3°C)
T1	Ambient temperature test	+20°C
T2	High temperature test	+49°C
T3	Low temperature test	–29°C
T4	Tested at both high (T2) and low (T3) temperature	See T2 and T3
T5	Tested at ambient (T1), high (T2), and low (T3) temperature	See T1, T2 and T3
T6	Temperature gradient test (winter)	–29°C | +20°C
T7	Temperature gradient test (summer)	+49°C | +20°C
T8	Multi-gradient temperature, tested at both winter (T6) and summer (T7)	See T5 and T6



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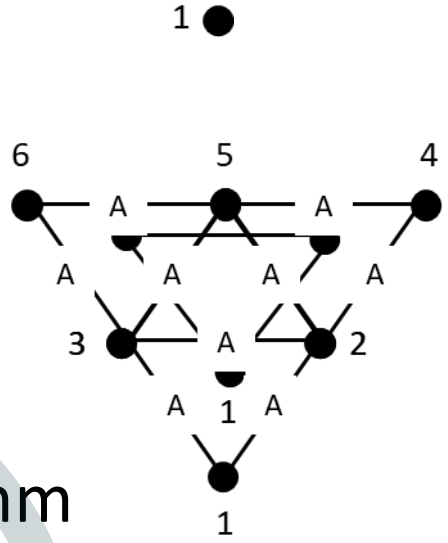
Shot patterns

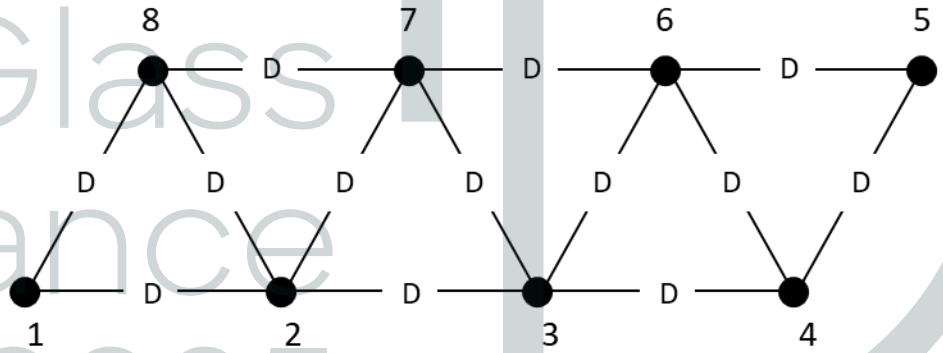
Four basic shot patterns

- Single, Triangle Point, Square Point, ZigZag
- Mid shots added



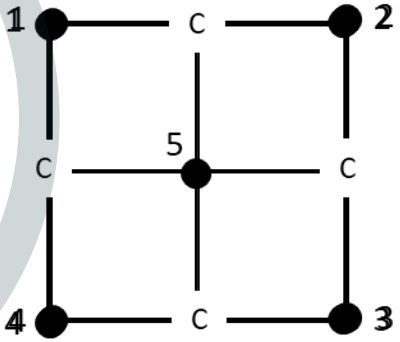
Shot separation differences

- (A) 102 mm, (B) 178 mm (C) 114 mm, (D) 102 mm, (E) 175 mm



6 total shot patterns

11 shot options



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Shot codes and number of fair hits

Pattern/shot code	Pattern description	Min. number of fair hits
S1	Single shot	1
A3	Triangle	3
B3	Triangle	3
C4	Square	4
C5	Square	5
D8	Parallelogram	8
E8	Parallelogram	8

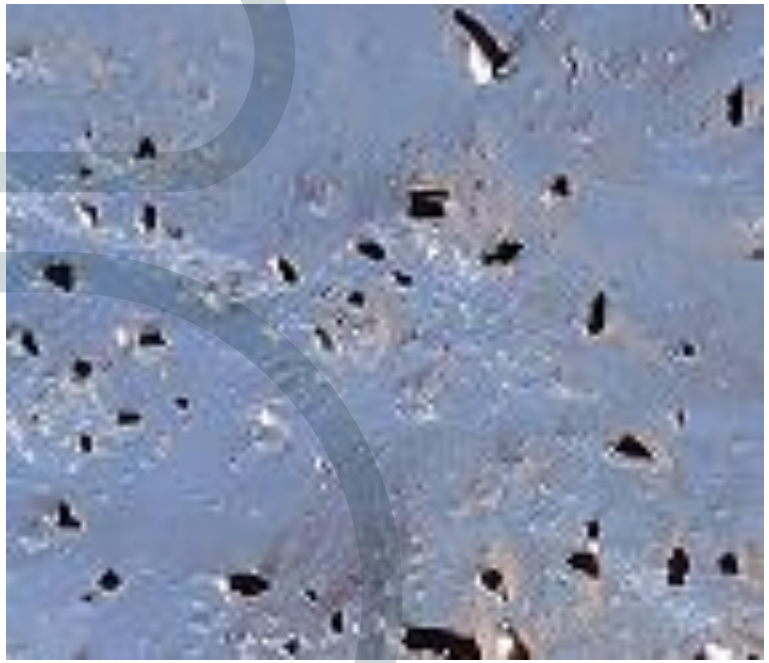
Ballistic Resistance Class (BRC)

Amount and severity of spall

- Based on the witness panel selected and the amount of damage.
- Set back from the specimen 15.2 cm (same for either type)
- Witness panels are aluminum sheeting with two thickness options
  - 0.051 mm
    - Used when “no spall” is needed.
    - Designated “O”, signifying the resistance to ocular injury
  - 0.51 mm
    - No life-threatening spall (significant size and velocity)
    - Designated as “L”, signifying non-life threatening
- No perforation greater than 3 mm in length or width
  - Bullet fragments are considered in the spall rating

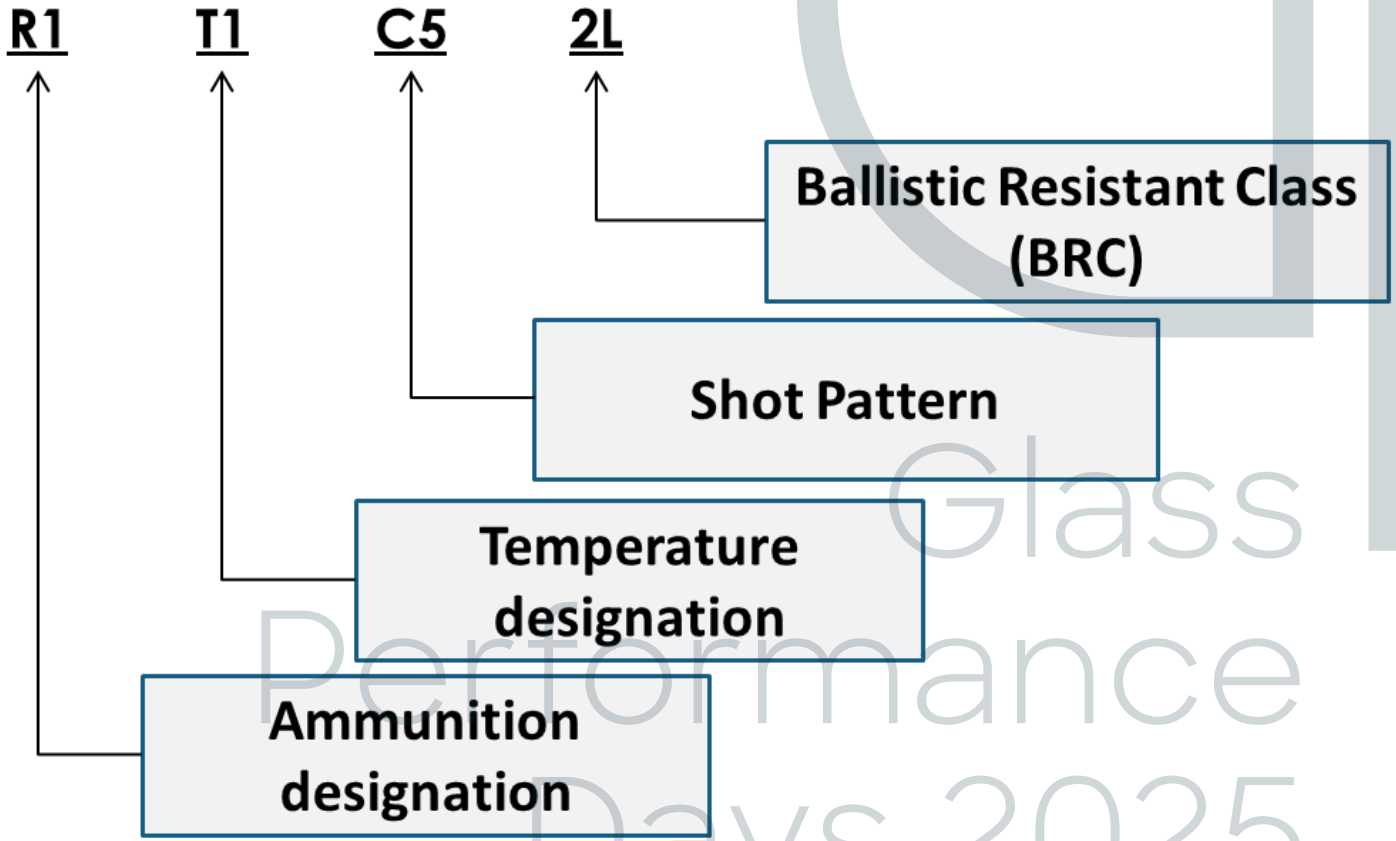
BRC criteria

BRC	Witness material impact allowed	Witness material penetration allowed
1O	No	No
1L		
2O	Yes	No
2L		
3O	Yes	Yes[1]
3L		



Ballistic Test Identity (BTI)

4 segment code describing testing and performance capability of glazing configuration



BTI: R1-T1-C5-2L

Details:

- 5.56x45mm, M193, Copper Jacket Lead Core, FMJ
- Tested at 20°C
- Square with center @ 114 cm
- 0.51 mm witness panel impacted, no penetration

- A.K.A. industry Level 4

Ballistic glazing

- Configurations typically proprietary
- Conventional PVB used between glass layers
  - Thinner better than thicker
  - High adhesion witness panel
- Composite interlayers
  - 2+ layers to replace thin PC
  - Thinner overall constructions
- Basic thickness (NGA Laminating Reference Manual)
- High temperature most taxing
- Interlayers hold layers together
- Glass flatten and slows bullets

Level	All-glass laminate		Composite laminate		All plastic laminate	
BTI	Thickness mm (inch)	Weight kg/m^2 (lbs./ft^2)	Thickness mm (inch)	Weight kg/m^2 (lbs./ft^2)	Thickness mm (inch)	Weight kg/m^2 (lbs./ft^2)
H1-T5-A3-10	30 (1.19)	74 (15)	21 (0.813)	44 (9)	19 (0.750)	24 (5)
H5-T5-A3-10	38 (1.50)	98 (20)	27 (1.063)	59 (12)	25 (1.00)	34 (7)
H6-T5-A3-10	44 (1.75)	112 (23)	32 (1.25)	68 (14)	32 (1.25)	44 (9)
R6-T5-S1-10	51 (2.00)	127 (26)	35 (1.375)	68 (14)	*	*
R5-T5-S1-10	51 (2.00)	127 (26)	35 (1.375)	68 (14)	*	*
H2-T1-C5-10	46 (1.813)	112 (23)	27 (1.063)	49 (10)	*	*
R2-T1-C5-10	*	*	51 (2.00)	108 (22)	*	*
R4-T1-C5-10	*	*	55 (2.188)	122 (25)	*	*

*** This configuration may not be offered—please contact the manufacturer for full details.**

This table is offered as an approximate guide. The actual thickness and weights vary from manufacturer to manufacturer.

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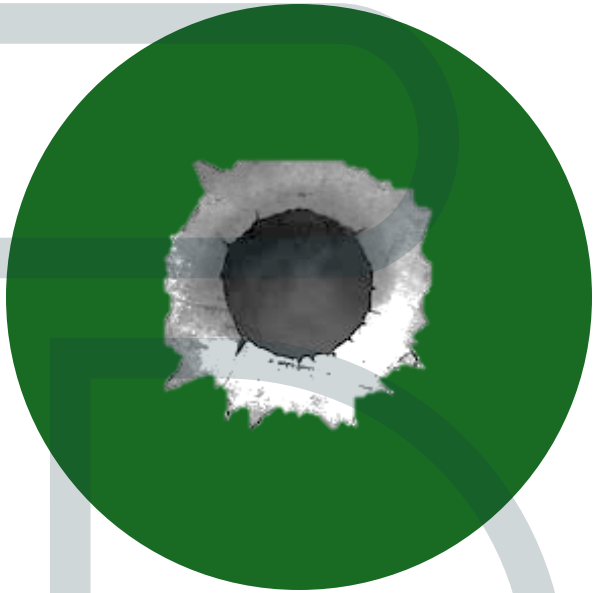
Evolutionary or adjacent plans



2025 VERSION OF ASTM F3561 (TO BE PUBLISHED)

ASTM GLAZING RETROFIT STANDARD

NON-GLAZING TESTING INTO ASTM F3279

REMOVAL OF BALLISTIC FROM ASTM F1233

REPUBLISH ASTM F1233 AS FE/DUAL

Summary and questions

- Rising social and political unrest and targeted attacks have **increased focus on security glazing use –** especially protecting schools and public buildings
- Use laminated glass in **high-risk or accessible areas**
- Laminated security glazing with advanced interlayers offers **multi-functional protection**—from safety to forced entry to ballistic threats—while maintaining clarity, durability, and design flexibility
- The new ASTM standards provide a **modern, reproducible framework** for evaluating and specifying security glazing
- **Composite PVB interlayers** (e.g., Saflex VS) outperform conventional PVB and help reduce overall thickness
- Laminated glass with PVB based interlayers can achieve **ASTM F3561 levels 1–8** and can be used for ballistic resistant glazing to **ASTM F3279**
- Ballistically weakened glass resists forced entry
- Integrate security glazing during the **design phase – not an after thought**!

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Acknowledgements

NGA NATIONAL GLASS ASSOCIATION

ASTM INTERNATIONAL ADVANCING STANDARDS TRANSFORMING MARKETS

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Thank you!

Contact information

Julia Schimmelpenningh

Technical Engagement Manager - Architectural

Springfield MA, USA

jcschi@eastman.com

EASTMAN

saflex-vanceva.eastman.com

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