Designation: F3279 – 24

Standard Test Method for Ballistic-Resistant Security Glazing Materials[1]

This standard is issued under the fixed designation F3279; 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 procedures whose purpose is limited to the evaluation of the resistance of security glazing materials against ballistic threats.

1.1.1 Glazing tested in accordance with these methods is able to be assigned a ballistic resistant class (BRC) criterion.

1.1.2 Glazing tested in accordance with these methods is able to be assigned a ballistic test identity (BTI).

1.1.3 BRC's by themselves are not indicators of performance ranking. Only the BTI is the performance indicator of ballistic resistance derived from this test method. BRC by itself is not an indication of the complete ballistic resistance performance.

1.2 The values stated in SI units are to be regarded as standard. The values given in parentheses after SI units are provided for information only and are not considered standard.

1.3 *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.*

1.4 *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]

D1415 Test Method for Rubber Property—International Hardness

E3005 Terminology for Body Armor

E3062 Specification for Indoor Ballistic Test Ranges for Small Arms and Fragmentation Testing of Ballistic-resistant Items

2.2 *Other Documents:*

Sporting Arms and Ammunition Manufacturer's Institute (SAAMI)—Ammunition[3]

United States Military Ammunition Specifications—Ammunition[4]

American Iron and Steel Institute M-1020—Structural Steel[5]

3. Terminology

3.1 *Definitions:*

3.1.1 *bullet yaw, n*—the angular deviation between the projectile's axis of symmetry and its line of travel.

3.1.2 *spall, n*—material fragments from the back face (side opposite the attack) of the test specimen that have completely detached from the larger test specimen body during testing.

3.1.3 *splinter collection box, n*—a box placed securely at the back-side (side opposite the attack) of the test specimen which is designed to collect spall.

3.1.4 *strike face, n*—the first surface of the test specimen that is impacted by projectiles once the test specimen is mounted in the frame.

3.1.5 *test projectiles, n*—projectiles or ammunition selected from Table 1 or Table X1.1 that are used to determine the BRC of a test specimen (see Table 4 for BRC criteria).

3.1.6 *test specimen, n*—the particular security glazing material configuration which is being evaluated by this test method.

3.1.7 *test weapon, n*—a mounted firearm or receiver and test barrel which is capable of shooting a test projectile with accurate, precise, and repeatable performance.

3.1.8 *witness material, n*—material located beyond the back face (side opposite the attack) of the test specimen during

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[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.

[3] Available from Sporting Arms and Ammunition Manufacturers' Association (SAAMI), Box 1075, Riverside, CT 06878.

[4] Available from Standardization Documents Order Desk, DODSSP, Bldg. 4, Section D, 700 Robbins Ave., Philadelphia, PA 19111-5098.

[5] Available from American Iron and Steel Institute (AISI), 1101 17th St., NW, Suite 1300, Washington, DC 20036.

TABLE 1 Threat and Corresponding Test Ammunition

Threat/ Performance Level	Threat	Ammunition Description	Ammunition Identity Classification (AIC)	Bullet Weight gram (grain)	Velocity (Meters (fps)) ±15 m/s (±50 fps)	Required BTI
1	H2	9 mm Luger, Copper Jacket Lead Core, RN, FMJ	None	8.04 g (124 grain)	436 m/s (1430 fps)	H2-T1-A3-2L
2	H5	.357 Magnum, Copper Jacket Lead Core, JSP	None	10.24 g (158 grain)	436 m/s (1430 fps)	H5-T1-A3-2L
3	H6	.44 Magnum, Copper Jacket Lead Core, SJHP	None	15.55 g (240 grain)	436 m/s (1430 fps)	H6-T1-A3-2L
4	R1	5.56 × 45 mm, M193, Copper Jacket Lead Core, FMJ	M193	3.56 g (55 grain)	960 m/s (3150 fps)	R1-T1-C5-2L
5	R2	5.56 × 45 mm, Copper Jacketed Steel and Lead Core, FMJ	M855	4.0 g (62 grain)	930 m/s (3050 fps)	R2-T1-C5-2L
6	R3	7.62 × 39 mm, Mild Steel Core (Type 56)	Core Hardness HRB 80 ± 5	7.97 g (123 grain)	716 m/s (2350 fps)	R3-T1-C5-2L
7	R4	7.62 × 51 mm, NATO Ball, Copper Jacketed Lead Core, FMJ	M80 Ball	9.65 g (149 grain)	838 m/s (2750 fps)	R4-T1-C5-2L
8	R7	.30-06 Caliber Rifle, Copper Jacketed Steel Core, APM2, (AP)	Original Ammunition Design	10.75 g (166 grain)	868 m/s (2850 fps)	R7-T1-B3-2L
9	R9	.50 caliber (12.7 × 99 mm) Rifle, APM2 (AP), Copper Jacketed steel core	Original Ammunition Design	45.94 g (709 grain)	887 m/s (2910 fps)	R9-T1-S-2L

testing, used to determine the BRC of a test specimen (see Table 2 for witness material thickness and makeup; see Table 1 for BRC criteria).

3.1.9 *witness material impact, n*—any part of the test projectile or the test specimen, or both, which impacts the witness material.

3.1.9.1 *Discussion*—A witness material impact will not necessarily result in a perforation of the witness material as described in 9.4, for example, if witness material dents but no perforation occurs.

3.1.10 *witness material penetration, n*—when any part of the test projectile or the test specimen, or both, makes a hole (perforation) in the witness material as described in 9.4.

3.2 *Abbreviations:*

3.2.1 *Bullet Types:*

3.2.1.1 *AP*—Armor Piercing bullet

3.2.1.2 *API*—Armor Piercing Incendiary bullet

3.2.1.3 *BT*—Boat Tail bullet

3.2.1.4 *BTHP*—Boat Tail Hollow Point bullet

3.2.1.5 *FMJ*—Full Metal Jacket bullet

3.2.1.6 *FN*—Flat Nose bullet

3.2.1.7 *JHP*—Jacketed Hollow Point bullet

3.2.1.8 *JSP*—Jacketed Soft Point bullet

3.2.1.9 *MSC*—Mild Steel Core bullet

TABLE 2 Witness Material Thickness and Makeup

Performance Level	Witness Material Thickness and Makeup
O	0.051 mm (0.002 in.) thick Aluminum Alloy Material (that is, 5052)
L	0.51 mm (0.020 in.) thick 2024-T3 or 2024-T4 Aluminum Alloy Sheet

3.2.1.10 *RN*—Round Nose bullet

3.2.1.11 *SJHP*—Semi-Jacketed Hollow Point bullet

3.2.1.12 *SP*—Soft Point bullet

3.2.2 *Other Abbreviations:*

3.2.2.1 *AIC*—ammunition identity classification

3.2.2.2 *A"x"*—Additional Test Rounds

3.2.2.3 *BRC*—Ballistic Resistance Class

3.2.2.4 *BTI*—Ballistic Test Identity

3.2.2.5 *D1*—distance from muzzle to test specimen

3.2.2.6 *D2*—distance from velocity sampling to test specimen

3.2.2.7 *fps* —feet per second

3.2.2.8 *FSP*—Fragment Simulating Projectiles

3.2.2.9 *ft*—feet

3.2.2.10 *H"x"*—Handgun Rounds

3.2.2.11 *lm*—lumen

3.2.2.12 *mm*—millimeter

3.2.2.13 *m/s*—meters per second

3.2.2.14 *N/A*—not applicable

3.2.2.15 *rcc*—right circular cylinders

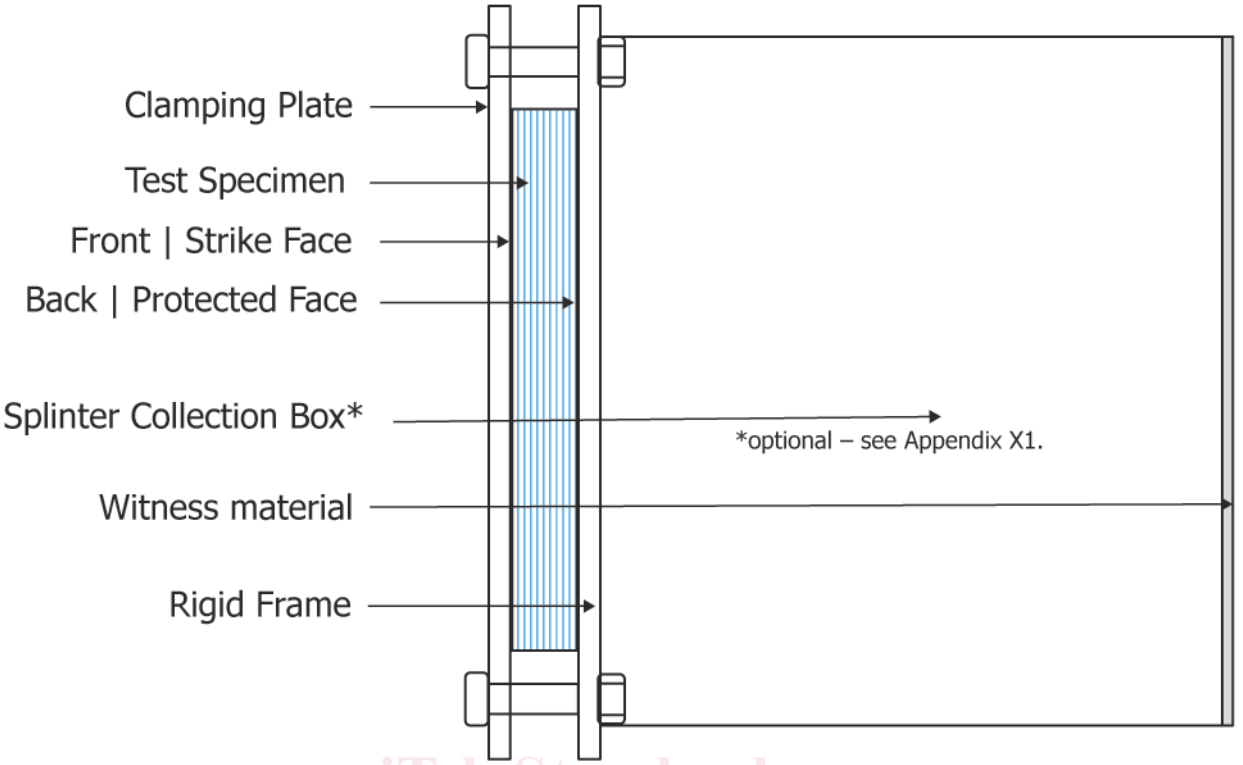
3.2.2.16 *R"x"*—Rifle Rounds

3.2.2.17 *S"x"*—Shotgun Rounds

3.2.2.18 *T"x"*—Temperature category

4. Summary of Test Method

4.1 The ballistic resistance of the glazing shall be determined by ballistics testing only, using the following: the setup shown in Fig. 1, a threat selected from Table 1 or Table X1.1,



NOTE 1—Not drawn to scale.

FIG. 1 Example of Test Set-up

witness material selected from Table 2, temperature condition(s) selected from Table 3, and a shot pattern selected from Figs. 2-6. The results of ballistic testing will determine the glazing's Ballistic Resistant Class (BRC) from Table 4, and its resultant Ballistic Test Identity (BTI) from Fig. 5).

5. Significance and Use

5.1 This test method provides a basis for the comparative evaluation of the ballistic resistance of security glazing and should not be used to establish or confirm the absolute prevention of damage, harm, or injuries from such attacks.

5.2 Ballistic threat levels and corresponding test ammunition of historical commercial significance are indicated in Table 1. The description, weights, and velocities have been updated to correspond with available and in-use ammunitions. If a user desires to utilize these threat levels, then the BTI for the corresponding Threat/Performance level needs to be met.

TABLE 3 Test Specimen Temperature Categories Summary

Category	Description	Min. Total Number of Test Specimens	Conditioning Time	Conditioning Temperature
T1	Ambient Temperature Test	1	Specimen – minimum 3 h	+20 °C ± 3 °C (+68 °F ± 5 °F)
T2	High Temperature Test	1	Specimen – minimum 3 h	+49 °C ± 3 °C (+120 °F ± 5 °F)
T3	Low Temperature Test	1	Specimen – minimum 3 h	–29 °C ± 3 °C (–20 °F ± 5 °F)
T4	Tested at both High (T2) and Low (T3) Temperature	2 (one for T2 and one for T3)	See T2 and T3	See T2 and T3
T5	Tested at Ambient (T1), High (T2), and Low (T3) Temperature	3 (one each for T1, T2, and T3)	See T1, T2, and T3	See T1, T2, and T3
T6	Temperature Gradient Test (Winter)	1	Strike Face of Specimen – 3 h Edges and Protected Face of Specimen – 3 h	–29 °C ± 3 °C (–20 °F ± 5 °F) +20 °C ± 3 °C (+68 °F ± 5 °F)
T7	Temperature Gradient Test (Summer)	1	Strike Face of Specimen – 3 h Edges and Protected Face of Specimen – 3 h	+49 °C ± 3 °C (+120 °F ± 5 °F) +20 °C ± 3 °C (+68 °F ± 5 °F)
T8	Multi-Gradient Temperature, Tested at both Winter (T6) and Summer (T7)	2 (one for T6 and one for T7)	See T6 and T7	See T5 and T6

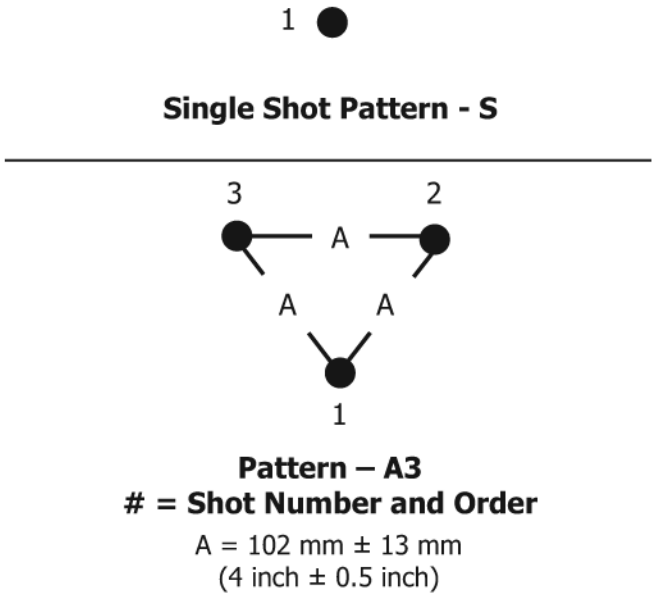


FIG. 2 Single and "A" Shot Patterns and Sequence

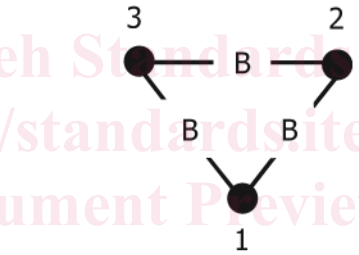


FIG. 3 "B" Shot Pattern and Sequence

Additional threat level(s) and corresponding test ammunition are included in Table X1.1.

6. Apparatus

6.1 *Test Weapon*—See 3.1.6.

6.2 *Test Projectiles*—See 3.1.7.

6.2.1 Hand-loaded ammunition may be required to achieve acceptable range of bullet velocities.

NOTE 1—Threat/performances levels are defined in Table 1. Additional ammunition and performance criteria and ratings may be obtained using information and test parameters offered in this test method and designated using the Ballistic Test Identity (BTI) – see Fig. 5. Further ammunition offerings are in Table X1.1.

6.3 *Velocity Measurement System*—The velocity measurement system shall be capable of providing projectile velocities with at least a 1×10^{-6} s sampling resolution and an accuracy of at least ±1.5 m/s (±5 ft/s). The system shall maintain position and alignment throughout the testing sequence and shall minimize the effects of shock waves, sound waves, ultraviolet and infrared light, ejected propellant, sabots and other debris that can decrease measurement accuracy. Redundant velocity measurement system is required.

6.3.1 If radar, high-speed video, or X-ray is used for velocity measurement, the velocity reported shall be either the

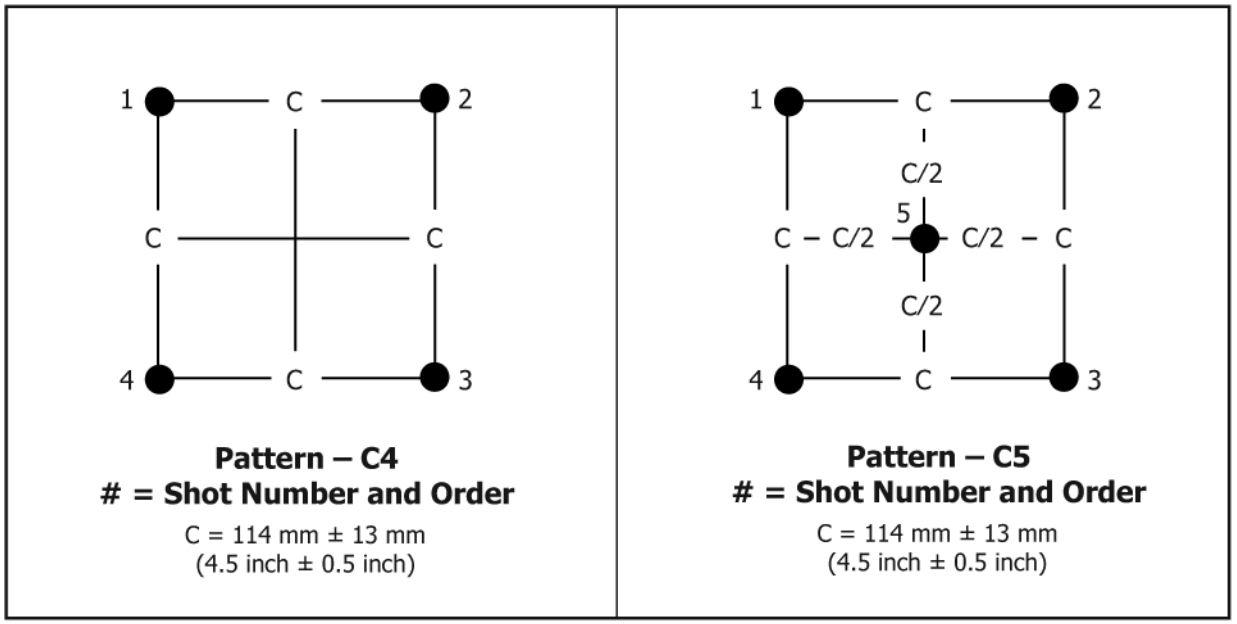
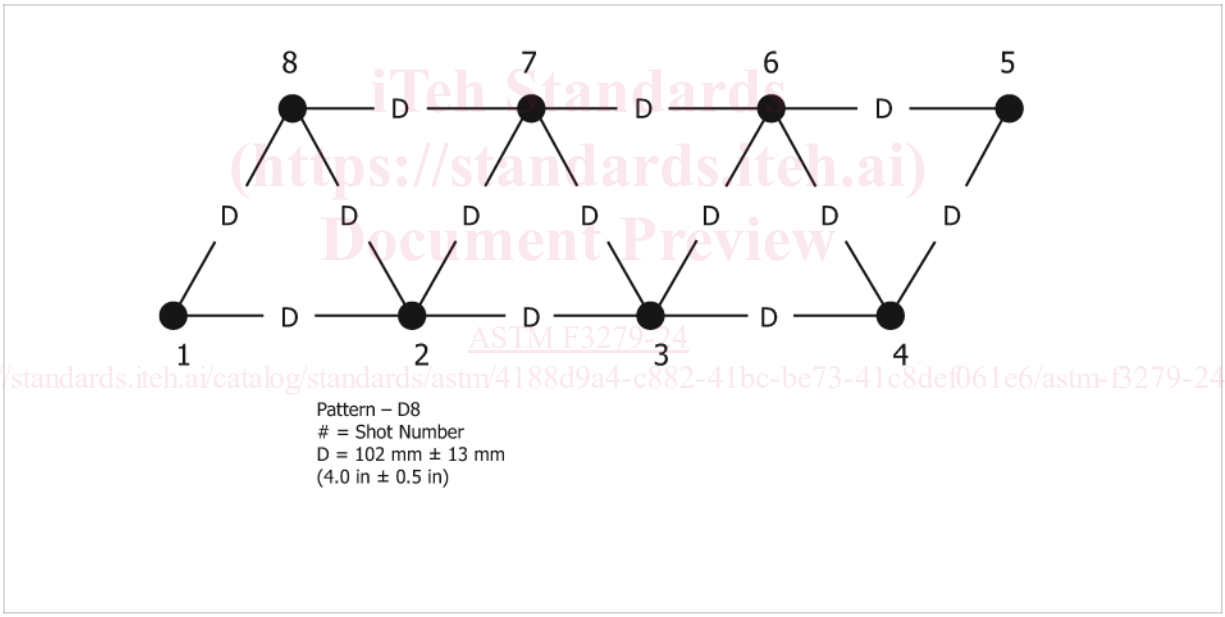


FIG. 4 "C" Shot Patterns and Sequence



NOTE 1—No required sequence but debris from prior shots should not accumulate so as to influence the testing results.

FIG. 5 "D" Shot Pattern

velocity measured at the location given in Table 3 of Specification E3062 or the velocity measured at the test specimen as specified.

6.3.2 If light screens are used for velocity measurement, the requirements in 6.3.2.1 – 6.3.2.5 shall be met.

6.3.2.1 The light screens shall be positioned as shown in Specification E3062.

6.3.2.2 The inner screens shall be paired together, and the outer screens shall be paired together.

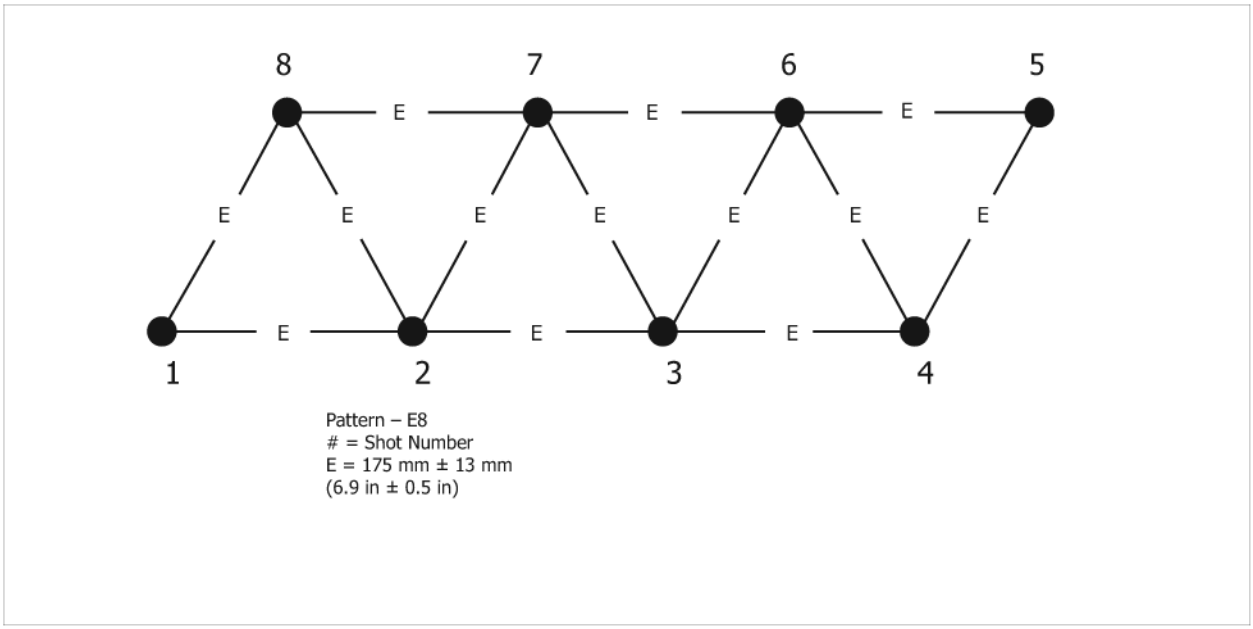
6.3.2.3 The light screen pairs shall be parallel to each other and perpendicular to the projectile firing system barrel.

6.3.2.4 The distance from the last light screen to the test specimen reference plane shall be no greater than 1.5 m (5 ft).

6.3.2.5 The light screens shall be fastened together to prevent inadvertent changes in spacing.

NOTE 2—The spacing between the light screens may be adjusted to meet velocity measurement requirements.

6.4 *Support Fixture and Frame*—The test specimen shall be mounted in the frame along the full length of all specimen edges.



NOTE 1—No required sequence but debris from prior shots should not accumulate so as to influence the testing results.

FIG. 6 "E" Shot Pattern

TABLE 4 Ballistic Resistant Class (BRC) Criteria Summary

BRC	Witness Material Performance Thickness (T); Table 2	Witness Material Impact Allowed	Witness Material Penetration Allowed
1O	O	No	No
1L	L		
2O	O	Yes	No
2L	L		
3O	O	Yes	Yes[A]
3L	L		

[A] No perforation formed by spall in the witness material may be greater than 3 mm (0.125 in.) in length or width when measured as presented.

6.4.1 The frame shall have a clamping plate to hold the glazing in position and means for producing uniform clamping of the glazing.

6.4.2 All edges of the test specimen shall be uniformly clamped with a clamping pressure sufficiently large that the edges remain in position during the test.

NOTE 3—The clamping pressure has relatively little effect on the test results for glass but can have considerable influence on the test results for plastic glazing sheet materials. For these materials, the manner of support and retention shall be reported.

6.4.3 The specimen shall have an edge support/coverage on all edges of 25 mm ± 6 mm (1 in. ± 0.25 in.). The specimen shall be separated from the frame and the clamping plate by continuous rubber strips, 5 mm ± 0.5 mm (0.197 in. ± 0.02 in.) thick, 30 mm ± 5 mm (1.18 in. ± 0.197 in.) wide, and of hardness (50 ± 10) IRHD, in accordance with Test Method D1415.

NOTE 4—The rigidly supported fixture prevents specimen translation along the line of flight but permits its position and attitude to be readily adjusted so that it is perpendicular to the line of flight at the projectile point of impact.

6.4.4 The test specimen in the frame shall be placed normal to the direction of attack with an accuracy of ±1°(degree) in any orientation. Test specimen shall be oriented to strike face in accordance with manufacturer's documentation. Manufacturer shall clearly mark the strike face on each specimen. The support and retention system shall be reported.

6.5 *Witness Material and Dimensions:*

6.5.1 *Witness Material Thickness and Makeup*—Select witness material thickness and makeup from Table 2 for the desired safety performance described in X1.3.

6.5.2 *Witness Material Mounting*—The witness material shall be securely mounted perpendicular to the projectile line of flight and rigidly affixed to its support so that it remains in position throughout the test to minimize the likelihood of premature tear or excessive in-plane displacement at material supports. A singular witness material shall be spaced at a distance consistent with the Ballistic Resistant Class (BRC) shown in Table 4. Witness material shall be spaced 152 mm ± 13 mm (6 in. ± 0.5 in.) beyond the back face of a test specimen.

6.5.3 *Witness Material Length and Width*—The witness material shall be centered on either the current shot, or the shot pattern as a whole (see Figs. 2-6 for shot patterns), as appropriate. The size of the witness material shall be in accordance with Table 5 and sufficiently large to cover the affected area by adding a minimum of 152 cm (6 in.) on all sides.