



Standard Test Method for Security Glazing Materials And Systems¹

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1. Scope

1.1 This test method sets forth procedures whose purpose is limited to the evaluation of the resistance of security glazing materials and systems against the following threats:

- 1.1.1 *Ballistic Impact,*
- 1.1.2 *Blunt Tool Impacts,*
- 1.1.3 *Sharp Tool Impacts,*
- 1.1.4 *Thermal Stress,* and
- 1.1.5 *Chemical Deterioration.*

NOTE 1—Specifically exempted from this test method are the use of power (motor or engine-driven) tools or devices, explosives, military ordinance (excepting small arms) and tools, processes or devices requiring more than two persons to transport and operate.

1.2 The values stated in inch-pounds are to be regarded as the standard. The values given in parentheses are for information only.

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 and health practices and determine the applicability of regulatory limitations prior to use.* For a specific warning statement, see Warning in 9.1.1.6.

2. Referenced Documents

2.1 ASTM Standards:²

- A 36/A 36M Specification for Carbon Structural Steel
- A 53/A 53M Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
- A 574 Specification for Alloy Steel Socket-Head Cap Screws
- F 1029 Guide for Selection of Physical Security Measures for a Facility

2.2 Other Documents:

Sporting Arms and Ammunition Manufacturer's Institute

- (SAAMI)—Ammunition³
- United States Military Ammunition Specifications—Ammunition⁴
- Federal Specification GGG-313U—Cold Chisel⁵
- American Iron and Steel Institute M-1020—Structural Steel⁶
- UL 10BC—Fire Extinguisher⁷

3. Terminology

3.1 Definitions:

3.1.1 *test director*—the individual identified by the independent testing laboratory as being responsible to complete the specified tests as required and to document the results.

4. Summary of Test Method

4.1 Forced entry shall be determined by resistance of the glazing material or system to the following:

- 4.1.1 Ballistics attack only.
- 4.1.2 Physical attack only to include blunt tool impacts, sharp tool impacts, thermal stress, and chemical deterioration.
- 4.1.3 Ballistics attack followed by, and in combination with, physical attack.

5. Significance and Use

5.1 This test method is based on field experience rather than laboratory analysis. It provides a basis for the comparative evaluation of ballistic/forced entry/containment resistance of security glazings and systems and should not be used to establish or confirm the absolute prevention of forcible entries or forced exits. This test method defines three factors which determine the success or failure of any attempt to forcefully enter (or exit) the glazing or system. They are: (1) the tools employed, (2) the techniques and methods used by the attackers, and (3) the total time available to effect the entry or exit.

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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 General Services Adm., 7th and D Sts. SW, Washington, DC 20407.

⁶ Available from American Iron and Steel Institute (AISI), 1101 17th St., NW, Suite 1300, Washington, DC 20036.

⁷ Available from Underwriters Laboratories (UL), Corporate Progress, 333 Pfingsten Rd., Northbrook, IL 60062.

This test method defines two of the three factors (tools and techniques) and allows the third (duration) to vary in order to establish levels of forced entry or exit resistance.

6. Apparatus (Ballistics)

6.1 *Ballistic Firing Devices*—Firearms or test barrels suitable for use with the following calibers of ammunition producing minimum velocities as required:

- 6.1.1 *.38 Special*, 158 grain (10.2 g), lead,
- 6.1.2 *.357 Magnum*, 158 grain (10.2 g), jacketed soft point,
- 6.1.3 *9 mm*, 124 grain (8.0 g), full metal casing,
- 6.1.4 *.44 Magnum*, 240 grain (15.6 g), lead gas check,
- 6.1.5 *.223 (5.56 mm, M193 Ball)*, 55 grain (3.6 g), full metal casing,
- 6.1.6 *.30-'06*, 180 grain (11.7 g), soft point,
- 6.1.7 *.308 Winchester (7.62 mm, M80 Ball)*, 147 grain (9.5 g), full metal casing,
- 6.1.8 *.30-'06*, 164 grain (10.6 g), M2-AP (armor piercing),
- 6.1.9 *12 gage, 3 in. Magnum*, 00 Buckshot, 15 pellets, and
- 6.1.10 *12 gage, 1 oz. (437.5 grain, 28.3 g)*, rifled slug.

6.2 *Ammunition/Standard Specification Ballistic Protection Levels*—All ammunition used in conducting tests within this test method shall be manufactured in compliance with current configurations and standards established by the Sporting Arms and Ammunition Manufacturer's Institute (SAAMI) or United States Military Specifications as applicable, except as may be noted within this test method. This test method shall be defined by the following ballistic threat levels:

6.2.1 *Caliber 9 mm Parabellum/Submachine Gun*—Ammunition conforming to U.S. Military specifications for caliber 9 mm NATO 124 grain copper jacket producing velocities of 1400 (± 50) ft per s (425 (± 15) m per s) at 15 ft (4.5 m) from the muzzle.

6.2.2 *Caliber .44 Magnum/Handgun*—Ammunition conforming to SAAMI specifications for caliber .44 Magnum, 240 grain, soft point producing velocities of 1450 (± 50) ft per s (425 (± 15) m per s) at 15 ft (4.5 m) from the muzzle.

6.2.3 *Caliber .38 Super/Handgun*—Ammunition conforming to SAAMI Specifications for caliber .38 super, 130 grain, metal case producing, velocities of 1280 (± 50) ft. per s (390 (± 15) m per s) at 15 ft (4.5 m) from the muzzle.

6.2.4 *Caliber 7.62 mm Steel Jacketed NATO/Rifle*—Ammunition conforming to U.S. Military specifications for caliber 7.62 mm NATO, M80 ball producing velocities of 2800 (± 50) ft per s (850 (± 15) m per s) at 15 ft (4.5 m) from the muzzle.

6.2.5 *Caliber .30-'06 Armor Piercing/Rifle (AP)*—Ammunition conforming to U.S. Military specifications for caliber .30-'06, M2AP producing velocities of 2775 (± 50) ft per s (845 (± 15) m per s) at 15 ft (4.5 m) from the muzzle.

6.2.6 *Shotshell 12-gage 3 in. Magnum/Shotgun*—Ammunition conforming to SAAMI specifications for Shotshell 12-gage, 3 in. Magnum, 00 Buckshot producing velocities of 1315 (± 50) ft per s (400 (± 15) m per s) at 15 ft (4.5 m) from the muzzle. The 12-gage ballistic threat is to be used as a confirmatory test of assemblies. Glazing materials are not to be tested or rated against this threat.

6.3 *Witness Material:*

6.3.1 Aluminum foil, kitchen foil, or equivalent, 0.00094 in. (.024 mm) $\pm 10\%$ thick. Alloy may be 8111 or 1100, "0" temper.

6.4 *Instrumentation:*

6.4.1 *Photosensitive Triggering Screens*,⁸

6.4.2 *Chronograph*,⁸

6.4.3 *Thermometer*—Temperature range from +120 to -30°F (+49 to -16°C).

6.5 *Test Frame and Stand:*

6.5.1 Samples of glazing submitted for testing shall be in sizes that would be encountered during normal use, but in no case smaller than 12 by 12 in. (30 by 30 cm) or larger than 29 $\frac{3}{4}$ by 29 $\frac{3}{4}$ in. (75 by 75 cm). The size and configuration of each sample will be such that it can be mounted in a structurally sound, rigid test fixture capable of accommodating a variety of sizes of rectangular samples. The framing must be affixed to the glazing sample in a manner which does not enhance or detract from the ballistic resistance of any portion of the sample to be ballistically impacted. For testing of glazing materials only, the mounting method is not subject to any tests herein.

6.6 *Test Set-Up:*

6.6.1 The sample shall be mounted rigidly (bolted) to the test fixture to produce a zero degree (± 3 degrees (estimated)) obliquity (ZDO) to the path of the bullet. Photosensitive triggering screens shall be positioned 5 and 15 ft (1.5 and 4.5 m) from the threat side of the sample which, in conjunction with an elapsed time counter or direct reading chronograph, shall be used to determine bullet velocities 10 ft (3 m) from the strike face of the sample. The test weapon shall be rigidly mounted at a distance of 25 ft (7.5 m) from the muzzle to the target area of the test assembly. The test weapon shall be aimed to produce a zero degree obliquity trajectory to the target area within the tolerances of this test method.

6.6.2 The witness material shall be securely positioned parallel to, and no more than 6 in. (15 cm) behind (protected side), the target area of the test assembly. Curvilinear features of the target area shall therefore have the witness contoured to parallel these features. The witness material shall be stretched taut.

6.6.3 Should there be reason to suspect bullet flight stabilities, the test director is obligated to implement a paper witness panel, positioned 3 ft (91 cm) in front of the target area. This witness panel shall be inspected following each test firing as to indication of a yawed projectile. Evidence of a yawed or unstable projectile shall constitute an unfair hit, and shall require retesting.

6.6.4 The number and location of ballistic impacts required of this specification are minimum requirements. Further, the test director shall be obligated to conduct zero degree obliquity or oblique firings (as required by design) into the test specimen features that have design features passing completely or partially through the thickness of the glazing to examine all

⁸ The sole source of supply of the apparatus known to the committee at this time is Oehler Research, P.O. Box 9135, Austin, TX 78766. If you are aware of alternative suppliers, please provide this information to ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee¹, which you may attend.

- 7.2.2.3 Integrity of the frame.
- 7.2.2.4 Strength of base material.
- 7.2.2.5 Size of removable stop.
- 7.2.2.6 Removable stop fastener.
- 7.2.2.7 Interface between glazing and frame.
- 7.2.2.8 Integrity of anchorage of glazing system to adjoining architectural features.

7.3 Blunt Impacting Tools:

7.3.1 *Sledge Hammer*, 12-lb (5.5-kg), double-faced, drop-forged steel head with 36-in. (91-cm) handle.

7.3.2 *Pipe*, Steel, 4-in. (10-cm), in accordance with Specification A 53/A 53M, 90° cut-off.

7.3.3 *Ram*, Two man, 120-lb (54-kg), steel with 4 by 4-in. (10 by 10-cm) strike face and two 1-in. (2.5-cm) round handles mounted perpendicular to the longitudinal centerline extending 12 in. (30.5 cm) beyond the extremity of two opposing sides.

7.3.4 *Ball Peen Hammer*, 32-oz (0.5-kg), drop-forged, steel head, with 16-in. (41-cm) handle.

7.4 Sharp Impacting Tools:

7.4.1 *Ripping Bar*—Slotted claw and chisel ends, forged steel, 24 in. (61 cm).

7.4.2 *Cold Chisel*—Conforming to Federal Specification GGG-313U, 7/8-in. (22-mm) edge, 8 in. (20 cm) long, to be struck with 16-oz. (0.25-kg) claw hammer.

7.4.3 *Structural Steel Angle*, 20 by 2 in. (51 by 5 cm), 1/4 in. (6 mm) thick, AISI-M1020, 90° cut-off.

7.4.4 *Pipe*, Steel, 1 1/2 in. (4 cm), Schedule 80, in accordance with Specification A 53/A 53M, 90° cut-off.

7.4.5 *Fireman's Axe-Pick Head*—Drop-forged steel, 6 lb (3 kg), 36 in. (91 cm) long.

7.4.6 *Wood Splitting Maul*, 8-lb (3.5-kg), heat-treated steel head with 3-in. (7.5-cm) cutting edge with 36-in. (91-cm) handle.

7.5 Thermal Stress Tools:

7.5.1 *Fire Extinguisher CO₂*—Steel cylinder, 20 lb (9 kg), conforming to UL 10BC, or equivalent.

7.5.2 *Propane Torch*, 12 to 15-oz (5.5 to 7-kg) cylinder with general purpose Tip No. HT-880-2,9⁹ or equivalent.

7.6 Chemically Deteriorating Materials:

7.6.1 *Gasoline*—American Oil Company unleaded premium, 93 octane or equivalent.

7.6.2 *Solvent*, Containing acetone (minimum of 95 % concentration-technical grade).

7.6.3 *Dispenser*, Hand-operated, pump-type atomizing dispenser similar to that used for dispensing window cleaning solutions and other household products (polypropylene or polyethylene).

7.7 Materials:

7.7.1 *Forced Entry Shape*—A rigid, rectangular shape measuring 8 in. by 8 by 5 in. ($\pm 1/8$ in.) (20 by 20 by 13 cm (± 3 mm)) fabricated from 16 MSG steel.

7.8 Test Personnel:

7.8.1 Six males, muscular (180 to 250 lb (82 to 113 kg)), in good health, who carry out an enthusiastic assault.

7.8.2 No less than two members of the test team will be left-handed, and no less than two shall be right-handed.

7.9 Test Specimens:

7.9.1 *Number of Samples*—All testing is done on a single sample. Replicate testing is to be specified by the purchaser.

7.9.2 Size of Samples:

7.9.2.1 *Base Material Tests*—The size of all transparent glazing material samples will be no larger than 29 3/4 by 29 3/4 in. (75 by 75 cm) or smaller than 12 by 12 in. (30 by 30 cm). Sample size submitted for test shall be the installed size for the intended use, but in no case larger or smaller than the aforesaid dimensions. To facilitate fixturing, the sample thickness shall not be less than 1/4 in. (6 mm) nor more than 2 1/2 in. (0.4 cm). The sample shall be submitted without framing, gaskets, or edging except that which is essential to maintaining any laminar spacing (or sealing of that spacing).

8. Preparation for Test

8.1 *Forced Entry Test Environment*—The location of the forced entry fixturing shall be in a protected environment whose ambient temperature is $72 \pm 5^\circ\text{F}$ ($22 \pm 3^\circ\text{C}$). All test materials will be in this environment for a minimum of 24 h immediately preceding initiation of the test. The area immediately adjacent to the test sample extending 6 ft (1.8 m) to the left and right of either vertical edge of the sample, 10 ft (3 m) from the assault face of the sample, and 8 ft (2.4 m) over the horizontal surface supporting the test (attack) personnel, shall be free of all obstructions and appurtenances.

8.2 *Ballistic Test Environment*—The location of the ballistic test apparatus shall be in a protected environment whose ambient temperature is essentially at room temperature conditions $72 \pm 5^\circ\text{F}$ ($22 \pm 3^\circ\text{C}$).

8.2.1 *Extreme Temperature Firings*—Extreme temperature ballistic testing of glazing materials intended for use in exterior applications shall be required. One sample shall be required for each of the following tests. The tests must be performed immediately (2 min maximum) after the sample is removed from the conditioning chamber. Glazing intended for interior use only shall have relief from these extreme temperature firings but must be permanently labelled FOR INTERIOR USE ONLY.

8.2.1.1 *High-Temperature Test*—Condition sample for 3 h at $+120 \pm 5^\circ\text{F}$ ($+49 \pm 3^\circ\text{C}$).

8.2.1.2 *Cold-Temperature Test*—Condition sample for 3 h at $-20 \pm 5^\circ\text{F}$ ($-29 \pm 3^\circ\text{C}$).

8.2.1.3 *Temperature Gradient Test (Winter)*—Condition strike face of sample for 3 h at $-20 \pm 5^\circ\text{F}$ ($-29 \pm 3^\circ\text{C}$) with edges and rear face at ambient ($+70 \pm 10^\circ\text{F}$ or $21 \pm 5^\circ\text{C}$).

8.2.1.4 *Temperature Gradient Test (Summer)*—Condition strike face of sample for 3 h at $+120 \pm 5^\circ\text{F}$ ($48 \pm 3^\circ\text{C}$) with edges and rear face at ambient ($+70 \pm 10^\circ\text{F}$ or $21 \pm 5^\circ\text{C}$).

9. Procedures

9.1 *Ballistic Test*—Five primary ballistic levels (see 6.2) establish varying degrees of protection. A sixth level, shotgun, is used to further evaluate the ability of designed-through openings to resist fragmentary threats.

⁹ The sole source of supply of the apparatus known to the committee at this time is Turner Companies, 821 Park Ave., Sycamore, IL 60178. If you are aware of alternative suppliers, please provide this information to ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee¹, which you may attend.

9.1.1 *Procedure*—Ammunition of the appropriate type and caliber shall be single fired to obtain the required number of fair hits on each glazing sample according to Table 1. The separation between any two ballistic impacts on a single contiguous area of glazing shall be no less than 4 in. (10 cm) center-to-center.

9.1.1.1 After each firing, the witness panel on the protected side shall be inspected visually. Only a complete perforation of the witness panel, whether by bullet fragments or material from the test sample (spall), shall be classified as a “penetration.” Any perforation of the witness panel through which the light from 40-W lamp can be detected shall be termed a “penetration.” Impacts which produce any other results will be classified as “no penetration.” These definitions shall apply whether or not the test sample has been completely perforated.

9.1.1.2 For purposes of this test method, a fair hit shall be a zero degree obliquity ballistic impact ($\pm 3^\circ$) using the specified weight and type of unyawed bullet (3° maximum) within the specified velocity range on the specified location of the test sample. All other firings shall be classified as unfair except:

9.1.1.3 An impact at less than the minimum acceptable velocity which results in penetration but which is otherwise a fair hit shall be classified as a fair hit.

9.1.1.4 An impact at more than the maximum acceptable velocity which does not produce penetration but which is otherwise a fair hit shall be classified as a fair hit.

9.1.1.5 Oblique shots required by the test director because of suspected weak points.

9.1.1.6 All firings shall be conducted after the sample has been conditioned to the ambient temperature range for a maximum of 4 h and shall continue until the required number

of non-penetrating fair hits or a single penetrating fair hit is (are) obtained, whichever occurs first. (**Warning**—Personal safety during ballistic tests is paramount and shall be strictly enforced by the test director to preclude injury to those persons conducting or observing the tests, or both.)

9.1.2 *Data*—Data records of each firing will be maintained and submitted with the test report by the testing laboratory, and shall include the following:

9.1.2.1 Complete identification of the test sample.

9.1.2.2 Ballistic rating of test sample (see Annex A2).

9.1.2.3 Temperature of the test sample, if different from the ambient temperatures.

9.1.2.4 Type and lot number of the test ammunition.

9.1.2.5 Velocity and impact location of each shot.

9.1.2.6 Fair/unfair, penetration/no penetration, and spall/no spall determination of each shot.

9.1.2.7 Date, location, and ambient temperature of the test.

9.1.2.8 Photograph (test director’s and manufacturer’s option) of sample before and after each shot or complete test, or both.

9.1.3 *Reporting*—After completion of all testing, a comprehensive test report shall be prepared by the test laboratory which will specify the date, location, and results of the test and shall include, as appendices thereto, all data and photographs (see 9.1.2).

9.1.4 *Acceptance Criteria*—Where samples are submitted for *ballistic rating*, any fair hit which produces a “penetration” shall be cause to reject the sample and prohibit the labelling and use of that design of that glazing type as a bullet-resisting element for the ballistic rating tested, regardless of the number of other fair hits which did not produce “penetration.”

TABLE 1 Ballistic Criteria

Class/Level	Weapon Description	Caliber	Bullet Mass ^A /Type ^B	Velocity ^C , ft/s (m/s)	Minimum No. of Impacts ^D
HG1	Handgun - Low	.38 Special	158 gr (10.2 g), lead	850–900 (259–274)	3
HG2	Handgun - Medium, Soft Point	.357 Magnum	158 gr (10.2 g), JSP	1350–1450 (381–411)	3
HG3	Handgun - Medium, Jacketed	9 mm	124 gr (8.0 g), FMC	1200–1300 (365–396)	3
HG4	Handgun - High	.44 Magnum	240 gr (15.6 g), LGC	1400–1450 (427–442)	3
SMG	Submachine-gun	9 mm	124 gr (8.0 g), FMC	1400–1500 (426–457)	3
R1	Rifle - Light	.223 (5.56 mm)	55 gr (3.6 g), M193 Ball, FMC	3200–3300 (975–1006)	3
R2	Rifle - Heavy, Soft Point	.30-'06	180 gr (11.7 g), SP	2850–3000 (867–914)	3
R3	Rifle - Heavy, Jacketed	.308 Winchester (7.62 mm)	147 gr (9.5 g), M80 Ball, FMC	2700–2800 (823–853)	3
R4-AP	Rifle - Armor Piercing	.30-'06	164 gr (10.6 g), M2-AP	2750–2850 (838–867)	1
SH1 ^E	Shotgun - Buckshot	12 gage, 3 in. Magnum	00 buckshot, 15 pellets	1150–1250 (350–381)	1 ^F
SH2	Shotgun - Slug	12 gage	1 oz. (437.5 gr, 28.3 g) rifled slug	1600–1700 (487–518)	3

^A gr denotes grain as a unit of mass: 1 gr = 1.429 × 10⁻⁴ lb (0.0647981 g)

^B FMC = Full Metal Casing, JSP = Jacketed Soft Point, LGC = Lead Gas-Check, and SP = Soft Point.

^C Velocity measured at a distance of 10 ft (3 m) from the strike face of the sample. Muzzle of the barrel is positioned at a distance of 25 ft (7.6 m) from the strike face of the sample.

^D Minimum number of shots required on glazed features plus additional shots to examine other features of the assembly. Prior to testing the intended impact location(s) shall be marked in the approximate center of the target area. Where 3 impacts are specified, they are to be located at the corners of a 5 in. (127 mm) equilateral triangle. The minimum spacing between impact locations is 4 in. (102 mm).

^E This ammunition is to be used as an adjunct to the primary test to further evaluate the ability of designed assembly details to resist fragmentary threats.

^F The shot pattern of the pellets shall be such that they all impact within an 8 in. (203 mm) diameter circle at a distance of 25 ft (7.62 m) from the muzzle of the weapon.

9.1.5 *Resubmission*—Failure of any glazing material to demonstrate full compliance with the requirements of 9.1.1 does not preclude the modification and resubmission of that design of the glazing for retesting. All such retesting shall be conducted in accordance with the full range of the requirements of this test method even though the glazing may have demonstrated partial compliance with the requirements of this test method.

9.2 *Forced Entry Testing:*

9.2.1 Any glazing sample or assembly to be evaluated as a forced entry barrier shall be subjected to forced entry testing in accordance with 9.2.4 and 9.2.5.

9.2.2 *Optional Ballistic Testing*—When required ballistic testing may be performed on any glazing sample in accordance with 9.1. Following ballistic testing, the same sample will be subjected to forced entry testing.

9.2.3 *Optional Ballistic Testing Acceptance Criteria*—When forced entry samples are being tested for ballistics, “spall penetration” shall be noted but is not cause for rejection of the sample.

9.2.4 *Forced Entry Acceptance Criteria*—Any glazing sample breached sufficiently to allow the following categories shall be determined to have been forcibly entered.

9.2.4.1 *Passage of Contraband*—Any penetration of the glazing material such that a 1/8-in. (3-mm) diameter solid shape can be probed and passed through the glazing test specimen will be considered a failure for the passage of contraband by forcible entry. These criteria will apply whether free passage of the shape is made through a hole in the glazing or through the gap created by dissociation of the glazing material from its frame.

9.2.4.2 *Body Passage*—Any opening in the glazing that is sufficient to freely pass a solid incompressible rectangular object measuring 8 by 8 by 5 in. (20 by 20 by 13 cm) constitutes a failure by forcible entry. Free passage is defined as passing the object through the opening with an applied force no greater than 10 lb (4.4 N). This criterion will apply whether

the free passage of the shape is made through a hole through the glazing or through the gap created by dissociation of the glazing material from its frame.

9.2.4.3 *Flame Test*—After removal of the flame of the propane torch and immediately extinguishing any self-sustained burning for Class II (Table 2, Sequence 6), or removal of the flame and the 10-min self-sustained burning period for Classes III, IV, and V (Table 2, Sequences 11, 20, 31), the sample will be determined to have been forcibly entered if:

(a) The size of any hole entirely through the sample of Class II created by the propane torch application allows passage of contraband (see 9.2.4.1) or body passage (see 9.2.4.2), or,

(b) The burning of the sample of Classes III, IV, and V is self-sustaining for a period of 10 min, and the size of any hole through the sample (whether created previously or by the flame test) increases in size by self-sustained burning to allow passage of contraband (see 9.2.4.1) or body passage (see 9.2.4.2).

9.2.5 *Forced Entry Test*—The glazing test sample shall be tested in accordance with the sequence of Table 2 until entry is forced.

9.2.6 *Data*—Data records of all testing will be maintained and submitted with the following:

9.2.6.1 Complete identification of the test sample.

9.2.6.2 Forced entry rating of test sample (see Annex A2).

9.2.6.3 Temperature of the test sample, if different from ambient.

9.2.6.4 Complete description of the attack, including number of attackers, tools, impacts, and overall time of the attack.

9.2.6.5 Specific features of the sample attacked, tools used to attack that feature, and elapsed time for each segment of the attack.

9.2.6.6 Date, location, and ambient temperature of the test.

9.2.6.7 Photographs of the sample before and after testing.

9.3 *Combined Ballistic and Forced Entry Testing:*

TABLE 2 Forced Entry Sequence of Testing

Test Implements	Class I Sequence	Class II Sequence	Class III Sequence	Class IV Sequence	Class V Sequence
Blunt Impacting (Impacts)					
Sledge Hammer (25)	A	5	10, 16	19, 22, 27	30, 33, 36, 39
4-in. (10-cm) Diameter Pipe/Sledge (25)	A	A	9	18	29
Ram (10)	A	A	8	17	28
Ball Peen Hammer (10)	1	2	A	A	A
Sharp Tool (Impacts)					
Ripping Bar (10)	A	7	12	23	A
Chisel/Hammer (25)	A	A	13	25	35, 40
Angle Iron/Sledge (25)	A	A	15	A	A
1½-in. (4-cm) Diameter Pipe/Sledge (25)	A	3	A	A	A
Fire Axe (25)	A	A	A	24	32, 38
Wood Splitting Maul (25)	A	A	A	21	34, 41
Thermal Stress (Minutes)					
Extinguisher, CO ₂ (1)	A	4	A	A	A
Propane Torch (5)	A	6 ^B	11 ^C	20 ^C	31 ^C
Chemical Deterioration (Amount)					
Gasoline (½ Pint) (¼ L)	A	A	14	A	A
Acetone (½ pint) (¼ L)	A	A	A	26	37
Total Forced Entry Sequences:	1	7	16	27	41

^A Not Applicable.

^B For Class II, the flame shall be extinguished with a fine mist of water immediately after the propane torch application.

^C For Classes III, IV, and V, if the sample continues to burn after removal of the flame (self-sustaining), it shall be allowed to burn an additional 10 min and then extinguished with a fine mist of water.

9.3.1 Certain type of glazing or assemblies may require a combination of ballistics and forced entry attack. These requirements shall be specified at the time the testing criteria are established for a particular test sample.

9.3.2 *Procedure*—When required, the sample will be subjected to the ballistics testing as detailed in 9.1. Following ballistics testing, the same sample will be subjected to the forced entry test as detailed in 9.2.

10. Keywords

10.1 asset level; ballistic attack in combination with physical attack; ballistic impacts; ballistic penetration; blunt tool impacts; body passage; chemical deterioration; forced entry; glazing classification; glazing system tests; passage of contraband; relation ballistic threats; security glazing; security glazing materials; security glazing systems; spall; thermal stress; threat level; witness plate

ANNEXES

(Mandatory Information)

A1. PHYSICAL IMPLEMENT TESTING

A1.1 *Scope*—This test method sets forth the test procedures to be used to determine the forced entry protection characteristics of glazing materials or systems intended for use in buildings and structures (or portions thereof) which have been identified as those structural features likely to come under forced entry or forced exit attack.

A1.1.1 The procedures of these tests are intended to impose the most stringent requirements on each glazing tested within the constraints of personal endurance, tools, and time to assault discussed in 7.3, 7.4, 7.5, 7.6, and 9.2.5.

A1.2 *Precision and Bias*—No statement is made about either the precision or bias of the test method for measuring forced entry resistance since the result merely states whether there is conformance to the criteria for success specified in the procedure.

A1.2.1 The precise scientific identification and reproduction of the forced entry threat likely to be encountered in the field is not possible within reasonable constraints of cost. For example, the maximum force produced by a 12-lb (5.5-kg) sledge hammer is dependent on a variety of human indeterminables descriptive of the attacker—height, weight, arm length, physical conditioning, enthusiasm, etc. Even if this force were known, its precise, repeated reproduction could not, within reasonable costs and elapsed testing times, reproduce the unlimited capacity of the brain to sense weaknesses and minutely adjust the point and angle of the impact to exploit these weaknesses.

A1.3 *Blunt Instrument Testing*—During the conduct of all phases of blunt impact testing, the test director will continually note the vigor of each member of the team. Should, in his sole judgment, any member of the attack team be less than vigorous in conducting these tests he will immediately suspend the test and replace that attacker.

A1.3.1 *Ram Test*—Ten blows will be applied to the assault face of the sample midway between the vertical edge of the sample and at that height which is most accommodating to the physical make-up of the attackers and which will produce the maximum impact force on the assault face of the sample.

A1.3.2 *Sledge Hammer Test*—Two attackers, one left-handed and one right-handed, equipped with 12-lb (5.5-kg)

sledge hammers will deliver 25 impacts to the attack face of the test sample. The location of 25 blows will be indicated by the test director who will direct these blows to that portion of glazing which, in his judgment, is most likely to result in a forced entry.

A1.3.3 *Pipe/Sledge Hammer Test*—This phase of the test is to be carried out by two attackers one of whom is to position the pipe with either end bearing on the transparency while the other attacker impacts the other end with a 12-lb (5.5-kg) sledge hammer. The test will be conducted by repeated impacting at one location if in the judgment of the test director, impacting at that location will result in forced entry. The angle between the centerline of the pipe and the plane of the surface of the impacted area should be varied to examine the resistance of the transparency to both puncture (90°) and gouging (45° to 60°).

A1.3.4 *Exploitation of Pre-Weakened Areas*—The blunt instrument impacting is to be directed, whenever applicable according to established test sequences, at locations preweakened by other phases of the test such as sharp tool notching, heating, cooling, and the like.

A1.4 *Sharp Instrument Testing*—No procedural verification of the sharp impacting tools and implements shall be required except that the test director shall inspect all tools and implements to ensure they have been unused since sharpening (cold chisel, fire-axe, and wood splitting maul) and their edges are sharp corners (angle iron and pipe).

A1.4.1 *Chisel/Hammer Test*—This phase of the test is to be carried out by an attacker who is equipped with a cold chisel and ball peen hammer.

A1.4.1.1 The chisel attack will be a direct attack on areas of the test sample preweakened by previous phases of the test and, when applicable, against portions of any plastic materials (acrylics, polycarbonates, etc.) which have been exposed by removal of glass layer(s) on the attack side. The test director may, at any time during this test, direct the attacker to direct his attack at any specific location of the test sample (transparent or nontransparent elements).

A1.4.2 *Angle Iron/Sledge Hammer Test*—This phase of the test is to be carried out by two attackers, one of whom is to position the angle iron against the face of the transparent

element. The second attacker is to impact the other end of the angle iron with a 12-lb (5.5-kg) sledge hammer.

A1.4.3 Pipe/Sledge Hammer Test—This phase of the test is to be conducted in accordance with the provisions and procedures of A1.4.2, substituting the 1½-in. (4-cm) steel pipe for the angle iron.

A1.4.4 Fire-Axe Test—The fire-axe phase of the test is to be carried out by two men, one left-handed and one right-handed, who are equipped with pick-head fire-axes. Unless otherwise directed by the test director, one is to impact the sample with the pick end of the head and the other with the blade of the head, and all impacts are to be directed at the transparent element during an assembly test.

A1.4.5 Wood Splitting Maul—This phase of the test is to be carried out in accordance with the procedures of the Fire-Axe Test (see A1.4.4).

A1.5 Thermal Testing:

A1.5.1 CO₂ Extinguisher Test—The CO₂ extinguisher test is to be carried out by two men, one of whom is to be equipped with a sufficient number of CO₂ extinguishers to provide for a total discharge time of 1 min (2 to 3 fully charged extinguishers) and the other with a 12-lb (5.5-kg) sledge hammer required by the sequence following the thermal (CO₂ extinguisher) phase. See Table 2.

A1.5.1.1 Unless otherwise directed, the extinguishers will be sequentially and fully discharged onto the attack side of the transparency. Immediately after each extinguisher has been discharged the impact procedures of the next phase of the test will be partially applied to the same location of the transparency, for example, 10 blows with a 12-lb (5.5-kg) sledge hammer. After the total discharge time has been reached, all of the then remaining blunt instrument impacts will be applied to the transparency.

A1.5.1.2 The test director is to ensure that the entire test sequence is conducted as rapidly as possible to optimize the cumulative effects of the thermal conditioning and will ensure that the last impact of the blunt instrument impact phase is no longer than 7 min from the initiation of the first extinguisher discharging.

A1.5.1.3 The test director shall further ensure that the thermal conditioning of the next phase is initiated immediately after the last impact test of the first thermal test, and that both thermal phases and the blunt and sharp impact test associated with the thermal tests are completed within a total elapsed time of 15 min.

A1.5.2 Propane Torch Test—The propane torch test is to be carried out by one person who will continually apply the flame of the propane torch to the sample surface in an effort to create an opening, to enlarge an opening that might have been previously created, or to exploit any apparent weakness in the glazing sample or system to facilitate penetration in a later step

of the attack sequence. Any ash or char that is developed during the course of this portion of the test may not be removed until the beginning of the next step in the attack sequence. Throughout this portion of the test the blue tip of the torch flame shall be held no further than 1 in. (2.5 cm) from the surface of the sample or ash.

A1.5.2.1 After removal of the flame of the propane torch from the test sample for Class II (Table 2), the flame shall be immediately extinguished with a fine mist of water.

A1.5.2.2 If, after removal of the flame of the propane torch from the test sample (for Classes III, IV, or V (Table A1.1)), the test sample continues to burn (self-sustaining), it shall be allowed to burn for an additional 10 min and then extinguished with a fine mist of water.

A1.6 Chemical Deterioration Testing:

A1.6.1 Gasoline Test—A minimum of ½ pint (¼ L) (US) of gasoline is to be dispensed from an atomizing device similar to that used for a variety of home cleaning products onto the surface of the transparency. The dispensing of the gasoline will be directed at a single location which, as a result of previous impact testing, has had the non-plastic attack face removed, fractured, or cracked exposing the plastic inner or rear laminants to direct impingement of the gasoline. The application of the gasoline will be at sufficient intervals to fully dispense the required quantity of gasoline in no less than 5, nor more than 8, min.

A1.7 Miscellaneous—While conducting these tests should a portion of the transparent or opaque materials of the test sample be disassociated from the test sample as glass shards, pulverized or granulated glass, and which could be used as a life-threatening weapon, the data records will be so annotated but testing will continue. This provision shall apply regardless of the side of the sample (attack or protected) from which the fragments disassociate.

A1.8 Safety of Test Personnel—All personnel actively engaged in forced entry testing will be equipped with appropriate items of personal protection which will include—but not necessarily be limited to—full face shields, dust masks, sound deadening ear protection, heavy gloves, and, if necessary, appropriate chemical respirators.

TABLE A1.1 Recommended Security Glazing Classes for Different Threat and Asset Levels

	Threat Level 1	Threat Level 2	Threat Level 3	Threat Level 4
Residential asset	I ^A	II	III	III
Commercial asset	II	III	III	IV
Industrial asset	III	III	IV	V
High-risk asset	III	IV	V	V

^A Class of security glazing.

A2. RECOMMENDED PROTECTION LEVEL RATINGS

A2.1 Summary:

A2.1.1 Section 9.1 provides acceptance criteria (see 9.1.4) and establishes six different levels (or types) of ballistic attack against security glazing and systems. As indicated in A2.5, these levels may be used as the basis for ballistic ratings.

A2.1.2 Section 9.2.4 provides criteria for determining if security glazing and systems have been forcibly entered. Section 9.2.5 establishes five different classes of resistance against forced entry. As indicated in A2.6, these classes may be used as basis for forced entry ratings. Recommended security glazing classes for different threat and asset levels are given in Table A1.1.

A2.1.3 Section 9.3 provides requirements for determining resistance against both ballistic and forced entry attacks. Combined ballistic and forced entry ratings may be established on the basis of the separate ratings given in A2.5 and A2.6.

A2.2 Terminology:

A2.2.1 Definitions:

A2.2.1.1 The following terms are based on terms used in Guide F 1029:

A2.2.1.2 *Threat*—An actual or perceived source of jeopardy.

A2.2.1.3 *Threat Level*—A perception of the capability, motivation, and skill level of an intruder; four threat levels are identified.

A2.2.1.4 *Threat Level 1*—One or more unskilled individuals who have little knowledge of security systems or protective measures, who attack with little or no advanced planning, usually on target assets with little or no security measures. Motivation is usually monetary or vandalistic.

A2.2.1.5 *Threat Level 2*—One or more semi-skilled individuals with some knowledge of and ability to defeat or compromise low-level security measures. Motivation is usually profit.

A2.2.1.6 *Threat Level 3*—A group of skilled individuals with strong motivation, capability, knowledge, and funding. Motivated by profit, public attention, or disruption of services.

A2.2.1.7 *Threat Level 4*—A group of high-skilled individuals with strong motivation, substantial technological support, knowledge, and funding. Motivated by profit, public attention, sabotage, or acts of war.

A2.2.2 *Asset Level (Risk)*—An assigned category which is intended to convey the principal characteristics of that asset level and classify relative risk; four asset levels can be categorized:

A2.2.2.1 *Residential*—An average to above average home containing normal valuable assets.

A2.2.2.2 *Commercial*—Offices, retail stores, small businesses with moderate value assets. Residential areas with high-value assets should be included in this category.

A2.2.2.3 *Industrial*—Manufacturing facilities, high-value retail, or wholesale stores, and where higher risk commodities such as firearms or narcotics are stored.

A2.2.2.4 *Very High-Risk Facilities*—Utility facilities for which security requirements are not regulated, detention and correctional facilities and installations which are attractive to Threat Level 4.

A2.3 Marking of Samples:

A2.3.1 All materials and each assembly will be indelibly marked-etched, or metal stamped as appropriate, with the manufacturer's name, model number, and serial number (or date of manufacture) in a manner which is visible on the completed forced entry barrier.

A2.3.2 *Material and Design Changes*—All glazing samples and test assemblies which undergo modification or change of insufficient magnitude to warrant assignment of a new basic model or type number will have an addendum applied to its basic model number which will clearly indicate it differs from all previous or subsequent configurations of that basic type or model.

A2.3.3 *Critical Orientation*—Materials whose orientation is critical to its performance as a forced entry barrier, and whose configuration does not render all other orientations impossible, will have the correct orientation clearly and indelibly marked on them in a manner which will remain clearly visible after the construction of the forced entry barrier is completed.

A2.3.4 *Optional Markings*—The above marking requirements are the minimum acceptable markings for transparent forced entry materials and systems. The manufacturer is encouraged to include any additional markings which may preclude their inadvertent misuse or abuse-compliance with specifications, susceptibility to chemicals, etc.

A2.4 Configuration Documentation:

A2.4.1 *Configuration Disclosure Drawing*—All glazing materials tested for use in a forced entry/exit barrier are to be identified and documented by appropriate drawings or specifications, or both. The documentation may be used to verify the consistency of subsequent procurements of the material and is to include, but not necessarily be limited to:

A2.4.1.1 *Material*—Specific industrial specifications including size, thickness, hardness, and the like.

A2.4.1.2 Make, model number and serial numbers or date of manufacture (as appropriate).

A2.4.1.3 *Assembly Instructions*—Weldments, bolting, bonding materials, etc.

A2.4.1.4 *Proprietary Information*—None of the requirements of A2.4.1 are intended to circumvent a supplier's proprietary rights with respect to any feature, configuration, or material. Those portions of the design disclosure document considered proprietary will be clearly marked or eliminated from the disclosure documentation with an appropriate explanation.

A2.5 Ballistic Ratings:

A2.5.1 Any glazing sample which is not "penetrated" shall be rated for use in barriers requiring the ballistic resistance levels of 6.2. Recommended ratings are:

- A2.5.2 Submachine Gun,
- A2.5.3 Handgun (.44 Magnum),
- A2.5.4 Handgun (.38 Super),
- A2.5.5 Rifle, and
- A2.5.6 Rifle (AP).

A2.6 Forced Entry Ratings:

A2.6.1 Glazing or assemblies shall be rated for forced entry resistance in accordance with one of the five classes listed in Table 2.

A2.6.2 Recommended security glazing classes for different threat and asset levels are shown in Table A1.1.

A2.7 *Compliance*—Ballistic and forced entry ratings shall be based on tests described herein which must be conducted by an independent testing facility. Interested parties should be extended invitations to have their representative(s) present for and to witness all testing. The test director should provide sufficient advance notice of all testing for that purpose.

A2.7.1 Once a glazing material or assembly is committed to testing for the purpose of obtaining a rating as a forced entry or ballistic barrier, or both, a report of all testing conducted on the material is to be provided to the office or authority bearing pecuniary responsibility for the testing regardless of the outcome of those tests.

APPENDIX

(Nonmandatory Information)

X1. RELATIVE BALLISTIC THREATS

X1.1 General

X1.1.1 Table X1.1 summarizes ballistic threat levels and ratings contained in various standards. Data for each class of weapon is listed in approximate order, starting with lower power weapons and ending with higher power weapons.

X1.1.2 Due to the differences in the standards, such as bullet type or weight, velocity, velocity measurement location, number of shots and range, it is not possible to make precise comparisons between the threat levels of each standard.

X1.1.3 With few exceptions, all of the various standards call for shots to be fired at 0° angle of obliquity.

TABLE X1.1 Summary of Ballistic Threat Levels and Ratings

Standard ^A	Threat Level, Rating	Weapon Caliber	Bullet Weight (Grains)	Bullet Velocity, fps ^B		Number of Shots	Range, ft
				min	max		
Handguns (Automatic Pistols and Revolvers)							
NIJ	I	.22 L.R. ^C	40	1010		5	16.0
HPW	A	.38 spec.	158	700	800	3 ^D	20.0
NIJ	I	.38 spec.	158	800	900	5	16.0
NIJ	II-A	9 mm by 19 (LV)	124	1050	1130	5	16.0
DIN	C1-SF	9 mm by 19 (HV)	124	1166	1199	3	9.84
HPW	B	9 mm by 19 (HV)	124	1100	1180	3 ^D	20.0
NIJ	II	9 mm by 19 (HV)	124	1135	1215	5	16.0
ANSI/UL	M.P.S.A.	.38 super auto.	130	1152	1344	3	15.0
ASTM	.38 super	.38 super auto.	130	1230	1330	3 ^E	25.0
NIJ	II-A	.357 mag. (LV)	158	1200	1300	5	16.0
ANSI/UL	H.P.S.A.	.357 mag. (HV)	158	1305	1523	3	15.0
BSI	G1	.357 mag. (HV)	158	1378	1574	3	9.84
DIN	C2-SF	.357 mag. (HV)	158	1363	1396	3	9.84
ANSI/UL	S.P.S.A.	.44 mag.	240	1323	1544	3	15.0
ASTM	.44 mag.	.44 mag.	240	1400	1500	3 ^E	25.0
BSI	G2	.44 mag.	240	1451	1647	3	9.84
DIN	C3-SF	.44 mag.	240	1429	1461	3	9.84
HPW	C	.44 mag.	240	1350	1450	3 ^D	20.0
NIJ	III-A	.44 mag.	240	1350	1450	5	16.0
Carbines and Sub-Machine Guns							
ASTM	sub. m.g.	9 mm by 19 (HV)	124	1350	1450	3 ^E	25.0
BSI	GO	9 mm by 19 (HV)	115	1247	1443	3	9.84
NIJ	III-A	9 mm by 19 (HV)	124	1350	1450	5	16.0
SD	minimum	9 mm by 19 (HV)	115	1350	1450	3 ^F	30.0
Rifles (Center Fire)							
ANSI/UL	H.P.R.	.30-06	220 SRP	2169	2531	1	15.0
SD	Rifle	5.56 by 45 mm	55 (M193)	3135	3235	3 ^F	30.0
ASTM	Rifle	7.62 by 51 mm	147 (M80)	2750	2850	3 ^E	25.0
BSI	G3	7.62 by 51 mm	147 (M80)	2609	2805	3	32.81
DIN	C4-SF	7.62 by 51 mm	147 SRP	2578	2611	3	32.81
HPW	D	7.62 by 51 mm	147 (M80)	2725	2825	3 ^D	20.0
NIJ	III	7.62 by 51 mm	147 (M80)	2700	2800	5	16.0
SD	Rifle	7.62 by 51 mm	147 (M80)	2700	2800	3 ^F	30.0
Rifles (Center Fire Armor Piercing)							
DIN	C5-SF	7.62 by 51 mm	150 AP	2627	2660	3	82.02
SD	rifle, AP	7.62 by 51 mm	150 (AP, M61)	2700	2800	3 ^F	30.0
ASTM	rifle (AP)	.30-06	165 (AP, M2)	2725	2825	3 ^E	25.0
HPW	E	.30-06	165 (AP, M2)	2725	2825	3 ^D	20.0
NIJ	IV	.30-06	165 (AP, M2)	2800	2900	1	16.0
SD	rifle, AP	.30-06	165 (AP, M2)	2750	2850	3 ^F	30.0

^A Standards:

ASTM—American Society for Testing and Materials, Test Method for Security Glazing Materials and Systems, F 1233.

NIJ—National Institute of Justice, U.S. Department of Justice, Ballistic Resistant Protective Materials, NIJ Standard—0108.01, September 1985.

ANSI/UL—American National Standards Institute/Underwriters Laboratories, Inc., Standard for Bullet-Resisting Equipment, ANSI/UL 752—1985, Rev. 13, May 1988.

SD—U.S. Department of State, Ballistic Resistance of Structural Materials (Opaque and Transparent) Test Procedures and Acceptance Criteria, SD-STD-02.01, March 1986.

HPW—H.P. White Laboratory, Inc., Transparent Materials and Assemblies for Use in Entry or Containment Barriers, HPW-TP-0100.00, Rev. B, Dec. 10, 1983.

BSI—British Standards Institution, Security Glazing, Part 1. Specification for Bullet-Resistant Glazing for Interior Use, BS 5051, October 1973.

DIN—Deutsches Institut für Normung e. V., Security Glazing, DIN 52 290, Part 2, May 1981.

^B The various standards specify different locations to measure the bullet velocity. They are as follows: ASTM—15 ft from weapon muzzle; ANSI/UL—at muzzle; BSI—strike face of the target; DIN—8.20 ft from weapon muzzle; HPW—15 ft from weapon muzzle; NIJ—6.60 ft from weapon muzzle; and SD—10 ft from strike face of the target. For meeting the various velocity measurement requirements, the use of custom (special) powder loads may be required.

^C Abbreviations: AP—Armor Piercing; HV—Higher Velocity; LD—Lead; L.R.—Long Rifle; LV—Lower Velocity; Mag.—Magnum; Spec.—Special; SRP—Soft Round Point; M2, M61, M80, M193—U.S. Military Ammunition, Full Metal Jacket, Spire Point.

^D Three shots required for the base materials and twelve shots required for assemblies.

^E Minimum number of shots.

^F Minimum of three shots required for the glazing and six shots required for other parts of the assembly.

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