



Designation: F 1233 – 98

## Standard Test Method for Security Glazing Materials And Systems<sup>1</sup>

This standard is issued under the fixed designation F 1233; 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 approval. A superscript epsilon ( $\epsilon$ ) 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 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 Note 2.

### 2. Referenced Documents

#### 2.1 ASTM Standards:

- A 36/A 36M Specification for Carbon Structural Steel<sup>2</sup>
- A 53 Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless<sup>3</sup>
- A 574 Specification for Alloy Steel Socket-Head Cap Screws<sup>4</sup>
- F 1029 Guide for Selection of Physical Security Measures for a Facility<sup>5</sup>

#### 2.2 Other Documents:

Sporting Arms and Ammunition Manufacturer's Institute

(SAAMI)—Ammunition<sup>6</sup>

United States Military Ammunition Specifications—Ammunition<sup>7</sup>

Federal Specification GGG-313U—Cold Chisel<sup>8</sup>

American Iron and Steel Institute M-1020—Structural Steel<sup>9</sup>

UL 10BC—Fire Extinguisher<sup>10</sup>

### 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.

<sup>1</sup> This test method is under the jurisdiction of Committee F-12 on Security Systems and Equipment and is the direct responsibility of Subcommittee F12.10 on Systems, Products and Services.

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<sup>2</sup> *Annual Book of ASTM Standards*, Vol 01.04.

<sup>3</sup> *Annual Book of ASTM Standards*, Vol 01.01.

<sup>4</sup> *Annual Book of ASTM Standards*, Vol 15.08.

<sup>5</sup> *Annual Book of ASTM Standards*, Vol 15.07.

<sup>6</sup> Available from Sporting Arms and Ammunition Manufacturers' Association (SAAMI), Box 1075, Riverside, CT 06878.

<sup>7</sup> Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094, Attn: NPODS.

<sup>8</sup> Available from General Services Adm., 7th and D Sts. SW, Washington, DC 20407.

<sup>9</sup> Available from American Iron and Steel Institute, 1000 16th St. NW, Washington, DC 20036.

<sup>10</sup> Available from Underwriters Laboratories, Inc., 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 ( $\pm 50$ ) ft per s (425 [ $\pm 15$ ] 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 ( $\pm 50$ ) ft per s (425 [ $\pm 15$ ] 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 ( $\pm 50$ ) ft. per s (390 [ $\pm 15$ ] 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 ( $\pm 50$ ) ft per s (850 [ $\pm 15$ ] 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 ( $\pm 50$ ) ft per s (845 [ $\pm 15$ ] 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 ( $\pm 50$ ) ft per s (400 [ $\pm 15$ ] 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*,<sup>11</sup>

6.4.2 *Chronograph*,<sup>11</sup>

6.4.3 *Thermometer*—Temperature range from +120 to  $-30^{\circ}\text{F}$  (+49 to  $-16^{\circ}\text{C}$ ).

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 ( $\pm 3$  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 possible penetration paths. Not only shall the primary weapon/ammunition be used, but the 12-gage shotgun (as defined

<sup>11</sup> An example of an acceptable chronograph is available from Oehler Research, P.O. Box 9135, Austin, TX 78766.

within this test method as an adjunct to the primary test) as well. 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.

6.6.4.1 Due to chronograph/triggering screen accessibility, the test director may elect not to electronically measure muzzle velocities of certain oblique firings.

**7. Apparatus (Physical Attack)**

7.1 *Test Stand*—The test glazing samples will be mounted in a vertical test stand of rigid, 6 in. (15 cm) steel wide flange beams as in Fig. 1. The wide flange beam stand will be anchored in, or rigidly fixed to, a substantial concrete structure at each of its four corners (minimum requirements), and no linear dimension between supports of the test will exceed 8 ft (2.5 m).

7.2 *Test Frame:*

7.2.1 *Glazing Material Tests*—Unframed glazing samples will be mounted in a test frame detailed in Fig. 2 and Fig. 3, a weldment constructed of structural steel angle iron (conforming to Specification A 36 for 6 by 3½ by ⅝ in. (15 by 9 by 1.6 cm) which has a 1¼ in. (3.18 cm) square steel bar fixed stop (conforming to Specification A 36 for 1¼ in. square (3.18 by 3.18 cm) which will accept a square test sample of minimum 12 by 12 in. (30 by 30 cm) and maximum 29¾ by 29¾ in. (75 by 75 cm), and will allow ¼-in. (6-mm) clearance on all edges. The fixed stop square bar will be oriented to support the entire periphery of the sample facing the protected side for a maximum distance of 1.0 in. (2.5 cm) from its edge.

7.2.1.1 The test sample will rest at the bottom on two neoprene setting blocks (¼ by 4-in. [6 by 100-mm] sample thickness) of 60 to 80 durometer placed at the quarter points. Prior to inserting the glazing sample in the test frame, a ⅜-in. (5-mm) glazing tape shall be applied to the fixed stop and adjustable stop where contact is made with the test sample.

7.2.1.2 The mounting is completed by bolting the adjustable stop to the test frame with ½-in. (13-mm) socket head cap screws (conforming to Specification A 574) torqued to 120 ft. lbs. ± 10 ft. lbs. (16.6 kg. meters ± 1.4 kg. meters) each. The center to center location of adjustable stop mounting bolts shall be no greater than 6 in. (15 cm). When the test sample is

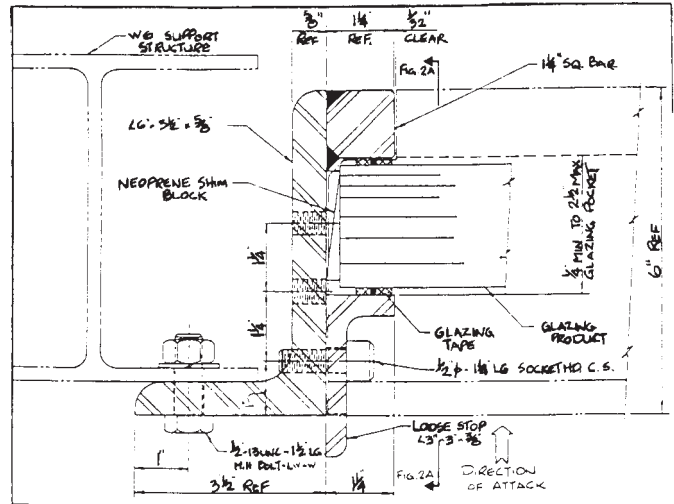


FIG. 2 Glazing Material Test Frame

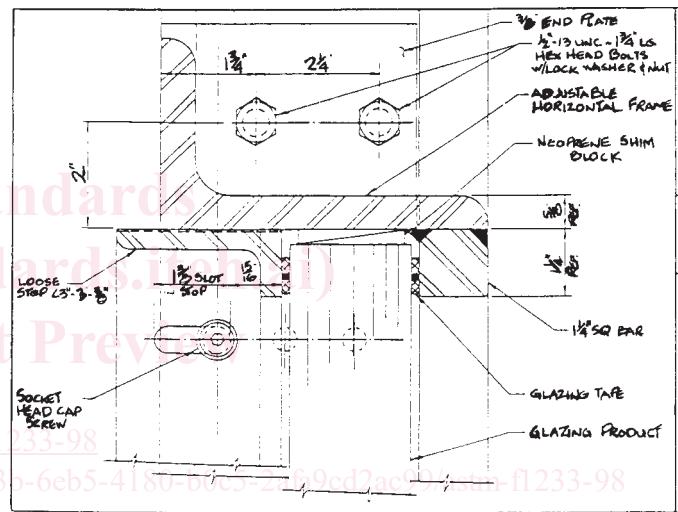


FIG. 3 Glazing Material Test Frame

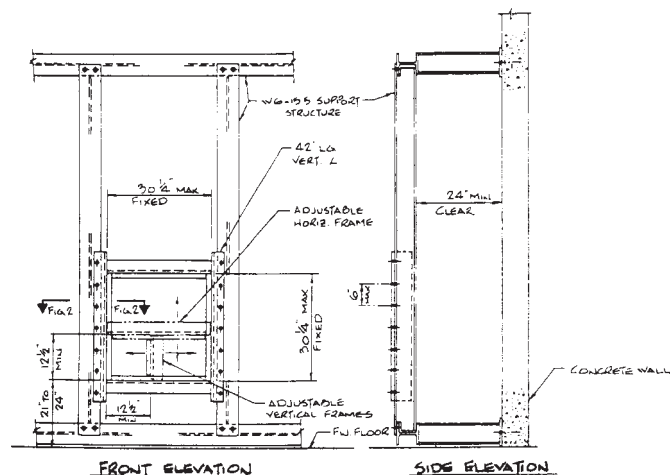


FIG. 1 Test Stand and Frame Assembly

mounted it will be centered in the test frame and positioned with neoprene shims to result in not more than 1.0-in. (2.5-cm) edge coverage (bite) of the test sample.

7.2.1.3 Compression of the glazing tape will be made by the adjustable stop, but not to allow a test sample face to stop clearance of more than ⅛ in. (3 mm). When mounted, the bottom edge of the exposed faces (protected and assaulted) of the sample will be no higher than 24 in. (61 cm) nor lower than 21 in. (53 cm) from the horizontal surface supporting the test (attack) personnel.

7.2.2 *Glazing System Tests*—The glazing system will be mounted in accordance with the manufacturer’s recommendations and shall be securely anchored so as the mounting system will not absorb any of the testing shock. Consideration should be given to, but is not limited to:

- 7.2.2.1 Overall size of glazing system.
- 7.2.2.2 Amount of “bite” within the frame.
- 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, 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, 1½ in. (4 cm), Schedule 80, in accordance with Specification A 53, 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 CO<sub>2</sub>*—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-880-2,9 or equivalent.<sup>12</sup>

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 [ $\pm 3$  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 29¾ by 29¾ 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 ¼ in. (6 mm) nor more than 2½ 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.

9.1.1 *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.

<sup>12</sup> Available from Turner Companies, 821 Park Ave., Sycamore, IL 60178.

**TABLE 1 Ballistic Criteria**

Class/Level	Weapon Description	Caliber	Bullet Mass <sup>A</sup> /Type <sup>B</sup>	Velocity <sup>C</sup> , ft/s (m/s)	Minimum No. of Impacts <sup>D</sup>
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 <sup>E</sup>	Shotgun - Buckshot	12 gage, 3 in. Magnum	00 buckshot, 15 pellets	1150–1250 (350–381)	1 <sup>F</sup>
SH2	Shotgun - Slug	12 gage	1 oz. (437.5 gr, 28.3 g) rifled slug	1600–1700 (487–518)	3

<sup>A</sup> gr denotes grain as a unit of mass: 1 gr = 1.429 × 10<sup>-4</sup> lb (0.0647981 g)

<sup>B</sup> FMC = Full Metal Casing, JSP = Jacketed Soft Point, LGC = Lead Gas-Check, and SP = Soft Point.

<sup>C</sup> 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.

<sup>D</sup> 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).

<sup>E</sup> 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.

<sup>F</sup> 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.

9.1.1.1 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 ( $3^\circ$  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.

**NOTE 2—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.”

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*:

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

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 <sub>2</sub> (1)	A	4	A	A	A
Propane Torch (5)	A	6 <sup>B</sup>	11 <sup>C</sup>	20 <sup>C</sup>	31 <sup>C</sup>
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

<sup>A</sup> Not Applicable.

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

<sup>C</sup> 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.