Designation: F2781 – 15

Standard Practice for Testing Forced Entry, Ballistic and Low Impact Resistance of Security Fence Systems[1]

This standard is issued under the fixed designation F2781; 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 The forced entry resistance of fence systems is evaluated relative to three levels of forced entry threat using the limited hand tool inventory outlined in Table 1. It also establishes a system for rating the forced entry resistance of those systems (see Table 2). The tools specified to be used for testing at each threat level are those that are known to have a maximum destructive effect on structures and their subassemblies and are readily available to aggressors categorized as posing that level of threat.

1.1.1 *Low Threat Level (L)*—Specifically exempted from the inventory of available tools for the low (L) threat level category are power tools (gasoline, electric or hydraulic), and devices requiring more than one person to transport and operate.

1.1.2 *Medium Threat Level (M)*—Specifically exempted from the inventory of available tools for the medium (M) threat level category are power tools requiring an outside power source or self contained gasoline or battery driven tools and devices requiring more than two persons to transport and operate.

1.1.3 *Aggressive Threat Level (A)*—Specifically exempted from the inventory of available tools for the high (H) threat level category are devices requiring more than two persons to transport and operate.

1.2 The ability of a fence system to offer protection from bullets fired from a rifle or handgun would be beneficial particularly in Border Fence areas where security personnel can be targets during patrol activities. Accordingly, a limited test using a .38 Special handgun and a 7.62-mm rifle is performed to determine if any level of protection is provided by the fence system.

1.3 The ability of a fence system to provide impact resistance from a 4000 pound mass vehicle moving at a velocity of 20 MPH at a modest cost will provide relative guidance as to the strength of a security fence system in resisting low impact situations.

2. Referenced Documents

2.1 *ASTM Standards:*[2]

F1233 Test Method for Security Glazing Materials And Systems

2.2 *SAE Standard:*[3]

SAE J972 Moving Rigid Barrier Collision Tests

2.3 *U.S. Military Standards:*[4]

MIL-STD-662F Department of Defense Test Method Standard V50 Ballistic Test for Armor

2.4 *U.S. Dept. of Justice:*[5]

NIJ Standard 0108.01 National Institute of Justice Ballistic Resistant Protective Materials

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

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

3.1.2 *forced entry*—creating a four square feet opening.

4. Summary of Practice

4.1 For each rating a structured portion and a discretionary portion as described in 4.2 and 4.3 is required.

4.2 The structured portion of the test provides for a zero to five minute test with specific tools selected as the most debilitating from the tool list in Table 1, regardless of the fence system being tested.

[1] This practice is under the jurisdiction of ASTM Committee F14 on Fences and is the direct responsibility of Subcommittee F14.50 on High Security Fences and Perimeter Barriers.

Current edition approved Nov. 1, 2015. Published December 2015. Originally approved in 2009. Last previous edition approved in 2010 as F2781 - 10. DOI:10.1520/F2781-15.

[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 SAE International (SAE), 400 Commonwealth Dr., Warrendale, PA 15096, http://www.sae.org.

[4] Available from National Institute of Standards and Technology (NIST), 100 Bureau Dr., Stop 1070, Gaithersburg, MD 20899-1070, http://www.nist.gov.

[5] Available from National Institute of Justice (NIJ), 810 7th St., NW, Washington, DC 20531, http://nij.gov.

4.3 Following the structured portion of the test, the discretionary portion of the test provides up to 55 minutes of testing, optimizing forced entry efforts by selecting any (or all) tools from the applicable category of the list (low (A), medium (B), or aggressive (C)). Selection of tools is based on the perception of the test director as to which tools will most effectively result in a forced entry.

4.4 Testing of security fence systems in accordance with the requirements of this test method shall result in a rating reflecting the severity of the threat and the cumulative penetration resistance time (see Table 2).

4.5 The times used to establish the protection ratings of Table 2 range from 0–60 minutes and are intended to reflect the elapsed time of forced entry resistance necessary for a response force to arrive and counter the threat with additional defensive personnel and equipment. It is important to recognize that the lowest threat level time will establish the maximum time limit for a greater threat level.

4.6 The ballistic is intended to provide the probability of a person standing behind the secure fence side from being hit with a bullet fired by a 38-caliber hand gun or a .30-06 rifle.

4.7 The impact test is intended to provide relative guidance as to the strength of a fence system to absorb 53.5 K-ft-lbs of kinetic energy.

5. Significance and Use

5.1 The success or failure of any attempt to forcefully penetrate a fence system is dependent upon three primary factors that collectively define the threat—the tools and devices employed, the number of aggressors, and their level of sophistication.

5.2 Normally, a test procedure of this scope would be supported by years of laboratory testing intended to qualify and accurately reproduce the destructive effects of a variety of tools, implements, and devices. However, rapidly changing social conditions have created an immediate need for building components resistant to evolving forced entry techniques. Accordingly, the procedures presented herein are based more on field experience than laboratory analysis. They are more representative than inclusive, are intended to provide a basis for the comparative evaluation of different fence systems using forced penetration procedures, ballistic tests and impact testing, and are not primarily intended to be used to establish or confirm the absolute prevention of forced entries.

TABLE 1 Schedule of Testing—All Levels of Threat Severity
(See Sections 8 and 14 for unabridged tool list.)

	Time of Application (minutes)					
	Structured Testing			Discretionary Testing		
Tool(s)	L	M	A	L	M	A
Crowbar 5 lb by 28 in. (2)	3-5	3-5	3-5	0-55	0-55	0-55
Cold Chisels and Hammer (2)	3-5	3-5	3-5	0-55	0-55	0-55
Hacksaw and Two HSS Blades	3-5	3-5	3-5	0-55	0-55	0-55
Sledgehammer 16 in. by 6 lb	3-5	3-5	3-5	0-55	0-55	0-55
Fire Axe 36 in. by 6 lb	3-5	3-5	3-5	0-55	0-55	0-55
Bolt Cutter (2)	3-5	3-5	3-5	-	0-55	0-55
Fire Axe 36 in. by 10 lb	-	3-5	3-5	-	0-55	0-55
Hole Saw 2 in. (1) and Jigsaw	-	0-5	0-5	-	0-55	0-55
Pry Bar 30 in. Steel (2)	-	0-5	0-5	-	0-55	0-55
Sledgehammer 30 in. by 12 lb	-	0-5	0-5	-	0-55	0-55
Steel Wedge 6 in. long (2) and Plate Shears	-	0-5	0-5	-	0-55	0-55
Circular Saw 8 in., 1100 W, and 3 Blades (1)	-	0-5	0-5	-	-	0-55
Disc Grinder 5 in., 1100 W, and 3 Blades (1)	-	0-5	0-5	-	-	0-55
Rotary and Hammer Drill 750 W and 5 Drill Bits, ½ in. (1)	-	-	0-5	-	-	0-55
Hole Saw Greater than 2 in. (1)	-	0-5	0-5	-	-	0-55
Steel Pinch Bar 60 in. long (2)	-	-	0-5	-	-	0-55

TABLE 1 *Continued*

Tool(s)	Time of Application (minutes)					
	Structured Testing			Discretionary Testing		
	L	M	A	L	M	A
Reciprocating Saw 750 W and 3 Carbide Blades (1)	-	0-5	0-5	-	-	0-55
Sledgehammer 30 in. by 15 lb (1)	-	-	0-5	-	-	0-55
Oxyacetylene Torch with 80 ft^3 Oxygen and 40 ft^3 Acetylene Tanks (1)	-	-	0-5	-	-	0-55
Cut-Off Saw 5 KW or HD Gasoline 18 in. Dia. and 3 Blades (1)	-	-	0-5	-	-	0-55
Breaker (1900 W) 30 lb with 3 Bits (1)	-	-	0-5	-	-	0-55
Scissor Jack 1500 lb with 4 in. min retraction and 8 in. Stroke (1)	-	-	0-5	-	-	0-55
Adhesive Tape (1)	-	-	-	0-55	0-55	0-55
Fishing Line (250')	-	-	-	0-55	0-55	0-55
Grappling Hook (1)	-	-	-	0-55	0-55	0-55
5-in. Knife (1)	-	-	-	0-55	0-55	0-55
8 in. Std and Self Grip Pliers (2)	-	-	-	0-55	0-55	0-55
10 in. Multiple Slip Pliers (2)	-	-	-	0-55	0-55	0-55
10 in. Pipe Wrench (2)	-	-	-	0-55	0-55	0-55
1.660 in. O.D. by 12 ft. pipe (2)	-	-	-	0-55	0-55	0-55
8 in. Plate Shears (1)	-	-	-	0-55 (1)	0-55 (1)	0-55 (2)
Screwdrivers 7 in.,10 in., and 16 in. (1)	-	-	-	0-55	0-55	0-55
Cordless ½ in. Drill with spare power pack and carbide bits (1)	-	-	-	0-55	0-55	0-55
Butane Torch (1)	-	-	-	0-55	0-55	0-55
Rope (1)	-	-	-	0-55	0-55	0-55

TABLE 2 Forced Entry Resistant Ratings

Threat Level	Active Test Personnel	Resistance Time (minute)			Rating
		Structured Test	Discretionary Test	Cumulative	
Low (L)	2	Less than 5	0	Less than 5	L0 to L4.9
		5	Less than 5	Less than 10	L5 to L9.9
		5	5 to 9.9	Less than 15	L10 to L14.9
		5	10 to 14.9	Less than 20	L15 to L19.9
		5	20 to 25	30	L20 to L30
		5	31 to 55	60	L31 to L60
Medium (M)	2	Less than 5	0	Less than 5	M0 to M4.9
		5	Less than 5	Less than 10	M5 to M9.9
		5	5 to 9.9	Less than 15	M10 to M14.9
		5	10 to 14.9	Less than 20	M15 to M19.9
		5	20 to 25	30	M20 to M30
		5	31 to 55	60	M31 to M60

TABLE 2 *Continued*

Threat Level	Active Test Personnel	Resistance Time (minute)			Rating
		Structured Test	Discretionary Test	Cumulative	
Aggressive (A)	4	Less than 5	0	Less than 5	A0 to A4.9
		5	Less than 5	Less than 10	A5 to A9.9
		5	5 to 9.9	Less than 15	A10 to A14.9
		5	10 to 14.9	Less than 15	A15 to A19.9
		5	20 to 25	30	A20 to A30
		5	31 to 55	60	M31 to A60

5.3 The test requirements specified herein have been established for use in evaluating the penetration resistance characteristics of standard fence systems to be used in commercial, government and military installations.

5.3.1 The success of any forced entry threat is dependent on the cumulative effect of the implements used, the elapsed time, and the sophistication and motivation of the personnel affecting the forced entry.

5.3.2 Absolute penetration resistance from forced entry by a determined and well-equipped attack group is impossible.

5.3.3 Aggressor groups range from unsophisticated criminals and vandals to organized criminals.

5.3.4 Attempts to force an entry may be thwarted by increasing the time necessary to affect such an entry and by early detection. Intrusion sensors positioned as far as possible from the protected environment in conjunction with optimal structural and component design will maximize the time available for a response force to intercept the intruders.

5.4 The procedures of this test method are intended to evaluate the time necessary for vandals and unsophisticated criminals to forcefully penetrate security fence systems by using manually operated tools—defined as a low, medium, or aggressive forced entry threat.

6. Documentation of Test Materials

6.1 *Configuration Documentation*—All materials and assemblies to be tested shall conform to and be in compliance with the latest revision of the appropriate publication or specification governing the fence system configuration. The following documents shall apply:

6.1.1 *Standard Commercial Materials*—Commercial materials used in fabricating security fence systems will conform to the configuration and performance standards established for that material by ASTM International.

6.1.2 *Non-Standard Materials*—All materials and subassemblies used in the fabrication of forced entry barriers whose nature and configuration are not otherwise controlled by recognized industrial, government, or manufacturer's specifications will be accompanied by full disclosure drawings and specifications.

6.1.2.1 *Component Material Details*—Specific industrial specifications, including size, thickness composition, etc.

6.1.2.2 Make, model number, serial numbers, and date of manufacture (as appropriate).

6.1.2.3 Construction instructions, including weldments, bolting, bonding materials, etc.

6.1.3 *Proprietary Information*—None of the requirements of 6.1.1 through 6.1.2.3 are intended to compromise or circumvent a manufacturer's proprietary rights with respect to any feature, configuration, material, or design. Those portions of the design disclosure documentation considered proprietary would be clearly marked or eliminated from the disclosure documentation with an appropriate explanation. All submitted documentation, however, would accurately represent the sample tested.

7. Sampling, Test Specimens, and Test Units

7.1 *Sample Size*—In order to facilitate test standardization all test samples will conform to the sizes specified in 7.1.1.

7.1.1 A minimum lateral area of 96 in. high and 30 ft in length. The requirements of this section and the procedures of the test method are intended to minimize test costs by conducting as much testing on single test segments, if possible. Impact Tests shall target the impact location of the vehicle at the midpoint of the 30 ft. length to avoid contacting the vertical posts and performed after penetration tests have been completed to minimize costs of material and repair labor.

7.1.2 *Test Environment*—The location of the test shall be in a natural environment where the temperature minimum is not less than 40°F and the maximum is 95°F during the performance of the test. All tested materials and tools will be temperature conditioned in this environment for a minimum of 24 h immediately prior to initiation of any test. The area immediately adjacent to the test sample extending 6 ft to the left and right of either vertical edge of the sample, 10 ft from the assault face of the sample, and 10 ft above the horizontal surface supporting the test (attack) personnel, shall be free of any and all obstructions and appurtenances.

8. Preparation of Apparatus

8.1 *Tools, Devices and Materials:*

8.1.1 Analysis of many of the aggressive actions against installations that have resulted in forced entry has produced an extensive list of tools and implements that are readily accessible to aggressor groups. From this comprehensive listing, tools and devices have been categorized as to the likelihood of their use and forced entry threat severity. While infinite in type, size, and construction, all can be categorized with respect to their principal effect and function—prying, screwing, pulling, shearing, cutting, and impacting. Additionally, certain tools have been identified as those which are not actually tools, but which have a debilitating effect on protective barriers and are readily available (that is, ropes, and so forth). While no attempt will be made to completely list all the tools and implements which can be utilized to effect forced entry, Table 1 presents those tools and implements which have been determined to be readily available and representative of the most effective of forced entry tools for the very low, low, medium, and high threat severity categories, respectively.

8.1.2 All tools proposed for use in this test are to be clean and verified for proper operation prior to commencement with the test.

8.2 *Low Threat Severity Category Tools:*
8.2.1 *Adhesive Tape.*
8.2.2 *Fishing Line.*
8.2.3 *Grappling Hook.*
8.2.4 *Knife,* 5 in.
8.2.5 *Standard and Self-Gripping Pliers,* 8 in.
8.2.6 *Multiple Slip Pliers,* 10 in.
8.2.7 *Pipe Wrench,* 10 in.
8.2.8 *Pipe,* 1.660 in. O.D. by 12 ft.
8.2.9 *Plate Shears,* 8 in.
8.2.10 *Screwdrivers,* 7 in., 10 in., and 16 in. long.
8.2.11 *Crowbar,* 5 lb, 28 in.
8.2.12 *Cold Chisels,* 10 in. long by 1 in. wide.
8.2.13 *Drill,* cordless, ½ in., spare power pack, and carbide drill bits.
8.2.14 *Butane Torch.*
8.2.15 *Hacksaw,* two HSS blades.
8.2.16 *Sledgehammer,* 16 in., 6 lb.
8.2.17 *Rope,* 20-ft length of ½-in. diameter manila rope, (4-lb).
8.2.18 *Fireman's Axe,* 36 in., 6 lb.
8.2.19 *Pipe Cutter,* 4 in. O.D.
8.2.20 *Bolt Cutter.* 12 in.
8.2.21 *Fence Pliers,* 10 in.
8.2.22 *Cable Ratchet,* 2000 lb capacity.

8.3 *Medium Threat Severity Category Additional Tools:*
8.3.1 *Bolt Cutter,* 20 in.
8.3.2 *Disc Grinder,* 12 V with spare power pack and three cutting discs.
8.3.3 *Drill Bits,* 5.5 in., carbide.
8.3.4 *Axe,* 36 in., 10 lb.
8.3.5 *Hole Saw,* 2 in.
8.3.6 *Steel Pry Bar.*
8.3.7 *Jigsaw,* cordless, 12 V, and three carbide blades.
8.3.8 *Plate Shears,* 12 in.
8.3.9 *Sledgehammer,* 30 in., 12 lb.
8.3.10 *Pipe,* 1.660 in. O.D. by 20-ft long.
8.3.11 *Steel Wedges,* 6-in. long.
8.3.12 *Circular Saw,* cordless, 18 V, 8-in. diameter, and three blades.
8.3.13 *Disc Grinder,* 18 V with spare power pack and three cutting discs.
8.3.14 *Jigsaw,* cordless, 18 V with spare power pack, and three carbide blades.
8.3.15 *Reciprocating Saw,* cordless, 18 V with spare power pack, and three carbide blades.
8.3.16 *Proof Test Grade 100 Alloy Chain,* 20 ft, 7⁄32 in., 5400 lb minimum.

8.4 *Aggressive Threat Severity Category Additional Tools:*
8.4.1 *Circular Saw,* 1100 W, 8-in. diameter, and three blades.
8.4.2 *Disc Grinder,* 1100 W, 5-in. diameter and three discs.
8.4.3 *Rotary and Hammer Drill,* 750 W, five drill bits, ½-in. carbide.
8.4.4 *Hole Saw,* greater than 2 in.
8.4.5 *Steel Pinch Bar,* 60-in. long.
8.4.6 *Reciprocating Saw,* 750 W and three carbide blades.
8.4.7 *Sledgehammer,* 30 in., 15 lb.
8.4.8 *Oxyacetylene Torch,* with 80-ft^3 oxygen tank, 40-ft^3 acetylene tank, and 20 ft of hose (119.0 lb).
8.4.9 *Cut-Off Saw,* 5 KW or HD Gasoline 18-in. diameter, with three blades.
8.4.10 *Breaker,* (1900 W), 30 lb with three bits.
8.4.11 *One Scissor Jack,* 1500 lb capacity with a minimum retraction and an 8-in. stroke.

9. Ballistic Equipment

9.1 *Ballistic Firing Devicesin accordance with Test Method F1233*—Firearms or test barrels suitable for use with the following calibers of ammunition producing minimum velocities as required:
9.1.1 *.38 Special*—158 grain (10.2 g), lead.
9.1.2 *.308 Winchester (7.62 mm, M80 Ball)*—147 grain (9.5 g), full metal casing.

9.2 *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:
9.2.1 *Caliber .38 Special/Handgun*—Ammunition conforming to SAAMI Specifications for caliber .38 Special, 158 grain, lead round nose producing, velocities of 875 ft/s (±25 ft/s) at 15 ft from the muzzle.
9.2.2 *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 2550 ft/s and 2320 ft/s (±50 ft/s) at 15 ft from the muzzle.

9.3 *Witness Material in accordance with NIJ Standard 0108.01*—The witness plate shall be 0.020 in. (0.51 mm) thick aluminum sheet. The minimum size of the witness plate shall be 9 by 12 in. (229 by 305 mm) for half-scale testing or 18 by 24 in. (457 by 610 mm) for full-scale testing. The witness plate shall be made of 2024-T3, 2024-T4 or 5052 aluminum alloy sheet, and shall be located 5 ft (half scale) or 10 ft (full scale) behind and parallel to the test sample.

9.4 *Instrumentation:*
9.4.1 *Photosensitive Triggering Screens (or similar)*—Either high-velocity lumiline screens, infrared ballistic screens, or electrical contact screens which either open or close an electrical circuit by passage of the projectile through the detector shall be used. Contact screens may consist of metallic foils separated by a thin insulating layer, or may consist of a circuit printed on paper with the circuit spacing such that the projectile passing through the screen will "break" the circuit.
9.4.2 *Chronograph*—The chronograph shall have a precision of 1 ms and an accuracy of 2 ms. Its triggering devices shall be of either the photoelectric or conductive screen types

as described in 9.4.1. Chronograph or electronic timers used shall be calibrated and certified for accuracy.

9.5 *Test Frame and Stand in accordance with MIL-STD-662F and NIJ Standard 0108.01:*

9.5.1 The sample shall be mounted rigidly (bolted or clamped) to the test fixture to produce a zero degree (for handgun testing) and five degree (for rifle testing) to the path of the bullet. The frame supports and clamps or mounting fixtures must be capable of retaining the sample and withstanding shock resulting from ballistic impact by the test projectiles. The test sample mount shall be capable of adjustment for moving the sample in the vertical or horizontal directions so that the point of impact can be located anywhere on the sample. Photosensitive triggering screens shall be positioned 5 and 15 ft 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 from the strike face of the sample. The test weapon shall be rigidly mounted at a distance of 25 ft 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.

9.5.2 The witness material shall be securely positioned parallel to, at 5 ft (half-scale) or 10 ft (full-scale) behind (protected side), the target area of the test assembly. The center of the witness panel should be directly behind the desired point of impact.

9.5.3 Should there be reason to suspect bullet flight stabilities; the test director is obligated to implement a paper witness panel, positioned 3 ft 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.

9.5.4 Due to limitations in range space, the dimensions for the chronographs and target holder in relation to the gun system are approximate. Alternate dimensions can be used (with the exception of the witness plate location) as long as the intent of this test specification is met.

10. Impact Test Equipment

10.1 *Bogie Vehicle*—A bogie vehicle is used for impact testing. The vehicle should be fabricated in accordance with SAE specification J972 and equipped with a 6-in. tall by 42-in. wide steel bumper. The sharp corners of the bumper should be rounded off. The impact bumper should be positioned to impact the fence system at 24 in. above grade. Fig. 1 illustrates a photograph of the bogie vehicle and of the bogie vehicle's bumper height in relation to the fence system. The wheelbase of the bogie is to be 114 ±6 in. Four wheels of 7.00-15 size are to be attached to two 3500 lb rated axles with a 4 inch inverted drop. The center of gravity of the bogie should be along its central axis at 24 ± 4 in. above the grade to minimize the potential for rear wheels to break the contact with the pavement during the impact. The bogie vehicle weight should be capable of being ballasted to the proximity weight of 4000 lb required for the impact test. The bogie vehicle weight must be confirmed with four current calibrated platform scales (Detecto, Model 954F 100P).

11. Instrumentation for All Threat Severity Categories Including Ballistic and Impact Testing

11.1 In order to comply with the full range of test requirements of this test, the following support instrumentation, materials, and equipment must be available to the test director.

11.1.1 *Instrumentation*—The following instrumentation is the minimum instrumentation required to meet the testing requirements of this standard.

11.1.1.1 *Video Camera*—Digital recording media onto CD.

11.1.1.2 *Still Camera*—Still photography camera utilizing digital recording media.

11.1.1.3 *Timing Device*—Stopwatch, 60 second sweep hand, stop-reset capable or equivalent.

12. Testing Guidelines

12.1 *General Test Sequence*—All samples submitted for testing shall be in compliance with 6.1.1. The forced entry testing of all samples shall begin with a structured portion of testing as outlined in Tables 1 and 3 and continue through the discretionary portion of testing (Tables 1 and 3) or until forced entry has been achieved.

12.2 *Sequence of Testing*—Forced entry testing in accordance with this standard shall be conducted in two phases:

12.2.1 *Structured Testing*—The testing of the sample shall be strictly limited to the tools, times and procedures of the test methods section.

FIG. 1 Bogie Vehicle Used to Simulate an Impact Vehicle

TABLE 3 Chargeable Tool Set-up Times for All Threat Levels

Tool	Ref.	Chargeable Time (minutes)		
		Set-Up	Usage	Total
Roto-Hammer Drill	8.4.3	0.25	As Timed	.25 + Usage
Oxyacetylene Torch	8.4.8	0.5	As Timed	.5 + Usage

12.2.2 *Discretionary Testing*—Following the structured test, forced entry testing will continue limited only by the personnel limits, the complete inventory of tools of Table 1, and the test director's perception of the quickest and most likely means of affecting an entry.

12.2.3 *Ballistic Firings*—Gun firings are intended to provide a means of evaluating whether any protection is provided by the security fence system with maximum openings of ⅜ in. for personnel 10 ft behind the security fence. A probability of being hit by a bullet is to be established with a confidence level of 95 percent (see Table 4).

12.2.3.1 All firings shall be in accordance with the ammunition and velocity requirements previously described.

12.3 *Forced Entry Criteria*—Any sample which has an opening of four square feet.

12.4 *Impact Test Results*—Measure amount of vehicle penetration, structural fence damage, and if openings caused by damage exceed four square feet to permit aggressor penetration.

12.5 *Photography*—Prior to initiation of testing, after 5 min (structured testing), 10, 15, 30, 60 minutes (completion) or at failure, the test sample shall be photographed to document its physical condition.

12.6 *Test Personnel:*

12.6.1 *Number of Active Aggressors*—The number of active aggressors used during the Structured and Discretionary testing shall be two.

12.6.2 *Number of Team Members*—The maximum number of personnel comprising the test team is not limited by this standard. However, a minimum of four team members are recommended to provide for periodic substitution for the active personnel to minimize the effects of fatigue.

12.6.3 *Physical Requirements for Team Members*—The team members shall be young (18-35 years of age), muscular (150-250 lb of body weight) in good health, who have the ability to carry out an enthusiastic assault.

12.6.4 *Miscellaneous*—During testing, active test personnel will not be permitted to occupy or partially occupy the space adjacent to the test sample for any purpose that could be perceived as increasing the efficacy of the tool, that is, increasing leverage. This limitation is imposed with the belief that any field installation will be on a monoplane surface and not on an external, structural corner of an included angle exceeding 180°.

12.7 *Repairs and Modifications:*

12.7.1 No repairs or replacements are to be made to any material or assembly being tested between the initiation and completion of the test. The only exceptions to this are:

12.7.2 After forced entry has been made and thoroughly documented; and then only to facilitate evaluation of additional tests to be performed.

12.7.3 Such repairs or replacements are to be confined to areas that have already been breached and will be made in a manner that returns the system to its original condition.

12.7.4 The results of any testing performed subsequent to repairs or replacement to the test sample can be used to evaluate the acceptability of that material or assembly provided, in the opinion of the test director, the system is not compromised.

12.8 *Design and Material Changes*—Once testing in accordance with this standard has been initiated, no design or material change is to be made unless the modified material or assembly is marked with an addendum to the model number of the sample originally submitted that clearly identifies it as a revised configuration. Materials or assemblies subsequently modified will bear an addendum to the model number that clearly identifies it as a revised configuration differing from all previous modifications.

12.9 *Retesting:*

12.9.1 Failure of any assembly (or material) to demonstrate full compliance with the requirements of Section 9 does not preclude the modification and resubmission of that design or assembly or material for retesting. All such retesting will be conducted in accordance with the full range of the requirements of this standard even though the assembly (or material) may have demonstrated partial compliance with the requirements of the standard in the original testing. Resubmission of modified assemblies or materials will be marked with a type or model number that clearly differs from that of the original (unmodified) submission.

12.10 *Reporting*—After completion of all testing, a comprehensive test report will be prepared which will specify the date, location and results of the test and will include, as appendices thereto, configuration documentation, photographs and all data.

12.10.1 *Data*—Data records of all testing will be maintained and submitted with the test report and will include, but not necessarily be limited to the following:

12.10.2 Complete identification of the test samples.

TABLE 4 Ballistic Probability for Injury at 95 % Confidence Level

	Ref	Probability of Being Hit	
		Hand Gun	Rifle
Caliber—38 Special	9.1		N/A
Caliber—30-06	9.2	N/A	

TABLE 5 Impact Testing at 20 MPH with 4000 Pound Mass

Fence Description(s)	Ref	Penetration Distance (ft)	Opening from Damage
A	1.2		
B	7.1.1		
C	10		
D	12.4		

12.10.3 Date, location and outside temperature at the time of testing.

12.10.4 Complete description of the test, including number of technicians, tools, impacts (during structured portion of testing), and overall time of test.

12.10.5 Specific features of the sample tested, tools used, and total time each feature was tested.

12.10.6 A complete summary of results of the test, including the time required to effect entry in the case of failure.

12.10.7 Forced entry threat severity level and time rating.

12.10.8 Photographs of the sample taken at required stages of the test.

12.10.9 Videotaped recording of the entire test.

12.10.10 *Material and Design Changes*—All materials and assemblies which undergo modification or change will have an addendum applied to its basic type or model number which will clearly indicate it differs from all previous or subsequent configurations of that basic type or model.

12.10.11 *Critical Orientation*—Materials and assemblies whose orientation (test face) 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 in a manner which will remain clearly visible after construction of the forced entry barrier is completed.

13. Summary of Practice

13.1 The individual who is to be in overall control of the test (test director) shall determine the features of the sample most vulnerable to forced entry. The test director's evaluation of this information shall be utilized and exploited by test technicians during both the structured and discretionary portion of testing to effect forced entry on the test sample. The test director shall assign a team of technicians to each test sample of sufficient number to provide for the periodic relief of active technicians. At no time are active technicians to exceed two in number.

13.2 The procedures of these tests are intended to impose the most stringent requirements on each assembly tested within the defined constraints of personnel, tools, and time. Should it become evident in either the structured or discretionary portions of testing that variations in these procedures (but within these constraints) will produce—or more nearly produce—a forced entry, the test director is authorized and obligated to modify these procedures accordingly. Any modifications to the test procedures will be thoroughly recorded and documented for inclusion in the final report.

14. Procedure

14.1 *Structured Penetration Testing:*

14.1.1 *Implements Used for Low (L) Threat Level*—The structured testing portion of this test procedure is to be conducted by two technicians who may be relieved periodically by other members of the test team to minimize the effect of fatigue. The specific tools used in the structured portion of the test for all threat levels shall be selected from the following implements:

14.1.1.1 *Crowbar,* 5 lb, 28 in.

14.1.1.2 *Cold Chisels,* 10-in. long by , 1-in. wide.

14.1.1.3 *Hacksaw,* two HSS blades.

14.1.1.4 *Sledgehammer,* 16 in., 6 lb.

14.1.1.5 *Fire Axe,* 36 in., 6 lb.

14.1.1.6 *Bolt Cutter,* 12 in.

14.1.2 *Additional Implements Used for Medium (M) Threat Level*—The structured testing portion of this test procedure is to be conducted by two technicians who may be relieved periodically by other members of the test team to minimize the effect of fatigue. The specific tools used in the structured portion of the test for this threat levels shall be selected from the following implements:

14.1.2.1 *Bolt Cutter,* 20 in.

14.1.2.2 *Fire Axe,* 36 in., 10 lb.

14.1.2.3 *Hole Saw,* 2 in.

14.1.2.4 *Pry Bar,* 30 in. steel.

14.1.2.5 *Sledgehammer,* 30 in., 12 lb.

14.1.2.6 *Steel Wedge,* 6 in. long.

14.1.3 *Additional Implements Used for Aggressive (A) Threat Level*—The structured testing portion of this test procedure is to be conducted by two technicians who may be relieved periodically by other members of the test team to minimize the effect of fatigue. The specific tools used in the structured portion of the test for this threat level shall be selected from the following implements:

14.1.3.1 *Circular Saw,* 1100 W, 8 in. diameter, and three blades

14.1.3.2 *Disc Grinder,* 1100 W, 5 in. diameter, and three blades.

14.1.3.3 *Rotary and Hammer Drill,* 750 W, five drill bits, ½ in. carbide.

14.1.3.4 *Hole Saw,* greater than 2 in.

14.1.3.5 *Steel Pinch Bar,* 60 in. long.

14.1.3.6 *Reciprocating Saw,* 750 W and three carbide blades.

14.1.3.7 *Sledgehammer,* 30 in., 15 lb.

14.1.3.8 *Oxyacetylene Torch,* with 80 ft^3 oxygen tank and 40 ft^3 acetylene tank with 20 ft of hose (119 lb).

14.1.3.9 *Cut-Off Saw,* 5 KW or HD gasoline, 18 in. diameter with three blades.

14.1.3.10 *Breaker,* (1900 W), 30 lb with three bits.

14.1.3.11 *One Scissor Jack,* 1500 lb capacity with a 4 in. minimum retraction and an 8 in. stroke.

14.1.4 The impacts of any of the impacting tools (sledgehammer, maul, fire axe), including impacts used to drive the wedge, shall be accurately counted and charged against the five-minute total test time at the rate of 40 impacts per minute with a minimum of 120 impacts delivered. Lesser or greater rates of impacting shall be at a pro-rated rate based on 40 impacts per minute. Times listed in Table 1 for these tools are advisory in nature, that is, the overriding requirement is 40 impacts per minute, not three minutes of elapsed time. The apportioning of tool usage during the structured test (see Table 1) is advisory in nature. At anytime during the structured test the test director may reapportion these times limited only by the tools, number of active test personnel and the total test time of five minutes. Justification for any such reapportioning shall be included in the report of testing.

14.1.5 Testing conducted in accordance with the structured test procedures shall continue until:

14.1.5.1 Five minutes of test time has elapsed, or

14.1.5.2 Forced entry has been achieved.

14.2 *Discretionary Testing:*

14.2.1 The discretionary testing of this standard is to be conducted by the same number of technicians specified for Structured Testing. They may utilize any or all of the tools listed in under the category of their threat level and are limited only by the 55 minute total elapsed time allotted for discretionary testing. The objective of the discretionary portion of testing is to provide maximum flexibility to the test director. The director's perceptions and analysis of the forced entry resistance of the sample, to the exclusion of all other factors, shall dictate the tool selection for the discretionary test.

14.2.2 After 30 seconds of attack with any implement, if it becomes evident that the particular implement is not effective at achieving progress toward the goal of creating or enlarging an opening in the test barrier, that implement shall be replaced with another tool selected from the appropriate list.

14.2.3 Testing in accordance with the discretionary portion of testing as defined by this procedure shall be conducted subsequent to the structured portion of testing and continue until:

14.2.3.1 60 minutes (total testing time structured plus discretionary testing) has elapsed, or

14.2.3.2 Forced entry has been achieved.

14.3 *Additional Chargeable Times*—Most of the tools of Table 1 require little if any preparation time prior to their use, however, the set-up times associated with certain tools of that listing are significant. Estimates of the times necessary to transport the tools from a typical "on-hand" location to the test sample location (10-15 ft), assemble and convert from storage/transporting configuration to ready-to-use configuration (collectively referred to as set-up time) are listed in Table 3. When any of these tools are actually put into usage during either structured or discretionary testing the set-up times listed in Table 3 are to be charged against the total test time. Such charges will be made once only, even though a tool may be used intermittently. Any times that may be consumed in periodically replacing worn components or replacing consumed materials, such as changing cutters, drill bits, saw blades, etc., shall be included in the tool usage times. Times required to replace inadvertently broken tools shall not be charged against the test time.

14.4 *Ballistic Testing*—The ballistic test is intended to evaluate the ability of the fence cross-section to provide protection against handgun and rifle fire for personnel on the protected (safe) side of the fence. A fence can provide ballistic protection by stopping the incoming round, deflecting the incoming round from its intended target, or slowing the projectile such that it causes minimal injuries to personnel. (The ability of the fence to obscure the intended target from a shooter's field of view is not evaluated in this test protocol.) It should be noted that certain fence configurations could cause secondary fragments under ballistic impact which could in turn, may injure personnel located on the protected side of the fence.

For the purposes of testing, it is assumed that personnel are located 10 ft from the fence on the protected (safe) side and that the vital area of a human target is approximately 18-in. wide and 24-in. high. (Half-scale testing is accomplished by using a 9-in. wide by 12-in. high target at 5 ft.) Handgun testing is conducted at zero degrees obliquity using a defined pistol threat at muzzle velocity. Rifle testing is conducted at five degree obliquity using a defined rifle threat at a 100-yd and 200-yd velocity. (Zero-degree impact of a rifle round at near muzzle velocity is deemed an unrealistic real world scenario.)

To evaluate the effectiveness of the fence to provide ballistic protection it shall be assumed that stationary, unprotected personnel have a near 100 % likelihood of being impacted by a competent marksman for the scenario defined above. Note that unprotected personnel would also be impacted by only a single projectile.

14.4.1 *Required Number of Tests*—Ammunition of the appropriate type and caliber shall be single fired to obtain the required number of fair hits five (5) on each of the five (5) samples for a total of 25 shots per threat per fence design. (Since three threats are defined, two rifle and one pistol, the complete testing of a fence configuration required 75 fair tests.)

14.4.2 *Shot Pattern*—Each of the five samples will be tested using a five-shot pattern consisting of a 6-in. square. Shots are taken at each corner of the 6 in. square followed by a single shot at the center of the square. The square should be marked roughly on the center of the sample using a template. At the discretion of the test lab, the pattern may be rotated so that all important features of the fence are tested. Testing will continue in this manner using separate five-shot samples until a total of 25 shots are taken per threat per fence design.

14.4.3 *Pass / Fail Criteria in accordance with MIL-STD-662F and NIJ Standard 0108.01*—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 60-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. For each shot, the total number of "penetration" and "no penetration" impacts on the witness plate should be counted and recorded. This may require the use of a new witness panel on every test.

14.4.4 *Fail Hit Definition in accordance with MIL-STD-662F and NIJ Standard 0108.01*—For purposes of this test method, a fair hit shall be a zero degree obliquity ballistic impact for pistol (five degree ballistic impact for rifle) using the specified weight and type of unyawed bullet (5° maximum) within the required velocity range on the specified location of the test sample. All other firings shall be classified as unfair except:

14.4.4.1 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.

14.4.5 *Warning in accordance with F1233*—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.

14.4.6 *Data in accordance with F1233*—Data records of each firing will be maintained and submitted with the test report by the testing laboratory, and shall include the following:

14.4.6.1 Complete identification of the test sample.

14.4.6.2 Ballistic threat and required impact velocity.

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

14.4.6.4 Type and lot number of the test ammunition.

14.4.6.5 Velocity and impact location of each shot.

14.4.6.6 Fair/unfair, penetration/no penetration determination of each shot.

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

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

14.4.7 *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 14.4.6). Additionally, the total number of penetration impacts (on the witness panel) per threat should be summed and presented in the report. Also, measurements should be taken of any open areas in the fence design. If based on these measurements, either the pistol or rifle threat can pass through the fence without impacting it, this shall be documented in the report.

14.4.8 *Optional Field Test Procedure*—At the direction of the test lab, an alternative procedure may be utilized to allow for full-scale testing of mock-up sections of the fence construction. This would require shooting at 10 yards (pistol) and 100, 200 yards (rifle). Ranges would be measured using a laser range finder or similar. Muzzle velocities for each threat / weapon combination must be documented by prior ballistic testing through a chronograph if not done so during the field testing. The exact test procedure will be determined by the test lab such that the intent of this test specification is met. Special care must be taken to ensure accurate shot placement and safety for the shooter (especially at the 10 yard range).

14.5 *Impact Testing:* The impact test is intended to provide relative guidance as to the strength of a fence system to absorb 53.5 K-ft-lb of kinetic energy. The previously described bogie vehicle having a specific mass and a bumper height can be used to simulate an impacting vehicle. The intended point of impact is in the middle of the thirty foot section avoiding the vertical support structure.

The impact vehicle can be accelerated up to the desired speed by means of pulley system and a tow vehicle. A speed controller system can be used to provide the means of controlling the speed at which the bogie vehicle is propelled into the fence system. The bogie vehicle must be released and free wheeling prior to the impact with the test article once the desired speed is attained.

A detailed inspection of the fence system is performed after the impact. The static deflection of the fence system is measured at 24 in. above grade. The conditions of the fence system's main components are documented and High speed video is used to determine the dynamic deflection of the fence system during the impact.

15. Miscellaneous

15.1 *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 and heavy gloves.

15.2 *Ballistic*—**Warning—**It is the test director's responsibility to ensure the safety of all personnel throughout testing but particularly during ballistic tests. To that end, ballistic tests should be conducted by remote firing of securely mounted firearms or with personnel barriers to protect the shooter from ricochet and spall.

15.3 The calibers, numbers of shots, and impact locations will be recorded and included in the final report along with still photographs of the test sample immediately before and after ballistic impact testing.

15.4 *Supplemental Testing*—All testing required is terminated when entry is forced or after a total of 60 minutes of testing establishing a maximum rating of L60, M60 or A60 (see Table 2). Testing beyond the point at which entry is forced within the 60-minute limit or after the sample has resisted entry for 60 minutes (test to failure), may from time-to-time, be required by appropriate authority.

15.5 *Tool Replacement*—During testing, should any tool be rendered useless through loss or breakage the test will be temporarily suspended, the tool or device replaced or repaired and the test continued from the point of suspension.

16. Keywords

16.1 forced entry resistance; devices; security fence systems; tools