H.P. WHITE LABORATORY, INC.

TEST PROCEDURE

TRANSPARENT MATERIALS
FOR USE IN
FORCED ENTRY OR CONTAINMENT BARRIERS

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ABSTRACT

This test procedure establishes standards with which the ballistic resistance and forced entry resistance of transparent materials can be evaluated.

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1.0 INTRODUCTION

1.1 BACKGROUND

1.1.1 Increasing levels of international terrorism and domestic social disorder have highlighted the vulnerability of government and commercial institutions to overt attacks on structural elements intended to resist such attack. The failure of these elements to provide adequate resistance must be attributed either to overestimating the performance of the materials, or to underestimating the level of the threat. Frequently, the element assaulted in such incidents is a transparent portion of the protective barrier, and too often these transparent elements prove inadequate. Historically, transparent materials have been extremely vulnerable to overt forced entry (or forced exit); however, technical advances have provided a variety of transparent materials which offer increased resistance - in varying degrees - to forced entry/exits.

1.1.2 As a leader in the field of testing transparent armoring and impact resistant materials, H.P. White Laboratory, Inc. is acutely aware of a compelling and urgent requirement for an industrial standard with which the forced entry/containment characteristics of transparent materials may be evaluated.

1.2 DISCUSSION

1.2.1 The success or failure of any attempt to forcefully enter (or exit) a structure is dependent on several factors, including the tools employed, the techniques used, and the time available to effect the entry (or exit).

1.2.1.1 Tools - The tools, devices and materials specified herein are those which are known to have a maximum destructive effect on a transparent barrier and are commonly found in all types of buildings and structures or would be otherwise readily available to an attacking mob. The tools and materials used to test the transparent materials were selected to replicate the effects of four basic forms of stress - blunt impacting, sharp impacting, thermal stress, and chemical stress. Specifically exempted from these tools and materials are demolition devices (including explosives), power and powder actuated tools, and devices which require more than two persons to carry and manipulate them.

1.2.1.2 Procedures - The procedures presented herein are intended to reflect techniques known to have been used to effect forced entries (or exits) using the tools specified. The procedures are based more on field experience than laboratory analysis, and are intended to provide a basis for the comparative evaluation of forced entry/containment resistance materials. The procedures are not intended to be used to establish, or confirm, the absolute prevention of forced entries or exits.

1.2.1.3 Times – This test procedure does not express forced entry resistance in terms of time.

1.2.2 Included in these procedures is an OPTIONAL procedure for evaluation of the ballistic resistance of transparent materials, which is independent of the forced entry/exit evaluation.

1.3 OBJECTIVE

1.3.1 The objective of this specification is to evaluate transparent armor materials for use as a barrier to ballistic impact and forced entry (or exit).

1.4 SCOPE

1.4.1 This specification sets forth tests whose purpose is limited to the evaluation of the resistance of transparent materials to ballistic impacts (optional), blunt tool impacts, sharp tool impacts, thermal stress, and chemical deterioration.

2.0 REQUIREMENTS

2.1 DISCUSSION

2.1.1 The requirements specified herein have been established by H.P. White Laboratory, Inc. for use in evaluating the forced entry resistance and containment characteristics of transparent materials.

2.1.2 The requirements of this specification are the minimum recommended requirements for transparent elements of a forced entry/exit barrier. They are based on an analysis of overt, forced entries/exits of institutions and government buildings over the last several years. The following highlights of that analysis provide a general background and a basis for the requirements of this section and the procedures of Section 3.0.

2.1.2.1 Absolute protection from forced entry by a determined and well-equipped team is impossible.

2.1.2.2 Many overt forced entries/exits are committed by an ill-equipped, undisciplined mob.

2.1.2.3 Many overt attempts to enter or exit forcibly will be thwarted by a protection system which makes such an entry time consuming and hazardous.

2.1.2.4 All but the most determined and well-equipped attempts to forcefully enter or exit any structure can be effectively discouraged and delayed by a system of riot control munitions (noxious gases, non-lethal gunfire, etc.) and structural, forced entry/exit barriers.

2.1.3 The requirements specified herein are intended only to establish the minimum acceptable performance characteristics of the transparent materials used in forced entry or forced exit barriers.

2.2 TEST SAMPLE

2.2.1 The requirements of this section and the procedures of the following section are intended to minimize test costs by conducting all testing on a single sample. While this approach may be criticized, it is representative of actual forced entry/exit attempts which frequently employ more than one type of tool to mount two or more types of threat on the same sample.

2.2.2 The size of all transparent material samples shall be 48 x 36 inches. To facilitate fixturing, the sample thickness shall not be less than ¼ inch and no more than 3 inches. 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) in base materials configured with such laminations and spacing.

2.2.3 Materials which satisfy the requirements of this standard based on testing of a 48 x 36-inch sample are recommended for application of that size or less, but not for applications requiring viewing areas in excess of 48 x 36 inches.

2.3 TEST FIXTURING

2.3.1 The test sample shall be mounted in a vertical Test Stand of rigid, 6-inch steel I-beams. The I-beam stand shall 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 stand shall exceed 8 feet.

2.3.2 Material samples shall be mounted in a Test Frame constructed of structural Z-beams (conforming to ASTM A-36 for 4-inch x 3-inch x 3-inch x 0.25-inch iron) which will accept a rectangular test sample of 48 x 36 inches. One leg of the two legs of the Z-beam shall be oriented to support the entire periphery of the protected face of the sample for a distance of 1 inch from its edge. Prior to inserting the sample in the Test Frame, a 3/16-inch thick rubber gasket (complying with ASTM D-1330, Type 2 Specifications For Durometer and Testing Strength) shall be wrapped around the edge of the sample and extended over the protected and threatened face of the sample for a minimum of 1 inch. The mounting shall be completed with a framing closure against the threatened face of the sample held in place with adjusting screws (see Figure 1).

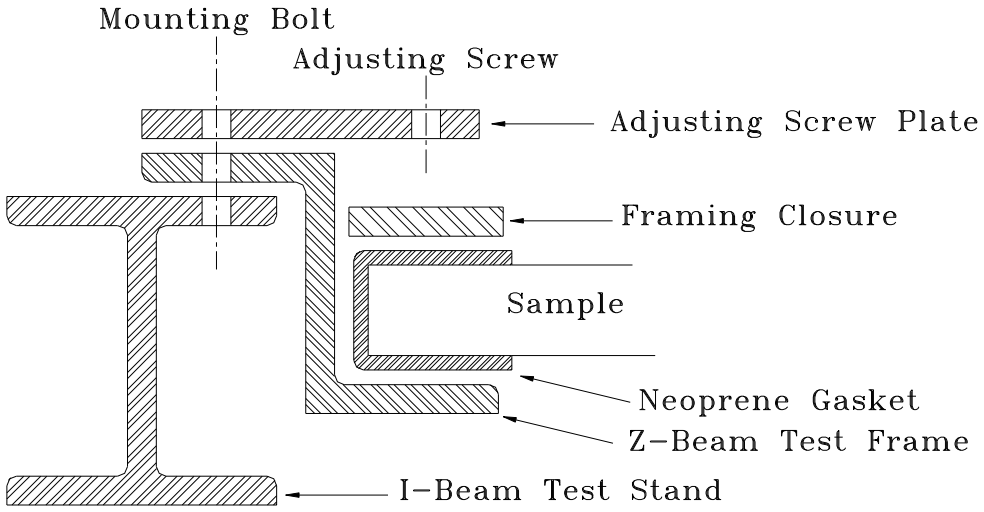

FIGURE 1. FRAMING AND FIXTURING OF TEST SAMPLE

2.3.3 The fixturing of the sample shall be completed by bolting of the Test Frame to the Test Stand with ½-inch machine bolts. The center-to-center location of the frame mounting bolts and the adjusting screws shall be no greater than 6 inches. When mounted, the bottom edge of the exposed faces (protected and threatened) of the sample shall be no higher than 24 inches, nor lower than 21 inches, from the horizontal surface supporting the test personnel.

2.3.4 The location of the test fixturing shall be in a protected environment whose ambient temperature does not fluctuate beyond 60°F and 90°F, and all test materials shall be in this environment for a minimum of 24 hours immediately preceding initiation of the test. The area immediately adjacent to the sample, extending 6 feet to the left and right of either vertical edge of the sample, 10 feet from the assault face of the sample, and 8 feet over the horizontal surface supporting the test personnel, shall be free of all obstructions.

2.4 TOOLS, DEVICES AND MATERIALS

2.4.1 Analysis of a variety of actual forced entries/exits has produced a list of tools and implements used by the attackers. From this listing, all explosive (except firearms), electrical, pneumatic or hydraulic tools, devices or implements have been eliminated. The remaining tools and implements can be categorized with respect to their principal effect - blunt impacting, sharp impacting, thermal stressing, chemically deteriorating and ballistically penetrating. Table I presents those tools and implements of each category selected as being representative of the most effective of forced entry/exit tools. In every category, they are the size, type and nature of tools deemed to have the most destructive effect on transparent materials for that category of forced entry/exit threat.

2.4.2 Blunt Impacting Tools - The tools and implements used to conduct the blunt impact portions of these tests shall be limited to the tools and implements of Paragraphs 2.4.2.1 through 2.4.2.7.

2.4.2.1 Sledgehammer – 12-pound, double face, drop-forged steel head with 36" handle.

2.4.2.2 Ram - Two-man, 120-pound, steel with 4" x 4" strike face and two 1" round handles mounted perpendicular to the longitudinal center line extending 12" beyond the extremity of two opposing sides.

2.4.2.3 Pipe - Steel, 4", Schedule 40, ASTM-A53, 90° cut-off, steel strike face on one end.

2.4.2.4 Wedge - Forged steel, 9" long, 2 ½" wide cutting.

2.4.2.5 Crowbar - Pinch point bar, 60", forged steel.

2.4.2.6 Crowbar - Pinch point bar, 48", forged steel.

2.4.2.7 Ripping Bar - Slotted claw and chisel ends, forged steel, 24".

2.4.3 Sharp Impacting Tools - The tools and implements used to conduct the sharp impact portions of these tests shall be limited to the tools and implements of 2.4.3.1 through 2.4.3.11.

2.4.3.1 Sledgehammer – 12-pound, double faced, drop-forged steel head with 36" handle.

2.4.3.2 Ball Peen Hammer – 32-ounce, drop-forged steel head.

2.4.3.3 Fireman's Axe - Pick head, drop-forged steel, 6 pounds, 36" long.

2.4.3.4 Wood Chisel - Drop-forged high carbon steel, 1 ¼" wide.

2.4.3.5 Cold Chisel - Conforming to Federal Specification GGG-313b, 7.8" edge, 8" long.

2.4.3.6 Masonry Chisel - Forged steel, 3" wide.

2.4.3.7 Pipe - Steel, 1 ½", Schedule 80, ASTM-A53, 90° cut-off, steel strike face on one end.

2.4.3.8 Angle Iron - 2" x 2", steel, ¼" thick, AISI-M1020, 90° cut-off.

2.4.3.9 Wood Splitting Maul – 8-pound, heat treated steel head with 3" cutting edge.

2.4.3.10 Compass Saw - 15" length (nominal), 8-12 teeth per inch (keyhole saw).

2.4.3.11 Hacksaw - Flexible, high-speed tool steel, 12" long, 24 teeth per inch.

2.4.4 Thermal Stress Tools - The tools and implements used to conduct the thermal stress portions of these tests shall be limited to the tools and implements of 2.4.4.1 through 2.4.4.3.

2.4.4.1 Fire Extinguisher, CO_2 - Steel cylinder, 20-pound, conforming to UL10BC, or equivalent.

2.4.4.2 Propane Torch - 12 to 15-ounce cylinder with general purpose Tip No. HT-880-2, Turner Company, Sycamore, Illinois, or equivalent.

2.4.4.3 Oxygen-Acetylene Torch - Two-stage, with cutting Tip No. 3.

2.4.5 Ballistic Impacting Materials (Ammunition) - The ammunition used to conduct the ballistic impact portions of these tests shall be limited to that of 2.4.5.1 through 2.4.5.5.

2.4.5.1 Caliber .38 Special - Ammunition conforming to SAAMI specifications for caliber .38 Special, 158 grain, RN, Lead ammunition and gun or test barrel producing velocities of 750 fps (±50 fps) at 10 feet from the muzzle.

2.4.5.2 Caliber 9mm Luger - Ammunition conforming to SAAMI specifications for caliber 9 mm, 124 grain, Full Metal Jacket ammunition and gun or test barrel producing velocities of 1150 fps (±50 fps) at 10 feet from the muzzle.

2.4.5.3 Caliber .44 Magnum - Ammunition conforming to SAAMI specifications for caliber .44 Magnum, 240 grain, Jacketed Soft Point ammunition and gun or test barrel producing velocities of 1400 fps (±50 fps) at 10 feet from the muzzle.

2.4.5.4 Caliber 7.62x51 mm - Ammunition conforming to U.S. Military specifications for caliber 7.62x51 mm, 147 grain, M80 NATO, Ball (steel jacketed) ammunition and gun or test barrel producing velocities of 2775 fps (±50 fps) at 10 feet from the muzzle.

2.4.5.5 Caliber .30-06 AP - Ammunition conforming to U.S. Military specifications for caliber .30-06 AP, M2 ammunition, 164 grain and gun or test barrel producing velocities of 2775 fps (±50 fps) at 10 feet from the muzzle.

2.4.6 Chemically Deteriorating Materials - The materials used to conduct the Chemical deterioration portions of these tests shall be limited to the materials specified in 2.4.6.1 through 2.4.6.4.

2.4.6.1 Gasoline - Unleaded premium, 93 Octane, or equivalent.

2.4.6.2 Solvent - Windshield washer, concentrated, Therm-X-Chemical and Oil Corporation, Commack, New York, or equivalent.

2.4.6.3 Solvent - Acetone, Parks Corporation, Specific Gravity of 0.80 ±0.03, boiling point of 133 ±2°F, or equivalent.

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

TABLE I. FORCED ENTRY TOOLS AND IMPLEMENTS

Category	Principal Effect on Barrier	Test Implements	
		Description	Minimum Quantity
Blunt Impact	Break and Deform	12-lb. Sledgehammer	3
		120-lb. Ram	1
		4" Diameter Pipe	1
		Wedge, 2 ½" wide	6
		Pinch Bar, 24"	4
		Pinch Bar, 48"	4
		Ripping Bar, 60"	2
Sharp Impact	Notch, Shave and Puncture	Wood Chisel	3
		Cold Chisel	3
		Masonry Chisel, 2 ¼"	4
		Hacksaw, 12"	1
		2-lb. Hammer	3
		Angle Iron	1
		Water Pipe, 1 ½"	1
		Fire Axe	2
		12-lb. Sledgehammer	2
		Wood Splitting Maul	2
		Compass Saw	2
Thermal Stress	-80ºF to 6300ºF	CO_2 Extinguisher	(a)
		Propane Torch	(a)
		Acetylene Torch	(a)
Ballistic Impact	Puncture and Spall	Caliber .38 Special	(a)
		Caliber 9 mm Luger	(a)
		Caliber .44 Magnum	(a)
		Caliber 7.62x51 mm	(a)
		Caliber .30-06 AP	(a)
Chemical Deterioration	Dissolve and Soften	Gasoline	(a)
		Windshield Washer	(a)
		Acetone	(a)

(a) As Required

2.5 MISCELLANEOUS MATERIALS

2.5.1 In order to comply with the full range of test requirements of this specification, the support materials, equipment, and instrumentation of Paragraphs 2.5.1.1 through 2.5.1.7 must be available to the Test Director.

2.5.1.1 Lumiline Screens - Electronic Counters, Inc Model 6300 or equivalent.

2.5.1.2 Chronograph - Electronic Counters, Inc. Model 4010 or equivalent.

2.5.1.3 Temperature Determining Instrumentation – Omega, Model HH-21 (or equivalent) and compatible thermocouples for measuring temperatures to 2000°F.

2.5.1.4 Ballistic Penetration Witness Foil - Aluminum Foil, .001" thick (Reynolds Wrap kitchen foil or equivalent).

2.5.1.5 Forced Entry Shape - A rigid, rectangular shape, 8" x 8" x 5" (-? ").

2.5.1.6 Test Stand - A rigid, substantial test stand equivalent to that described in Paragraph 2.3.1.

2.5.1.7 Test Frame - A test frame as described in Paragraph 2.3.2 is required.

2.6 TEST SEQUENCE

2.6.1 Any samples submitted for optional ballistic resistance testing shall be tested at the level specified by the supplier (see Table II). Following the ballistic testing the test sample (without repair or alteration of the damage incurred in the ballistic test) shall be tested for forced entry resistance in accordance with Table III. The forced entry testing of all samples shall begin with Sequence Number 1 and continue consecutively through each subsequent sequence until entry is forced (Paragraph 2.8.3, below).

2.6.2 Alternatively, the supplier may submit a separate 12 x 12-inch sample for ballistic resistance testing.

2.7 BALLISTIC RESISTANCE TESTING (OPTIONAL)

2.7.1 With submission of the sample, the supplier shall, if applicable, indicate the level of ballistic threat (Table II) that this sample is designed to resist.

2.7.2 Three shots of the appropriate ammunition shall be fired at the velocity specified in Table II to produce unyawed, zero degree obliquity impacts at 120° intervals on the periphery of an 8-inch diameter circle at the approximate center of the sample.

2.7.3 Any fair impact which produces a complete penetration (see Paragraph 3.3.3) of the sample shall be cause to reject the sample and prohibit the use of the design of that sample as a ballistic resistant element for that level of protection, regardless of the number of other fair impacts which did not produce penetration.

TABLE II. BALLISTIC THREAT SPECIFICATIONS

Threat		Bullet		Velocity @10' (fps)	
Level	Caliber	Weight (gr)	Type	Minimum	Maximum
A	.38 Special	158	RN, Lead	700	800
B	9 mm Luger	124	FMJ	1100	1200
C	.44 Magnum	240	JSP	1350	1450
D	7.62x51 mm	147	M80, Ball	2725	2825
E	.30-06 AP	164	M2, AP	2725	2825

2.8 FORCED ENTRY RESISTANCE TESTING

2.8.1 The test sample shall be subjected to forced entry resistance testing in accordance with this paragraph. Samples having been ballistically penetrated MAY be tested for forced entry resistance, and may be rated as suitable forced entry ONLY barrier materials.

2.8.2 Subsequent to the ballistic testing of Section 2.7, if applicable, the test sample shall be tested in accordance with the procedures of Section 3.0 using the sequences of Table III until entry is forced.

2.8.3 Any sample which is breached sufficiently to permit passage of a solid, incompressible rectangular object measuring 8 x 8 x 5 inches (Paragraph 2.5.1.5) shall be determined to have been forcibly entered.

2.8.3.1 This criterion shall apply whether the passage of the shape is made through a hole in the transparent material, or through a gap created by disassociation of the transparency from the test frame.

2.8.3.2 After removal of the flame of the propane or oxygen-acetylene torch (Paragraphs 3.6.2 and 3.6.3) and a 15-minute self-sustained burning period, the sample shall be determined to have been forcibly entered if:

a) The burning of the sample is self-sustaining for a period of 15 minutes, AND

b) The size of any hole entirely through the sample (whether created previously or by the flame test) increases in size by self-sustained burning.

TABLE III. FORCED ENTRY TEST REQUIREMENTS

	Testing Sequence				
	Level I	Level II	Level III	Level IV	Level V
Blunt Impacting (Impacts)					
Sledgehammer/Wedge (25)	1,4	8,10	18,24,26	29,32,39	42,45,48,51,54
4" Dia. Pipe/Sledge (25)	2	7	17	28	41
Ram (10)	na	6	16	27	40
Pinch Bar (a)					
Sharp Tool (Impacts)					
Chisel/Hammer (25)	na	12	21,23	33,36,38	47,52
Angle Iron/Sledge (25)	na	13	22	na	na
1 ½ " Pipe/Sledge	5	na	na	na	na
Fire Axe (25)	na	na	na	35	44,50
Wood Maul (25)	na	15	20	31	46,53
Compass Saw (b)					
Hacksaw (b)					
Thermal Stress (Minutes)					
Extinguisher, CO_2 (1)	3	9	na	na	na
Propane Torch (5)	na	11	19	30	na
Acetylene Torch (5)	na	na	na	na	43
Chemical Deterioration (Amount)					
Gasoline (8 oz.)	na	14	na	na	na
Windshield Washer (8 oz.)	na	na	25	34	na
Acetone (8 oz.)	na	na	na	37	49
Total Forced Entry Sequences	5	15	26	39	54

(a) Pinch or ripping bars may be substituted for any portion of blunt impacting sequence at a rate of 1 minute for each 5 impacts (Test Director option).

(b) Additional sequences of 1-minute intervals in conjunction with all sharp tool sequences (see paragraphs 3.5.7 and 3.5.8).

2.9 PROTECTION LEVEL RATING

2.9.1 The levels of protection specified herein are established by utilizing the tools and materials of Section 2.4.

2.9.2 The protection levels established by this specification are intended to reflect the ballistic resistance and forced entry resistance of the test sample.

2.9.2.1 Ballistic Rating - Any sample which is not penetrated ballistically shall be rated as suitable for use in barriers requiring the appropriate ballistic resistance of Table II - A through E.

2.9.2.2 Forced Entry Rating - Any sample which is not forcibly entered through the last test sequence of a specific protection level of Table III, shall be rated as suitable for use in barriers requiring the threat level of protection for which the sample was not breached - I through V.

2.9.2.3 Overall Rating - The collective ballistic and forced entry ratings (if appropriate) shall be in accordance with Table IV.

TABLE IV. OVERALL BARRIER RATINGS

Not Penetrated By-	Last Sequence Completed Without Forced Entry					
	0-4	5-14	15-25	26-38	39-53	54
.38 Special	None	A-I	A-II	A-III	A-IV	A-V
9 mm Luger	None	B-I	B-II	B-III	B-IV	B-V
.44 Magnum	None	C-I	C-II	C-III	C-IV	C-V
7.62x51 mm	None	D-I	D-II	D-III	D-IV	D-V
.30-06 AP	None	E-I	E-II	E-III	E-IV	E-V
Not ballistically tested (or failed ballistically).	None	I	II	III	IV	V

2.10 CONFLICTING REQUIREMENTS

2.10.1 None of the requirements or provisions of this document are to be used to justify exceptions to - or waivers of - the structural requirements and operating requirements of materials, fittings and hardware specified in the construction drawings and specifications of the basic structure.

2.10.2 To the extent that conflicts exist in applicable documents, the procurement agreement shall prevail, followed by the structural and non-forced entry requirements of the structures involved, this Specification, Industrial, Military and Manufacturer's Specifications (in that order of priority).

2.11 RE-TESTING

2.11.1 From time to time, verification of the forced entry suitability of a material previously tested and found suitable may be conducted for quality control purposes. All such testing shall be conducted in accordance with the full range of requirements of the MOST RECENT revision of this standard.

2.12 ADDITIONAL/ALTERNATE TESTING

2.12.1 Materials whose barrier performance is dependent on its orientation (Paragraph 2.16.1, below) and which have successfully demonstrated compliance with the requirements of this specification could, in actual usage, be assaulted in a manner which invalidates that orientation and demonstrated performance. Therefore, materials whose PROTECTED side could, during periods of social - or institutional - disorder, become the THREATENED side may have to undergo a second testing, reversing the orientation of the previous test. Should a test of the PROTECTED side be required by the proposed usage of the material, such testing MAY be conducted on the same sample or on a previously untested sample (supplier option).

2.13 TEST PERSONNEL

2.13.1 A minimum of two forced entry test personnel shall be required. They shall be young (18-40 years of age), muscular (150-250 pounds of body weight) males, in good health, who carry out the assault with vigor and enthusiasm.

2.14 DATA

2.14.1 Data records of all testing shall be maintained and submitted with the test report and shall include - but not necessarily be limited to - the following:

2.14.1.1 Date and location of the test.

2.14.1.2 Complete identification of the test sample.

2.14.1.3 Photographs of the sample before and after testing.

2.14.1.4 Forced entry rating of test sample.

2.15 REPORTING

2.15.1 After completion of all testing, a comprehensive test report shall be prepared which shall specify the date, location and results of the test and shall include, as appendices thereto, all data and photographs (Paragraph 2.14).

2.16 MARKINGS

2.16.1 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, shall have the correct orientation clearly and indelibly marked on them in a manner which shall remain clearly visible after the fixturing of the forced entry barrier is completed (see Paragraph 2.12.1).

2.17 MISCELLANEOUS

2.17.1 Compliance with the forced entry and ballistic resistance requirements of this standard is to be determined by tests described herein, and shall 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, and the Test Director shall provide sufficient advanced notice of all testing for that purpose.

2.17.2 Once a material is committed to testing, 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.

3.0 PROCEDURES

3.1 SCOPE

3.1.1 This standard sets forth the test procedures to be used to determine the forced entry protection characteristics of transparent materials 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 exit) attack during periods of social disorder.

3.2 DISCUSSION

3.2.1 That 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 and the nature of the most effective assault on that feature, limited to the tools and techniques described in this test specification.

3.2.2 The procedures of these tests are intended to impose the most stringent requirements on each material within the constraints of personal endurance, tools and time. Should it become evident that variations in these procedures (but within these constraints) shall produce - or more nearly produce - a forced entry, the Test Director is authorized - and OBLIGATED - to modify these procedures accordingly. Any modifications to the procedures shall be thoroughly recorded and documented for inclusion in the final report.

3.2.3 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-pound sledgehammer is dependent on a variety of factors 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.

3.3 BALLISTIC IMPACT TESTING

3.3.1 A test barrel shall be positioned so that the muzzle is 25 feet from the sample surface. Lumiline screens positioned at 5 and 15 feet from the muzzle, shall, in conjunction with an elapsed time counter, be used to determine bullet velocities at 10 feet from the muzzle (15 feet from the test sample).

3.3.2 If the Test Director suspects that there may be excessive projectile yaw, then a paper yaw panel shall be positioned as close to the impact surface as practicable.

3.3.3 Penetrations shall be determined by visual inspection of a witness panel of 0.001-inch aluminum foil positioned 6 inches behind - and parallel to - the test sample. Any perforation of this panel through which the light from a 40-watt lamp can be detected shall be termed a "Complete Penetration." All other results shall be declared "Partial Penetrations."

3.3.4 All bullet velocities shall be in compliance with the requirements of the test ammunition specifications of Table II and may, depending on the length and condition of the barrel, require specially loaded cartridges.

3.3.5 Bullet impacts whose velocities are in compliance with Table II and whose unyawed impacts are otherwise in compliance with Paragraph 2.7.2 are "Fair Impacts." Ballistic testing shall continue until the minimum number of "Fair Impacts" specified by Paragraph 2.7.2 are obtained, or until the sample is ballistically penetrated (see Paragraph 2.7.3).

3.3.6 Any ballistic impact which exceeds the MAXIMUM velocity requirements of Table II, and which does NOT penetrate the sample, shall be declared a "Fair Impact."

3.3.7 Any ballistic impact which does not comply with the MINIMUM velocity requirements of Table II, BUT which PENETRATES the sample, shall be classified as a "Fair Impact," and the sample declared ballistically unsatisfactory.

3.4 BLUNT INSTRUMENT TESTING

3.4.1 During the conduct of all phases of blunt impact testing, the Test Director shall continually note the vigor of each member of the team. Should - in his sole judgement - a member of the test team be less than vigorous in conducting these tests, he shall immediately suspend the test and replace that member of the team.

3.4.2 Ram Test - Two test personnel shall apply ten blows with the ram to the assault face of the sample in a location pre-weakened by the previous phases of the test, or in a location specified by the Test Director.

3.4.3 Sledgehammer Test - Two personnel equipped with 12-pound sledgehammers shall deliver twenty five impacts to that portion of the material which - in the Test Director's judgement - is most likely to result in a forced entry (Paragraph 2.8.3).

3.4.3.1 At any time during any sequence of hammer-only impacts, except the initial sequence, wherein a seam, crack or opening is developed which will accept the edge of a wedge and which - in the judgement of the Test Director - is the most likely means of forcing an entry, the Test Director shall direct exploitation of this weakness. That exploitation is to continue until the required number of impacts has been met without entry, entry is forced, or until - in the Test Director's judgement - forced entry is more likely to result by reverting to direct sledgehammer impacting.

3.4.4 Pipe/Sledgehammer Test - This phase of the test is to be carried out by two personnel, one of whom is to position one end of the 4" pipe on the transparency, while the other impacts the other end with a 12-pound sledgehammer.

3.4.4.1 The test shall be directed at any location which - in the judgement of the Test Director - is most likely to facilitate a forced entry. Likewise, the angle between the centerline of the pipe and the plane of the surface of the impacted area shall be determined by the Test Director.

3.4.5 Exploitation of Pre-Weakened Areas - The blunt instrument impacting is to be directed, whenever applicable, at locations pre-weakened by other phases of the test - sharp tool notching, heating, cooling, etc. At any time during any Blunt Impact Test Sequence, the Test Director may direct the personnel to suspend their current activities, and to replace the balance of the test sequence with a crowbar assault if - in his judgement - such a change is more likely to produce a forced entry. The extent of all crowbar testing shall be limited to the balance of the blunt sequence test, and shall be substituted at the rate of 1 minute of testing for every five hammer blows.

3.5 SHARP INSTRUMENT TESTING

3.5.1 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 insure they have been unused since sharpening (chisel and axe), and their edges are sharp corners (angle iron and pipe).

3.5.2 Chisel/Hammer Test - This phase of the test is to be carried out by an individual equipped with a chisel and ball peen hammer. The chisel test shall be a direct test of areas of the transparency pre-weakened 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 from the attack-side facing. The Test Director may, at any time during this test, direct the personnel to use either a wood chisel, cold chisel, or masonry chisel and to direct their efforts at any specific location of the transparency.

3.5.3 Angle Iron/Sledgehammer Test - This phase of the test is to be carried out by two personnel, one of whom is to position the angle iron against the face of the transparent element, while the second impacts the other end of the angle iron with a 12 pound sledgehammer. This phase of the test shall otherwise be conducted in accordance with Paragraph 3.5.2, above.

3.5.4 Pipe/Sledgehammer Test - This phase of the test is to be conducted in accordance with the provisions and procedures of 3.5.3, above, substituting the 1 ½ inch steel pipe for the angle iron.

3.5.5 Fire Axe Test - The fire axe phase of the test is to be carried out using pick-head fire axes. The Test Director shall specify whether the pick-end or blade-end of the fire axe is to be used.

3.5.6 Wood Splitting Maul Test - This phase of the test is to be carried out in accordance with the procedures of the fire axe test, Paragraph 3.5.5, above.

3.5.7 Compass Saw Test - At any time during a sharp impact test sequence, wherein a hole of sufficient size to accept the compass saw is forced in the transparent material, the Test Director shall direct the personnel to exploit this breach with the compass saw for 1 minute, and he shall direct a similar action during each subsequent sharp impact test sequence. The use of the compass saw is an added sequence, and the time expended in its use shall NOT be deducted from other sequences of the overall test.

3.5.7.1 The compass saw shall be used following each sharp impact test sequence. If the sharp impact sequence is the last sequence in a level (e.g., Sequences 5 or 15) and the material was not forcibly entered immediately prior to the use of the compass saw, the material shall be judged as having successfully completed that sequence (5 or 15).

3.5.8 Hacksaw Test - This phase of the test is to be conducted in accordance with, but in lieu of, the provisions of Paragraph 3.5.7, above.

3.6 THERMAL TESTING

3.6.1 Each phase of thermal testing is to be conducted in two stages. During the first stage, ½ of the specified thermal stress duration is applied, followed by ½ of the required sharp/blunt impacts of the next sequence. This process is then repeated in the second stage. For example, in Level I, Sequences 3 and 4 consist of 1 minute of thermal conditioning and 25 sledgehammer/wedge impacts. This shall be conducted as 30 seconds of thermal conditioning, 13 impacts, 30 seconds thermal, and 12 impacts. A similar process shall be used for sequences 9-10, 11-12, 19-20, 30-31 and 43-44.

3.6.2 CO_2 Extinguisher Test - The CO_2 extinguisher test is to be carried out with a sufficient number of CO_2 extinguishers to provide for a total discharge time of 1 minute. The discharge shall be focused on an area specified by the Test Director. The impacts of the next testing sequence shall be applied to the same location of the transparency.

3.6.2.1 The Test Director is to insure that the entire test sequence is conducted as rapidly as possible in order to optimize the cumulative effects of the thermal conditioning. The last impact of the blunt instrument impact phase shall occur no longer than 7 minutes from the initiation of the first extinguisher discharging.

3.6.2.2 The Test Director shall further insure that the thermal conditioning of the next phase (see Sequences 9-12 of Table III) is initiated immediately after the last sledgehammer impact 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 minutes.

3.6.3 Propane Torch Test - The propane torch test is to be carried out with the same time constraint of 7 minutes total for the completion of the thermal and sharp impacting tests of Sequences 11-12, 19-20 and 30-31 (see Table III).

3.6.3.1 Testing shall be suspended if the test sample exhibits self-sustained burning (Paragraph 2.8.3.2).

3.6.4 Oxygen-Acetylene Torch Test - The oxygen-acetylene torch test is to be carried out in accordance with the procedures of Paragraph 3.6.3, above, including the overall time constraints of the following sharp instrument tests (see Table III).

3.7 CHEMICAL DETERIORATION TESTING

3.7.1 Gasoline Test – 8 ounces of gasoline (Paragraph 2.4.6.1) shall be dispensed using the device specified in Paragraph 2.4.6.4, onto the surface of the transparency. The dispensing of the gasoline shall be directed at a single location which, as a result of previous impact testing, has had the non-plastic surface removed, fractured or cracked, exposing the plastic inner or rear laminates to direct impingement of the gasoline. The gasoline shall be dispensed within 5 minutes.

3.7.2 Windshield Washer Solution Test - The windshield washer solution test shall be conducted with a solution conforming to that specified in Paragraph 2.4.6.2, and in accordance with the procedure of 3.7.1, above.

3.7.3 Acetone Test - The acetone test shall be conducted with a solution conforming to that specified in Paragraph 2.4.6.3, and in accordance with the procedures of 3.7.1, above.

4.0 MISCELLANEOUS

4.1 SAFETY OF TEST PERSONNEL

4.1.1 All personnel actively engaged in forced entry testing shall be equipped with appropriate items of personal protection.

4.2 REVISIONS

4.2.1 This standard will, from time to time, be revised to reflect the evolution of technique for evaluation of the forced entry protection of transparent materials.

4.3 AVAILABILITY

4.3.1 Additional copies of this specification may be obtained from:

www.hpwhite.com

or

H.P. White Laboratory, Inc.
3114 Scarboro Road
Street, MD 21154

REVISIONS RECORD SHEET

Revision	Date	Paragraph(s) Affected	Substance (brief)
.00	July, 1988	Standard Number	Changed from 0100.00 to 0500.00
.01	August, 1989	Section II, 3.1-3.2	Clarification of ballistic test set-up.
		Section II, 6.0	Forced Entry/Exit rating is independent of Ballistic test results.
		Section III, 5.6-5.7	Mandatory use of Compass Saw and Hacksaw.
		Miscellaneous	Added Table of Contents. Insignificant grammar corrections.
.02	September, 1993	All	Format and general rewrite removing assemblies from this standard.
			Use of sledgehammer amended.
			Use of crowbar amended.
			Use of Acetone versus Methylene Chloride.
.03	March, 2003	2.4.3.10 & others	Replaced "keyhole saw" with "compass saw" (proper designation).
		2.4.5.2, 2.7-Table II	9 mm velocity changed from 1100-1180 to 1100-1200 for consistency with other velocity ranges (±50 fps).
		2.19, Addendum	Section 2.19 removed, Addendum added.
		2.5.1.5, 3.3	Reference ammunition test requirement deleted. Yaw cards optional.
		Miscellaneous	Document reformat and rewording for clarification.

ADDENDUM - FORCED ENTRY RESISTANCE TESTING ISSUES

Contention has arisen regarding the re-testing provisions of HPW-TP-0500.02, Section 2.19. With the promulgation of HPW-TP-0500.03, Section 2.19 has been removed. The test procedure will remain mute regarding this issue. The decision to retest shall be made by the consumer of glazing material. An explanation for this change follows.

Forced entry of a glazing sample is characterized by the construction of the glazing to be breached, the tool complement available, the number of perpetrators, the elapsed time available, the experience of the perpetrators, and the vigor of the perpetrators. While the first four factors can be quantified, the latter two cannot.

There are two fundamental means by which forced entry resistance testing may be performed:

One method is repeatable, but unrealistic. It may involve the use of a pendulum, thus permitting test variables to be quantified. However, the inanimate pendulum cannot discern, and exploit, the development of weaknesses in a glazing sample in a manner that will most readily effect forced entry.

The other method is realistic, but not repeatable. It involves the use of human beings, where not all test variables can be quantified. While human beings can discern, and exploit, weaknesses in test items as they develop, the results of their efforts are not repeatable in a precise way.

This test procedure employs the latter method. Realistic simulations of forced entry assaults require real people employing their tools and knowledge in a manner that will most readily effect a forced entry. If a glazing sample can be breached within the limits of the test procedure, it is the obligation of the testing facility to effect this breach. Any other mindset is a disservice to the consumers of the glazing material.

It is true that test personnel will become more proficient at performing forced entry resistance testing as they gain experience. Therefore, it is conceivable a glazing sample that once satisfied a given level of assault may fail that level, if re-tested. The converse is also possible. A glazing sample that once failed a given level of assault may pass that level, if re-testing is performed by less experienced, less motivated, and less physically fit personnel.

Repeatability is further diminished when more than one facility performs the testing. Since HPW-TP-0500 permits any test facility to perform this test, it is up to the glazing consumer to specify that testing be performed at a competent facility.

H.P. White Laboratory, Inc. will perform forced entry resistance testing in a manner that most readily effects forced entry within the limits of the test procedure. As we continue to gain experience, our testing will become more severe, though the written test procedure remains unchanged. **We cannot conjecture, therefore, as to how a previously tested item will perform if re-tested.**