INTERNATIONAL

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Standard Test Method for Door Systems Subject to Airblast Loadings[1]

This standard is issued under the fixed designation F2927; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This test method identifies the standard procedures that shall be followed when utilizing either an air blast simulator, shock tube, or a controlled open-air explosion to evaluate the blast capacity of a door system. This test method is designed for all types of swinging doors, including single and double doors construction. This method is used to test complete door assemblies. The door panel(s) may also contain one or more integral vision lites (part of the glazing system). The door assembly shall be arranged so that the initial blast force either acts to seat the door panel(s) into the frame or unseat the door panel(s) from the frame to simulate the blast threat. When the initial blast force acts to unseat the door(s) from the frame, the force is concentrated on the restraining hardware (that is, the latching mechanism, the hinges, and the frame connection). The results gathered from this method can be used for door installations in non-rigid wall openings. The test method may be adapted to horizontal sliding and vertical-lift doors.

1.2 When testing with an explosive charge, a charge in-contact with the test specimen or any charge resulting in high localized loading is not covered by this method. When testing with an explosive charge to this standard, to avoid brittle modes of response from the blast, the scaled range of the charge shall be $(1.19\ m/kg)^{1/3}$ $(3\ ft/lb)^{1/3}$ or greater from the test specimen, with an absolute minimum of 1 m (39 in.) standoff of the charge from the test specimen.

1.3 Swinging doors that may be required to resist or mitigate the effects of a blast shall have restraining hardware (latching mechanisms and hinges). The performance of these items is critical in determining the blast resisting or mitigating properties of a door assembly. A door assembly may also contain ancillary hardware. Although many of these critical restraining and ancillary items are mounted on what is deemed the "safe side" of the door system, the test director must verify whether these items stay affixed to the assembly or become dislodged from the assembly. Hardware items that dislodge from the door or frame during the test and become a flying debris hazard shall be assigned a door response damage category as defined in Table 1. When the test results of a door system do not include ancillary hardware as specified by the specifier, it shall be the responsibility of the test sponsor or vendor/manufacturer to determine the risk of an ancillary component becoming a flying debris hazard to the satisfaction of the specifier.

1.4 Unless otherwise specified by end user, this test method and the resulting data are valid for the door size tested, and for smaller doors of identical construction (including any ancillary hardware) with a similar (±20 %) aspect ratio up to 25 % smaller. Acceptance criteria are divided into five door response damage categories (Categories I, II, III, IV, and V). Damage Category III has two subcategories: III/U that permits an unsecured door after the loading event and III/S that requires a secured door after the loading event. Refer to 7.1 and Table 1 for a description of each category.

1.5 A door assembly may also contain ancillary hardware. Although these hardware components may not influence blast resistance performance, the specifier may wish to verify that these items do not dislodge from the door or frame during a test and become a flying debris hazard.

1.6 For doors equipped with a vision lite, the door shall be evaluated using the door response damage categories in Table 1, and the glazing and glazing system of the vision lite shall also be evaluated using the glazing hazard levels in Table 2 (see also 7.5).

1.7 This method is intended to test the blast capacity of a door assembly from a shock wave. It does not attempt to address all testing required of door assemblies. These tests may include, but are not limited to, charge-in-contact blast resistance, forced entry resistance, ballistic resistance, fire resistance, sound attenuation, and gas or water leakage. These types of tests are not covered by this test method.

1.8 This test method does not verify the blast performance of the wall that a tested door will be placed in.

1.9 The values stated in SI units (International System of Units) are to be regarded as the standard. The values given in parentheses are provided for information only.

1.10 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the*

[1] This test method is under the jurisdiction of ASTM Committee F12 on Security Systems and Equipment and is the direct responsibility of Subcommittee F12.10 on Systems Products and Services.

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TABLE 1 Door Response Damage Categories and Descriptions

Damage Rating	Description of Door/Frame Response	Damage Level Category
Undamaged	The door specimen is substantially unchanged after the airblast loading and is fully operable. Any permanent deformation shall be within 3 mm (⅛ in.) of the pre-test condition. The door must be checked that it is operable by unlatching and swinging the door open and then closed and latched. The door can be locked. The external portion of the frame, frame anchorage, latches, and hinges shall not show any visible damage.	I
Damaged but Openable	The door panel, the frame, or the hardware, or combinations thereof, have acceptable permanent deformation or damage; however, the door remains openable. The door must be checked that it is openable by unlatching and swinging the door open far enough to allow ingress/egress. Acceptable permanent deformation or damage and degree of opening to permit ingress/egress is determined by the specifier based on the end use of the door.	II
Non-catastrophic Failure Security or Secured Application	The door shall remain shut and secure both during and after the loading event. The door panel(s) may get lodged into the frame from the blast force to hinder ingress/egress. After the loading event, the door system shall be non-openable from the threat side, nor shall a man-passable* opening be allowed or created using the force of a single person without tools, from the threat side. End user may elect to specify additional limitation, such as permanent deformation or hardware detachment, as required based upon intended end use of the door system.	III/S
Non-catastrophic Failure Unsecure Application	The door need not remain secure after the loading event – a door panel is openable or man-passable, or both, by means other than operation of the manufacturer's supplied hardware, or by using the force of one person without tools. Acceptable permanent deformation or damage is determined by the specifier based on the end use of the door. The door hardware components, including ancillary hardware, are permitted to detach from the door panel or frame and come to rest on the floor of the witness area within the 3-m (120-in.) distance to the witness panel. No flying debris can strike the witness panel. The frame and frame anchorage must remain an integral system and attached to the test structure wall. The door panel may swing open during the rebound phase of the loading event. Should the door panel swing open it must remain affixed to the frame by the door hinges.	III/U
Limited Hazard Failure	A door leaf becomes separated from frame or the frame anchorage fails and the entire door leaf and frame assembly become separated from the test structure wall and are thrown into the test structure witness area. The dislodged door leaf or assembly must remain within the 3-m (120-in.) finish floor as shown in Fig. 1. There shall be no evidence of any dislodged hardware component striking the witness panel mounted on the back wall of the test structure. Note: A door assembly equal to or exceeding 3 m (120 in.) in height cannot obtain a "Limited Hazard Failure – Category IV Rating" due to the size limitation of the test structure witness area and thus shall be given a damage rating category of V.	IV
High Hazard Failure	A door leaf becomes separated from frame or the frame anchorage fails and the entire door leaf and frame assembly become separated from the test structure wall and are thrown into the test structure witness area and strike the witness panel above the "High Hazard Threshold" shown in Fig. 1. There shall be no evidence of any dislodged hardware component striking the witness panel above the High Hazard Threshold. Note: A door assembly equal to or exceeding 3 m (120 in.) in height can only be assigned a damage category of V.	V

responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.

1.11 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

E699 Specification for Agencies Involved in Testing, Quality Assurance, and Evaluating of Manufactured Building Components

F1642 Test Method for Glazing and Glazing Systems Subject to Airblast Loadings

F2912 Specification for Glazing and Glazing Systems Subject to Airblast Loadings

F3038 Test Method for Timed Evaluation of Forced-Entry-Resistant Systems

2.2 *Other Standards:*[3]

ISO/IEC International Standard 17025:2017 General Requirements for the Competence of Testing and Calibration Laboratories

3. Terminology

3.1 *Definitions:*

3.1.1 *airblast load*—either an air blast simulator, shock tube or a high explosive charge used to generate the desired peak pressure and positive phase impulse on the test specimen; if an

[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 American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.

TABLE 2 Glazing Hazard Levels and Descriptions

Hazard Rating	Description of Door's Glazing Response	Hazard Level
No Break	The glazing is observed not to fracture and there is no visible damage to the glazing system.	H1
No Hazard	The glazing is observed to fracture but is fully retained in the door's vision lite frame and the rear surface (the side opposite the airblast loaded side of the specimen) is unbroken.	H1
Minimal Hazard	The glazing is observed to fracture and the total length of tears in the glazing plus the total length of pullout from the edge of the vision lite frame is less than 20 % of the glazing sight perimeter. Also, there are three or less perforations caused by glazing slivers and no fragment indents anywhere in a vertical witness panel located 3 m (120 in.) from the interior face of the specimen and there are fragments with a sum total united dimension of 25 cm (10 in.) or less on the floor between 0 m to 1 m (0 in. to 40 in.) from the interior face of the specimen. Glazing dust and slivers are not accounted for in the rating. Fragments are defined as any particle with a united dimension of 2.5 cm (1 in.) or greater. The united dimension of a glass particle is determined by adding its width, length, and thickness. Glazing dust and slivers are all smaller particles.	H2
Very Low Hazard	The glazing is observed to fracture within 1 m (40 in.) of the original location. Also, there are three or less perforations caused by glazing slivers and no fragment indents anywhere in a vertical witness panel located 3 m (120 in.) from the interior face of the specimen and there are fragments with a sum total united dimension of 25 cm (10 in.) or less on the floor between 1 m (40 in.) and 3 m (120 in.) from the interior face of the specimen. Glazing dust and slivers are not accounted for in the rating.	H3
Low Hazard	The glazing is observed to fracture, but the glazing fragments generally fall between 1 m (40 in.) of the interior face of the specimen and 50 cm (20 in.) or less above the floor of a vertical witness panel located 3 m (120 in.) from the interior face of the specimen. Also, there are ten or fewer perforations in the area of a vertical witness panel located 3 m (120 in.) from the interior face of the specimen and higher than 50 cm (20 in.) above the floor and none of the perforations penetrate through the full thickness of the foil backed insulation board layer of the witness panel.	H4
High Hazard	Glazing is observed to fracture and there are more than ten perforations in the area of a vertical witness panel located 3 m (120 in.) from the interior face of the specimen and higher than 50 cm (20 in.) above the floor or there are one or more perforations in the same witness panel area with fragment penetration through the first layer and into the second layer of the witness panel.	H5

explosive charge is used, the charge weight and standoff distance shall be determined by the test director to accommodate the desired peak positive pressure and positive phase impulse.

3.1.2 *ambient temperature*—refers to the temperature of the air that surrounds the test specimen.

3.1.3 *blast mat*—a steel or concrete pad upon which high explosives may be detonated to reduce the incidence of ejecta.

3.1.4 *blast-resistant door*—a door assembly that is designed and manufactured to resist a specified series of impulse pressures of designated magnitude in kilopascals (kPa) (or pounds per square inch (psi)) and duration in milliseconds (msec); blast may result from an accidental or planned explosion or pressure release; the door assembly may be made from any materials that the door vendor/manufacturer or specifier desires.

3.1.5 *door assembly*—a door assembly includes the door panel(s), latching hardware, hinges, post mullion (if applicable), frame and frame connection to a rigid reaction structure; a door assembly may also include ancillary hardware.

3.1.6 *door clearance*—refers to the space between the top of the door and header rabbet, the door and jamb rabbets, and the bottom of the door and the finished floor.

3.1.7 *door size:*

3.1.7.1 *actual door size*—for swing doors, the exact width and height of the door panel itself.

3.1.8 *door opening size:*

3.1.8.1 *height*—the distance measured vertically between the frame head rabbet and the bottom of the frame; equal to the Actual Door Height + Undercut + Top Clearance.

3.1.8.2 *width*—the distance measured horizontally between the jamb rabbets; equal to the Actual Door Width (or widths for pairs) + Door Edge Clearance.

3.1.9 *door response damage category*—the rating that the door receives based upon the severity of the door panel(s) and frame deformation, the hardware component damage, and the amount and location of integral materials expelled from the door assembly under specific blast conditions of the test; see Table 1.

3.1.10 *door undercut*—clearance between the finished floor or threshold and the bottom of the door.

3.1.11 *effective positive phase duration*—duration, in milliseconds (msec), of an idealized triangular-shaped positive air blast, having an instantaneous rise-time to the measured peak positive pressure and a linear decay to ambient conditions; the impulse of the idealized pressure/time history equals the measured positive phase impulse of the air blast pressure/time history.

3.1.12 *flying debris hazard*—debris which can become dislodged and dispersed into the air at great speed, with potential to cause impact injuries.

3.1.13 *force gauge*—a measuring instrument used to measure the force during a push or pull opening/closing test on the door (kg or lb).

3.1.14 *fragments*—fragments to be considered in rating the glazing or glazing system include those generated by the glazing, and any other parts of the glazing system not considered to be part of the test facility.

3.1.15 *glazing:*

3.1.15.1 *glazing hazard level*—when the door is equipped with a vision lite, a rating is assigned to the performance of the glazing and the glazing system components based on the amount and location of integral materials expelled from the vision lite under specific blast conditions of the test; see Table 2.

3.1.15.2 *glazing materials*—transparent or translucent materials used for windows within the door's vision lite; glazing materials may be tinted, colored, or coated.

3.1.15.3 *glazing system*—the assembly comprised of the glazing, its framing system, and anchoring devices of the vision lite that mount to the door panel; the glazing system may include, but not be limited to those fabricated from monolithic glass, laminated glass, plastic, glass-clad plastics, glass/plastic glazing materials, and filmed-backed glass; the vision lite glazing system also includes the frame kit(s), the fasteners, and the glazing compound.

3.1.16 *hardware:*

3.1.16.1 *ancillary hardware*—any hardware included on a door system that does not provide primary engagement of the door leaf(s) to the jamb; ancillary hardware may include but is not limited to: door pulls, knobs, openers, closers, push plates, kick plates, coordinators, identification tags and labels, gaskets, etc.

3.1.16.2 *frame mounting hardware*—hardware, such as bolts, that provide the door system's structural connection to the test structure.

3.1.16.3 *restraining hardware*—hardware that provides primary door leaf connection/engagement to the door frame; may include but not limited to, the hinges, latch hardware, throw bolts, latch bolts, head/foot bolt(s), etc.

3.1.17 *header*—the main horizontal member that forms the top of the door frame.

3.1.18 *hinges*—hinges consist of butt plates, bearings, and fasteners.

3.1.19 *jamb*—the main vertical members forming the sides of the door frame.

3.1.20 *latch bolt(s)*—a bolt or bolts, typically spring-activated and beveled, in the edge of the door to keep the door closed.

3.1.21 *latching mechanisms*—latching mechanisms may consist of a latchset or lockset, lever handles, decorative trim, an emergency exit crossbar or push pad, extension rods for multi-point latches, frame-mounted strike plates, fasteners, etc.

3.1.22 *man-passible*—terminology is defined by Test Method F3038-14.

3.1.23 *openable*—door can be unlatched from either the threat or secure side, as determined by specifier, and swung open far enough to allow ingress and/or egress; the amount of ingress/egress is determined by the specifier.

3.1.24 *operable*—door can be unlatched and swung open, and then closed and latched; the door is able to be locked and unlocked by normal means.

3.1.25 *peak positive pressure*—the maximum measured positive phase air blast pressure in kilopascals (kPa) (or pounds-force per square foot (psf) or pounds-force per square inch (psi)).

3.1.26 *permanent deformation*—the permanent displacement from an original position remaining after an applied load has been removed, measured in millimeters (mm) (or inches (in.)).

3.1.27 *positive phase duration*—the duration, in milliseconds (msec), of a classic air blast pressure/time history, having a nearly instantaneous rise-time to the peak positive pressure and an exponential decay to ambient conditions; a negative phase of the air blast pressure will follow the positive phase; however, it does not need to be included in this test method unless required by the specifier.

3.1.28 *positive phase impulse*—the integral of the measured positive phase air blast pressure/time history, expressed in kilopascals-millisecond (kPa-msec) (or pounds-force per square foot-millisecond (psf-msec) or pounds-force per square inch-millisecond (psi-msec)).

3.1.29 *post mullion*—a slender vertical member that subdivides a door opening.

3.1.30 *rabbet*—the recess or offset in the frame to receive the door.

3.1.31 *rebound*—stress reversal in the material of the door.

3.1.32 *seating pressure*—an applied pressure that causes the door to seat against the frame, expressed in kilopascals (kPa) (or pounds-force per square foot (psf) or pounds-force per square inch (psi)).

3.1.33 *secure door*—the door is not openable nor man-passible using the force of one person from the threat side without tools.

3.1.34 *shock tube*—an apparatus that produces a shock load used for testing building components.

3.1.35 *specifier*—individual or party requiring that a door assembly meets specific blast resistance criteria.

3.1.36 *standoff/range:*

3.1.36.1 *minimum range*—when testing with an explosive charge to this standard, to avoid brittle modes of response from the blast the scaled range of the charge shall be 1.19 m/kg$^{1/3}$ (3 ft/lb$^{1/3}$) or greater from the test specimen, with an absolute minimum of 1 m (39 in.) standoff of the charge from the test specimen.

3.1.36.2 *scaled range*—the scaled range is the distance at which a uniform loading can be expected; any distance less than that will result in a breaching form of loading.

3.1.36.3 *standoff distance*—the distance from the centroid of the explosive charge to the specified door opening; the distance is measured in meters (feet).

3.1.37 *strain gauge*—a device that indicates the strain on the material or structure at point of application.

3.1.38 *strike plate*—a metal plate affixed to the door jamb with a hole or holes for the latchbolt(s) of the door; when the door is closed, the latchbolt(s) extend into the hole(s) and holds the door closed.

3.1.39 *test agency*—the party performing the testing and documenting the test results.

3.1.40 *test director*—the individual identified by the test agency as being responsible to complete the specified tests as required and to document the results in accordance with this test method; the test director must sign all of the test reports.

3.1.41 *test frame*—the rigid steel fixture supporting the test specimen; the fixture allows for the installation of the door assembly onto the blast simulator, shock tube or at a particular standoff distance from an explosion in an open-air arena; the door assembly will be installed to the test frame in a manner similar to the way it would be installed into a steel subframe.

3.1.42 *test load*—the specified pressure differential (positive or negative) for which the specimen is to be rated, expressed in kilopascals (kPa) (or pounds-force per square foot (psf) or pounds-force per square inch (psi)).

3.1.43 *test specimen*—a complete door assembly provided for the test; it includes a door panel(s), a frame, hardware, and anchors to attach the frame to the test frame; a test specimen may be shipped to the test site as a pre-hung unit or it can be assembled at the site.

3.1.44 *test sponsor*—party requesting and sponsoring the test program; the test sponsor may be the end user of the door assembly or the door assembly manufacturer; the end user may desire proof of performance on a particular project and the door manufacturer may desire general proof of performance of a door assembly that will be used for numerous projects.

3.1.45 *ultimate load*—the pressure at which failure of the specimen occurs, expressed in kilopascals (kPa) (or pounds-force per square foot (psf) or pounds-force per square inch (psi)).

3.1.46 *unseating pressure*—an applied pressure that tends to "unseat" the door from the frame, expressed in kilopascals (kPa) (pounds-force per square foot (psf) or pounds-force per square inch (psi)); the unseating pressure is resisted by the restraining hardware only.

3.1.47 *vendor/manufacturer*—company or individual that offers door products to clients for purchase.

3.1.48 *vision lite*—the glazed area of the glazing system in the door.

4. Summary of Test Method

4.1 This test method describes the required procedures, apparatus, test specimens, reporting requirements, and any other requirements necessary to verify that a door assembly meets a defined damage category after being subjected to a known air blast pressure over a given period of time. The door shall be evaluated using the five (5) Door Response Damage Categories defined in 1.4 and Table 1. For doors equipped with a vision lite, the glazing and glazing system of the door lite will also be evaluated using the six (6) hazard rating system defined in 1.6 and Table 2.

5. Significance and Use

5.1 This test method provides standardized procedures that must be followed to establish that a particular door assembly meets a defined damage category (Table 1). Test results can be used to specify a door assembly for a particular pressure/time loading and damage level.

5.2 When a door system is subjected to this test method, it does not imply that a door system of visually similar design will resist the same applied test load. The probability that a single door assembly will resist the specified air blast pressure for which it is certified increases with the number of test specimens used to certify the door design. See Annex A1 for additional statistical considerations.

5.3 Arena testing and shock tube testing may not translate to equivalent results from one method to the other. A specifier may require testing using one method instead of the other. The specifier should be consulted prior to the initiation of any testing.

6. Apparatus

6.1 *Test Facility*—Test facilities shall be accredited for this method to the requirements of ISO/IEC 17025 or qualified according to Practice E699. The test facility shall consist of either a blast simulator, shock tube, or an open-air arena from which the airblast loading is generated. Open-air arenas should be sited on a clear and level terrain and be of sufficient size to accommodate the detonation of the required amount of explosives to provide the desired peak positive pressure and positive phase impulse. The test facility shall also consist of a test frame and witness area as described below. The test facility shall also have a test frame and enclosure/witness area as described in 6.5 and 6.6. The test director shall ensure that potential environmental impact issues are determined and resolved prior to testing.

6.2 *Airblast Load*—Either an air blast simulator, shock tube, or a high explosive charge shall be used to generate the desired peak pressure and the positive phase impulse on the test specimen. If an explosive charge is used, the charge shape and location shall be determined by the test director to accommodate the desired peak positive pressure and positive phase impulse. See Annex A1 for information to be used in calculating pressures, impulses, and durations, and for accounting for different types of explosives. Note that the procedures in Annex A1 account for loading from a hemispherical charge imparting load on a large facade and do not address the issues of clearing or other explosive shapes.

6.3 *Blast Mat*—Used only in an open-air arena test. If there is a possibility of crater ejecta interfering with the test, the explosive charge shall be placed on a blast mat. The decision to use a blast mat shall be at the discretion of the test director.

6.4 *Shock Tube*—A general shock tube consists of two major sections: a driven section and an expansion section. The shock tube may be driven by compressed gas or explosively driven with fuel-air mixtures or explosives. A shock wave is created by the sudden release of the compressed gas or explosive that, when suddenly released or ignited, creates a shock wave that travels into the expansion section. As the shock wave travels through the expansion section, it enlarges. The test specimen or target is generally located at the end of the expansion section, opposite the driven section. The peak pressure and impulse applied to the target is controlled by the initial conditions of the driven section. Specific features of shock tubes can vary greatly depending on the type and specific design and configuration of the shock tube used.

6.5 *Test Frame*—A test frame suitable for supporting a door specimen shall be used. The test frame shall represent the rough opening in a wall for the installation of the door assembly. Unless otherwise specified, the dimensions of the rough opening shall be from 10 mm (3⁄8 in.) to 25 mm (1 in.) greater than the actual door frame. The frame shall be capable of resisting the air blast elastically and the maximum deflection, including connection displacement of any individual component, shall be limited to L/360. Once installed, the door face shall be recessed no more than 150 mm (6 in.) from the loaded surface of the test frame. The door frame shall be centered in the test frame ±3 mm (1⁄8 in.) and, unless otherwise specified, shall be anchored and shimmed in accordance with the supplier's recommendations for the intended application.

6.6 *Enclosure and Witness Area*—The area immediately behind the door specimen shall be enclosed to prevent the air blast pressure from wrapping behind the test specimen and reducing the applied test load. The enclosed area shall be of sufficient size to replicate the degree of swing of the door required by the specifier. Thus, the swing arc of the door shall range from 90° minimum to 180° maximum without interference. In some circumstances, it may be beneficial to have the enclosure designed to replicate a room of a building. Within the enclosure is the witness area. The witness area shall have the following attributes. The floor of the witness area shall be at or below the bottom of the opening where the door is being mounted. The vision lite glazing and glazing system shall be rated based on throw distance relative to its position in the door panel. The ceiling of the enclosure shall be a minimum of 100 mm (4 in.) from the top of the test frame opening used to receive the door and door frame assembly. The back wall of the witness area shall be 3.0 ± 0.15 m (120 ± 6 in.) from the interior face of the door.

6.7 *Pressure Transducers*—The airblast pressure transducer shall be capable of defining the anticipated airblast pressure history within the linear range of the transducer. The transducers shall have a rise/response time and resolution sufficient to capture the complete event. Limited low frequency response transducers shall have a discharge time constant equal to approximately 30 to 50 times the initial positive phase duration of the anticipated airblast pressure history.

6.8 *Strain Gauge*—Strain gauges may be used and positioned at the discretion of the test specifier and test director. The strain gauge sensors shall measure the electrical resistance variation from the applied force.

6.9 *Data Acquisition System (DAS)*—The DAS shall consist of an analog or digital recording system with enough data channels to accommodate the pressure transducers and any other electronic measuring devices. The DAS must operate at a sufficiently high frequency to record reliably the peak positive pressure. The DAS shall also incorporate filters to preclude alias frequency effects from the data. Pressure transducers and strain gauges would be part of the DAS.

6.10 *Photographic Equipment*—Each test shall be documented with still photography. Video or high-speed photography of the testing is also recommended.

NOTE 1—Unless using a visual aid such as placing masking tape across the door panel and frame, video or high-speed photography may be the only way to confirm if a door rebounds open and then closes.

6.11 *Force Gauge*—A force gauge shall be used to measure the force required to operate the door's hardware and to swing the door open and closed before and after each test. The force gauge shall have the capacity to measure twice the listed operable force of an undamaged door and have an accuracy rating of 0.5 kg (1 lb) or less. The force gauge shall have memory storage for the maximum force.

6.12 *Temperature Measuring Device (TMD)*—A TMD shall be used to measure for ambient temperature and also, if applicable, measure the glazing surface temperature.

6.13 *Witness Panel*—A witness panel is used to detect flying debris from the glazing or glazing systems or hardware components. The witness panel shall be mounted parallel to and at a distance no greater than 3.0 ± 0.15 m (120 ± 6 in.) from the most interior face of the door panel. The witness panel shall cover the entire back wall of the witness area and shall consist of two layers of material. The witness panel shall consist of a rear layer of 25-mm (1-in.) extruded polystyrene foam with a density of 28.0 kg/m^3 (1.8 lb/ft^3) to 32.0 kg/m^3 (2.0 lb/ft^3) and a front layer consisting of 12.5 mm (0.5 in.) rigid foam plastic thermal insulation board composed of polyisocyanurate foam bonded to a durable white-matte nonglare aluminum facer and a reflective reinforced aluminum facer. The reflective surface shall be placed toward the door system. The insulation board shall have a density of 32.0 kg/m^3 (2.0 lb/ft^3). The reflective reinforced facer shall be 0.08-mm (0.003-in.) thick and shall be reinforced through lamination to kraft paper. To accommodate high-speed photography, a hole no greater than 30.5 by 30.5 cm (12 by 12 in.) may be made in the upper or lower one-ninth portions of the witness panel.

7. Acceptance Criteria Door Response Damage Categories and Door Glazing Hazard Ratings

7.1 Door response damage categories shall be according to the following rating criteria definitions. The damage category that the door assembly receives is based upon the severity of the deformation and hardware component damage resulting from the airblast test. Refer to Table 1 for door damage categories and descriptions.

7.2 The frame anchorage shall not fail in shear, tension, or pullout for Categories I, II, or III. Limited deformation in the anchors is permitted for Categories II and III.

7.3 In applying the test results by this method, consideration must be given that the performance of the door assembly, the wall or its components, or both, may be a function of fabrication, installation, or adjustment, and that the test specimen may or may not truly represent the actual structure. In service, the performance will depend on the rigidity of the supporting construction and on the resistance of the components to deterioration by various causes.

7.4 See Table 1, Damage Category IV and V for doors over 3 m (120 in.) in height.

7.5 For door specimens equipped with a vision lite, the hazard rating of the glazing or glazing system shall be according to the glazing hazard levels and descriptions provided in Table 2 and further demonstrated in Fig. 1. The glazing hazard level that glazing or glazing systems receive is based upon the severity of fragments generated during an airblast test. The fragment severity is determined based upon the number, size, and location of fragments observed during post-test data gathering. Fragments to be considered in rating the glazing or glazing system include those generated by the glazing, and any other parts of the glazing system not considered to be part of the test facility. Refer to 6.1 for a definition of the test facility. The test director must also verify that the vision lite's glazing system did not dislodge from the door or frame during a test and become a flying debris hazard, and assign a hazard rating as defined in Table 2.

8. Hazards

8.1 Storage, handling, and detonation of high explosive material or the operation of an air blast simulator or shock tube should be conducted in accordance with applicable state and federal statutes by experienced professionals qualified by a U.S. government agency to handle explosives.

9. Sampling, Test Specimens, and Test Units

9.1 Each test specimen shall be supplied as a complete door assembly. This includes a door panel(s), frame, hardware, and anchors to attach the frame to the test frame and structure wall.

9.2 Unless specified by end user the following shall apply: For testing to meet Damage Category I, a minimum of one test specimen shall be supplied and tested for each pressure and impulse combination. For less predictable scenarios when Category II, III/U, III/S, or IV would be deemed acceptable, a minimum of three identical specimens shall be supplied and tested for each pressure and impulse combination. Should a Category V be encountered, the design of the door assembly must be reviewed, and an additional three test specimens must be tested if a higher rating is desired.

9.3 The test director shall ensure that the test specimens are handled and stored according to the manufacturer's instructions.

10. Preparation of Test Specimens

10.1 *Door Construction*—The door shall adhere to the requirements for a blast-resistant door, as defined in 3.1.4. This test method is general and does not limit the door vendor/manufacturer to specific material(s), door construction(s), or fabrication process(es). Ultimately, the door's design is based upon the test load established by the specifier or vendor/manufacturer and proven through testing or structural analysis, or both.

10.2 The size of the test specimen is subject to the size limitation as set forth in 1.4. The size of the test specimen shall be determined by either the manufacturer or the specifier based upon the intended end use.

10.3 Materials used to internally stiffen the door panel such as: pre-manufactured cores, injected foams, individual stiffeners, etc. shall be designed by the specifier or the door vendor/manufacturer. If applicable, the voids between the stiffeners may be filled with insulation.

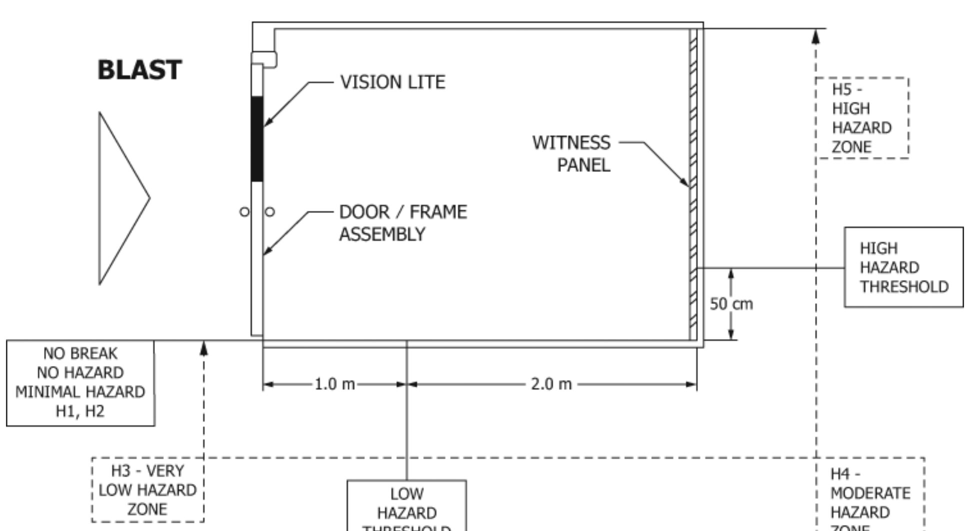

FIG. 1 Cross-Section Through Witness Area