Designation: F 1642 – 03

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

This standard is issued under the fixed designation F 1642; 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.

INTRODUCTION

Historical records show that fragments from glazing that has failed as the result of intentional or accidental explosions present a serious threat of personal injury. Glazing failure also allows blast pressure to enter the interior of buildings thus resulting in additional threat of personal injury and facility damage. These risks increase in direct proportion to the amount of glazing used on the building facade. This test method addresses only glazing and glazing systems. It assumes that the designer has verified that other structural elements have been adequately designed to resist the anticipated airblast pressures.

1. Scope

1.1 This test method sets forth procedures for the evaluation of hazards of glazing or glazing systems against airblast loadings.

1.2 This test method allows for glazing to be tested and rated with or without framing systems.

1.3 This test method is designed to test and rate all glazing, glazing systems, and glazing retrofit systems including, but not limited to, those fabricated from glass, plastic, glass-clad plastics, laminated glass, glass/plastic glazing materials, and film-backed glass.

1.4 The values stated in SI units are to be regarded as the standard. Values given in parentheses are for information only. For conversion of quantities in various systems of measurements to SI units, see Practice E 380.

1.5 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.* See Section 9 for specific hazards statements.

2. Referenced Documents

2.1 *ASTM Standards:*

E 997 Test Method for Structural Performance of Glass in Exterior Windows, Curtain Walls, and Doors Under the Influence of Uniform Static Loads by Destructive Methods[2]

SI 10 American National Standard for Use of the International System of Units (SI): The Modern Metric System[2]

3. Terminology

3.1 *Definitions:*

3.1.1 *ambient temperature*—24 ± 11°C (75 ± 20°F).

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

3.1.3 *effective positive phase duration (T)*—the duration of an idealized triangular positive phase reflected airblast pressure history, having an instantaneous rise to the measured *P*, with a linear decay to ambient, such that the impulse of the idealized pressure history equals *i* of the measured positive phase reflected airblast history.

3.1.3.1 *Discussion*—The idealized triangular airblast wave is considered to provide a reliable standard measure of the positive phase airblast intensity.

3.1.4 *glazing*—transparent materials used for windows, doors, or other panels.

3.1.5 *glazing system*—the assembly comprised of the glazing, its framing system, and anchorage devices.

[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.

Current edition approved Nov. 1, 2003. Published November 2003. Originally approved in 1995. Last previous edition approved in 1996 as F 1642 – 96.

[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.

3.1.6 *peak positive pressure (P)*—the maximum measured positive phase reflected airblast pressure, kPa (psi).

3.1.7 *positive phase impulse (i)*—the integral of the measured positive phase reflected airblast pressure history, kPa-ms (psi-ms) (more correctly called the *specific positive phase impulse*).

3.1.8 *reflected airblast pressure*—the pressure increase that a surface, oriented other than parallel to the line from the detonation point to the surface, experiences due to the detonation of a high explosive charge.

3.1.8.1 *Discussion*—The reflected airblast pressure history, as measured at a point on the surface, consists of two separate phases. The positive phase is characterized by a nearly instantaneous rise to a maximum pressure followed by an exponential decay to ambient pressure. In the negative phase, which follows immediately the positive phase, the pressure decreases below ambient for a period of time before returning to ambient.

3.1.9 *simply supported glazing*—glazing supported in accordance with Test Method E 997 with the edges of the glass extending a minimum of 3-mm (⅛-in.) beyond the neoprene supports.

3.1.10 *test director*—the individual identified by the independent testing laboratory as being responsible to complete the specified tests as required and to document the results, in accordance with this test method.

4. Summary of Test Method

4.1 This test method prescribes the required apparatus, procedures, specimens, and other requirements necessary to determine the hazard rating of a glazing or glazing system subjected to an airblast loading.

5. Significance and Use

5.1 This test method provides a structured procedure to establish the hazard rating of glazing and glazing systems subjected to an airblast loading. Knowing the hazard rating provides the ability to assess the risk of personal injury and facility damage.

5.2 The hazard rating for a glazing or glazing material does not imply that a single specimen will resist the specific airblast for which it is rated with a probability of 1.0. The probability that a single glazing or glazing construction specimen will resist the specific airblast for which it is rated increases proportionally with the number of test specimens that successfully resist the given level of airblast to the hazard level for which it is rated.

6. Number of Specimens

6.1 *Number of Specimens*—A minimum of three test specimens representative of a glazing or glazing system, or a glazing retrofit system shall be tested at a given level of airblast, defined in terms of *P* and *i*.

7. Hazard Rating

7.1 The hazard rating of the glazing or glazing system shall be according to the rating criteria definitions provided below and further demonstrated in Fig. 1. The hazard rating 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. See 8.1 for a definition of the test facility.

7.1.1 *No Break*—The glazing is observed not to fracture and there is no visible damage to the glazing system.

7.1.2 *No Hazard*—The glazing is observed to fracture but is fully retained in the facility test frame or glazing system frame

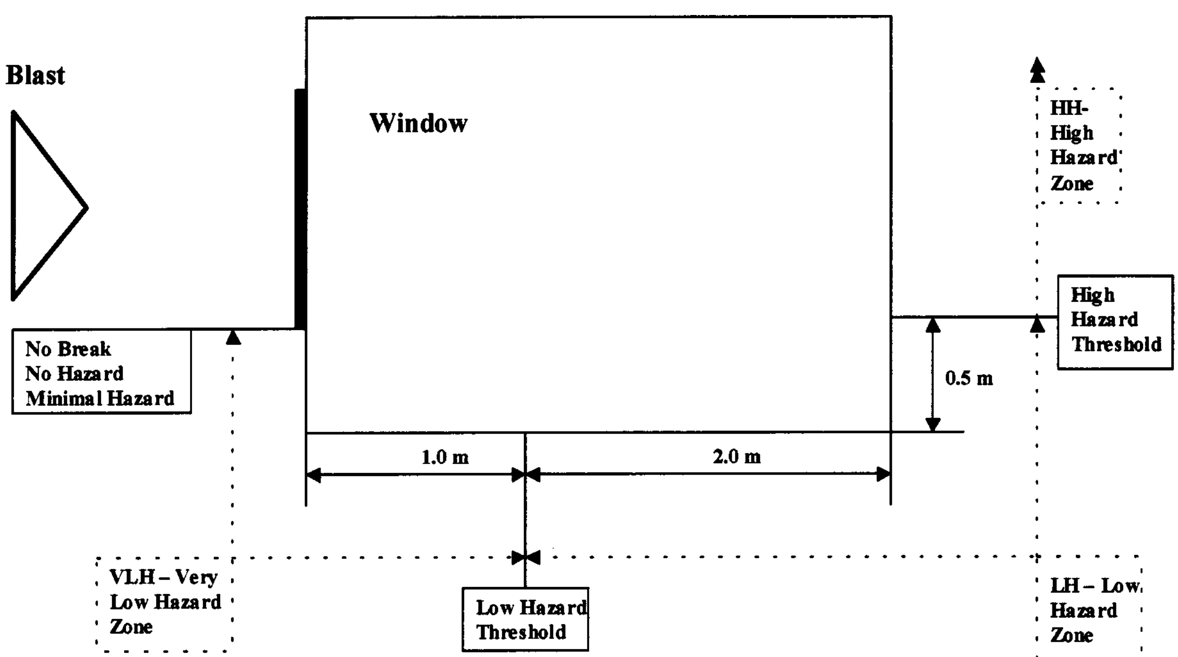

FIG. 1 Cross-section Through Witness Area

and the rear surface (the side opposite the airblast loaded side of the specimen) is intact.

7.1.3 *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 frame is less than 20 % of the glazing sight perimeter. Also, there are three or less pinhole perforations 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.

7.1.3.1 *Discussion*—Fragments are defined as any particle with a united dimension of 2.5 cm (1 in.) or greater. Glazing dust and slivers are all other smaller particles.

7.1.4 *Very Low Hazard*—The glazing is observed to fracture and is located within 1 m (40 in.) of the original location. Also, there are three or less pinhole perforations 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.

7.1.5 *Low Hazard*—The glazing is observed to fracture, but glazing fragments generally fall between 1 m (40 in.) of the interior face of the specimen and 0.5 m (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 0.5 cm (20 in.) above the floor and none of the perforations penetrate through the first layer of the witness panel as defined in 8.7.5.

7.1.6 *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 0.5 m (20 in.) above the floor or there are one or more perforations in the same witness panel area with fragment penetration into the second layer of the witness panel.

8. Apparatus

8.1 *Test Facility*—The test facility shall consist of either a shock tube or an open-air arena from which the airblast loading is generated. Open-air arenas should be sited on 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 director shall ensure that potential environmental impact issues are determined and resolved prior to testing. The test director shall ensure that testing is conducted at ambient temperature in accordance with Section 3.1.1.

8.2 *Airblast Load*—Either a shocktube 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 shall be hemispherical and detonated at ground level. Other explosive charge configurations can be used. The effects of using other explosive charge configurations must be accounted for and documented.

8.3 *Blast Mat*—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.

8.4 *Test Frame*—A test frame suitable for supporting glazing or glazing systems shall be part of the test facility. Glazing tested without a specific framing system shall be, as a minimum, supported in a simple support subframe that is attached to the test frame. At the request of a test sponsor, other subframe support conditions may be used. If a glazing system is tested, the glazing system shall be mounted to the test frame in a manner that closely models the manner in which it will be mounted in the field. The test frame shall be capable of resisting the airblast loads with deflections that do not exceed $L/360$ along lines of support for the simple support subframe or the glazing system. The area immediately behind the test specimens shall be designated as the witness area. For arena testing, the witness area shall be enclosed to prevent airblast pressure from wrapping behind the test specimens, and shall be designed to resist the wrap around the pressures.

8.5 *Simple Support Subframe*—A subframe, attachable to the test frame, to support glazing in accordance with Test Method E 997.

8.6 *Witness Area*—The witness area shall have the following dimensions. The floor shall be 0.5 ± 0.05 m (20 ± 2 in.) from the subframe opening used to receive the glazing or glazing system. The ceiling shall be a minimum of 0.5 m (20 in.) from the top of the subframe opening used to receive the glazing or glazing system. The sides shall be a minimum of 0.15 m (6 in.) from the subframe opening used to receive the glazing or glazing system. The back wall of the witness area shall be 3.0 ± 0.15 m (120 ± 6 in.) from the interior glazing face of the specimen.

8.7 *Instrumentation*:

8.7.1 *Pressure Transducers*—A minimum of three reflected and one free field airblast pressure transducers shall be used in each test frame for arena testing. A minimum of three reflected pressure transducers shall be used for shocktube testing. 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 reflected airblast pressure history.

8.7.2 *Data Acquisition System (DAS)*—The DAS shall consist of either an analog or digital recording system with a sufficient number of 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.