



Designation: F2248 – 19

Standard Practice for Specifying an Equivalent 3-Second Duration Design Loading for Blast Resistant Glazing Fabricated with Laminated Glass¹

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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. This standard practice provides a means for designers to determine equivalent 3-second duration design loadings with which they can size blast resistant glazing comprised of laminated glass or insulating glass fabricated with laminated glass, or both. Blast resistant glazing systems of this genre can reduce the number and size of glass fragments in an explosion as well as reducing greatly or eliminating blast pressure that enters buildings when an explosion occurs.

1. Scope

1.1 This practice sets forth a method to specify an equivalent 3-second design loading suitable to use with Practice E1300 to select the thickness and type of blast resistant glazing fabricated with laminated glass to glaze a fenestration. Glass plies used to construct laminated glass are recommended to be either annealed or heat strengthened glass. This analytical method for glazing should be used with caution for glazing panels larger than 1.8 m by 2.4 m (6 ft by 8 ft) as this size panel exceeds database of testing upon which this standard is based.

1.2 This practice applies to blast resistant glazing fabricated using laminated glass only, including single laminated glass and insulating glass fabricated with laminated glass. As a minimum, insulating glass shall use laminated glass for the inboard (protected side) lite.

1.3 This practice assumes that blast resistant glazing shall be attached to its supporting frame using a captured bite so that it does not detach in the event of fracture due to a blast event.

1.4 Blast resistant glazing designed using this practice recommends the use of annealed or heat strengthened glass plies for the laminated glass. Blast testing has shown that use of fully tempered glass plies, when fractured during a blast

event, have poorer post blast performance than annealed or heat strengthened glass plies. Laminated glass fabricated with fully tempered glass plies has a tendency to leave the supporting glazing system frame after fracture whereas laminated glass fabricated with annealed or heat strengthened glass plies will remain in the frame and absorb remaining load through tensile membrane behavior. Use of the annealed or heat strengthened glass plies will also reduce the amount of load transferred into the structure.

1.5 The equivalent 3-second design load as determined herein shall not apply to the design of monolithic glazing, plastic glazing, or security film applied to existing glazing configurations in an attempt to achieve blast resistance.

1.6 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 refer to ANSI IEEEE/SI 10.

1.7 *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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.8 *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.*

¹ This practice 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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2. Referenced Documents

2.1 ASTM Standards:²

C1036 Specification for Flat Glass

C1048 Specification for Heat-Strengthened and Fully Tempered Flat Glass

C1172 Specification for Laminated Architectural Flat Glass

C1422/C1422M Specification for Chemically Strengthened Flat Glass

C1564 Guide for Use of Silicone Sealants for Protective Glazing Systems

E631 Terminology of Building Constructions

E1300 Practice for Determining Load Resistance of Glass in Buildings

F1642/F1642M Test Method for Glazing and Glazing Systems Subject to Airblast Loadings

F2912 Specification for Glazing and Glazing Systems Subject to Airblast Loadings

2.2 ANSI Standard:³

IEEE/SI 10 Use of the International System of Units (SI): (The Modernized Metric System)²

3. Terminology

3.1 Definitions:

3.1.1 *blast resistant glazing, n*—glazing that provides protection against air blast pressure generated by explosions.

3.1.2 *blast resistant glazing systems, n*—a fenestration product that includes, but is not limited to, blast resistant glazing, framing systems, connections, and materials, when used, to adhere the glazing to the frame and hardware.

3.1.3 *design load, n*—magnitude in kPa (psf) of 3-second duration uniformly distributed lateral pressure.

3.1.4 *equivalent TNT charge mass, n*—mass of TNT placed on the ground in a hemisphere that represents the design explosive threat.

NOTE 1—If a different high explosive material comprises the design threat, tables exist to convert its mass to an equivalent TNT mass. Refer to Test Method **F1642/F1642M**, for example.

3.1.5 *glass breakage, n*—the fracture of any lite or ply in monolithic, laminated, or insulating glass.

3.1.6 glass types:

3.1.6.1 *annealed (AN) glass, n*—a flat, monolithic, glass lite of uniform thickness where the residual surface stresses are nearly zero as defined in Specification **C1036**.

3.1.6.2 *chemically strengthened glass, n*—glass that has been strengthened by ion-exchange to produce a compressive stress at the treated surface as defined in Specification **C1422/C1422M**.

3.1.6.3 *fully tempered (FT) glass, n*—a flat, monolithic, glass plate of uniform thickness made from annealed glass subjected to a special heat treatment process whereby the

residual surface compression is not less than 69 MPa (10 000 psi) or the edge compression not less than 67 MPa (9700 psi) as defined in Specification **C1048**.

3.1.6.4 *heat strengthened (HS) glass, n*—a flat, monolithic, glass lite of uniform thickness that has been subjected to a special process where the residual surface compression is not less than 24 MPa (3500 psi) or greater than 52 MPa (7500 psi) as defined in Specification **C1048**.

3.1.6.5 *insulating glass (IG), n*—consists of any combination of two glass lites that enclose a sealed space filled with air or other gas.

3.1.6.6 *laminated glass, n*—a flat lite of uniform thickness consisting of two or more monolithic glass plies bonded together with interlayer materials as defined in Specification **C1172**.

3.1.6.7 *Discussion*—Many different interlayer materials are used in laminated glass. The information in this practice applies only to laminated glass fabricated with polyvinyl butyral (PVB) interlayers.

3.1.7 *glazing, n*—transparent, translucent, or opaque laminated glass used for windows, doors, or other panels.

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

3.1.9 *lateral, adj*—perpendicular to the glass surface.

3.1.10 *load, n*—a uniformly distributed lateral pressure.

3.1.11 *load resistance, n*—the 3-second duration uniform lateral load that a glass construction can sustain associated with a probability of breakage of 8 L per 1000 as determined from Practice **E1300**.

3.1.12 *maximum air blast pressure, n*—the peak reflected positive pressure that the blast resistant glazing will experience.

3.1.13 *probability of breakage (P_b), n*—the fraction of glass lites or plies that would break at the first occurrence of a specified design load, typically expressed in lites per 1000.

3.1.14 *standoff distance, n*—the distance from the glazing surface to the centroid of a hemispherical high explosive charge.

4. Summary of Practice

4.1 This practice facilitates the determination of a 3-second duration design load associated with a specified weight of a hemispherical TNT charge located at a specified standoff distance from a building fenestration.

4.2 The design load shall be used in conjunction with Practice **E1300** to select the thickness(es) and glass type(s) for blast resistant glazing comprised of a single lite of laminated glass or insulating glass fabricated with laminated glass.

5. Significance and Use

5.1 This practice provides a design load suitable for sizing blast resistant glazing comprised of laminated glass or insulating glass fabricated with laminated glass.

5.2 Blast resistant glazing comprised of laminated glass or insulating glass fabricated with laminated glass shall be sized

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.