



Designation: E997 – 15 (Reapproved 2021)

Standard Test Method for Evaluating Glass Breakage Probability Under the Influence of Uniform Static Loads by Proof Load Testing¹

This standard is issued under the fixed designation E997; 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 proof load test method is a procedure to determine, with a 90 % confidence level, if the probability of breakage under design loads for a given population of glass specimens is less than a selected value. It is not intended to be a design standard for determining the load resistance of glass. Practice E1300 shall be used for this purpose.

1.2 This test method describes apparatus and procedures to select and apply a proof load to glass specimens, to determine the number of glass specimens to be tested, and to evaluate statistically the probability of breakage. This test method may be conducted using the standard test frame specified herein or a test frame of the user's design.

1.3 Proper use of this test method requires a knowledge of the principles of pressure measurement and an understanding of recommended glazing practices.

1.4 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

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, health, and environmental practices and determine the applicability of regulatory limitations prior to use. Specific precautionary statements are given in Section 7.*

1.6 *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 test method is under the jurisdiction of ASTM Committee E06 on Performance of Buildings and is the direct responsibility of E06.52 on Glass Use in Buildings.

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2. Referenced Documents

2.1 *ASTM Standards:*²

E631 Terminology of Building Constructions

E1300 Practice for Determining Load Resistance of Glass in Buildings

3. Terminology

3.1 *Definitions:*

3.1.1 For definitions of general terms related to building construction used in this test method refer to Terminology E631.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *coefficient of variation, v* —ratio of the standard deviation of the breakage load to the mean breakage load.

3.2.2 *design load, n* —the specified uniform load and load duration.

3.2.3 *glass specimen, n* —the glass to be tested, for example, a single pane, an insulating glass unit, laminated glass, etc. (does not include test frame).

3.2.4 *glass specimen breakage, n* —the fracture or cracking of any glass component of a glass specimen.

3.2.5 *negative load, n* —an outward-acting load that results in the indoor side of a glass specimen being the high-pressure side.

3.2.6 *positive load, n* —an inward-acting load that results in the outdoor side of a glass specimen being the high-pressure side.

3.2.7 *probability of breakage, n* —the probability that a glass specimen will break when tested at a given load.

3.2.8 *proof load, n* —a uniform load at which glass specimens shall be tested.

3.2.9 *proof load factor, a, n* —the constant which, when multiplied by the design load, determines the proof load.

3.2.10 *specifying authority, n* —professional(s) responsible for determining and furnishing information required to perform the test.

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.



4. Summary of Test Method

4.1 This test method consists of individually glazing glass specimens in a test frame that is mounted into or against one face of a test chamber and supplying air to, or exhausting air from, the test chamber so that each glass specimen is exposed to a proof load. Load-time records shall be kept for each glass specimen. Each glass specimen break shall be recorded.

4.2 After testing the required number of glass specimens, it is determined, with a 90 % confidence level, if the probability of breakage under design loads for the given population of glass specimens is less than a specified allowable probability of breakage.

5. Significance and Use

5.1 Glass specimens to be tested shall be mounted in a standard test frame with four sides supported, or in a test frame designed to represent specific glazing conditions.

5.2 Loads on glass in windows, curtain walls, and doors may vary greatly in magnitude, direction, and duration. Any design load (wind, snow, etc.) that can reasonably be applied to the test specimens or transformed into an equivalent uniform design load can be considered. Load transformation techniques are addressed in the literature (1, 2, 3).³

5.3 The strength of glass varies with many different factors including surface condition, load duration, geometry, relative humidity, and temperature (4). A thorough understanding of those strength variations is required to interpret results of this test method.

6. Apparatus

6.1 The description of apparatus is general in nature. Any equipment capable of performing the test procedure within the allowable tolerances is permitted.

6.2 Major Components:

6.2.1 *Test Frame*, in which glass specimens are mounted for testing. The test frame shall provide either standardized support conditions or specified support conditions. Specifications of standardized support conditions are presented in Annex A1.

6.2.2 *Test Chamber*, sealed, with an opening in which or against which the test frame is installed. At least one static pressure tap shall be provided to measure the test chamber pressure and shall be so located that the reading is minimally affected by the velocity of the air supply to or from the test chamber or any air movement. The air supply opening into the test chamber shall be arranged so that the air does not impinge directly on the glass specimen with any significant velocity. A means of access into the test chamber may be provided to facilitate adjustments and observations after the specimen has been installed.

6.2.3 *Air System*, a controllable blower, compressed air supply, exhaust system, reversible blower, or other device designed to apply the proof load to the glass specimen with required control.

6.2.4 *Pressure Measuring Apparatus*, to record continuous test chamber pressures within an accuracy of ± 2 %.

6.2.5 *Temperature Measuring Apparatus*, to measure the ambient temperature within an accuracy of ± 1 °F (0.6 °C).

6.2.6 *Relative Humidity Apparatus*, to measure the relative humidity within an accuracy of ± 2 %.

7. Safety Precautions

7.1 Proper precautions shall be taken to protect observers in the event of glass breakage. At the pressures used in this test method, considerable energy and hazard are involved. In cases of breakage, the hazard to personnel is less with an exhaust system, as the specimen will tend to blow into rather than out of the test chamber. Personnel should not be permitted in such chambers during tests.

8. Sampling and Glass Specimens

8.1 Surface condition, cutting, fabrication, and packaging of the glass specimens shall be representative of the glass whose strength is to be evaluated.

8.2 All glass specimens shall be visually inspected for edge or surface irregularities prior to testing. All glass specimens with edge or surface irregularities not representative of the glass whose strength is to be evaluated shall not be tested.

8.3 Glass specimens shall be handled carefully at all times because the strength of glass is influenced by its surface and edge conditions.

9. Calibration

9.1 Pressure-measuring systems should be verified prior to testing. If calibration is required, the manufacturer's recommendations or good engineering practices shall be followed.

10. Required Information

10.1 The specifying authority shall provide the design load (positive or negative), the orientation of the glass specimen to the test chamber, the design load allowable probability of breakage for the glass specimens, and the coefficient of variation of the breakage loads typical of the glass specimens tested.

10.2 The specifying authority shall state whether the glass specimens shall be glazed in a standard test frame (see Annex A1) or in a test frame designed to simulate a specific glazing system. If the test frame is to simulate a specific glazing system, complete glazing details and support conditions shall be provided by the specifying authority.

11. Selection of Proof Load and Initial Sample Size

11.1 The glass specimens shall be tested with a proof load that is larger than the design load. The proof load is found by multiplying the design load by the proof load factor, a , as follows:

$$q_p = a q_d \quad (1)$$

where:

q_p = proof load,
 a = proof load factor, and

³ The boldface numbers in parentheses refer to a list of references at the end of this standard.