Standard Test Methods for Internal Pressure Strength of Glass Containers[1]

This standard is issued under the fixed designation C 147; 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 These test methods cover the determination of the breaking strength of glass containers when subjected to internal pressure. These test methods are intended to determine the pressure strength of containers manufactured to contain products reasonably expected to develop a sustained pressure of 138 kPa (20 psi) or greater, after processing. Two test methods are covered as follows:

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Test Method A—Application of Uniform Internal Pressure for a Predetermined Period	5-7
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1.2 The values stated in SI units are to be regarded as the standard. The values given in parentheses are for information only.

1.3 *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.*

2. Referenced Documents

2.1 *ASTM Standards:*

C 224 Practice for Sampling Glass Containers[2]

2.2 ASTM Adjuncts:

C 147 Single-head hydraulic testing machine (8 blueprints)[3]

3. Sampling

3.1 Methods of sampling a minimum lot from a group of containers of a given type are given in Practice C 224, for the various situations to which it may apply.

4. Precision and Bias

4.1 Statements regarding either precision or bias of the internal pressure test results are not possible because suitable internal pressure reference test materials are not available.

4.2 *Test Method A*—The pressure test precision is within one half the incremental step size used at failure. Pressure test bias is generally within ±1 % of full scale.

4.3 *Test Method B*—The pressure test precision is within ±1 psi (7 kPa). Pressure test bias is generally within ± % of full scale.

TEST METHOD A—APPLICATION OF UNIFORM INTERNAL PRESSURE FOR A PREDETERMINED PERIOD

5. Apparatus

5.1 The apparatus[3] shall embody the following principles:

5.1.1 The bottles to be tested shall be held in such a manner that the bottle is not clamped, but is suspended from the *bead of the finish.*

5.1.2 There shall be a resilient sealing member that shall act with the sealing surface of the container to retain the pressurizing medium during the period of the test.

5.1.3 There shall be a means of applying fluid pressure to a predetermined level at a minimum rate of 69 MPa (10 000 psi)/min and of maintaining that pressure constant during the period of test. Applied incremental fluid pressure levels shall be provided extending over the range from 0.18 MPa (25 psi) to at least 2.41 MPa (350 psi). The applied fluid pressure level shall be reproducible to within ±1 % of full scale.

5.1.4 An automatically controlled timing mechanism shall be built into the apparatus so that the container will be subject to uniform internal pressure for a predetermined period which shall be not less than 3 s nor more than 1 min (Note 1). The period of test shall be reproducible within ±2 %.

NOTE 1—For test durations between 3 s and 1 min, the actual pressure (P_I) can be converted to the 1-min pressure (P_{60}) calculated as follows:

$$P_{60} = \left(\frac{7.97 + 1.53 \log t}{10.69}\right) P_I \quad (1)$$

where t is the duration of the test in s. For instance, the actual pressure in a 3-s test would be multiplied by 0.81 in order to be equivalent to the pressure at a test period of 1 min.

6. Procedure

6.1 Fill the containers with water or other low-density liquid, if such is used as the medium for applying pressure.

6.2 Use one of the following test procedures, depending upon the purpose of the test:

[1] These test methods are under the jurisdiction of ASTM Committee C-14 on Glass and Glass Products and are the direct responsibility of Subcommittee C14.07 on Glass Containers.

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[2] *Annual Book of ASTM Standards*, Vol 15.02.

[3] Single-head automatic sustained pressure testing machine developed by American Glass Research, Inc., Butler, PA, meets these requirements for durations greater than 15 s. Detailed working drawings of this machine are available from ASTM Headquarters. Order Adjunct No. 12-301470-00. An increment pressure tester developed by the same laboratory is suitable for shorter durations.

6.2.1 *Pass Test*—Apply the internal test pressure and hold it constant for the predetermined time of test. This pass test, usually at a pressure 50 % greater than that reasonably expected under actual conditions of use of the containers, is sufficient for routine testing of samples from continuous production in a manufacturer's plant.

6.2.2 *Progressive Test (to a Predetermined Percent of Breakage)*—Where it may be desirable to conduct the test as a measurement test, repeat or continue the test described in 6.2.1, increasing the pressure stepwise by uniform increments (usually 172 or 335 kPa (25 or 50 psi) each step), until the predetermined percent of containers is broken.

6.2.3 *Progressive Test (Total)*—As an alternative to the progressive test described in 6.2.2, continue the progressive test until all of the containers break.

7. Report

7.1 Report the following information:

7.1.1 Report of method of sampling (see Practice C 224),

7.1.2 Number of containers from each mold included in the sample,

7.1.3 Duration of the test, and

7.1.4 Results of the test (use one of the following depending on the kind of test):

7.1.4.1 For the pass test in accordance with 6.2.1: (*1*) pressure used, and (*2*) number of containers that failed in the test.

7.1.4.2 For the progressive test in accordance with 6.2.2: (*1*) pressure at which first failure occurred and number of containers that failed at that pressure, and (*2*) pressure required to break the predetermined percent of the sample, interpolated to the nearest 34 kPa (5 psi).

7.1.4.3 For the progressive test in accordance with 6.2.3: (*1*) pressures used in the test and number of containers that failed at each pressure, and (*2*) average breaking pressure (corrected for the size of the pressure increment by subtracting one half of the increment; for example, 86 kPa (12.5 psi) for 172-kPa (25-psi) steps or increments).

TEST METHOD B—APPLICATION OF INTERNAL PRESSURE INCREASING AT A PREDETERMINED CONSTANT RATE

8. Apparatus

8.1 The apparatus[4] shall embody the following principles:

8.1.1 The bottles to be tested shall be held in such a manner that the bottle is not clamped, but is suspended from the bead of the finish.

8.1.2 There shall be a resilient sealing member which shall act with the sealing surface of the container to retain the pressurizing medium during the period of the test.

8.1.3 There shall be a means of applying fluid pressure increasing at a predetermined constant rate until the container fails or a predetermined level is reached. The rate of increase of pressure shall be reproducible to ±2 %. Applied fluid pressure levels shall be provided over the range from 0.34 MPa (50 psi) to at least 4.07 MPa (590 psi), determinable to the nearest 0.01 MPa (or nearest integral psi unit). The applied fluid pressure level shall be reproducible to within ±1 % of full scale.

8.1.4 The apparatus shall include a means of indicating the pressure level at which the container failed or the maximum pressure reached during the test.

8.1.5 If desired, the apparatus may be equipped to read out the equivalent pressure values for an appropriate fixed-duration test rather than actual pressures reached in the constant rate tests. When this is done, the conversion factor to be incorporated in the apparatus shall be determined from actual pressure tests on appropriate samples of glass containers, and the apparatus shall clearly indicate that an equivalent pressure value is being used.

NOTE 2—For the apparatus mentioned in footnote 4, the relationship between the actual pressure (P_R) and the 1-min pressure (P_{60}) is as follows:

$$P_R = 1.38\, P_{60} + 25.9 \qquad (2)$$

9. Procedure

9.1 Fill the containers with water or other low-density liquid, if such is used as the medium for applying pressure.

9.2 Use one of the following test procedures, depending upon the purpose of the test:

9.2.1 *Pass Test*—Increase the internal test pressure at the predetermined constant rate until a predetermined level of pressure has been reached or exceeded. This pass test level, usually at a pressure 50 % greater than that reasonably expected under actual conditions of use of the containers, is sufficient for routine testing of samples from continuous production in a manufacturer's plant.

9.2.2 *Test to Destruction*—Where it may be desirable to conduct the test as a measurement test, increase the internal test pressure at the predetermined constant rate until each container breaks.

10. Report

10.1 Report the following information:

10.1.1 Report of method of sampling (see Practice C 224),

10.1.2 Number of containers from each mold included in the sample,

10.1.3 The rate of increase of pressure used in the tests or the equivalent duration if the apparatus has been calibrated in terms of a constant level test, and

10.1.4 Results of the tests (use one of the following depending on the kinds of test):

10.1.4.1 For the pass test in accordance with 9.2.1, the pressure of the pass level and number of containers that failed at or below the pass level.

10.1.4.2 For the test to destruction in accordance with 9.2.2, the pressure level at which first failure occurred, and average breaking pressure for all containers tested.

11. Keywords

11.1 glass containers; increment pressure test; internal pressure; 1-min pressure test; ramp pressure test; static pressure test

[4] The Ramp Pressure Tester developed by American Glass Research, Inc., Butler, PA meets the requirements for this test method.