Designation: C1914 – 21

Standard Test Method for Bake and Boil Testing of Laminated Glass[1]

This standard is issued under the fixed designation C1914; 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 The purpose of this test method is to measure quantitatively the laminate stability under controlled conditions, specifically in relation to the formation of bubbles in a laminate with heat exposure.

1.2 This test method can be performed on laminates which have been exposed to weathering or as manufactured samples to determine the amount of excess air dissolved in the interlayer.

1.3 This test method determines the stability of laminated glass when subjected to high heat environments.

1.4 This test method outlines a procedure to be used on laminated glass with two or more layers of glass bonded by an interlayer.

1.5 This test method covers visual rating of tested specimens.

1.6 The values stated in SI units are to be regarded as standard. The values given in parentheses after SI units are provided for information only and are not considered standard.

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.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

C1172 Specification for Laminated Architectural Flat Glass

3. Terminology

3.1 *Definitions:*

3.1.1 *boil tank, n*—a vessel capable of holding laminated glass specimens submerged in water at a set temperature for a specified amount of time.

4. Summary of Test Method

4.1 This test method involves engulfing the laminate in heat for a predetermined amount of time, removing the laminates from the heat source, allowing the specimen to cool and rating the number and location of any bubbles or other anomalies formed in the laminated glass.

5. Significance and Use

5.1 It is generally recognized that excess moisture and air within an interlayer will cause bubble formation in a laminate when exposed to heat or UV radiation, or both. These may be caused by initial moisture and air in the interlayer and be generated by thermal exposure. The purpose of this test method is to measure quantitatively the laminate stability under controlled conditions, specifically in relation to the formation of bubbles in the body of the laminate.

5.2 Subjecting the laminated glazing to extended heat at a controlled temperature and time provides the excess moisture and air which are forced into the interlayer during processing to surface as bubbles. This occurs only if there are excess moisture and air trapped in between the glass. Therefore, making these thermal tests efficient to determine proper de-airing of laminated glass products.

5.3 This test method provides a means to visually determine if discoloration has or is occurring and serves as a pass/fail test for some aspects of lamination quality.

5.4 This test method can be performed after natural or accelerated exposure to determine if there are changes to the polymer such as the stability with high temperature which is useful for understanding the visual stability of installed glazing.

5.5 This test method does not provide an indication of laminated glass capability for impact resistance, glass shard retention on breakage or edge stability of laminated glass.

[1] This test method is under the jurisdiction of ASTM Committee C14 on Glass and Glass Products and is the direct responsibility of Subcommittee C14.08 on Flat Glass.

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[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.

6. Apparatus

6.1 *Safety Equipment (Minimum):*
6.1.1 Heat and cut-resistant gloves.
6.1.2 Eye protection.

6.2 *Tools:*
6.2.1 Ruler or distance measurement instrument.

6.3 *Equipment:*
6.3.1 Boil tank.
6.3.2 Oven.

7. Hazards

7.1 Heat and boiling water, glass handling.

8. Sampling, Test Specimens, and Test Units

8.1 Typical specimen size is 300 × 300 ± 6 mm (12 × 12 ± 0.25 in.).

8.2 Specimen minimum size is 152 × 152 ± 6 mm (6 × 6 in. ± 0.25 in.).

NOTE 1—Specimens may be sectioned from a larger laminate.

8.3 A minimum of three laminated glass specimens per sample set.

9. Calibration and Standardization

9.1 Oven temperature shall be calibrated to maintain the air target temperature ±2 °C (±5 °F) for a minimum of 16 h.

9.2 Boil tank shall be capable of maintaining a water temperature of 100 ± 2 °C (212 ± 5 °F) for 2 h.

10. Conditioning

10.1 Specimens shall be conditioned between 18 and 29 °C (65 and 85 °F) for at least 4 h prior to introducing the sample to the heat source.

11. Procedure

11.1 *General:*
11.1.1 Mark each sample in a manner that allows the specimen to be identified after testing.

NOTE 2—Permanent marker may not survive boil testing; glass etching with a scriber or electric engraver may be necessary.

11.1.2 Three specimens shall be subjected to an extended heat history through bake testing in an oven or boil testing.
11.1.3 The thermal test may be conducted either in a heating chamber or boiling water.
11.1.4 The test target temperature is 100 to 4 °C (212 to 8 °F).
11.1.5 The specimens shall be conditioned in accordance with 10.1 to a uniform test temperature after removal from the heat chamber with separation to permit free air circulation prior to rating.

11.2 *Boil Testing:*
11.2.1 To help prevent thermal shock and cracking, samples may be immersed, vertically, in water at 66 ± 6 °C (150 ± 10 °F) for 3 min and then quickly transferred to and similarly immersed in water at 100 ± 2 °C (212 ± 4 °F).
11.2.2 Samples are placed in the water bath ensuring samples are not contacting the walls or floor of the boil tank except for the racking mechanism while allowing free flow of water around each specimen.
11.2.3 The boil tank is allowed to regain set temperature prior to the beginning of the duration timing and test is maintained uninterrupted at the target temperature for 2 h.

11.3 *Bake Testing:*
11.3.1 Samples are placed in a preheated chamber ensuring samples are not contacting the walls of the chamber except for the racking mechanism and allowing for free flow of air around each specimen. The chamber is allowed to regain set temperature prior to the beginning of the duration timing and test is maintained uninterrupted at the target temperature for 16 h and then removed and allowed to cool to room temperature.

12. Interpretation of Results

12.1 The glass layers may crack in this test.

12.2 Specimen has "PASSED" if there are no bubbles beyond 12 mm (0.5 in.) of the specimen edges or any crack.

12.3 Specimen has "FAILED" if any part of one or more bubbles is beyond 12 mm (0.5 in.) of the specimen edges or any crack.

12.4 If any one of the three specimens of the sample set fail the test, the set is deemed a fail.

12.5 If discoloration of any part of the laminate is visible after testing the color and extent is noted in the report but is not deemed a failure.

12.6 Any specimen in which the glass cracks to an extent which confuses the results shall be discarded, and another specimen shall be tested in its place.

13. Reporting

13.1 Report shall include the following:
13.1.1 Specimen designation,
13.1.2 Specimen size,
13.1.3 Number of specimens per sample set,
13.1.4 Test type (boil or bake),
13.1.5 Glass ply thickness,
13.1.6 Glass type and color,
13.1.7 *Glass Orientation,* tin side in or out and if low-e coating on surface (2) or (3),
13.1.8 Interlayer formulation and type,
13.1.9 Interlayer thickness (mm),
13.1.10 Interlayer color,
13.1.11 Inks, coatings, frit, or other inserts,
13.1.12 Number and location of bubbles (if applicable),
13.1.13 Description of discoloration (if applicable), and
13.1.14 Pass/Fail rating per specimen and per sample set.

14. Precision and Bias

14.1 Boil and bake tests are pass/fail and therefore precision or bias cannot statistically be obtained.

15. Keywords

15.1 bake; boil; bubbles; durability; laminated glass