Designation: E 2188 – 02

Standard Test Method for Insulating Glass Unit Performance[1]

This standard is issued under the fixed designation E 2188; 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 test method covers procedures for testing the performance of preassembled permanently sealed insulating glass units or insulating glass units with capillary tubes intentionally left open.

1.2 This test method is applicable only to sealed insulating glass units that are constructed with glass.

1.3 The unit construction used in this test method contains dimensions that are an essential component of the test. Different types of glass, different glass thicknesses and different airspace sizes may affect the test results.

1.4 This test method is not applicable to sealed insulating glass units containing a spandrel glass coating due to testing limitations.

1.5 The values stated in SI units are to be regarded as the standard. The values given in parentheses are for information only.

1.6 *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 1036 Specification for Flat Glass[2]

E 546 Test Method for Frost Point of Sealed Insulating Glass Units[3]

E 2190 Specification for Insulating Glass Unit Performance[4]

3. Terminology

3.1 *Definition of Terms*:

3.1.1 For definitions of terms found in this Standard, refer to Standard Terminology of Building Seals and Sealants, C 717, Terminology of Glass and Glass Products, C 162 and Terminology of Building Constructions, E 631.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *frost/dew point, n*—the temperature at which water, organic vapor, or other chemicals begin to appear on the interior glass surface of a sealed insulating glass unit.

4. Significance and Use

4.1 This test method is intended to provide a means for testing the performance of the sealing system and construction of sealed insulating glass units.

4.1.1 Sealed insulating glass units tested in accordance with this method may be suitable for structurally glazed applications. However, factors such as sealant longevity when exposed to long term ultraviolet light and the structural properties of the sealant must be reviewed for these applications.

4.1.2 Sealed insulating glass units tested in accordance with this method are not intended for continuous exposure to high relative humidity conditions or long-term immersion in water.

5. Test Specimens

5.1 Each test specimen shall measure 355 ± 6 mm by 505 ± 6 mm (14 ± ¼ in. by 20 ± ¼ in.) and shall be composed of two or three lites of clear, tinted or coated annealed, heat-strengthened, tempered or laminated glass.

5.1.1 The double glazed test samples shall be fabricated with at least one lite of clear, uncoated glass. The triple glazed test samples shall be fabricated with at least one outer lite of clear, uncoated glass. The other outer lite shall be fabricated with a glass which allows easy viewing of the frost point.

5.1.2 The thickness of the glass lite shall be between nominal 3.0 mm (⅛ in.) and a maximum of 6.0 mm (¼ in.) nominal.[5]

5.1.3 The airspaces for units with either two or three lites of glass shall be a minimum of 6.0 mm (¼ in.) ± 0.8 mm (1/32 in.).

5.1.4 Triple pane units where the intermediate airspace divider is a plastic film are acceptable.

NOTE 1—Overall unit thickness has some limits. Testing laboratories are usually able to accommodate 30 mm overall thickness. If testing

[1] This test method is under the jurisdiction of ASTM Committee E06 on Performance of Buildings and is the direct responsibility of Subcommittee E06.22 on Durability Performance of Building Constructions.

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

[3] *Annual Book of ASTM Standards*, Vol 04.11.

[4] This test specification is under development by ASTM Committee E06 on Performance of Buildings and is the direct responsibility of Subcommittee E06. 22 on Durability Performance of Building Constructions.

[5] The construction of the test units is optional and shall be determined by the test specifier. When testing to Specification E 2190, the required unit construction is specified in that document.

thicker units, contact the testing laboratory prior to manufacturing to ascertain their capabilities for testing thicker units.

5.2 The thickness tolerance of the glass shall conform to Specification C 1036.

5.3 Each specimen shall be permanently and legibly marked with the designation of the manufacturer, the date of fabrication (month or quarter and year) and orientation intended in the field (for units constructed with coated glass).

5.4 At least twelve specimens of identical component materials and construction shall be submitted.

5.5 During all stages of exposure and storage, the units shall be held in a vertical position with equal support to all panes and no compression loading.

5.6 Selection of units for testing shall be made at random except for units damaged in transit. Damaged units shall not be tested.

5.7 Test samples representing units that will be gas filled shall be fabricated using the same hole sealing and gas filling techniques as those used for manufacturing. For example, if a gas-filling plug is used in manufacturing then it must be used in the test units. The samples do not need to be filled with gas providing that the gas is classified as inert. Test samples representing products that are normally filled with an inert gas in production, may be submitted air filled for this testing as long as they have been manufactured with the same techniques as used in production.

5.8 Test samples representing units that include tubes intended to be left open shall be fabricated with one tube. These tubes shall be left open during testing. Test samples representing units that include tubes intended to be closed off after shipping shall be fabricated with one tube. These tubes shall be closed at the exterior end prior to testing.

5.9 Test samples representing units that include muntins shall be fabricated with muntins dividing the sample into nine equal areas (3 by 3). See Fig. 1.

6. Apparatus

6.1 *For Weather Cycle Phase*:

6.1.1 *Weather Cycle Test Apparatus*[6]—The weather cycle test apparatus shall be essentially that shown in Figs. 2 and 3 to provide the required test conditions indicated in Section 8. Modifications to this test apparatus are acceptable providing that the required test conditions are met.

6.1.1.1 *Ultraviolet Light Source*:

NOTE 2—**Warning:** Ultraviolet light sources used in this test method are harmful, especially to the eyes. Appropriate protective measures must be observed.

6.1.1.2 The source shall consist of two fluorescent black light lamps, Type F72T12BL/HO[7] (Note 3), for each test specimen located as shown in Fig. 2.

NOTE 3—Rated average life at 3 h per start: 12 000 h. Rated average life at 12 h per start: 18 000 h. Useful length: 1625 mm (64 in.). Wattage: 85 W. Relative black light energy output is 190 % that of F40BL lamp. UVA 340 nanometers.

6.1.1.3 Each lamp must be replaced when its ultraviolet light intensity falls below 10 W/m^2 (1000 $\mu W/cm^2$) when measured with a long-wave ultraviolet meter[8] in direct contact with the lamp.

6.1.2 Protect the accelerated weathering chamber from overheating and from overcooling with protective devices.

6.1.3 Equip the accelerated weather cycle chamber with one or more sensors and a continuous temperature recording device placed in an area that monitors the average temperature at any time inside the chamber.

6.2 *For High Humidity Phase*:

6.2.1 *High Humidity Test Chamber*—A chamber of convenient dimensions capable of maintaining 60 ± 3°C (140 ± 5°F) and 95 ± 5 % relative humidity.

6.2.2 The high humidity chamber shall be protected from overheating with a protective device.

[6] The apparatus is a modification of the device developed by the Institute for Research in Construction (IRC) of the National Research Council of Canada. One modification was to expose each test specimen to two black light lamps.

[7] Available from General Electric Company, Nela Park, Cleveland, OH 44112.

[8] A suitable meter is the Black-Ray UV Meter with J221 sensor cell. Available from Ultra-Violet Products, Inc., 2066 West 11th Street, Upland, CA 91786.

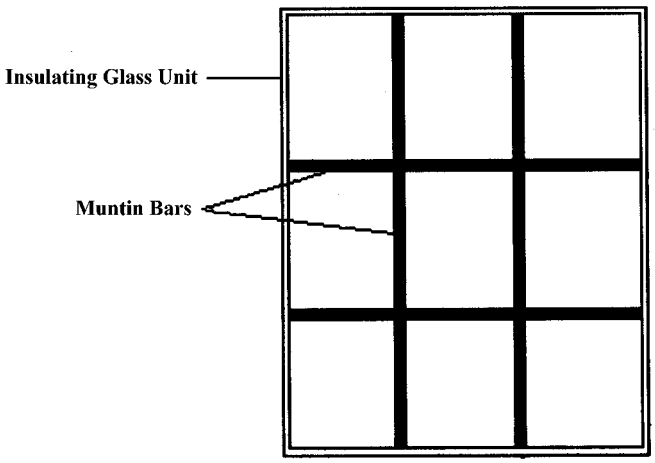
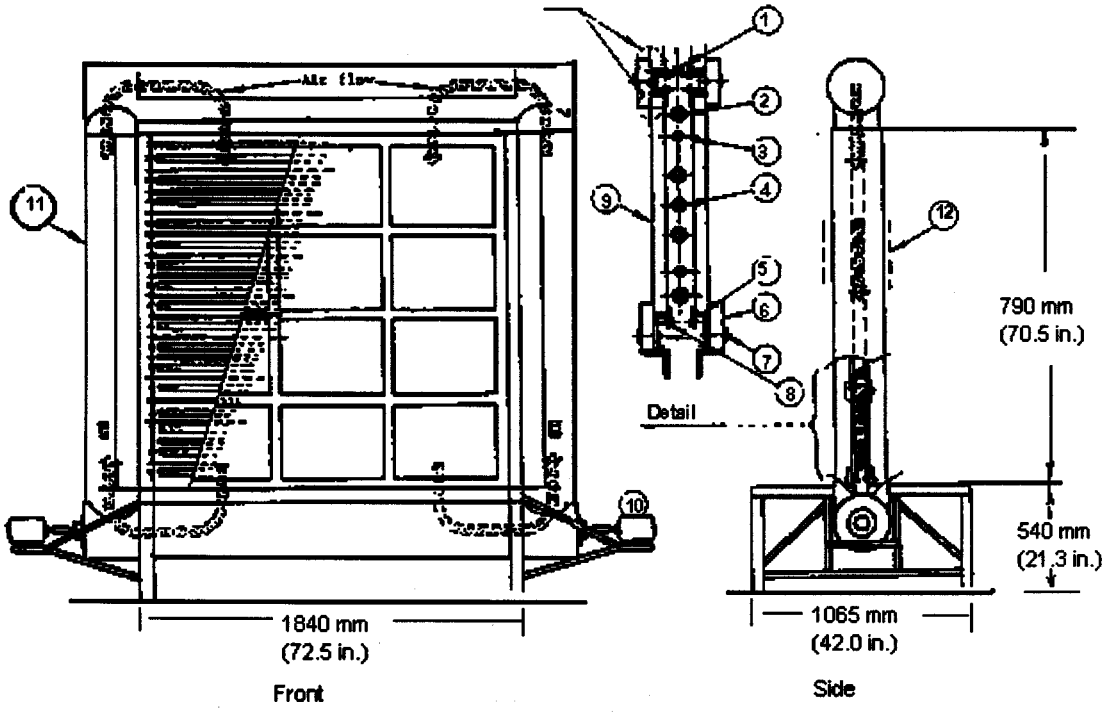


FIG. 1 Schematic Drawing of Insulating Glass Unit with Muntin Bars



Description: 1. Fog or mist spray; 2. Cooling coil; 3. Fluorescent black light lamp, F72T12BL/HO; 4. Heating coil; 5. Rubber pad; 6. Polystyrene insulation; 7. Rubber washer; 8. Clamping device; 9. Test specimen; 10. Fan motor; 11. Air duct; 12. Insulation

FIG. 2 Schematic Drawing of Typical Accelerated Weathering Apparatus

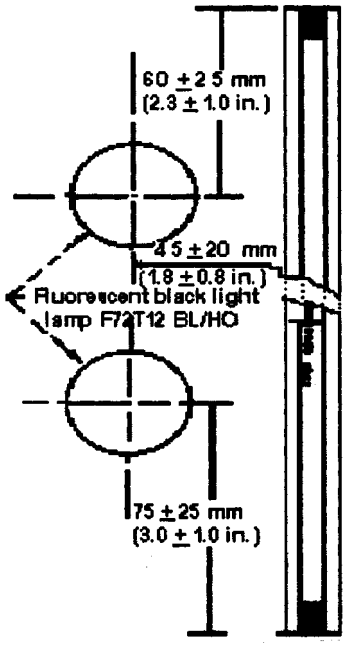


FIG. 3 Location of Fluorescent Black Light Lamp Relative to the Test Specimen

6.2.3 Equip high humidity chamber with one or more sensors and a continuous temperature-recording device placed in an area that monitors the average temperature in the chamber.

7. Preparation of Test Specimens

7.1 Uncleanable stain or scum may remain on the exterior glass surface of the specimen after the accelerated weathering test. Measures shall be taken to have a clear view of the interior glass surface for detection of frost. For example, place a mask of plastic tape[9] 50 by 50 mm (2 by 2 in.) or larger, on the

[9] Scotch Plastic Tape #471 available from 3M Company, 3M Center, Commercial Office Supply Division, Bldg. 230-3 South-17, St. Paul, MN 55101 has been found suitable for this purpose.

central region of both exterior glass surfaces before exposing the unit to weathering conditions. Remove the mask for frost/dew point measurement.

7.2 The sealed insulating glass units shall be sealed a minimum of 4 weeks from date of manufacture to allow for stabilization before testing. The manufacturer has the option to waive this requirement.

8. Procedure for Seal Durability

8.1 *Initial Frost/Dew Point Test*:

8.1.1 Determine the initial frost/dew point on all airspaces on all units submitted using Test Method E 546 or equivalent.

8.2 *High Humidity Phase*:

8.2.1 Place the test specimens that were tested in accordance with 8.1 in the high humidity test apparatus. Expose six specimens in the high-humidity test chamber at 60 ± 3°C (140 ± 5°F) and 95 ± 5 % relative humidity. Arrange the specimens so that each specimen has at least 6 mm (¼in.) clearance all around.

8.2.2 When the specified time period (days) has been attained[10], remove the test specimens. Allow the test specimens to equilibrate at 23 ± 3°C (73 ± 5°F) for not less than 24 h. Determine the frost/dew point in accordance with Test Method E 546 or equivalent. For triple pane units, the frost/dew point shall be determined for all airspaces. If liquid appears, record the temperature at which it occurs.

8.3 *Weather Cycle Phase*:

8.3.1 Place the six test specimens tested in accordance with 8.1 and 8.2 in the weather cycle chamber. Mount the specimens so that one exterior surface of the specimen is exposed to the weather cycles and the other to room temperature (23 ± 3°C) (73 ± 5°F). Install all specimens as shown in Fig. 2, taking care that no stress is induced in the test specimens by the method of fastening.

8.3.2 The test specimens shall be oriented in the weather cycle chamber with the number one surface facing the weather changes as it does in normal field exposure.

8.3.3 *Cycling*—Each cycle shall be 6 h ± 5 min and composed of the following test conditions (see Fig. 4):

8.3.3.1 During the first 60 ± 5 min, decrease the temperature from room temperature to −29 ± 3°C (−20 ± 5°F).

8.3.3.2 Maintain temperature at −29 ± 3°C (−20 ± 5°F) for 1 h ± 5 min.

8.3.3.3 Turn on heat and allow temperature to rise from −29 ± 3°C (−20 ± 5°F) to room temperature over a period of 60 ± 5 min.

8.3.3.4 Start ultraviolet lamps and over a time period of 60 ± 5 min control the temperature rise from room temperature to 60 ± 3°C (140 ± 5°F). At the beginning of this same 60 min period, turn on water or mist supply. The interior of the chamber, at the test specimens, shall reach a minimum of 90 % relative humidity within this time period.

8.3.3.5 Turn off the water or mist supply after 60 min.

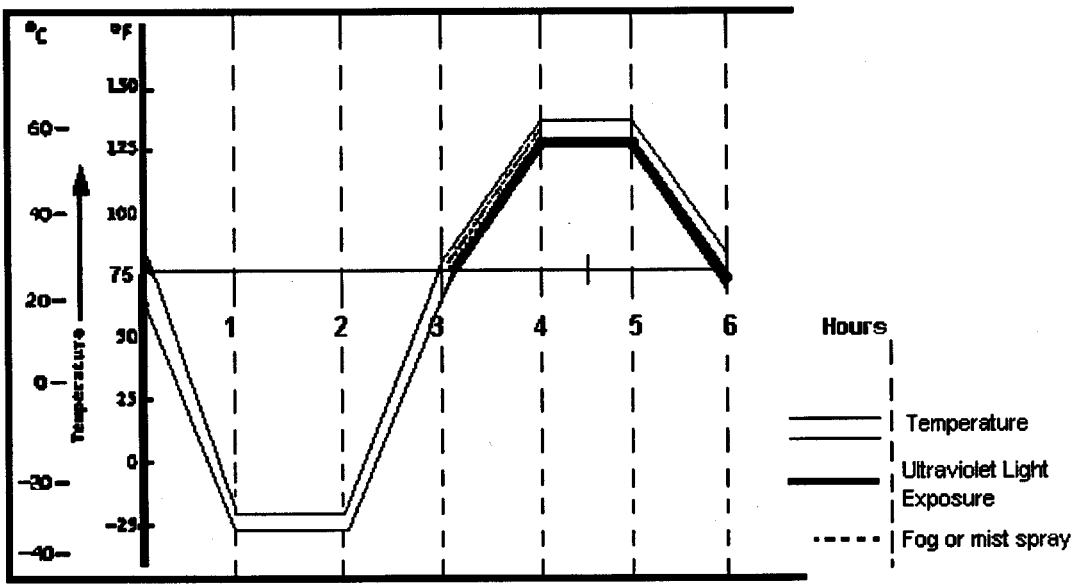
8.3.3.6 Maintain temperature at 60 ± 3°C (140 ± 5°F) and continue ultraviolet exposure for a period of 60 ± 5 min.

8.3.3.7 Over a period of 60 ± 5 min, decrease temperature from 60 ± 3°C (140 ± 5°F) to room temperature, and continue ultraviolet exposure. At the end of this period, turn off ultraviolet lamp.

8.3.3.8 When the specified time period (cycles) has been attained[11], remove the test specimens. Allow the test specimens to equilibrate at 23 ± 3°C (73°F ± 5°F) for not less than 24 h.

[10] The amount of time under the high humidity test condition is optional and is at the discretion of the test specifier. When testing to Specification E 2190, the amount of time required is specified in that document.

[11] The number of cycles is optional and is at the discretion of the test specifier. When testing to Specification E 2190, the number of cycles is specified in that document.



NOTE—This figure represents the ideal cycle described in this test method. Any temperature variation within the tolerance zone shown is acceptable.

FIG. 4 Schematic Drawing of Each Cycle for Accelerated Weather Cycle Test

Determine the frost/dew point in accordance with Test Method E 546 or equivalent. For triple pane units, the frost/dew point shall be determined for all airspaces. If liquid appears, record the occurrence.

9. Measurements and Observations

9.1 Observe the following:

9.1.1 Glass breakage.

9.1.2 Any visible deposit in the airspace.

9.2 Measure the following:

9.2.1 Measure the frost/dew point of each insulating glass unit.

10. Report

10.1 *Complete Description of Specimen Tested*:

10.1.1 Dimensions of the test specimen (width by height) and overall thickness.

10.1.2 Type and thickness of glass.

10.1.3 Glass coatings and surface locations if applicable.

10.1.4 Airspace thickness(es).

10.1.5 Describe the spacer composition(s) and configuration(s).

10.1.6 Describe the corner construction including the type and number of corner keys.

10.1.7 Desiccant type and quantity, if provided.

10.1.8 Presence and type of tube, if applicable.

10.1.9 Presence and composition (if known) of muntin bars.

10.1.10 Sealant type(s) and dimensions, if provided.

10.1.11 Manufacturer and manufactured date (month or quarter, if known, and year).

10.1.12 Date testing was started.

10.2 *Duration of Test*:

10.2.1 Duration of high humidity phase described in 8.2 (number of days).

10.2.2 Duration of accelerated weather cycle phase described in 8.3 (number of cycles).

10.2.3 Duration of any additional testing including type and order of testing and number of cycles or days.

10.3 Glass breakage, if observed.

10.4 Frost/dew point of each unit after testing to 8.1-8.3, if observed.

10.5 Any visible deposit(s) in the airspace.

11. Precision and Bias

11.1 *Precision*—The precision of the procedures in these test methods is being determined.

11.2 *Bias*—Since there is no accepted reference material suitable for determining the bias for the procedures in this test method, bias has not been determined.

12. Keywords

12.1 IGU performance; IGU seal durability; insulating glass units (IGU); sealed insulating glass units