



Designation: C1900 – 20

Standard Practice for Weathering and Evaluation of Laminated Glass¹

This standard is issued under the fixed designation C1900; 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 reappraisal. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reappraisal.

1. Scope

1.1 This practice is intended to cover procedures for the exposure of laminated glass materials to natural and accelerated weather.

1.2 This practice is limited to the method by which the material is to be exposed and the general procedure to be followed. It is intended for use with finished articles of commerce as well as with all sizes and shapes of test specimens.

1.3 Means of evaluation of the effects of weathering will depend on the intended use for the test material.

1.4 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.

1.5 *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.*

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.*

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

D1003 Test Method for Haze and Luminous Transmittance of Transparent Plastics

¹ This practice 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.

Current edition approved Aug. 1, 2020. Published September 2020. DOI: 10.1520/C1900-20.

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.

D1435 Practice for Outdoor Weathering of Plastics

D2244 Practice for Calculation of Color Tolerances and Color Differences from Instrumentally Measured Color Coordinates

D2565 Practice for Xenon-Arc Exposure of Plastics Intended for Outdoor Applications

D4459 Practice for Xenon-Arc Exposure of Plastics Intended for Indoor Applications

E308 Practice for Computing the Colors of Objects by Using the CIE System

E313 Practice for Calculating Yellowness and Whiteness Indices from Instrumentally Measured Color Coordinates

G7 Practice for Atmospheric Environmental Exposure Testing of Nonmetallic Materials

G84 Practice for Measurement of Time-of-Wetness on Surfaces Exposed to Wetting Conditions as in Atmospheric Corrosion Testing

G141 Guide for Addressing Variability in Exposure Testing of Nonmetallic Materials

G155 Practice for Operating Xenon Arc Light Apparatus for Exposure of Non-Metallic Materials

2.2 *ISO Standard:*³

ISO 4892-2 Plastics — Methods of exposure to laboratory light sources — Part 2: Xenon-arc lamps

3. Terminology

3.1 *Definitions:*

3.1.1 For definitions of technical terms pertaining to glazing used in this practice, see Terminology C1036, C1048, and C1172.

4. Significance and Use

4.1 Tests conducted in accordance with this practice are used to evaluate the stability of laminated glazing materials when they are exposed outdoors or used indoors. The relative durability of glazing in outdoor use can be very different depending on the location of the exposure because of differences in ultraviolet (UV) radiation, time of wetness, temperature, pollutants, and other factors. It cannot be assumed, therefore, that results from one exposure in a single

³ Available from International Organization for Standardization (ISO), ISO Central Secretariat, BIBC II, Chemin de Blandonnet 8, CP 401, 1214 Vernier, Geneva, Switzerland, http://www.iso.org.

location will be useful for determining relative durability in a different location. When comparing exposure results, at a minimum, the locations of exposure are to be as similar as possible with regard to critical factors such as the amount and rate of solar radiation deposited on the specimens, temperature and humidity levels during exposure. Exposures in several locations with different climates that represent a broad range of anticipated service conditions may be necessary.

4.2 Because of year-to-year climatological variations, results from a single exposure test cannot be used to predict the absolute rate at which a material degrades. Several years of repeat exposures are needed to get an average test result for a given location.

4.3 The results of short-term natural and accelerated exposure tests can provide an indication of relative outdoor performance, but they should not be used to predict the absolute long-term performance of a material. The results of tests conducted under natural exposure for less than twelve months will depend on the particular season of the year in which they begin.

5. Test Sites and Apparatus

5.1 Natural Weathering Exposure:

5.1.1 The natural test site shall conform to the requirements of Practice **G7**.

5.1.2 Unless otherwise specified, position exposure racks so that they face the equator. The angle of the exposure rack shall be positioned relative to the horizontal conditions that are being evaluated.

NOTE 1—Test sites at latitudes less than 23°27'8" from the equator in either hemisphere will have a period during the year when the declination of the sun will exceed the latitude of the site.

5.1.3 *Natural Weather Racks*—These racks shall be in accordance with Practice **D1435**.

5.1.3.1 *At-latitude Racks*—These racks shall be adjusted such that the exposed surfaces are at an angle from the horizontal corresponding exactly to the site latitude angle (**Note 2**).

NOTE 2—At-latitude exposure provides maximum annual total solar radiant exposure at most nonsubtropical sites. In most non-desert areas, however, maximum annual ultraviolet-radiant exposure is provided by exposure at an angle of the latitude angle minus 10°.

5.1.3.2 *45° Racks*—These racks shall be adjusted such that the exposed surfaces of specimens are at an angle of 45° to the horizontal.

5.1.3.3 *90° Racks*—These racks shall be adjusted such that the exposed surfaces of specimens are at an angle of 90° to the horizontal.

5.1.3.4 *Horizontal Racks*—These racks shall be positioned such that the exposed surfaces of the specimens are horizontal (**Note 3**).

NOTE 3—To provide moisture runoff for most horizontal-type testing of plastics, 5° south exposure is usually preferred. However, plastic roofing membranes, artificial turf, and other plastics that may be exposed at horizontal in their end-use condition should be exposed at 0° horizontal.

5.1.4 *Materials and Manner of Construction*—Test racks and hardware shall conform to the requirements of Practices **G7** and **D1435**.

5.1.5 *Specimen Holders*—Specimen holders shall be in accordance with Practice **D1435**.

5.2 Accelerated Weathering Exposure:

5.2.1 *Accelerated Chamber*—Chamber shall comply with Practice **G155** and shall be operated in accordance with the conditions specified in **10.3**.

5.2.2 *Accelerated Weathering Racks*—These racks shall be in accordance with Practice **G155** with all portions of a specimen being equidistant from the light source.

5.3 Instruments for Measuring Climatological Data:

5.3.1 *Instruments Used to Measure Ambient Temperature and Relative Humidity*—Instruments and procedures used for measurement of ambient temperature and relative humidity shall be in accordance with Practice **G7**.

5.3.2 *Instruments Used to Measure Solar Radiation*—Instruments and calibration procedures used for measurement of total solar radiation, total solar ultraviolet radiation, or narrow band solar ultraviolet radiation shall be in accordance with Practice **G7**.

6. Sampling

6.1 For natural weathering, sampling shall be in accordance with the pertinent considerations outlined in Guide **G141** with a minimum of three specimens per interval.

6.2 For accelerated weathering a minimum of three specimens per interval shall be used.

7. Test Specimens

7.1 Exposure test specimens shall be a minimum size of 152 × 152 mm for natural exposure and a minimum size of 76 × 127 mm for accelerated exposure. They must be capable of being mounted in a holder or applied directly to the racks. Exposure test specimens should be large enough that mounting edges may be removed where evaluation test results would otherwise be affected but small enough to ensure consistent exposure.

7.2 As far as practical, exposure test specimens shall simulate service conditions of an end-use application or shall have prescribed evaluation procedures to allow comparison of products.

7.3 The total number of specimens will be determined by the removal schedule and number of replicates plus file specimens. These file specimens shall be retained at conditions of 23.0 ± 2 °C and 50 ± 20 % relative humidity. They shall be covered with inert wrapping to exclude light exposure during the exposure and retain period.

8. Exposure Stages

8.1 Use one of the following methods to specify the exposure stages at which changes in properties of test specimens are determined.

NOTE 4—The same exposure stage (by whichever method is used) will not necessarily give the same changes in properties of the test specimen at different exposure sites. The exposure states must be regarded as providing only a general indication of the degrees of exposure, and the results should always be considered in terms of characteristics of the exposure site as well.

8.1.1 *Natural Exposure Time*—Specify the duration of the exposure in terms of months (1, 3, 6, 12, 15, etc.) or years (1, 1.5, 2, 3, 4, 5, etc.), unless otherwise instructed.

NOTE 5—The results for exposure stages of less than one year will depend on the season of the year in which the exposure was made. For instance, summer exposures are generally more severe than winter exposures. Seasonal effects are averaged in exposures of several years.

8.2 *Accelerated Exposure Time*—Specify the duration of the exposure in terms of hours (100, 500, 1000, 3000, etc.) unless otherwise instructed.

9. Procedure

9.1 Mark the test and control specimens to be exposed with an identifying number, letter, or symbol so that they may be identified readily after exposure. Specimen marking shall be on the exterior or No. 1 surface, such that there is no interference with the exposure, testing, or interlayer.

9.2 Natural weathering procedures shall be in accordance with Practice D1435. On average, a one-year exposure approximates a Total Ultraviolet (TUV) exposure of 300 ± 25 MJ/m² at 295 to 385 nm.

9.2.1 All materials are exposed in an unbacked condition. Specific conditions of use may require the glass material to also be evaluated with a suitable backing material to conform to projected practice. The effect of backing is highly significant and may contribute to a change in the weathering performance of the exposed materials.

9.2.2 For products intended for external use (for example, façade, storefront, window, door), use a 26° North latitude, 45° angle of exposure, direct, facing South, open-backed mounting.

9.2.3 For products intended for internal use only (for example, partitions, shower doors, balcony) use a 26° North latitude, 45° angle of exposure, direct, facing South, open-backed mounting. The specimens may be exposed under a 3 mm clear glass with visible light transmittance of 88 ± 3 %.

9.2.4 Natural weathering for outdoor use qualifies products for indoor use without additional exposure or testing.

9.3 Accelerated weathering procedures shall be in accordance with Practice G155.

9.3.1 Accelerated exposure testing shall occur in a xenon arc type operating light apparatus with filters as specified in accordance with Practice G155.

9.3.2 *Accelerated Weather Exposure Method A—Outdoor Applications No Spray:*

9.3.2.1 The specimens shall be exposed in accordance with Practice D2565 (or ISO 4892-2) and the following conditions as stated in Table 1.

9.3.3 *Accelerated Weathering Exposure Method B—Outdoor Applications With Water Spray:*

9.3.3.1 The purpose of weathering laminated glazing is to determine if degradation of the interlayer occurs over the duration of the exposure. Surface etching of the glazing may occur in the accelerated chamber or on natural exposure and erroneously indicate interlayer or adhesive changes. An identical piece of glazing material from which the laminates have been manufactured, a blank (that is, glass, plastic, etc.), may be

TABLE 1 Accelerated Weathering Exposure Conditions Method A—Outdoor Applications No Spray

Parameter	Description
Practice D2565 Cycle	Cycle 1
Black Panel Temperature	64 ± 2 °C (145 ± 4 °F)
Relative Humidity	50 ± 5 %
Spray Water	None
Irradiance ^A	0.35 ± 0.02 W/m ² at 340 nm, or 41.5 ± 2.5 W/m ² from 300 to 400 nm
Exposure Duration ^A	3000 h

^A Minimum acceptable levels of irradiance and duration are indicated and shall be recorded in the report section.

TABLE 2 Accelerated Weathering Exposure Conditions Method B—Outdoor Applications With Water Spray

Parameter	Description
Practice D2565 Cycle	Cycle 1
Black Panel Temperature	64 ± 2 °C (145 ± 4 °F)
Relative Humidity	50 ± 5 %
Spray Water	De-ionized
Irradiance ^A	0.35 ± 0.02 W/m ² at 340 nm, or 41.5 ± 2.5 W/m ² from 300 to 400 nm
Exposure Duration ^A	3000 hours

^A Minimum acceptable levels of irradiance and duration are indicated and shall be recorded in the report section.

weathered concurrently to determine the weathering of glazing and eliminate those changes from the interlayer or adhesive evaluation.

9.3.3.2 The specimens shall be exposed in accordance with Practice D2565 (or ISO 4892-2) and the following conditions as stated in Table 2.

9.3.4 *Accelerated Weathering Exposure Method C—Indoor Applications Only:*

9.3.4.1 The purpose of these tests is to determine whether laminated glazing is durable for indoor use.

9.3.4.2 Specimens passing the requirements of natural or accelerated outdoor exposure and subsequent testing (Section 11) are deemed qualified for indoor applications without further evaluation.

9.3.4.3 The specimens for indoor exposure use only shall be subjected to exposure in a xenon arc type operating light.

9.3.4.4 Apparatus as specified in Practice G155 with filters as specified in accordance with Practice D4459.

9.3.4.5 The specimens shall be exposed in accordance with Practice D4459 and the following conditions as indicated in Table 3.

10. Evaluation of Weathered Materials

10.1 *Tests After Weathering for Laminated Glazing:*

10.1.1 After exposure, the test specimens may be cleaned, if necessary, using a procedure recommended by their manufacturer to remove any residues present.

10.1.2 Both the unexposed and exposed specimens shall be conditioned prior to examination or further testing for a minimum of 48 h at 71 to 75 °F (22 to 24 °C).

10.1.3 After conditioning, the exposed specimens shall be examined and compared visually with and measured at the same time as the unexposed controls.

10.1.3.1 *Visual Assessment After Weathering:*

(1) Specimens shall be placed in a vertical position.

**TABLE 3 Accelerated Weathering Exposure Conditions
Method C—Indoor Product Use**

Parameter	Description
Light Mode	Continuous
Black Panel Temperature	55 ± 2 °C (131 ± 4 °F)
Relative Humidity	55 ± 5 %
Spray Water	None
Irradiance ^A	0.3 ± 0.02 w/(m ² · nm) at 340 nm, or 0.8 ± 0.05 w/(m ² · nm) at 420 nm, or 36.5 ± 2.5 w/m ² between 300 and 400 nm
Exposure Duration	3000 h

^A Minimum acceptable levels of irradiance indicated. Higher irradiance levels and longer duration are permitted. Levels and duration shall be recorded in the report section.

(2) The viewer shall look through the specimen using daylight without direct sunlight or using a background light suitable for observing blemishes.

(3) Specimens shall be viewed at a distance of 910 mm (36 in.).

(4) Determine the presence of the following characteristics through visual assessment:

(a) Bubbles of any size, located 12 mm (0.5 inch) or more from any outer edge of the specimen.

(b) Delamination of any size visible 12 mm (0.5 in.) or more from any outer edge of the specimen.

(c) Craze or cracking of the interlayer in any portion of the specimen.

(d) Noticeable decomposition or other defects.

10.1.3.2 Assessment of optical changes after weathering are included for laminated glazing as significant changes can be indicative of product degradation which may influence performance. Changes in the blank glazing based on the comparison of nonweathered retain data, shall be deducted from the weathered laminated specimens for evaluation of the properties listed.

10.2 *Measurement Location*—Specimens shall be measured at a point more than 12 mm (0.5 in.) inward from any edge.

10.2.1 The same specimen is to be measured before and after weathering when calculating the properties for 10.3.

10.3 *Performance Requirements*—When compared to control (unexposed) samples, and after adjustment of the glazing blank characteristics (water spray cycle only), no weathered specimen shall exhibit more than the allowable change, as specified, for the following properties:

10.3.1 Visible Light Transmittance change not greater than five percentage units (for example, 91 % control ± 5 % = 96 or 86 %) as measured in accordance with Test Method D1003.

10.3.2 Yellowness Index (for clear products only) increase not greater than 0.5 YI units (for example, 0.70 YI control + 0.5 = 1.20) as measured in accordance with Practice E313.

10.3.3 Haze increase not greater than 0.5 percentage units (for example, 0.70 control + 1.20) as measured in accordance with Test Method D1003.

10.3.4 Delta E less than or equal to five units as measured in accordance with Practice E308 and calculated in accordance with Practice D2244.

11. Interpretation of Results

11.1 Due to glass etching with exposure when the water spray method is used, a specimen of unlaminated glass (a “blank”), from the identical stock used to make the laminated glass specimens being assessed, is to be placed in the weathering chamber along with the samples. This “blank” is used as a control from which haze, yellowness, visible light transmittance and Delta E is measured and deducted from the measurement seen in the exposed laminated glass specimens. The deviations caused by the glass itself are not indicative of a change in the interlayer material.

11.2 The glass itself may crack in this test, but no bubbles or delamination shall develop more than 0.5 in. (12 mm) from the any crack that may develop. Any specimen in which the glass cracks to an extent confusing the results shall be discarded without prejudice, and another specimen shall be tested instead.

11.3 Any improvement in clarity or discoloration is acceptable.

11.4 Laminates free of visual characteristics listed in 10.1.3.1 shall be deemed “visually acceptable.”

11.5 Laminates with one or more of the visual characteristics listing in 10.1.3.1 shall be deemed “visually blemished.”

11.6 Laminates complying the to all the performance requirements of 10.3 shall be deemed as passing. A single specimen non-compliance to the performance requirements of 10.3 shall deem the glazing material as non-compliant.

11.7 When the thinnest construction of all components of laminated glazing’s have passed the applicable weathering requirements and subsequent assessments and evaluation as stated in Section 10, thicker components and colored components of the same material are deemed as qualified for weathering compliance.

12. Report

12.1 *General:*

12.1.1 Specimen identification,

12.1.2 Number of specimens,

12.1.3 Description of specimens,

12.1.4 Laboratory name,

12.1.5 Test method and sequence of the test events,

12.1.6 Exposure duration (hours, months, years) and intervals of testing,

12.1.7 Visual assessment data including results from property measurements on unexposed file specimens,

12.1.8 Optical assessment data including results from property measurements on unexposed file specimens,

12.1.9 Observations, deviations, and waivers pertinent to the testing, and

12.1.10 Dates of tests (start, finish, and interval testing).

12.2 *For Natural Weathering Exposure:*

12.2.1 Total solar radiant exposure and total solar UV radiant exposure that has been measured in accordance with Practice G7 using radiometers positioned at the same tilt and azimuth angle as the test specimens.