



Designation: D904 – 99 (Reapproved 2021)

Standard Practice for Exposure of Adhesive Specimens to Artificial Light¹

This standard is issued under the fixed designation D904; 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 practice covers the basic principles and operating procedures for ultraviolet (UV) light aging (with or without water) of adhesive bonded joints having at least one glass or transparent adherend, using fluorescent UV (see Method A) or xenon-arc light sources (see Method B).

1.2 This practice is limited to the apparatus for obtaining, measuring, and controlling the aging conditions, and to the procedures for exposure. Sample preparation, strength, test conditions, and evaluation of the results are described in other ASTM test methods or specifications.

1.3 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

1.4 *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.*

1.5 *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

D907 Terminology of Adhesives

G151 Practice for Exposing Nonmetallic Materials in Accelerated Test Devices that Use Laboratory Light Sources

G154 Practice for Operating Fluorescent Ultraviolet (UV) Lamp Apparatus for Exposure of Nonmetallic Materials

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

3. Terminology

3.1 *Definitions*—Many of the terms in this practice are defined in Terminology D907.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *irradiance, n*—(1) the rate at which light energy falls on a unit area of surface (W/m^2), or (2) the radiant power incident upon a unit area of surface.

3.2.2 *radiant exposure (or light dosage), n*—(1) the accumulated light energy which has fallen on a unit area over time (J/m^2), or (2) the irradiance integrated with respect to time.

3.2.3 *spectral irradiance, n*—the distribution of irradiance in accordance with wavelength.

3.2.3.1 *Discussion*—Spectral irradiance is usually shown as a curve relating irradiance (ordinate) and light wavelength (abscissa). Because shorter wavelength UV is usually more damaging than longer wavelength UV, lamps with different spectral irradiance curves can cause drastically different amounts of UV damage, even if they produce the same total irradiance.

3.2.4 *spectral power distribution (SPD), n*—the amount of radiation present at each wavelength.

3.2.4.1 *Discussion*—The SPD can be expressed by power in watts, irradiance in watts/square metre, or energy in joules. The shape of the SPD would be identical in all of these units. Fluorescent lamps are frequently described by relative SPD's which show the amount of radiation at each wavelength as a percentage of the amount of radiation at the peak wavelength.

3.2.5 *UV-A, n*—ultraviolet light in the wavelength band between 315 and 400 nm.

3.2.6 *UV-B, n*—ultraviolet light in the wavelength band between 280 and 315 nm.

4. Significance and Use

4.1 This practice is for determining the effects of UV light, or UV light and water, on adhesive bonded joints under controlled but artificial conditions. The results of this practice can be used for comparing the relative durability of several adhesives in a specific laboratory UV exposure.

¹ This practice is under the jurisdiction of ASTM Committee D14 on Adhesives and is the direct responsibility of Subcommittee D14.40 on Adhesives for Plastics.

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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.

4.2 This practice is not for determining a forecast of the life of an adhesive bond in service. It is only for determining the relative durability of different adhesives compared to each other.

4.3 The results obtained may vary between the different light sources (xenon-arc or fluorescent UV), because of the different spectral-irradiance of the lamps. Adhesives should not be compared to each other based on their performance under different types of light sources.

4.4 The results obtained may vary when operation conditions are varied within the limits of a given method. The results may also vary when exposures are performed on instruments made by different manufacturers. Comparisons between materials must only be made when they are tested at the same time in the same instrument. Be sure to accurately report the operating conditions.

4.5 The type and UV transmittance characteristics of the transparent adherend used can have a significant effect on the rate and type of degradation of the adhesives being tested. Comparisons between adhesives must only be made when tested on transparent adherends of the same type (preferably the same lot) with the same UV transmission.

4.6 This practice is not for determining the effects of atmospheric pollutants, biological organisms, salt, or freeze/thaw cycles.

5. Method A—Fluorescent UV

5.1 *Apparatus*—A fluorescent UV and condensation chamber in accordance with Practices **G151** and **G154**.

5.2 *Lamp Type*—Use fluorescent UV-A lamps, with a peak emission at 343 nm.

NOTE 1—UV-A lamps are preferable to UV-B lamps, because UV-A wavelengths can pass through the transparent portion of the test specimen without being absorbed, whereas most of the UV-B wavelengths are filtered out by the glass.

5.2.1 Other fluorescent UV lamps meeting the size and electrical characteristics in **5.2** may be used by prior agreement, provided that the lamp and spectral power distribution are reported in conformance with Section **7**. Use of lamps other than those specified in **5.2** may result in significant differences in test results.

5.3 *Specimen Mounting*—Mount the specimens in the specimen holders so that the UV passes through the transparent adherend to reach the adhesive joint or so that the joint is exposed to the effects of condensation (if applicable). Use a suitable backing panel to ensure that vapor does not escape from the test chamber around the test specimen. When the test specimens do not completely fill the racks, fill the empty spaces with blank panels to maintain the test conditions within the chamber.

5.4 *Time/Temperature Cycles*—Program the apparatus to achieve the desired test conditions, as follows:

5.4.1 *Cycle I*—4 h UV at $60 \pm 3^\circ\text{C}$ followed by 4 h condensation at $50 \pm 3^\circ\text{C}$, for applications where the adhesive will be exposed to moisture.

5.4.2 *Cycle II*—24 h UV at $60 \pm 3^\circ\text{C}$ with no condensation, for applications where moisture is not a factor.

5.4.3 Other temperatures and time cycles are acceptable, as long as they are reported in accordance with Section **7**.

NOTE 2—Temperatures are black-panel temperatures measured in the panel rack.

5.5 Operate the apparatus in accordance with Practices **G151** and **G154**.

5.6 Expose the specimens for 168 h or multiples thereof, unless a significant change is observed in a shorter time.

6. Method B—Xenon Arc

6.1 *Apparatus*—Any xenon arc apparatus in accordance with Practices **G151** and **G155**.

6.2 Filter configuration in accordance with Practices **G151** and **G155**.

6.3 *Irradiance Level*—Set the irradiance level to a level selected by mutual agreement.

6.4 *Time/Temperature Cycles*—Program the unit for one of the following light/spray cycles:

6.4.1 *Cycle I*—40 min of light followed by 20 min of light and specimen spray followed by 60 min of light followed by 60 min of dark. During the light cycle operate at a $63 \pm 3^\circ\text{C}$ black-panel temperature and $50 \pm 5\%$ relative humidity. During the dark cycle operate at $38 \pm 2^\circ\text{C}$ black-panel temperature and $95 \pm 5\%$ relative humidity.

6.4.2 *Cycle II*—Continuous light without water at a black-panel temperature of $60 \pm 3^\circ\text{C}$.

6.5 Other filters, irradiance levels, relative humidities, temperatures, and time cycles are acceptable, as long as they are reported in accordance with Section **7**.

6.6 Operate the apparatus in accordance with Practices **G151** and **G155**.

6.7 Expose the specimens for either (1) 168 h or multiples thereof, unless a significant change is observed in a shorter time, or (2) a given amount of radiant exposure.

7. Report

7.1 Report the following information:

7.1.1 Type and model of exposure apparatus and the manufacturer's designation.

7.1.2 Type of light source and the manufacturer's designation. If a xenon-arc device is used, report the filter combination and irradiance setting.

7.1.3 Specimen temperature setting.

7.1.4 Time cycle.

7.1.5 Relative humidity if controlled.

7.1.6 Number of hours of exposure, or radiant exposure.

7.1.7 Type of specimen and property evaluated for change due to light effects.

7.1.8 Type, thickness, and (optionally) UV transmission characteristics of transparent adherend used. If UV transmission is reported, describe how it was measured.

7.1.9 Mean and precision of property measured before exposure.