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Standard Practice for Xenon-Arc Exposure of Plastics Intended for Outdoor Applications[1]

This standard is issued under the fixed designation D2565; 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.

This standard has been approved for use by agencies of the U.S. Department of Defense.

1. Scope*

1.1 This practice covers specific procedures and test conditions that are applicable for xenon-arc exposure of plastics conducted in accordance with Practices G151 and G155. This practice also covers the preparation of test specimens, the test conditions best suited for plastics, and the evaluation of test results.

1.2 The values stated in SI units are to be regarded as standard. The values given in parentheses are mathematical conversions to inch-pound units that are provided for information only and are not considered standard.

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~~safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

NOTE 1—This practice and ISO 4892-2 address the same subject matter, but differ in technical content.

1.4 *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]

D3980 Practice for Interlaboratory Testing of Paint and Related Materials (Withdrawn 1998)[3]
D5870 Practice for Calculating Property Retention Index of Plastics
E691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method
G113 Terminology Relating to Natural and Artificial Weathering Tests of Nonmetallic Materials
G141 Guide for Addressing Variability in Exposure Testing of Nonmetallic Materials
G147 Practice for Conditioning and Handling of Nonmetallic Materials for Natural and Artificial Weathering Tests
G151 Practice for Exposing Nonmetallic Materials in Accelerated Test Devices that Use Laboratory Light Sources
G155 Practice for Operating Xenon Arc Lamp Apparatus for Exposure of Materials
G169 Guide for Application of Basic Statistical Methods to Weathering Tests

[1] This practice is under the jurisdiction of ASTM Committee D20 on Plastics and is the direct responsibility of Subcommittee D20.50 on Durability of 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.

[3] The last approved version of this historical standard is referenced on www.astm.org.

***A Summary of Changes section appears at the end of this standard**

2.2 *ISO Standard:*[4]
ISO 4892-2 Plastics—Methods of Exposure to Laboratory Light Sources—Part 2, Xenon Arc Lamp
2.3 *Society of Automotive Engineers' Standards:*[5]
SAE J2412 Accelerated Exposure of Autmotive Interior Trim Components Using a Controlled Irradiance Xenon-Arc Apparatus
SAE J2527 Accelerated Exposure of Autmotive Exterior Materials Using a Controlled Irradiance Xenon-Arc Apparatus

3. Terminology

3.1 The definitions in Terminology G113 are applicable to this practice.

4. Significance and Use

4.1 The ability of a plastic material to resist deterioration of its electrical, mechanical, and optical properties caused by exposure to light, heat, and water can be very significant for many applications. This practice is intended to induce property changes associated with end-use conditions, including the effects of daylight, moisture, and heat. The exposure used in this practice is not intended to simulate the deterioration caused by localized weather phenomena, such as, atmospheric pollution, biological attack, and saltwater exposure.

4.2 **Caution**—Variations in results are possible when operating conditions are varied within the accepted limits of this practice. Therefore, all references to the use of this practice must be accompanied by a report prepared in accordance with Section 9 that describes the specific operating conditions used. Refer to Practice G151 for detailed information on the caveats applicable to use of results obtained in accordance with this practice.

NOTE 2—Additional information on sources of variability and on strategies for addressing variability in the design, execution, and data analysis of laboratory-accelerated exposure tests is found in Guide G141.

4.3 Reproducibility of test results between laboratories has been shown to be good when the stability of materials is evaluated in terms of performance ranking compared to other materials or to a control.[6,7] Therefore, exposure of a similar material of known performance (a control) at the same time as the test materials is strongly recommended. It is preferable that the number of specimens of the control material be the same as that used for test materials. It is recommended that at least three replicates of each material be exposed to allow for statistical evaluation of results.

4.4 Test results will depend upon the care that is taken to operate the equipment in accordance with Practice G155. Significant factors include regulation of line voltage, freedom from salts or other deposits from water, temperature and humidity control, and condition and age of the lamp and filters.

5. Apparatus

5.1 Use xenon-arc apparatus that conform to the requirements defined in Practices G151 and G155.

5.2 Unless otherwise specified, the spectral power distribution (SPD) of the xenon lamp shall conform to the requirements of Table 1 in Practice G155 for a xenon lamp with daylight filters.

NOTE 3—G155 has two different types of daylight filters. Type I filters represent the closest match to the spectral irradiance of noon summer sunlight. Type II filters allow more shortwave UV than noon summer sunlight, but are a close match to the daylight filters used in most historic xenon arc tests. Both types meet the ASTM G155 requirements for daylight filters, but Type I and Type II filters may produce different results.

6. Test Specimen

6.1 The size and shape of specimens to be exposed will be determined by the specifications of the particular test method used to evaluate the effects of the exposure on the specimens; the test method shall be determined by the parties concerned. Where

[4] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.
[5] Available from SAE International (SAE), 400 Commonwealth Dr., Warrendale, PA 15096, http://www.sae.org.
[6] Fischer, R., "Results of Round Robin Studies of Light- and Water-Exposure Standard Practices," *Accelerated and Outdoor Durability Testing of Organic Materials, ASTM STP 1202*, Warren D. Ketola and Douglas Grossman, eds., American Society for Testing and Materials, Philadelphia, 1993.
[7] Ketola, W., and Fischer, R., "Characterization and Use of Reference Materials in Accelerated Durability Tests," *VAMAS Technical Report No. 30*, available from NIST, Gaithersburg, MD.

practical, it is recommended that specimens be sized to fit specimen holders and racks supplied with the exposure apparatus. Unless supplied with a specific backing as an integral part of the test, specimens shall be mounted so that only the minimum specimen area required for support by the holder shall be covered. This unexposed surface must not be used as part of the test area. In cases where it is necessary to support flexible specimens during exposure, attach the flexible specimens to a thin supporting panel.

NOTE 4—For supporting flexible specimens, aluminum panels that are 0.025 in. (0.64 mm) thick have been found to be acceptable for many applications.

6.2 Unless otherwise specified, expose at least three replicate specimens of each test material and of the control material, if used.

6.3 Retain a supply of unexposed file specimens of all materials evaluated.

6.3.1 For destructive tests, it is preferred to retain unexposed file specimens. When this practice is followed, ensure that sufficient file specimens are retained so that the property of interest can be measured on the file specimens for all planned evaluations of the exposed materials.

NOTE 5—Since it is possible that the stability of the file specimen is also time-dependent, users are cautioned that over prolonged exposure periods, or where small differences in the order of acceptable limits are anticipated, it is possible that comparison of exposed specimens with the file specimen is invalid. The stored initial measurements of the file specimens are recommended wherever possible.

6.4 Follow the procedures described in Practice G147 for identification and conditioning and handling of test specimens, control, and reference materials prior to, during, and after exposure.

6.5 Do not mask the face of a specimen for the purpose of showing on one panel the effects of various exposure times. Misleading results are possible using this method, since the masked portion of the specimen is still exposed to temperature and humidity cycles that in many cases will affect results.

6.6 Since it is possible that the thickness of a specimen will markedly affect the results, thickness of test and control specimens shall be within ±10 % of the nominal dimensions.

NOTE 6—The thickness of a specimen is especially important when mechanical properties are being investigated.

7. Procedure

7.1 If performance comparisons are not being made between the test materials themselves, it is recommended that a control material be exposed simultaneously with experimental materials for determination of relative performance. All concerned parties must agree on the control material used.

7.2 Practice G155 lists a number of exposure cycles that are used for xenon-arc exposures of nonmetallic materials. Table 1 lists some of these cycles. It is possible to use any exposure conditions as long as the exact conditions are detailed in the report. The exposure cycles listed in the table are not necessarily preferred and no recommendation is implied. These cycles are provided for reference only. Obtain mutual agreement among all concerned parties for the specific exposure cycle used. Each setpoint and its tolerances found in Table 1 represent an operational control point for equilibrium conditions at a single location in the cabinet that has the potential not to represent the uniformity of those conditions throughout the cabinet.

NOTE 7—Spray, condensation, and immersion are different kinds of moisture exposures and frequently produce different results.

TABLE 1 Test Cycles Commonly Used for Xenon-Arc Exposure Testing of Plastics[A]

Cycle Number	Cycle Description[B]	Parameter	Set Point[C,D,E,F]	Maximum Allowed Operational Fluctuation[C,D,E]	Typical Uses[G]
1[H]	102 minutes of light followed by 18 minutes of light and front spray	Irradiance	0.35 W/(m^2 nm) at 340 nm or	±0.02 W/(m^2 nm)	Historical convention[J]
			41.5 W/m^2 from 300 to 400 nm	±2.5 W/m^2	
		Uninsulated Black Panel Temperature	63°C	±2°C	
	[repeat]				

TABLE 1 *Continued*

Cycle Number	Cycle Description[B]	Parameter	Set Point[C,D,E,F]	Maximum Allowed Operational Fluctuation[C,D,E]	Typical Uses[G]
1A[H]	102 minutes of light followed by 18 minutes of light and front spray	Irradiance	0.35 W/(m^2 nm) at 340 nm or 41.5 W/m^2 from 300 to 400 nm	±0.02 W/(m^2 nm) ±2.5 W/m^2	Modified historical convention with air temperature and humidity control option[J]
		Uninsulated Black Panel Temperature	63°C	±2°C	
		Air Temperature	47°C[I]	±2°C	
		Relative Humidity	50 %	±10 %	
	[repeat]				
2[H]	18 h, consisting of alternating 102 minutes of light followed by 18 minutes of light and front spray	Irradiance	0.35 W/(m^2 nm) at 340 nm or 41.5 W/m^2 from 300 to 400 nm	±0.02 W/(m^2 nm) ±2.5 W/m^2	General plastics[J]
		Uninsulated Black Panel Temperature	63°C	±2°C	
	6 h dark, with no water spray	Uninsulated Black Panel Temperature	38°C	±2°C	
		Relative Humidity	95 %	+5 /–10 %	
	[repeat]				
2A[H]	18 h, consisting of alternating 102 minutes of light followed by 18 minutes of light and front spray	Irradiance	0.35 W/(m^2 nm) at 340 nm or 41.5 W/m^2 from 300 to 400 nm	±0.02 W/(m^2 nm) ±2.5 W/m^2	Modified general plastics with air temperature control option[J]
		Uninsulated Black Panel Temperature	63°C	±2°C	
		Air Temperature	47°C[I]	±2°C	
		Relative Humidity	50 %[K]	±10 %	
	6 h dark, with no water spray	Uninsulated Black Panel Temperature	38°C	±2°C	
		Air Temperature	38°C	±2°C	
		Relative Humidity	95 %	+5 / –10 %	
	[repeat]				
3[H]	1.5 h light followed by 0.5 h light and front water spray	Irradiance	0.35 W/(m^2 nm) at 340 nm or 41.5 W/m^2 from 300 to 400 nm	±0.02 W/(m^2 nm) ±2.5 W/m^2	Fabrics
		Uninsulated Black Panel Temperature	77°C	±2°C	
		Relative Humidity	70 %	±10 %	
	[repeat]				
4[K,L]	40 minutes light	Irradiance	0.55 W/(m^2 nm) at 340 nm or 65.5 W/m^2 from 300 to 400 nm	±0.02 W/(m^2 nm) ±2.5 W/m^2	Automotive exterior
		Uninsulated Black Panel Temperature	70°C	±2°C	
		Air Temperature	47°C	±2°C	
		Relative Humidity	50 %	±10 %	
	20 minutes light with front water spray	Irradiance	0.55 W/(m^2 nm) at 340 nm or 65.5 W/m^2 from 300 to 400 nm	±0.02 W/(m^2 nm) ±2.5 W/m^2	
		Uninsulated Black Panel Temperature	70°C (158°F)	See Footnote *E*	
		Air Temperature	47°C	±2°C	
	60 minutes light	Irradiance	0.55 W/(m^2 nm) at 340 nm or 65.5 W/m^2 from 300 to 400 nm	±0.02 W/(m^2 nm) ±2.5 W/m^2	
		Uninsulated Black Panel Temperature	70°C	±2°C	
		Air Temperature	47°C	±2°C	
		Relative Humidity	50 %	±10 %	
	60 minutes dark with front and back spray	Uninsulated Black Panel Temperature	38°C	See Footnote *E*	
		Air Temperature	38°C	±2°C	
		Relative Humidity	95 %	+5 / 10 %	
	[repeat]				