



Designation: D4364 – 05

# Standard Practice for Performing Outdoor Accelerated Weathering Tests of Plastics Using Concentrated Sunlight<sup>1</sup>

This standard is issued under the fixed designation D4364; 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 ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

## 1. Scope\*

1.1 This practice covers the use of Fresnel-reflecting concentrators that use the sun as a source of ultraviolet (UV) and longer wavelength radiation. Such devices are used in the outdoor accelerated exposure testing of plastics.

1.2 This practice provides a procedure for performing outdoor accelerated exposure testing of plastics using a Fresnel-reflector outdoor accelerated weathering test machine. The apparatus is described herein and in Practice G90 more completely.

1.3 This practice is applicable to a range of plastic materials including, but not limited to, plastic films, sheets, laminates, and extruded and molded products in a variety of shapes and sizes, as specified in 8.2 and 8.3.

1.4 This practice describes test conditions that attempt to simulate plastics exposures in desert and subtropical climates. Specimen preparation, property testing procedures, and the evaluation of results are covered in existing test methods or specifications for specific materials.

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 and health practices and determine the applicability of regulatory limitations prior to use.* Specific precautionary statements are given in Section 7.

NOTE 1—This standard and ISO 877.2-1991, Method C, are technically equivalent.

## 2. Referenced Documents

2.1 *ASTM Standards:*<sup>2</sup>

D859 Test Method for Silica in Water

D883 Terminology Relating to Plastics

<sup>1</sup> 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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<sup>2</sup> For referenced ASTM standards, visit the ASTM website, [www.astm.org](http://www.astm.org), or contact ASTM Customer Service at [service@astm.org](mailto: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

D1600 Terminology for Abbreviated Terms Relating to Plastics

D1898 Practice for Sampling of Plastics (Withdrawn 1998)<sup>3</sup>

D4141 Practice for Conducting Black Box and Solar Concentrating Exposures of Coatings

D4517 Test Method for Low-Level Total Silica in High-Purity Water by Flameless Atomic Absorption Spectroscopy

E772 Terminology of Solar Energy Conversion

E824 Test Method for Transfer of Calibration From Reference to Field Radiometers

G7 Practice for Atmospheric Environmental Exposure Testing of Nonmetallic Materials

G24 Practice for Conducting Exposures to Daylight Filtered Through Glass

G90 Practice for Performing Accelerated Outdoor Weathering of Nonmetallic Materials Using Concentrated Natural Sunlight

G113 Terminology Relating to Natural and Artificial Weathering Tests of Nonmetallic Materials

2.2 *ISO Standard:*<sup>4</sup>

ISO 877.2-1991, Method C, Methods of Exposure to Direct Weathering, to Weathering Using Glass-Filtered Daylight, and to Intensified Weathering Using Fresnel Mirrors

## 3. Terminology

3.1 *Definitions*—For definitions of technical terms pertaining to plastics used in this practice, see Terminologies D883, D1600, E772, and G113 (for weathering terminology).

## 4. Significance and Use

4.1 This practice involves the concentration of sunlight by a system of plane mirrors, arranged to simulate a parabolic trough focused on an air-cooled target board on which the test specimens are mounted. Exposure cycles with and without water spray that are commonly used for this method are

<sup>3</sup> The last approved version of this historical standard is referenced on [www.astm.org](http://www.astm.org).

<sup>4</sup> Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036.

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

described in **Table 1**. Other exposure cycles not listed in **Table 1** can be used, upon consensual agreement between interested parties.

4.1.1 Accelerated outdoor exposure tests performed using this practice in an absence of a programmed moisture cycle are intended to simulate conventional exposure testing on racks facing the equator in desert and arid regions.

4.1.2 Accelerated outdoor exposure tests performed using this practice with a programmed moisture cycle shall possess the feature of spraying high purity water on the specimens in a regular, periodic fashion that is intended to simulate the results of conventional exposure testing on fixed racks facing the equator in subtropical, semi-humid, and temperate regions. Water-spray cycles that are recommended by this practice are given in **Table 1**.

4.2 The effectiveness of the Fresnel-reflector accelerated outdoor weathering test machines depends primarily on the amount and character of the UV in the direct-beam component of sunlight.

NOTE 2—Use of the apparatus in regions of moderate- to high-diffuse irradiance will reduce the test machine’s effectiveness substantially for providing concentrated UV in the target (specimen) area.

4.3 Testing to specific levels (quantities) of solar ultraviolet radiant exposure is recommended. Elapsed time exposure-level determinations shall not be used for testing with this practice. Testing to specific levels of UV irradiation, whether to total UV or within selected wavebands, is an effective method for improving agreement between wintertime and summertime testing on the Fresnel-reflector weathering-test machines. Other seasonal factors such as temperature and time of wetness can affect the weathering of test specimens significantly.

4.4 The weathering machines described provide for specimen cooling that reduces thermal problems in most materials. It is recommended that monthly temperature measurements be performed on heat-sensitive plastics to record the typical monthly test specimen temperatures.

NOTE 3—It is possible for heat-sensitive plastic materials and thick specimens that are self-insulating to exhibit thermal-induced degradation that is unrealistic compared to natural weathering. Clear, thin-film photodegradable plastics are not recommended for testing with this practice for this reason.

4.5 Since the natural environment varies with respect to time, geography, and topography, it can be expected that the effects of natural exposure will vary accordingly. Furthermore, all materials are not affected equally by increased irradiance

and temperature. The quantitative correlation between exposures conducted in accordance with this practice and those conducted under specified natural exposure conditions will therefore vary with the type and composition of the material.

4.6 While reference materials tested in accordance with this practice and Practices **G7** and **D1435** are useful for providing information on the relationship between accelerated and real-time tests, the acceleration factor found for the reference material cannot be used to extrapolate results of the accelerated test to predict lifetimes under natural exposure except for the specific material for which the relationship has been established.

**5. Apparatus**

5.1 The testing apparatus shall be a Fresnel-reflecting device possessing ten flat mirrors that focus direct sunlight onto an air-cooled specimen area. A more complete description of the apparatus can be found in Practice **G90**. See **Fig. 1**.

NOTE 4—The apparatus should be operated in dry, sunny climates receiving 3500 to 4000 h or more of sunshine per year and an average annual relative humidity of approximately 30 % or less.

*5.2 Water Quality:*

5.2.1 The purity of water used for specimen spray is very important. Without proper treatment to remove cations, anions, organics, and particularly silica, exposed panels will develop spots or stains that do not occur in exterior exposures.

5.2.2 Water used for specimen spray shall leave no objectionable deposits or stains on the exposed specimens. It is strongly recommended that the water contain below 1 ppm solids and below 0.2 ppm silica. Silica levels should be determined in accordance with the procedures in Test Methods **D859** or **D4517**. Prepackaged analysis kits are commercially available that are capable of detecting silica levels of below 200 ppb. A combination of deionization and reverse-osmosis treatment can produce water with the desired purity effectively. The solids and silica levels must be reported if the spray water used is above 1 ppm solids.

5.2.3 If specimens are found to have deposits or stains after exposure in the apparatus, the water purity must be checked to determine if it meets the requirements above. On some occasions, exposed specimens can be contaminated by deposits from bacteria that can grow in the purified water used for specimen spray. If bacterial contamination is detected, the entire system used for specimen spray must be flushed with chlorine and thoroughly rinsed before resuming exposures.

**TABLE 1 Fresnel-Reflector Test Machine Standard Spray Cycles**

Cycle	Daytime			Nighttime		
	Spray Duration	Dry-Time Duration	Cycles, h	Spray Duration	Dry-Time Duration	Cycles, h
1	8 min	52 min	1	8 min	172 min	Water is sprayed on the test specimens at: 9:00 p.m. 12:00 midnight 3:00 a.m.
2	no water spray used			no water spray used		
3 <sup>a</sup>	no water spray used			3 min	12 min	4 cycles per hour (from 7PM to 5 AM)

<sup>a</sup> This is the cycle specified in Procedure C of Practice **D4141**.