



Designation: D 4364 – 94

Standard Practice for Performing Outdoor Accelerated Weathering Tests of Plastics Using Concentrated Sunlight¹

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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 G 90 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:

- D 859 Test Method for Silica in Water²
- D 883 Terminology Relating to Plastics³
- D 1293 Test Methods for pH of Water²
- D 1435 Practice for Outdoor Weathering of Plastics³
- D 1600 Terminology for Abbreviated Terms Relating to Plastics³
- D 1898 Practice for Sampling of Plastics³

¹ This practice is under the jurisdiction of ASTM Committee D-20 on Plastics and is the direct responsibility of Subcommittee D20.50 on Permanence Properties.

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² *Annual Book of ASTM Standards*, Vol 11.01.

³ *Annual Book of ASTM Standards*, Vol 08.01.

D 4141 Practice for Conducting Accelerated Outdoor Exposure Tests of Coatings⁴

D 4517 Test Method for Low-Level Total Silica in High-Purity Water by Flameless Atomic Absorption Spectroscopy⁵

E 772 Terminology Relating to Solar Energy Conversion⁶

E 824 Method for Transfer of Calibration from Reference to Field Pyranometers⁶

G 7 Practice for Atmospheric Environmental Exposure Testing of Nonmetallic Materials⁷

G 24 Practice for Conducting Natural Light Exposures Under Glass⁷

G 90 Practice for Performing Accelerated Outdoor Weathering of Nonmetallic Materials Using Concentrated Natural Sunlight⁷

G 113 Terminology Relating to Natural and Artificial Weathering Tests of Nonmetallic Materials⁷

2.2 ISO Standard:⁸

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 D 883, D 1600, G 113, and E 772.

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. Two exposure methods are used, as described in Procedures A and B.

4.1.1 *Procedure A*—Procedure A outdoor exposure tests are performed in an absence of a programmed moisture cycle and are intended to simulate conventional exposure testing on south-facing racks in desert and arid regions.

⁴ *Annual Book of ASTM Standards*, Vol 06.01.

⁵ *Annual Book of ASTM Standards*, Vol 11.02.

⁶ *Annual Book of ASTM Standards*, Vol 12.02.

⁷ *Annual Book of ASTM Standards*, Vol 14.02.

⁸ Available from American National Standards Institute, 11 W. 42nd St., 13th Floor, New York, NY 10036.

4.1.2 *Procedure B*—Procedure B accelerated-outdoor-exposure tests are essentially identical to Procedure A, but they 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 south-facing racks 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 test 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 may 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 Practices G 7 and D 1435 may be useful for providing infor-

mation 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 may be found in Practice G 90. 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 Water used for the specimen tray shall have a pH of 6.0 to 8.0. Measure the pH in accordance with Test Method D 1293.

5.2.2 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.

5.2.3 Water used for specimen spray shall leave no objectional 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 D 859 or D 4517. 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.

6. Reagents and Materials

6.1 Water shall conform to the specifications presented in 5.2.1-5.2.3.

6.2 The mirrors used on Fresnel-reflector test machines shall be flat and have a specular UV reflectance of 65 % or greater at 310 nm wavelength.

7. Safety Precautions

7.1 Suitable eye protection shall be required when working with Fresnel-reflector test machines to prevent UV and infrared

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		
2N	no water spray used			8 min	172 min	water is sprayed on the test specimens at: 9:00 p.m. 12:00 midnight 3:00 a.m.
3 ^A	no water spray used			3 min	12 min	4

^A This is the cycle specified in Procedure C of Practice D 4141.