



Designation: G 90 – 98

Standard Practice for Performing Accelerated Outdoor Weathering of Nonmetallic Materials Using Concentrated Natural Sunlight¹

This standard is issued under the fixed designation G 90; 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 Fresnel-reflecting concentrators using the sun as source are utilized in the accelerated outdoor exposure testing of nonmetallic materials.

1.2 This practice covers a procedure for performing accelerated outdoor exposure testing of nonmetallic materials using a Fresnel-reflector accelerated outdoor weathering test machine. The apparatus (see Fig. 1 and Fig. 2) and guidelines are described herein to minimize the variables encountered during outdoor accelerated exposure testing.

1.3 This practice does not specify the exposure conditions best suited for the materials to be tested but is limited to the method of obtaining, measuring, and controlling the procedures and certain conditions of the exposure. Sample preparation, test conditions, and evaluation of results are covered in existing methods or specifications for specific materials.

1.4 The Fresnel-reflector accelerated outdoor exposure test machines described may be suitable for the determination of the relative durability of materials exposed to sunlight, heat, and moisture, provided the mechanisms of chemical or physical change, or both, which control the rates of acceleration factors for the materials do not differ significantly.

1.5 This practice establishes uniform sample mounting and in-test maintenance procedures. Also included in the practice are standard provisions for maintenance of the machine and Fresnel-reflector mirrors to ensure cleanliness and durability.

1.6 This practice shall apply to specimens whose size meets the dimensions of the target board as described in 8.2.

1.7 For test machines currently in use, this practice may not apply to specimens exceeding 13 mm (1/2 in.) in thickness because cooling may be questionable.

1.8 Values stated in SI units are to be regarded as the standard. The inch-pound units in parentheses are provided for information only.

1.9 *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.

2. Referenced Documents

2.1 ASTM Standards:

- D 859 Test Method for Silica in Water²
- D 1014 Practice for Conducting Exterior Exposure Tests of Paints on Steel³
- D 1435 Practice for Outdoor Weathering of Plastics⁴
- D 1898 Practice for Sampling of Plastics⁴
- D 4141 Practice for Conducting Accelerated Outdoor Exposure Tests of Coatings³
- 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 Test Method for Transfer of Calibration from Reference to Field Radiometers⁷
- E 891 Tables for Terrestrial Direct Normal Solar Spectral Irradiance for Air Mass 1.5⁷
- E 903 Test Method for Solar Absorptance, Reflectance, and Transmittance of Materials Using Integrated Spheres⁶
- G 7 Practice for Atmospheric Environmental Exposure Testing of Nonmetallic Materials⁷
- G 24 Practice for Conducting Exposures to Daylight Filtered through Glass⁷
- G 113 Terminology Relating to Natural and Artificial Weathering Tests of Nonmetallic Materials⁷

2.2 Other Standards:

- SAE J576 Plastic Materials for Use in Optical Parts Such as Lenses and Reflectors of Motor Vehicle Lighting Devices
- SAE J1961 Accelerated Exposure of Automotive Exterior Materials Using a Solar Fresnel-Reflector Apparatus

3. Terminology

3.1 **Definitions**—Definitions of terms common to G 3 durability standards can be found in Terminology G 113.

¹ This practice is under the jurisdiction of ASTM Committee G-3 on Weathering and Durability and is the direct responsibility of Subcommittee G03.02 on Natural and Environmental Exposure Tests.

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² Annual Book of ASTM Standards, Vol 11.01.

³ Annual Book of ASTM Standards, Vol 06.01.

⁴ Annual Book of ASTM Standards, Vol 08.01.

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.



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|--------------------------|-----------------------------|
| A - AIR PLENUM | H - MAST, AZIMUTH ADJUST |
| B - AIR BLOWER | I - AIR FLOW SWITCH |
| C - ROTOR ASSEMBLY | J - WATER SPRAY NOZZLE |
| D - AIR DEFLECTOR | K - CLUTCH DISC, ELEV DRIVE |
| E - A-FRAME ASSEMBLY | L - SOLAR CELLS/SHADOW HAT |
| F - MIRROR | M - SAMPLE PROTECTION DOOR |
| G - GEAR BOX, ELEV DRIVE | N - DOOR RELEASE MECHANISM |

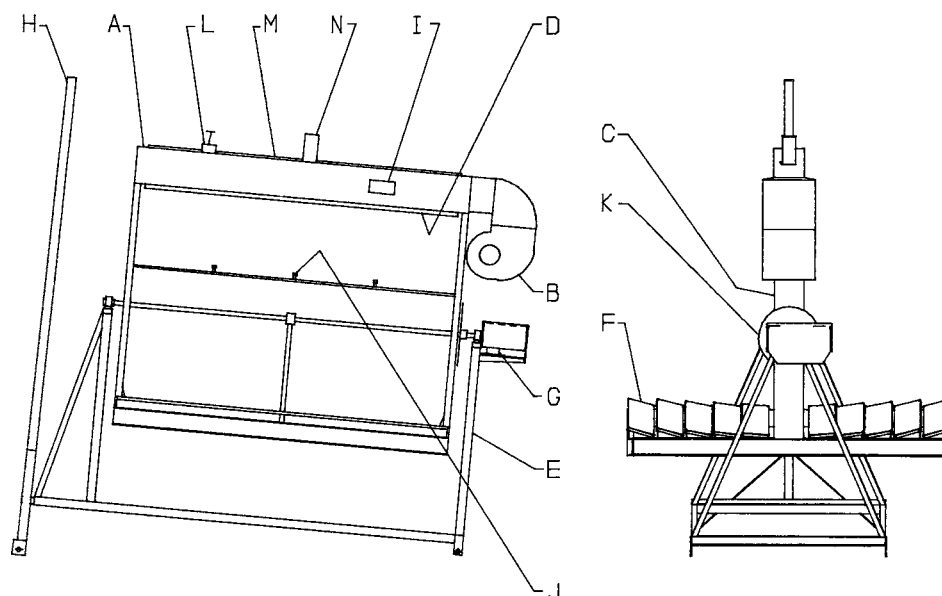


FIG. 1 Schematic of Fresnel-Reflecting Concentrator Accelerated Weathering Machine Single Axis Tracking

4. Significance and Use

4.1 Results obtained from this practice can be used to compare the relative durability of materials subjected to the specific test cycle used. No accelerated exposure test can be specified as a total simulation of natural or field exposures. Results obtained from this practice can be considered as representative of natural or field exposures only when the degree of comparative performance has been established for the specific materials being tested.

4.2 The relative durability of materials in natural or field exposure can be very different depending on the location of the exposure because of differences in UV radiation, time of wetness, temperature, pollutants, and other factors. Therefore, even if results from a specific accelerated test condition are found to be useful for comparing the relative durability of materials exposed in a particular exterior location, it cannot be assumed that they will be useful for determining relative durability for a different location.

4.3 Variations in results may be expected when operating conditions vary within the limits of this practice. For example, there can be large differences in the amount of degradation in

a single material between separate, although supposedly identical, exposures carried out for the same duration or number of exposure cycles. In addition, results from exterior exposures can vary due to seasonal or annual differences in important climatic factors. Because of the variability between materials and in results obtained using this practice and the variability in results from exterior exposures, use of a single acceleration factor relating x hours of this accelerated exposure to y months or years of exterior exposure is not recommended. If acceleration factors are determined, they must be based on results from a sufficient number of separate accelerated exposures so that data relating times to failure in each exposure can be analyzed using statistical methods. In addition, use of acceleration factors assumes that the degradation mechanism is the same in both conventional and accelerated exposures.

4.4 This practice is best used to compare the relative performance of materials tested at the same time in the same fresnel reflector device. Because of possible variability between the same type of exposure devices, comparing the amount of degradation in materials exposed for the same duration or radiant energy at separate times, or in separate

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|--------------------------|-----------------------------|
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| B - AIR BLOWER | J - AIR FLOW SWITCH |
| C - ROTOR ASSEMBLY | K - WATER SPRAY NOZZLE |
| D - TURN TABLE ASSEMBLY | L - CLUTCH DISC, ELEV DRIVE |
| E - A-FRAME ASSEMBLY | M - SOLAR CELLS/SHADOW HAT |
| F - MIRROR | N - SAMPLE PROTECTION DOOR |
| G - GEAR BOX, ELEV DRIVE | O - DOOR RELEASE MECHANISM |
| H - CONTROL BOX | P - AIR DEFLECTOR |

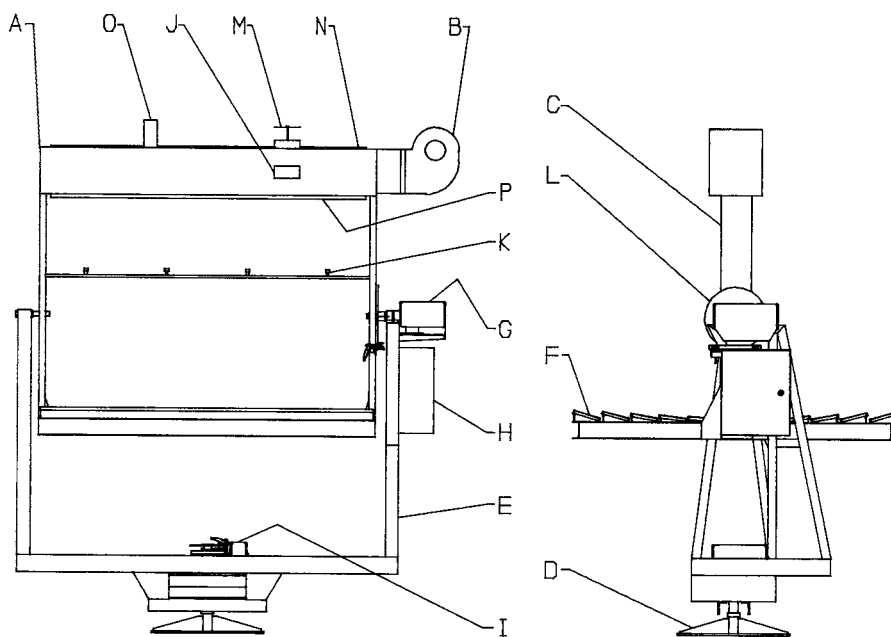


FIG. 2 Dual Axis Tracking

devices running the same test condition, is not recommended. This practice should not be used to establish a “pass/fail” approval of materials after a specific period of exposure unless performance comparisons are made relative to a reference material exposed simultaneously, or the variability in the test is defined so that statistically significant pass/fail judgements can be made.

4.5 It is strongly recommended that at least one control test specimen be exposed with each test. The control test specimen should meet the requirements of Terminology G 113, and be chosen so that its degradation mechanism is the same as that of the test specimen. It is preferable to use two control test specimens, one with relatively good durability and one with relatively poor durability.

4.6 The use of at least two replicates of each control test specimen and each material being evaluated is recommended to allow statistical evaluation of results.

5. Apparatus

5.1 *Test Machines*—Fresnel-reflector test machines used in Cycles 1, 2, and 3 of Table 1 are nearly identical. The only

TABLE 1 Fresnel-Reflector Test Machine Typical 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	52 min	3 during the night
2		no water spray			no water spray	
3 ^A		no water spray		3 min	12 min	4

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

difference between the machines is the addition of a water delivery system to the device used in Cycles 1 and 3. Use of the specific cycle should relate to end use of the material and should be agreed upon by all interested parties.

5.1.1 The Fresnel-reflector test machine is a follow-the-sun apparatus having flat mirrors so positioned that the sun's rays strike them at near-normal incident angles while in operation. The mirrors are arranged to simulate tangents to a parabolic trough in order to reflect sunlight uniformly onto the specimens in the target area (see Fig. 1, Fig. 2, and Fig. 3).