



SURFACE VEHICLE STANDARD

J1961™

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Accelerated Exposure of Automotive Exterior Materials Using a Solar Fresnel Reflector Apparatus

RATIONALE

This standard is being revised because it is due for its Five-Year Review.

1. SCOPE

- 1.1 This test method specifies the operating procedures for using a solar fresnel reflector apparatus for the accelerated exposure of various automotive materials.
- 1.2 Sample preparation, test durations, and performance evaluation procedures are covered in material specifications of the different automotive manufacturers.

2. REFERENCES

2.1 Applicable Documents

The following publications form a part of this specification to the extent specified herein. Unless otherwise indicated, the latest issue of SAE publications shall apply.

2.1.1 ASTM Publications

Available from ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959, Tel: 610-832-9585, www.astm.org.

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|------------|--|
| ASTM D859 | Test Methods for Silica in Water |
| ASTM D4517 | Test Method for Low-Level Total Silica in High Purity Water by Flameless Atomic Absorption Spectroscopy |
| ASTM E891 | Standard Tables for Terrestrial Direct Normal Solar Spectral Irradiance for Air Mass 1.5 |
| ASTM G90 | Standard Practice for Performing Accelerated Outdoor Weathering of Nonmetallic Materials Using Concentrated Natural Sunlight |
| ASTM G113 | Standard Terminology Relating to Natural and Artificial Weathering of Nonmetallic Materials |
| ASTM G147 | Standard Practice for Conditioning and Handling of Nonmetallic Materials for Natural and Artificial Weathering Tests |

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https://www.sae.org/standards/content/J1961_202107/

2.2 Related Publications

The following publications are provided for information purposes only and are not a required part of this SAE Technical Report.

2.2.1 ASTM Publications

Available from ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959, Tel: 610-832-9585, www.astm.org.

ASTM E903 Test Method for Solar Absorptance, Reflectance, and Transmittance of Materials Using Integrating Spheres

3. DEFINITIONS

3.1 BLACK PANEL THERMOMETER, n.

A temperature measuring device, the sensing unit of which is covered with a black coating designed to absorb most of the radiant energy encountered in fade/weathering testing.

NOTE: This device provides an estimation of the maximum temperature a specimen may attain during exposure to natural or artificial light.

3.2 IRRADIANCE, SPECTRAL, n.

The radiant power within a specified wavelength interval that falls upon a unit area of exposed surface (W/m^2).

3.3 IRRADIANCE, TOTAL, n.

Radiant power integrated over all wavelengths falling upon a unit area of exposure at a point in time expressed in watts per square meter (W/m^2).

3.4 IRRADIATION, n.

See radiant exposure.

3.5 RADIANT EXPOSURE, n.

The time integral of irradiance expressed in joules per square meter (J/m^2).

3.6 RADIANT EXPOSURE, SPECTRAL, n.

The integration of spectral irradiance with respect to time.

3.7 REFERENCE MATERIALS, n.

One or more light fastness standards selected for exposure as a check on a test apparatus and operating conditions.

3.8 SAMPLE, LABORATORY, n.

A portion of material taken to represent the lot sample, or the original material, and used in the laboratory as a source of test specimens.

3.9 SPECIMEN, n.

A specific portion of a material or a laboratory sample upon which a test is performed or selected for that purpose.

3.10 SPECTRAL POWER DISTRIBUTION, n.

The variation of power due to the source over the wavelength span of the emitted radiation.

4. SIGNIFICANCE AND USE

This test method is designed to simulate extreme environmental conditions encountered outside a vehicle due to sunlight, heat, and moisture (in the form of humidity, condensation, or rain) for the purpose of predicting the performance of automotive materials.

5. APPARATUS

5.1 The testing apparatus shall be a fresnel-reflecting device typically possessing 10 flat mirrors that focus direct sunlight onto an air-cooled sample area. A more complete description of the apparatus may be found in ASTM G90. See Figures 1 and 2.

NOTE: The apparatus shall be operated in a warm desert climate receiving approximately 3500 to 4000 hours of sunshine per year and an average annual relative humidity of approximately 25 to 35%.

A	FRESNEL-REFLECTING MIRROR	H	CENTER OF ROTATION
B	WATER SPRAY NOZZLE	J	REVERSIBLE MOTOR/GEAR DRIVE
C	AIR TUNNEL	K	CLUTCH
D	SQUIRREL CAGE BLOWER	L	ALTITUDE ADJUSTMENT MAST
E	AIR SWITCH	M	MIRROR BED/FRAME
F	SOLAR CELL TRACKER	N	ANCHORS
G	SPECIMENS ON TARGET BOARD	P	A-FRAME

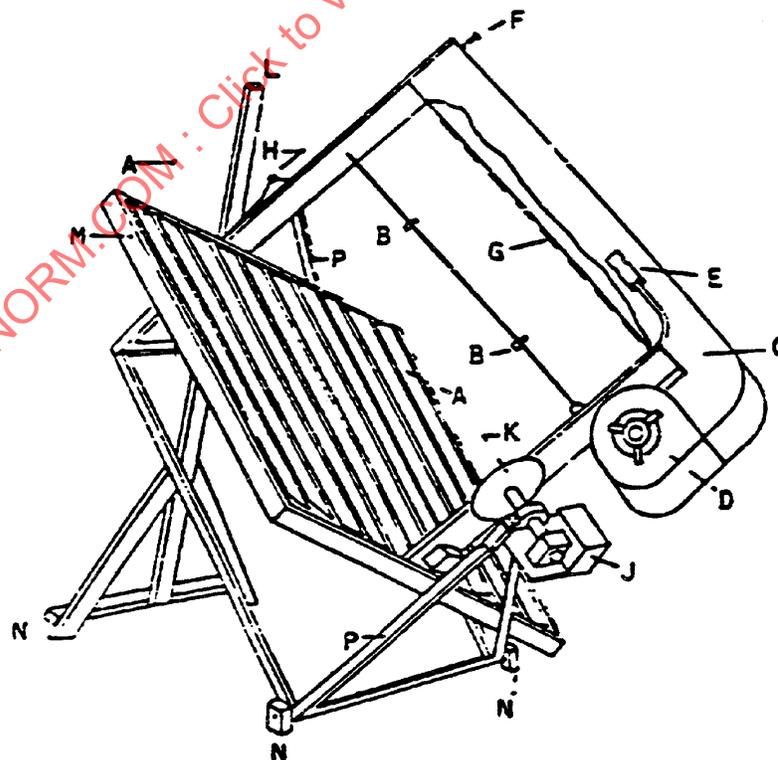


Figure 1 - Schematic of a typical fresnel reflecting concentrator accelerated weathering machine (single axis tracking)

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|---|----------------------|---|-------------------------|
| A | AIR PLENUM | I | GEAR BOX, AZIMUTH DRIVE |
| 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 |

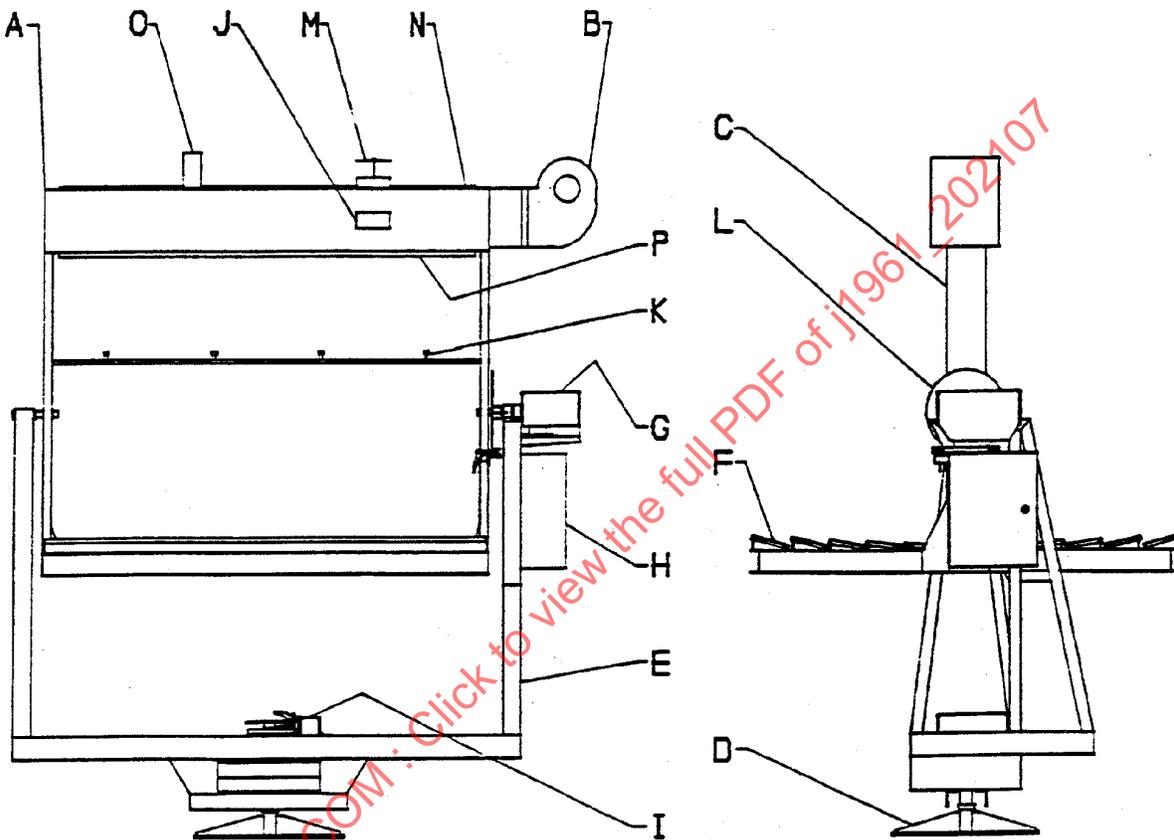


Figure 2 - Dual axis tracking

- 5.2 A black panel thermometer may be mounted onto the sample exposure area to assist in monitoring expected maximum sample temperatures. If used, the black panel sensor shall meet the requirements defined in ASTM G90.
- 5.3 Water Quality
- 5.3.1 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.
- 5.3.2 Water used for specimen spray shall leave no objectionable deposits or stains on the exposed specimens. The water should contain a maximum of 1 ppm solids and a maximum of 0.2 ppm silica. Water used for specimen sprays shall meet the requirements for deionized water contained within ASTM G90. If the spray water used is above 1 ppm solids, the solids and silica levels shall be reported.

6. CALIBRATION AND MAINTENANCE

- 6.1 The specular reflectance of each mirror shall be measured at 6 month intervals or less in two places along the mirror's centerline as required by ASTM G90. Replace mirrors which do not meet the requirements contained within ASTM G90. Replace individual mirrors if the average 310 nm specular reflectance is less than 0.65 (65%).
- 6.1.1 For apparatus where each mirror cannot be measured directly, provision shall be made for mounting a removable optical-mirror sample to serve as a surrogate for one or more mirrors in the array. This removable optical-mirror sample shall have a minimum exposed surface area of 2580 mm² (4 in²) and be from the same batch and lot as the mirror stock-material used to irradiate the target sample area. This sample shall be labelled with a number which identifies which mirrors the sample applies to. The optical mirror sample shall be mounted at the same time as the mirrors used to irradiate the sample area, and its specular reflectance measured in accordance with 6.1.
- 6.2 Monitor and adjust the tracking system and mirrors as required by ASTM G90
- 6.3 Clean mirrors (and removable optical-mirror samples) at intervals necessary to maintain the reflectance specified in 6.1. To maintain optimum specular reflectance, it is recommended that mirrors be cleaned on an established frequency to minimize the effects of surface deposits that may alter spectral irradiance at the target area.
- 6.4 Optionally, clean black panel thermometers at an interval necessary to maintain optical performance.

7. TEST PROCEDURES

- 7.1 Maintain the apparatus in accordance with Section 6 and the manufacturer's specifications.
- 7.1.1 Conditioning and handling of test, control, reference, and file specimens shall be according to ASTM G147.
- 7.2 Mount samples in the exposure area using one of two methods:

7.2.1 Non-Insulated Exposure

Mount samples into sample holders constructed of a corrosion-resistant metal such as stainless steel or aluminum in an unbacked configuration such that panels can lose heat from back-side cooling.

7.2.2 Insulated Exposure

Mount samples into sample holders such that samples are backed with an insulating water-resistant material such as 13 mm (1/2-inch) thick exterior plywood.

- 7.3 Coated metal specimens shall be mounted using the schedule in Table 1:

Table 1 - Mounting conditions

Time Period	Mounting Condition
November 1 - March 31	Insulated
April 1 - October 31	Noninsulated

- 7.4 Specimens which are not coated metal shall be mounted for a non-insulated exposure.
- 7.5 If a black panel thermometer is mounted onto the sample area with the test samples to be exposed, it shall be mounted using the same mounting condition as the test samples. If temperature control is used, the requirements in ASTM G90 shall be followed.
- 7.6 Apparatus shall be set up to provide conditions in accordance with one of the cycles in Table 2:

Table 2 - Spray cycles

Cycle	Daytime			Nighttime		
	Spray Duration	Dry-Time Duration	Cycles, Hours	Spray Duration	Dry-Time Duration	Cycles, Hours
1	8 minutes	52 minutes	1	8 minutes		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	No water spray used			3 minutes	12 minutes	4 cycles per hour (from 7 PM to 5 AM)

NOTE: Prior to 2010, the spray cycles specified in this method were: Cycle 1 (same as Cycle 3 above), and Cycle 2 (same as Cycle 2 above). These spray cycles were changed to be in conformance to ASTM and ISO standards.

7.7 Spray Orientation

The apparatus shall be positioned so that specimens are sprayed at night either with specimens facing up or down.

7.7.1 Specimens Face Down

The apparatus is oriented with the mirrors below the target specimen area such that nozzles spray high purity water in an upward direction onto the specimens.

7.7.2 Specimens Face Up

The apparatus is oriented with the mirrors above the target specimen area such that nozzles spray high purity water in a downward direction onto the specimens.

NOTE: Different spray orientations may produce different test results. To date, no data has been published indicating that exposures performed using different spray orientations yield equivalent results.

7.8 Expose samples for a predetermined amount of ultraviolet radiant exposure measured in J/m². Determine the solar radiant exposure of the test specimens in accordance with Equations 1 and 2:

$$H_s = M \rho_s \sum_{i=1}^N H_d \quad (\text{Eq. 1})$$

$$\rho_s = \frac{\rho}{M} \sum_{i=1}^M \cos \theta_i \quad (\text{Eq. 2})$$

where:

H_s = solar radiant exposure, J/m²

M = number of mirrors

ρ_s = the cosine corrected specular reflectance

ρ = the average energy-weighted specular reflectance of the mirrors

N = number of days of exposure

θ_i = the angle of incidence of the irradiance from each mirror at the specimen target area

H_d = direct-normal daily solar radiant exposure measured in a 6 degree field of view