



Designation: E 927 – 91 (Reapproved 1997)

# Standard Specification for Solar Simulation for Terrestrial Photovoltaic Testing<sup>1</sup>

This standard is issued under the fixed designation E 927; 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 approval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

## 1. Scope

1.1 This specification describes solar simulation to be used for indoor testing of terrestrial flat plate (nonconcentrating) photovoltaic devices in conjunction with a spectrally matched reference cell. Solar simulators are used to supply irradiance to photovoltaic devices during a controlled indoor test. The output of a solar cell is a strong function of the wavelength of incident irradiance. Hence, the measured efficiency of a cell can vary as the spectral content of the incident irradiance changes. To reduce such measurement errors, the light source for the solar simulator is limited to those which offer an acceptable match to the solar spectrum, as defined in this specification. Specifications for simulators matched to either a direct spectrum (as defined in Standard E 891) or a global spectrum (as defined in Standard E 892) are included in this specification. This specification covers both pulsed and steady-state simulators.

1.2 The following precautionary caveat pertains only to the hazards portion, Section 6, of this specification. *This standard does not purport to address all of the safety problems, 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:

E 491 Practice for Solar Simulation for Thermal Balance Testing of Spacecraft<sup>2</sup>

E 772 Terminology Relating to Solar Energy Conversion<sup>3</sup>

E 891 Tables for Terrestrial Direct Normal Solar Spectral Irradiance for Air Mass 1.5<sup>3</sup>

E 892 Tables for Terrestrial Solar Spectral Irradiance at Air Mass 1.5 for a 37° Tilted Surface<sup>3</sup>

<sup>1</sup> This specification is under the jurisdiction of ASTM Committee E-44 on Solar, Geothermal, and Other Alternative Energy Sources and is the direct responsibility of Subcommittee E44.09 on Photovoltaic Electric Power Systems.

Current edition approved Feb. 22, 1991. Published April 1991. Originally published as E 927 – 83. Last previous edition E 927 – 85.

<sup>2</sup> Annual Book of ASTM Standards, Vol 15.03.

<sup>3</sup> Annual Book of ASTM Standards, Vol 12.02.

E 1328 Terminology Relating to Photovoltaic Solar Energy Conversion<sup>3</sup>

## 3. Terminology

3.1 *Definitions*— Definitions of terms used in this specification may be found in Terminology E 772 and Terminology E 1328.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *field of view*—the maximum angle between any two incident irradiance rays from the simulator at an arbitrary point in the test plane.

3.2.2 *measurement period*—the period of time required to take all the data using simulated sunlight for a particular test.

3.2.3 *nonuniformity of total irradiance (in percent):*

$$\pm 100 \left( \frac{\text{Maximum Irradiance} - \text{Minimum Irradiance}}{\text{Maximum Irradiance} + \text{Minimum Irradiance}} \right)$$

where the maximum and minimum irradiances are in the test plane area.

3.2.4 *pulsed simulator*—simulator whose irradiance output at the test plane area is in a single short duration pulse of 100 ms or less.

3.2.5 *solar spectrum*—the spectral distribution of typical terrestrial sunlight at air mass 1.5 as defined in Standards E 891 and E 892 (see Fig. 1).

3.2.6 *steady-state simulator*—simulator whose irradiance output at the test plane area is continuous for periods of a second or greater.

3.2.7 *temporal instability of irradiance (in percent):*

$$\pm 100 \left( \frac{\text{Maximum Irradiance} - \text{Minimum Irradiance}}{\text{Maximum Irradiance} + \text{Minimum Irradiance}} \right)$$

where the maximum and minimum irradiances are measured at one location in the test plane with the spread generated by the irradiance varying with time over a period equal to the measurement period.

3.2.8 *test plane area, A*—the area of the plane intended to contain the device under test and the irradiance monitor.

## 4. Components

4.1 A solar simulator usually consists of three major components: (1) a light source and an associated power supply; (2) any optics and filters required to modify the output beam to