

Solar Simulator Definitions of Characteristics

This technical note briefly defines the terms and units most frequently used in the Solar Simulation Technical Discussions on the following pages. These definitions are limited to the context in which the terms are used in discussion of Newport's Oriel® product line, in this catalog.

Actinic dose: quantity obtained by weighing spectrally the radiation dose using the action spectrum.

Actinic (radiation): the radiation that produces a specified effect.

Action spectrum (actinic): efficiency of monochromatic radiations for producing a specified actinic phenomenon in a specified system.

Air mass (relative optical): ratio of the slant optical thickness to the vertical optical thickness of the standard atmosphere.

Albedo: reflectance of solar radiation by the surroundings. This applies to the full integrated spectrum; the reflectance may depend strongly on the spectral region (definition limited to solar radiation).

Blackbody: a body that absorbs all radiant energy incident on it.

Collimation and angle of terrestrial solar irradiation: the terrestrial irradiance from the sun is composed of a direct beam with a collimation angle of approximately 0.5° and a diffuse component; the spectra and magnitude of each component changes throughout the day. Measurement of direct radiation requires limiting the field of view (FOV). (The recommended aperturing system limits the input to a slope half angle of 0.5° , an opening half angle of 2.65° , and a limit half angle of 4.65° . Measuring the total radiation requires an instrument with a 180° FOV.)

Daylight: visible part of global solar radiation.

Diffuse sky radiation: the part of solar radiation that reaches the earth as a result of being scattered by air molecules, aerosol particles, cloud particles, or other particles.

Direct solar radiation: the part of extraterrestrial solar radiation which, as a collimated beam, reaches the earth's surface after selective attenuation by the atmosphere.

Dobson unit (D.U.): measure of columnar density of ozone. 1 D.U. is one milliatmosphere centimeter of ozone at STP. Typical values range from 200 - 600 D.U. with values of 110 in the Antarctic "ozone hole."

Dose: term used in photochemistry, phototherapy, and photobiology for the quantity radiant exposure (of optical radiation of a specified spectral distribution). Unit, J m^{-2} .

Dose Rate: term used in photochemistry, phototherapy, and photobiology for the quantity irradiance. Unit, W m^{-2} .

Effective dose: that part of the dose that actually produces the actinic effect considered.

Effective exposure rate: the integrated product of the spectral irradiance and action spectra.

Erythema (actinic): Reddening of the skin, with or without inflammation, caused by the actinic effect of solar radiation or artificial optical radiation.

Erythema radiation: optical radiation effective in causing actinic erythema.

Extraterrestrial solar radiation: solar radiation incident on the outer limit of the earth's atmosphere.

Global illuminance (Eg): illuminance produced by daylight on a horizontal surface of the earth.

Global solar radiation: combined direct solar radiation and diffuse sky radiation.

Infrared radiation: optical radiation for which the wavelengths are longer than those for visible radiation, 700 nm to 1000 μm .

Irradiance: describes the flux, radiative power density, and incidence on a surface. Units, W m^{-2} or W cm^{-2} . The surface must be specified for the irradiance to have meaning. (Laboratory surfaces are not usually as large as a square meter; this happens to be the appropriate SI unit of area).

Langley: $1 \text{ calorie cm}^{-2} = 2.39 \times 10^5 \text{ J m}^{-2}$

Minimum Erythema Dose (MED): the actinic dose that produces a just noticeable erythema on normal, non-exposed, "white" skin. This quantity corresponds to a radiant exposure of monochromatic radiation at the maximum spectral efficiency ($\lambda = 295 \text{ nm}$) of roughly 100 J m^{-2} .

Ozone (O₃): what is produced when molecular oxygen in the stratosphere absorbs shortwave ultraviolet (up to 242.2 nm), and photodissociates. Ozone can be a health hazard in concentrated amounts. (Our solar simulators use ozone free lamps.)

Solar constant (I_{sc}): irradiance produced by the extraterrestrial solar radiation on a surface perpendicular to the sun's rays at a mean sun-earth distance ($I_{sc} = (1367 \pm 7 \text{ W m}^{-2})$).

Spectral irradiance $E(\lambda)$: the irradiance per unit wavelength interval at a specified wavelength.

Spectral irradiance units, $\text{W m}^{-2} \text{ nm}^{-1}$

To convert into $\text{W m}^{-2} \mu\text{m}^{-1}$, multiply by 1000 (1000 E)

To convert into $\text{W cm}^{-2} \text{ nm}^{-1}$, multiply by 10^{-4} (10^{-4} E)

To convert into $\text{W cm}^{-2} \mu\text{m}^{-1}$, multiply by 0.1 (0.1 E)

Standard solar radiation: spectra that have been developed to provide a basis for theoretical evaluation of the effects of solar radiation, and as a basis for simulator design. In this catalog, we refer to the ASTM E490, E891 and E892 standards, which define AM 0, AM 1.5 D and 1.5 G, respectively. We also refer to the CIE Pub. 85 and 904-3 standards, which define AM 1 and AM 1.5 G, respectively.

Sunlight: the visible part of direct solar radiation.

Sunshine duration: the sum of time intervals within a given time period during which the irradiance from direct solar radiation on a plane normal to the sun direction is equal to or greater than 200 W m^{-2} .

Terrestrial spectra: the spectrum of the solar radiation at the earth's surface.

Ultraviolet radiation: optical radiation for which the wavelengths are shorter than those for visible radiation, $<400 \text{ nm}$.

Note: For ultraviolet radiation, the range below 400 nm is commonly subdivided into:

UVA $320 - 400 \text{ nm}$

UVB $280 - 320 \text{ nm}$

UVC $<280 \text{ nm}$

Uniformity: a measure of how the irradiance varies over a selected (or defined) area. Usually expressed as non-uniformity, the maximum and minimum % differences from the mean irradiance.

$$\pm 100 \left(\frac{E_{\max} - E_{\min}}{E_{\max} + E_{\min}} \right)$$

Visible radiation: any optical radiation capable of causing a visual sensation directly, $400 - 700 \text{ nm}$.