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Standard Terminology of Solar Energy Conversion[1]

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1. Scope

1.1 This terminology pertains to the conversion of solar energy into other forms of energy by various means, including thermal absorption (i.e., solar thermal) and the photovoltaic effect (i.e., photovoltaics).

1.2 This terminology also pertains to instrumentation used to measure solar radiation.

1.3 This terminology also pertains to glass for solar energy applications.

1.4 Fundamental terms associated with electromagnetic radiation that are indicates as derived units in Standard IEEE/ASTM SI 10 are not repeated in this terminology.

1.5 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

2. Referenced Documents

2.1 *ASTM Standards:*[2]

C162 Terminology of Glass and Glass Products
C1048 Specification for Heat-Strengthened and Fully Tempered Flat Glass
C1651 Test Method for Measurement of Roll Wave Optical Distortion in Heat-Treated Flat Glass
D1003 Test Method for Haze and Luminous Transmittance of Transparent Plastics
D1245 Practice for Examination of Water-Formed Deposits by Chemical Microscopy
D4865 Guide for Generation and Dissipation of Static Electricity in Petroleum Fuel Systems
D5544 Test Method for On-Line Measurement of Residue After Evaporation of High-Purity Water
D7236 Test Method for Flash Point by Small Scale Closed Cup Tester (Ramp Method)
E349 Terminology Relating to Space Simulation
E490 Standard Solar Constant and Zero Air Mass Solar Spectral Irradiance Tables
E491 Practice for Solar Simulation for Thermal Balance Testing of Spacecraft
E927 Specification for Solar Simulation for Photovoltaic Testing
E816 Test Method for Calibration of Pyrheliometers by Comparison to Reference Pyrheliometers
E1021 Test Method for Spectral Responsivity Measurements of Photovoltaic Devices
E1036 Test Methods for Electrical Performance of Nonconcentrator Terrestrial Photovoltaic Modules and Arrays Using Reference Cells
E1125 Test Method for Calibration of Primary Non-Concentrator Terrestrial Photovoltaic Reference Cells Using a Tabular Spectrum
E1171 Test Methods for Photovoltaic Modules in Cyclic Temperature and Humidity Environments
E1362 Test Method for Calibration of Non-Concentrator Photovoltaic Secondary Reference Cells
E1462 Test Methods for Insulation Integrity and Ground Path Continuity of Photovoltaic Modules
E2236 Test Methods for Measurement of Electrical Performance and Spectral Response of Nonconcentrator Multijunction Photovoltaic Cells and Modules
E2527 Test Method for Electrical Performance of Concentrator Terrestrial Photovoltaic Modules and Systems Under Natural Sunlight
F1863 Test Method for Measuring the Night Vision Goggle-Weighted Transmissivity of Transparent Parts
G113 Terminology Relating to Natural and Artificial Weathering Tests of Nonmetallic Materials
G130 Test Method for Calibration of Narrow- and Broad-Band Ultraviolet Radiometers Using a Spectroradiometer
G138 Test Method for Calibration of a Spectroradiometer Using a Standard Source of Irradiance
G167 Test Method for Calibration of a Pyranometer Using a Pyrheliometer
G173 Tables for Reference Solar Spectral Irradiances: Direct Normal and Hemispherical on 37° Tilted Surface
G197 Table for Reference Solar Spectral Distributions: Direct and Diffuse on 20° Tilted and Vertical Surfaces

[1] This terminology is under the jurisdiction of ASTM Committee E44 on Solar, Geothermal and Other Alternative Energy Sources and is the direct responsibility of Subcommittee E44.01 on Terminology and Editorial.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

IEEE/ASTM SI 10 American National Standard for Metric Practice

2.2 *ISO Standard:*[3]

ISO 9060 Specification and Classification of Instruments for Measuring Hemispherical Solar and Direct Solar Radiaiton

2.3 *WMO Document:*[4]

WMO-No. 8 Guide to Meteorological Instruments and Methods of Observation, Seventh ed., 2008, World Meteorological Organization (WMO), Geneva

3. Adjectives for Electromagnetic Radiation

3.1 Properties and quantities associated with electromagnetic radiation vary with:

3.1.1 The direction and geometric extent (solid angle) over which the incident or exitant flux, or both, is evaluated, and

3.1.2 The relative spectral distribution of the incident flux and the spectral response of the detector for exitant flux.

3.2 Adjective modifiers can be used to indicate the geometric, spectral, and polarization conditions under which radiometric properties and quantities are evaluated. The adjectives defined in this Terminology are: **conical, diffuse, direct, directional, hemispherical, luminous, normal,** and **spectral**.

3.3 For reflectance and transmittance, the direction and geometric extent of both the incident beam and exitant beam must be specified.

3.4 For emittance, only the exitant beam need be specified, and for absorptance, only the incident beam need be specified.

3.5 Radiometric properties also vary with the polarization of the incident flux and the sensitivity to polarization of the collector-detector system for flux incident or exitant at angles greater than about 15° from normal.

3.6 An instrument used for solar energy measurements or a solar energy receiver will usually determine the directions and geometric extents, such as a pyranometer, a pyrheliometer, or a flat-plate solar thermal collector.

4. Terminology

ELECTROMAGNETIC RADIATION AND OPTICS

absorptance, *n*—ratio of the absorbed radiant or luminous flux to the incident flux. **E349**

absorption, *n*—transformation of radiant energy to a different form of energy by interaction with matter. **E349**

aerosol, *n*—any solid or liquid particles, with a nominal size range from 10 nm to 100 µm, suspended in a gas (usually air). **D5544**

aerosol optical depth, *AOD*, *n*—a measure of the **extinction** caused by **aerosols** in the atmosphere relative to the **zenith** and modeled with Ångstrom's **turbidity** formula.

Discussion—Although it varies with wavelength, it is common to report aerosol optical depth at a single wavelength only, especially 0.5 µm.

air mass, *AM*, *n*—relative optical mass (see **optical mass, relative**) calculated using the density of air as a function of altitude.

$$AM \approx l_s / l_z = \sec\theta_z, \text{ for } \theta_z \leq 1 \text{ rad } (60°) \quad (1)$$

Discussion—Eq 1 is a simple approximation of the **optical mass, relative** (see Eq 5) that uses the ratio of the path length along the sun vector (l_s) to the path length along the zenith (l_z) (see **sun vector, zenith**, and **zenith angle, solar**). Other solutions are more complicated and take factors such as refraction and local air pressure into account.

Discussion—The abbreviation **AM** is also commonly used to refer to a particular standard solar spectral irradiance, such as those in Standard E490, Tables G173, and Table G197. Thus, **AM0** can indicate the extraterrestrial spectral irradiance table in Standard E490, and **AM1.5** the hemispherical spectral irradiance table in Tables G173. Using AM1.5 in this way is discouraged because air mass is but one of many variables that modify solar spectral irradiance such as clouds, aerosol scattering, and water vapor absorption; note that both Tables G173 and Table G197 use an air mass value of 1.5, but differ greatly. The distinction between a spectral irradiance and a path length ratio should be made clear whenever these abbreviations are used.

air mass one, *AM1*, *n*—a relative optical mass (see **optical mass, relative**) that is equal to one. Because of the way in which relative optical mass is defined, AM1 always denotes a vertical path at sea level.

air mass, optical—see **optical mass, relative**.

air mass, pressure corrected, AM_p, *n*—an approximation of **air mass** for locations above sea level that uses the ratio of the local barometric pressure *P*, to the standard sea level atmospheric pressure P_0 = 101.325 kPa (see Eq 2).

$$AMp \approx \frac{P}{P_0} AM \quad (2)$$

air mass ratio—see **optical mass, relative**.

air mass, relative optical—see **optical mass, relative**.

air mass zero, *AM0*, *n*—the absence of atmospheric attenuation of the solar irradiance at one astronomical unit from the sun. **E491**

albedo—discouraged in favor of the preferred term, **reflectance**.

angle of incidence, rad or °, *n*—the angle between a ray and the normal vector to the plane on which the ray is incident; especially the angle between the sun vector and the normal vector.

angle of reflection, rad or °, *n*—the angle between the direction of propagation of a reflected ray and the normal vector to the surface of interest at the point of reflection.

angle of refraction, rad or °, *n*—the angle between the direction of propagation of a refracted ray and the normal vector to the interface of interest at the point of refraction.

altitude angle, solar—see **elevation angle, solar**.

attenuation—see **extinction**.

[3] Available from International Organization for Standardization (ISO), 1, ch. de la Voie-Creuse, CP 56, CH-1211 Geneva 20, Switzerland, http://www.iso.org.

[4] Available from World Meteorological Organization, http://www.wmo.int.

azimuth angle, solar, ψ[rad or °], *n*—the angle between the line of longitude (or geographical meridian) at the location of interest and the horizontal component of the **sun vector**. By convention, the azimuth angle is positive when the sun is east of the line of longitude and negative when it is west of the line of longitude.

beam, *n—of radiant energy*, a collection of rays confined to a specific path.

blackbody, Planckian radiator, *n*—a thermal radiator which completely absorbs all incident radiation, whatever the wavelength, the direction of incidence, or the polarization. This radiator has, for any wavelength, the maximum spectral concentration of radiant exitance at a given temperature. **E491**

Bouguer's Law, *n*—an expression of the **extinction** of radiation in a medium that states the intensity exponentially decreases due to both scattering and absorption as it passes through the medium (see Eq 3), where τ_λ is the wavelength-dependent **extinction optical thickness**. The ratio of I to I_0 is equal to the atmospheric transmittance, T, and τ_λ is equal to the summation of the extinction optical thicknesses associated with each individual scattering or absorption process $\tau_{i\lambda}$.

$$I = I_0 exp(-\tau_\lambda) = I_0 exp\left(-\sum_{i=1}^{n} \tau_{i\lambda}\right) \quad (3)$$

Discussion—Bouguer's Law is also known as Lambert's Law or Beer's Law.

circumsolar diffuse radiation—**see radiant energy, circumsolar**.

conical, *adj*—describing a solid angle larger than an infinitesimal element and less than a hemisphere (2π sr); the geometry of the solid angle must be described in context.

diffuse, *adj—describing radiometric quantities*, indicates flux propagating in many directions, as opposed to a collimated beam.

diffuse, *adj—describing solar irradiance*, the global hemispherical irradiance minus the direct beam irradiance.

diffuse, *adj—describing reflectance*, the directional hemispherical reflectance minus the specular reflectance.

Discussion—**Diffuse** has been used in the past to refer to hemispherical collection (including the specular component) or irradiation, with equal radiance for all directions over a hemisphere. This use is deprecated in favor of the more precise term **hemispherical**.

diffusion, *n*—change of the spatial distribution of a beam of radiation when it is deviated in many directions by a surface or a medium. **E349**

direct, *adj—describing solar radiation*, a collimated beam.

directional, *adj*—of or relating to a direction in space.

Discussion—For optical properties, over an infinitesimal solid angle, the property is assumed constant. The variation in optical property with respect to changing azimuth (counter-clockwise) and incidence angle (from the surface normal), with respect to a reference mark on a sample, is the directional response.

elevation angle, solar, α [rad or °], *n*—the complement of the solar zenith angle, i.e. $\pi/2 - \theta_z$ radians. See **zenith angle, solar**.

emission, *n*—release of radiant energy. **E349**

emissive power—discouraged in favor of the preferred term **radiant exitance**.

emittance, ε, *n*— for a sample at a given temperature, ratio of the radiant flux emitted by a sample to that emitted by a blackbody radiator at the same temperature, under the same spectral and geometric conditions of measurement.

extinction, *n*—the attenuation of radiant energy from an incident beam by the processes of molecular absorption and scattering caused by atmospheric constituents.

Discussion—Scattering by air molecules can be modeled with **Rayleigh scattering**, and scattering by **aerosols** with Ångstrom's **turbidity** formula. Absorption processes are modeled with tables of measured absorption coefficients versus wavelength.

extinction coefficient, monochromatic, $k_{i\lambda}$ *[dimensionless]*, *n*—a measure of the **extinction** caused by a particular atmospheric constituent (see **Bouguer's Law** and **extinction optical thickness, monochromatic**).

extinction optical depth, monochromatic, [dimensionless], *n*—the product of the **extinction coefficient** $k_{i\lambda}$ for a particular atmospheric constituent times the path length to the top of the atmosphere, m_r, see **extinction optical thickness, monochromatic** and **optical mass, relative**.

Discussion—Optical depth is sometimes used synonymously with optical thickness, but the preferred distinction between the two is that optical thickness refers to the extinction along the entire path through the atmosphere rather than the vertical path.

extinction optical thickness, monochromatic, $\tau_{i\lambda}$ [dimensionless], *n*—the product of the **extinction coefficient** $k_{i\lambda}$ for a particular atmospheric constituent times the path length through atmosphere, see **Bouguer's Law** and Eq 4, in which m_{act} is the **optical mass, actual**.

$$\tau_{i\lambda} = k_{i\lambda} \cdot m_{act} \quad (4)$$

hemispherical, *adj*—describing half of a sphere, i.e. a 2π sr solid angle.

incident angle—see **angle of incidence.**

index of refraction, *n*—the numerical expression of the ratio of the velocity of light in a vacuum to the velocity of light in a substance. **D1245**

infrared radiation, *n*—radiation for which the wavelengths of the monochromatic components are greater than those for visible radiation, and less than about 1 mm. **E349**

irradiance, E [$W \cdot m^{-2}$], *n—at a point on a surface*, radiant flux incident per unit area of the surface; the derived unit **heat flux density, irradiance** in Standard IEEE/ASTM SI 10.

irradiance, spectral, E_λ *or* $E(\lambda)$[$W \cdot m^{-2} \cdot nm^{-1}$ or $W \cdot m^{-2} \cdot \mu m^{-1}$], *n*—the irradiation at a specific wavelength over a narow bandwidth, or as a function of wavelength; also, the derivative with respect to wavelength of irradiance.

Discussion—Spectral irradiance is commonly reported in tabular form as pairs of wavelength and irradiance values, as in Standard E490, Tables G173, and Table G197; see **spectral**.

Discussion—Following the normal SI rules for compound units (see Standard IEEE/ASTM SI 10), the units for spectral irradiance, the derivative of irradiance with respect to wavelength $dE/d\lambda$, would be $W \cdot m^{-3}$. However, to avoid possible confusion with a volumetric power density unit and for convenience in numerical calculations, it is common practice to separate the wavelength with a compound unit. Compound units are used in Standard E490, Tables G173, and Table G197.

irradiance, total, E_T [$W \cdot m^{-2}$], *n*—the integration over all wavelengths of spectral irradiance, or the solar irradiance measured with a pyranometer or a pyrheliometer.

irradiation, *n*—application of radiation to an object. **E349**

irradiation—at a point on a surface, see **radiant exposure**.

isotropic radiant energy— see **radiant energy, isotropic**.

local zenith—see **zenith**.

luminous, *adj—referring to a radiometric quantity*, weighted according to the spectral luminous efficiency function V() of the CIE (1987). **D1003**

monochromatic radiation, *n*—radiation charcterized by a single frequency. By extension, radiation of a very small range of frequency or wavelenght that can be described by stating a single frequency or wavelength. **E349**

normal, *adj*—describing a direction that is perpendicular to a surface.

normal vector, *n*—the upward-pointing vector normal to the plane of a receiver.

optical depth—see **extinction optical depth, monochromatic**.

optical mass, actual, m_{act} [dimensionless], *n*—the line integral along the **sun vector** of the density (ρ) of a substance as a function of altitude between a point in the atmosphere (0) and the vacuum of space (∞); in atmospheric transmittance calculations, the densities are normalized with units of $(\text{length})^{-1}$ (see Eq 5).

$$m_{act} = \int_0^\infty \rho ds \quad (5)$$

Discussion—The word "air" has been avoided in this definition because direct solar radiation is attenuated not only by air molecules but also by additional constituents such as aerosols and water vapor. Thus, it is possible to calculate water vapor mass as well as air mass using this equation. Optical masses are occasionally reported with units of km.

optical mass, relative, m_r [dimensionless], *n*—the ratio of the actual optical mass (see **optical mass, actual**, m_{act}) to the line integral along the **zenith** of the density of a substance as a function of altitude (ρ) between a point in the atmosphere (0) and the vacuum of space (∞) (see Eq 6).

$$m_r = m_{act} / \int_0^\infty \rho ds \quad (6)$$

optical thickness—see **extinction optical thickness, monochromatic**.

polarization, *n— with respect to optical radiation*, the restriction of the magnetic or electric field vector to a single plane. **G138**

polarization, parallel, *n*—a plane of polarization parallel to the plane of incidence, reflectance, or transmittance.

polarization, perpendicular, *n*—a plane of polarization perpendicular to the plane of incidence, reflectance, or transmittance.

polarization, plane of, *n*—by convention, the plane containing an electromagnetic wave's electric vector.

radiance, $W \cdot m^{-2} \cdot sr^{-1}$, *n*—the SI derived unit **radiance** in Standard IEEE/ASTM SI 10.

radiant emissive power—see **radiant exitance**.

radiant energy, Q[J], *n*—energy in the form of photons or electromagnetic waves.

radiant energy, atmospheric, Q[J], *n*—the portion of terrestrial radiation that is emitted by the atmosphere.

radiant energy, blackbody, J, *n*—radiant energy emitted by a (laboratory) blackbody, or radiant energy having that spectral distribution. See **Planck's law** in Practice E491.

radiant energy, circumsolar, J, *n*—radiation scattered by the atmosphere so that it appears to originate from an area of the sky immediately adjacent to the sun. Often referred to as the solar aureole, its angular extent is generally directly related to the aerosol optical depth.

radiant energy, effective nocturnal, J , *n*—energy transfer required to maintain a horizontal upward-facing blackbody surface at the ambient air temperature, in the absence of solar irradiance.

radiant energy, infrared—see **infrared radiation**.

radiant energy, isotropic, J, *n*—diffuse radiant energy that has the same radiance in all directions.

radiant energy, terrestrial, J, *n*—radiant energy emitted by the earth, including its atmosphere.

radiant exitance at a point on a surface, M[$W \cdot m^{-2}$], *n*—quotient of the radiant flux leaving an element of the surface containing the point, by the area of that element. **E349**

radiant exitance—see **radiant exitance at a point on a surface**.

radiant exitance, emitted—see **radiant exitance at a point on a surface**.

radiant exposure, H[$J \cdot m^{-2}$], *n—at a point on a surface*, time integral of irradiance.

radiant flux, Φ[J/s], *n*—the SI derived quantity **power, radiant flux** in Standard IEEE/ASTM SI 10.

radiant flux, net, W, *n*—difference between downward and upward (total solar and terrestrial) radiant flux; net flux of all radiant energy across an imaginary horizontal surface.

radiant flux, net terrestrial, W, *n*—difference between downward and upward terrestrial radiant fluxes; net flux of terrestrial radiant energy.

radiant power—see **radiant flux.**

radiation, *n*—*(1)* emission or transfer of energy in the form of electromagnetic waves or particles. *(2)* the electromagnetic waves or particles. **E349**

radiation coefficient, *n*—the quotient of the net radiant exitance of a blackbody (full radiator), by the temperature difference between the blackbody and the surroundings with which it is exchanging radiation. **E349**

Rayleigh scattering, *n*—a model of molecular scattering in the atmosphere in which the **monochromatic extinction coefficient** varies as the wavelength raised to the negative fourth power. Eq 7 is an approximation for dry air using wavelengths in µm.

$$k_{r\lambda} = 0.008735\lambda^{-4.08} \quad (7)$$

reflectance, *n*—ratio of the reflected radiant or luminous flux to the incident flux. **E349**

reflection, *n*—return of radiation by a surface without change of frequency of the monochromatic components of which the radiation is composed. **E349**

reflection angle—See **angle of reflection**.

reflectivity, *n*—reflectance of a layer of material of such a thickness that there is no change of reflectance with increased thickness. **E349**

Discussion—Reflectivity is a property of a material and reflectance is a property of a sample of the material, with no restriction on thickness or surface topography.

refraction, *n*—change in the direction of propagation of radiation determined by change in the velocity of propagation in passing from one medium to another medium with a different index of refraction.

refraction angle—see **angle of refraction.**

refraction index—see **index of refraction.**

reradiation, *n*—loss of energy by radiation from a surface previously heated by absorption.

spectral, *adj—referring to radiometric quantities*, for monochromatic radiation at a specified wavelength (or frequency), or, by extension, for radiation within a narrow wavelength band about a specified wavelength. **E349**

Discussion—When applied to a property, spectral is indicated by the subscript λ following the symbol for the quantity, as $L_\lambda = dL/d\lambda$; at a specific wavelength, it is indicated by the subscript λ with the wavelength in parentheses, as L_λ (500 nm).

sun vector, *n*—the vector pointing from the location of interest (usually a point on the Earth's surface in solar energy applications) to the center of the sun's disk.

Discussion—Because of the curvature of the Earth, and because of the refraction due to density variations with altitude, the sun vector varies along the path a beam of solar radiation follows from the top of atmosphere to the ground.

transmission, *n*—passage of radiation through a medium without change of frequency of the monochromatic components of which the radiation is composed. **E349**

transmission coefficient—see **extinction coefficient**.

transmittance, *T* [dimensionless], *n*—ratio of the transmitted radiant or luminous flux to the incident flux. **E349**

turbidity, *n*—an empirical expression of **aerosol optical depth** that uses Ångstrom's wavelength-dependent formula (see Eq 8).

$$k_{\alpha\lambda} = \beta \cdot \lambda^{-\alpha} \quad (8)$$

Discussion—In Eq 8, α and β are called the Ångstrom turbidity parameters and λ is the wavelength. The units of α and β are such that the units of k_α are dimensionless. With wavelength units of µm, β is commonly called the "turbidity" because it varies more than α, which tends to stay fairly constant.

ultraviolet radiation, *n*—radiation for which the wavelengths of the monochromatic components are smaller than those for visible radiation and more than about 1 nm. **E349**

visible radiation, *n*—any radiation capable of causing a visual sensation. **E349**

zenith, *n*—the upward-pointing vector normal to the Earth's surface at the location of interest (usually a point on the Earth's surface in solar energy applications).

zenith angle, solar, θ_z[rad or °], *n*—the angle between the **zenith** and the **sun vector**.

INSTRUMENTATION

absolute cavity pyrheliometer—see **self-calibrating absolute cavity pyrheliometer**.

absolute cavity radiometer—see **self-calibrating absolute cavity pyrheliometer**.

bolometer, *n*—instrument for measuring irradiance. Its principle is based on the variation of electrical resistance, with the incoming radiation of one or both of the resistance elements which comprise the instrument, as a result of temperature changes.

cavity radiometer—see **self-calibrating absolute cavity pyrheliometer**.

edge-stress meter—see **polarimeter, edge-stress**.

field pyrheliometer, *n*—pyrheliometers that are designed and used for long-term field measurements of direct solar radiation. These pyrheliometers are weatherproof and therefore possess windows, usually quartz, at the field aperture that pass all solar radiation in the range from 0.3 to 4-µm wavelength. **E816**

full width at half maximum, *FWHM*[nm or µm], *n—in a bandpass filter*, FWHM is the interval between wavelengths at which transmittance is 50 % of the peak, frequently referred to as bandwidth. **G130**

grazing-angle surface polarimeter—see **polarimeter, grazing-angle surface**.

international pyrheliometric scale—see **World Radiometric Reference**.

net pyrgeometer—see **pyranometer, net.**

net pyrradiometer— see **pyranometer, net.**

photometer, *n*—a device that measures luminous intensity or brightness by converting (weighing) the radiant intensity of an object using the relative sensitivity of the human visual system as defined by the photopic curve. **F1863**

polarimeter, *n*—an instrument used to measure the rotation of the plane of polarization of polarized light passing through an optical structure or sample.

polarimeter, edge stress, *n*—a specialized **polarimeter** for measuring residual edge stress in annealed, heat-strengthened, or thermally tempered flat glass. Used as a non-destructive method of characterizing strength and relative frangibility of glass.

polarimeter, grazing-angle surface, *n*—a specialized **polarimeter** for measuring residual surface stress in annealed, heat-strengthened, or thermally tempered flat glass. Used as a non-destructive method of characterizing strength and relative frangibility of glass.

polarimeter, photoelastic, *n*—a **polariscope** adapted for quantitative measurement of optical retardation, birefringence, or stress and strain using photoelastic analysis techniques.

polariscope, *n*—an optical device consisting of a light source, mutually perpendicular polarizing elements, and generally equipped with one or more retardation plates for qualitative observations of relative optical retardation by color differentiation. **C162**

primary standard pyrheliometers, *n*—pyrheliometers, selected from the group of absolute pyrheliometers (see **self-calibrating absolute cavity pyrheliometer**). **E816**

pyranometer, *n*—a radiometer with a hemispherical field-of-view (i.e. a 2π sr solid angle) used to measure the total solar radiant energy incident upon a surface per unit time per unit area. This energy includes the direct radiant energy, diffuse radiant energy, and reflected radiant energy from the background.

pyranometer, field, *n*—a pyranometer meeting World Meteorological Organization (WMO) Second Class "moderate quality" or better (that is, "Good Quality" or "High Quality") First Class specifications, described in WMO-No. 8, appropriate to field use, and typically exposed continuously.

pyranometer, net, *n*—an instrument for measuring the difference between the irradiance falling on the top and bottom of a horizontal surface.

pyranometer, reference, *n*—a pyranometer (see also ISO 9060), used as a reference to calibrate other pyranometers, which is well-maintained and carefully selected to possess relatively high stability and has been calibrated using a pyrheliometer. **G167**

pyranometer, spherical, *n*—instrument for measuring the solar flux falling from a 4π sr solid angle onto a spherical surface.

pyrgeometer, *n*—an instrument for measuring infrared atmospheric irradiance at wavelengths greater than 3000 nm on a horizontal upward facing black surface at the ambient air temperature.

pyrheliometer, *n*—a radiometer used to measure the direct or beam solar irradiance incident on a surface normal to the sun's rays.

pyrheliometer, compensated, *n*—pyrheliometer based on the comparison of the heating of two identical metal strips, one exposed to a solar radiant energy, the other to a joule effect.

pyrheliometer, field—see **field pyrheliometer**.

pyrheliometer, primary standard—see **primary standard pyrheliomers**.

pyrheliometer, reference—see **reference pyrheliometer**.

pyrheliometer, secondary standard—see **secondary standard pyrheliometer**.

pyrheliometer, self-calibrating absolute cavity—see **self-calibrating absolute cavity pyrheliometer**

pyrheliometer, secondary reference, *n*—a pyrheliometer essentially meeting the World Meteorological Organization (WMO) "High Quality" specifications as described in WMO-No. 8, but not having self-calibrating capability.

pyrradiometer, spherical, *n*—instrument for measuring total flux incident from a 4π sr solid angle onto a spherical surface.

radiometer, *n*—a general class of instruments designed to detect and measure radiant energy. **G113**

radiometer, broad-band, *n*—a relative term generally applied to radiometers with interference filters or cut-on/cut-off filter pairs having a FWHM between 20 and 70 nm and with tolerances in center (peak) wavelength and FWHM no greater than ±2 nm. **G130**

radiometer, narrow-band, *n*—a relative term generally applied to radiometers with interference filters with FWHM ≤ 20 nm and with tolerances in center (peak) wavelength and FWHM no greater than ±2 nm. **G130**

radiometer, wide-band, *n*—a relative term generally applied to radiometers with combinations of cut-off and cut-on filters with FWHM greater than 70 nm. **G130**

radiometry, *n*—measurement of the quantities associated with radiation. **E349**

reference pyrheliometer, *n*—pyrheliometers of any category serving as a reference in calibration transfer procedures. They are selected and well-tested instruments (see Table 2 of ISO 9060), that have a low rate of yearly change in responsivity. The reference pyrheliometer may be of the same type, class, and manufacturer as the field radiometers