Designation: G113 – 22

Standard Terminology Relating to Natural and Artificial Weathering Tests of Nonmetallic Materials[1]

This standard is issued under the fixed designation G113; 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 This terminology standard covers terms that relate to the durability testing of Nonmetallic Materials using natural and artificial weathering exposure techniques.

1.2 It is the intent of this terminology standard to include those weathering terms in wide use in ASTM for which standard definitions appear desirable.

1.3 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D9 Terminology Relating to Wood and Wood-Based Products

D4023 Terminology Relating to Humidity Measurements (Withdrawn 2002)[3]

E772 Terminology of Solar Energy Conversion

E973 Test Method for Determination of the Spectral Mismatch Parameter Between a Photovoltaic Device and a Photovoltaic Reference Cell

G84 Practice for Measurement of Time-of-Wetness on Surfaces Exposed to Wetting Conditions as in Atmospheric Corrosion Testing

G90 Practice for Performing Accelerated Outdoor Weathering of Materials Using Concentrated Natural Sunlight

G201 Practice for Conducting Exposures in Outdoor Glass-Covered Exposure Apparatus with Air Circulation

2.2 *AATCC Method:*[4]

16 Colorfastness to Light

2.3 *ANSI Standards:*[5]

ANSI/NCSL Z540-2-1997 American National Standard for Expressing Uncertainty—U.S. Guide to the Expression of Uncertainty in Measurement

ISO 9370 Plastics -- Instrumental Determination of Radiant Exposure in Weathering Tests -- General Guidance and Basic Test Method

2.4 *CIE Publication:*[6]

CIE 17.4 International Lighting Vocabulary (E) (F) (G) (R)

2.5 *BIPM Publication:*[7]

Guide to the Expression of Uncertainty Measurement (GUM)

3. Significance and Use

3.1 This terminology is not intended to supersede the requirements of similar definitions in certain other documents, but is intended to provide a listing of terms that are in current widespread usage, and their context in relation to weathering.

4. Terminology

4.1 *Definitions:*

accelerated outdoor weathering, *n*—outdoor weathering using the sun as the source of irradiance, and where the rate of deterioration is accelerated by increasing one or more of the influencing parameters above a level obtained in the natural environment.

DISCUSSION—Examples of these types of exposures are found in Practice G90 and Practice G201.

[1] This terminology is under the jurisdiction of ASTM Committee G03 on Weathering and Durability and is the direct responsibility of Subcommittee G03.92 on Terminology.

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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.

[3] The last approved version of this historical standard is referenced on www.astm.org.

[4] Available from American Association of Textile Chemists and Colorists (AATCC), P.O. Box 12215, Research Triangle Park, NC 27709, http://www.aatcc.org.

[5] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.

[6] Available from U.S. National Committee of the CIE (International Commission on Illumination), C/o Alan Laird Lewis, 282 E. Riding, Carlisle, MA 01741, http://www.cie-usnc.org.

[7] Available from Bureau International des Poids et Mesures (BIPM), Pavillon de Breteuil, F-92312 Sèvres Cedex, France, https://www.bipm.org.

acceleration factor, *n*—the ratio of exposure time required to produce a specified amount of change in a material by one exposure test divided by the exposure time required to produce the same change by another exposure test.

DISCUSSION—Acceleration factors must be used with great caution because they vary between materials (including different formulations of the same material) and are strongly dependent on the exposure conditions and variability of both the natural and laboratory accelerated exposures. Acceleration factors may also vary depending on the level of material property change used to determine the acceleration factor. Do not ratio irradiance in laboratory accelerated tests to irradiance in outdoor exposures, or use equivalent radiant exposures to estimate time to fail in outdoor exposures. These calculations ignore differences in temperature and moisture between the accelerated test and exterior exposures, and in the spectral power distributions of the laboratory light source and sunlight.

actinic radiation, *n*—the spectral region(s) of a light source responsible for the photodegradation of a particular material.

ambient temperature, *n*—the existing temperature of the air or of an object in thermal equilibrium with the surrounding atmosphere.

artificial accelerated irradiation, *n*—exposure of a material to a laboratory radiation source meant to simulate window glass filtered solar radiation or radiation from interior lighting sources and where specimens may be subjected to relatively small changes in temperature and relative humidity in an attempt to more rapidly produce the same changes that occur when the material is used in an indoor environment.

DISCUSSION—These exposures have been commonly referred to as fading or lightfastness tests.

artificial accelerated weathering, *n*—exposure of a material in a laboratory weathering device to conditions which may be cyclic and intensified over those encountered in outdoor or in-service exposure. This involves a laboratory radiation source, thermal stress, and moisture (in the form of relative humidity, and/or water spray, condensation, or immersion) in an attempt to more rapidly produce the same changes that occur in long term outdoor exposure.

DISCUSSION—The device may include means for control and/or monitoring the light source and other weathering variables. It may also include exposure to special conditions, such as acid spray to simulate the effect of industrial gases.

azimuth angle, *n*—an angle of a plane to the horizon measured clockwise to the object.

backed exposure, *n*—a technique of weathering in which the test specimens being exposed are mounted onto a solid backing material, of sufficient strength to hold the specimen. When the specimen and the backing are in direct contact the backing material must be of a type that will not contaminate the specimen. When two materials are intimately joined together to form one composite, the materials below the top surface are not considered as a backing.

DISCUSSION—The backing is typically plywood which has the effect of increasing specimen temperature and wet time during exposure, compared to exposure unbacked.

black box, *n*—a thin metal box painted flat black on the outside only exclusive of the bottom surface with an open top where the flat test specimens to be exposed constitute the top surface of the box; the box is equipped with mounting strips to hold the test specimens firmly in place; the top surface of the box must be completely filled at all times; any blank spaces on the top surface must be occupied by flat black "dummy" panels to maintain correct operating condition.

black box under glass, *n*—a glass covered enclosure or cabinet of any convenient size. It shall be constructed of corrosion resistant metal and be enclosed to prevent ambient air from circulating over the samples. Exterior non-glass surfaces shall be painted black. The interior shall remain unpainted.

black panel thermometer, *n*—a temperature measuring device consisting of a metal panel, having a black coating which absorbs all wavelengths uniformly, with a thermal sensitive element firmly attached to the center of the exposed surface. The black panel thermometer is used to control an artificial weathering device and to provide an estimate of the maximum temperature of samples exposed to a radiant energy source.

climatological types, *n*—major regions of significantly different recurring weather patterns. In weathering, several distinct climatological types are used to evaluate the atmospheric durability of materials. Within any single climatological variation, at a specific geographic location, short term weather patterns may fluctuate significantly. This may cause variability in short term exposures. Major climatic variations that are used for the study of weathering are:

warm, moist climate,—subtropical climate distinguished as warm and humid year round, with frequent rain showers.

hot, dry climate,—desert climate distinguished as sunny, hot, and dry year round, with rare scattered showers.

control, *n*—**in weathering**, the term control has three current widespread uses:

1. A material which is of similar composition and construction to the test material used for comparison, exposed at the same time.

DISCUSSION—A reference material can often be used as the control.

2. A portion of the material to be tested which is stored under conditions in which it is stable, and is used for comparison between exposed and original state.

DISCUSSION—This definition is deprecated in favor of "File Specimen."

3. A portion of the exposed specimen which is protected from light exposure by masking.

DISCUSSION—This definition is deprecated in favor of "Masked Area."

daylight , *n*—as used in weathering, the term equivalent to "sunlight". It refers to the full spectrum of solar irradiance, that is, ultraviolet through infrared, and includes both diffuse sky and direct solar irradiance.

DISCUSSION—This definition differs from CIE (Commission Internationale de l'Eclairage) Publication No 17.4 which defines daylight as "the visible par of global (sun plus sky) radiation.

direct weathering, *n*—a technique of weathering in which the test specimens are exposed to all prevailing elements of the atmosphere.

dry-bulb temperature, *n*—the temperature of the ambient air; for example, the temperature that is measured by the dry-bulb thermometer of a psychrometer. **D4023**

durability, *n*—in weathering, the ability of a material to maintain a defined property in a defined application as a function of its end use exposure conditions and time.

enclosed carbon arc, *n*—a light source in which an arc is produced across a pair of carbon rods by a high energy electrical source, such that a high intensity light is emitted. The carbons are enclosed in an inverted glass dome which acts to prolong the life of the carbons, and to modify the spectral power distribution received by the specimens.

exposure, *n*—the act of subjecting the test specimen to the test conditions.

exposure angle, *n*—the tilt from horizontal of the test specimen or any other exposed material, or both.

fading unit (AATCC), *n*—a specific amount of exposure made under the conditions specified in various test methods where one Fading Unit is one-twentieth (1/20 th) of the exposure required to produce a color change equal to Step No. 4 on the Gray Scale for Color Change or 1.7 ± 0.3 CIELAB units of color difference on Blue Wool Lightfastness Standard L 4 or 20 ± 1.7 CIELAB units of color difference on the Xenon Reference Fabric or combination thereof.
AATCC Technical Manual

file specimen, *n*—portion of the material to be tested which is stored under conditions in which it is stable, and is used for comparison between exposed and original state.

fluorescent ultraviolet lamp, *v*—a lamp in which the irradiance from a low pressure mercury arc is transformed to a longer wavelength UV radiation by a phosphor; the spectral power distribution of a fluorescent lamp is determined by the emission spectrum of the mercury arc light source, the emission spectrum of the phosphor and the UV transmittance of the glass tube.

fresnel-reflector system, *n*—flat mirrors arranged in an array such that they reflect onto a target, the illuminated area of which simulates the size and shape of the flat mirror. Such an array simulates the ray-tracing of a parabolic trough of the same aperture angle. **G90**

gray scale, *n*—the scale consists of nine pairs of standard gray chips each pair representing a difference in color or contrast (shade and strength) corresponding to a numerical fastness rating. The results of colorfastness tests are rated by visually comparing the difference in color represented by the scale.
AATCC Technical Manual

irradiance, *n*—the radiant power per unit area incident on a receiver, typically reported in watts per square metre, W m^{-2} **E973**

light (weathering), *n*—electromagnetic radiation present in natural terrestrial sunlight encompassing wavelengths ranging from the ultraviolet solar cut-on (about 295 nm) through the visible (380 to 780 nm) into the infrared (up to about 4050 nm).

DISCUSSION—In weathering, the terms *light* and *radiation* are used interchangeably. Although light is classically defined as wavelengths stimulating human visual response, it is commonly used in weathering to also include the UV and IR radiation found in natural sunlight.

masked area, *n*—a portion of the exposed specimen which is protected from light exposure by masking. (See also **control**.)

DISCUSSION—The mask area is not protected from heat and moisture.

moisture content, *n*—the percent by weight of moisture present in a sample as determined by prescribed methods.

natural weathering, *n*—outdoor exposure of materials to unconcentrated sunlight, the purpose of which is to assess the effects of environmental factors on various functional and decorative parameters of interest.

open flame sunshine carbon arc, *n*—a light source in which an arc is produced across a pair of copper coated carbon rods filled with rare earth elements intended to produce a specific spectral power distribution. The carbons are open to the atmosphere and may be surrounded by a glass lantern arrangement which acts to modify the spectral power distribution received by the specimens.

operational control point, *n*—a set point for equilibrium conditions measured at sensor location(s) in an exposure device.

operational fluctuations, *n*—the positive and negative deviations from the setting of the sensor at the operational control set point during equilibrium conditions in a laboratory accelerated weathering device.

DISCUSSION—The operational fluctuations are the result of unavoidable machine variables and do not include measurement uncertainty. The operational fluctuations apply only at the location of the control sensor and do not imply uniformity of conditions throughout the test chamber.

operational uniformity, *n*—the range around the operational control point for measured parameters within the intended exposure area within the limits of intended operational range.

DISCUSSION—It is assumed, as with all measurements, that the measurement of uniformity has uncertainty of measurement.

photodegradation, *n*—photochemically induced changes in the condition of the material.

pyranometer, *n*—a radiometer used to measure the total solar radiant energy incident upon a surface per unit time per area. This energy includes the direct radiant energy, diffuse radiant energy, and reflected radiant energy from the background. **E772**

pyrheliometer, *n*—a radiometer used to measure the direct or beam solar irradiance incident on a surface normal to the sun's rays. **E772**

radiant exposure, *n*—time integral of irradiance, typically reported in joules per square metre, J m^{-2} E772

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

reference material, *n*—a material with known performance.

reference specimen, *n*—a portion of the reference material that is to be exposed.

relative humidity, *n*—the ratio of the actual pressure of existing water vapor to the maximum possible (saturation) pressure of water vapor in the atmosphere at the same temperature, expressed as a percentage.

sample, *n*—a group of units or portion of material, taken from a larger collection of units or quantity of material, which serves to provide information that can be used as a basis for action on the larger quantity.

DISCUSSION—Where sample is used as a term for the item to be exposed, the term is deprecated in favor of specimen.

solar azimuth angle, *n*—the angular distance measured clockwise from due north to the projection of the beam radiation on the horizontal plane (see Fig. 1).

solar irradiance, *n*—as related to natural weathering of materials, the irradiance of the sun incident on the earth's surface, having wavelengths between about 295 nm and 4050 nm (4.05 microns). E772

solar irradiance, global $E_5(2\pi)$, *n*—solar irradiance received on an upward facing horizontal surface directly transmitted from the solid angle of the sun's disk or scattered in traversing the atmosphere, measured in watts per square metre.

solar irradiance, infrared,—as related to natural weathering of materials, terrestrial solar irradiance for which the wavelengths are longer than those for visible irradiance and shorter than about 4.05 microns.

DISCUSSION—The limits of the spectral range of infrared radiation are not well defined and may vary according to the user. Committee E-2.1.2 of the CIE distinguishes in the spectral range between 780 nm and 1 mm into IR-A, IR-B, and IR-C as shown below.

IR-A	780 to 14 μm
IR-B	1.4 to 3 μm
IR-C	3 μm to 1 mm

solar irradiance, ultraviolet, *n*—as related to natural weathering of materials, terrestrial solar irradiance for which the wavelengths are shorter than those for visible irradiance and longer than about 295 nm.

DISCUSSION—The upper limit is not well defined because it is dependent on eye sensitivity. It has been identified as either 380 nm or 400 nm.CIE Committee E-2.1.2 of the CIE divides the spectral range between 280 and 400 nm into UV-A and UV-B as shown below.

UV-A	315 to 400 nm
UV-B	280 to 315 nm

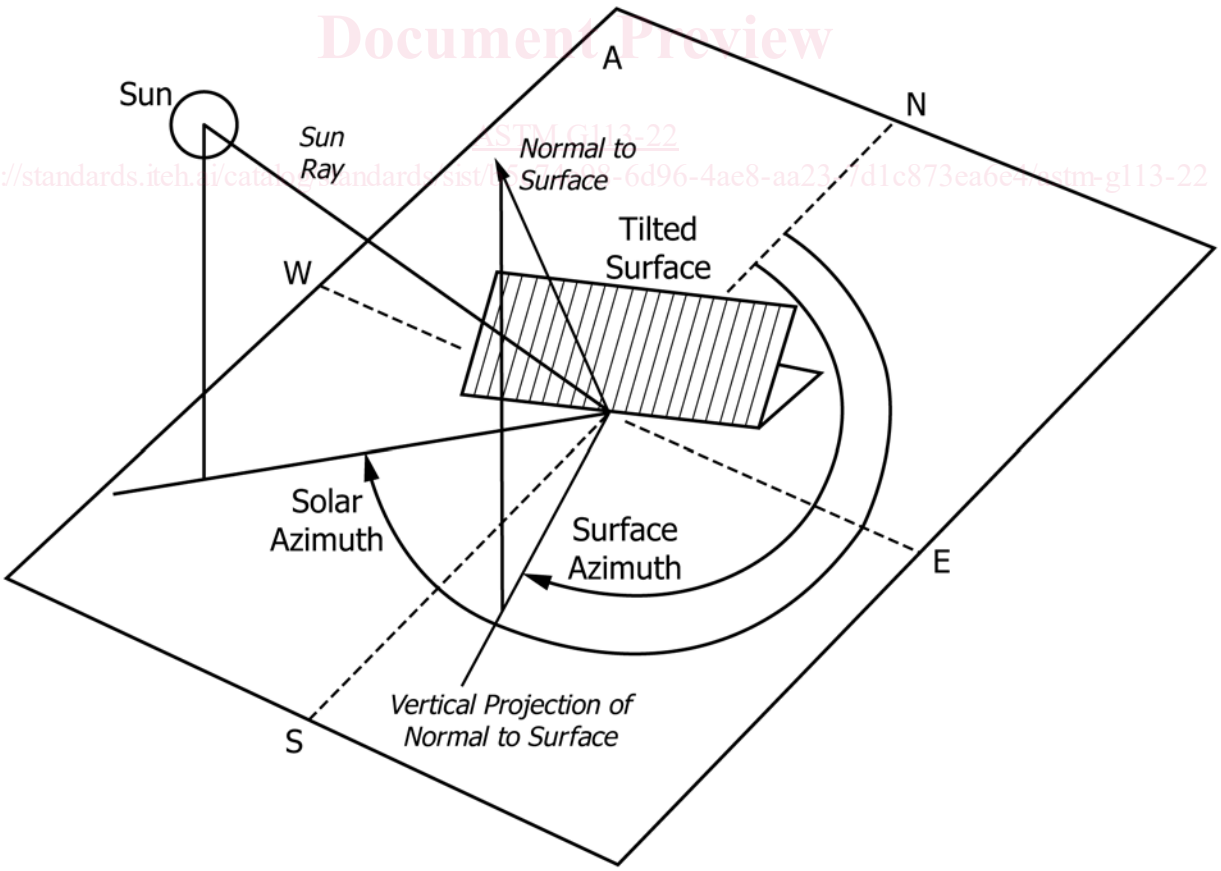

FIG. 1 Solar Azimuth Angle and Surface Azimuth Angle