Designation: G7/G7M – 21

Standard Practice for Natural Weathering of Materials[1]

This standard is issued under the fixed designation G7/G7M; 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.

This standard has been approved for use by agencies of the U.S. Department of Defense.

1. Scope*

1.1 This practice covers procedures to be followed for direct exposure of materials to the environment. Typically, this testing is performed on exposure racks tilted at a commonly-used tilt angle from the horizontal (such as 5 or 45 degrees) and facing the equator. Other exposure orientations can be used.

1.2 This practice is not intended for the corrosion testing of bare metals, or for testing behind glass.

1.2.1 For corrosion testing, refer to Practice G50

1.2.2 For exposures behind glass, refer to Practice G24

1.3 *Units*—The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system are not necessarily exact equivalents; therefore, to ensure conformance with the standard, each system shall be used independently of the other, and values from the two systems shall not be combined.

1.4 This practice is technically equivalent to the parts of ISO 877-1 and -2 that describe direct exposures of specimens to the environment.

1.5 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.6 *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]

D3614 Guide for Laboratories Engaged in Sampling and Analysis of Atmospheres and Emissions
E772 Terminology of Solar Energy Conversion
E824 Test Method for Transfer of Calibration From Reference to Field Radiometers
G24 Practice for Conducting Exposures to Daylight Filtered Through Glass
G50 Practice for Conducting Atmospheric Corrosion Tests on Metals
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
G167 Test Method for Calibration of a Pyranometer Using a Pyrheliometer

2.2 *ISO Standards:*[3]

ISO 877 Plastics—Methods of Exposure to Direct Weathering; to Weathering Using Glass-Filtered Daylight, and to Intensified Weathering by Daylight Using Fresnel Mirrors
ISO 9370 Plastics—Instrumental Determination of Radiant Exposure in Weathering Tests—General Guidance and Basic Test Method
ISO 9060:2018 Solar Energy – Specification and Classification of Instruments for Measuring Hemispherical Solar and Direct Solar Radiation

2.3 *Other Standards:*

WMO – No. 8, "Guide to Meteorological Instruments and Methods of Observation," seventh edition, World Meteorological Organization, Geneva, Switzerland, 2008

[1] This practice is under the jurisdiction of ASTM Committee G03 on Weathering and Durability and is the direct responsibility of Subcommittee G03.02 on Natural and Environmental Exposure Tests.

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

***A Summary of Changes section appears at the end of this standard**

3. Terminology

3.1 *Definitions*—The definitions given in Terminologies G113 and E772 are applicable to this practice.

4. Significance and Use

4.1 The relative durability of materials in natural exposures can be very different depending on the location of the exposure because of differences in ultraviolet (UV) radiation, relative humidity, time of wetness, temperature, wet-dry cycling, freeze-thaw cycling, pollutants, and other factors. Therefore, it cannot be assumed that results from one exposure in a single location will be useful for determining relative durability in a different location. Exposures in several locations with different climates which represent a broad range of anticipated service conditions are recommended.

4.2 Because of year-to-year climatological variations, results from a single exposure test cannot be used to predict the absolute rate at which a material degrades. Several exposures, repeated over several years are needed to get a representative test result for a given location.

4.3 Solar UV radiation varies considerably as a function of time of year. This can cause large differences in the apparent rate of degradation in many materials. Comparing results for materials exposed for short periods (less than one year) is not recommended unless materials are exposed at the same time in the same location.

4.4 The duration of natural weathering tests is often based on time (24 months for example). The variability between different exposures can be reduced by using a duration based on total solar or solar UV radiant exposure. Solar UV measurements are typically made using instruments which record broadband UV (for example, 295 to 385 nm), as described in 7.2.4. An inherent limitation in timing a weathering test based solely on solar-radiation measurements is that temperature and moisture may also influence the rate or type of degradation.

4.5 The design of the exposure rack, the location of the specimen on the exposure rack, and the type, color, and emissivity of adjacent specimens can affect specimen temperature and time of wetness. In order to minimize variability caused by these factors, control and weathering reference material specimens should be placed adjacent to test specimens during exposure.

4.6 It is recommended that at least one control specimen be part of any exposure evaluation. When used, the control specimen shall meet the requirements of Terminology G113, and be of similar composition and construction compared to

FIG. 1 Typical Exposure Rack

test specimens. It is preferable to use two control specimens, one with relatively good durability and one with relatively poor durability. Unless otherwise specified, use at least two replicate specimens of each test and control specimen being exposed. Control specimens included as part of a test shall be used for the purpose of comparing the performance of test specimens relative to the controls.

5. Test Sites, Location of Test Fixtures, and Exposure Orientation

5.1 *Test Sites*—Exposures can be conducted in any type of climate. However, in order to get more rapid indications of outdoor durability, exposures are often conducted in locations that receive high levels of solar radiation, temperature, and moisture. Typically, these conditions are found in hot desert and subtropical or tropical climates. Known attributes of the use environment should be represented by the locations selected for outdoor durability evaluation. For example, if the use environment for the product being evaluated will include freeze-thaw cycling, specimen exposure in a northern temperate climate is recommended. In addition, exposures are often conducted in areas where specimens are subjected to salt air (seashore) or industrial pollutants.

5.1.1 Unless otherwise specified, the area beneath and in the vicinity of the test fixtures shall have ground cover typical of the climatological area where the exposures are being conducted. In desert areas, the typical ground cover is often gravel to control dust, and in most temperate or subtropical areas, the typical ground cover is low-cut grass. The type of ground cover at the exposure site shall be indicated in the test report. If test fixtures are placed over ground covers not typical of the climatological area (for example, rooftops, concrete or asphalt), specimens may be subjected to different environmental conditions than if using typical ground cover or exposing at ground level. These differences may affect test results.

5.2 The lowest row of specimens on a test fixture or rack shall be positioned at least 0.45 m [18 in.] above the surface of the ground and shall not contact vegetation. This will also minimize the possibility that damage that might occur during grounds maintenance.

5.3 Test fixtures shall be placed in a location so that there is no shadow on any specimen when the sun's angle of elevation above the horizon is greater than 20°.

5.4 *Exposure Orientation*—Unless otherwise specified, exposure racks shall be oriented so that specimens face the equator. Specimens can be exposed at any orientation or "exposure angle" in order to simulate end-use conditions of the material being evaluated. Typical exposure angles are as follows:

5.4.1 *Latitude Angle*—Exposure rack is positioned so that the exposed surface of specimens are at an angle from the horizontal that is equal to the latitude of the exposure site and facing the equator.

5.4.2 *45°*—Exposure rack is positioned so that the exposed specimens are at an angle of 45° from the horizontal facing the equator. This is the most commonly used exposure orientation.

5.4.3 *90°*—Exposure rack is positioned so that the exposed specimens are at an angle of 90° from the horizontal facing the equator.

5.4.4 *5°*—Exposure rack is positioned so that the exposed specimens are at an angle of 5° from the horizontal facing the equator. This angle is preferred over horizontal exposure to avoid standing water on exposed specimens. This exposure angle typically receives the highest levels of solar radiant

FIG. 2 Backed Exposure Rack

exposure during mid-summer and is used to expose materials that would normally be used in horizontal or nearly horizontal applications.

NOTE 1—Exposures conducted at less than the site latitude typically receive more UV radiant exposure than exposures conducted at larger angles.

5.4.5 Any other angle that is mutually agreed on by all interested parties may be used. In some instances, exposures facing directly away from the equator or some other specific direction may be desired. The test report shall contain the angle and specimen orientation.

5.5 *Specimen Backing*—Three types of specimen backing can be used. Avoid comparisons between materials degradation unless all exposures were conducted with the same specimen backing.

5.5.1 *Unbacked Exposures*—Specimens are exposed so that the portion of the test specimen being evaluated is subjected to the effects of the weather on all sides. For materials that deform easily during exposure, a wire mesh can be used to provide support and prevent deformation or distortion.

5.5.2 *Backed Exposures*—Specimens are attached to a solid substrate so that only the front surface is exposed. Surface temperatures of specimens in backed exposures will be higher than for specimens subjected to unbacked exposures. In some cases, the substrate is painted black, which produces significant differences in surface temperature compared to exposures conducted on unpainted substrates. This can cause large differences in degradation rates when compared to backed exposures conducted on unpainted substrates.

5.5.3 *Black Box Exposure*—Specimens are attached to the front face of a black painted aluminum box (see 6.2.3 and Fig. 3). The specimens form the top surface of the box. If there are not enough test specimens to completely cover the top surface, open areas shall be filled with black painted sheet metal panels so that the box is completely closed.

6. Construction of Test Fixtures (Exposure Racks)

6.1 *Materials of Construction*—All materials used for test fixtures shall be noncorrodible without surface treatment. Aluminum Alloys 6061T6 or 6063T6 have been found suitable for use in most locations. Properly primed and coated steel is suitable for use in desert areas. Monel has been found suitable in highly corrosive areas. Untreated wood is acceptable in desert areas but may pose maintenance problems in other areas. (See Fig. 1.)

6.1.1 For backed exposures (see 6.2.2 and Fig. 2), use exterior-grade plywood to form a solid surface to which specimens are directly attached. Replace the plywood when there is any warping or distortion that changes the orientation of the specimens, or when there are visible signs of delamination or fiber separation. Medium-density overlay (MDO) or high-density overlay (HDO) plywood types are satisfactory substrates and require less frequent replacement than plywood with no overlay. The edges of the plywood should be sealed with a durable paint to prevent delamination. The type and thickness of plywood used shall be described in the test report. Other substrates can be used if agreed upon between interested parties.

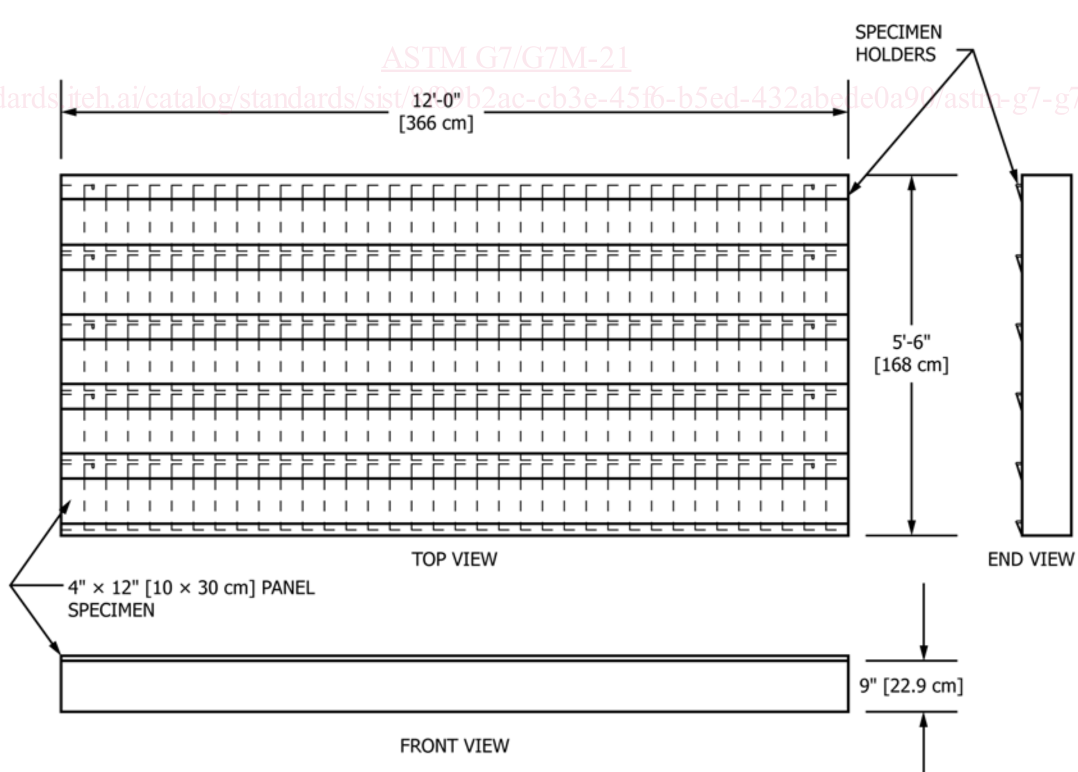

FIG. 3 Black Box