



Designation: G156 – 09

Standard Practice for Selecting and Characterizing Weathering Reference Materials¹

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1. Scope

1.1 This standard describes the criteria to be used for selection of a weathering reference material (WRM) and procedures to be used for determining within lab and between lab tolerances of changes in measured properties of a reference materials. This standard also describes a procedure for comparing different lots of the same type of a reference material.

NOTE 1—Examples of laboratory accelerated tests in which a weathering reference material could be used to monitor consistency are exposure tests such as those described in Practices G152, G153, G154, and G155 and other standards in which tests conducted according to these standards are referenced. Examples of outdoor exposures where a weathering reference material could be used to monitor consistency are those conducted according to Practices G7, G24, or G90. A reference material can also be used to monitor consistency of exposure or conditioning test that do not involve exposure to light.

1.2 Weathering reference materials are most often used to (1) monitor consistency of conditions in exposure tests, (2) to determine the time or radiant exposure at which test materials are evaluated, (3) as a reference material for comparing to test materials exposed at the same time. Weathering reference materials cannot be used to classify or characterize the relative severity of any exposure test because of the large variability in material responses to the effects of light, heat, and water.

1.3 This practice does not cover control materials which, by definition are selected to be of similar composition and construction to the test materials, and are exposed at the same time as test materials.

1.4 This practice provides an outline of experiments required to determine how the measured properties of the reference material change as a function of exposure to specified test conditions. It includes establishment of reproducible measurement procedures, determination of the critical spectral region in the light source causing the changes, and effects of other critical exposure stresses such as temperature and moisture.

¹ This practice is under the jurisdiction of ASTM Committee G03 on Weathering and Durability and is the direct responsibility of Subcommittee G03.01 on Joint Weathering Projects.

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2. Referenced Documents

2.1 ASTM Standards:²

- E177 Practice for Use of the Terms Precision and Bias in ASTM Test Methods
- E691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method
- E1169 Practice for Conducting Ruggedness Tests
- G7 Practice for Atmospheric Environmental Exposure Testing of Nonmetallic Materials
- G24 Practice for Conducting Exposures to Daylight Filtered Through Glass
- G90 Practice for Performing Accelerated Outdoor Weathering of Nonmetallic Materials Using Concentrated Natural Sunlight
- G113 Terminology Relating to Natural and Artificial Weathering Tests of Nonmetallic Materials
- G152 Practice for Operating Open Flame Carbon Arc Light Apparatus for Exposure of Nonmetallic Materials
- G153 Practice for Operating Enclosed Carbon Arc Light Apparatus for Exposure of Nonmetallic Materials
- G154 Practice for Operating Fluorescent Light Apparatus for UV Exposure of Nonmetallic Materials
- G155 Practice for Operating Xenon Arc Light Apparatus for Exposure of Non-Metallic Materials
- G178 Practice for Determining the Activation Spectrum of a Material (Wavelength Sensitivity to an Exposure Source) Using the Sharp Cut-On Filter or Spectrographic Technique

2.2 SAE Standard:

- SAE J1960, Accelerated Exposure of Automotive Exterior Materials using a Controlled Irradiance Water-Cooled Xenon Arc Apparatus³
- SAE J1885, Accelerated Exposure of Automotive Interior Materials Using a Controlled Irradiance Water-Cooled Xenon Arc Apparatus³

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 Society of Automotive Engineers (SAE), 400 Commonwealth Dr., Warrendale, PA 15096-0001, <http://www.sae.org>.

3. Terminology

3.1 *Definitions*—The definitions listed in Terminology G113 are applicable to this standard.

4. Significance and Use

4.1 Weathering reference materials are used in laboratory accelerated exposure tests to verify consistency among tests run at different times and in different laboratories, using the same exposure conditions. Specifications defining consistency of exposure conditions are based on the property change of a reference material after a defined period of time. Some weathering reference materials are used to define periods of exposure. Specifications calling for use of these materials require the material to be exposed until a defined change in the weathering reference material is achieved. Specifications are usually based on results for a single lot of the weathering reference material. When a new lot of the reference material is introduced, round-robin studies are necessary to compare the new and old lots and to establish appropriate limits for expected performance of the new lot.

NOTE 2—An example of the use of a clear polystyrene reference standard for this purpose is given in SAE J1885 and SAE J1960.

NOTE 3—Some weathering reference materials (for example blue wools) are also used to define periods of exposure. Although not specifically covered by this standard, the procedures described for characterizing a reference material used to monitor consistency of exposures are also generally applicable to characterizing reference materials used to define periods of exposure.

4.2 It is important to test the consistency of exposure in the laboratory accelerated device with a weathering reference material that responds to the test conditions similar to the way the test materials respond. Therefore, the weathering reference material should be sensitive to the spectral region of the light source mainly responsible for producing degradation in the test materials to provide the most meaningful evaluation of exposure test consistency. The weathering reference material should also provide information on consistency of temperature and humidity conditions if the latter are important factors in degradation of the test materials.

NOTE 4—Material homogeneity can also be an important factor in selection of a weathering reference material, particularly if weathering is initiated by the radiation absorbed by impurities as is the case in aliphatic type polymers exposed to radiation longer than 300 nm.

4.3 The measurement of the characteristic property of a weathering reference material can be subject to error depending on the instrument and the procedure used to measure the property. It is important to develop measurement procedures that are clear and which minimize chances for operator misinterpretation. It is also important to determine the level of variability caused by measurement of the characteristic property.

4.4 When a reference material is used to monitor or specify the consistency of an exposure test, it is important that any specification limits defined by changes in the reference material be based on a sound statistical analysis of results from a properly designed round-robin experiment. This practice provides a procedure which can be followed to set up the round-robin, analyze results, and establish reasonable limits of

change in the characteristic property of the reference material that can be used in specifications.

4.4.1 The results obtained according to this practice are valid only for the exposure cycle used for the round-robin and cannot be applied to the same weathering reference material used in a different exposure cycle.

4.5 The change in characteristic property of a reference material may be affected by the placement of the reference material in the exposure device. This is often due to variations in light intensity and temperature within the allowed exposure area. Random placement of replicate specimens of the weathering reference material through-out the allowed exposure area provides the best indication of the overall consistency of the exposure test.

NOTE 5—In some cases, procedures require exposure of a weathering reference material at a specific location within the exposure device or chamber. Results for a reference material used in this way may not provide an accurate representation of the exposure conditions in other positions within the device.

5. Procedure

5.1 Select a weathering reference material that exhibits a significant change in a characteristic property when exposed for an acceptable period of time, to the exposure conditions described in the applicable test procedure.

5.2 Determine the procedure used that can best measure the change in characteristic property of the reference material.

5.2.1 Conduct a series of experiments to determine the effect of important factors in the measurement procedure. It is recommended that this be done using a ruggedness test according to Guide E1169 to determine which factors significantly affect results. The results from this test can be used to tighten the test measurement procedures.

5.2.2 When the results from the ruggedness testing are complete, write a set of instructions for measuring the characteristic property that is unambiguous and clearly understood by operators who will be making the measurement. Have two operators in one laboratory conduct the measurement on at least three replicate specimens of the reference material. Interview the operators to determine whether the procedure provides clear and easy to understand directions. Modify the procedure to remove any ambiguity in instructions.

5.3 Determine the homogeneity of the weathering reference material by measuring the property change of randomly selected replicate specimens that have been exposed to very tightly controlled test conditions, or by appropriate chemical analysis techniques such as ultraviolet and/or infrared spectroscopy.

5.4 For any new weathering reference material, determine the response of the reference material to critical exposure stresses. These results are important to determining whether the material being considered is appropriate for monitoring the specific conditions of the exposure test being used. Tests to determine the materials response to exposure stresses should be done in a single laboratory or a series of laboratories agreed upon by all interested parties.