Designation: G 156 – 02

Standard Practice for Selecting and Characterizing Weathering Reference Materials Used to Monitor Consistency of Conditions in an Exposure Test[1]

This standard is issued under the fixed designation G 156; 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 standard describes the criterion to be used for selection of a WRM and procedures to be used for determining within lab and between lab tolerances of changes in measured properties of a reference material intended for use in monitoring operating conditions to establish the consistency of exposure tests.

NOTE 1—Examples of laboratory accelerated tests in which a weathering reference material could be used to monitor consistency are light and water exposure tests such as those described in Practices G 152, G 153, and G 154 G 155and 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 G 7, G 24, or G 90. A reference material can also be used to monitor consistency of exposure or conditioning test that do not involve exposure to light.

1.2 This practice does not cover (1) control materials used for comparison of stability with test materials, or (2) standard materials used to time exposures.

1.3 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 region in the light source causing the changes, and effects of other critical exposure stresses such as temperature and moisture.

1.4 This practice describes procedures for conducting round-robin tests with the weathering reference material to determine reproducibility of the reference material property change in exposures conducted in different laboratories, and the repeatability when replicate reference material specimens are exposed in a single device and tested in one laboratory.

1.5 This practice describes procedures for using the results from analysis of variance on results from round-robin tests to determine the contribution of the exposure, the measurement device, reference material variability, and operator error to total variability.

2. Referenced Documents

2.1 *ASTM Standards:*

D 3980 Practice for conducting an Interlaboratory Study for Tess of Paints and Related Coatings[2]

E 177 Practice for Use of the Terms Precision and Bias in ASTM Test Methods[3]

E 691 Practice for Conducting an Interlaboratory Study to Determine Precision of a Test Method[3]

E 1169 Guide for Conducting Ruggedness Tests[3]

G 7 Practice for Atmospheric Environmental Exposure Testing of Nonmetallic Materials[4]

G 24 Practice for Conducting Exposures to Daylight Filtered Through Glass[4]

G 90 Practice for Performing Accelerated Outdoor Weathering of Nonmetallic Materials Using Concentrated Natural Sunligh[4]t

G 113 Terminology Relating to Natural and Artificial Weathering Tests of Nonmetallic Materials[4]

G 152 Practice for Operating Open Flame Carbon Arc Light Apparatus for Exposure of Nonmetallic Materials[4]

G 153 Practice for Operating Enclosed Carbon Arc Light Apparatus for Exposure of Non metallic Materials[4]

G 154 Practice for Operating Fluorescent Light Apparatus for Exposure of Nonmetallic Materials[4]

G 155 Practice for Operating Xenon-Arc Light Apparatus for Exposure of Nonmetallic Materials[4]

2.2 *SAE Standard:*

SAE J1960, Accelerated Exposure of Automotive Exterior

[1] This practice is under the jurisdiction of ASTM Committee G3 on Weathering and Durability and is the direct responsibility of Subcommittee G03.01 on Joint Weathering Projects.

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[2] Discontinued—See *Annual Book of ASTM Standards*, Vol 06.02.

[3] *Annual Book of ASTM Standards*, Vol 14.02.

[4] *Annual Book of ASTM Standards*, Vol 14.04.

Materials using a Controlled Irradiance Water-Cooled Xenon Arc Apparatus[5]

SAE J1885, Accelerated Exposure of Automotive Interior Materials Using a Controlled Irradiance Water-Cooled Xenon Arc Apparatus[5]

3. Terminology

3.1 *Definitions*—The definitions listed in Terminology G 113 are applicable to this standard.

4. Significance and Use

4.1 Weathering reference materials are used in laboratory accelerated exposure tests to establish consistency among tests run at different times and in different laboratories in the same type of device. Specifications defining consistency of exposure conditions based on the property change of a reference material are usually based on results for a single lot of the 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 reference material which exhibits a measurable change in a characteristic property when exposed in the specific type of device and exposure cycle to be monitored.

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 E 1169 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 running the test used to determine the level of 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 spectroscopic analysis.

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

[5] Available from Society of Automotive Engineers, 400 Commonwealth Drive, Warrendale, PA 15096.