Designation: D 750 – 04

Standard Practice for Rubber Deterioration Using Artificial Weathering Apparatus[1]

This standard is issued under the fixed designation D 750; 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 Department of Defense.

1. Scope

1.1 This practice covers specific variations in the test conditions and procedures which shall be applicable when Practice G 151 plus either Practices G 152, G 153, G 154, or G 155 are employed for exposure of vulcanized rubber compounds. It also covers the preparation of test specimens and the evaluation of results.

1.2 The values stated in SI units are to be regarded as the standard.

1.3 *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 and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:* [2]

D 412 Test Methods for Vulcanized Rubber and Thermoplastic Elastomers—Tension

D 925 Test Methods for Rubber Property—Staining of Surfaces (Contact, Migration, and Diffusion)

D 3182 Practice for Rubber—Materials, Equipment, and Procedures for Mixing Standard Compounds and Preparing Standard Vulcanized Sheets

D 3183 Practice for Rubber—Preparation of Pieces for Test Purposes from Products

G 151 Practice for Exposing Nonmetallic Materials in Accelerated Test Devices That Use Laboratory Light Sources

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

G 153 Practice for Operating Enclosed Carbon Arc Light Apparatus for Exposure of Nonmetallic Materials

G 154 Practice for Operating Fluorescent Light Apparatus for UV Exposure of Nonmetallic Materials

G 155 Practice for Operating Xenon Arc Light Apparatus for Exposure of Non-Metallic Materials

3. Significance and Use

3.1 This practice describes procedures to use in determining the effects of an open-flame carbon-arc light source, an enclosed carbon-arc light source, a xenon-arc light source, or a fluorescent UV light source along with heat and moisture on rubber specimens held in a jig or holder with or without a specified strain. The purpose is to attempt to accelerate the effects produced by light, heat, and moisture in the natural environment. Exposures are not intended to simulate the deterioration caused by localized weather phenomena, such as atmospheric pollution, biological attack, and saltwater exposure.

3.2 Results obtained by using any of these test procedures shall not be represented as equivalent to those of any natural exposure test until the degree of quantitative correlation has been established for the material in question.

3.3 Because of differences in the spectral power distributions of the exposure sources as well as other conditions used in the different types of laboratory weathering tests, the procedures may not result in the same performance rankings or types of failure modes of the materials. Comparisons shall not be made of the relative stabilities of materials exposed in different types of apparatus.

3.4 When conducting exposures in devices that use laboratory light sources, it is important to consider how well the artificial weathering conditions will reproduce property changes and failure modes caused by end-use environments on the materials being tested.

NOTE 1—Refer to Practice G151 for full cautionary guidance regarding laboratory weathering.

3.5 The primary criterion used in estimating resistance to light aging is the percentage decrease in tensile strength and in elongation at break. A supplementary criterion for estimating resistance to light aging is the observed extent of surface crazing and cracking.

3.6 Practices G 151, G 152, G 153, G 154, and G 155 recommend that a similar material of known performance (a control) be exposed simultaneously with the test specimen to provide a standard for comparative purposes. Preferably, two

[1] This test method is under the jurisdiction of ASTM Committee D11 on Rubber and is the direct responsibility of Subcommittee D11.15 on Degradation 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.

control materials, one known to have poor durability as well as one that has good durability should be used. The reason for using a control is that reproducibility in ranking stabilities is usually better than reproducibility of absolute changes. Therefore, the use of controls is particularly important when test materials are not being compared with one another.

4. Apparatus

4.1 Historically, this Standard utilized carbon arc exposure apparatus in a test method for rubber deterioration. The options of using either xenon arc or fluorescent UV exposure apparatus have been added in order to update the tests with the use of light sources that give a better representation of the effects of solar radiation than carbon arcs. The xenon arc source with daylight filters, whcih conforms to Practice G 155, gives the closest simulation of the full spectrum of terrestrial solar radiation and the fluorescent UV/condensation test apparatus with the UVA-340 fluorescent UV lamp, which conforms to Practice G 154, closely simulates the UV of terrestrial solar radiation in the 300 to 360 nm region.

4.2 The type of carbon-arc exposure apparatus preferred is the filtered open flame, which conforms with Practice G 152, but the enclosed carbon arc apparatus conforming with Practice G 153 may be used by mutual consent of the concerned parties.

4.3 Choice of the type of apparatus and duration of exposure shall be by mutual agreement among the interested parties.

5. Test Specimens

5.1 Unless otherwise mutually agreed upon, test specimens prepared especially for this practice or cut from the material to be evaluated shall be three tension test replicates prepared in accordance with Practices D 3182 and D 3183. An additional three tension test replicates shall be prepared and stored for testing in accordance with 7.1.3. Unless otherwise mutually agreed upon, the specimens shall have a maximum thickness of 0.75 mm (0.030 in.) and a minimum thickness 0.60 mm (0.025 in.).

5.2 If evaluation is limited only to visual observation, then specimens of any thickness may be used and the thickness shall be included in the report. Dimensions of the specimens are not critical but previous practice called for specimens 75 mm (3 in.) wide by 150 mm (6 in.) in length.

5.3 Exposing at least duplicate sets, preferably triplicate sets, of test specimens whenever possible is recommended.

5.4 Specimens cut from rubber products may be buffed.

6. Procedure

NOTE 2—Committee G03 is developing information to be published in Appendices of Practices G 151, G 152, G 153, G 154 and G 155 for guidance on uniformity of conditions in the test chambers and allowed operational fluctuations of the set points.

6.1 *Procedure for Exposure in Open Flame Carbon Arc Apparatus (Practice G152) or Enclosed Carbon Arc Apparatus (G153)*——Unless otherwise specified, use the following operating conditions:

6.1.1 The open flame carbon arc apparatus and the enclosed carbon arc apparatus shall be used with daylight type filters and conform with the spectral power distribution specifications in Practices G 152 and G 153, respectively.

6.1.2 Unless otherwise mutually agreed upon or specified, operate with a cycle cam of 102 min light followed by 18 min of light plus water spray on the front surface of the sample (see Note 3). The water spray temperature is typically 21 ± 5°C, but may be lower if ambient water temperature is low and a holding tank is not used to store purified water.

NOTE 3—This cycle is recommended only because it has long historical usage, not because it has been established for technical reasons as superior.

6.1.3 Set the uninsulated black panel temperature (BPT) at 63°C during the dry period of exposure to light.

6.1.4 Set the relative humidity at 60 % during the dry period of exposure to light.

6.1.5 The chamber air temperature shall be set at 48°C in equipment that provides for adjustment of the chamber air temperature.

6.2 *Procedure for Exposure in Xenon Arc Light Apparatus (Practice G 155)*—Unless otherwise specified, use the following operating conditions:

6.2.1 The xenon arc shall be used with daylight type filters and conform with the spectral power distribution specifications in Practice G 155.

6.2.2 Set the irradiance level at 0.55 W/(m^2·nm) at 340 nm. For equivalent broad band irradiance levels at 300 to 400 nm and 300 to 800 nm, consult the manufacturer of the apparatus.

6.2.3 The default exposure cycle shall be 102 minutes light only followed by 18 minutes light plus either water spray on the front surface or immersion in water[3]. The water spray temperature is typically 21 ± 5°C, but may be lower if ambient water temperature is low and a holding tank is not used to store purified water. The immersion water is kept at a constant temperature, which shall be less than 40°C.

NOTE 4—Water spray and immersion in water are different kinds of moisture and frequently produce different results.

6.2.4 Set the uninsulated black panel temperature (BPT) at 63°C during the dry period of exposure to light. For the equivalent insulated black panel temperature [black standard temperature (BST)], consult the manufacturer of the apparatus.

6.2.5 Relative humidity shall be set at 60 % during the dry period of exposure to light in xenon arc apparatus that provides for control of relative humidity.

6.2.6 The chamber air temperature shall be set at 48°C in equipment that provides for adjustment of the chamber air temperature.

6.3 *Procedure for Exposure in Fluorescent UV/Condensation Apparatus (Practice G154)*—Unless otherwise specified, use the following operating conditions:

6.3.1 Use fluorescent UVA-340 lamps that comply with the spectral power distribution specifications in Practice G 154.

[3] In the immersion technique, the test specimens are placed in a chamber that is periodically flooded with either recirculated or running water, which completely covers the specimens. The maximum temperature attained by a black colored specimen is determined with the black standard thermometer (BST) held under water on the same plane and distance from the surface as the test specimens. The immersion system is made from corrosion resistant materials that do not contaminate the water.

6.3.2 The irradiance level shall be set at 0.68 W/(m^2. nm) at 340 nm in apparatus with irradiance control.

6.3.3 For specimens that are less than 20 mm thick including support dimensions, the exposure cycle shall be 8 hours UV at an uninsulated black panel temperature of 60°C followed by a dark period of 4 hours with wetting by condensation at an uninsulated black panel temperature of 50°C.

6.3.4 For specimens that are more than 20 mm thick including support dimensions, the exposure cycle shall be 8 hours UV at an uninsulated black panel temperature of 60°C followed by UV plus wetting by water spray on the front surface for 4 hours. The water temperature shall be less than 40°C.

NOTE 5—Wetting by condensation is not applicable to specimens having a thickness greater than 20 mm because of inadequate heat transfer.

6.4 Firmly fasten the test specimens in a jig or holder that permits exposure either with or without elongation. While exposures are usually made without elongation of the test specimen, when mutually agreed upon, any specified amount of elongation may be employed but this must be reported in the results of the test.

6.5 The periods of exposure shall be a mutually agreed upon specified time or amount of radiant energy. For guidance on minimum exposure and periods of exposure, consult Section 8 of Practice G 151.

NOTE 6—The presence of ozone should be avoided since it can contribute to the crazing and cracking caused by light, heat and moisture.

7. Interpretation of Results

7.1 The effects of exposure shall be determined in the following manner:

7.1.1 At the conclusion of the exposure interval the specimens shall be removed from the exposure test apparatus and examined visually for indications of crazing and cracking. The number and degree of cracks and crazes shall be reported by a mutually agreed upon method.

7.1.2 The tensile strength and ultimate elongation of these replicates shall be determined in accordance with Test Methods D 412.

7.1.3 For the purpose of comparison, tensile strength and elongation of duplicate unexposed specimens of the same material shall be determined at the time the exposed replicates are tested.

8. Report

8.1 In addition to the report requirements of Practice G 151, report the following information:

8.1.1 Any variations from the specified conditions,

8.1.2 Description and dimensions of specimens,

8.1.3 Number of cracks and degree of crazing or cracking of the specimens,

8.1.4 Percentage of elongation during exposure, if any,

8.1.5 Tensile strength in kilopascals (or pounds-force per square inch) before and after exposure,

8.1.6 Ultimate elongation at break before and after exposure,

8.1.7 Percentage loss in tensile strength as a result of exposure,

8.1.8 Percentage loss in elongation at break as a result of exposure, and

8.1.9 Chlorine content of the water.

9. Keywords

9.1 enclosed carbon arc; filtered open flame carbon arc; filtered xenon arc; fluorescent UV lamps; rubber products; ultraviolet/visible light aging; weathering