Designation: D750 – 12

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

This standard is issued under the fixed designation D750; 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 that shall be applicable when Practice G151 plus either Practice G152, G153, G154, or G155 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 standard. The values given in parentheses are for information only.

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]

D412 Test Methods for Vulcanized Rubber and Thermoplastic Elastomers—Tension

D3182 Practice for Rubber—Materials, Equipment, and Procedures for Mixing Standard Compounds and Preparing Standard Vulcanized Sheets

D3183 Practice for Rubber—Preparation of Pieces for Test Purposes from Products

D4483 Practice for Evaluating Precision for Test Method Standards in the Rubber and Carbon Black Manufacturing Industries

G151 Practice for Exposing Nonmetallic Materials in Accelerated Test Devices that Use Laboratory Light Sources

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 Ultraviolet (UV) Lamp Apparatus for Exposure of Nonmetallic Materials

G155 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 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. The Significance and Use section in Practice G151 and the standard for the appropriate apparatus, that is, Practices G152, G153, G154, or G155 should be consulted for additional information on significance and use of the exposure tests.

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

3.3 Results obtained by use of these test procedures should 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.

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

3.5 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.

[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.

3.6 Practices G151, G152, G153, G154, and G155 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, a control material 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, which conforms to Practice G155, 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 G154, 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 carbon arc, which conforms with Practice G152, but the enclosed carbon arc apparatus conforming with Practice G153 may be used by mutual consent of the concerned parties.

5. Test Specimens

5.1 Unless otherwise mutually agreed upon, test specimens prepared especially for this test or cut from the material to be evaluated shall be three tension test replicates prepared in accordance with Practices D3182 and D3183. 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 should 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

6.1 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.

6.2 The four exposure procedures use different types of exposure sources and test conditions. Therefore, they may produce different test results. They shall not be used interchangeably without supporting data that demonstrates equivalency of the procedures for the materials tested. Choice of the type of apparatus and duration of exposure shall be by mutual agreement among the interested parties.

6.3 For the allowed operational fluctuations of the specified set points for irradiance, temperature, and relative humidity, refer to Table A3.1 in Practice G151. If the actual operating conditions do not comply with the maximum allowable fluctuations in Table A3.1 after the equipment has stabilized, discontinue the test and correct the cause of the problem before continuing.

6.4 Specimens should be confined to an exposure area in which the irradiance is at least 90 % of the irradiance at the center of the exposure area. Unless it is known that irradiance uniformity meets this requirement, use one of the procedures described in Practice G151, Appendix X2 to ensure equal radiant exposure on all specimens or to compensate for differences within the exposure chamber. If the specimens do not completely fill the racks, fill the empty spaces with blank metal panels to maintain the test conditions within the chamber.

6.5 The apparatus shall be operated continuously. However, if the test needs to be interrupted to perform routine maintenance or inspection, it should be during a dry period.

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

6.6.1 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 G152 and G153, respectively.

6.6.2 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 1). 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 1—This cycle is recommended only because it has long historical usage, not because it has been established for technical reasons as superior.

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

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

6.7 *Procedure for Exposure in Xenon Arc Light Apparatus (Practice G155)*—Unless otherwise specified, use the following operating conditions:

6.7.1 The xenon arc shall be used with daylight type filters and conform with the spectral power distribution specifications in Practice G155.

6.7.2 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.

6.7.3 The default exposure cycle shall be 102 min light only followed by 18 min light plus either water spray on the front surface or immersion in water.[3]

NOTE 2—Water spray and immersion in water are different kinds of moisture and frequently produce different results. Spray water can be fresh or re-circulated from a holding tank. The temperature of the spray water is uncontrolled and for fresh water is typically 21 ± 5°C. Re-circulated spray water can be at a higher temperature. Immersion water is generally in a holding tank for recirculation. The uncontrolled temperature of the re-circulated immersion water during operation of the weathering device is typically 40 ± 5°C.

6.7.4 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.

6.7.5 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.

6.7.6 The chamber air temperature shall be set at 44°C in equipment that provides for adjustment of the chamber air temperature.

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

6.8.1 Use fluorescent UVA-340 lamps that comply with the spectral power distribution specifications in Practice G154.

6.8.2 The irradiance level shall be set at 0.77 W/(m^2·nm) at 340 nm in apparatus with irradiance control.

6.8.3 The exposure cycle shall be 8 h UV at an uninsulated black panel temperature of 60°C followed by a dark period of 4 h with wetting by condensation at an uninsulated black panel temperature of 50°C.

NOTE 3—Wetting by condensation may not be applicable to specimens of insulating materials having a thickness greater than 25 mm because of inadequate heat transfer.

NOTE 4—The presence of ozone should be avoided since it can contribute to the crazing and cracking caused by light, heat, and moisture.

6.9 The periods of exposure shall be a mutually agreed upon specified time or amount of radiant energy. It shall be determined by one of the following procedures (for guidance on minimum exposure, consult Section 8 of Practice G151):

6.9.1 A mutually agreed upon specified number of hours, or

6.9.2 The number of hours of exposure required to produce mutually agreed upon minimum detectable changes in either the test specimen or an agreed upon standard sample.

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 D412.

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 G151, report the following additional 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. Precision and Bias

9.1 *Precision*—The repeatability and reproducibility of results obtained in exposures conducted according to this practice will vary with the materials being tested, the material property being measured, and the specific test conditions and cycles that are used.

9.2 *Bias*—Bias cannot be determined because no acceptable standard weathering reference materials are available.

10. Keywords

10.1 enclosed carbon arc; filtered open flame carbon arc; filtered xenon arc; rubber products; ultraviolet and ultraviolet/visible light aging; weathering

[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.