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Standard Practice for Outdoor Weathering of Construction Seals and Sealants[1]

This standard is issued under the fixed designation C 1589; 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 practice describes outdoor exposure procedures to be used as part of a test designed to determine the weathering durability of building construction, seals and sealants.

NOTE 1—See Practice G 24 for Exposures to Daylight Filtered Through Glass.

1.2 This practice is limited to the method by which the construction seals or sealants are exposed to outdoor weathering as part of a test program. It does not describe the test methods to be performed following the outdoor exposure. It is intended for specimens of any size and shape to be used in static or dynamic tests.

1.3 Means of evaluation of the effects of weathering will depend on the intended use for the test material.

1.4 The values stated in SI units are to be regarded as the standard. The values given in parentheses are for information only.

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

2. Referenced Documents

2.1 *ASTM Standards:* [2]

C 717 Terminology of Building Seals and Sealants

E 772 Terminology Relating to Solar Energy Conversion

G 7 Practice for Atmospheric Environmental Exposure Testing of Nonmetallic Materials

G 24 Practice for Conducting Exposures to Daylight Filtered Through Glass

G 84 Practice for Measurement of Time-of Wetness on Surfaces Exposed to Wetting Conditions as in Atmospheric Corrosion Testing

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

G 147 Practice for Conditioning and Handling of Nonmetallic Materials for Natural and Artificial Weathering Tests

G 178 Practice for Determining the Activation Spectrum of a Material (Wavelength Sensitivity to an Exposure Source) Using the Sharp Cut-On Filter or Spectrographic Technique

3. Terminology

3.1 *Definitions*—Definitions are found in Terminologies C 717, G 113, and E 772.

4. Significance and Use

4.1 Tests conducted in accordance with this practice are used to evaluate the stability of construction seals and sealant materials when they are exposed to outdoor weather conditions. The durability of seals and sealants in actual outdoor use can be very different depending on the location, because of differences in solar radiation, moisture, temperature, pollutants, and other factors. Sealant color may also affect durability.

4.2 The type, frequency and amount of movement of sealants varies with location and may affect durability. It cannot be assumed, therefore, that results from one exposure in a single location will be useful for determining durability in a different location. Exposures in several locations with different climates (for example, solar radiation, moisture, temperature, pollutants, biological and other factors) that represent a broad range of anticipated service conditions are recommended.

4.3 It is strongly recommended that control materials with known durability should be included with each exposure test. Control materials should be exposed along with the test specimens for the purpose of comparing the performance of test materials to the controls. It is preferable to use two control materials of similar composition and construction to the test specimens, one with relatively good durability and one with relatively poor durability. Unless otherwise specified, use at least three replicate specimens of each test and control material.

4.4 The results of short-term exposure tests can provide an indication of relative outdoor performance, but they shall not be used to predict the absolute long-term performance of a seal

[1] This practice is under the jurisdiction of ASTM Committee C24 on Building Seals and Sealants and is the direct responsibility of Subcommittee C24.40 on Weathering.

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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.

or sealant material. The results of tests conducted for less than 12 months will depend on the particular season of the year in which they begin.

4.5 Because of year-to-year climatatological variations, results from a single exposure test cannot be used to predict the absolute rate at which a seal or sealant degrades. Several years of repeat exposures are needed to get an average test result for a given location.

4.6 Climatic and construction factors can impose movement upon sealed joints in use. This movement can impact the effects of outdoor weathering. Consideration shall be given to the effect of movement when analyzing exposure results obtained on static specimens.

4.7 When combined with proper provision for natural or forced cyclic movement, this outdoor weathering procedure can also be used as an indicator of the ability of a seal or sealant to withstand climate influences and the stresses of cyclic movement.

5. Apparatus

5.1 The test site shall conform to the requirements of Practice G 7. Unless otherwise specified, position exposure racks 45° relative to horizontal, facing the equator. The angle of exposure rack, and the orientation relative to the equator can vary depending upon the application and performance criteria that are being evaluated. Consult Practice G 7 for information on other exposure rack angles.

5.2 *Specimen Holders*:

5.2.1 The specimens for most static tests under test will not be of an exact size for mounting directly onto the frame. Specimen holders shall be used to support the many sizes of specimens involved in this testing. In no case shall the specimen holder constitute a backing for that portion of the material to be evaluated.

5.2.2 The specimen holders shall be constructed of a material agreed upon by the mutual parties. Aluminum panels, glass, and marble shapes have been found suitable for static exposures.

5.2.3 The design of the specimen holders intended to induce or allow for cyclic movement (for example, testing rigs, manually adjusted vices, and fully automatic mechanical devises) shall be agreed upon by the mutual parties.

5.3 *Materials and Manner of Construction*—Test racks and hardware shall conform to the requirements of Practice G 7 and shall provide for the attachment of specimens or holders of any convenient width and length. The structural members of the test racks shall not constitute a backing to the specimens under test. Fasteners used to attach specimens to the test rack shall provide for secure attachment but allow specimens to expand or contract with thermal changes, moisture absorption or desorption, or plasticizer loss.

5.4 *Instruments for Measuring Climatological Data*:

5.4.1 *Instruments Used to Measure Ambient Temperature and Relative Humidity*—Instrument and procedures used for measurement of ambient temperature and relative humidity shall be in accordance with Practice G 7.

5.4.2 *Instruments Used to Measure Solar Radiation*—Instrument and calibration procedures used for measurement of total solar radiation, total solar ultraviolet radiation, or narrow band solar ultraviolet radiation shall be in accordance with Practice G 7.

6. Preparation of Samples

6.1 Follow the manufacturer's instructions for mixing and/or preparing materials to be tested.

6.2 It is strongly recommended that control materials and test materials be of the same dimensions.

7. Test Specimen

7.1 Exposure test specimens may be of any size or shape that can be mounted in a fixture, a holder or applied directly to the racks. They may be specimens suited to the means of evaluating the effects of weathering on specific properties, or they may be larger specimens from which smaller specimens for evaluation may be cut. The exposure test specimens shall be large enough that mounting edges may be removed where evaluation test results would be otherwise affected.

7.2 As far as practical, exposure test specimens shall simulate those used in service conditions of an end-use application. When conditions of use are known, the specimen exposed will consist of seal or sealant material being evaluated plus suitable substrate or installation materials to conform to the projected practice. The effect of substrate or installation materials is highly significant and contributes to the degradation due to reflectance, heat absorption, moisture retention, etc.

7.3 The use of replicates of each experimental material being evaluated is required in order to allow for variability.

7.4 The total number of specimens will be determined by the removal schedule and number of replicates plus file specimens. These unexposed file specimens shall be retained at conditions of 23.0 ± 2°C and 50 ± 20 % relative humidity. They shall be covered with inert opaque wrapping to exclude light during the storage period. Refer to Practice G 147 for more information on specimen handling and conditioning.

8. Test Sites

8.1 Weathering racks shall be located in cleared areas, preferably at a suitable number of climatologically different sites representing the variable conditions under which the construction seal or sealant will be used. Climatological variations within these areas may include those represented by desert, seashore (salt air), industrial locations, tropical, and subtropical regions, plus areas exhibiting a wide range of in solar radiant energy. The area beneath and in the vicinity of the weathering racks shall be typical of the ground cover in that climatological area. In desert areas in which sand is the prevailing ground cover, coarse gravel is required to prevent abrasion and significant dust accretion due to wind-blown sand (Note 2). The ground cover shall be low-cut grass in most temperate, tropical, and subtropical areas.

NOTE 2—Sand as a ground cover may be desirable where the abrasive effects of exposure to wind-blown sand is a part of the desired exposure.

9. Exposure Stages

9.1 Use one of the following methods to specify the exposure stages at which changes in properties of test specimens are determined:

NOTE 3—The same exposure stage (by whichever method is used) will not necessarily give the same changes in properties of the test specimen at different exposure sites. The exposure stages must be regarded as providing only a general indication of the degree of exposure, and the results shall always be considered in terms of characteristics of the exposure site as well. The use of control materials exposed along with the test materials can aid in evaluating performance although test results may vary at different exposure sites.

9.1.1 *Exposure Time*—Specify the duration of the exposure in terms of months (1, 3, 6, 12, 15, etc.) or-years (1, 1.5, 2, 3, 4, 5, etc.), unless otherwise instructed.

NOTE 4—The results for exposure stages of less than one year will depend on the season of the year in which the exposure was made. For instance, summer exposures are generally more severe than winter exposures. Seasonal effects are reduced in exposures of several years, but the results may still depend on the particular season in which exposure was started (for example, exposures started in spring may exhibit more degradation than exposures started in autumn).

9.1.1.1 If available, record the total full spectrum solar radiant exposure and total solar UV radiant exposure that has been measured by radiometers positioned at the same tilt and azimuth angle as the test specimens.

9.1.2 *Solar-Radiation Measurements*—Since solar radiation is one of the most important factors in the deterioration of seals or sealants during weathering, exposure stages may be defined in terms of the amount of radiation received by the specimens. Total solar radiation, total solar ultraviolet radiation or narrow band solar ultraviolet radiation, are measured by radiometers positioned at the same tilt and azimuth angle as the test specimens. An inherent limitation to timing exposures based on solar radiation is that it does not reflect the variations in temperature and moisture, which are important weathering factors in conjunction with solar radiation.

9.1.2.1 *Total Full Spectrum Solar Radiation*—Measure total full spectrum solar (nominally 300 to 2500 nm) radiant exposure using the instrumentation described in Practice G 7. The radiant energy measured shall be expressed in MJ/m^2.

9.1.2.2 *Total Solar Ultraviolet Radiation*—- Measure total solar ultraviolet (295 to 385 nm) radiant exposure using the instrumentation described in Practice G 7. The radiant energy measured shall be expressed in MJ/m^2. This is the recommended method for determining exposure stages.

9.1.2.3 *Specified Narrow-Band Solar Ultraviolet Radiation*—The UV radiant exposure in specified narrow wavelength intervals (or bands) that conform closely to the wavelengths to which the material is most sensitive may also be used to follow the exposure stages. In order to identify the narrow band that conforms closely to the wavelengths to which the material is most sensitive, it may be necessary to determine the activation spectrum of the material based on exposure to solar radiation. A procedure for this has been described by N.D. Searle[3] and is contained in Practice G 178.

10. Procedure

10.1 Mark the test specimens to be exposed with an identifying number, letter, or symbol so that they may be identified readily after exposure. The marking shall be such that there is no interference with either the exposure or the subsequent testing. (Preferably, mark both specimen and specimen holder on the side not exposed to weather, as advanced weathering can obscure even deeply scribed marks.)

10.2 Record the initial appearance and physical-property data appropriate to the evaluation method used.

10.3 Mount the test specimens in the holder or directly to the exposure rack. It is convenient to group specimens to be removed from exposure at the same time in one holder.

10.4 Record a diagram of the test specimen holder layout, and record the date of installation and length of exposure planned.

10.5 Ensure that the pyranometer is mounted at a tilt and azimuth angle that is identical to that of the test specimens.

10.6 Mount the specimens on racks for the prescribed time, solar radiant energy, or total UV radiant energy or narrow band UV radiant energy.

10.7 Establish a fixed procedure of cleaning, visual examination, conditioning, and testing of the specimens. This procedure will vary with materials, but it must be uniform in a series of tests on one material to provide comparative results.

10.8 The face of the specimen shall not be masked for the purpose of showing the effects of various exposure times on one panel. Misleading results can be obtained by this method since the masked portion of the specimen is still exposed to temperature and humidity that will affect the results in many cases.

10.9 Unexposed file specimens shall be used for visual comparison to exposed specimens at various exposure stages. Masked areas of exposed specimens may undergo changes which could affect the visual comparison.

10.10 Exposures and evaluations shall be planned to permit reporting one of the following for the test material(s) and control(s), if used:

10.10.1 Change after a specified exposure,

10.10.2 Amount of time for a specified change in properties to occur, and

10.10.3 A record of a series of measurements versus exposure.

11. Report

11.1 Report the following information:

11.1.1 Laboratory name and location,

11.1.2 Site latitude,

11.1.3 Test method and sequence of the test events,

11.1.4 Specimen mounting,

11.1.5 Observations, deviations, and waivers pertinent to the test,

11.1.6 Angle of exposure (horizontal, at-latitude, 45° or 90°), and direction of exposure,

11.1.7 Duration of exposure of each specimen at each site, and dates of exposure,

11.1.8 *Solar Radiation*:

11.1.8.1 If available, total full spectrum solar radiant exposure (nominally 300 to 2500 nm) for each exposure level, expressed in MJ/m^2.

11.1.8.2 If available, total UV radiant exposure (295 to 385 nm) for each exposure stage, expressed in MJ/m^2.

[3] Searle N. D., "Activation Spectra of Polymers and Their Application to Stabilization and Stability Testing," *Handbook of Polymer Degradation, 2nd Ed.*, S. H. Hamid, Ed., Marcel Dekker, New York, 2000, Chapter 16.

11.1.8.3 If available, solar UV radiant exposure measured in a narrow bandpass including the bandpass in which the radiant exposure was measure.

11.1.9 Description of the climate at each site and summary of the pertinent climatological data at each site for the exposure period involved, as follows:

11.1.9.1 Rainfall,

11.1.9.2 If available, time of wetness (see Practice G 84),

11.1.9.3 Temperature average and temperature extremes,

11.1.9.4 Humidity average and humidity extremes, and

11.1.9.5 Geographical location of the National Weather Service relative to the test site if climatological data is not measured at the test site.

NOTE 5—These data are intended as an indication of the climate at the test site, and the values reported are not to be used as absolute limits for any particular specimen on exposure.

12. Precision and Bias

12.1 It is not possible to specify the precision of this practice due to the highly subjective nature of weathering exposures. Bias cannot be determined due to the lack of any known reference material.

13. Keywords

13.1 construction seals; sealants; weathering