



Designation: D 4141 – 95

AMERICAN SOCIETY FOR TESTING AND MATERIALS
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Standard Practice for Conducting Accelerated Outdoor Exposure Tests of Coatings¹

This standard is issued under the fixed designation D 4141; 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 covers three accelerated outdoor exposure procedures for evaluating the exterior durability of coatings applied to metal substrates.

1.2 The three procedures are as follows:

1.2.1 *Procedure A*—Black Box Exposure,

1.2.2 *Procedure B*—Heated Black Box Exposure, and

1.2.3 *Procedure C*—Fresnel Reflector Rack Exposure.

1.3 The durability rankings of coatings provided by these three procedures may not agree when coatings differing widely in composition are compared.

1.4 The acceleration of degradation rates of coatings produced by the three procedures of exposure are discussed.

NOTE 1—Other exposure procedures may provide accelerated results for some types of products.

1.5 The values stated in either inch-pound or SI units are to be regarded separately as the standard. The values given in parentheses are for information only.

1.6 *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.* A specific precautionary statement is given in Note 5.

2. Referenced Documents

2.1 *ASTM Standards:*

D 523 Test Method for Specular Gloss²

D 660 Test Method for Evaluating Degree of Checking of Exterior Paints²

D 714 Test Method for Evaluating Degree of Blistering of Paints²

D 823 Practices for Producing Films of Uniform Thickness of Paint, Varnish, and Related Products on Test Panels²

D 1186 Test Methods for Nondestructive Measurement of Dry Film Thickness of Nonmagnetic Coatings Applied to a Ferrous Base²

¹ This practice is under the jurisdiction of ASTM Committee D-1 on Paint and Related Coatings, Materials, and Applications, and is the direct responsibility of Subcommittee D01.27 on Accelerated Tests for Protective Coatings.

Current edition approved July 15, 1995. Published September 1995. Originally published as D 4141 – 82. Last previous edition D 4141 – 93.

² *Annual Book of ASTM Standards*, Vol 06.01.

D 2244 Test Method for Calculation of Color Differences from Instrumentally Measured Color Coordinates²

D 4214 Test Methods for Evaluating Degree of Chalking of Exterior Paint Films²

G 7 Practice for Atmospheric Environmental Exposure Testing of Nonmetallic Materials³

G 90 Practice for Performing Accelerated Outdoor Weathering of Nonmetallic Materials Using Concentrated Natural Sunlight³

3. Summary of Practice

3.1 Several procedures are described that provide acceleration of the degradation that coatings experience during natural weathering. The procedures appear in the following order:

3.1.1 *Procedure A*—Exposure on a black box panel rack facing the equator at 5° from horizontal.

3.1.2 *Procedure B*—Exposure on a heated black box panel rack facing the equator at 5° from horizontal.

3.1.3 *Procedure C*—Exposure on a Fresnel reflector panel rack that provides a high intensity of sunlight irradiation by following the sun and focusing the sunlight on the test panels by means of mirrors. The panels are wet periodically by deionized water spray.⁴

3.2 Each of these procedures requires that coated test panels be placed on racks of specified design and be exposed under specified conditions of weathering.

3.3 The selection of a procedure for producing accelerated degradation is dependent on the intended end use of the coatings, limitations on the time available for the exposure tests, and the degree of reliability required for predictions of durability performance.

4. Significance and Use

4.1 The procedures described in this practice are designed to provide greater degradation rates of coatings than those provided by fixed angle open-rack outdoor exposure racks. For many products, fixed angle exposures will produce higher degradation rates than the normal end use of the material.

4.2 Following are comments regarding the relative rates of degradation that can be expected for coatings exposed by the

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

⁴ Fresnel reflector panel racks are located at Heraeus DSET Laboratories, Inc., 45601 N. 47th Avenue, Phoenix, AZ 85027-7042 and South Florida Test Service, Desert Site, 31818 N. 203rd Ave., Wittmann, AZ 85361.

procedures described in this practice.

4.2.1 Procedure A (Black Box)—For many coatings, this procedure provides greater rates of degradation than those provided by 5°, equator-facing, open-rack exposures because the black box produces higher panel temperatures during irradiation by the sun and longer time of wetness. The black box panel temperatures are comparable to those encountered on the hoods, roofs, and deck lids of automobiles parked in direct sunlight.

4.2.2 Procedure B (Heated Black Box)—This procedure is most useful for exposures conducted in the late fall, winter, and early spring when it produces significantly higher panel temperatures than those produced by the 5°, equator-facing, black box. Therefore, this procedure produces greater rates of degradation than those produced by Procedure A, particularly in the case of coatings with rates of degradation that are very temperature dependent.

NOTE 2—The relative rates of gloss loss and color change produced in some automotive and coil coatings by exposures in accordance with Procedures A and B are given in ASTM STP 781.⁵

4.2.3 Procedure C (Fresnel Reflector Rack)—This method provides greater rates of degradation of coatings than those provided by Procedure A or Procedure B. This high acceleration is produced by very high sunlight intensity and high panel temperature.

4.2.4 The degradation rates produced by any of the three procedures depend on the seasons of exposure, geographical location, and type of coating. The rates are higher in late spring, summer, and early fall when the intensity of sunlight irradiation is the greatest and when panel temperatures are higher.

4.2.5 Because outdoor weather conditions vary from season to season and year to year, these procedures are not reliable for establishing absolute performance ratings for coatings. The procedures should be used only for comparing the relative performance of coatings exposed at the same time at the same location.

PROCEDURE A—BLACK BOX EXPOSURE

5. Apparatus

5.1 Black Box, constructed of materials in accordance with Practice G 7, or its equivalent, and positioned so that the surfaces of the test specimens are 5° from the horizontal, facing the equator.

6. Test Specimens

6.1 Each test specimen and control specimen shall consist of a uniform coating applied to the surface of a rigid panel. Suitable application procedures are given in Practices D 823.

6.2 Use surfaces of good planarity because warpage, waviness, or curvature may seriously affect the measurements of gloss and color and may produce a poor air seal on the black box rack.

6.3 Prepare reference specimens for inclusion in each exposure series to act as comparison standards and to provide a

means for determining the severity of the exposure conditions encountered by the series. For best results, there should be at least two reference materials differing significantly in their durability performance.

6.4 Optionally, using Test Methods D 1186, measure the dry film thickness of the coatings at several different positions on the test specimens.

7. Procedure

7.1 If change in gloss is to be measured, determine the specular gloss value for each unexposed specimen using a properly calibrated glossmeter in accordance with Test Method D 523.

7.2 If change in color is to be measured, determine the color coordinates for each unexposed specimen using Test Method D 2244. Unless otherwise agreed upon, use the CIE Lab Color Scale. The color-measuring instrument shall be stable and properly calibrated.

NOTE 3—As an alternative procedure, reserve unexposed duplicate specimen panels of each coating as file specimens to determine the color change of the exposed specimens. To minimize color drift, store these panels in a dark, room temperature environment.

7.3 Mount and fasten the specimens on the exposure box. Cover all empty spaces on the black box using black panels so that the entire surface is covered.

NOTE 4—The predominant color of the specimen panels on the black box as well as the temperature of a standard panel should be noted. A black panel on the box will attain a lower temperature if all the other panels are white than if all the other panels are black.

7.4 Expose the test and reference specimens for a specified period of time on the basis of one of the following:

7.4.1 Expose for a specified number of days, months, or years with respect to an agreed upon starting date.

7.4.2 Expose for a specified quantity of radiant exposure either total, typically measured from 300 to 3000 nm, or ultraviolet, typically measured from 300 to 385 nm.

7.4.2.1 For Procedures A and B, when solar ultraviolet radiation is measured, use a total ultraviolet radiometer that measures ultraviolet radiation in the wavelength region from 295 to 385 nm.⁶ Calibrate the radiometer and readout system in suitable radiometric units, and maintain in at least annual calibration against a standard source of spectral irradiance.⁷

7.4.2.2 For Procedure C, use the measurement technique specified in Practice G 90.

7.4.3 Exposure until a specified physical change has occurred in the test specimens, or

7.4.4 Exposure until a specified change has occurred in a reference specimen exposed with the test specimens.

7.5 Unless otherwise agreed upon, remove the test specimens from the black box and gently wash a portion of the

⁶ Model TUVR Total Ultraviolet Radiometer manufactured by the Eppley Laboratory, 12 Sheffield Ave., Newport, RI 02804, has been found to be suitable for this purpose. Instruments manufactured with quartz diffusers (typically prior to 1988) should be returned to the manufacturer for installation of a TFE-fluorocarbon diffuser and a recalibration.

⁷ Suitable calibrations may be obtained from some manufacturers, and from the Eppley Laboratory, 12 Sheffield Ave., Newport, RI 02804. Any large decrease in sensitivity from one calibration to another (5 to 10 %) requires that the diffuser be removed and the internal filter visually checked for water damage.

⁵ *Symposium on Permanence of Organic Coatings, ASTM STP 781, ASTM, 1982.*