Designation: D1006/D1006M – 21

Standard Practice for Conducting Exterior Exposure Tests of Hand and Factory Applied Paints on Wood and Wood Composite Materials[1]

This standard is issued under the fixed designation D1006/D1006M; 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 U.S. Department of Defense.

1. Scope*

1.1 This practice covers procedures to be followed for direct exposure of house and trim paints on new, previously unpainted wood and wood composite materials to the environment. When originators of a weathering test have the actual exposure conducted by a separate agency, the specific conditions for the exposure of test and control specimens should be clearly defined and mutually agreed upon between all parties.

1.2 This standard covers specimen preparation including the application of the test paint to the wood substrate.

1.3 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system are not necessarily exact equivalents; therefore, to ensure conformance with the standard, each system shall be used independently of the other, and values from the two systems shall not be combined.

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

1.5 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D523 Test Method for Specular Gloss

D660 Test Method for Evaluating Degree of Checking of Exterior Paints

D661 Test Method for Evaluating Degree of Cracking of Exterior Paints

D714 Test Method for Evaluating Degree of Blistering of Paints

D772 Test Method for Evaluating Degree of Flaking (Scaling) of Exterior Paints

D2244 Practice for Calculation of Color Tolerances and Color Differences from Instrumentally Measured Color Coordinates

D4214 Test Methods for Evaluating the Degree of Chalking of Exterior Paint Films

D5237 Guide for Evaluating Fabric Softeners

D6132 Test Method for Nondestructive Measurement of Dry Film Thickness of Applied Organic Coatings Using an Ultrasonic Coating Thickness Gage

D7787 Practice for Selecting Wood Substrates for Weathering Evaluations of Architectural Coatings

E122 Practice for Calculating Sample Size to Estimate, With Specified Precision, the Average for a Characteristic of a Lot or Process

E1677 Specification for Air Barrier (AB) Material or Assemblies for Low-Rise Framed Building Walls

G7 Practice for Atmospheric Environmental Exposure Testing of Nonmetallic Materials

G113 Terminology Relating to Natural and Artificial Weathering Tests of Nonmetallic Materials

G147 Practice for Conditioning and Handling of Nonmetallic Materials for Natural and Artificial Weathering Tests

3. Terminology

3.1 *Definitions*—The definitions given in Terminology G113 are applicable to this practice.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *rainscreen, n*—a system of construction where the siding stands off from the moisture-resistant surface of a building wall, creating an air gap to allow drainage and ventilation.

[1] This practice is under the jurisdiction of ASTM Committee D01 on Paint and Related Coatings, Materials, and Applications and is the direct responsibility of Subcommittee D01.27 on Accelerated Testing.

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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.

***A Summary of Changes section appears at the end of this standard**

4. Significance and Use

4.1 The procedure described in this practice is intended to aid in evaluating the performance of house and trim paints to new, previously unpainted wood.

4.2 The relative durability of paints in outdoor exposures can be very different depending on the location of the exposure because of differences in solar radiation, time of wetness, temperature, pollutants, and other factors. Therefore, it cannot be assumed that results from one exposure in a single location will be useful for determining relative durability in a different location. Exposures in several locations with different climates which represent a broad range of anticipated service conditions are recommended.

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

4.2.2 Solar radiation varies considerably as function of time of year. This can cause large differences in the apparent rate of degradation in many paints. Comparing results for materials exposed for short periods (less than one year) is not recommended unless materials are exposed at the same time in the same location.

4.2.3 It is recommended that at least three replicates of each material be tested. A statistical estimate of the number of replicates needed based on parameters known about the material can be found in Practice E122.

4.3 The Significance and Use section in Practice G7 addresses many variables to be considered in exterior exposure tests.

5. Location of Test Sites and Exposure Orientation

5.1 *Test Sites*—The climatic conditions of the test sites should be representative of those of the area in which the paints are to be used. The type and rate of failure of a paint film will vary when exposed to different combinations of climatic and atmospheric conditions. For reliable results, exposure sites should be selected that are representative geographically, climatically, and in atmospheric contaminations with those of the locality in which the paint will be used. To obtain conclusions that are valid for paints with national distribution requires exposure at several sites, selected to cover a wide range in climatic conditions. Suggested sites include South Florida, the Great Lakes region, the hot desert southwest, the northeast, and extreme southern Louisiana.

5.2 *Exposure Orientation*—Unless otherwise specified, specimens for testing house paint should be exposed on vertical test fixtures facing either north or south, or both. In comparisons where dirt collection and mildew resistance are not pertinent, north vertical exposures may be omitted. Test fixtures shall be placed in a location so that there is no shadow on any specimen when the sun's angle of elevation is greater than 20°. Specimens can be exposed at north or south orientations or other " exposure angles" in order to focus on the degradation mode desired. Typical exposure angles are as follows:

5.2.1 *Vertical North (Northern Hemisphere)*—Exposure rack is positioned so that the exposed surfaces of specimens are vertical (90°) facing north, away from the equator. This orientation encourages the growth of biological organisms since the amount of direct sunlight reaching the specimens is reduced or completely eliminated depending on latitude.

5.2.2 *Vertical South (Northern Hemisphere)*—Exposure rack is positioned so that the exposed surfaces of the specimens are vertical (90°) facing south, toward the equator. This orientation allows direct sunlight to reach the specimens and results in degradation commonly associated with ultraviolet exposure.

5.2.3 *Other Exposure Orientations*—If desired, exposures may also be conducted at other angles or facing directions to provide faster results. See Practice G7 for more information on other exposure options.

NOTE 1—A 45 degree exposure facing the equator may speed up the deterioration compared to a vertical exposure, but the change in angle may also change the type of failure mode.

5.3 In the case where it is desirable to expose coated panels in a sheltered area, such as under eaves, a suitable test rack with a sheltered or eave arrangement can be used.

6. Construction of Test Fixtures (Exposed Racks)

6.1 Test fixtures should be durable and rigid enough to withstand the effects of weather. All materials used for test fixtures shall be either treated wood or noncorrodible metal without surface treatment. Aluminum Alloys 6061T6 or 6063T6 have been found suitable for use in most locations. Properly primed and coated steel is suitable for use in desert areas.

6.2 *Test Fixture Design*—Test racks of several different designs are currently used for the exposure testing of paints on wood. Test racks for the exposure of paints and trims that more closely simulate end-use applications, including under eave and rainscreen exposures, are presented fully in Appendix X1. Test racks that are commonly used for the exposure of wood siding boards, primarily for the evaluation of mildew growth, dirt accumulation, and color change are shown in Fig. 1. These racks can be configured to hold specimens or specimen holders of any convenient width and length. Adjustable racks can be used to accommodate specimens of different lengths. An offset design (notched cutouts) in the mounting hardware shall be used in order to avoid contamination from specimens mounted above other specimens. Offsets shall be of the proper size to accommodate the width of the siding board. Typically, 152-mm [6-in.] or 230-mm [9-in.] sized offsets are used. Other sizes are available. An example of an offset mounting hardware is shown in Fig. 2.

6.3 To create a sheltered eave type exposure, place a 90 degree cap along the top of the exposure rack which projects 25 mm [1 in.] beyond the face of the mounted panels.

7. Construction of Test Specimens

7.1 Choose a wood substrate in accordance with Practice D7787. Prior to use, test lumber and panels shall be stored under such conditions that the moisture content of the wood will be maintained within the normal range for exterior

FIG. 1 Typical Exposure Rack

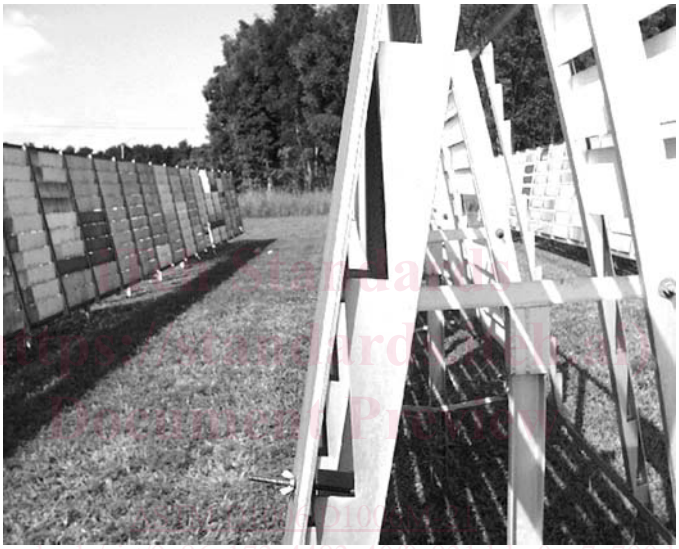

FIG. 2 Offset Mounting Hardware

woodwork in the region in which the tests are conducted. Exposures on wood substrates should be performed on three panels to allow for variations in wood. In selecting wood test boards, care should be taken to consider features of cladding that may be present in usage environments such as variations and orientation of grain patterns, age, and presence of knots.

7.2 For house paints, unless the pattern of siding requires some other choice, test panels should be made of one or the other of two patterns of siding, namely 127-mm [0.5-in.] or 190-mm [0.75-in.] bevel siding or 25-mm [1-in.] by 152-mm [6-in.] drop siding. A test panel may be subdivided into two or more test areas. A subdivided panel is one complete panel in which multiple paint specimens are applied to sections of the panel. If the panels in the house paint test are not subdivided, one 914-mm [3-ft] length of 152-mm siding will be acceptable. If the panels are subdivided, each test area shall be a minimum of 152-mm in length.

7.3 For trim paints, the test panel may have 25-mm [1-in.] by 102-mm [4-in.] pieces of lumber at each end.

7.4 For exposures of paints on test fixtures described in 6.2 and Fig. 1, a test panel should be a 914-mm [36-in.] length of 152-mm [6-in.] siding substrate unless otherwise agreed upon. Each area shall be a minimum of 152 mm in length. Each test area can be painted with a different paint thus providing a side-by-side comparison for performance.

NOTE 2—It is important to remember that up to 75 mm [3 in.] of each end of the test panel will be masked by the exposure rack.

7.5 When it will not interfere with the property to be tested, all panels should be coated on the back to protect against warping.

8. Use of Control or Reference Materials

8.1 When several paints are being compared, one paint should be selected as a “control.” The control paint should be applied to one area of each test panel. Variations caused by wood differences are revealed in the performance of the control paint, and can be used to adjust the ratings of other paints to a common basis. For best results there should be two controls, one known to perform well and one known to perform poorly.

9. Specimen Preparation

9.1 All materials being compared in a single study shall be prepared within a thirty-day period. All specimens in a single

study shall start testing on the same day. Any deviation from this mounting procedure shall be documented in the test report.

9.2 It is best in theory and practice to do the painting outdoors in proper weather for painting; however, indoor painting is permissible provided no more than one week (72 h is the preferred maximum time) elapses between the successive coats. Furthermore, all painting must be performed under essentially the same drying conditions. It is necessary to allow each coat to cure sufficiently before top coating. Ensure the top coating is sufficiently cured before sending out the panels for outdoor exposure. See Practice G147 for more instructions. Factory finish wood products shall be prepared using the exact factory finish system (not hand painted).

NOTE 3—If coated panels are shipped to the exposure location before the coating is fully cured, the surfaces of the panels may stick to each other and may not be able to be separated without damaging the surface.

9.3 The preferred procedure is to apply paints with the test panel in a vertical position and kept vertical until the paint has set. If paint is spread on horizontal panels, the panels should be placed vertically immediately thereafter.

9.4 Paint must be applied according to manufacturer recommendations. Some manufacturers specify spread rate, others, paint dry film thickness (DFT) and number of coats. Prior to exposure, it is recommended to check actual DFT for selected samples using appropriate ASTM standards (Guide D5237 or, if applicable due to wood surface texture, Test Method D6132).

9.5 It is strongly recommended to report the moisture content (MC) in painted wood, if specified by the manufacturer. MC should be within the range expected for the sheltered exterior exposed wood in the region where the paint will be sold. It is also recommended to report wood drying history (green or kiln dried, kiln cycles and temperature - if known).

9.6 Records should be kept of the spreading rates at which paints are applied. When the purpose of the tests is to compare commercial paints, it may be appropriate to let the painter apply them at their natural spreading rates. When the purpose is to study variation in the paint composition, application should usually be at suitable predetermined spreading rates that can be controlled by applying a given weight or volume of coating to a measured area.

10. Procedure

10.1 After the panels have been prepared, identify each specimen with a unique mark that will not be destroyed or become illegible during the exposure. Practice G147 provides guidance for this procedure.

10.2 Measure the desired properties on all test and reference control specimens prior to exposure.

10.3 Mount the specimens on the correctly oriented exposure rack that accommodates the dimensions of the specimens being exposed.

10.4 Perform the exposure test in accordance with the guidelines in Practices G7 and G147.

10.5 Select one of the methods for defining the duration of the exposure in accordance with Practice G7.

11. Inspection and Records

11.1 After the panels have been exposed to the weather, inspections should be made after not more than one month, at three months, and at intervals of three months during the first two years, and every six months thereafter. Characteristics to be evaluated may include checking Test Method D660, cracking Test Method D661, flaking Test Method D772, blistering Test Method D714, chalking Test Methods D4214, color change Practice D2244, gloss change Test Method D523, microbiological fouling, local discoloration over knots, paint failure on resin pockets, tannin bleeding, etc. Midwinter inspections, however, may be omitted or delayed in higher latitudes if the specimens are covered in snow or ice. Inspections may be made more frequently if desired. Usually the exposures should be continued for a considerable length of time after deterioration has reached the point at which best practice calls for repainting.

NOTE 4—It is better to omit a report or delay the evaluation if there is a possibility of damaging the specimens when thawing them out in order to see the surface.

11.2 Records should be kept on report forms agreed upon between the purchaser and the seller.

12. Report

12.1 The report section shall contain the following information when applicable and available. In most cases, commercial testing agencies used to perform exposures may not have specific information about the materials used or preparation of the test specimens and, therefore, cannot be reported.

12.1.1 Complete description of the test specimens and any control and weathering materials used, including:

12.1.1.1 Composition, including description of substrate to which the paint is applied,

12.1.1.2 Method of preparation (reference applicable standards here),

12.1.1.3 Paint spread rate,

12.1.1.4 Drying temperature,

12.1.1.5 Recoat time, and

12.1.1.6 Dry film thickness.

12.1.2 Location of exposure (including whether specimens were exposed at ground level, on a rooftop, and so forth).

12.1.3 Ground cover in area of test racks.

12.1.4 Angle and facing directions at which exposure was conducted.

12.1.5 Type of exposure (unbacked or backed). If backed exposure is used, include thickness and type of backing and, if painted, the color of paint used to paint the backing.

12.1.6 Date exposure started and date exposure completed.

12.1.7 If required, solar radiant energy for all exposures oriented towards the equator including the wavelength bandpass in which radiant energy is measured. All solar radiant energy reported should be measured in accordance with Practice G7.

12.1.8 If used, details of any specimen treatment such as washing conducted during the exposure. Include description of the treatment used and the frequency of treatment.

12.1.9 If required, the following climate information:

12.1.9.1 Ambient temperature (daily maximum and minimum),

12.1.9.2 Relative humidity (daily maximum and minimum),

12.1.9.3 Total hours of wetness and method used to measure,

12.1.9.4 Rainfall in millimetres, and

12.1.9.5 Concentration of pollutants such as NO_2, SO_2, O_3, and method used to measure the concentration.

12.1.10 Results of property measurements and inspections, if required or conducted before and after exposure. This shall include a description of the method used to measure the property.

13. Precision and Bias

13.1 *Precision:*

13.1.1 Repeatability and reproducibility of results obtained by this practice will vary depending on the materials being tested, the material property being measured, the climate in which the exposures are conducted, and year-to-year differences in climate at a single location. Therefore, no specific statement about the absolute precision of the results obtained by this practice can be made.

13.1.2 Comparison of test materials to control materials exposed at the same time has been shown to reduce the effects of variability in exposure tests.[3]

13.2 *Bias*—Bias in results obtained in accordance with this practice will vary with the materials being tested, the material property being measured, the climate in which the exposures are conducted, and year-to-year differences in climate at a single location. In addition, no acceptable standard reference materials are available for the myriad of material weathering property responses.

14. Keywords

14.1 durability; exposure; weathering

[3] Fisher, R., "Results of Round Robin Studies of Light and Water Exposure Standard Practices," Accelerated and Outdoor Durability Testing of Organic Materials, ASTM STP 1202, Warren D. Ketola and Doug Grossman, Eds, ASTM, 1993.

APPENDIX

X1. CONSTRUCTION OF TEST RACK AND TEST PANELS FOR OVERLAPPING EXPOSURES

X1.1 The plan for the test rack and panels described in this appendix conforms to the principles set forth in this practice. It represents only one of numerous possible embodiments of the principles recommended. Typically the clapboard panels are mounted directly in an offset frame as shown in Fig. 1 and Fig. 2, but the following description has been used when overlapping exposures are needed for clapboards or trim boards.

X1.2 *Construction of Test Rack:*

X1.2.1 The test fence, or test rack, runs east and west, and may be constructed to hold test panels on one or both sides so that there are panels facing either or both North and South. There are multiple rows of panels, one above the other. A 90° cap may be placed along the top of the rack, and if used projects approximately 25 mm [1 in.] beyond the face of the mounted panels. The rack must be sufficiently sturdy in construction to withstand strong winds. It is mounted on posts that are permanently anchored to prevent the rack from falling over.

X1.2.2 Fig. X1.1 shows one span or unit. The rack can be extended to as many units as the site permits or as needed for the number of exposure tests to be made. Additional fences may be built parallel to one another, but they must be spaced far enough apart to keep each fence from casting shadows on the adjacent fences during all but the first 2 h after sunrise and the last 2 h before sunset at the time of the winter solstice.

X1.2.3 When cleated panels of drop siding, which do not have backing, are used, there shall be some means provided to protect the backs of the panels from the weather.

X1.3 *Construction of Test Panels:*

X1.3.1 *House Paints*—The boards of siding are assembled in a manner similar to house construction. Five pieces of 13 by 150-mm [½ by 6-in.] bevel siding are nailed securely on a backing of 6-mm [¼-in.] plywood exterior grade, as shown in Fig. X1.2. The top board is a blank connecting board, cut to narrower width and painted as hereinafter described. The other four boards are test boards: they may be all of one species or two each of two different species. The overlap between boards should be not less than 25 mm [1 in.]. When being installed with nails or screws, these fasteners shall be applied to the test fence according to the manufacturer's instructions in terms of fastener position, fastener type, and siding overlap. If a manufacturer's recommendation is not available, corrosion-resistant nails, 28 mm [1-⅛ in.] long, should be used and should be spaced as indicated, and clinched on the back. The lower edge of the bottom board is shimmed out from the plywood with a wood shim and the bottom board projects 6 mm [¼ in.] beyond the shim in order to permit insertion of a panel underneath. The top of the panel, which is a blank board precoated with chalk-resisting exterior paint such as aluminum paint, is cut to a width of 115 mm [4½ in.]; the cutting makes a suitable shim for use under the bottom board. The plywood projects 13 mm [½ in.] beyond the boards at the ends and 25 mm [1 in.] at the bottom; at the top the plywood projects 50 mm [2 in.] beyond the top of the second board and is overlapped by about 65 mm [2½ in.] by the top blank board. Holes are bored through the top blank board as indicated to permit positioning of the panel on the rack by means of small pegs. Holes are bored through the projecting ends of the plywood to permit secure fastening of the panels to the rack by means of wood clamps held in position by bolts with wing nuts as indicated (see also Fig. X1.1).