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Designation: D 2199 – 82 (Reapproved 1987)

Standard Method for Measurement of Plasticizer Migration From Vinyl Fabrics to Lacquers[1]

This standard is issued under the fixed designation D 2199; 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 method covers an accelerated test for the measurement of a tendency for plasticizers in finished vinyl fabric to be transferred to coatings with which they come in contact.

NOTE—Age of fabric sample may affect results of test. To ensure most reliable results, test with fabric sample closest in age to what will be coated.

1.2 *This standard does not purport to address all of the safety problems, 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. Summary of Method

2.1 A small sample of vinyl fabric is placed on a conditioned coating film under a pressure of ½ psi (3.45 kPa). The assembly is placed in an oven for 3 days at elevated temperature. At the end of that time, the coating is examined for marring or softening. For coatings that may block or print at 50°C or lower, a lower test temperature and a longer test time may have to be used.

3. Significance and Use

3.1 Plasticizers in finished vinyl fabric can be transferred to coatings with which they come in contact. When this takes place, objectionable marring and softening occur. This method covers an accelerated test for measurement of this tendency.

4. Apparatus

4.1 *Drawdown Blade*, 5-mils (125-μm) clearance to provide a wet film of approximately 2.5 mils (63 μm) in thickness.

4.2 *Plate Glass Panels.*

4.3 *Window Glass*, 2 by 2-in. (51 by 51-mm) square, double strength.

4.4 *Sponge Rubber*, 2 by 2-in. (51 by 51-mm) square by ¼ in. (6.3 mm) thick.

4.5 *Weights*, flat-bottom, sufficient to place a total weight of 2 lb (910 g) on each test sample.

4.6 *Forced-Convection Oven*, thermostatically controlled to ±2°C.

4.7 *Photograph Roller.*[2]

4.8 *Aluminum Foil.*

5. Procedure

5.1 Apply the coating to the glass panel with the drawdown blade to provide a uniform film with an area of at least a 2-in. (51-mm) square and a dry thickness of at least 1 mil (25 μm) or as agreed upon. Dry the coating in accordance with the recommendations of the manufacturer or for a minimum of 24 h at room temperature and 2 h at 50°C.

5.2 Preheat the glass plate bearing the coating, the 2 by 2-in. glass square, and the weights for 30 min at 50°C. Place the square of vinyl fabric on the coating with care and ensure intimate contact by rolling with the photographic roller. Cover the fabric with foil, sponge rubber, glass, and weight in that order. The total weight shall be 2 lb (910 g).

5.3 Place the assembly in the forced convection oven at a temperature of 50°C for 72 h. After removal from the oven and cooling, remove the weight, sponge rubber, and aluminum foil, and carefully remove the vinyl fabric. Note and report any resistance to removal. Wipe the surface of the fabric with a soft rag dampened with heptane and examine for removal of exuded plasticizer.

6. Rating

6.1 Rate the degree of migration by viewing the surface of the coating at a low angle against the light within 2 h after termination of heating and within 15 min of removal of the fabric.

7. Report

7.1 Report marring or softening, or both, on the scale of no change, faint imprint, severe imprint, or marring.

7.2 If plasticizer is evident when the surface is wiped, this shall be reported.

8. Precision

8.1 This method does not result in a numerical value for precision but repeated tests have demonstrated that several laboratories will assign the same rating to various coating fabric combinations. Also, replicate tests by one laboratory are in good agreement.

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[1] This method is under the jurisdiction of ASTM Committee D-1 on Paint and Related Coatings and Materials and is the direct responsibility of Subcommittee D01.55 Factory-Applied Coatings on Preformed Products.

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[2] A squeegee-type roller is satisfactory.

Designation: D 2200 – 91

Swedish Standards Association
Standard SIS 05 59 00
Steel Structures Painting Council
SSPC-Vis 1
Danish Standards Association
Danish Standard DS 2019
European Committee of Paint and Printing
Ink Manufacturers' Association

Standard
Pictorial Surface Preparation Standards for Painting Steel Surfaces[1]

This standard is issued under the fixed designation D 2200; 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 The visual surface preparation standards consist of a series of color prints available as separate publications. Two different sets of photographs are described in this standard, designated as Method A (ISO/Swedish Standard[2]) and Method B (SSPC Standard[3]). The two methods differ in the depiction of the initial surface, in the definition and depiction of the cleaning conditions, and in the number of cleaning methods included. Because of these differences, the specifier should state whether Method A or Method B should be used.

The colored visual surface preparation standards represent different conditions of hot rolled steel before and after surface preparation. Prior to cleaning, there are four rust grades, A to D, that cover the range from intact mill scale to 100 % rusted and pitted steel. The standards then depict the appearance of the four grades after cleaning by one or more methods (for example, blast cleaning) to various degrees of thoroughness.

2. Referenced Documents

2.1 *Adjuncts:*
Pictorial Surface Preparation Standards[2]
Surface Cleanliness Definitions[3]

3. Terminology

3.1 *Definitions:*

3.1.1 The cleanliness definitions for the Method A visual surface preparation standard appear in the text of the pictorial surface preparation standards publication.[2] The definitions for Method B are found in a separate publication.[3]

4. Significance and Use

4.1 The appearance of the various degrees of blast cleaning are influenced by the initial rust grades of the steel being cleaned. The standards aid visually in judging and evaluating the degree of rusting before cleaning and the degree of cleaning of steel surfaces prior to painting.

4.2 Two methods for visual standards have evolved because of differences in the practice of using visual standards throughout the world. In Europe, the visual standards (Method A) are used as the primary means of determining the degree of cleaning. In the US, the SSPC written definitions take precedence with the visual standards used as a supplement. The visual standards of Method B comply with the SSPC definitions.

5. Procedure and Interpretation

Method A—ISO/Swedish Standard

5.1 Determine the method of cleaning to be used (for example, hand/power tool cleaning, abrasive blast cleaning, or flame cleaning).

5.2 Determine the initial condition of the steel in accordance with four initial grades (A, B, C, or D).

5.3 Following the cleaning operation, compare the surface prepared with the photographs showing the degree of thoroughness for that particular initial condition. Select the degree that most closely corresponds to the prepared surface.

5.4 Repeat the procedure for representative areas of structure and record all three items (initial condition, method of cleaning, and degree of thoroughness achieved).

Method B, SSPC Visual Standard

5.5 Determine the degree of blast cleaning to be employed.

5.6 Determine the initial condition of steel in accordance with photographs A, B, C, and D.

5.7 Following the cleaning operation, compare the prepared surface with the photographs showing the degree of thoroughness for that particular initial condition. Select the degree that most closely corresponds to the prepared surface.

5.8 Repeat for all representative areas of structure and record for each area the initial condition and degree of thoroughness achieved.

5.9 When abrasives other than silica sand are used for

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[1] This standard is under the jurisdiction of ASTM Committee D-1 on Paint and Related Coatings and Materials and is the direct responsibility of Subcommittee D01.46 on Industrial Protective Coatings.

The pictorial standards described were prepared by the Swedish Corrosion Inst. and have been jointly approved by ASTM, the Steel Structures Painting Council (Vis 1), and the Swedish Standardizing Commission.

Current edition approved Sept. 15, 1991. Published November 1991. Originally published as D 2200 – 66. Last previous edition D 2200 – 85 (1989).

[2] The pictorial surface preparation standards are available from ASTM Headquarters (request Adjunct No. 12-422000-00); the Steel Structures Painting Council, 4400 Fifth Ave., Pittsburgh, PA 15213; and Sveriges Standardiseringskommission, Box 3295, Stockholm 3, Sweden.

[3] The Visual Standards Method B and surface cleanliness definitions are available from the Steel Structures Painting Council, 4400 Fifth Avenue, Pittsburgh, PA 15213.

blast cleaning, consult the photographs in the appendix of the SSPC Standard for possible variations in appearance created by the abrasive type.

NOTE 1—Different steel surfaces show differences in shade, color, tone, pitting, flaking, mill scale, etc. To some extent, these differences between the actual steel surface and the visual standard can be reconciled between the painting contractor and the inspector.

6. Keywords

6.1 blast cleaning; flame cleaning; photographic standards for surface preparation; power tool cleaning; surface preparation; surface preparation standards

Designation: D 2205 - 85 (Reapproved 1990)$^{\epsilon1}$

Standard Guide for Selection of Tests for Traffic Paints[1]

This standard is issued under the fixed designation D 2205; 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.

$^{\epsilon1}$ NOTE—Sections 12 and 13 were editorially changed in March 1990.

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1. Scope

1.1 This guide covers the selection and use of procedures for testing traffic paints in the laboratory and in the field.

1.2 This guide covers the testing of a ready-mixed paint product of sprayable consistency that shall be suitable for use as a reflecting traffic guide on paved roadways.

1.3 *This standard does not purport to address the safety problems 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:*

C 219 Terminology Relating to Hydraulic Cement[2]
D 8 Terminology Relating to Materials for Roads and Pavements[3]
D 16 Terminology Relating to Paint, Varnish, Lacquer, and Related Products[4]
D 154 Guide for Testing Varnishes[4]
D 185 Test Methods for Coarse Particles in Pigments, Pastes, and Paints[5]
D 215 Methods of Chemical Analysis of White Linseed Oil Paints[5]
D 562 Test Method for Consistency of Paints Using the Stormer Viscometer[4]
D 711 Test Method for No-Pick-Up Time of Traffic Paint[6]
D 713 Practice for Conducting Road Service Tests on Fluid Traffic Marking Materials[6]
D 868 Test Method for Evaluating Degree of Bleeding of Traffic Paint[6]
D 869 Test Method for Evaluating Degree of Settling of Paint[6]
D 870 Practice for Testing Water Resistance of Coatings Using Water Immersion[4]
D 913 Test Methods for Evaluating Degree of Resistance to Wear of Traffic Paint[6]
D 968 Test Methods for Abrasion Resistance of Organic Coatings by Falling Abrasive[4]
D 969 Test Method for Laboratory Determination of Degree of Bleeding of Traffic Paint[6]
D 1210 Test Method for Fineness of Dispersion of Pigment-Vehicle Systems[4]
D 1309 Test Method for Settling Properties of Traffic Paints During Storage[6]
D 1475 Test Method for Density of Paint, Varnish, Lacquer, and Related Products[4]
D 1644 Test Methods for Nonvolatile Content of Varnishes[4]
D 1647 Test Methods for Resistance of Dried Films of Varnishes to Water and Alkali[5]
D 1729 Practice for Visual Evaluation of Color Differences of Opaque Materials[4]
D 1737 Test Method for Elongation of Attached Organic Coatings with Cylindrical Mandrel Apparatus[8]
D 2244 Test Method for Calculation of Color Differences from Instrumentally Measured Color Coordinates[4]
D 2371 Test Method for Pigment Content of Solvent-Reducible Paints[4]
D 2372 Method of Separation of Vehicle from Solvent-Reducible Paints[4]
D 4061 Test Method for Retroreflectance of Horizontal Coatings[4]
E 97 Test Method for Directional Reflectance Factor, 45-deg 0-deg, of Opaque Specimens by Broad-Band Filter Reflectometry[9]
E 308 Method for Computing the Colors of Objects by Using the CIE System[4]

2.2. *U.S. Federal Test Methods Standard 141B:*[10]
4121 Dry Opacity

3. Terminology

3.1 *Definitions*—For definitions used in this guide, refer to Terminology C 219 and Definitions D 8 and D 16.

4. Summary of Guide

4.1 This guide consists of the following tests that, although not exhaustive, cover the areas normally of concern in traffic paint testing:

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[1] This guide is under the jurisdiction of ASTM Committee D-1 on Paint and Related Coatings and Materials and is the direct responsibility of Subcommittee D01.44 on Traffic Coatings.

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[2] *Annual Book of ASTM Standards*, Vol 04.01.

[3] *Annual Book of ASTM Standards*, Vols 04.02 and 04.03.

[4] *Annual Book of ASTM Standards*, Vol 06.01.

[5] *Annual Book of ASTM Standards*, Vol 06.03.

[6] *Annual Book of ASTM Standards*, Vol. 06.02.

[7] *Annual Book of ASTM Standards*, Vol 14.02.

[8] Discontinued; see *1988 Annual Book of ASTM Standards*, Vol 06.01.

[9] Discontinued; see *1991 Annual Book of ASTM Standards*, Vol 06.01.

[10] Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094.

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Field Evaluations	25 through 29

5. Conditions Affecting Traffic Paint

5.1 Practical requirements for traffic paint may vary with:

5.1.1 Substrate type, such as portland cement and asphaltic concretes, and the various coarse aggregates used therein.

5.1.2 Climatic conditions, both generally and specifically, at the time of paint application.

5.1.3 Service density, such as heavy traffic areas in cities versus lightly traveled rural highways and parking lots.

5.1.4 Traffic type, whether light passenger cars or heavy trucks and airplanes.

5.1.5 Presence of foreign matter on the road surface, such as oil, old paint, skid marks, sand, salt, concrete curing compound, etc.

5.2 New portland cement concrete surfaces have a greater degree of moisture and alkalinity than older surfaces and thereby adversely affect paint adhesion. Paint adhesion is also affected by the ratio of cement to fine aggregate, coarse aggregate, and mixing water, as well as by the surface character of the aggregate that can range from impervious smooth quartz to irregular, porous slag.

LIQUID PAINT PROPERTIES

6. Skinning

6.1 Paints containing a binder that dries by oxidation are subject to skin formation in a partially filled can or by diffusion of air into a filled can. Since skins are insoluble in the paint they must be removed before use. The referenced test employs a partially filled container to indicate the tendency of a paint to skin. A typical minimum time for skinning is 18 to 24 h.

6.2 Examine the original sample for skins both on the surface and in the mass. Using a well-mixed, skin-free portion of the sample, perform a skinning test in accordance with Guide D 154, except use a 1-pt (0.5-L) friction-top can instead of an 8-oz (0.25-L) jar.

7. Coarse Particles

7.1 Paints must be free of oversize particles and foreign matter to avoid clogging application equipment, a typical maximum being 1 % by weight of total paint. The referenced test with a 325-mesh (45-μm) screen gives the percent of this material in the paint.

7.2 Determine coarse particles in accordance with Test Methods D 185.

NOTE 1—This test is not used for traffic paint containing pre-mixed glass beads.

8. Fineness of Dispersion

8.1 The more finely a pigment is dispersed, the more efficiently it is being used. One method for measuring the degree of dispersion (commonly referred to as "fineness of grind") is to draw the material down a calibrated, tapered groove in a hardened steel block with the groove varying in depth from 4 to 0 mils (100 to 0 μm). The point at which continuous groupings of particles or agglomerates, or both, protrude through the surface of the liquid is taken as the fineness reading. Lower readings in mils or micrometres or higher reading in Hegman units indicate better fineness of dispersion.

8.2 Fineness of grind is not generally specified for traffic paint but some application equipment may require a limit of 1 to 2 Hegman units (3 to 3.5 mils, 75 to 90 μm). If additional assurance is needed that the paint will not clog application equipment, determine the fineness in accordance with Test Method D 1210 after reducing the traffic paint with mineral spirits, or compatible aromatic solvent with a similar evaporation rate, to keep the film wet long enough to determine the end point more easily. When a premix traffic paint is being tested, conduct the test on the paint before addition of the beads.

9. Density or Weight per Gallon

9.1 Density as measured by weight per unit volume is not a performance characteristic but is used to check product uniformity from batch to batch. A calibrated weight per gallon cup is used.

9.2 For an unbeaded paint, determine the density in accordance with Test Method D 1475.

9.3 For beaded paints, use a special weight-per-gallon cup[11] having a modified cap so that the beads do not interfere with a snug fit of the cap to the cup. Proceed in accordance with Test Method D 1475.

10. Consistency

10.1 Paints of a given type should fall within a stated consistency range as agreed upon between the purchaser and the seller. Consistency is used mainly to ensure product uniformity. Improper consistency, however, can adversely affect application properties, and in turn, paint performance.

10.2 Determine consistency using the Stormer viscometer in accordance with Test Method D 562. If the requirement is in Krebs units, Table 1 of Test Method D 562 permits changing seconds to KU.

11. Package Stability

11.1 Since paints are not normally used immediately after manufacture, they must remain stable in the can for some time, which for traffic paints does not generally exceed 6 months. Although package stability can usually be determined by alternatively heating and cooling a specimen, occasionally the results do not coincide with storage at normal temperature. The referenced methods determine the degree of pigment settling after 2 weeks cycling or after 6 months storage at room temperature. These are usually sufficient as it is difficult to rate numerically the ease of redispersing an aged traffic paint.

11.2 Determine the degree of pigment settling in the accelerated test in accordance with Test Method D 1309. Determine the degree of pigment settling and ease of

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[11] A satisfactory modified cup is available from BYK-Gardner, Inc., Gardner Laboratory, 2435 Linden Lane, Silver Spring, MD 20910.

remixing a shelf-aged specimen in accordance with Test Method D 869.

APPLICATION AND APPEARANCE PROPERTIES

12. Drying Time

12.1 The drying time of a traffic paint is particularly important because it determines how quickly a lane can be opened to free flow of traffic without the paint being transferred to adjacent pavement.

12.2 Though no-pick-up time as determined by Test Method D 711 has no direct correlation with field application, it is employed as a quality control test.

13. Bleeding

13.1 Bleeding refers to the passage of colored matter such as bitumen from an asphalt pavement through the traffic paint film. It is a function of the age of the asphalt, its compatability with the paint, and the speed of drying of the paint. Typical traffic paints give results of 6 to 10 on an arbitrary scale of photographic standards where 10 is no bleeding and 2 is considerable bleeding. Determine bleeding in accordance with Test Methods D 868 and D 969.

14. Hiding Power

14.1 Hiding power or opacity is a measure of the ability of a paint to hide the substrate. It varies, naturally, with the thickness of the applied film that may be influenced by the flow and application properties of the paint.

14.2 Determine the dry hiding power of traffic paints in accordance with Procedure A, Method 4121 of U.S. Federal Test Method Standard 141B. (This method is being rewritten in ASTM form.)

15. Color and Color Difference

15.1 The color of a paint may be determined precisely by means of a spectrophotometer. However, the exact color is not usually as important as how closely a paint matches a standard. Color difference between a product and a standard can be determined visually or with less elaborate instruments than for color measurement. Visual comparison of color is fast and often acceptable although numerical values are not obtained. Color difference instruments, while not more sensitive than the eye, provide numerical values that can be subsequently compared to later measurements.

15.2 If required, determine the color in terms of tristimulus values or chromaticity coordinates in accordance with Method E 308.

15.3 Determine color difference by visual comparison against standard color chips[12] in accordance with Practice D 1729. This practice covers the spectral photometric, and geometric characteristics of light source, illuminating and viewing conditions, size of specimens, and general procedures to be used in the visual evaluation of color differences of opaque materials.

15.4 Determine color difference instrumentally in accordance with Test Method D 2244. The method covers the instrumental measurement of small color differences observable in daylight illumination between nonfluorescent, nonmetameric, opaque surfaces.

16. Reflectance

16.1 Reflectance is a measure of the light reflected from the surface of a paint. It determines which of two specimens appears lighter when viewed in average daylight at an angle that eliminates gloss effects.

16.2 Determine the green filter reflectance in accordance with Test Method E 97.

17. Night Visibility or Retroreflectance of Beaded Paints at Low Angles

17.1 This property is important to traffic paint but visibility at night is not related to daylight reflectance. The retroreflectance evaluation of test panels coated with traffic paint should be in accordance with Test Method D 4061. Such panels can serve as controls in monitoring the application of traffic paint and can be helpful in correlating visual ratings with absolute values.

PROPERTIES OF THE DRIED FILM

18. Resistance to Wear

18.1 Resistance to wear is a measure of the ability of the dried film to withstand wear from traffic and from objects rolled or pulled across the surface. In the referenced method abrasive is poured onto a dry film on a glass panel until the paint is removed. A typical value for traffic paint is 65 L of sand for removal of a 3-mil (75-μm) dry film. Determine resistance to wear in accordance with Test Method D 913.

18.2 Using unbeaded traffic paint, determine the abrasion resistance to falling sand or silicon carbide in accordance with Test Methods D 968.

19. Elongation

19.1 Elongation is a measure of the flexibility of a paint film. Traffic paints may have difficulty in meeting the referenced test if they are over-pigmented to obtain high reflectance.

19.2 Using unbeaded traffic paint, determine the flexibility in accordance with Test Method D 1737 but using 30-gage (0.32-mm) tin plate in place of the specified steel panel.

19.2.1 As the thickness and curing conditions are not specified in Test Method D 1737, one of the following alternatives should be used for testing traffic paint:

19.2.1.1 Apply a 15-mil (380-μm) wet film, allow to air dry 18 h, bake 2 h at 50°C, and let cool before conducting the test with a ½-in. (12.7-mm) mandrel.

19.2.1.2 Apply a 10-mil (250-μm) wet film, allow to air dry 24 h, bake 1 h at 65°C, cool, and use a ¼-in. (6.4-mm) mandrel.

19.2.1.3 Apply a 6-mil (150-μm) wet film, bake 6 h at 100°C, cool, and use a ¼-in. (6.4-mm) mandrel.

20. Water Resistance

20.1 This property is important to traffic paints because they are frequently exposed to rain or condensation on bridges. The immersion test time is quite short in relation to

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[12] Standard yellow color chips may be obtained from the Traffic Control Systems Div., HTO-20, Office of Traffic Operations, Federal Highway Administration, Washington, DC 20590.

actual exposure so that the test detects only paints with poor water resistance.

20.2 Using unbeaded paint, determine water resistance in accordance with either Practice D 870 or Test Methods D 1647.

20.3 As Practice D 870 specifies steel panels but not the immersion time, while Test Methods D 1647 requires tin plate and an immersion of 18 h, the following should be used for testing traffic paint: apply a 5-mil (130-µm) wet film to a clean glass panel, allow to air dry for 72 h, immerse in reagent water for 24 h, and allow a recovery period of 2 h before examining.

ANALYSIS OF PAINT

21. Chemical Analysis

21.1 If a specification requires certain raw materials or certain components in a given amount, then chemical analysis is necessary to determine whether the specified materials are present in the required amounts. Analysis does not necessarily establish paint quality that can also be greatly affected by manufacturing techniques. Select test procedures from Methods D 215 and other ASTM methods that are pertinent to the components of traffic paints.

NOTE 2—No single schematic analysis is comprehensive enough to cover the wide variety of traffic paint compositions.

22. Nonvolatile Content (Paint)

22.1 The percent nonvolatile matter indicates the amount of material remaining after the solvent evaporates and is a measure of the film solids. Determine the nonvolatile content in accordance with Test Methods D 1644 using a larger specimen size in the case of beaded paint. It is suggested that the methods be selected as follows:

22.1.1 *Test Method A*—3 h at 105°C for paints where the nonsolvent components decompose at 149°C, and

22.1.2 *Test Method B*—10 min at 149°C for most paints where the nonsolvent components are reasonably stable at 149°C.

23. Pigment Content

23.1 Pigment gives paint its hiding and color and influences many other properties. Determine the percent pigment in accordance with Test Method D 2371.

24. Binder Content

24.1 The nonvolatile vehicle is that portion of the film-forming solids in a paint other than the pigment. It is not to be confused with the nonvolatile portion of the vehicle. Subtract the pigment content from the nonvolatile content to obtain the nonvolatile vehicle content. If desired, separate the vehicle for further analysis in accordance with Method D 2372.

FIELD EVALUATIONS

25. Road Service Test

25.1 Whereas numerous laboratory tests in the previous sections indicate general suitability of traffic paint, and also batch-to-batch uniformity, these tests cannot predict performance under all possible end uses. Accordingly, the test paint should be applied in a repeatable manner under carefully stated conditions of end use and then tested, observed, and evaluated at stated times throughout the useful life of the paint.

25.2 Proceed in accordance with Practice D 713, being careful to record the value of each variable stated.

26. Retroreflectance

26.1 Since there is no acceptable instrumental method of evaluating the retroreflectance in the field of the glass spheres on (in) the traffic paint stripe (Note 4), the following two visual methods are extensively used: (*1*) rating longitudinal stripes from a car traveling at approximately 20 to 35 mph and requiring a test line 50 ft (15 m) long, and (*2*) rating transverse test stripes in the wheel tracks with tungsten illumination from the side of the road with eye and light source (held chest high) and separated by a distance that corresponds to the observation angle of a driver viewing the stripes on a highway.

26.1.1 These ratings are based on a scale of 10 (complete (100 %) retroreflectance) to 0 (no retroreflectance).

NOTE 3—The wheel track is the area extending 9 in. (230 mm) to each side of the point of greatest wear.

NOTE 4—An instrumental method with much greater precision is being developed.

27. Durability

27.1 The test line rating is based on the paint film remaining at the time of inspection when estimated by close observation with the unaided eye. The rating is on the scale from 0 to 10, the latter representing 100 % remaining, a rating of 9 representing 90 % remaining, etc.

28. Appearance

28.1 This is the complete impression conveyed when the test stripe is viewed at a distance of at least 10 ft (3 m). Any discoloration of the surface due to bleeding, dirt collection, darkening, fading, mold growth, etc. will affect the rating that is also on the scale from 10 to 0.

29. Length of Useful Life

29.1 The length of useful life is the length of time (in days) between application of the test lines and when the weighted rating first reaches a value of 4, or when any specific quality (appearance, durability, or night visibility) first reaches the numerical rating of 3, whichever is the lesser number of days.

29.2 When it is necessary to calculate the "length of useful life," calculate as follows (Practice D 713):

$$L = D \times (10 - 4)/(10 - R) = 6D/(10 - R)$$

where:

L = length of useful life,

D = number of days the test stripe has been on the road, and

R = weighted rating at time of calculation.

Designation: D 2243 – 90

Standard Test Method for Freeze-Thaw Resistance of Water-Borne Coatings[1]

This standard is issued under the fixed designation D 2243; 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 test method has been approved for use by agencies of the Department of Defense to replace Method 3012 of Federal Test Method Standard No. 141 and for listing in the DoD Index of Specifications and Standards.

1. Scope

1.1 This test method covers the determination of the extent to which water-borne coating retain their original properties free of detrimental changes.

1.2 *This standard does not purport to address all of the safety problems 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:*

D 562 Test Method for Consistency of Paints Using the Stormer Viscometer[2]

D 2196 Test methods for Rheological Properties of Non-Newtonian Materials By Rotational (Brookfield) Viscometer[2]

3. Apparatus

3.1 *Test Chamber*—A suitable cabinet, room, or enclosure space large enough to contain the specimens to be tested permitting at least 1 in. (25 mm) of air space between the sides of adjacent cans and capable of being maintained continuously at a temperature of 0°F (−18°C).

NOTE 1—Although a variation of the test chamber temperature of ±3.5°F (±2°C) is allowed, the test chamber temperature should be maintained as near 0°F (−18°C) as practicable and the amount of variation should be recorded and reported.

3.2 *Viscometer*—A Stormer viscometer with paddle type rotor as described in Test Method D 562 or a Brookfield viscometer as described in Test Methods D 2196.

3.3 *Test Charts*—Smooth surface paper charts having adjacent black and white areas, and coated with a suitable varnish or lacquer to render the surface impermeable to paint liquids.

3.4 *Paint Brush*, 1 in. (25 mm).

4. Preparation of Sample and Specimens

4.1 Prepare specimens for testing by filling 1-pt (500 mL) resin-lined, friction-top cans two thirds full. Ensure that the bulk sample from which the cans are filled is well stirred and uniform, that the containers used are clean, and that the lids are applied promptly to the cans to prevent evaporation losses. Two such specimens are required for each test.

5. Exposure to Test Conditions

5.1 Store one can at room temperature and identify this as the control specimen.

5.2 Place the second can, the paint under test, identified as the "test specimen", in the chamber maintained at 0°F (−18°C) in such a manner that it does not touch the walls or bottom of the chamber and so that free circulation of air around it is permitted. The placing of cans on racks that raise them off the bottom of the chamber or upon pieces of insulating board resting on the bottom is suggested. In the case of several test specimens, maintain a minimum of 1 in. (25 mm) of air space between adjacent cans and between cans and the chamber walls. Keep the test specimen in the chamber for 17 h and then remove and allow to stand for 7 h undisturbed at room temperature, adjacent to the control specimen, for a complete freeze-thaw cycle of 24 h.

5.3 Repeat 5.2 for additional freeze-thaw cycles, as many as agreed on between cooperating laboratories or buyer and seller (One to five cycles are usual.).

6. Examination

6.1 After completion of the agreed or specified number of cycles, before stirring, examine both specimens for condition in the can, observing and rating any evidence of settling, gelation, coagulation, lumpiness, etc. as slight, moderate or pronounced.

6.2 Then stir the specimens and determine their viscosities in accordance with Test Method D 562 or Test Methods D 2196, and record the temperature of measurement.

NOTE 2—Stir specimens by hand in their can using a stainless steel paint spatula with a blade measuring approximately 5 by ¾ in. (125 by 20 mm). Stir carefully so as to avoid air entrainment and foam.

NOTE 3—In carrying out consistency determinations using Test Method D 562, specimens should be maintained in 77°F (25°C) until two successive readings agree within 5 g. As is the case with all non-Newtonian fluids, viscosity variation is dependent to a degree upon intensity and duration of agitation. Utmost care should be taken that control and test specimens receive identical treatment during all stirring operations.

6.3 Immediately following the viscosity determinations, apply both specimens of paint to a test panel (3.3) by means of a clean 1-in. (25-mm) brush. Allow to dry at least 24 h, then compare the test specimen with the control. Note any changes in hiding power, gloss, speckiness, agglomeration, coagulation, or color as slight, moderate or pronounced.

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[1] This test method is under the jurisdiction of ASTM Committee D-1 on Paint and Related Coatings and Materials and is the direct responsibility of Subcommittee D01.42 on Architectural Finishes.

Current edition approved Oct. 26, 1990. Published December 1990. Originally published as D 2243 - 64 T. Last previous edition D 2243 - 82 (1987)$^{\epsilon 1}$.

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

7. Report

7.1 Report on the condition of the paint in the can, in accordance with 6.1.

7.2 Report the viscosities of the test and control specimens, and the temperature of measurement, in accordance with 6.2.

7.3 Report comparatively on the visible dry film characteristics of the test and control specimens, in accordance with 6.3.

8. Precision

8.1 The precision of this test method in regard to viscosities is as specified in Test Methods D 562 or D 2196, whichever is employed.

8.2 No precision statement is made in regard to the other properties, because of the subjective nature of the observations.

9. Keywords

9.1 freeze-thaw resistance; package stability

Designation: D 2336 – 87 (Reapproved 1991)$^{\epsilon 1}$

Standard Practice for Specifying Properties from Liquid Through Cured State for Coatings Factory Applied to Wood Products[1]

This standard is issued under the fixed designation D 2336; 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.

$^{\epsilon 1}$ NOTE—Keywords were added editorially in August 1991.

1. Scope

1.1 This practice summarizes the test methods that may be used to assist in quality control during application and in specifying pigmented coatings that shall be used in factory finishing of wood products.

1.2 This practice is not intended for use by the consumer of coated wood products in specifying such coated wood products.

1.3 *This standard does not purport to address all of the safety problems, 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:*

D 154 Guide for Testing Varnishes[2]
D 523 Test Method for Specular Gloss[2]
D 562 Test Method for Consistency of Paints Using the Stormer Viscometer[2]
D 869 Test Method for Evaluating Degree of Settling of Paint[3]
D 1005 Test Methods for Measurement of Dry-Film Thickness of Organic Coatings Using Micrometers[2]
D 1186 Test Methods for Nondestructive Measurement of Dry Film Thickness of Nonmagnetic Coatings Applied to a Ferrous Base[2]
D 1200 Test Method for Viscosity by Ford Viscosity Cup[2]
D 1210 Test Method for Fineness of Dispersion of Pigment-Vehicle Systems[2]
D 1212 Methods for Measurement of Wet Film Thickness of Organic Coatings[2]
D 1400 Test Method for Nondestructive Measurement of Dry Film Thickness of Nonconductive Coatings Applied to a Nonferrous Metal Base[2]
D 1474 Test Methods for Indentation Hardness of Organic Coatings[2]
D 1475 Test Method for Density of Paint, Varnish, Lacquer, and Related Products[2]
D 1644 Test Methods for Nonvolatile Content of Varnishes[2]
D 1729 Practice for Visual Evaluation of Color Differences of Opaque Materials[2]
D 2196 Test Methods for Rheological Properties of Non-Newtonian Materials by Rotational (Brookfield) Viscometer[2]
D 2197 Test Methods for Adhesion of Organic Coatings by Scrape Adhesion[2]
D 2244 Test Method for Calculation of Color Differences from Instrumentally Measured Color Coordinates[2]
D 2691 Test Methods for Microscopical Measurement of Dry Film Thickness of Coatings on Wood Products[4]
D 2793 Test Method for Block Resistance of Organic Coatings on Wood Substrates[3]
D 2801 Test Method for Leveling Characteristics of Paints by Draw-Down Method[5]
D 2805 Test Method for Hiding Power of Paints by Reflectometry[2]
D 3003 Test Method for Pressure Mottling and Blocking Resistance of Organic Coatings on Metal Substrates[3]
D 3259 Practice for Infrared Determination of the Temperature of Applied Coatings on Wood Products During the Curing Cycle[3]
D 3278 Test Methods for Flash Point of Liquids by Seta-Flash Closed-Cup Apparatus[2]
D 3359 Test Methods for Measuring Adhesion by Tape Test[2]
D 3960 Practice for Determining Volatile Organic Content (VOC) of Paints and Related Coatings[2]

2.2 *U.S. Federal Test Method:*

141b/3011 Condition in Container[6]

3. Significance and Use

3.1 Control of the parameters that are measured by the test methods outlined in this practice has been found to be the primary determinant of coating quality and reproducibility in the package, during coating application and on the coated product. Accurate measurement is essential if such control is to be achieved.

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[1] This practice is under the jurisdiction of ASTM Committee D-1 on Paint and Related Coatings and Materials and is the direct responsibility of Subcomittee D01.52 on Factory-Coated Wood Building Products.

Current edition approved Oct. 30, 1987. Published December 1987. Originally published as D 2336 – 65 T. Last previous edition D 2336 – 81.

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

[3] *Annual Book of ASTM Standards*, Vol. 06.02.

[4] Discontinued; see *1992 Annual Book of ASTM Standards*, Vol 06.01.

[5] Discontinued; see *1989 Annual Book of ASTM Standards*, Vol 06.01.

[6] Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094.

4. Characteristics in the Package

4.1 *Skinning, Settling, and Condition in the Container:*

4.2 Settling is determined in accordance with Test Method D 869, and by Federal Test Method No. 141b, Method 3011 which also covers condition in the container. Both of these methods are designed for trade sales type paints rather than industrial coatings, but could be adapted satisfactorily.

4.3 Skinning can occur in a partially filled container. Remove insoluble skins and perform a skinning test on a well-mixed portion in accordance with Guide D 154.

4.4 *Consistency*—Consistency of a paint varies considerably depending upon the type of instrument used to measure it. Consistency is determined in accordance with Test Method D 562 and Test Method D 1200. For most coatings therer is not a straight line relationship between Stormer viscosity, a rotational method, and Ford cup viscosity, an efflux method. (The Zahn efflux cup and the Brookfield Rotational Viscometer (Test Methods D 2196) are also used widely by the paint industry.)

4.4.1 Most factory wood finishing is done with airless spray, curtain coating, or roller coating techniques. It is doubtful that any single method of viscosity measurement is truly indicative of the ability of coatings to be applied by production methods or, more especially, to be applied satisfactorily by curtain coating.

4.4.2 These methods are useful in that once a certain formula has been established, control of the viscosity by either method helps to ensure subsequent reproduction of that formula. In this way, they would be useful in specifying previously qualified coatings for factory finishing of wood products.

4.5 *Fineness of Dispersion*—The fineness of dispersion determined in accordance with Test Method D 1210, is based on visual observation of a few of the largest size particles remaining in a coating after dispersion. In itself, the test does not indicate the degree of dispersion of the bulk of the pigment in the coating except that when batches are dispersed in similar equipment the ratio of large particles remaining in the coating to the dispersion of the bulk of the pigment tends to remain constant. Therefore, if in an enamel with satisfactory gloss no particles remain that are above a size of 0.5 mil (7 Hegman dispersion), then successive batches of that coating having a similar Hegman rating can be said to have a good enamel grind. Hiding power and color control along with fineness of dispersion control should be adequate to ensure proper dispersion.

4.6 *Weight per Gallon*—Weight per gallon is determined in accordance with Test Method D 1475 to ensure batch-to-batch and composition product uniformity. This method is not related to the quality of the coatings per se.

4.7 *Nonvolatile Content*—Non-volatile content is determined in accordance with Test Methods D 1644 as another measure of coating uniformity and of the amount of film-forming material provided.

4.8 *Volatile Organic Content (VOC)*—VOC is determined in accordance with Practice D 3960 both to ensure coating uniformity and to comply with governmental regulation where required.

4.9 *Flash Point*—Flash point is determined in accordance with Test Methods D 3278 as a measure of the degree of flammability or fire hazard of a coating material.

5. Coating Characteristics During and Immediately After Application

5.1 *Flow*—Flow is a property related to consistency, but it is influenced by other factors such as rate and order of solvent release. Visual observation of the leveling of a coating film during and after drying and the tendency of the film to sag during application and drying are usually adequate to determine flow. However, Test Method D 2801 may be used if desired.

5.2 *Gloss*—Specular gloss may be determined in accordance with Test Method D 523.

5.3 *Hiding Power*—Hiding power determined in accordance with Test Method D 2805 is a measure of the ability of a paint to hide the substrate. It is dependent upon uniform film thickness which is influenced by flow and leveling.

5.4 *Wet Film Thickness*—The thickness of a wet paint film is determined in accordance with Test Methods D 1212 as a rapid indication that the required amount of coating has been applied.

6. Coating Characteristics During and Immediately After Curing

6.1 *Curing Temperature*—The temperature of a coating film during the curing cycle is an important quality control parameter and should be monitored. Practice D 3259, discusses several infrared measuring instruments that can be used for such monitoring. Infrared measuring instruments can be based on the measurement of carefully filtered narrow bands of infrared energy emitted from test surfaces and can be unaffected by surface color or gloss. Thermocouples have been used but are subject to the defects that metals are good heat conductors and do not necessarily absorb heat from infrared radiation at the same rate as the paint film. Better results are obtained with portable pyrometers if they are preheated slightly above the operating temperature. Papers impregnated with wax powders of varying melting points have been suggested also. These tend to absorb infrared energy faster than most wet paint films and, therefore, give higher temperatures than actual.

6.2 *Film Thickness*—Measurement of film thickness in accordance with Test Methods D 1005, is designed for use on plane rigid surfaces such as metal or glass. It can be adapted to forest products by the simple use of an auxiliary panel of metal or glass placed alongside the wood substrate and coated in the identical way that the wood substrate is coated. Test Methods D 1400 or D 1186 also could be adapted to the forest products industry in a similar manner. This is a simpler but perhaps less accurate method. This adaptation leads to a measurement of application rate rather than to a true measurement of film thickness of the coating on a wood product because of the possibility of penetration by the coating into the wood product. Test Methods D 2691 gives a method for measuring the actual film thickness present on a wood products substrate.

6.3 *Hardness*—The measurement of hardness of coating films by means of an indenter, as described in Test Methods D 1474, calls for the measurement of film hardness on smooth, rigid substrates such as glass or metal. There may be some question as to its applicability on films applied to some of the softer forest products substrates. However, if the films are thick enough (1.5 mils or greater), it should be applicable on the harder forest products substrate.

6.4 *Color Difference*—Color difference between a product and the standard can be measured instrumentally. Generally, the tolerance is agreed upon by the purchaser and the seller and may also be required if a product specification is involved. Although color instruments are not more sensitive than the eye, and Practice D 1729 may be used for visual evaluation of color differences, color instruments do provide numerical values that can be subsequently compared to later measurements. Test Method D 2244 covers the instrumental determination of small color differences observable in daylight illumination between nonfluorescent, nonmetameric, or opaque surfaces such as coated specimens. If metamerism is suspected, visual evaluation should be used to verify the results.

6.5 *Adhesion*—There are no available ASTM test methods directly applicable to measuring adhesion on forest products substrates. It has been found that the available test methods have poor precision even on hard, smooth substrates. They would probably be even less satisfactory on wood substrates. Two methods that might give some indication of adhesion are Test Methods D 2197 and D 3359.

6.6 *Blocking*—Many coated wood products are immediately stacked after curing. Often they are subject to "blocking" or sticking together if improperly coated or cured. Test Method D 2793[7] may be used to detect and quantify the degree of blocking. It may be used as a control test to detect this condition during the coating operation.

7. Keywords

7.1 cured properties; factory application; wood coatings; wood products

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[7] Subcommittee D01.52 is developing a revision to Test Method D 3003 to replace Test Method D 2793.

Designation: D 2337 - 84 (Reapproved 1989)

Standard Test Method for Freeze-Thaw Stability of Multicolor Lacquers[1]

This standard is issued under the fixed designation D 2337; 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 test method covers the determination of the extent to which multicolor lacquers resist coagulation and coalescence when subjected to freezing and subsequent thawing.

1.2 *This standard may involve hazardous materials, operations, and equipment. This standard does not purport to address all of the safety problems 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 Document

2.1 *ASTM Standard:*

D 562 Test Method for Consistency of Paints Using the Stormer Viscometer[2]

3. Summary of Test Method

3.1 Specimens of multicolor lacquers are placed in a chamber maintained at a temperature between −10 and −15°F (−23 and −26°C) and allowed to remain 24 h. The specimens are removed from the chamber and allowed to remain at room temperature for 24 h to reach thermal equilibrium. After the specimens are mixed and the viscosity adjusted, they are then sprayed and allowed to dry before comparing with the control standard sprayed from the original specimen.

4. Significance and Use

4.1 Waterborne coatings, when subjected to cycles of freezing and thawing, can undergo detrimental changes in application and performance characteristics. This test method evaluates the ability of multicolor lacquers to resist these changes.

5. Apparatus and Materials

5.1 *Cabinet, Room, or Enclosed Space,* large enough to contain the specimens to be tested and allowing at least 1 in. (25 mm) of air space between the sides of adjacent cans. It should be capable of being maintained at a temperature between −10 and −15°F (−23 and −26°C).

5.2 *Stormer Viscometer,* with paddle-type rotor.

5.3 *Spray Gun,* pressure-feed internal-mix type, tip 0.086 in. (2 mm) in diameter with wide-spray nozzle.

5.4 *White Paper Stock,* minimum size 8 by 11 in. (200 by 280 mm).

6. Preparation of Samples

6.1 For all gloss and semigloss multicolor lacquers, prepare ten 1-qt (1-L) specimens and for flat multicolor lacquers four 1-qt specimens for testing. Mix the sample from which the specimens are filled well by boxing so that it is of a uniform consistency and appearance. After recording the consistency reading as determined with a Stormer viscometer (in accordance with Test Method D 562 fill all samples in baked varnish-lined containers and apply the lids promptly to prevent evaporation loss).

7. Preparation of Control Standard

7.1 Prepare a control standard by spraying from one of the 1-qt (1-L) specimens of each product to be tested. Use a coated white paper stock and spray on a sheet at least 8 by 11 in. (200 by 280 mm) in size. Adjust the fluid and atomizing pressures to give a spreading rate of 150 to 200 ft^2/gal (3.7 to 4.9 m^2/L) for complete covering and 200 to 300 ft^2/gal (4.9 to 7.35 m^2/L) for scatter coat application.

8. Exposure of Samples to Test Conditions

8.1 Place nine specimens of all gloss and semigloss multicolor lacquers and three specimens of all flat multicolor lacquers under test in the chamber that is maintained between −10 and −15°F (−23 and −26°C). Place the specimens on racks in such a manner that they do not touch the walls or bottom of the chamber and so that there is at least 1 in. (25 mm) of air space between adjacent specimens. On each cycle allow all specimens to remain in the chamber for 24 h before removal. Remove from the chamber all specimens of each multicolor lacquer and let them come to thermal equilibrium by allowing them to remain at room temperature (77°F (25°C)) for 24 h. Mix these specimens to a uniform consistency by boxing. Run a minimum of three specimens and all specimens shall pass the test for multicolor to be acceptable.

9. Examination of Samples and Spray After Test

9.1 Check the consistency of all specimens on the Stormer viscometer after each test cycle and adjust if necessary by adding water to the viscosity of the original before testing. Spray three specimens after each cycle on white paper stock using the same equipment and adjustments of the spray gun that were used to spray the control standard. Allow the sprayed panels to dry thoroughly (16 h) and compare with the control standard in each case for color, particle size, and pattern of the background as well as the accent colors.

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[1] This test method is under the jurisdiction of ASTM Committee D-1 on Paint and Related Coatings and Materials and is the direct reponsibility of Subcommittee D01.55 on Factory-Applied Coatings on Preformed Products.

Current edition approved Nov. 14, 1984. Published January 1985. Originally published as D 2337 - 65 T. Last previous edition D 2337 - 68 (1979)$^{\epsilon 1}$.

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

10. Report

10.1 Report significant change in color, particle size, or tendency to show coalescence or coagulation when compared with the control standard. To be considered satisfactory for freeze-thaw resistance, all gloss and semigloss multicolor lacquers shall show a satisfactory appearance after three cycles and all flat multicolor lacquers shall show a satisfactory appearance after one cycle.

11. Precision

11.1 It is recognized that the seller has no control over the conditions under which the purchaser will apply multicolor lacquer finishes and, therefore, meaningful estimates of precision cannot be given. In round-robin tests fairly good agreement was obtained by the cooperators as long as the same equipment was used to spray the multicolor before and after the test.

Standard Test Method for Determining Particle Size of Multicolor Lacquers[1]

This standard is issued under the fixed designation D 2338; 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.

$^{\epsilon 1}$ NOTE—Editorial changes were made throughout, including the title, in April 1989.

1. Scope

1.1 This test method employs photographic reference standards to evaluate the particle size of multicolor lacquers.

1.2 *This standard may involve hazardous materials, operations, and equipment. This standard does not purport to address all of the safety problems 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 Adjuncts:*
Grain Sizes (5 photos)[2]

3. Summary of Test Method

3.1 The samples to be tested are mixed by pouring from one container to another until they are uniform in consistency before spraying on coated white paper stock. After the lacquers are dry they are compared with photographic reference standards to determine the particle size.

4. Significance and Use

4.1 This test method provides a uniform nomenclature for the producer and user in the identification of the various particle sizes used in the manufacture of nitrocellulose-type multicolor lacquers.

5. Reference Standards

5.1 The photographic reference standards[2] were prepared by photographing actual sprayed panels of multicolor lacquers that were made in the five particle sizes normally used in commercial multicolor lacquers. The standard designations are as follows (Figs. 1 (a), (b), (c)): fine, small, medium, large, and extra large, and represent the correct nomenclature for properly applied multicolor lacquer.

6. Apparatus

6.1 *Spray Gun*, pressure-feed internal-mix type, tip 0.086 in. (2.2 mm) in diameter with wide-spray nozzle.

7. Procedure

NOTE—The particle size of multicolor lacquer is dependent upon the spray conditions during the application procedure. In order to get uniform results the exact spray conditions should be agreed upon between the purchaser and the seller.

7.1 Spray the lacquer on a coated white paper panel with the fluid and atomizing pressures adjusted to give a spreading rate of 150 to 200 ft^2/gal (3.7 to 4.9 m^2/L) for complete covering and 200 to 300 ft^2/gal (4.9 to 7.35 m^2/L) for scatter coat application. After the sprayed lacquer is thoroughly dry, determine the particle size on the panel by comparing it to the photographic reference standards.[2]

8. Precision

8.1 This test method entails the use of visual judgment and as such does not readily lend itself to a precision statement.

8.2 In general there has been good agreement between operators in judgment of particle size.

9 Keywords

9.1 particle size; multicolor lacquers; lacquer

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[1] This test method is under the jurisdiction of ASTM Committee D-1 on Paint and Related Coatings and Materials and is the direct responsibility of Subcommittee D01.55 on Factory-Applied Coatings on Preformed Products.

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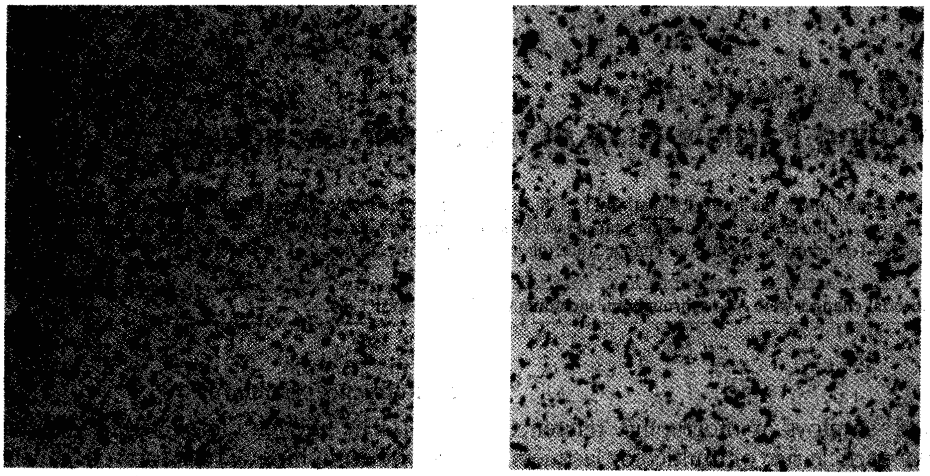
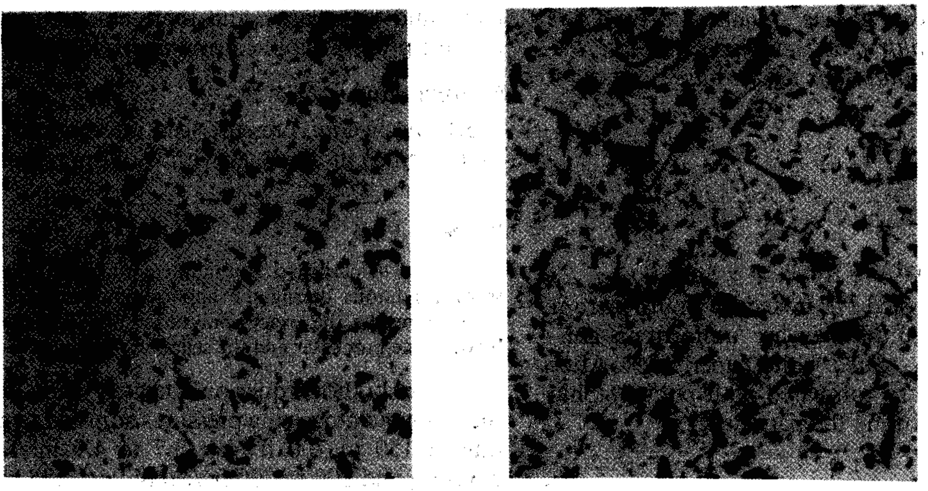
[2] Glossy prints of the photographic reference standards showing various particle sizes are available at nominal charge from ASTM Headquarters. Request Adjunct No. 12-423380-00.



Fine

Small

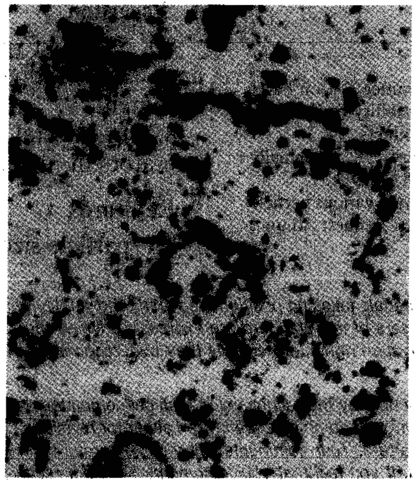
FIG. 1(a) Particle Size (for other particle sizes, see Figs. 1(b) and 1(c))



Medium

Large

FIG. 1(b) Particle Size (for other particle sizes, see Figs. 1(a) and 1(c))



Extra large

FIG. 1(c) Particle Size (for other particle sizes, see Figs. 1(a) and 1(b))

Last ASTM Designation: D 2353 – 83

Standard Test Method for Flow Ratings of Organic Coatings Using the Shell Flow Comparator

This test method covers the determination of the flow rating, in terms of flow-out characteristics or degree of film smoothness, of an organic film applied to a flat substrate.

Formerly under the jurisdiction of Committee D-1 on Paint and Related Coatings and Materials, this test method was discontinued in 1992.

Designation: D 2354 - 91

Standard Test Method for Minimum Film Formation Temperature (MFFT) of Emulsion Vehicles[1]

1. Scope

1.1 This test method covers the determination of the minimum temperature at which emulsion vehicles coalesce to form continuous films. The term "emulsion" in this test method includes latex vehicles.

1.2 This test method is limited to emulsions having minimum film formation temperatures below 25°C.

1.3 *This standard does not purport to address all of the safety problems, 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. Summary of Test Method

2.1 In this test method the minimum film formation temperature (MFFT) is determined by visual observation of cracking or whitening in films that have dried over a substrate having a controlled temperature gradient.

3. Significance and Use

3.1 The satisfactory film integrity of emulsion coatings requires that as the aqueous phase evaporates the resinous portion of the vehicle coalesces into a continuous film. Low temperature impairs the fluidity of the resin particle and thereby their ability to coalesce. Vehicles that can withstand low temperatures are therefore required, and MFFT is an important quality feature of emulsion vehicles.

4. Apparatus

4.1 *Minimum Film Formation Temperature Bar*—An MFFT unit[2] such as is illustrated in Fig. 1. The bar represented in Fig. 1 is designed to be used with thermocouples. The thermocouple leads used with the assembly are iron-constantan with an external resistance of 10 Ω. Also included is a pyrometer (not shown in Fig. 1).

NOTE 1—Thermometers can be used as an alternative way of measuring temperature.[3] It is noted that larger holes (5/32 in.) (4 mm) will have to be drilled in the bar to accommodate the thermometers. If thermometers are selected, all holes are drilled on the same side of the bar, as opposed to the system of alternate placement of holes when using thermocouples.

NOTE 2—A self-contained unit eliminating the need for external cooling and requiring only an electrical outlet, piped water and an air or nitrogen supply has been developed by ICI Paints Division.[4]

4.2 *Dry Air or Dry Nitrogen Supply*, with a regulating valve and flow meter.

4.3 *Film Caster*, having a 6-mil (150-µm) clearance.

5. Reagents and Materials

5.1 *Dry Ice*.

5.2 *Isopropanol*, anhydrous.

6. Procedure

6.1 Set up the MFFT bar in a level position with the lower temperature leg of the bar immersed in a dry ice-isopropanol bath. It is important that the surface of the bar be smooth and plane to ensure uniform film thicknesses. Use a ½-gal (2-L) container for this purpose. (The container can be insulated with any suitable material to reduce heat loss.) Adjust the height of the dry ice-isopropanol bath as needed to bring the temperature of the bar to approximately 0°C at the lowest temperature-measuring stage of the unit. Lower or higher temperatures can be obtained, if needed, by adjusting the bath height. The bath height needed to obtain 0°C will vary depending on the heat conductivity of the metal used in the construction of the bar. Expose the higher temperature end of the bar at approximately 25°C by either conducting the test in a constant-temperature room at this temperature or by thermostatting the leg.

6.2 Immediately after imposing the temperature gradient on the bar, place the cover over it and start the flow of dry air (or nitrogen) at a rate of 3000 cm^3/min from the low-temperature end to the high-temperature end of the bar, controlling the rate by a simple flow meter. Allowing the air to retain moisture by warming up prevents water condensation at the cold temperature end that would interfere with film drying. Approximately 1 to 1½ h is needed for the temperature gradient to reach equilibrium once the bar is placed in operation. The air manifold holes must be clean and free of frost before starting a test.

NOTE 3—A mixture of ethylene glycol and surfactant applied to the air outlet alleviates the frosting condition temporarily.

6.3 Once a constant-temperature gradient is established,

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[1] This test method is under the jurisdiction of ASTM Committee D-1 on Paint and Related Coatings and Materials and is the direct responsibility of Subcommittee D01.42 on Architectural Finishes.

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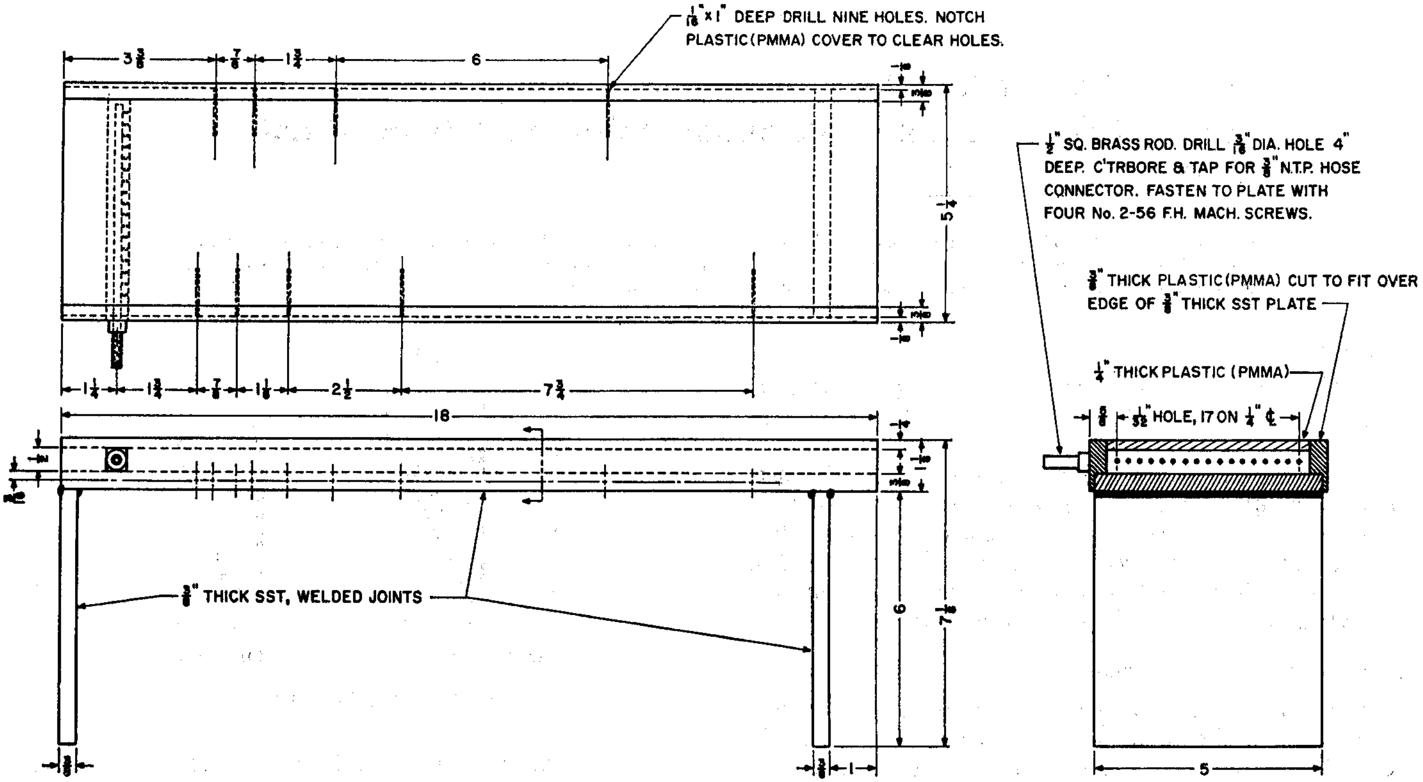
[2] A unit manufactured by Custom Scientific Instruments Inc., 13 Wing Dr., Cedar Knolls, NJ 07927, has been found suitable for this purpose.

[3] An example of such a thermometer is Prince No. A-011044, 90° angle, red-reading, range from −5 to +50°C, having an accuracy of > ±0.5°C and manufactured by Princo Instruments Inc., 1020 Industrial Hwy., Southampton, PA 18966.

[4] The unit identified as an MFFTBAR, Model SS-3000, manufactured by Sheen Instruments, Ltd., 8 Waldegrave Rd., Teddington, Middlesex TW11 8LD, England has been found suitable for this purpose.



Note—1 in. = 25.4 mm.

FIG. 1 Minimum Film Formation Temperature Bar

remove the cover and cast the films using the 6-mil applicator (Note 3). Cast films from the low to the high-temperature end of the bar because the extension at the high-temperature end is designed to permit overflow to fall into a container below the bar. After the film is cast and the cover put in place, approximately 1 to 2 h are required for the film to dry. Check the air flow and isopropanol bath height before any tests are started and then maintain them at their respective levels until the test is completed.

NOTE 4—If desired, a ½-mil (13-μm) polyethylene terephthalate sheet of 5-in. (125-mm) width can be placed on the bar surface before casting the film. Tests show that there are no differences between minimum filming temperatures determined with and without the sheet. The polyethylene terephthalate film permits not only easier clean-up of the apparatus, but also a semi-permanent record of the test. Special care must be exercised to ensure good contact of the sheet with the bar. Accomplish this by either of the following techniques:

(*1*) Wipe the sheet with a dry cloth to develop a static charge before placement on the bar.

(*2*) Coat the sheet with silicone oil before placement on the bar.

6.4 After the film has dried, observe for discontinuity as evidenced by whitening or cracking or both. Record the lowest temperature on the bar at which the film is still continuous as the minimum film formation temperature.

7. Report

7.1 Report the following information:

7.1.1 MFFT in degrees Celsius, and

7.1.2 Description of the discontinuity indicating degree of whitening and cracking.

8. Precision and Bias

8.1 *Precision*—Information for a formal precision statement has not yet been obtained, but it is reported that MFFT values obtained by this test method can be expected to fall within ±2°C of their mean.

8.2 *Bias*—Bias has not yet been determined.

9. Keywords

9.1 emulsion vehicles; film formation; minimum film formation temperature, MFFT

Designation: D 2376 – 84 (Reapproved 1989)

Standard Test Method for Slump of Face Glazing and Bedding Compounds on Metal Sash[1]

This standard is issued under the fixed designation D 2376; 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 test method covers face glazing or bedding compounds, or both, used on exterior steel, aluminum, and other metal sash.

1.2 *This standard may involve hazardous materials, operations, and equipment. This standard does not purport to address all of the safety problems 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. Summary of Test Method

2.1 A triangular bead of glazing or bedding compound is tooled into a steel channel and then placed in a 122 ± 4°F (50 ± 2°C) oven for 7 h and then visually inspected for slump.

3. Significance and Use

3.1 This test method provides an accelerated means for predicting slump of such glazing compounds.

4. Apparatus

4.1 *Number 28 U.S. Gage Steel Channel* (smooth, unpainted), 1 in. (25.4 mm) wide, ½ in. (12.7 mm) deep, and 8 in. (203 mm) in length. The flanges of the channel shall be approximately at right angles with the web of the channel. The fillet at the bottom of the channel shall have an internal radius of no more than 1⁄16 in. (1.6 mm).

4.2 *Gravity Convective Oven*, having a temperature controlled at 122 ± 4°F (50 ± 2°C).

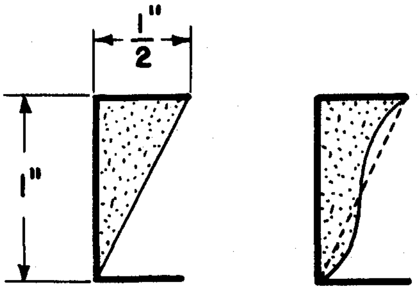
4.3 *Putty Knife.*

5. Reagent

5.1 *Solvent*, such as methyl ethyl ketone or ethylene dichloride.

6. Sampling

6.1 Thoroughly mix the entire contents of a full, previously unopened container on a clean, nonabsorptive surface, and take from this the sample to be tested.



(a) Passes test. (b) Fails test.

FIG. 1 Slump Test Diagram

7. Conditioning

7.1 Condition both the channel and the mixed compound (in a closed container) for at least 5 h at 73.4 ± 3.6°F (23 ± 2°C).

8. Procedure

8.1 Thoroughly clean the channel with solvent.

8.2 Apply a portion of the thoroughly mixed compound to the channel in a triangular shape with a putty knife as illustrated in Fig. 1(*a*).

8.3 When the channel is so filled, set it in an oven with the flanges horizontal, as shown in Fig. 1(*a*), with the mass of the material toward the top, and maintain the temperature at 122 ± 4°F (50 ± 2°C) for 7 h.

9. Report

9.1 The report shall indicate if there was sagging or slumping of the compound at the top towards the bottom, as illustrated in Fig. 1(*b*).

9.2 Any sagging or slumping from the original configuration, Fig. 1(*a*), shall be construed as failure.

10. Precision and Bias

10.1 No statement is made about the precision or bias for measuring slump since the result merely states whether there is conformance to the criteria for success in the procedure.

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[1] This test method is under the jurisdiction of ASTM Committee C-24 on Building Seals and Sealants and is the direct responsibility of Subcommittee C24.12 on Oil and Resin Base Glazing and Caulking Compounds.

Current edition approved Nov. 30, 1984. Published January 1985. Originally published as D 2376 – 65 T. Last previous edition D 2376 – 74 (1979).

Designation: D 2486 – 89

Standard Test Method for Scrub Resistance of Interior Latex Flat Wall Paints[1]

1. Scope

1.1 This test method covers an accelerated procedure for determining the resistance of latex flat wall paints to erosion caused by scrubbing.

1.2 *This standard may involve hazardous materials, operations, and equipment. This standard does not purport to address all of the safety problems 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:*

D 4213 Test Method for Wet Abrasion Resistance of Interior Paints[2]

3. Summary of Test Method

3.1 The test paint is applied to a black plastic panel. After aging, the coated panel is placed over a ½-in. by 10-mil (12.7 by 0.25-mm) shim and held in place on a glass plate in a washability machine by means of a gasketed frame. It is then scrubbed with a nylon bristle brush and an abrasive scrub medium until failure occurs over the shim.

4. Significance and Use

4.1 Interior wall paints often become soiled especially near doorways, windows, and in work and play areas. This test method covers determination of the relative resistance of different wall paints to erosion when repeatedly scrubbed to remove the stains during the life of the paint.

4.2 Results developed by use of this test method do not necessarily represent the scrub resistance of aged paint films.

4.3 This test method measures scrub resistance by the traditional scrub-to-failure concept. Test Method D 4213 is a more precise method that measures essentially the same property by a weight-loss technique and reports it as a volumetric film erosion rate. Test Method D 2486 is maintained as an ASTM standard along with the newer Test Method D 4213 because it has served the paint industry usefully for many years, its techniques are familiar, and its results are meaningful. To discard it as a standard would be to minimize a great deal of significant past experience.

5. Apparatus

5.1 *Washability Machine.*[3]

5.1.1 *Accessory Apparatus*: (Fig. 1).

5.1.1.1 *Nylon Bristle Brush, Rubber Mat, and Holder* (total weight 454 g).

5.1.1.2 *Glass Plate*, measured to fit.

5.1.1.3 *Shim*, ½-in. by 10-mils (12.7- by 0.25-mm).

5.1.1.4 *Gasketed Frame and Clamps.*

5.2 *Film Caster,*[4] having 7-mil (0.18-mm) clearance.

6. Reagents and Materials

6.1 *Black Plastic Panels.*[5]

6.2 *Masking Tape.*

6.3 *Flannel Cloth.*

6.4 *Detergent.*[6]

6.5 *Scrub Medium*[7] (Note 1), consisting of the following:

	grams
Water, distilled or deionized	49.7[A]
Hydroxyethyl cellulose[8]	1.0
Ammonium hydroxide, 28 %	0.1
Detergent[6]	2.0
Trisodium phosphate, anhydrous	2.0
Silica[9]	45.0
Acetic acid (glacial)	0.2[B]
Preservative[10]	0.1
	100.0

[A] Adjust to achieve viscosity of 110 to 120 Krebs Units before use.

[B] Vary to achieve a pH of 9.5 to 10.0.

NOTE 1—When a referee test is made, prepare fresh medium or use standardized scrub medium[7] from a previously unopened container that is no more than 1 year old.

6.5.1 Slowly add the hydroxyethyl cellulose to the water while stirring mechanically. Stir until uniform, then continue stirring for an additional 5 min. Then slowly add 3 drops of

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[1] This test method is under the jurisdiction of ASTM Committee D-1 on Paint and Related Coatings and Materials and is the direct responsibility of Subcommittee D01.42 on Architectural Finishes.

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[2] *Annual Book of ASTM Standards*, Vol 06.02.

[3] The Gardner washability machine Model M-105A and accessory apparatus, available from the Gardner Laboratories, Inc., 5521 Landy Lane, Bethesda, MD 20014, has been found satisfactory for this purpose. Other straight-line wash testers may be adapted to meet the requirements of this test method.

[4] The Dow film caster, available from the Gardner Laboratories, Inc., has been found satisfactory for this purpose.

[5] Leneta P-121-10N dull black plastic panels 6½ by 17 in. by 10 mils (165 by 432 by 0.25 mm) in size (production tolerance: ±1 mil), obtainable from the Leneta Co., P.O. Box 576, Ho-Ho-Kus, NJ, are suitable for the purpose.

[6] Octyl phenoxy polyethoxy ethanol has been found satisfactory. Triton X-100 obtainable from Rohm & Haas Co., Independence Sq., Philadelphia, PA, is representative of this product.

[7] Laboratory standardized scrub medium is available from the Leneta Co.

[8] Cellosize QP-4400, obtainable from Union Carbide Corp., Chemicals Div., 270 Park Ave., New York, NY, has been found satisfactory for this purpose.

[9] Silica No. 22, obtainable from Whittaker, Clark, & Daniels, Inc., 100 Church St., New York, NY 10007, has been found satisfactory for this purpose.

[10] 1.3.5-triethyl hexahydro-sym-triazine (Vancide TH) obtainable from R. T. Vanderbilt Co., 230 Park Ave., New York, NY 10017, has been found satisfactory.

28 % ammonium hydroxide while mixing, and continue mixing until solution turns clear. In the order given, add the other ingredients separately, employing mechanical stirring. Be sure that each item is uniformly dispersed before adding the next one. The addition of the silica should take about 5 min to ensure uniform dispersion. Finally, add the preservative and adjust the pH with glacial acetic acid.

7. Preparation of Apparatus

7.1 *Washability Machine*—The washability machine should be leveled before use and operated at 37 ± 1 counts per minute. Before each test check the tightness of the motor belt or chain drive, alignment of the pulleys and cables in both horizontal and vertical planes, and tautness of the cable.

7.2 *Brush*—The bristles, if new, must be leveled before use to permit uniform wear on the paint surface. Leveling is accomplished by running the brush over 100 or 120-mesh aluminum oxide close grain sandpaper or emery cloth attached lengthwise on the glass plate in the washing machine. The total number of cycles required will vary from 1000 to 5000. Additional weight, up to 454 g, may be used to expedite the procedure. Change the sandpaper or emery cloth if it becomes clogged. Tape down the edges if any tearing is observed. Replace brush when bristles have worn to extend less than $\frac{5}{8}$ in. (16 mm) from block.

7.3 *Brush Holder*—Screws on the brush holder shall be removed and not used. Instead, insert a $\frac{1}{8}$-in. (3.2-mm) thick rubber mat in the holder above the brush block. When in operation, this mat allows the brush to ride evenly on the paint surface without tilting (Fig. 1). The brush must fit loosely in the holder.

8. Procedure

8.1 Clean the top of the glass plate (or preferably suction plate) and both sides of the black plastic panel to be sure they are free of specks. Place the black panel on the plate and tape one end to the plate. Smooth the panel along the plate by rubbing with flannel, creating static electricity which improves adhesion to the plate.

8.2 Stir the test paint thoroughly and strain to remove all skins and particles. Draw down the paint on the panel using the 7.0-mil (0.18-mm) side of the film caster, starting from the taped end of the panel. The time for application should be fairly slow—3 to 4 s from end to end—to prevent formation of pinholes or holidays in the film. Air dry in a horizontal position for 7 days in an open room kept at 73.5 ± 3.5°F (23 ± 2°C) and 50 ± 5 % relative humidity.

8.3 Clean the plate and set it in the pan of the washability machine. Be sure that the shim is smooth and free of burrs and placed across the center of the plate. Wipe the test panel carefully and place it on top of the shimmed plate with the painted side up. Be sure that there are no defects in the film above the shim and that the test area is level. Prewet the gasket of the frame and wipe it dry before use. Place the frame over one half of the drawdown, being sure that the entire gasket is on the painted surface. (The other half can be used for a second test if desired.) Clamp the gasket in place. The clamps should be tight enough to ensure close contact, but not tight enough to cause warping of the panel.

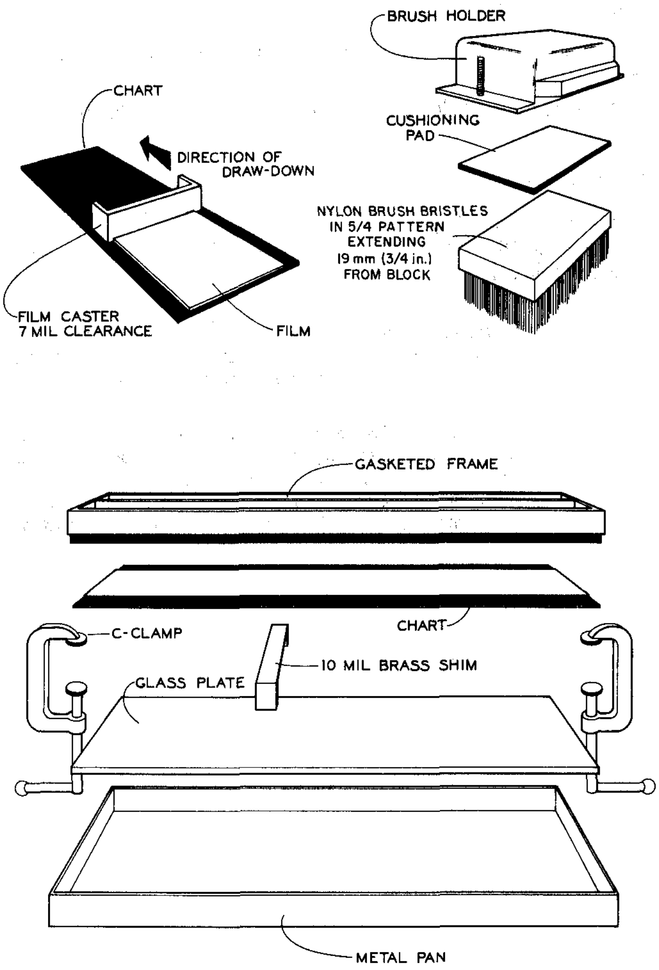

FIG. 1 Accessory Apparatus for Scrub Test

8.4 Soak the brush in a 1 % solution of detergent[6] overnight. Remove the brush and shake it vigorously to remove any excess. Mount the brush in the holder being sure that the mat is in place above the brush block and that the brush is always in the same position. (Mark both brush and holder beforehand.) Stir the scrub medium and spread 10 g evenly on the brush bristles. Place the brush at one end of the path and attach the guide cables. Wet the panel with 5 mL of reagent water in the path of the brush.

8.5 Set the cycle counter at zero. Start the test. After each 400 cycles before failure remove the brush (do not rinse); add 10 g of stirred scrub medium; replace the brush, being sure that brush and holder are in the same position with relation to each other and in the machine. Place 5 mL of water on the path before continuing.

8.6 Record the number of cycles to remove the paint film fully in one continuous line across the $\frac{1}{2}$-in. (12.7-mm) width of the shim. Stop the machine and wipe off the area to determine the end point.

8.7 Make three drawdowns of each specimen. Test two and average them if they are within 25 % repeatability. If they are not, test a third and average the three, unless one of the results is obviously discrepant, in which case it should be discarded. According to the 90 % confidence limits specified herein, the running of a third test will be required, on the average, only one out of ten times for normal results.

9. Report

9.1 Report the mean number of cycles to failure (see Section 10).

9.2 Outline any deviations from standard procedure.

10. Precision

10.1 The following criteria should be used for judging the acceptability of results of scrub resistance tests at a 90 % confidence level.

10.1.1 *Repeatability*—Duplicate results by a single operator should be considered suspect if they differ by more than 25 % of their mean value.

10.1.2 *Reproducibility*—Two results (each the mean of duplicate measurements) obtained by operators in different laboratories should be considered suspect if they differ by more than 50 % of their mean.

11. Keywords

11.1 Scrub resistance; abrasion resistance

Designation: D 2571 – 88

Standard Guide for Testing Wood Furniture Lacquers[1]

1. Scope

1.1 This Guide covers the evaluation of gloss or flatted, unpigmented lacquers designed for use on wood substrates. This Guide is to be used in conjunction with Test Methods D 333. Also included are several methods of special relevance to the application of lacquer on wood. The selection of the tests to be used for any given product or system must be governed by experience and by the requirements agreed upon by the producer and user.

1.2 The tests on films apply to those films applied in sufficient quantity to form a continuous film. It is recommended that reports include the thickness of the film under test.

1.3 *This standard may involve hazardous materials, operations, and equipment. This standard does not purport to address all of the safety problems 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:*

D 235 Specification for Mineral Spirits (Petroleum Spirits) (Hydrocarbon Dry Cleaning Solvent)[2]

D 333 Test Methods for Clear and Pigmented Lacquers[3]

D 1211 Test Method for Temperature-Change Resistance of Clear Nitrocellulose Lacquer Films Applied to Wood[3]

D 1308 Test Method for Effect of Household Chemicals on Clear and Pigmented Organic Finishes[3]

D 1544 Test Method for Color of Transparent Liquids (Gardner Color Scale)[4]

D 2091 Test Method for Print Resistance of Lacquers[3]

D 2199 Method for Measurement of Plasticizer Migration from Vinyl Fabrics to Lacquers[3]

D 3359 Test Methods for Measuring Adhesion by Tape Test[4]

D 3459 Test Method for Humid-Dry Cycling for Coatings on Wood and Wood Products[3]

G 23 Practice for Operating Light-Exposure Apparatus (Carbon-Arc Type) With and Without Water for Exposure of Nonmetallic Materials[4]

3. Significance and Use

3.1 This Guide is intended to compile as well as provide screening tests in evaluating wood furniture coatings both high gloss and flatted type, as used by the furniture industry.

3.2 Each wood finishing system may vary from a simple two-step operation to a complex operation consisting of as many as 15 steps.

3.3 The substrate is a complex and varied substrate that does absorb moisture from the surrounding environment. Variation in the moisture content of the wood before and after coating and during the testing affects the test results. Grease, dirt and foreign matter also affect the test results.

3.4 Results from these various tests are not necessarily useful in evaluating performance of all different types of furniture finishing systems.

4. Test Panels and Panel Preparation

4.1 Test panels should be regular production finish panels.

4.2 If regular production finish panels are not available, the producer and the user should agree on the substrate to be used and on the complete finishing system.

5. Nonvolatile Matter

5.1 Test for nonvolatile matter in accordance with Test Methods D 333.

6. Self-Lifting Properties

6.1 Apply a second coat after the first top-coat has been applied and air dried for 1, 6, and 24 h. Report any tendency of self-lifting.

7. Color

7.1 Test color of the liquid lacquer in accordance with Test Method D 1544.

8. Rubbing Properties

8.1 In the absence of a specified procedure, air dry the lacquer 18 h, sand with No. 320 W/D sandpaper wetted with mineral spirits, and then rub with 3-F pumice and paraffin oil (white mineral oil, U.S.P. heavy, or other suitable rubbing compound).

8.2 Examine the rubbed surface immediately and after 24 h, or the time agreed upon by the producer and the user, in a

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[1] This Guide is under the jurisdiction of ASTM Committee D-1 on Paint and Related Coatings and Materials and is the direct responsibility of Subcommittee D01.55 on Factory-Applied Coatings on Performed Products.

Current edition approved March 25, 1988. Published September 1988. Originally published as D 2571 – 67. Last previous edition D 2571 – 81(1987).

[2] *Annual Book of ASTM Standards*, Vol 06.04.

[3] *Annual Book of ASTM Standards*, Vol 06.02.

[4] *Annual Book of ASTM Standards*, Vol 06.01.

standard atmosphere, for example, 73.5 ± 3.5°F (23 ± 2°C) and 50 % relative humidity, and report any difference in appearance.

9. Print Test

9.1 Test for resistance to imprinting in accordance with Test Method D 2091.

10. Cold Check Test

10.1 Test for resistance to checking and cracking in accordance with Test Method D 1211 on a substrate agreed upon by the producer and the user. Report any difference in appearance.

11. Resistance to Oils, Greases, Cosmetics, and Other Household Chemicals

11.1 Test for resistance to the agents in 11.2 to 11.5. For other household chemicals test in accordance with Test Method D 1308.

11.2 *Cosmetic Stain*—Apply to the finished surface a heavy smear of lipstick of indelible type and place the panel in a 125°F (50°C) oven overnight. Remove the lipstick with mineral spirits meeting the requirements of Specification D 235, and evaluate.

11.3 *Alcohol Resistance*—Place 0.5 mL of 50 % ethanol (by weight) in water on the lacquer film and trap with a 2-in. (50-mm) watch glass. Pure, undiluted ethyl alcohol or denatured alcohol conforming to Formula 2-B of the U.S. Bureau of Internal Revenue are considered equivalent for this test. One hundred proof vodka may be used in place of 50 % ethanol. After at least 6 h, remove the watch glass and allow the alcohol to evaporate. Report whitening or spotting that cannot be removed with light polishing using a dry cotton pad.

11.4 *Boiling Water Resistance*—Pour 25 mL of boiling distilled or deionized water on the leveled panel and allow to cool to room temperature. Dry and examine. Report graying, spotting, softening, or other film deterioration.

11.5 *Coffee Stain Resistance*—Prepare coffee by each of the following methods:

11.5.1 Dissolve 1 teaspoon (5 cm^3) of instant coffee, 1 teaspoon of sugar, and 1 teaspoon of powdered cream substitute in 8 fl oz (240 mL) of at least 180°F distilled or deionized water.

11.5.2 Dissolve 1 teaspoon (5 cm^3) of instant coffee and sufficient synthetic sweetener (dry or liquid) to supply 5 mg of saccharin in 8 fl oz (240 mL) of at least 180°F distilled or deionized water.

11.5.3 Place 1 mL of each type of hot coffee on the panel and cover with 2-in. (50-mm) watch glasses. After 2 h, remove the watch glasses, and allow to evaporate. Wash the panel with a rag moistened with water. Report how readily the residue is removed.

12. Light Exposure

12.1 Test for the effect of light exposure in accordance with all methods except 1, 2, and 3 of Practice G 23, but operated without water spray. Report method used and results.

13. Tape Marring

13.1 Press a strip of cellophane tape, on the test panel, rolling it down with a 70 to 80 durometer hardness rubber roller. Allow the tape to remain on the panel for 30 min. Slowly remove the tape. After 30 min recovery, report any visible marring.

14. Tape Adhesion

14.1 Test for tape adhesion in accordance with Test Methods D 3359.

15. Resistance to Plasticizer Migration

15.1 Test and rate plasticizer migration in accordance with Test Method D 2199.

16. Accelerating Aging by Humid-Dry Cycling

16.1 Evaluate and report the accelerated aging in accordance with Test Method D 3459.

Standard Test Method for Light Stability of Clear Coatings[1]

1. Scope

1.1 This test method covers the determination of the discoloration of clear coatings by sunlight through glass.

1.2 *This standard may involve hazardous materials, operations, and equipment. This standard does not purport to address all of the safety problems 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:*

D 1729 Practice for Visual Evaluation of Color Differences of Opaque Materials[2]

D 1925 Test Method for Yellowness Index of Plastics[3]

G 24 Practice for Conducting Natural Light Exposures Under Glass[2]

3. Summary of Method

3.1 The effect of sunlight on discoloration of clear coatings is determined by exposing under glass, coated panels masked at one end, to natural sunlight for a specified time. At the end of the exposure, the mask is removed and the panels evaluated for degree of discoloration.

4. Significance and Use

4.1 Color change, particularly yellowing, is not generally acceptable to users of coatings when it is readily noticeable. In designing clear coating systems for interior use on various substrates, it is of interest to know how well the clear coats will resist color change caused by ambient light. This test method permits the evaluation of the effect of natural indoor light on the color stability of clear coatings.

5. Apparatus

5.1 *Exposure Cabinet* as described in Practice G 24.

6. Test Specimens

6.1 For each clear coating under test, use one test panel approximately 3 by 5 in. (75 by 125 mm) of white carrara glass or other specified substrate material.

NOTE 1—Other materials that may be considered for this purpose include: (*1*) White ceramic tile. (*2*) A white pigmented, light-stable coating which would not be lifted by the clear topcoat. (A baking enamel with the composition of 30 % melamine formaldehyde resin and 70 % of the phthalic anhydride/coconut alkyd resin with 3 lb/gal (1.36 kg/L) of titanium dioxide per gallon has been found satisfactory.) (*3*) The substrate intended for use with the clear coating. The light stability of the substrate may be determined by including an extra test panel without a clear topcoat.

6.2 Prepare specimens of the test materials by applying the coatings on the test panels to a dry film thickness of 2 ± 0.2 mil (50 ± 5 μm).

6.3 Prepare a reference specimen, representing a material of known performance in this test, with each set of test specimens.

6.4 Record the panel preparation details: method of coating application, baking conditions, film thickness, etc. These details will be established by mutual agreement between purchaser and seller in accordance with the type of product and its intended use.

7. Conditioning

7.1 Unless otherwise specified, condition the coated panels at 73.5 ± 3.5°F (23 ± 2°C) and 50 ± 5 % relative humidity for 48 h if baked, or 7 days if air dried.

8. Procedure

8.1 Prior to exposure, mask one-half of each test panel with aluminum foil to exclude sunlight from the other half of the coating.

NOTE 2—The tape used to attach the mask to the panel should not extend over the edge of the mask but should extend beyond the ends of the mask and stick to the rear of the panel, thereby holding the mask in position. This will prevent contact between the tape and the finish and eliminate the possibility of staining from the tape.

8.2 Mount the test specimens in the glass-covered exposure cabinet continuously 24 h a day for the specified period of exposure. It is recommended this period should be approximately 5 weeks, since longer periods of exposure do not significantly change the results.

NOTE 3—In cooperative tests, exposure of nitrocellulose lacquers, cellulose acetate butyrate lacquer, and low-bake alkyd enamel for 22 weeks did not show significantly greater discoloration than after exposure for 5 weeks.

9. Interpretation of Results

9.1 Visual ratings of the degree of discoloration may be made. However, it is preferred that an instrumental method be used as described in Test Method D 1925, (see Test Method D 1729).

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[1] This test method is under the jurisdiction of ASTM Committee D-1 on Paint and Related Coatings and Materials and is the direct responsibility of Subcommittee D01.55 on Factory-Applied Coatings on Preformed Products.

Current edition approved May 29, 1987. Published July 1987. Originally published as D 2620 – 67. Last previous edition D 2620 – 68 (1981)$^{\epsilon 1}$.

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

[3] *Annual Book of ASTM Standards*, Vol 08.02.

10. Color Changes Not Caused by Light

10.1 In many cases atmospheric conditions (temperature, humidity, reactive gases) may produce significant color changes even without the presence of light. An indication as to whether or not side effects are operating may be obtained by retaining unexposed a duplicate set of specimens in the laboratory. A difference in color between the unexposed specimens and the covered portion of the exposed specimens indicates that the material has been affected by some agent other than light.

10.2 Further clarification regarding atmospheric effects may be obtained by simultaneously exposing a duplicate set of test specimens in another cabinet of the same type used in the light exposures but with the glass covered with an opaque material so that the light is excluded.

11. Report

11.1 Report the following information:

11.1.1 Visual ratings or instrumental values for degree of discoloration of coatings or both,

11.1.2 Date and location of exposure,

11.1.3 Length of exposure,

11.1.4 Substrate used,

11.1.5 Details of panel preparation, and

11.1.6 Conditioning of panels prior to testing.

12. Precision

12.1 Because of the many variations in visual rating of discoloration, meaningful estimates of precision cannot be given. In cooperative tests, however, fairly good agreement was obtained by the various cooperators in the visual rating of the test panels.

Last ASTM Designation: D 2691 – 88

Standard Test Methods for Microscopical Measurement of Dry Film Thickness of Coatings on Wood Products

These test methods cover the measurement of film thickness of dried coatings applied to a plane rigid substrate of wood or a wood-base material.

Formerly under the jurisdiction of Committee D-1 on Paint and Related Coatings, Materials, and Applications, these test methods were discontinued in 1992 and replaced by ASTM Test Method D 5235 for Microscopical Measurement of Dry Film Thickness of Coatings on Wood Products.[1]

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[1] *Annual Book of ASTM Standards*, Vol 06.01.

Designation: D 2743 – 68 (Reapproved 1987)

Standard Practices for Uniformity of Traffic Paint Vehicle Solids by Spectroscopy and Gas Chromatography[1]

This standard is issued under the fixed designation D 2743; 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 These practices provide general information on the instrumental techniques available for detecting adulteration or nonuniformity of the chemical nature of the vehicle solids in purchased lots of traffic paints by means of the individual or combined use of infrared and ultraviolet spectroscopy and gas chromatography. The procedures given are applicable when traffic paint is selected and purchased on the basis of pre-qualification laboratory or road performance tests, or both, and a *reference sample* of the original paint so evaluated and selected is retained and compared with test samples representative of subsequent purchased and delivered lots of such paint and which are required to be the same as the original reference sample.

1.2 Although not specifically provided for in these practices, the methods given may also be applied, with appropriate modification, to evaluating the acceptability of traffic paints that have been purchased on the basis of composition specifications. In such cases, application is limited to the vehicle solids as before, as well as the availability of a suitable standard or range of standards representative of the vehicle solids that are acceptable and with which samples of subsequent delivered lots will be compared.

1.3 The techniques provided are wholly adequate for detecting gross adulteration of the vehicle solids where completely different drying oils, resins, or polymers, or combinations of these have been substituted for those originally contained in the reference sample. In cases of lesser adulteration or modification, these methods have been found adequate for detecting vehicle solids, adulterations, or modifications as low as 5 weight % of the vehicle solids.

1.4 These techniques have been developed on the basis of cooperative work with alkyd, chlorinated rubber-alkyd, and poly(vinyl toluene) type paints involving the detection of nonuniformity when such extraneous materials as rosin, fish oil, hydrocarbon resin, and chlorinated paraffin have been added. The procedures given may be, but are not necessarily completely applicable to all other types of vehicle solids or extraneous additions, or both.

1.5 The methods provided appear in the following order:

	Section
Method A—Infrared Spectral Analysis of Total Vehicle Solids	10 to 12
Method B—Infrared Spectral Analysis of Unsaponifiable Matter from Vehicle Solids	13 to 15
Method C—Gas Chromatographic Analysis of Oils and Oil Acids Separated from Vehicle Solids	16 to 18
Method D—Ultraviolet Spectral Analysis of Total Vehicle Solids	19 to 21

1.6 *This standard may involve hazardous materials, operations, and equipment. This standard does not purport to address all of the safety problems 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:*

D 1259 Test Methods for Nonvolatile Content of Resin Solutions[2]

D 1397 Test Method for Unsaponifiable Matter in Alkyd Resins and Resin Solutions[3]

D 2245 Method for Identification of Oils and Oil Acids in Solvent-Reducible Paints[2]

D 2372 Practice for Separation of Vehicle from Solvent-Reducible Paints[2]

D 2621 Test Method for Infrared Identification of Vehicle Solids from Solvent-Reducible Paints[2]

E 105 Practice for Probability Sampling of Materials[4]

E 131 Terminology Relating to Molecular Spectroscopy[5]

3. Terminology

3.1 For definitions of terms and symbols, refer to Definitions E 131.

4. Summary of Methods

4.1 Each of the methods given requires both a reference and a test sample of traffic paint and a preliminary separation and removal of the pigment component in each.

4.2 *Method A* involves infrared spectral analysis of cast films of the total vehicle solids to detect spectral differences between the reference and test samples caused by gross or minor adulteration of the test sample.

4.3 *Method B* involves infrared spectral analysis of cast films of the unsaponifiable matter that has been separated from the vehicle solids in order to detect spectral differences between the reference and test samples caused by lesser

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[1] These recommended practices are under jurisdiction of ASTM Committee D-1 on Paint and Related Coatings and Materials and are the direct responsibility of Subcommittee D01.44 on Traffic Coatings.

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

[3] *Annual Book of ASTM Standards*, Vol 06.03.

[4] *Annual Book of ASTM Standards*, Vol 14.02.

[5] *Annual Book of ASTM Standards*, Vol 14.01.

adulterations of an unsaponifiable nature and which was not readily evident when using Method A.

4.4 *Method C* involves gas chromatographic analysis of prepared methyl esters of the separated fatty acids obtained from the vehicle solids in order to detect chromatographic differences between the reference and test samples caused by either gross or lesser adulteration of the drying oil fraction with extraneous drying oils which may not have been readily evident by the use of Methods A and B.

4.5 *Method D* involves quantitative ultraviolet spectral analysis of the total vehicle solids dissolved in a nonaromatic spectral grade solvent to give precise concentrations in order to detect ultraviolet spectral absorbance differences between the reference and test samples caused by minor or sophisticated adulterations of the vehicle solids and which may not be readily detected by Method A. Method D is to be used as an alternative to Methods B and C.

5. Selection of Test Methods and Significance and Use

5.1 All of the methods provided involve comparisons between the spectra or chromatograms of the reference and test samples to determine if they show significant differences. It is not possible at this time to establish quantitative limits as a guide to whether a spectral or chromatographic difference is truly significant. Certainly the presence or absence of a moderate or strong peak in the test sample which is not evident in the reference is significant. A persistent difference in the ratios of two peaks of one spectrum as compared to the reference sample is significant. On the whole, some judgment must be exercised in this respect and it is advisable to refer to published data on infrared or gas chromatography in order to establish, where feasible, the possible overall nature of the adulterant or its functional group which might be causing the comparison spectra to differ.

5.2 *Method A* is rapid and the most convenient of the procedures given. It should be utilized first in order to detect nonuniformity of the test sample. Significant spectral differences from that of the reference sample can be taken as an indication of adulteration and in such cases the use of the other methods is not necessary. As a general rule. Method A is sufficient to detect gross or major adulteration of the vehicle solids. However, where Method A shows no significant spectral differences, it cannot be assumed that the test sample is completely acceptable since changes in the type of drying oil, polyol, and certain dibasic acids in alkyd resins, addition of certain aliphatic or nonfunctional hydrocarbon resins, and many minor adulterations may not always show characteristic infrared spectral differences. Therefore, in such cases it is best to proceed to additional tests as given in Methods B and C or else alternatively directly to Method D.

5.3 *Method B* is useful in detecting adulterations that are unsaponifiable or else have an unsaponifiable component that has escaped detection in Method A only because the adulterant may have been small in amount and therefore its strong spectral peaks may have been masked over by the rest of the vehicle solids. Some care should be taken in interpreting spectral differences in Method B to avoid an erroneous conclusion that the test sample is unacceptable because its spectrum is different. Apparent but unreal differences can occur as a result of incomplete saponification, failure to remove all saponifiable material, and varying degrees of contamination of the unsaponifiable fraction with sterols, etc., present in the vehicle solids. After it has thus been firmly established that a real spectral difference does exist, further tests are unnecessary, except that it is wise to resort again to the published literature on infrared to attempt to identify the possible nature of the adulterant. Where Methods A and B indicate acceptability of the test sample, it is still not always possible to rule out adulteration caused by changes or modifications in the saponifiable portion, that is, the type of fatty acid, dibasic acids, and polyol. In such cases, it is best to continue on to Method C for determination of the oil acids, and to other gas chromatographic methods for the polyol and dibasic acids when such equipment is available.

5.4 *Method C* is extremely sensitive in detecting adulterations and changes that have been made in the oil or fatty acid portion of the vehicle solids. It can, for example, detect whether linseed, coconut, oiticica, etc., has been substituted for soya oil and vice versa, or whether fish or tall oil has partially or wholly replaced some other drying oil, etc. Consequently, when the results of Methods A and B suggest that the test sample is acceptable and where a drying oil component is known to be present, Method C should be used additionally for more complete assurance of product uniformity. Where the results from Method C along with those from Methods A and B indicate product uniformity, it is a fairly safe assumption that the product has not been significantly altered.

5.5 *Method D* is intended as an alternative to Methods B and C and where the results from Method A indicate apparent product acceptability. Method D, by the use of quantitative ultraviolet spectral absorbance data, is an extremely sensitive procedure for the detection of complete or even partial adulteration of the test sample. However, considerable caution must be exercised in the preliminary pre-drying of the vehicle solids since it is at this stage that the components are extremely sensitive to oxidative changes. Even minor oxidative changes can seriously affect the absorbance data obtained in ultraviolet spectral analysis and may give an impression that the two samples being compared are different when in fact they are the same. When these considerations are provided for, and the comparison spectra are identical in Method D as well as in Method A, then it can be assumed that the sample is acceptable. Significant differences in the spectra from Method D would indicate nonuniformity of the product even though Method A may fail to reveal such nonuniformity.

6. Reference Sample

6.1 The reference sample of traffic paint should be at least ½ pt (250 mL) and should be truly representative of the initial paint found acceptable in pre-qualification laboratory or field service tests, or both, and which paint is subsequently specified for purchase.

6.2 In cases where paint is purchased on the basis of formulation specifications and it is desired to utilize these procedures to detect adulteration in delivered lots of paint, reference samples may be synthetically prepared to represent the extremes of the range that will be permitted in the formulation.

7. Test Sample

7.1 The test samples of the traffic paint should be at least ½ pt (250 mL) and should be representative of each delivered lot of paint that was specified for purchase and which is intended to be the same as the initial reference paint used in the pre-qualifications acceptance tests from which a reference sample was retained.

8. Sampling Reference and Test Samples

8.1 Test and reference samples of the traffic paint should be obtained in accordance with Recommended Practice E 105.

9. Preparation of Samples

9.1 Separate the vehicle from the pigment by centrifuging the paint in accordance with Method D 2372. Transfer and preserve the vehicle in a well-stoppered amber bottle.

METHOD A—INFRARED SPECTRAL ANALYSIS OF TOTAL VEHICLE SOLIDS

10. Apparatus

10.1 *Infrared Spectrophotometer*, recording double-beam, and accessory equipment as described in Test Method D 2621.

11. Procedure

11.1 Obtain the infrared spectra of a cast film of the vehicle solids of both the test and reference samples by utilizing the procedure referred to in 10.1. In all cases, however, the spectral intensity of both samples should be well matched (by adjusting the film thickness) to within 5 % transmission of each other at the strongest peak, and the transmission of this peak shall be between 5 and 15 %. It is also desirable to obtain additional spectra on thicker films or else ordinate scale expansion if available, to bring out spectral differences in the weak to moderate peak areas. Here again, the same degree of care should be taken as above to match the film thickness and thereby the overall spectral intensities of the two samples. If desired, an aid in comparison is to run the test sample against the reference sample in the reference beam in order to show significant differences by means of a single differential spectrum. Considerable caution is required in the use and interpretation of differential spectra as well as proper adjustments of gain, speed, and slit programs.

12. Interpretation of Results

12.1 Compare the companion spectra from the test and reference samples for identity by visual inspection preferably over a light box. Note particularly the presence of an extraneous peak or peaks in one which is (are) not in the other. Also note the ratio of intensities of two adjacent or pairs of peaks on one spectra and determine whether this ratio is similar on the comparison spectra. Any significant difference should be considered as an indication of lack of uniformity between the reference and test samples. Attempt to ascribe this difference to some extraneous component or formulation difference between the comparison samples by referring to available infrared literature and published spectra. Where it is evident that the comparison spectra are significantly different, no further tests are necessary. When the spectra are identical, proceed to Methods B and C or alternatively to Method D for a fuller evaluation of possible minor or more sophisticated adulteration.

METHOD B—INFRARED SPECTRAL ANALYSIS OF UNSAPONIFIABLE MATTER FROM VEHICLE SOLIDS

13. Apparatus

13.1 Same as in 10.1.

14. Procedure

14.1 Treat a portion of the separated vehicle from both the sample and reference paints so as to obtain an ether solution of the unsaponifiable matter in accordance with Test Method D 1397. Take care to ensure rigorous quantitative separations and similar handling and exposure of the comparison samples. Determine the percentage of unsaponifiable matter. Obtain infrared spectra of cast films of the dried unsaponifiable matter in a manner similar to that described in 11.1.

15. Interpretation of Results

15.1 Compare the percentages of unsaponifiable matter. Compare the spectra and interpret the results in a similar manner as in 12.1. Care should be taken to avoid an erroneous conclusion that the materials are different when in fact they are the same. Such a misinterpretation could be caused by incomplete removal of oil acids and varying degrees of sterol contamination, solvent residues, etc. If it is firmly established that the companion samples are truly different, then further tests are unnecessary. If, on the other hand, the spectra and unsaponifiable contents are identical and the results from Method A were similar, then proceed to Method C to determine adulteration of the oil fraction or by oils if such is present or suspected of being present.

METHOD C—GAS CHROMATOGRAPHIC ANALYSIS OF OILS AND OIL ACIDS SEPARATED FROM VEHICLE SOLIDS

16. Apparatus and Reagents

16.1 Same as in Method D 2245.

17. Procedure

17.1 Proceed as in Method D 2245 utilizing a portion of the vehicles separated from both the test and reference samples.

18. Interpretation of Results

18.1 Compare the two recorded chromatograms and the calculated percentages of individual fatty acids for similarity. Note particularly the absence or presence of extraneous peaks in one and not the other as well as the percentages of individual fatty acids and polymers in one sample as compared to the other. Any significant difference should be taken as an indication of test sample adulteration or lack of uniformity.

METHOD D—ULTRAVIOLET SPECTRAL ANALYSIS OF TOTAL VEHICLE SOLIDS

19. Apparatus

19.1 *Spectrophotometer*, recording double-beam, suitable for use in the ultraviolet region of the electromagnetic spectrum from 190 to 350 nm.

20. Procedure

20.1 On a portion of the previously separated vehicles of the test and reference samples, determine the nonvolatile content by means of Test Method D 1259. On the basis of this determination, quantitatively weigh out, by difference, from the stoppered bottles of the total vehicle, samples to yield 0.2 ± 0.0005 g of vehicle solids and place in a 100-mL beaker. Take care to avoid weighing errors caused by evaporation of solvent in the stoppered bottle during the weighing process.

20.2 Evaporate the volatile material by placing the beaker over an even heat source maintained at 60 to 65°C and under a constant blanket of dry, inert gas, preferably nitrogen, fed through a bell jar in which the beaker is placed. The bell jar should also be fitted with a stoppered separatory funnel with its delivery tube directly over the beaker. Evaporate until all the solvent is completely removed but avoid excessive exposure to these conditions much beyond this point. With the inert gas flow uninterrupted, transfer about 25 to 30 mL of spectral grade cyclohexane to the beaker through the assembled separatory funnel. Remove the beaker and immediately stir to dissolve all the solid material in the solvent. Quantitatively transfer to a 50-mL volumetric flask and fill to mark with additional spectral solvent. This yields a 0.4 % stock solution (wt/vol) of the vehicle solids in solution. If solution is not complete, try gentle warming or else start over using another suitable spectral grade nonaromatic solvent with an ultraviolet cut-off point at least as low as 220 or 230 nm.

20.3 With appropriate calibrated pipets or hypodermic syringes, volumetric flask, and the same lot of solvent used before, prepare several dilute quantitative solutions from aliquots of each stock solution that will enable quantitative measurements of all peak heights in the subsequent ultraviolet analysis (Note 1). In all cases, a specific quantitative dilution of the reference sample should be matched by exactly the same dilution of the test sample. For each such matched dilution, use the exact same pipet for the test sample as was used for the reference sample to avoid dilution errors of comparison samples.

NOTE 1—The concentrations and numbers of dilute solutions necessary to obtain all the spectral peaks characteristic of a material will vary with the type of vehicle solids under examination. Generally, three dilutions of each stock solution to yield 0.03, 0.01, and 0.005 % solutions should suffice.

20.4 Within 24 h, and after making certain that the dilute solution is perfectly clear and without sediment and insolubles, record the ultraviolet absorbance spectrum of the dilute solution using a 1-cm stoppered quartz cell against the solvent blank in a reference cell. Obtain all absorbance peaks for each material that may occur between 200 and 300 nm. By appropriate use of the various dilutions of each sample, the spectral peaks should be made to fall between 0.3 and 0.8 absorbance unit. In all cases, record the exact absorbance value for each of the peaks for both test and reference samples. For each peak at a specific wavelength, the concentrations used for both the test and reference samples should be identical. It is wise to prepare several replicate standard stock and dilute solutions for each concentration independently of each other in order to obtain an idea of the range in each peak absorbance of the standard sample that might be expected in this procedure, especially as a result of the preliminary removal of original solvent by heating and its possible oxidative effects.

21. Interpretation of Results

21.1 Compare the nature and shape of the ultraviolet absorption curves obtained for both the test and reference samples. Any significant difference is an indication of adulteration or nonuniformity. Also compare the absorbance value of each peak given by the test sample with that given by the comparison reference sample. Any significant difference should be an indication of adulteration or nonuniformity. It is difficult to fix precise criteria for spectral differences that apply to all materials. As a general guide, the following criteria may be useful for evaluating comparable absorbance peaks. Comparison peaks should be within 0.05 absorbance units when occurring between 220 and 350 nm, and within 0.08 at lower wavelengths.

22. Report

22.1 Indicate uniformity or lack of uniformity of the vehicle solids of the test sample with respect to the reference sample and the method or methods (A, B, C, and D) used for this judgment. If possible, attempt to report the nature of possible adulterant(s) present or the cause of the nonuniformity.

Designation: D 2792 - 69 (Reapproved 1987)

Standard Test Method for Solvent and Fuel Resistance of Traffic Paint[1]

This standard is issued under the fixed designation D 2792; 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 test method describes a laboratory test for determining the resistance of a dried film of traffic paint to the action of a specified hydrocarbon solvent or gasoline fuel test fluid.

1.2 *This standard may involve hazardous materials, operations, and equipment. This standard does not purport to address all of the safety problems 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:*

D 471 Test Method for Rubber Property—Effect of Liquids[2]

2.2 *Federal Standard:*

TT-S-735 Standard Test Fluids for Hydrocarbons[3]

3. Summary of Method

3.1 The test paint is applied to a specified, properly prepared, tin panel. After aging, the coated panel is immersed in the hydrocarbon test fluid for a specified period of time at a specified temperature. The paint is examined for blistering, wrinkling, and loss of adhesion immediately upon removal and for complete hardness after a specified recovery time.

4. Significance and Use

4.1 Traffic paints must have good resistance to motor oil and fuel drippings on the highway. This test method describes the procedure necessary to measure the resistance of traffic paint to reference test fluids in order to simulate this type of action.

5. Apparatus

5.1 *Tin Panel*—Panels shall be cut from bright tin plate weighing not more than 25 g and not less than 19 g/dm^2 (0.51 to 0.39 lb/ft^2). The panel should be about 75 by 130 mm (3 by 5 in.).

5.2 *Film Applicator*, which will produce a 3 or 6-mil (0.003 or 0.006-in.) (76 or 142-µm) wet film thickness.

6. Reagents and Materials

6.1 *Test Liquid*—The testing liquid shall be specified by the purchaser and shall be selected from the following, dependent on the paint tested:

6.1.1 Type I of Federal Specification TT-S-735 which is the same as ASTM Reference Fuel A (ASTM Test Method D 471).

6.1.2 Type III of Federal Specification TT-S-735 which is the same as ASTM Reference Fuel B (Test Method D 471).

7. Procedure

7.1 Clean the tin panels thoroughly with a suitable solvent, and buff lightly with fine steel wool. Prepare at least 3 panels for each paint to be tested.

7.2 Examine the test paint, remove any skins that are present, stir with a paddle to loosen any settled pigment, and mix thoroughly.

7.3 Draw down the material on the panels using a film applicator that will produce a 3 or 6-mil (76 or 142-µm) wet film as specified by the purchaser.

7.4 Air dry the coating for the time specified by the purchaser (usually 90 h) and then immerse the panels to half their length in the test liquid contained in a covered glass beaker at the temperature specified by the purchaser (generally 70 to 90°F (21 to 32°C)). Use a separate beaker for each paint tested.

7.5 At the end of the specified time (usually 4 to 18 h, depending on the type of paint) remove the panels and examine immediately for blistering, wrinkling, and loss of adhesion.

7.6 Allow the panels to dry at normal temperatures for the purchaser-specified time (generally 24 h), and examine for film defects and softening in comparison with the unimmersed portion of the panels.

8. Report

8.1 Report whether blistering, wrinkling, or loss of adhesion is evident immediately upon removal of panel from the test fluid as determined in 7.5.

8.2 Report whether any softening of the film is evident after the panel has recovered as determined in 7.6.

9. Precision

9.1 No statement of precision, in terms of percentages, can be made, although repeatability and reproducibility are exceptionally good.

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[1] This test method is under the jurisdiction of ASTM Committee D-1 on Paint and Related Coatings and Materials and is the direct responsibility of Subcommittee D01.44 on Traffic Coatings.

Current edition approved Oct. 3, 1969. Published December 1969.

[2] *Annual Book of ASTM Standards*, Vol 09.01.

[3] Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094, Attn: NPODS.

Designation: D 2793 – 69 (Reapproved 1987)

Standard Test Method for Block Resistance of Organic Coatings on Wood Substrates[1]

This standard is issued under the fixed designation D 2793; 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 method covers the determination of the block resistance of organic coatings on wood and wood-based substrates. Block resistance is the ability of a coating to resist sticking to another surface and to resist any change in appearance, when it is pressed against that surface for a prolonged period of time.

1.2 *This standard may involve hazardous materials, operations, and equipment. This standard does not purport to address all of the safety problems 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. Summary of Test Method

2.1 The coatings to be tested are applied to the desired substrate. They are cured in a manner duplicating the condition of end use as much as possible. Then a stack of these painted substrates is formed and subjected to a specified pressure for a sufficient time to develop any sticking tendencies that exist. The pressure is released and the painted surfaces are examined for any signs of sticking. If blocking (forming a block by panels sticking together) occurs, the material is unsatisfactory. If no sticking or damage to the film surface occurs, the material is satisfactory.

2.2 When the conditions of production finishing are established and known, the method of application, the substrate, film thickness, and cure of the film should duplicate those conditions as closely as possible.

2.3 When the conditions of storage and shipment are established and known, the temperature, relative humidity, duration, and pressure used for the test should duplicate those conditions as closely as possible.

3. Apparatus

3.1 *Rigid Platens*, 4-in. (100-mm) square, capable of being maintained at 120 ± 2°F (49 ± 1°C).

4. Test Specimens

4.1 For those cases where the intended use conditions are not established or known, the following specifications or some set of specifications agreed upon by the purchaser and seller apply: The test coating shall be applied by normal spray, using air, to a 4 by 4-in. (100 by 100-mm) panel. The panel shall be a piece of ¼-in. (6.4-mm) SIS (smooth one side) standard hardboard. The dry film thickness of pigmented coatings shall be 1.5 ± 0.2 mils (38 ± 5 μm), and of clear coatings shall be 1.2 ± 0.2 mils (30 ± 5 μm). Cure of the coating shall be as agreed and should be standardized for each coating.

NOTE 1—Film thickness can be measured by weight difference before and after painting, but this requires careful conditioning of the substrate under standard temperature and humidity conditions prior to each weighing. Film thickness can also be determined by using an aluminum tab alongside the test panel and measuring the film thickness with a standard eddy-current gage or using a steel panel with a magnetic film thickness gage.

5. Procedure

5.1 After 90 s cooling under ambient conditions or as agreed upon, make a stack of six panels and place under a uniform pressure of 35 ± 2 psi (240 ± 20 kPa) for Class I, 20 ± 1 psi (140 ± 10 kPa) for Class II, and 5 ± ¼ psi (35 ± 1.7 kPa) for Class III. These classes are arbitrary and simply designate three groups of coatings or possibly three groups of end uses. Stack the panels in the following order from the top to the bottom:

(*a*) Face down.
(*b*) Face down
(*c*) Face up.
(*d*) Face down.
(*e*) Face down.
(*f*) Face up.

This provides for two face-to-face contacts and two face-to-back contacts. Apply the load through rigid 4-in. square (100-mm square) pressure plates. Apply the load for a minimum of 24 h. Other pressures, types of pressure plates, and times may be used if agreed between the purchaser and seller. Conduct the test under ambient conditions but use press platens heated to 120 ± 2°F (49 ± 1°C). Slip sheets should not be used unless they are known to be used during storage of shipment.

NOTE 2—The most difficult portion of this test method to standardize on intelligently is the proper pressure to employ. Stacking pressure in production would be calculated as follows:

$$(DHA_1/A_2) \times F$$

where:
D = board density,
H = height of stack,
A_1 = area of stack,
A_2 = area of support, and
F = safety factor.

The area of support is difficult to establish. In some instances board is stacked smoothly on the floor while in other instances the stack is supported on 2 by 4 or 4 by 4 stringers which cut the support to very

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[1] This method is under the jurisdiction of ASTM Committee D-1 on Paint and Related Coatings and Materials.
Effective Oct. 3, 1969.

small areas. It has been found that pressures of 20 to 50 psi (140 to 340 kPa) are suitable on hardboard substrates while 2 to 5 psi (14 to 35 kPa) are suitable on solid wood surfaces.

NOTE 3—Many coatings are plasticized if they are contaminated with water. If possible, therefore, it is advisable to run blocking tests at as high relative humidities as might be encountered in production of warehousing.

NOTE 4—Blocking tests shall be run with panels wet with water, if water quenching is used for cooling the boards and the boards are wet when stacked in production.

5.2 At the end of the test period remove the pressure and pick up the stack in such a way that first the bottom panel, then the next to the bottom panel, and eventually all of the panels are free to fall of their own weight. This falling free is considered as passing the test if there also is no change in the appearance of the coated surfaces of any of the panels.

6. Report

6.1 This is a go/no-go test for both face-to-face and face-to-back conditions. In addition to the separate statement of satisfactory or not satisfactory under both of these conditions, the nature of the failure should be reported. The report should also include the particulars of the test as follows:

6.1.1 Type of substrate,

6.1.2 Method of application,

6.1.3 Curing cycle,

6.1.4 Film thickness,

6.1.5 Temperature, humidity, and pressure of the blocking test,

6.1.6 Type of stacking including identification and type of slip sheets if any, and

6.1.7 Duration of test.

7. Precision

7.1 A round robin will be made to establish precision.

Standard Test Method for Durability and Compatibility of Factory-Primed Wood Products with Representative Finish Coats[1]

1. Scope

1.1 This test method provides for the determination of the relative durability and compatibility of factory-primed wood and wood-based substrates with representative finish coats when exposed to the weather.

1.2 *This standard does not purport to address all of the safety problems, 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:*

D 659 Method of Evaluating Degree of Chalking of Exterior Paints[2]

D 660 Test Method for Evaluating Degree of Checking of Exterior Paints[2]

D 661 Test Method for Evaluating Degree of Cracking of Exterior Paints[2]

D 662 Test Method for Evaluating Degree of Erosion of Exterior Paints[2]

D 714 Test Method for Evaluating Degree of Blistering of Paints[2]

D 772 Test Method for Evaluating Degree of Flaking (Scaling) of Exterior Paints[2]

D 1006 Practice for Conducting Exterior Exposure Tests of Paints on Wood[2]

D 3274 Test Method for Evaluating Degree of Surface Disfigurement of Paint Films by Microbial (Fungal or Algal) Growth or Soil and Dirt Accumulation[2]

D 3359 Test Methods for Measuring Adhesion by Tape Test[2]

2.2 *U. S. Federal Standards:*[3]

TT-P-96b

TT-P-102

3. Summary of Test Method

3.1 This test method consists of the atmospheric exposure of at least three types of conventional exterior white house paints applied to panels of factory-primed wood or wood-base substrates that have been exposed to atmospheric weathering conditions for periods of 0, 3, and 6 months.

3.2 The finish coats are applied by brush.

3.3 An additional panel of original factory-primed substrate, without finish coat, is exposed for the duration of the test.

4. Significance and Use

4.1 This test method is useful for evaluating the weathering performance of factory-applied primers on wood or wood-based substrates overcoated with a field-applied topcoat.

4.2 This test method is useful for evaluating the weathering compatibility of commercial topcoats over factory-applied primers on wood or wood-based substrates.

5. Apparatus

5.1 A vertical (90° from horizontal) test fence constructed in accordance with requirements of Practice D 1006.

6. Materials

6.1 *Exterior Finishes:*

6.1.1 *Paint, Oil, Alkyd*, fume resistant, conforming to Federal Specification TT-P-102.

6.1.2 *Resin Latex Paint, Synthetic*, of the emulsion type designed for use on exterior wood surfaces (such as TT-P-96b).

6.1.3 *Flat Alkyd, Solvent-Thinned, Exterior.*

6.1.4 Any other type of exterior finish paint mutually agreed upon.

6.2 *Bristle Brush* (*Natural or Synthetic*).

7. Procedure

7.1 The minimum length of panel is 3 ft (910 mm) with a minimum width of 6 in. (150 mm) of a particular preprimed substrate.

7.2 Mark off one third of the panel area (in a manner which will not damage the prime coat) and apply by brush to the right one third panel area a single coat of one of the white finishes at a spreading rate as recommended by the manufacturer or by the appropriate Federal specification. Paint the panel and dry indoors for 7 days under prevailing conditions of temperature and humidity, taking care to avoid exposure to drafts or excessive heat.

7.3 Determine the spreading rate of the finish paints by the weight difference method or other suitable methods. Record the spreading rate, film thickness, and method used.

7.4 Fasten the panel to a south exposure rack.

NOTE 1—Panel mounting should be the same as normal practice for the mounting of a particular substrate.

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[1] This test method is under the jurisdiction of ASTM Committee D-1 on Paint and Related Coatings and Materials and is the direct responsibility of Subcommittee D01.52 on Factory-Coated Wood Building Products.

Current edition approved Oct. 15, 1991. Published December 1991. Originally published as D 2830 – 69. Last previous edition D 2830 – 82 (1987).

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

[3] Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094, Attn: NPODS.

7.5 After 3 months (±1 week) of exposure of the panel, coat the center one third section adjacent to the section already coated with exterior finish as specified in 7.2.

NOTE 2—If possible, the application should be made in the laboratory as in 6.2. No washing or cleaning should be done to the surface to be coated.

7.6 At completion of 6 months (±1 week) of exposure to the weather, apply finish coat to the final third section of the panel as specified in 7.2.

7.7 Examine each section of the panels visually for appearance, mildew, and film failure at intervals of not more than 3 months (preferably 1 month) beginning 1 month after initial exposure.

7.8 At the end of each 6 months exposure of a topcoated section, test for intercoat adhesion between the factory-applied primer and the topcoat as follows:

7.8.1 Cut a small "X" in the film with a sharp knife or razor blade. The cuts should penetrate the substrate slightly but not distort the film unduly. Apply pressure-sensitive tape[4] so that it crosses the "X" in the direction of the acute angles. Press the tape on carefully with the flat surface of the fingernail or with a rubber eraser. Remove the tape with a quick yank, at a 90° angle to the surface.

7.9 Exposure of the topcoated preprimed substrate may be terminated 12 months after application of the finish coat to the third section. Additional exposure may be agreed upon between buyer and seller.

8. Report

8.1 Report the following properties:

8.1.1 *Chalking*—Method D 659.
8.1.2 *Checking*—Test Method D 660.
8.1.3 *Cracking*—Test Method D 661.
8.1.4 *Erosion*—Test Method D 662.
8.1.5 *Flaking*—Test Method D 772.
8.1.6 *Blistering*—Test Method D 714.
8.1.7 *Intercoat Adhesion*—Test Methods D 3359.
8.1.8 *Mildew*—Test Method D 3274.

9. Precision and Bias

9.1 Varying weather conditions from year to year and at several exposure sites preclude development of precision and bias data.

10. Keywords

10.1 adhesion; factory primed wood; primer performance; topcoat compatibility; weathering

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[4] 3-M Company's No. 600 Cellophane Tape has been found satisfactory. Tape shall be stored in an airtight container and shall not be more than 6 months old.

Designation: D 2833 – 89

Standard Index of Methods for Testing Architectural Paints and Coatings[1]

This standard is issued under the fixed designation D 2833; 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 index is provided for reference in the selection of procedures, test methods, and specifications to be used in the evaluation of architectural paints and coatings designed for application in the field. Composition specifications and analytical methods in general, also tests on raw materials, are not included, the scope being limited to procedures required in the evaluation of finished coatings.

1.2 Methods suitable for both interior and exterior coatings of either the water-thinned or solvent-thinned type are listed by ASTM designation primarily. Where comparable (but not necessarily identical) methods exist in U.S. Federal Test Method Standard No. 141, the Federal Method numbers are also listed.

1.3 Where more then one test method is listed for the same characteristic in this index, no attempt is made to indicate superiority of one test method over another. Selection of the test methods to be followed must be governed by experience and the requirements in each individual case, together with agreement between the purchaser and the seller.

2. Precision and Bias

2.1 If available, precision for any procedure or test method selected is given in the latest issue of the subject standard.

3. Test Categories

3.1 For convenience in selection, the procedures, methods, and specifications listed in this index are classified into three groups and three classes. The category of each listing is indicated in a column preceding the reference. The classifications are as follows:

3.1.1 *Group I—Applicable to Either Water- or Solvent-Reducible Coatings:*

Class A—For both interior and exterior products.
Class B—For interior products only.
Class C—For exterior products only.

3.1.2 *Group II—Water-Thinned Coatings:*

Class A—For both interior and exterior products.
Class B—For interior products only.
Class C—For exterior products only.

3.1.3 *Group III—Solvent-Thinned Coatings:*

Class A—For both interior and exterior products.
Class B—For interior products only.
Class C—For exterior products only.

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[1] This index is under the jurisdiction of ASTM Committee D-1 on Paint and Related Coatings and Materials and is the direct responsibility of Subcommittee D01.42 on Architectural Finishes.

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[A] Discontinued; see *1980 Annual Book of ASTM Standards*, Part 27.

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[B] Discontinued; see *1988 Annual Book of ASTM Standards*, Vol 06.01.

[C] Discontinued; see *1976 Annual Book of ASTM Standards*, Part 27.

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Designation: D 2921 – 88

Standard Test Method for Qualitative Tests for the Presence of Water Repellents and Preservatives in Wood Products[1,2]

This standard is issued under the fixed designation D 2921; 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 test method describes simple qualitative field or laboratory tests to determine water repellency or the presence of chlorinated phenol[3] preservative chemicals in wood products that are specified to be water repellent preservative treated.

1.2 *This standard may involve hazardous materials, operations, and equipment. This standard does not purport to address all of the safety problems 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 *U.S. Federal Specification:*

TT-W-572 Wood Preservative Water-Repellant[4]

2.2 *NIST Standard:*

262-63 Water Repellent Preservative Non-Pressure Treatment for Mill Work[5]

3. Significance and Use

3.1 Although chlorinated phenol-treated wood has become less common due to environmental concerns, repellent-treated wood is commonly specified in construction. This test method provides a means to verify the presence of a significant level of water repellent protection.

4. Apparatus

4.1 *Eyedropper*, plastic squeeze bottle or similar means for metering drops of water.

4.2 *Flame Source*, such as bunsen burner, butane torch, or alcohol burner.

4.3 *Copper Wire Coil Specimen Holder* (*or Other Suitable Copper Holder*)—A suitable copper wire coil can be made by using a lead pencil as a mandrel to form a helix using copper wire of about 1/16 to 3/32 in. (1.6 to 2.4 mm) in diameter. Leave a space of approximately the diameter of the wire between each loop. The helix should be ¾ to 1 in. (19 to 25 mm) in length. Leave a pigtail of about 6 in. (152 mm) of wire at one end of the helix and form a loop of approximately 1 in. (25 mm) in diameter to be used as a holder for the coil.

4.4 *Sharp Knife.*

5. Water Repellent Test

5.1 Place uncut wood items to be tested so that the end grain is exposed as a horizontal surface. If the end grain cannot be so positioned, comparisons can be made on the flat grain.

5.2 With an eye dropper, or similar device, allow several drops of water to fall from about ½ in. (13 mm) on the end grain of the wood. Wait 5 min and then observe the degree of penetration. With flat grain or vertical grain surfaces, waiting periods of 10 to 15 min may be necessary.

5.3 Water drops that immediately flatten out, penetrate and darken the wood, indicate that the wood has not been treated with a water repellent.

5.4 Water drops that "bead-up" and remain as spheres, with little or no color change or penetration, indicate that the wood has been treated with a water repellent. Water repellent preservatives, meeting Fed. Spec. TT-W-572 and NBS Standard 262-63, impart sufficient water repellency to the end grain of wood to cause water drops to bead up and form spheres.

6. Preservative Test

6.1 Chlorinated phenol based wood preservatives emit a characteristic green flame upon pyrolysis within a ventilated copper envelope due to the release of chlorine and its consequent reaction with copper (Beilstein's test). Untreated wood produces a yellow-orange flame but any chlorine containing compound will give a positive test.

6.2 Using the copper wire specimen holder, described in 3.3, hold the coil portion in the flame until it burns with a characteristic yellow-orange color. This preheated coil is then allowed to cool.

6.3 With a knife, cleaned by heating after each use, cut a splinter from the specimen of wood to be tested. Samples should be taken near the end of the wood items where end grain is exposed and where normal concentration of the preservative chemicals is greatest. The size of the wood sample should be smaller than the length and inner diameter of the coil.

6.4 With the copper coil held horizontally, place the splinter in the center of the coil. Put the copper coil with wood splinter in the flame and burn. If chlorinated phenols are present, the characteristic green flame is produced. Untreated wood produces the yellow-orange flame.

7. Accuracy

7.1 The tests are less accurate on flat grain and the

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[1] This test method is under the jurisdiction of ASTM Committee D-1 on Paint and Related Coatings and Materials and is the direct responsibility of Subcommittee D01.52 on Factory-Coated Wood Products.

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[2] An improved quantitative test method for water repellents is under development by Subcommittee D01.42.

[3] Pentachlorophenol, tetrachlorophenol and other chlorinated phenols.

[4] Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094, Attn: NPODS.

[5] Available from the National Institute of Standards and Technology, Gaithersburg, MD 20899.

heartwood of some wood species, so that end grain and sapwood should be used whenever possible.

7.2 Tests on both a known untreated sample and a treated sample of the same wood species will provide comparison standards for the operator and will improve the accuracy of the tests.

7.3 Test results are improved if tests are made with wood samples taken from the center of a stack or from a protected area where the possibility of contamination is least. Untreated items which come in physical contact with preservative treated products during handling and shipping may show slight evidence of the preservative chemical.

7.4 More than one wood sample obtained from different areas from the unknown piece should be tested.

8. Precision and Bias

8.1 No numerical statement of precision is possible in this qualitative test method. One hundred percent agreement was obtained in a round-robin test.

8.2 *Bias*—Bias has not been determined.

Designation: D 2931 – 84 (Reapproved 1989)$^{\epsilon 1}$

Standard Guide for Testing Latex Flat Wall Paints[1]

This standard is issued under the fixed designation D 2931; 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.

$^{\epsilon 1}$ NOTE—The title was editorially changed in March 1989.

1. Scope

1.1 This guide covers the selection and use of procedures for testing flat latex paints for use on interior walls. The test methods included are listed in Tables 1 and 2.

1.2 This guide applies to ready-mixed flat latex paints for application by brushing, roller coating, spraying, or other means, on plaster, masonry surfaces, wood, wallboard, previously painted surfaces and other interior architectural surfaces.

1.3 *This standard may involve hazardous materials, operations, and equipment. This standard does not purport to address all of the safety problems 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:*

D 16 Terminology Relating to Paint, Varnish, Lacquer, and Related Products[2]
D 185 Test Methods for Coarse Particles in Pigments, Pastes, and Paints[3]
D 344 Test Method for Relative Hiding Power of Paints by the Visual Evaluation of Brushouts[2]
D 522 Test Method for Mandrel Bend Test of Attached Organic Coatings[2]
D 523 Test Method for Specular Gloss[2]
D 562 Test Method for Consistency of Paints Using the Stormer Viscometer[2]
D 823 Test Methods for Producing Films of Uniform Thickness of Paint, Varnish, and Related Products on Test Panels[2]
D 1210 Test Method for Fineness of Dispersion of Pigment-Vehicle Systems[2]
D 1475 Test Method for Density of Paint, Varnish, Lacquer, and Related Products[2]
D 1554 Definitions of Terms Relating to Wood-Base Fiber and Particle Panel Materials[4]
D 1640 Test Methods for Drying, Curing, or Film Formation of Organic Coatings at Room Temperature[3]
D 1729 Practice for Visual Evaluation of Color Differences of Opaque Materials[2]
D 1736 Test Method for Efflorescence of Interior Wall Paints[2]
D 1737 Test Method for Elongation of Attached Organic Coatings with Cylindrical Mandrel Apparatus[5]
D 1849 Test Method for Package Stability of Paint[6]
D 2196 Test Methods for Rheological Properties of Non-Newtonian Materials by Rotational (Brookfield) Viscometer[2]
D 2243 Test Method for Freeze-Thaw Resistance of Water-Borne Paints[6]
D 2244 Test Method for Calculation of Color Differences from Instrumentally Measured Color Coordinates[2]
D 2369 Test Method for Volatile Content of Coatings[2]
D 2486 Test Method for Scrub Resistance of Interior Latex Flat Wall Paints[6]
D 2574 Test Method for Resistance of Emulsion Paints in the Container to Attack by Microorganisms[2]
D 2805 Test Method for Hiding Power of Paints by Reflectometry[2]
D 2831 Test Method for Evaluating the Ability of a Latex Paint to Resist Efflorescence from the Substrate[7]
D 3258 Test Method for Porosity of Paint Films[6]
D 3450 Test Method for Washability Properties of Interior Architectural Coatings[6]
D 3925 Practice for Sampling Liquid Paints and Related Pigmented Coatings[2]
D 4062 Test Method for Leveling of Paints by Draw-Down Method[6]
D 4213 Test Method for Wet Abrasion Resistance of Interior Paints[6]
E 70 Test Method for pH of Aqueous Solutions with the Glass Electrode[8]
E 105 Practice for Probability Sampling of Materials[9]

2.2 *U. S. Federal Test Methods Standard 141:*[10]

2112 Application by Roller
2131 Application of Sprayed Films
2141 Application of Brushed Films

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[1] These practices are under the jurisdiction of ASTM Committee D-1 on Paint and Related Coatings and Materials and are the direct responsibility of Subcommittee D01.42 on Architectural Finishes.

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

[3] *Annual Book of ASTM Standards*, Vol 06.03.

[4] *Annual Book of ASTM Standards*, Vol 04.09.

[5] Discontinued; see *1988 Annual Book of ASTM Standards*, Vol 06.01.

[6] *Annual Book of ASTM Standards*, Vol 06.02.

[7] Discontinued, see *1980 Annual Book of ASTM Standards*, Part 27.

[8] *Annual Book of ASTM Standards*, Vol 15.05.

[9] *Annual Book of ASTM Standards*, Vol 14.02.

[10] Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094.

3011 Condition in Container
4321 Brush Properties
4541 Working Properties and Appearance of Dried Film

3. Definitions

3.1 For definition of terms used in this practice, refer to Definitions D 16 and D 1554.

4. Conditions Affecting Latex Wall Paints

4.1 *Substrate Type*—The substrate to be painted can affect not only the application properties and the physical properties of a latex paint, such as sheen and uniformity, but may also be a factor in determining the type of latex paint to be used. For instance, a latex paint with good sealing properties may be required for porous surfaces, such as new dry wall, bare plaster, new wood or porous masonry surfaces.

4.2 *Substrate Condition*—Dirty, chalky, alkaline, or water-soluble surfaces may affect the practical requirements and performance of interior latex flat paints.

4.3 *Application Properties*—The application properties of interior latex paints are affected by temperature, humidity, and the texture and porosity of the surface to be painted. Application will also depend upon the type and quality of equipment used.

4.4 *Physical Requirements*—The type of latex wall paint to be used will depend not only upon the surface to be painted, but also upon the desired physical properties of the finish. For instance, if maximum light diffusion and uniformity of appearance are the prime requirements, such as when painting ceilings, then a low sheen paint should be used. However, if cleanability or stain removal properties are desired for walls that become soiled, then a nonporous paint should be used.

5. Selection of Tests

5.1 It has been pointed out that there are many conditions that affect interior latex wall paints so that different types of latex paints have been developed specifically to meet the requirements of these various conditions. Although the recommended test methods presented in Tables 1 and 2 cover most of the properties of interior latex wall paints, all of these tests may not be required for each paint. If a paint is to be used only in a warm climate, for instance, then freeze-thaw tests or low temperature coalescence tests need not be considered.

5.2 The purchaser should first determine which properties a latex paint must have and then select only those test methods that will measure or evaluate these properties. After selecting the desired tests, the purchaser should determine which of these properties are the most important and then establish the requirements or specifications of these tests to get the most desired properties. Since some paint properties tend to oppose each other, such as low sheen versus good cleanability, or high viscosity versus good leveling, some properties may need to be attenuated if others are to be accentuated. This balance of properties must be considered when selecting the tests and establishing the requirements of these tests. The properties that these tests measure and the normal range of values have been presented for many of the tests, however.

5.3 Some tests cannot be selected as being more important than others and specific values for each test cannot be recommended since the properties that are important to one purchaser may not be important to another.

TABLE 1 List of Test Methods by Properties

Test Method	Section	ASTM Test Method	Federal Test Method Standard No. 141
Liquid Paint Properties:			
Condition in container	7.1	...	3011.1
Coarse particles and foreign matter	7.2	D 185	...
Density (weight per gallon)	7.3	D 1475	...
Fineness of dispersion	7.4	D 1210	...
Odor	7.5	...	...
Consistency (viscosity)	7.6	D 562	...
Rheological properties, non-Newtonian liquids	7.7	D 2196	...
pH	7.8	E 70	...
Color compatibility	7.9	...	...
Freeze-thaw stability	7.10	D 2243	...
Package stability	7.11	D 1849	...
Microorganism resistance	7.12	D 2574	...
Paint Application and Film Formation:			
Application properties	8.1	...	4541, 4321
Application by brush	8.1.1	...	2141.1
Application by roller	8.1.2	...	2112
Application by spray equipment	8.1.3	...	2131
Drying time	8.2	D 1640	4061.1
Flow and leveling	8.3	D 4062	...
Low-temperature coalescence of paints	8.4	D 3793	...
Producing uniform thickness of films	8.5	D 823	2162
Touch-up	8.6	...	...
Appearance of Dry Paint Film:			
Color difference of opaque materials, visual evaluation	9.1	D 1729	...
Color difference of opaque materials, instrumental evaluation	9.2	D 2244	...
Hiding power	9.3	D 344, D 2805	...
Specular gloss	9.4	D 523	...
Uniformity of appearance	9.5	...	4541
Properties of Dry Paint Film:			
Efflorescence of paint film	10.1	D 1736	...
Efflorescence from substrate	10.2	D 2831	...
Elongation (flexibility)	10.3	D 1737, D 522	6221 ...
Film porosity	10.4	D 3258	...
Scrubbability (wet abrasion)	10.5	D 2486	6142
Stain removal (cleanability)	10.6	D 3450	
Wet Abrasion Resistance	10.7	D 4213	...
Analysis of Paint:			
Chemical analysis	11.1	...	...
Volatile content	11.2	D 2369	...

6. Sampling

6.1 Prior to sampling, the condition of the container should be established since damage to it may cause evaporation, skinning, or other undesirable effects in the coating. Determine the condition of the coating in accordance with 7.1 and 7.2.

6.2 Sample in accordance with Practice D 3925. Determine the weight per gallon in accordance with Test Method D 1475. Repeat this procedure until successive readings agree within 0.2 lb (90 g) or as agreed upon between the purchaser and the seller. Samples for testing may then be taken.

6.3 Specify the amount of sample, the package sizes, and identification codes to assure a representative sample. A

TABLE 2 Alphabetical List of Test Methods

Test Methods	Section	ASTM Test Method	Federal Test Method Standard No. 141
Application by brush	8.1.1	. . .	2141.1
Application properties	8.1	. . .	4541, 4321
Application by roller	8.1.2	. . .	2112
Application by spray equipment	8.1.3	. . .	2131
Chemical analysis	11.1	. . .	. . .
Coarse particles and foreign matter	7.2	D 185	. . .
Color compatibility	7.9	. . .	. . .
Color difference of opaque materials, instrumental evaluation	9.2	D 2244	. . .
Color difference of opaque materials, visual evaluation	9.1	D 1729	. . .
Condition in container	7.1	. . .	3011.1
Consistency (viscosity)	7.6	D 562	. . .
Density (weight per gallon)	7.3	D 1475	. . .
Drying time	8.2	D 1640	4061.1
Efflorescence of paint film	10.1	D 1736	. . .
Efflorescence from substrate	10.2	D 2831	. . .
Elongation (flexibility)	10.3	D 1737, D 522	6221
Film porosity	10.4	D 3258	. . .
Fineness of dispersion	7.4	D 1210	. . .
Flow and leveling	8.3	D 4062	. . .
Freeze-thaw stability	7.10	D 2243	. . .
Hiding power	9.3	D 344, D 2805	. . .
Low-temperature coalescence of paints	8.4	D 3793	. . .
Microorganism resistance	7.12	D 2574	. . .
Odor	7.5	. . .	. . .
Package stability	7.11	D 1849	. . .
pH	7.8	E 70	. . .
Producing uniform thickness films	8.5	D 823	2162
Rheological properties of non-Newtonian liquids	7.7	D 2196	. . .
Scrubbability (wet abrasion)	10.5	D 2486	. . .
Specular gloss	9.4	D 523	. . .
Stain removal (cleanability)	10.6	D 3450	. . .
Touch-up	8.6	. . .	. . .
Uniformity of appearance	9.5	. . .	4541
Volatile content	11.2	D 2369	. . .
Wet Abrasion Resistance	10.7	D 4213	. . .

1-gal (4-L) sample is usually sufficient for the recommended tests, but for guidance in selecting a sampling plan, consult Recommended Practice E 105.

7. Liquid Paint Properties

7.1 *Condition in Container*—Thickening, settling, and separation are undesirable and objectionable if the paint cannot be reconditioned with a reasonable amount of stirring. The referenced method covers procedures for determining changes in properties of paints after storage. Determine the condition in the container in accordance with Method 3011 of Federal Test Method Standard No. 141.

7.2 *Coarse Particles and Foreign Matter:*

7.2.1 Paints must be free of coarse particles to form uniform films of good appearance, a typical maximum being 2 weight % of total paint. The specified test with a 325-mesh (45-µm) screen and water as the wash liquid gives the percent of these particles in a latex paint. Determine coarse particles and foreign matter in accordance with Test Methods D 185.

7.2.2 Another test method used in industry to determine whether coarse particles are present in a dry film is to scrape the surface of the film with a spatula or metal edge of a ruler. Any particles larger than 325 mesh can be clearly seen after the surface has been scraped.

7.3 *Density* (*Weight per Gallon*)—The density as measured by weight per gallon (kilograms per litre) is used to assure product uniformity from batch to batch. It does not necessarily measure the quality of a paint. In the referenced method, the density is expressed as the weight in pounds of 1 U.S. gal (kg/L) of the paint at a specified temperature. Most interior flat latex paints have densities of about 10 to 12 lb/gal (1.2 to 1.4 kg/L). Determine density in accordance with Test Method D 1475.

7.4 *Fineness of Dispersion:*

7.4.1 The more finely a pigment is dispersed, the more efficiently it is being used. One method for measuring the degree of dispersion (commonly referred to as "fineness of grind") is to draw the material down a calibrated tapered groove varying in depth from 4 to 0 mils (100 to 0 µm). The point at which continuous groupings of particles or agglomerates, or both, protrude through the surface of the liquid is taken as the fineness reading. Lower readings in mils or micrometres or higher readings in Hegman units indicate better fineness of dispersion.

7.4.2 The referenced method was designed primarily for coatings with good fineness of dispersion, such as enamels. Most interior flat latex paints have finenesses of about 70 to 90 µm (1 to 2.5 Hegman). Although these paints may contain pigments so coarse that it is impractical to measure the fineness with a grind gage, most of the pigments are so finely dispersed that particles or agglomerates cannot be seen by the unaided eye or felt on the surface of the dry film. In addition, the fast drying of some flat latex paints may make it difficult to make accurate measurements of fineness of dispersion.

7.4.3 Determine fineness of dispersion with Test Method D 1210.

7.5 *Odor*—One of the advantages of latex paints is that they do not have odors characteristic of solvent-based coatings. However, other ingredients, such as ammonia, may be used which might also be objectionable in confined spaces. Thus, interior latex paints should be tested for odor acceptability. Although there is no adequate ASTM test method to measure odor for nonorganic solvent paints, test methods are used by industry to measure this property. Examine to determine if the paint has an unpleasant or irritating odor during application or drying.

7.6 *Consistency* (*Viscosity*)—Paints of a given type should fall within a stated consistency for satisfactory reproduction of a specific formula. While consistency is an important property it does not determine the quality of a paint and should be used mainly to assure product uniformity. In the referenced method, consistency is defined as the load in grams to produce a specified rate of shear. Although the consistency of most latex wall paint is about 150 to 300 g/100 revolutions, a much wider range is possible because of the wide variations in rheological properties of these paints. Also two paints of the same consistency may have quite different rheological properties. Determine the consistency in accordance with Test Method D 562.

7.7 *Rheological Properties, Non-Newtonian Liquids*—Rheological properties are related to application and leveling properties of the liquid paint. The referenced method covers the determination of rheological properties and is particularly suited for use with paints that display thixotropic characteristics. It actually measures viscosity under varying conditions of time and rotational speed of the spindle. Determine rheological properties in accordance with Test Methods D 2196.

7.8 *pH*—Latex paints with low (acidic) pH may corrode the container. pH may vary from about 5 to 10 depending upon the type of latex used and the general formulation. pH does not determine the quality of a latex paint and should only be used to assure product uniformity. A change in pH during storage may indicate poor stability or a change in properties of a latex paint. Determine pH in accordance with Test Method E 70.

7.9 *Color Compatibility*—A test method to determine how well colorants can be dispersed in a paint so that the paint will have uniformity of color when applied is now in preparation and will be included in this guide when adopted by ASTM.

7.10 *Freeze-Thaw Stability*—Water-based paints may be subjected to freezing conditions during shipping and storage. Suitably stabilized paints will resist several cycles of freezing and thawing without showing deleterious changes such as coagulation, graininess, or excessive viscosity increase. Many latex paints will increase in viscosity but can still be considered usable if other properties, which may be affected by a higher viscosity, such as leveling and brushability, are satisfactory. Determine freeze-thaw stability in accordance with Test Method D 2243.

7.11 *Package Stability*—Since paints cannot normally be used immediately after manufacture, they must remain stable in the can for some time. At normal temperatures, most latex paints can be stored for over a year with little change in properties. Although package stability can usually be determined in several weeks at an elevated temperature such as 122°F (50°C), occasionally the results of the accelerated test do not coincide with those of prolonged room temperature storage. The referenced method covers the change in consistency and in certain other properties in packaged latex paint when stored at temperatures above freezing. Determine package stability in accordance with Test Method D 1849.

7.12 *Microorganism Resistance*—Bacteria in a latex paint can cause gassing, putrefactive, or fermentative odors and loss of viscosity. Determine if the paint contains living bacteria or if it is resistant to attack by bacteria in accordance with Test Method D 2574.

8. Paint Application and Film Formation

8.1 *Application Properties*—Determine the ease with which a paint can be applied to various wall surfaces with brush, roller, or spray equipment, in accordance with Method 4541 of Federal Test Method Standard 141. Application properties are generally compared to a standard, or described by requirements in a product specification.

8.1.1 *Brushing Properties*—The specified method covers the determination of the brushing properties of coatings. The test is quite subjective although someone experienced in the art can produce quite consistent results, particularly in the evaluation of "drag" properties. Determine brushing properties in accordance with Method 4321 of Federal Test Method Standard No. 141.

8.1.2 *Roller Application*—Determine the ease with which a paint can be roller applied in accordance with Method 2112 of Federal Test Method Standard 141. Since roller foam and roller spatter are often serious problems when latex paints are roller applied, these properties can also be determined in the test method for roller application. The amount of foam produced, the time that it takes for the bubbles to break, and the number of craters that remain after the bubbles have broken can be determined by visual examination of the test panel. Roller spatter can be determined by placing a strip of paper or a panel at the bottom of the test panel to catch the paint spatters from the roller. The degree to which a paint will spatter when roller applied can be determined by the density of the paint spatter.

8.1.3 *Sprayed Film Application*—Interior latex paints are sometimes applied by spray. Determine the spray application properties in accordance with Method 2131 of Federal Test Method Standard No. 141. The method can be modified to include application by airless spray equipment.

8.2 *Drying Time*—The drying time of an interior latex paint is important in determining when a freshly painted room can be put back to use. Under average conditions most flat latex paints are dry to touch in 1 or 2 h when the water has evaporated from the film. They can usually be recoated from within a few hours to 18 h. Curing to obtain the ultimate properties may take only a few days for some latex paints while others may require 1 or 2 weeks depending upon the composition. Determine drying time in accordance with Test Methods D 1640.

8.3 *Flow and Leveling*—These properties are usually evaluated by visually examining the test panel after a paint has been applied by brush or roller to see if any brush or roller marks can be seen in the dry film. Determine the ability of the paint to flow out after application in accordance with Test Method D 4062.

8.4 *Low-Temperature Coalescence of Paints*—Determine how well the latex particles in a paint will fuse together or coalesce, to form a continuous film at low temperatures in accordance with Test Method D 4062.

8.5 *Producing Films of Uniform Thickness*—The following method covers the preparation of various films of uniform thickness essential in conducting tests. Prepare films in accordance with Test Methods D 823.

8.6 *Touch-Up*—Although there is no test method published in Federal Test Method Standard 141 to measure touch-up, test methods are used by the paint industry. The usual method is to apply the test paint to a small section of a test panel that has previously been painted with the test paint and allowed to dry. The touch-up area is usually applied with a small brush. When the touch-up area has dried, it is examined to see if there is any difference in color or sheen between the touched-up area and the initial coat of paint.

9. Appearance of Dry Film

9.1 *Color Differences of Opaque Materials by Visual Evaluation*—Visual comparison of color is fast and often acceptable although numerical values are not obtained. The referenced method covers the spectral, photometric, and geometric characteristics of light source, illuminating and viewing conditions, size of specimens, and general procedures to be used in the visual evaluation of color differences of opaque materials. Determine color difference in accordance with Practice D 1729.

9.2 *Color Differences of Opaque Material by Instrumental Evaluation*—Color difference between a product and the standard can be measured by instrument. Generally, the tolerance is agreed upon by the purchaser and the seller and may also be required if a product specification is involved. Although color instruments are not more sensitive than the eye, they provide numerical values which can be subsequently compared to later measurements. The referenced method covers the instrumental determination of small color differences observable in daylight illumination between nonfluorescent, nonmetameric, opaque surfaces such as coated specimens. If metamerism is suspected, visual evaluation (9.1) should be used to verify the results. Make instrumental measurement of color difference in accordance with Method D 2244.

9.3 *Hiding Power* (*Dry Opacity*)—Hiding power is the measure of the ability of a paint to hide the substrate. It is, however, dependent upon uniform film thickness which is influenced by flow and leveling. Test Method D 344 is a practical test in which paint is applied with a brush, film thickness is approximately measured, opacity is evaluated visually as compared to a standard paint, and results are affected by flow and leveling application properties of the paint. Test Method D 2805 is considered to be a more precise and accurate test that does not need a material paint standard. Paint is applied with an applicator bar to minimize the effects of flow and leveling, film thickness is rigorously measured, and opacity is instrumentally evaluated. Determine hiding power in accordance with Test Methods D 344 or D 2805.

9.4 *Specular Gloss* (*Sheen*)—The method given, using the 85° geometry, is useful in characterizing the low angle appearance of flat paints. Most flat latex wall paints have an 85° sheen of about 1 to 10. Although paints with good uniformity of appearance are often paints of lower sheen and paints with good cleanability are often ones with higher sheen, this is not always the case, and the sheen of a paint should not be used as a measure of other paint properties. Determine the 85° gloss in accordance with Test Method D 523.

9.5 *Uniformity of Appearance*—Apply the paint as in Method 4541, Federal Test Method Standard 141, and examine the dry paint to see if there is any nonuniformity of color or sheen.

10. Properties of Dry Film

10.1 *Efflorescence of the Paint Film*—The referenced method measures efflorescence that comes from the paint itself, not from the substrate. Few interior latex paints effloresce due to improvements in latex and latex paint formulations. Salt formation is produced by specific conditions of temperature and humidity if a paint contains sufficient solid water-soluble material to cause a noticeable deposit on the film. Determine efflorescence resistance in accordance with Test Method D 1736.

10.2 *Efflorescence from Substrate*—Cementitious substrates may contain sufficient solid water-soluble materials to cause a surface deposit through leaching and evaporation. Determine if a latex paint applied over an alkaline masonry surface will allow soluble salts to pass through the film in accordance with Test Method D 2831.

10.3 *Elongation*—Elongation is a measure of the flexibility of a paint film. Most interior latex paints can be bent over a ¼ in. (6.4-mm) mandrel without affecting the film. Determine elongation in accordance with Test Methods D 522 or D 1737.

10.4 *Film Porosity*—The more porous a paint is, the worse will be its cleanability and enamel holdout. Determine the film porosity in accordance with Test Method D 3258.

10.5 *Scrubbability*—The ability of an interior finish to resist scrubbing is an important property. The referenced method provides a measure of the wet abrasion resistance of a film. However, wet abrasion resistance is not necessarily a measure of how well soils or stains can be removed since some paints have good scrubbability but poor stain cleanability because they are porous. The scrubbability of interior latex flat paints can vary from less than 100 to more than 1000 cycles. Determine the scrubbability in accordance with Test Method D 2486. A control paint should always be tested at the same time because of the variability of the method.

10.6 *Stain Removal* (*Cleanability*)—The ability to remove marks satisfactorily without damaging the film is an important property of interior finishes. A test method to determine how well stains and soils can be removed from a cured paint film is now in preparation and will be included in this guide when it is approved by ASTM. Test methods used by the paint industry consist of applying various household soils or stains to the cured paint film and attempting to remove these soils or stains by means of a washing or scrubbing operation. The attempted removal of the soils or stains can be done by hand or with a mechanical apparatus. Determine the relative ease of removal of soil from the dried film by washing with either an abrasive or nonabrasive cleaner in accordance with Test Method D 3450.

10.7 *Wet Abrasion Resistance* (*Weight Loss Method*)—This method differs from Test Method D 2486, scrub resistance (10.5), in that the loss in weight or volume of the paint film is recorded for each 100 scrub cycles. In Test Method D 2486 the number of scrub cycles required to wear through the paint film is recorded. Determine the wet abrasion resistance of the paint in accordance with Test Method D 4213.

11. Analysis of Paint

11.1 *Chemical Analysis*—If a specification requires certain raw materials or certain components in a given amount, then chemical analysis is required to determine whether the specified materials are present and in what amounts. Analysis does not necessarily establish paint quality which can also be greatly affected by manufacturing techniques. Most ASTM analytical methods apply to solvent-based coatings. However, some of them can be adapted for analysis of latex paints.

11.2 *Volatile Content*—The amount of volatile material in a paint cannot be used as an indication of the quality of a paint. This value is useful, however, in determining the similarity of two samples. Determine volatile content in accordance with Test Method D 2369.

12. Field Testing

12.1 Although the recommended test methods attempt to duplicate actual conditions under which latex flat wall paints are applied, it is not possible to duplicate all possible conditions. It is therefore necessary to test latex flat wall paints under actual existing conditions for a final evaluation of the quality of a paint.

Designation: D 2932 – 80 (Reapproved 1988)$^{\epsilon 1}$

Standard Guide for
Testing Exterior Solvent-Reducible House and Trim Coatings[1]

This standard is issued under the fixed designation D 2932; 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.

$^{\epsilon 1}$ NOTE—Editorial changes were made throughout, including the title, in October 1988.

1. Scope

1.1 This guide covers the selection and use of procedures for testing exterior solvent-reducible house paints and trim coatings in the laboratory and in the field. The test methods included are listed in Tables 1 and 2. All of these tests may not be required for each paint. Selection of the test methods to be followed must be governed by experience and the requirements in each individual case, together with agreement between the purchaser and the seller.

1.2 This guide covers the testing of ready-mixed solvent-reducible house paint or trim coatings for application by brush, roller, or spray on exterior surfaces. The paint may be any of the following types:

1.2.1 *Type I Paint, Oil*—Titanium, lead, zinc, and oil, nonfume-resistant, white and colors. For general exterior use, particularly on wooden structures.

1.2.2 *Type II Paint, Oil*—Titanium, zinc, and oil, fume-resistant, white and colors. Suitable for use on exterior surfaces such as wood and primed steel or sealed concrete, where resistance against discoloration from hydrogen sulfide is required.

1.2.3 *Type III Paint, Oil-Alkyd*—Combination of oil and alkyd in the vehicle and pigments, composed of chalk-resistant and chalking titanium dioxide, white and colors. For general exterior use, particularly on wooden surfaces, trim, primed steel, or sealed concrete.

1.2.4 *Type IV Paint, Miscellaneous Vehicles*—Combination of pigments and vehicle, white and colors. Suitable for use on exterior wooden surfaces, trim, primed steel, or sealed concrete.

1.3 *This standard may involve hazardous materials, operations, and equipment. This standard does not purport to address all of the safety problems 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:*

D 16 Terminology Relating to Paint, Varnish, Lacquer, and Related Products[2]
D 93 Test Methods for Flash Point by Pensky-Martens Closed Tester[3]
D 154 Guide for Testing Varnishes[4]
D 185 Test Methods for Coarse Particles in Pigments, Pastes, and Paints[4]
D 215 Practice for Chemical Analysis of White Linseed Oil Paints[2]
D 344 Test Method for Relative Hiding Power of Paints by the Visual Evaluation of Brushouts[2]
D 358 Specification for Wood to Be Used as Panels in Weathering Tests of Coatings[5]
D 522 Test Method for Mandrel Bend Test of Attached Organic Coatings[2]
D 523 Test Method for Specular Gloss[2]
D 562 Test Method for Consistency of Paints Using the Stormer Viscometer[2]
D 659 Method of Evaluating Degree of Chalking of Exterior Paints[2]
D 660 Test Method for Evaluating Degree of Checking of Exterior Paints[2]
D 661 Test Method for Evaluating Degree of Cracking of Exterior Paints[2]
D 662 Test Method for Evaluating Degree of Erosion of Exterior Paints[2]
D 772 Test Method for Evaluating Degree of Flaking (Scaling) of Exterior Paints[2]
D 1006 Practice for Conducting Exterior Exposure Tests of Paints on Wood[2]
D 1038 Definitions of Terms Relating to Veneer and Plywood[6]
D 1210 Test Method for Fineness of Dispersion of Pigment-Vehicle Systems[2]
D 1475 Test Method for Density of Paint, Varnish, Lacquer, and Related Products[2]
D 1554 Definitions of Terms Relating to Wood-Base Fiber and Particle Panel Materials[6]
D 1640 Test Methods for Drying, Curing, or Film Formation of Organic Coatings at Room Temperature[4]
D 1729 Practice for Visual Evaluation of Color Differences of Opaque Materials[2]
D 1737 Test Method for Elongation of Attached Organic Coatings with Cylindrical Mandrel Apparatus[7]

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[1] This practice is under the jurisdiction of ASTM Committee D-1 on Paint and Related Coatings and Materials, and is the direct responsibility of Subcommittee D 01.42 on Architectural Finishes.

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

[3] *Annual Book of ASTM Standards,* Vols 05.01, and 06.01.

[4] *Annual Book of ASTM Standards,* Vol 06.03.

[5] *Annual Book of ASTM Standards,* Vol 06.02.

[6] *Annual Book of ASTM Standards,* Vol 04.09.

[7] Discontinued; see *1988 Annual Book of ASTM Standards,* Vol 06.01.

D 2196 Test Methods for Rheological Properties of Non-Newtonian Materials by Rotational (Brookfield) Viscometer[2]
D 2244 Test Method for Calculation of Color Differences From Instrumentally Measured Color Coordinates[2]
D 2245 Test Method for Identification of Oils and Oil Acids in Solvent-Reducible Paints[2]
D 2366 Test Method for Accelerated Testing and Moisture Blister Resistance of Exterior House Paints on Wood[7]
D 2369 Test Method for Volatile Content of Coatings[2]
D 2371 Test Method for Pigment Content of Solvent-Reducible Paints[2]
D 2372 Practice for Separation of Vehicle from Solvent-Reducible Paints[2]
D 2621 Test Method for Infrared Identification of Vehicle Solids from Solvent-Reducible Paints[2]
D 2698 Test Method for Determination of the Pigment Content of Solvent-Reducible Paints by High-Speed Centrifuging[2]
D 2805 Test Method for Hiding Power of Paints by Reflectometry[2]
D 3278 Test Methods for Flash Point of Liquids by Setaflash Closed-Cup Apparatus[2]
E 97 Test Method for Directional Reflectance Factor, 45-deg 0-deg, of Opaque Specimens by Broad-Band Filter Reflectometry[8]
E 105 Practice for Probability Sampling of Materials[9]

2.2 *U. S. Federal Test Method Standard 141:*[10]
141/1021 Sampling (General)
141/2131 Application of Sprayed Films
141/2141.1 Application of Brushed Films
141/3011.1 Condition in Container
141/4203.1 Reducibility and Dilution Stability
141/4421 Absorption Test
141/4541 Working Properties and Appearance of Dried Film

3. Definitions

3.1 For definition of terms used in these practices, refer to Definitions D 16, D 1554, and D 1038.

4. Conditions Affecting Solvent-Based House and Trim Coatings

4.1 Practical requirements and performance for solvent house or trim paints may vary with:

4.1.1 Substrate type, such as type and quality of wood or hardboard; type of grain of wood; knots; and type, quality, and alkalinity of concrete substrates.

4.1.2 Condition of previously painted substrates such as degree of chalk, adhesion of film, dirt, mold, and general condition of old coating,

4.1.3 Type and quality of primer and time before topcoating,

4.1.4 Climatic conditions at the time of coating application and immediately after application,

4.1.5 Environmental conditions after application, both general for the area and specific, such as under eaves, behind shrubbery, and north- and south-side exposures, and

4.1.6 Structural aspects of the building. If construction or defects due to age are such that excessive moisture from the inside or from the outside makes its way through to the substrate, blistering, flaking, or peeling may result.

TABLE 1 List of Test Methods by Properties

Test Method	Section	ASTM Test Method	Federal Test Method Std. No. 141
Liquid paint properties:			
Skinning	6.1	D 154	3021
Condition in container	6.2	. . .	3011.1
Coarse particles and foreign matter	6.3	D 185	4091
Weight per gallon or density	6.4	D 1475	4184.1
Fineness of dispersion	6.5	D 1210	4411.1
Consistency	6.6	D 562	4281
Dilution stability	6.7	. . .	4203.1
Rheological properties of non-Newtonian liquids	6.8	D 2196	. . .
Absorption	6.9	. . .	4421
Flash point	6.10	D 93, D 3278	. . .
Paint application and film formation:			
Working properties	7.1	. . .	4541
Application by brush	7.2	. . .	2141.1
Application by spray	7.3	. . .	2131
Drying properties	7.4	D 1640	4061.1
Appearance of dry paint film:			
Color difference of opaque materials, visual evaluation of	8.1	D 1729	4249.1
Color difference of opaque materials, instrumental evaluation of	8.2	D 2244	6123
Directional reflectance	8.3	E 97	6121
Gloss (60-deg specular)	8.4	D 523	6101
Hiding power	8.5	D 2805	4121
		D 344	. . .
Properties of dry paint film:			
Elongation (flexibility)	9.1	D 1737	6221
Moisture blister resistance	9.2	D 2366, D 522	. . .
Fume resistance	9.3	. . .	. . .
Exterior exposure resistance	9.4	D 1006	6161.1
Wood panel description	9.4.1	D 358	2031
Chalk resistance ratings	9.4.2	D 659	6411
Checking resistance ratings	9.4.3	D 660	6421
Cracking resistance ratings	9.4.4	D 661	6471
Erosion resistance ratings	9.4.5	D 662	6431
Flaking resistance ratings	9.4.6	D 772	6441
Analysis of paint:			
Chemical analysis	10.1	D 215	. . .
Volatile content	10.2	D 2369	4041.1
Pigment content	10.3	D 2371, D 2698	4021.1
Pigment analysis	10.4	D 215	7261
Nonvolatile vehicle content	10.5	D 215	4053
Identification of vehicle solids	10.6	D 2621	. . .
Identification of oils	10.7	D 2245	7501

5. Sampling

5.1 To ensure an adequate and representative sample of paint to conduct tests agreed upon between the purchaser and the seller, proper sampling is important.

5.2 Sample the coating in accordance with Method 1021 of U. S. Federal Test Method Standard 141. Prior to

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[8] Discontinued; see *1991 Annual Book of ASTM Standards*, Vol 06.01.

[9] *Annual Book of ASTM Standards*, Vol 14.02.

[10] Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094.

TABLE 2 Alphabetical List of Test Methods

Test Method	Section	ASTM Test Method	Federal Test Method Standard No. 141
Absorption	6.9	...	4421
Application by brush	7.2	...	2141.1
Application by spray	7.3	...	2131
Chalk resistance ratings	9.4.2	D 659	6411
Checking resistance ratings	9.4.3	D 660	6421
Chemical analysis	10.1	D 215	...
Coarse particles and foreign matter	6.3	D 185	4091
Color difference of opaque materials, instrumental evaluation of	8.2	D 2244	6123
Color difference of opaque materials, visual evaluation of	8.1	D 1729	4249.1
Condition in container	6.2	...	3011.1
Exterior exposure resistance	9.4	D 1006	6161.1
Consistency viscosity	6.6	D 562	4201
Cracking resistance ratings	9.4.4	D 661	6471
Directional reflectance	8.3	E 97	6121
Dilution stability	6.7	...	4203.1
Drying properties	7.4	D 1640	4061.1
Elongation (flexibility)	9.1	D 1737, D 522	6221
Erosion resistance ratings	9.4.5	D 662	6431
Fineness of dispersion	6.5	D 1210	4411.1
Flaking resistance ratings	9.4.6	D 772	6441
Flash point	6.10	D 93, D 3278	...
Fume resistance	9.3	...	...
Gloss (60-deg specular)	8.4	D 523	6101
Hiding power	8.5	D 2805, D 344	4121
Identification of oils	10.7	D 2245	7501
Identification of vehicle solids	10.6	D 2621	...
Moisture blister resistance	9.2	D 2366	...
Nonvolatile vehicle content	10.5	D 215	4053
Pigment analysis	10.4	D 215	7261
Pigment content	10.3	D 2371, D 2698	4021.1
Rheological properties of non-Newtonian liquids	6.8	D 2196	...
Sampling	5		1021
Skinning	6.1	D 154	3021
Volatile content	10.2	D 2369	4041.1
Weight per gallon or density	6.4	D 1475	4184.1
Wood panel description	9.4.1	D 358	2031
Working properties	7.1	...	4541

sampling, stir the paint as in 4.21 of Method 1021. Determine the weight per gallon (or kilograms per litre) in accordance with Test Method D 1475. Stir again and recheck the weight per gallon. The two readings should agree within 0.10 lb (45 g).

5.3 Specify the amount of sample, the package sizes, and identification codes to assure a representative sample. A 1-gal (4-L) sample is usually sufficient for the recommended tests but for guidance in selecting a sampling plan consult Recommended Practice E 105.

6. Liquid Paint Properties

6.1 *Skinning*—Paints containing a binder, that dries by oxidation are subject to skin formation in a partially filled can or by diffusion of air into the can. Since skins are insoluble in the paint, they must be removed before use. This test in a partially filled container indicates the tendency of a paint to skin. Examine the original sample for skins, both on the surface and in its mass. Using a well-mixed, skin-free portion of the sample, perform a skinning test in accordance with Guide D 154.

NOTE 1—A typical minimum time for skinning in accordance with Guide D 154 is 48 h.

6.2 *Condition in Container*—After storage, paints should be suitable for application with minimum stirring. Characteristics that are undesirable and objectionable in a stored paint are given in the referenced test method. Determine condition in container in accordance with Method 3011.1 of Federal Test Method Standard No. 141.

6.3 *Coarse Particles and Foreign Matter*—Paints must be free of oversize particles and foreign matter to form a uniform film of good appearance. This test, with a 325-mesh (45-μm) screen, gives the percent of these particles in the paint. Determine coarse particles and foreign matter in accordance with Test Methods D 185.

NOTE 2—A typical maximum for coarse particles and foreign matter is 1 weight % of total paint.

6.4 *Density or Weight per Gallon*—The density of a paint as measured by weight per gallon (or kilograms per litre) provides a check against the theoretical weight calculated from the formula and is useful for determining similarity of two samples. The density is expressed as the weight in pounds of 1 U. S. gal (or kilograms per litre) of the liquid at a specified temperature. A calibrated weight per gallon cup is used. Determine weight per gallon in accordance with Test Method D 1475.

6.5 *Fineness of Dispersion*—The more finely a pigment is dispersed the more efficiently it is being utilized. One method for measuring degree of dispersion is to draw a paint down a tapered groove in a hardened steel block with the groove varying in depth from 4 to 0 mils ((100 to 0 μm) 0–8 Hegman units). The point at which continuous groupings of particles or agglomerates protrude through the surface of the wet film is taken as the dispersion reading. Higher readings (Hegman units) indicate better dispersion. Determine the fineness of dispersion in accordance with Test Method D 1210.

NOTE 3—A typical reading for house paint is 60 μm (approximately 2½ mils) and for trim paint 25 μm (1 mil). Several arbitrary scales and modifications of the gage are used by industry. The approximate relationship of these scales to micrometre and mil readings is shown in Test Method D 1210.

6.6 *Consistency (Viscosity)*—Paints of a given type should fall within a stated consistency range for satisfactory reproduction of a specific formula. While consistency is an important property, it does not determine the quality of a paint and should be used mainly to assure product uniformity. In the referenced method consistency is defined as the load in grams to produce a specified rate of shear. Although the consistency of most solvent-based house and trim coatings is about 150 to 300 g/100 revolutions, a much wider range is possible because of the wide variations in rheological properties of these paints. Also two paints of the same consistency may have quite different rheological properties. Determine the consistency in accordance with Test Method D 562.

6.7 *Dilution Stability*—Dilution with a specified thinner shows whether the materials are compatible and whether the reduced paint is stable. The referenced test is a measure of the stability of paint that has been reduced to a desired viscosity, for example, for spray application. The diluent suggested for reduction should be readily incorporated into the paint without excessive stirring or shaking. Determine dilution stability in accordance with Method 4203 of Federal Test Method Standard No. 141.

6.8 *Rheological Properties of Non-Newtonian Liquids*—Rheological properties are related to application and flow properties of the liquid coating. The referenced test method covers the determination of the rheological properties of a paint and is particularly suited for use with paints that display thixotropic characteristics. It actually measures viscosity under varying conditions of time and rotational speed of the spindle. Determine rheological properties in accordance with Test Methods D 2196.

6.9 *Absorption*—On porous surfaces, binder penetration can result in pigment volume concentration changes as the film dries. This may cause performance to vary. The referenced method provides a rapid means for measuring the relative penetration of the binder into a porous surface. It provides a rough measure of the wetting and penetrating quality of liquid materials. Determine the absorption in accordance with Federal Test Method Standard No. 141, Method 4421.

6.10 *Flash Point*—When the flash point of a material is required for shipping information, use Test Methods D 93, Part B, or D 3278.

7. Paint Application and Film Formation

7.1 *Working Properties*—Working properties of a paint are generally compared to a standard or described by requirements in the product specification. Test working properties in accordance with Method 4541 of Federal Test Method Standard No. 141.

7.2 *Application by Brush*—Brushed films should be smooth and free of seeds and on vertical surfaces should show no sagging, streaking, or excessive brush marks. For proper method of application of a brushed film for test purposes, refer to Method 2141.1 of Federal Test Method Standard No. 141.

7.3 *Application by Spray*—This method covers application of a paint by spray, which is sometimes used for house and trim paint. Refer to Method 2131 of Federal Test Method Standard No. 141.

7.4 *Drying Properties*—The drying time of a coating is determined by its composition and by atmospheric conditions during drying. Insufficient drying may result in dirt or insect pickup resulting in a poor appearance, or a nonuniform appearance caused by dew or rain falling on the paint film. Testing a paint for the required drying properties can determine whether the paint has lost its drying properties through aging or whether insufficient drier was included in the product at the time of manufacture. The specific category of drying should be selected to suit the types of house paint being tested, since drying times vary widely. Determine the drying time in accordance with Test Methods D 1640.

8. Appearance of Dry Paint Film

8.1 *Color Difference of Opaque Materials, Visual Evaluation of*—Visual comparison is fast and often acceptable although numerical values are not obtained. The referenced practice covers the spectral, photometric, and geometric characteristics of light source, illuminating and viewing conditions, sizes of specimens, and general procedures to be used in the visual evaluation of color differences of opaque materials. Determine the color difference in accordance with Practice D 1729.

8.2 *Color Difference of Opaque Materials, Instrument Evaluation of*—Color difference between a product and the standard can be tested by instrument. Generally the tolerance is agreed upon between the purchaser and the seller, and may also be required if a product specification is involved. Determine the color difference in accordance with Method D 2244.

8.3 *Directional Reflectance*—This property is a measure of light reflected from the surface of the paint. It usually is assigned a value in specifications for white and pastel shades. Determine daylight directional reflectance in accordance with Test Method E 97.

8.4 *Gloss (60-deg Specular)*—Determine the specular gloss in accordance with Test Method D 523. Oil house paints are typically in a gloss range from 30 to 70, while trim enamels are in a gloss range from 70 to 90.

8.5 *Hiding Power (Dry Opacity)*—Hiding power is the measure of the ability of a paint to hide the substrate. It is, however, dependent upon uniform film thickness which is influenced by the flow and leveling. Test Method D 344 is a practical test in which paint is applied with a brush, film thickness is approximately measured, opacity is evaluated visually as compared to a standard paint, and results are affected by flow and leveling application properties of the paint. Test Method D 2805 is considered to be a more precise and accurate test that does not need a material paint standard. Paint is applied with an applicator bar to minimize the effects of flow and leveling, film thickness is rigorously measured, and opacity is instrumentally evaluated. Determine hiding power in accordance with Test Methods D 344 or D 2805.

9. Properties of Dry Paint Film

9.1 *Elongation (Flexibility)*—Elongation is a measure of flexibility of a paint film. Generally, gloss house paints and trim paints will have no problem in passing a mandrel bend test. Flat house paints, however, may fail a sharp bend. Determine elongation in accordance with Test Methods D 1737 or D 522.

9.2 *Moisture Blister Resistance*—Blister resistance is related to the ability of a dry paint film to resist the formation of blisters caused by water from the wood substrate. The water can come from either the interior of the home or from structural defects that permit entry of the water behind the wood. Moisture blister resistance can be qualitatively evaluated in a laboratory test. Determine resistance to moisture blistering in accordance with Test Method D 2366.

9.3 *Fume Resistance*—Fume resistance is the ability of a dry paint film to resist discoloration in a moist hydrogen sulfide atmosphere. This type of atmosphere may be present near industrial or other polluted areas and can cause paint to yellow or darken in as little time as overnight exposure. There are no ASTM or Federal test methods for evaluating this property, but one procedure used by the industry is as follows:

9.3.1 Apply a sufficient number of coats of the paint to two glass plates to hide the surface completely, allow to dry for 6 h and expose one of the plates in a moist atmosphere of hydrogen sulfide for 18 h. Compare the color with the unexposed plate. The exposed plate should be practically no darker than the unexposed one. The color difference should not exceed that between plates that have been coated with a paint made with titanium dioxide pigment, lead-free zinc oxide, raw or refined linseed oil, and sufficient cobalt added for drying, and which has been similarly treated.

9.4 *Exterior Exposure Resistance*—In conducting exterior exposures, refer to Practice D 1006.

9.4.1 *Wood Panel Description*—In establishing exposure performance, use the panels as described in Specification D 358.

9.4.2 *Chalk-Resistance Ratings*—Determine chalk-resistance rating using Method D 659.

9.4.3 *Checking-Resistance Ratings*—Determine checking-resistance rating using Method D 660.

9.4.4 *Cracking-Resistance Ratings*—Determine cracking-resistance rating using Test Method D 661.

9.4.5 *Erosion-Resistance Ratings*—Determine erosion-resistance rating using Test Method D 662.

9.4.6 *Flaking-Resistance Ratings*—Determine flaking-resistance rating using Test Method D 772.

10. Analysis of Paint

10.1 *Chemical Analysis*—If a specification requires specific ingredients, chemical analysis may be required. Select test procedures from Methods D 215, and other ASTM methods that are pertinent to the components of exterior house paints.

NOTE 5—No single schematic analysis is comprehensive enough to cover the wide variety of house paint compositions.

10.2 *Volatile Content*—Thinner is removed from the paint at 110°C. The percentage of volatile matter calculated from this loss in weight indicates the thinner loss from the film as the paint dries. Determine volatile content of the paint in accordance with Test Method D 2369.

10.3 *Pigment Content*—The pigment gives paint its hiding and color and influences many other properties of the paint. Determine the percent pigment in accordance with Test Method D 2371.

10.4 *Pigment Analysis*—The analysis of pigment may be required if the product is covered by a specification, or upon agreement between the purchaser and the seller. Determine analysis of pigments in accordance with the selected test procedure from Method D 215.

10.5 *Nonvolatile Vehicle Content*—The nonvolatile vehicle is that portion of the film-forming solids in a paint other than the pigment. Water, volatile thinner, and pigment are determined and the sum subtracted from the total weight to give the nonvolatile vehicle content. Determine the nonvolatile vehicle content in accordance with Method D 215. Separate the vehicle for further analysis in accordance with Method D 2372.

10.6 *Identification of Vehicle Solids*—Determine identity of vehicle solids in accordance with Methods D 2621.

10.7 *Identification of Oils*—Determine identity of oils in accordance with Methods D 2245.

Designation: D 3002 - 81 (Reapproved 1987)

Standard Practice for Evaluation of Coatings for Plastics[1]

This standard is issued under the fixed designation D 3002; 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 is intended for the evaluation of clear and pigmented coatings designed for use on rigid or semirigid plastic substrates. Coated film and sheeting are not covered by this practice.

1.2 *This standard may involve hazardous materials, operations, and equipment. This standard does not purport to address all of the safety problems 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:*

D 523 Test Method for Specular Gloss[2]

D 658 Test Method for Abrasion Resistance of Organic Coatings by Air Blast Abrasive[2]

D 968 Test Methods for Abrasion Resistance of Organic Coatings by Falling Abrasive[2]

D 1308 Test Method for Effect of Household Chemicals on Clear and Pigmented Organic Finishes[3]

D 1474 Test Methods for Identation Hardness of Organic Coatings[2]

D 1544 Test Method for Color of Transparent Liquids (Gardner Color Scale)[2]

D 1644 Test Methods for Nonvolatile Content of Varnishes[2]

D 1729 Practice for Visual Evaluation of Color Differences of Opaque Materials[2]

D 2091 Test Method for Print Resistance of Lacquers[3]

D 2199 Test Method for Measurement of Plasticizer Migration from Vinyl Fabrics to Lacquers[3]

D 2244 Test Method for Calculation of Color Differences From Instrumentally Measured Color Coordinates[2]

D 2246 Test Method for Finishes on Primed Metallic Substrates for Humidity-Thermal Cycle Cracking[2]

D 2247 Practice for Testing Water Resistance of Coatings in 100 % Relative Humidity[2]

D 3170 Test Method for Chipping Resistance of Coatings[3]

D 3359 Test Methods for Measuring Adhesion by Tape Test[2]

G 24 Practice for Conducting Natural Light Exposures Under Glass[2]

3. Significance and Use

3.1 This practice is designed to set up a series of screening tests that will indicate the performance level to be expected of a coating or coating system on a given plastic substrate.

3.2 Rigid and semirigid plastic substrates vary widely in their acceptance characteristics for a given coating.

3.3 Surface cleaning or preparation prior to application of the coating can be critical to the proper performance of the coating.

4. Precaution

4.1 This standard may involve the use of hazardous materials, operations, and equipment. It is the responsibility of whoever uses this standard to establish appropriate safety practices and to determine the applicability of regulatory limitations prior to use.

5. Test Panels and Panel Preparation

5.1 Unless directed otherwise, conduct performance tests on coatings of specified thickness applied to a normally molded sample of the designated plastic. Applied coatings cannot correct surface defects from improper molding procedures.

5.2 Preparation of test samples shall include any cleaning, metalizing, or priming operations agreed upon by the producer and the user.

5.3 Air-dry or bake the system according to the established schedule and aged as agreed between the producer and the user.

6. Nonvolatile Matter

6.1 Test for nonvolatile matter in the coating material in accordance with Test Methods D 1644.

7. Color

7.1 *Clear* (*on liquid sample*)—Determine the Gardner color in accordance with Test Method D 1544.

7.2 *Pigmented* (*on dry film*)—Evaluate color differences visually in accordance with Practice D 1729 and instrumentally in accordance with Method D 2244.

8. Gloss

8.1 Test in accordance with Test Method D 523.

9. Print Test

9.1 Test in accordance with Test Method D 2091.

10. Hardness

10.1 Apply a film to a clean steel panel at a thickness agreed upon by the purchaser and the seller. Test in accordance with Test Methods D 1474.

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[1] This practice is under the jurisdiction of ASTM Committee D-1 on Paint, and Related Coatings and Materials and is the direct responsibility of Subcommittee D01.55 on Factory-Applied Coatings on Preformed Products.

Current edition approved Oct. 30, 1981. Published December 1981. Originally published as D 3002 - 71. Last previous edition D 3002 - 78.

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

[3] *Annual Book of ASTM Standards*, Vol 06.02.

11. Tape Adhesion

11.1 Test for tape adhesion in accordance with Methods D 3359.

12. Resistance to Plasticizer Migration

12.1 Test in accordance with Test Method D 2199. Time and temperature may be varied as agreed between the producer and the user.

12.2 If migration from a plastic substrate into a coating is being determined, the vinyl contact pad should be omitted.

13. Resistance to Temperature-Humidity Cycling

13.1 Expose the finished panel in accordance with Test Method D 2246.

13.2 After the number of cycles agreed between the producer and the user, determine whether adhesion (Section 11) and appearance (Sections 7 and 8) have changed.

14. Resistance to Continuous 100 % Humidity

14.1 Expose the finished panel in accordance with Practice D 2247.

14.2 After exposure for the length of time agreed between the producer and the user, determine whether adhesion (Section 11) and appearance (Sections 7 and 8) have changed.

15. Resistance to Household Chemicals

15.1 Test in accordance with Test Method D 1308.

16. Wear Resistance

16.1 Conduct an abrasion test in accordance with Test Method D 658 or Test Methods D 968 and determine the abrasion coefficient.

17. Light Stability Test

17.1 Expose to sunlight in accordance with Recommended Practice G 24. Duration of test and maximum acceptable change in color shall be as agreed between the producer and the user.

18. Weather Resistance

18.1 Expose panels in Florida or other area agreed between the producer and the user, 45° South for 12 months and determine changes in appearance (Sections 7.2 and 8.1), and adhesion (Section 11).

19. Resistance to Chipping

19.1 Using the plastic, pretreatment, primer, and topcoat system agreed between the producer and the user, test with the gravelometer in accordance with Test Method D 3170.

20. Effect on Substrates

20.1 Determine the physical properties of the substrate such as hardness, tensile strength, flexibility, or surface smoothness before and after applying the coating under test. Select the appropriate tests for the substrate from Volumes 08.01, 08.02, and 08.03 of the *Annual Book of ASTM Standards.*

21. Precision

21.1 The precision of this practice is described by each individual method cited.

Designation: D 3003 – 71 (Reapproved 1987)

Standard Test Method for Pressure Mottling and Blocking Resistance of Organic Coatings on Metal Substrates[1]

1. Scope

1.1 This method covers determination of the pressure mottling and sticking, or blocking resistance of organic coatings applied to coil-coated or factory-coated metal prior to postformed.

1.2 *This standard may involve hazardous materials, operations, and equipment. This standard does not purport to address all of the safety problems 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. Summary of Test Method

2.1 The coated metal is cut into suitably sized panels. A stack of these panels is then subjected to a specified pressure and temperature for a specified time to permit any pressure mottling and sticking or blocking to develop. The heating elements of the test apparatus are turned off and, after cooling, the specimens are examined for any signs of sticking or blocking, and mottling. The results are rated on the 0 to 10 scale and may be used in accepting or rejecting the coating according to standards established by the purchaser and the seller.

3. Description of Terms

3.1 *pressure mottling*—film distortion or uneven pattern giving a change of gloss and nonuniform appearance. It is usually caused by pressures within a painted coil or stacked painted sheets or other painted products.

3.2 *blocking* or *sticking*—the condition wherein coated surfaces adhere to each other.

4. Apparatus[2]

4.1 A suitable hydraulic or mechanical press or vise may be used. The equipment shall be capable of producing the required test pressure in pounds-force per square inch (or kilopascals) and be equipped with a suitable device for measuring the force applied.

5. Test Specimens and Conditions

5.1 At least four, and preferably six, flat panels shall be cut from the coated stock, the age of which shall be within the limits agreed upon by the purchaser and the seller.

5.2 Panels should be at least 4 by 2.5 in. (100 by 70 mm) to provide an adequate area for assessing the results. Where the equipment does not provide adequate pressure, smaller panels may be used. The minimum recommended size is 2 by 2 in. (50 by 50 mm).

5.3 Use only flat panels. If necessary, file the edges smooth to ensure maximum contact between the surfaces. When the equipment permits, panels larger than the pressure plates may be used, thus eliminating any effect from uneven edges. With this method, the pounds-force per square inch (or kilopascals) is calculated using only the panel area within the pressure plates.

5.4 The film thickness of the coating under test shall be as specified or agreed upon by the purchaser and the seller.

5.5 The coated stock shall be tested under the conditions of pressure, temperature, and time mutually agreed upon by the purchaser and the seller. Pressures ranging from 110 to 350 psi (750 to 2400 kPa), temperatures from 110 to 140°F (43 to 60°C), and times of 2 to 16 h have been used.

5.6 In the absence of agreed or specified test conditions, a pressure of 110 ± 5 psi (750 ± 35 kPa), a temperature of 110 ± 3°F (43 ± 1.5°C), and a time of 16 h shall be used.

5.7 The total force applied is measured by a suitable gage and the pounds-force per square inch (or kilopascals) is calculated by dividing the force (pounds-force or newtons) by the area in square inches (or square millimetres) of one side of one panel.

6. Procedure

6.1 Stack the panels face to back as used in production with both face and back coatings applied. Limit the number of panels in the test to the quantity that can be heated rapidly to and maintained at the correct panel temperature throughout the test.

6.2 For presses having heating units, place the test panels in the press and bring the heating platens in contact but with light pressure. Turn on the electrical heating unit, and heat the panels to the required test temperature. When this temperature is reached, the indicating light will shut off. Apply the required pressure and maintain it for the specified time (6.4).

6.3 Where the apparatus does not have built-in heating units, preheat the mechanical press or vise. Place the panels in the press at room temperature with very light contact and heat the unit in an oven to the required temperature. Then

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[1] This method is under the jurisdiction of ASTM Committee D-1 on Paint and Related Coatings and Materials and is the direct responsibility of Subcommittee D01.53 on Factory-Precoated Strip Metal.

Edition effective Dec. 22, 1971.

[2] Suitable equipment includes Pasadena or Studebaker Hydraulic Presses; Gardner Laboratories Cam-activated Pressure Mottling Tester; and drill press vises modified for use with a torque wrench if agreed between purchaser and seller (Hensley, W. L., "Pressure Mottling Test," *Journal of Paint Technology*, Vol 40, No. 517, February 1968, p. 54*A*).

TABLE 1 Classification

NOTE 1—Intermediate grades are permissible to distinguish small differences.

NOTE 2—Reasonable force is defined as that which can be exerted by the fingers only, using the fingernails as the only prying instrument.

NOTE 3—The transfer of components of one coating onto or into another coating is also known as offsetting or pickoff.

Grade	Sticking or Blocking	Grade	Mottling
10	Panels fall apart—no sticking.	10	No mottling immediately after separation.
8	Slight tackiness or panels pull apart easily.	8	No mottling after 24 h separation.
6	Panels pull apart with effort. No flexing or prying required to aid separation.	6	Light permanent mottling after 24 h separation.
4	Panels pull apart using reasonable force. Flexing may be required (Note 2).	4	Heavy permanent mottling after 24 h separation.
2	Panels require prying apart with a spatula or similar instrument.	2	Light pickoff or transfer of one or both coatings (Note 3).
0	Panels block together so they cannot be separated with a spatula or similar instrument, without using extreme force.	0	One or both coatings show heavy pickoff down to the metal or basecoat; or block together (Note 3).

apply the proper pressure and return the unit to the oven for the specified time.

6.4 Record the time only after the specified temperature and pressure are reached. Check the temperature and pressure at intervals during the test.

6.5 At the end of the specified time, turn off the heat and allow the panels to cool to room temperature under pressure before removal and separation.

6.6 After removal from the press, grade the panels separately for both sticking or blocking and mottling in accordance with Table 1. In assessing the results ignore effects due to sharp or uneven edges.

6.7 Maintain panels that are to be reaccessed after a recovery period at 75 ± 5°F (24 ± 3°C).

6.8 For both properties assign each coating a grade which is the arithmetic mean of all panels tested.

7. Report

7.1 Report the following data for each coating:

7.1.1 Equipment used,

7.1.2 Number of panels tested,

7.1.3 Pressure,

7.1.4 Temperature and heating process (built-in or oven),

7.1.5 Time,

7.1.6 Grade for sticking or blocking, and

7.1.7 Grade for mottling.

8. Precision

8.1 In an interlaboratory test of this method, two operators in each of seven laboratories tested two different coatings, subjected to two treatments (pressure, temperature, and duration) and rated them for sticking, and pressure mottling. The within-laboratory and between laboratory pooled standard deviations were found to be as follows:

Rating Parameter	Pooled Standard Deviations Within-Laboratory	Between Laboratory
S	0.42	1.10
PM	0.38	1.06
Average	0.40	1.08

Based on these results the following criteria should be used in judging the acceptability of results at the 95 % confidence level.

8.1.1 *Repeatability*—Two results, each the mean of the two sets of panels, obtained by the same operator should be considered suspect if they differ by more than 1 to 2 units.

8.1.2 *Reproducibility*—Two results, each the mean of two sets of panels, obtained by operators in different laboratories should be considered suspect if they differ by more than 3.7 units.

Standard Practice for Determination of Resistance of Factory-Applied Coatings on Wood Products to Stains and Reagents[1]

1. Scope

1.1 This practice covers evaluation of clear factory-applied coating systems on wood substrates.

1.2 *This standard may involve hazardous materials, operations, and equipment. This standard does not purport to address all of the safety problems 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:*

D 235 Specification for Mineral Spirits (Petroleum Spirits) (Hydrocarbon Dry Cleaning Solvent)[2]
D 333 Test Methods for Clear and Pigmented Lacquers[3]
D 2571 Guide for Testing Wood Furniture Lacquers[3]

3. Significance and Use

3.1 When used in conjunction with Methods D 333, this practice will provide a comprehensive evaluation of resistance to stains caused by chemical reagents and household chemicals.

3.2 This practice applies only to coatings applied in sufficient quantity to form a continuous film. It is recommended that the dry film thickness of the coating under test be reported.

3.3 Results from stain tests conducted in accordance with this practice distinguish differences between coatings.

4. Reagents

4.1 *Code for Applicability of Reagents*—V = Vertical, any surface that may be vertical as on a dresser front. H = Horizontal, any surface that may be horizontal as on a table top. L = Laboratory, any surface that may be used for laboratory furniture (Section 9).

4.2 *Water:*

4.2.1 *Tap Water*, V, H, L

4.2.2 *Boiling Water* (test in accordance with the Boiling Water Resistance section of Guide D 2571): H, L

4.3 *Alcohol:*

4.3.1 *Ethyl Alcohol* (test in accordance with the Alcohol Resistance section of Guide D 2571): V, H, L

4.4 *Aliphatic:*

4.4.1 *Mineral Spirits:* L (Specification D 235, Type III)

4.4.2 *Perchloroethylene:* V, H, L

4.5 *Ketone:*

4.5.1 *Methyl Ethyl Ketone:* L

4.6 *Acetate:*

4.6.1 *Amyl Acetate:* H, L

4.7 *Inorganic Acid:*

4.7.1 *Hydrochloric Acid* (*3 N*)—Dilute 258 mL of 12 *N* (36 %) HCl to 1 L: L

4.8 *Organic Acid:*

4.8.1 *Acetic Acid* (*3 N*)—Dilute 172 mL of 99 % acetic acid to 1 L: V, H, L

4.8.2 *Grape Juice* (unsweetened): V, H

4.8.3 *Lactic Acid* (5 % solution): V, H

4.9 *Bases:*

4.9.1 *Unscented Mild Soap* (saturated solution): V, H, L

4.9.2 *Potassium Tripolyphosphate* (saturated solution containing 0.5 % sodium *N*-methyl-*N*-oleyl laurate (Igepon T-73): V, H, L

4.9.3 *Ammonium Hydroxide* (3 % solution): L

4.9.4 *Trisodium Phosphate* (saturated solution): V, H, L

4.9.5 *Urea* (6.6 % solution): V, H, L

4.10 *Disinfectant:*

4.10.1 *Cresols* (5 % solution): V, H, L

4.11 *Ink:*

4.11.1 *Washable Ink:* V, H, L

4.11.2 *Permanent Ink:* V, H, L

4.11.3 *Ball-Point Ink:* V, H, L

4.12 *Dye:*

4.12.1 *Coffee* (test in accordance with the Coffee Stain Resistance section of Guide D 2571): V, H

4.13 *Wax:*

4.13.1 *Wax Crayons, Red, Blue, and Yellow*: V, H

4.13.2 *Lipstick* (test in accordance with the Cosmetic Stain section of Guide D 2571): V, H

4.14 *Shoe Polish:*

4.14.1 *Liquid Shoe Polish*, tan: V, H

4.15 *Oil:*

4.15.1 *Corn Oil* or equivalent: V, H

4.15.2 *Hair Oil:* V, H

4.16 *Miscellaneous:*

4.16.1 *Mustard:* V, H

4.16.2 *Tincture of Merthiolate* (1+1000): V, H (see Section 5)

4.16.3 *Sodium Hypochlorite* (6 % solution): V, H, L

4.16.4 *Tincture of Iodine*—Wet 50 g of potassium iodide (KI) with water, weigh into the wet KI 70 g of iodine, let stand 1 h to dissolve the iodine, and make up to 1 L with alcohol: V, H, L

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[1] This practice is under the jurisdiction of ASTM Committee D-1 on Paint and Related Coatings and Materials and is the direct responsibility of Subcommittee D01.55 on Factory-Applied Coatings on Preformed Products.

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[2] *Annual Book of ASTM Standards*, Vol 06.04.

[3] *Annual Book of ASTM Standards*, Vol 06.02.

4.17 *Staining Solutions*, unless otherwise specified, are water solutions.

5. Selection of Staining Agents for Testing Stain Resistance of Coatings

5.1 The producer and the user shall select staining agents from the reagents in Section 4. Selection of staining agents should depend on end use, such as wall, ceiling, horizontal surface, or floor.

5.2 In the absence of agreement between the producer and the user, the suggested staining reagents for each intended use are indicated in Section 4 by V, H and L.

5.3 It is not necessary that all finishes pass all tests.

6. Test Specimen

6.1 Test panels shall be of regular production finish.

6.2 If regular production finished panels are not available, the producer and the user shall agree upon the following variables: face veneer or wood surface, filler or filler stain, primer coat, topcoat, and dry film thickness for each coating material.

7. Panel Conditioning

7.1 Before testing, panels must be aged for a time and by a method agreed upon between the producer and the user.

8. Procedure

8.1 Conduct the test with panel surfaces horizontal at room temperature unless a different temperature is specified.

8.2 Place 0.5 mL of each staining agent on the finish surface and allow to stand uncovered for 18 h (or a time agreeable to the producer and the user) except for staining agents 4.3 to 4.6. On these put a 1-in. (25-mm) square of double-acid-washed quantitative filter paper. The purpose of the filter paper is to maintain a longer wet contact of volatile reagents with the surface of the finish.

8.3 After 18 h exposure, or other time period agreed to by the producer and the user, wash the surface with water, rinse with ethanol (1+1) and dry with a paper towel. Place the panel in a vertical position with a diffuse light source and view (Note) from a distance of 2 to 3 ft (0.6 to 0.9 m). Examine the surface for graying, spotting, wrinkling, discoloration, or other film defects and report.

NOTE—This method of viewing panels gives the best correlation of staining damage between laboratories. However, the following information should be noted: (*1*) When viewing panels across the grain at a low angle that is being varied, many more stains will appear visible than would appear visible perpendicular to the surface. These additional stains are superficial stains only. (*2*) When viewing with and against the grain, there appears to be an even greater number of superficial stains than would appear when viewing perpendicular to the surface or across the grain.

9. Interpretation of Results

9.1 Each product finish differs greatly in stain resistance requirements. The key, in general, is that the resistance to staining must be adequate for that finish's end use when first used in place and throughout the expected life span of the specific product.

9.2 The end use choice of resistance to staining should be agreed upon between the producer and the user.

10. Precision

10.1 Agreement between laboratories by visual comparison varied according to how samples were viewed.

10.1.1 Stains viewed perpendicular with a diffused light source at a distance of 2 to 3 ft (0.6 to 0.9 m) for graying, spotting, wrinkling, discoloration, or other film defects gave complete agreement between laboratories.

10.1.2 The same test stains viewed both with and across the grain at a low angle resulted in many more superficial stains being evident, depending upon the eyesight and judgment of the observer.

Designation: D 3129 – 92

Standard Guide for Testing Exterior Latex House Paints[1]

1. Scope

1.1 This guide covers the selection and use of procedures for testing latex house paints and trim paints intended for use on the exterior of buildings. The test methods included are listed in Tables 1 and 2. All of these may not be required for each paint. Selection of the test methods to be followed must be governed by experience and the requirements in each individual case, together with agreement between purchaser and seller.

1.2 The latex paints covered by this guide are intended for application by brushing, rolling, spraying, or other means, on masonry, wood, and previously painted surfaces.

1.3 *This standard does not purport to address the safety problems, 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:*

D 16 Terminology Relating to Paint, Varnish, Lacquer, and Related Products[2]

D 185 Test Methods for Coarse Particles in Pigments, Pastes, and Paints[3]

D 215 Practice for Chemical Analysis of White Linseed Oil Paints[2]

D 344 Test Method for Relative Hiding Power of Paints by the Visual Evaluation of Brushouts[2]

D 358 Specification for Wood to Be Used as Panels in Weathering Tests of Coatings[4]

D 522 Test Method for Mandrel Bend Test of Attached Organic Coatings[2]

D 523 Test Method for Specular Gloss[2]

D 562 Test Method for Consistency of Paints Using the Stormer Viscometer[2]

D 660 Test Method for Evaluating Degree of Checking of Exterior Paints[2]

D 661 Test Method for Evaluating Degree of Cracking of Exterior Paints[2]

D 662 Test Method for Evaluating Degree of Erosion of Exterior Paints[2]

D 772 Test Method for Evaluating Degree of Flaking (Scaling) of Exterior Paints[2]

D 823 Test Methods for Producing Films of Uniform Thickness of Paint, Varnish, and Related Products on Test Panels[2]

D 1006 Practice for Conducting Exterior Exposure Tests of Paints on Wood[2]

D 1038 Definitions of Terms Relating to Veneer and Plywood[5]

D 1210 Test Method for Fineness of Dispersion of Pigment-Vehicle Systems[2]

D 1475 Test Method for Density of Paint, Varnish, Lacquer, and Related Products[2]

D 1554 Definitions of Terms Relating to Wood-Base Fiber and Particle Panel Materials[5]

D 1640 Test Methods for Drying, Curing, or Film Formation of Organic Coatings at Room Temperature[3]

D 1729 Practice for Visual Evaluation of Color Differences of Opaque Materials[2]

D 1736 Test Method for Efflorescence of Interior Wall Paints[4]

D 2196 Test Methods for Rheological Properties of Non-Newtonian Materials by Rotational (Brookfield) Viscometer[2]

D 2243 Test Method for Freeze-Thaw Resistance of Water-Borne Paints[4]

D 2244 Test Method for Calculation of Color Differences From Instrumentally Measured Color Coordinates[2]

D 2369 Test Method for Volatile Content of Coatings[2]

D 2574 Test Method for Resistance of Emulsion Paints in the Container to Attack by Microorganisms[2]

D 2805 Test Method for Hiding Power of Paints by Reflectometry[2]

D 3456 Practice for Determining by Exterior Exposure Tests the Susceptibility of Paint Films to Microbiological Attack[2]

D 3719 Test Method for Quantifying Dirt Collection on Coated Exterior Panels[4]

D 3925 Practice for Sampling Liquid Paints and Related Pigmented Coatings[2]

D 3928 Test Method for Evaluation of Gloss or Sheen Uniformity[4]

D 4214 Test Methods for Evaluating the Degree of Chalking of Exterior Paint Films[2]

D 4287 Test Method for High-Shear Viscosity Using the ICI Cone/Plate Viscometer[2]

D 4585 Practice for Testing Water Resistance of Coatings Using Controlled Condensation[2]

D 4958 Test Method for Comparison of the Brush Drag of Latex Paints[4]

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[1] This guide is under the jurisdiction of ASTM Committee D-1 on Paint and Related Coatings, Materials, and Applications and is the direct responsibility of Subcommittee D 01.42 on Architectural Finishes.

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

[3] *Annual Book of ASTM Standards*, Vol 06.03.

[4] *Annual Book of ASTM Standards*, Vol 06.02.

[5] *Annual Book of ASTM Standards*, Vol 04.09.

TABLE 1 List of Test Methods by Properties

Test Method	Section	ASTM Test Method	Federal Test Method Std. No. 141
Sampling	5	D 3925	
Liquid Paint Properties:			
Condition in container	6.1		3011
Coarse particles and foreign matter	6.2	D 185	
Density or weight per gallon	6.3	D 1475	
Nonvolatile	6.4	D 2369	
Fineness of dispersion	6.5	D 1210	
pH	6.6	E 70	
Consistency	6.7	D 562	
Rheological properties of non-Newtonian liquids	6.8	D 2196	
Freeze-thaw stability	6.9	D 2243, D 4287	
Microorganism resistance	6.10	D 2574	
Paint Application and Film Formation:			
Drying properties	7.1	D 1640	
Producing films of uniform thickness	7.2	D 823	
Application properties	7.3		4541
Application by brush	7.3.1		2141
Application by spray	7.3.2		2131
Brush drag	7.4	D 4958	
Touch-up uniformity	7.5	D 3928	
Appearance of Dry Paint Film:			
Color differences by visual evaluation	8.1	D 1729	
Color differences using instrumental measurements	8.2	D 2244	
Daylight directional reflectance	8.3	E 97	
Gloss 60°	8.4	D 523	
Hiding power	8.5	D 2805, D 344	
Properties of Dry Paint Film:			
Flexibility	9.1	D 522	
Moisture blister resistance	9.2	D 4585	
Fume resistance	9.3		
Exterior exposure resistance	9.4	D 1006	
Wood panel description	9.4.1	D 358	
Chalk resistance	9.4.2	D 4214	
Checking resistance	9.4.3	D 660	
Crack resistance	9.4.4	D 661	
Erosion resistance	9.4.5	D 662	
Flaking resistance	9.4.6	D 772	
Mildew resistance	9.4.7	D 3456	
Stain resistance	9.4.8		
Efflorescence resistance	9.4.9	D 1736	
Fade resistance	9.4.10		
Dirt pickup	9.4.11	D 3719	
Adhesion to chalky substrates	9.4.12		6301
Wet adhesion	9.4.13		6301
Analysis of Paint:			
Chemical analysis	10.1		
Volatile content	10.2	D 2369	7261
Pigment analysis	10.3	D 215	

E 70 Test Method for pH of Aqueous Solutions with the Glass Electrode[6]

E 97 Test Method for Directional Reflectance Factor 45-deg, 0-deg of Opaque Specimens by Broad-Band Filter Reflectometry[7]

E 105 Practice for Probability Sampling of Materials[8]

TABLE 2 Alphabetical List of Test Methods

Test Method	Section	ASTM Test Method	Federal Test Method Std. No. 141
Adhesion to chalky substrates	9.4.12		6301
Adhesion, wet	9.4.13		6301
Application by brush	7.3.1		2141
Application by spray	7.3.2		2131
Application properties	7.3		4541
Brush drag	7.4	D 4958	
Chalk resistance	9.4.2	D 4214	
Checking resistance	9.4.3	D 660	
Chemical analysis	10.1		4091
Coarse particles and foreign matter	6.2	D 185	4249
Color differences by visual evaluation	8.1	D 1729	
Color differences using instrumental measurements	8.2	D 2244	3011
Condition in container	6.2		
Consistency	6.3	D 562	
Crack resistance	9.4.4	D 661	
Daylight directional reflectance	8.3	E 97	
Density or weight per gallon	6.3	D 1475	
Dirt pickup	9.4.11	D 3719	
Drying properties	7.1	D 1640	
Efflorescence	9.4.9	D 1736	
Erosion resistance	9.4.5	D 662	
Exterior exposure resistance	9.4	D 1006	
Fade resistance	9.4.10		
Fineness of dispersion	6.5	D 1210	
Flaking resistance	9.4.6	D 772	
Flexibility	9.1	D 522	
Freeze-thaw stability	6.9	D 2243	
Fume resistance	9.3		
Gloss 60°	8.4	D 523	
Hiding power	8.5	D 2805, D 344	
Microorganism resistance	6.10	D 2574	
Mildew resistance	9.4.7		
Moisture blister resistance	9.2	D 4585	
Nonvolatile	6.4	D 2369	
pH	6.6	E 70	
Pigment analysis	10.3	D 215	
Producing films of uniform thickness	7.2	D 823	
Rheological properties of non-Newtonian liquids	6.8	D 2196, D 4287	
Sampling	5	D 3925	
Stain resistance	9.4.8		
Touch-up uniformity	7.5	D 3928	
Wood panel description	9.4.1	D 358	

2.2 *U.S. Federal Test Methods Standard No. 141:*[9]

2131 Application of Sprayed Films

2141 Application of Brushed Films

3011 Condition in Container

4541 Working Properties and Appearance of Dried Film

6301 Wet Adhesion (Tape Test)

3. Terminology

3.1 *Definitions:*

3.1.1 For definitions of terms used in this practice, refer to Definitions D 16, D 1038, and D 1554.

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[6] *Annual Book of ASTM Standards*, Vol 15.05.

[7] Discontinued; see *1991 Annual Book of ASTM Standards*, Vol 06.01.

[8] *Annual Book of ASTM Standards*, Vol 14.02.

[9] Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094.

4. Conditions Affecting House Paint Topcoats

4.1 Practical requirements and performance of latex house paint may vary with:

4.1.1 Substrate type, such as type and quality of wood or hardboard, grain of wood, knots, pitch, etc., type and quality of masonry, ratio of cement to aggregate, alkalinity, etc.

4.1.2 Substrate weathering. Weathering of wood before painting will probably adversely affect the performance. Some weathering of masonry surfaces before painting may have beneficial effects on the performance.

4.1.3 The type, quality, and suitability of primer, undercoat, conditioner, etc., used under the topcoat and the time between coats.

4.1.4 Environmental conditions such as temperature at the time of application and during drying. As these paints contain water as a thinner, surfaces do not have to be completely dry before application. However, low temperature during drying may cause poor film formation.

4.1.5 Contaminants on the surface of the substrates.

4.1.6 Condition of previously painted substrates such as degree of chalk, adhesion of film, dirt, mold, general condition of substrate paint.

5. Sampling

5.1 Prior to sampling, the condition of the container should be established since damage to it may cause evaporation, skinning, or other undersirable effects in the coating. Determine the condition of the paint in accordance with 6.1 and 6.2.

5.2 Sample in accordance with Practice D 3925. Determine the weight per gallon in accordance with Test Method D 1475. Repeat this procedure until successive values agree within 0.1 lb (45 g) or as agreed upon between the purchaser and the seller. Samples for testing may then be taken.

5.3 Specify the amount of sample, the package sizes, and identification codes to assure a representative sample. A 1-gal (4-L) sample is usually sufficient for the recommended tests, but for guidance in selecting a sampling plan, consult Practice E 105.

6. Liquid Paint Properties

6.1 *Condition in Container*—Thickening, settling, and separation are undesirable and objectionable if a paint cannot be reconditioned and made suitable for application with a reasonable amount of stirring. The referenced method covers procedures for determining changes in properties of paints after storage. Determine the condition in the container in accordance with Method 3011 of Federal Test Method Standard No. 141.

6.2 *Coarse Particles and Foreign Matter*—Paints must be free of coarse particles to form uniform films of good appearance, a typical maximum being 1 weight % of total paint. The specified test with a No. 325 (45-μm) sieve gives the percent of these particles in a paint. Determine coarse particles and foreign matter in accordance with Test Method D 185.

6.3 *Density or Weight per Gallon*—The density as measured by weight in pounds per gallon or kilograms per litre is used to assure product uniformity from batch to batch. In the referenced method the density is expressed as the weight in pounds of 1 U.S. gal (kg/L) of the paint at a specified temperature. Determine the density in accordance with Test Method D 1475.

6.4 *Nonvolatile*—The amount of nonvolatile in a coating is not necessarily an indication of performance. It is, however, useful for determining similarity of two samples. Determine nonvolatile solids in accordance with Test Method D 2369.

6.5 *Fineness of Dispersion*—The more finely a pigment is dispersed, the more efficiently it is being used. One method for measuring the degree of dispersion (commonly referred to as "fineness of grind") is to draw the material down a calibrated, tapered groove in a hardened steel block with the groove varying in depth from 4 to 0 mils (100 to 0 μm) and calibrated Hegman 0–8. The point at which continuous groupings of particles or agglomerates, or both, are visible through the surface of the liquid is taken as the fineness reading. Lower readings in mils or micrometres or higher readings in Hegman units indicate better fineness of dispersion. Determine fineness of dispersion in accordance with Test Method D 1210.

NOTE—The fast drying of latex paints makes it difficult to make accurate measurements of this type. Low-gloss paints do not generally require dispersion finer than a 1 to 2 Hegman reading.

6.6 *pH*—Latex paints with low (acidic) pH may corrode the container. Changes in pH during storage may indicate poor stability of a latex paint. Determine pH in accordance with Test Method E 70.

6.7 *Consistency*—Paints of a given type should fall within a stated consistency range for satisfactory reproduction of a specific formula. In the referenced method, consistency is defined as the load in grams required to produce a specified rate of shear. Although the consistency of most latex paints is about 150 to 300 g/100 revolutions, a much wider range is possible because of the wide variations in rheological properties of these paints. Also two paints of the same consistency may have quite different rheological properties. Determine the consistency of the product in accordance with Test Method D 562.

6.8 *Rheological Properties of Non-Newtonian Liquids*—Rheological properties are related to application and leveling properties of the liquid paint. The referenced methods cover the determination of rheological properties and are particularly suited for use with paints that display thixotropic characteristics. They actually measure viscosity under different shear rates. Latex paints generally range from 0.5 to 3 poise (0.05 to 0.3 Pa·s) when the high-shear viscosity is measured with the cone and plate viscometer. Determine rheological properties in accordance with Test Methods D 2196 or D 4287, or both.

6.9 *Freeze-Thaw Stability*—Water-based paints may be subjected to freezing conditions during shipping and storage. Suitably stabilized paints will resist several cycles of freezing and thawing without showing deleterious changes such as coagulation, graininess, or excessive viscosity increase. Many latex paints will increase in viscosity but can still be considered satisfactory if other properties which may be affected by a higher viscosity such as leveling and brushability are satisfactory. Determine the extent of change in several properties in accordance with Test Method D 2243.

6.10 *Microorganism Resistance*—Bacteria in a latex paint can cause gassing, putrefactive or fermentative odors, and loss of viscosity. Determine if the paint contains living bacteria and if it is resistant to attack by bacteria in accordance with Test Method D 2574.

7. Paint Application and Film Formation

7.1 *Drying Properties*—Under average conditions most flat latex paints are dry-to-touch in 1 to 2 h when the water has evaporated from the film. Slow drying of the film may result in dust pickup, poor appearance and, when used on an exterior surface, rain or dew may cause a nonuniform appearance. They can usually be recoated from within a few hours to 18 h. Curing to obtain the ultimate properties may take only a few days for some latex paints, while others may require 1 to 2 weeks depending on composition. Determine drying time in accordance with Test Methods D 1640.

7.2 *Producing Films of Uniform Thickness*—Methods D 823 covers the preparation of coating films of uniform thickness essential in conducting tests.

7.3 *Application Properties*—Application properties of a paint are generally compared to a standard or described by requirements in the product specification. Determine application properties in accordance with Method 4541 of U.S. Federal Standard No. 141.

7.3.1 *Brush Application*—For proper method of application of a brushed film for test purposes refer to Method 2141 of U.S. Federal Test Method Standard No. 141.

7.3.2 *Spray Application*—House and trim paints are sometimes applied by spray. Determine the spray application properties in accordance with Method 2131 of U.S. Federal Test Method Standard No. 141.

7.4 *Brush drag*—As the brush drag (resistance encountered when applying a coating by brush) increases, any natural tendency of the painter to overspread the paint is reduced. All other factors being constant, increased brush drag results in greater film thickness with consequent improvements in hiding and film durability. Conversely, increasing brush drag too much can cause difficulties in spreading the paint easily and uniformly, leading to excessive sagging, prolonged drying time and, in highly-pigmented latex paints, possibly to "mud-cracking" due to excessive thickness. The referenced method covers the determination of relative brush drag of a series of coatings applied by brush by the same operator. It has been established that the subjective ratings thus obtained correlate well with high-shear viscosities obtained instrumentally using Test Method D 4287 (see 6.8), provided that the paints differ in viscosity by at least 0.3 poise (0.03 Pa·s). Determine brush drag ratings in accordance with Test Method D 4958.

7.5 *Touch-Up Uniformity*—After a paint has dried, areas where less material was applied sometimes become noticeable. If the paint has suitable touch-up properties, additional material can be applied to these areas only, instead of refinishing the complete wall. The color, gloss, and leveling of the touched-up areas and the previously coated area should be uniform. Differences in these properties are often caused by short wet-edge time, poor leveling on recoat, and pigment orientation or flotation during and after application. Determine touch-up properties in accordance with Test Method D 3928.

8. Appearance of Dry Paint Film

8.1 *Color Differences by Visual Comparison*—Visual comparison of color is fast and often acceptable although numerical values are not obtained. The referenced method covers the spectral, photometric, and geometric characteristics of light source, illuminating and viewing conditions, sizes of specimens, and general procedures to be used in the visual evaluation of color differences of opaque materials. Determine color difference in accordance with Practice D 1729.

8.2 *Color Differences Using Instrumental Measurements*—The differences in color between a product and its standard can be measured by instrument. Generally, the tolerance is agreed upon by the purchaser and the seller and may also be required if a product specification is involved. Color instruments provide numerical values that can be compared to subsequent measurements. The referenced method covers the instrumental determination of small color differences, observable in daylight illumination, between nonfluorescent, nonmetameric, opaque surfaces such as paint specimens. If metamerism is suspected, visual evaluation (8.1) should be used to verify the results. Calculate in accordance with Test Method D 2244 the color differences that have been measured instrumentally.

8.3 *Directional Reflectance*—This property is a measure of the appearance of lightness of a coating. It is usually assigned a value in specifications for white and pastel shades, a typical minimum reflectance being 86 % for white wall paint. In the referenced method, the direction of illumination and viewing is specified so as to eliminate the effect of gloss. Determine daylight directional reflectance in accordance with Test Method E 97.

8.4 *Gloss 60°*—Gloss level can affect dirt pickup and washability. Exterior latex house paints and trim paints may vary in gloss. A typical range would be from 5 to 60 units. Determine the specular gloss in accordance with Test Method D 523.

8.5 *Hiding Power (Dry Opacity)*—Hiding power is the measure of the ability of a paint to hide the substrate. It is, however, dependent upon uniform film thickness which is influenced by flow and leveling. Test Method D 344 is a practical test in which paint is applied with a brush, film thickness is approximately measured, opacity is evaluated visually as compared to a standard paint, and results are affected by flow and leveling application properties of the paint. Test Method D 2805 is considered to be a more precise and accurate test that does not need a material paint standard. Paint is applied with an applicator bar to minimize the effects of flow and leveling, film thickness is rigorously measured, and opacity is instrumentally evaluated. Determine hiding power in accordance with Test Method D 344 or D 2805.

9. Properties of Dry Paint Film

9.1 *Flexibility*—Elongation is a measure of flexibility of a paint film. Generally house paints will have no problem in passing a mandrel bend test. Most latex paints can be bent over a 1/4-in. (6.4-mm) mandrel without affecting the film. Determine elongation in accordance with Test Method D 522.

9.2 *Moisture Blister Resistance*—Moisture blister resistance is a necessary property of a house and trim paint. It can be evaluated by an accelerated laboratory test. Determine resistance to moisture blistering in accordance with Practice D 4585.

9.3 *Fume Resistance*—Fume resistance is the ability of a dry paint film to resist discoloration in a moist hydrogen sulfide atmosphere. This type of atmosphere may be present near industrial areas and can cause paint to yellow or darken in as little time as overnight exposure. There are no applicable ASTM or Federal test methods for fume resistance, but one method used in industry is as follows:

9.3.1 Apply a sufficient number of coats of the paint to two glass plates to hide the surface completely, allow to dry for 6 h, and expose one of the plates in a moist atmosphere of hydrogen sulfide for 18 h. Compare the color with the unexposed plate. The exposed plate should be no darker than the unexposed one.

9.4 *Exterior Exposure Resistance*—In conducting exterior exposures, refer to Practice D 1006.

9.4.1 *Wood Panel Description*—In establishing exposure performance, use the panels described in Specification D 358.

9.4.2 *Degree of Chalking*—Determine the rating using Test Methods D 4214.

9.4.3 *Degree of Checking*—Determine the rating using Test Method D 660.

9.4.4 *Degree of Cracking*—Determine the rating using Test Method D 661.

9.4.5 *Erosion Resistance*—Determine the rating using Test Method D 662.

9.4.6 *Flaking Resistance*—Determine the rating using Test Method D 772.

9.4.7 *Mildew Resistance*—All exterior latex paints are subject to microbiological discoloration that will occur on the surface of the coating over a period of time. This is especially true in warm, moist climates. Determine mildew resistance using Practice D 3456.

9.4.8 *Stain Resistance*—There is neither an ASTM nor a Federal test method available for evaluating stain resistance of exterior latex paints. There are, of course, different kinds of stain such as the water-soluble extractives in wood substrates, the formation of lead or mercury sulfides, and run-down from metal surfaces of oxides that stain. Different kinds of test methods are required for the various stains.

9.4.9 *Efflorescence Resistance*—Exterior latex paints can contain sufficient solid water-soluble material to cause a noticeable deposit on the film through leaching by water and subsequent evaporation. Determine the tendency of the paint to effloresce in accordance with Test Method D 1736.

9.4.10 *Fade Resistance*—Exterior latex paints usually have good color retention because of their good chalk resistance. However, the use of improper latex, pigment volume concentration, or pigments can lead to fading. There are no applicable ASTM or Federal test methods for fade resistance. One method on the evaluation of chalk-fade has been published in the literature.[10]

9.4.11 *Dirt Pickup*—Low-gloss exterior latex paints generally have good resistance to dirt pickup. Gloss or semigloss latex paints may be more subject to this type of disfigurement. Exterior exposure particularly under an overhang will indicate a paint's tendency for this property in a relatively short time (about 1 year). Determine degree of dirt collection in accordance with Test Method D 3719.

9.4.12 *Adhesion to Chalky Surfaces*—Latex paints generally have little ability to penetrate porous substrates. Therefore they do not adhere well to chalky substrates unless they are modified with some liquid that does penetrate and can bind a layer of chalk. (However certain latices do exist that are designed to adhere well to chalky surfaces. These could be considered without the need for a modifying liquid.) There are no directly applicable ASTM or Federal test methods for adhesion to chalky substrates. The industry generally uses a pressure-sensitive tape for testing this property. The tape is pressed firmly onto the dried latex film (fresh dry films do not adhere as well as aged dry films) and then removed rapidly by pulling back upon itself. Method 6301 of U.S. Federal Test Method Standard No. 141 describes a similar method but includes water exposure.

9.4.13 *Wet Adhesion*—Determine the wet adhesion of exterior latex paints in accordance with Method 6301 of U.S. Federal Standard Test Method No. 141.

10. Analysis of Paint

10.1 *Chemical Analysis*—If a specification requires certain raw materials or certain components in a given amount, then chemical analysis is required to determine whether the specified materials are present, and in what amounts. Analysis does not necessarily establish paint quality that can be also greatly affected by manufacturing techniques. Most ASTM analytical methods apply to solvent-reducible coatings. However, some of these can be adapted for analysis of water-reducible paints.

10.2 *Volatile Content*—The percent of volatile matter is a measure of the amount of a liquid coating lost as it dries. This quantity is not necessarily indicative of the quality of a coating. It is useful, however, for determining the similarity of two batches. The referenced method covers the determination of the volatile content of solvent- and water-reducible coatings. The quantity determined subtracted from 100 % gives the nonvolatile content. Determine the volatile content in accordance with Test Method D 2369.

10.3 *Pigment Analysis*—The analysis of pigment may be required if the product is covered by a specification, or if it is agreed between the purchaser and the seller. Analyze the pigment in accordance with selected test procedures from Methods D 215.

11. Keywords

11.1 Exterior paints; house paints; latex paints

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[10] Daiger, W. H., and Madson, W. H., "Chalk-Fade Evaluation of Pigmented Finishes by Use of Instrumentation and Computer Analysis," *Journal of Paint Technology*, Vol 39, No. 510, 1967, p. 399.

Designation: D 3133 – 72 (Reapproved 1989)$^{\epsilon 1}$

Standard Test Method for Quantitative Determination of Cellulose Nitrate in Alkyd Lacquers by Infrared Spectrophotometry[1]

This standard is issued under the fixed designation D 3133; 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.

$^{\epsilon 1}$ NOTE—Editorial changes were made throughout in March 1989.

1. Scope

1.1 This test method covers the quantitative determination of the content of cellulose nitrate (also known as nitrocellulose) in lacquers containing alkyd resins.

1.2 *This standard may involve hazardous materials, operations, and equipment. This standard does not purport to address all of the safety problems 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.* For a specific hazard statement, see Note 1.

2. Referenced Documents

2.1 *ASTM Standards:*

D 1644 Test Methods for Nonvolatile Content of Varnishes[2]

D 2372 Practice for Separation of Vehicle from Solvent-Reducible Paints[2]

E 168 Practices for General Techniques of Infrared Quantitative Analysis[3]

E 275 Practice for Describing and Measuring Performance of Ultraviolet, Visible, and Near Infrared Spectrophotometers[3]

3. Summary of Test Method

3.1 The method of standard additions is employed. Increments of cellulose nitrate, in solution, are added to aliquots of the sample. Absorbance measurements are made of the band at 848 cm^{-1} (11.8 μm) for each addition. The original content is then calculated from absorbance versus concentration.

4. Significance and Use

4.1 Coating compositions based on a mixture of synthetic resins and cellulose nitrate dissolved in organic solvents are quantitatively analyzed for the cellulosic derivative without isolating it. The test method is applicable to lacquers for which the grade of nitrocellulose is known and available. Other cellulosics, alkyd resins, many vinyl resins, and solvents do not interfere. Components, such as acrylic resins and some vinyl polymers, that absorb infrared near 848 cm^{-1} (11.8 μm) interfere with the determination. High boiling ester solvents, in particular methyl cellosolve acetate, may also interfere with the determination if not removed in the evaporation procedure (see 8.3).

5. Apparatus

5.1 *Infrared Spectrophotometer*, automatic recording, double-beam. Most infrared spectrophotometers operate from 4000 to 650 cm^{-1} (2.5 to 15 μm), but in this test method only the range between 1000 and 750 cm^{-1} (10 to 14 μm) is used. See Practices E 168.

5.2 *Absorption Cells*, sealed, with sodium chloride (NaCl) windows, 0.1-mm path length, one pair approximately matched.

5.3 *Film Vacuum Evaporator*, rotary thin or equivalent apparatus, to obtain redissolvable lacquer solids without decomposition of the cellulose nitrate.

5.4 *Oven*, vacuum drying, thermostatically controlled to operate at 65 ± 2 C.

6. Reagents

6.1 *Purity of Reagents*—Reagent grade chemicals shall be used in all tests. Unless otherwise indicated, it is intended that all reagents shall conform to the specifications of the Committee on Analytical Reagents of the American Chemical Society, where such specifications are available.[4] Other grades may be used, provided it is first ascertained that the reagent is of sufficiently high purity to permit its use without lessening the accuracy of the determination.

6.2 *Cellulose Nitrate*, of the same grade as in the sample.

6.3 *N,N-Dimethylacetamide* (*DMA*), spectrograde quality.

6.4 *Nitrogen Gas*, dry.

7. Standard Solution

7.1 Thoroughly dry a quantity of cellulose nitrate at 65°C, in the vacuum oven (Note 1). Transfer 4000 g, weighed to 0.1 mg, to a 200-mL volumetric flask. Add DMA, shake to dissolve the cellulose nitrate, and dilute to volume with DMA. One millilitre of solution is equivalent to 20 mg of

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[1] This method is under the jurisdiction of ASTM Committee D-1 on Paint and Related Coatings and Materials and is the direct responsibility of Subcommittee D01.55 on Factory-Applied Coatings on Preformed Products.

Current edition approved Oct. 27, 1972. Published January 1973.

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

[3] *Annual Book of ASTM Standards*, Vol 14.01.

[4] "Reagent Chemicals, American Chemical Society Specifications," Am. Chemical Soc., Washington, DC. For suggestions on the testing of reagents not listed by the American Chemical Society, see "Reagent Chemicals and Standards," by Joseph Rosin, D. Van Nostrand Co., Inc., New York, NY., and the "United States Pharmacopeia."

cellulose nitrate.

NOTE 1: **Warning**—Every precaution must be exercised in the handling and drying of cellulose nitrate because of its explosive nature. No more than 15 g should be dried at any one time.

8. Procedure

8.1 If the material is pigmented, remove the pigment quantitatively in accordance with Method D 2372, and proceed with the determination on the vehicle.

8.2 Determine the nonvolatile content of the clear lacquer, on the vehicle, in accordance with Test Methods D 1644.

8.3 Transfer, by any convenient means, 10.000 g of unpigmented material to a 50-mL volumetric flask. Attach the flask to the rotary evaporator and evaporate off the bulk of the solvents. Detach the flask, dissolve the lacquer solids in DMA, and dilute to volume with DMA. If the presence of methyl cellosolve acetate is suspected in the solvents, care must be taken to evaporate off the solvents as completely as possible.

8.4 Pipet 10.0 mL aliquots of this solution into each of three 25-mL volumetric flasks. To each, in turn, add 0, 5.0, and 10.0 mL of the standard solution. Dilute to volume with DMA.

8.5 *Infrared Analysis:*

8.5.1 Schedule the operating parameters of the infrared spectrometer to attain highly accurate absorbance values (refer to the directions of the manufacturer of the instrument). To accomplish this, set for lengthier scanning time and high signal-to-noise ratio, in accordance with Practice E 275.

8.5.2 Place one cell, containing DMA, in the reference beam. Place the other cell, filled in turn, with each of the solutions (Note 2), in the sample beam. Record the spectrum between 1000 and 750 cm^{-1} (10 and 14 μm) three times for each solution. Rinse the cell with DMA, and purge with dry nitrogen gas after each solution has been examined.

NOTE 2—To facilitate the transfer of the solutions to the cell, a small glass syringe fitted with a 3-in. (75-mm) hypodermic needle may be used.

8.5.3 Measure the difference in absorbance, ΔA, between the maximum absorbance at 848 cm^{-1} (11.8 μm) and the minimum at 813 cm^{-1} (12.3 μm). Determine the mean ΔA for the three runs on each solution.

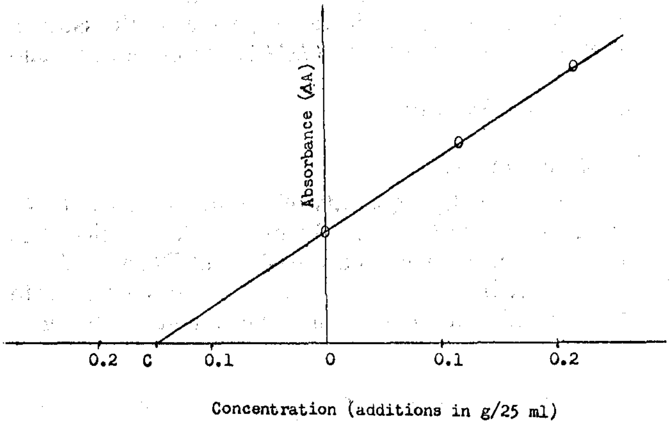

FIG. 1 Plot of ΔA verses Cellulose Nitrate Additions

9. Calculation

9.1 Plot the absorbance difference, ΔA, versus the cellulose nitrate additions and extrapolate the curve to zero absorbance. The intersection of the curve with the abscissa (concentration axis) gives the original cellulose nitrate content in the diluted sample. See Fig. 1.

9.2 *Alternative Method*—Solve for C in the three simultaneous equations derived from the expression for the Beer-Bourguer law, $A = abc$

$$\Delta A_0/(C + 0.0) = \Delta A_{0.1}/(C + 0.1) = \Delta A_{0.2}/(C + 0.2)$$

where:

C = original concentration of cellulose nitrate, in grams per 25 mL and the subscripts for ΔA correspond to the amounts of cellulose nitrate added in grams per 25 mL. Calculate the mean of C.

9.3 Calculate the weight percent of cellulose nitrate E in the original lacquer as follows:

$$E = (C \times D \times 100)/S$$

where:

D = dilution factor,
S = weight of specimen, and
C = grams of cellulose nitrate in 25 mL.

9.4 Calculate weight percent cellulose nitrate E in nonvolatile portion of original lacquer as follows:

$$E = (C \times 5 \times 100 \times 100)/(S \times N)$$

where:

N = nonvolatile content (see 8.2).

10. Precision

10.1 On the basis of a study in which four laboratories analyzed two different samples for percent of cellulose nitrate relative to the total samples, T, and relative to the nonvolatile matter, NVM, the within and between laboratory standard deviations were found to be:

Percent Relative to	Standard Deviations	
	Within	Between
T	0.14	0.12
NVM	0.39	0.64

Based on these standard deviations the following criteria should be used in judging the acceptability of results at the 95 % confidence level.

10.1.1 *Repeatability*—Two results obtained by one operator on one instrument should be considered suspect if they differ by more than the following:

Relative to	Percent
T	0.48
NVM	1.34

10.1.2 *Reproducibility*—Two results obtained by operators in different laboratories should be considered suspect if they differ by more than the following:

Relative to	Percent
T	0.71
NVM	2.51

Standard Test Method for Chipping Resistance of Coatings[1]

This standard is issued under the fixed designation D 3170; 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 test method has been approved for use by agencies of the Department of Defense. Consult the DoD Index of Specifications and Standards for the specific year of issue which has been adopted by the Department of Defense.

$^{\epsilon 1}$ NOTE—Keywords were added editorially in March 1991.

1. Scope

1.1 This test method covers the determination of the resistance of coatings to chipping damage by stones or other flying objects.

NOTE 1—This test method is similar to SAE J-400.

1.2 *This standard does not purport to address the safety problems, 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:*

D 609 Practice for Preparation of Cold-Rolled Steel Panels for Testing Paint, Varnish, Conversion Coatings, and Related Coating Products[2]

D 823 Test Methods for Producing Films of Uniform Thickness of Paint, Varnish, and Related Products on Test Panels[2]

D 1005 Test Methods for Measurement of Dry-Film Thickness of Organic Coatings Using Micrometers[2]

D 1186 Test Methods for Nondestructive Measurement of Dry Film Thickness of Nonmagnetic Coatings Applied to a Ferrous Base[2]

D 1400 Test Method for Nondestructive Measurement of Dry Film Thickness of Nonconductive Coatings Applied to a Nonferrous Metal Base[2]

D 1733 Method of Preparation of Aluminum-Alloy Panels for Testing Paint, Varnish, Lacquer, and Related Products[3]

D 2201 Test Method for Preparation of Hot-Dipped Nonpassivated Galvanized Steel Panels for Testing Paint, Varnish, Lacquer, and Related Products[2]

2.3 *Other Documents:*

Test for Chip Resistance of Surface Coatings (J-400)[4]

New Pictorial Standards Coating Defects[5]

3. Summary of Test Method

3.1 Standardized road gravel is projected by means of a controlled air blast at the coated specimens. Generally the test conditions are made more severe by performing the test at low ambient temperatures. The resultant chipping effect is evaluated by comparison with a set of photographic standards that appear in the *Pictorial Standards Coating Defects.*

4. Significance and Use

4.1 Chipping of coatings, particularly on the leading faces and edges of automobile surfaces, is considered unacceptable by owners. In formulating a coating or coating system to meet service requirements, the resistance to chipping damage by flying objects such as gravel is one of the properties of importance since it can vary considerably as other properties are adjusted. Since resistance to chipping decreases at lower temperatures partly as the result of decreased flexibility, the test may be more directly related to service conditions by performing it at a low temperature. This test method is designed to produce a controlled amount of impact by the media on the coated panel in order to enhance reproducibility.

5. Apparatus

5.1 *Gravel-Projecting Machine,* constructed according to the design specifications shown in Fig. 1.[6]

5.2 *Gravel*—Water-eroded alluvial road gravel[7] passing through a ⅝-in. (16-mm) space screen but retained on a ⅜-in. (9.5-mm) space screen. Note that mesh screen is not a substitute for a space screen. It is important to remove the small pieces of gravel before reusing the gravel.

5.3 *Masking Tape,* 4 in. (100 mm) wide.[8]

5.4 *Temperature-Conditioning Equipment* (*alternatives*):

5.4.1 A cold room or freezer of sufficient size in which the gravel-projecting machine and test specimens can be maintained at the specified temperature of testing.

5.4.2 A freezer or cooler in which the test panels can be cooled 10°F (5°C) below the specified test temperature.

5.5 *Chipping Rating Standards*—A set of photographic standards depicting size and number of chips in each

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[1] This test method is under the jurisdiction of ASTM Committee D-1 on Paint and Related Coatings and Materials and is the direct responsibility of Subcommittee D 01.55 on Factory-Applied Coatings on Preformed Products.

Current edition approved May 29, 1987. Published July 1987. Originally published as D 3170 – 73. Last previous edition D 3170 – 74 (1980)$^{\epsilon 1}$.

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

[3] Discontinued, see *1980 Annual Book of ASTM Standards,* Part 27.

[4] Available from the Society of Automotive Engineers, 400 Commonwealth Dr., Warrendale, PA 15096.

[5] Available from the Federation of Societies for Coatings Technology, 492 Norristown Rd., Blue Bell, PA 19422-2350.

[6] A suitable apparatus meeting these specifications can be obtained from Q-Panel Co., 26200 First St., Westlake, OH 44135.

[7] Gravel meeting these specifications can be obtained from Q-Panel Co., 26200 First St., Westlake, OH 44135.

[8] No. 202-2 masking tape manufactured by the 3M Co., St. Paul MN 55101, has been found satisfactory for this purpose.

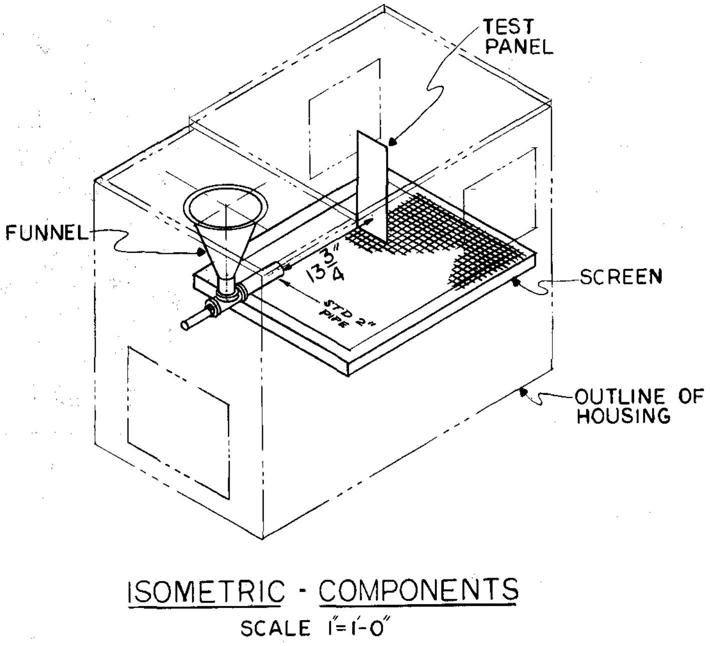


FIG. 1 Gravel-Projecting Machine

category (see 2.3). The photographs in Fig. 2 are for illustration purposes only and should not be used for evaluation(s).

6. Test Specimens

6.1 The composition, surface preparation, and size of specimens shall be agreed upon between the purchaser and the seller. Test panels of 4 by 12 in. (102 by 305 mm) are most suitable for this test.

6.2 The number, type, method of application, and aging of coatings shall be agreed upon between the purchaser and the seller.

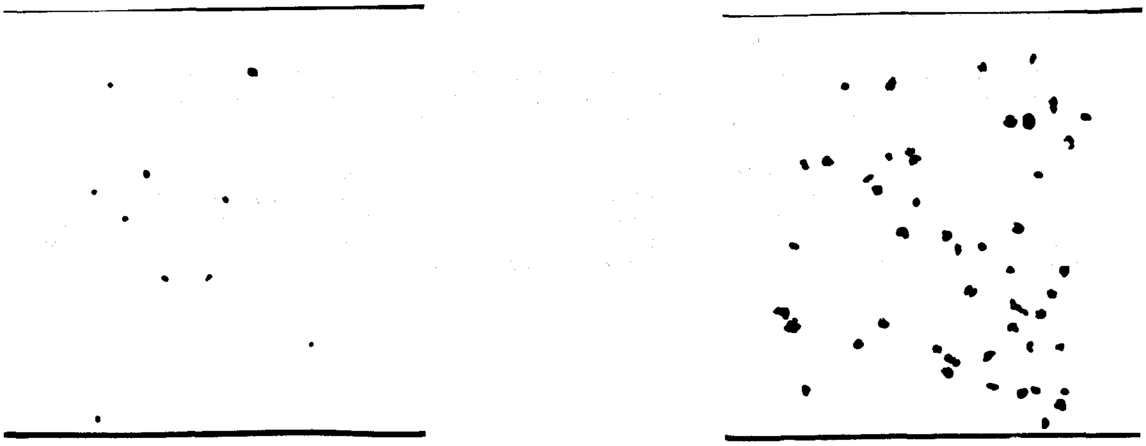
NOTE 2—Application, metal preparation, and film thickness measurement methods are given in the following ASTM methods: D 609, D 823, D 1005, D 1186, D 1400, D 1733, and D 2201.

7. Procedure

7.1 Condition the specimens for a minimum of 1 h at the specified test temperature in the equipment specified in 5.4. Make certain the test specimens are separated and have free access to the conditioning environment so that optimum heat transfer occurs.

7.2 Adjust the air pressure on the gravel apparatus to 70 ± 3 psi (480 ± 20 kPa) with the air valve open. Keep the lid to the gravel chamber on the apparatus closed during this operation as a safety precaution.

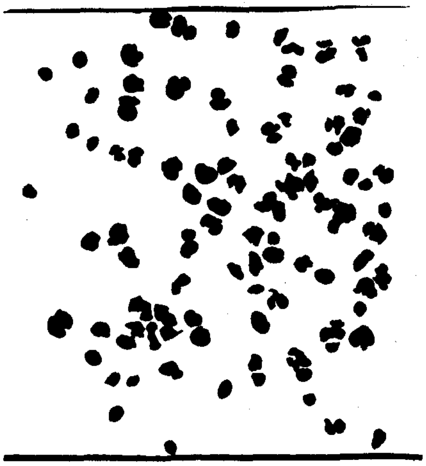
7.3 After adjusting the air pressure, shut off the air valve, open the lid to the gravel chamber and collect 1 pt (550 mL) of graded gravel (approx 250 to 300 stones) in a suitable container. Collect the gravel by scraping across the screen to allow fines to fall through.



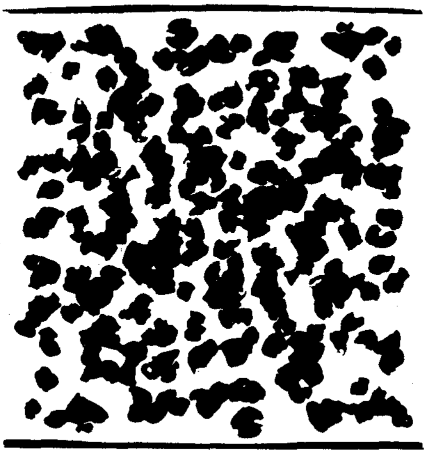
7A 10-24 Chips
Dia: Less than 1 mm.
Illustration: 10 Chips

5B 50-74 Chips
Dia: 1-3 mm.
Illustration: 50 Chips

FIG. 2 Reference Photographs (Illustration Purpose Only)



3C 100-150 Chips
Dia: 3-6 mm.
Illustration: 100 Chips



1D Over 250 Chips
Dia: Over 6 mm.
Illustration: 250 Chips (Theoretical)

FIG. 2 Reference Photographs (Contd)

7.4 Place one test specimen at the desired test temperature in the panel holder with the coated side facing the front of the apparatus and close the lid to the gravel chamber.

NOTE 3—Due to space limitations, it may not be possible to operate the apparatus at the desired test temperature. In this event, the panels should be cooled below the desired test temperature by 10°F (5°C) and the test begun within 10 s of removal from the cooler.

7.5 *Automatic Gravel Feed*, with automatic feed apparatus, place one pt of the gravel in the vibrating hopper. Opening the air valve automatically feeds the gravel into the air stream over approximately a 10-s interval.

7.6 *Manual Gravel Feed*, with a manual feed, slowly pour the gravel into the funnel over approximately a 10-s interval.

7.7 Shut off the air valve, open the lid to the gravel chamber, and remove the tested panel. Allow the panel to return to room temperature and remove any condensed moisture by wiping dry with a cloth.

7.8 Cover the test panel with a 4-in. (100 mm) strip of masking tape. Press the tape down firmly by rubbing; then pull off slowly to remove any loose chips of paint.

7.9 Determine the degree of chipping by comparison with the photographic standards.

8. Report

8.1 Report the substrate composition, type and age of coating, test temperature, and chipping rating.

9. Precision

9.1 Since the rating scale consists of a combination letter and number, no standard deviation value is obtainable from the supporting test results. It is the judgment of those familiar with this test method that the following precision statements are representative:

9.1.1 *Repeatability*—Results of tests within a laboratory differing by more than one letter or number unit should be considered suspect.

9.1.2 *Reproducibility*—Results of tests between laboratories differing by more than two letters or number units should be considered suspect.

10. Keyword

10.1 chip resistance

Designation: D 3258 – 80 (Reapproved 1992)$^{\epsilon 1}$

Standard Test Method for Porosity of Paint Films[1]

This standard is issued under the fixed designation D 3258; 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.

$^{\epsilon 1}$NOTE—Keywords were added editorially in September 1992.

1. Scope

1.1 This test method covers the determination of the porosity of a white or near white mineral spirits insoluble paint film to indicate the degree to which a subsequent coat will penetrate.

1.2 The texture of the film can affect cleanup that will influence the results of the test. A stain applied to a high-hiding paint will not lower the reflectance as much as the same stain applied to a low-hiding paint of equal porosity. These points must be considered in comparing different paints.

1.3 *This standard does not purport to address all of the safety problems, 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 Document

2.1 *ASTM Standard:*

E 97 Test Method for Directional Reflectance Factor, 45-deg 0-deg, of Opaque Specimens by Broad-Band Filter Reflectometry[2]

3. Summary of Test Method

3.1 The test paint is applied to a nonporous surface, air dried, then measured for reflectance. A special colored penetrating medium is applied, the excess removed in a specified manner, and reflectance measured again. The difference between the two readings indicates the degree of porosity; the smaller the difference, the lower the porosity of the film and the greater its ability to resist penetration.

4. Apparatus and Materials

4.1 *Film Applicator,* 6 in. (150 mm) wide with a clearance of 12 mils (300 µm).[3]

4.2 *Film Applicator,* 5½ in. (140 mm) wide with a clearance of 10 mils (250 µm).[4]

4.3 *Reflectometer,* meeting the requirements of Test Method E 97.

4.4 *Vacuum Drawdown Plate.*

4.5 *Camelhair Brush* (approximately ½ in. (13 mm) wide).

4.6 *Plastic Wash Bottle,* containing odorless mineral spirits (about 16 oz (500 mL)).

4.7 *Test Panel*—Smooth nonporous panel such as sealed white, cardboard chart, or white plastic sheet.

4.8 *Penetrating Medium*—A composition of pigment and dark-colored dye dispersed in organic liquid vehicle.[5]

4.9 *Filter Paper.*

5. Procedure

5.1 Place the test panel on the vacuum plate and apply the paint under test with the 12-mil (30-µm) clearance drawdown blade. Remove the test panel from the vacuum plate and air dry 48 h under standard conditions of 73 ± 3.5°F (23 ± 2°C) and 50 ± 5 % relative humidity.

5.2 Determine the percent reflectance of the dry film using the green filter on the reflectometer. When making this reading, back up the panel with a flat rigid opaque object and mark the area on which the reading was made.

5.3 Place the panel containing the dry paint film on the vacuum plate. Using the 10-mil (25-µm) clearance blade, apply the penetrating medium over the test paint, covering the area marked as above and drawing the applicator blade in the same direction as before.

5.4 After 5 min ± 15 s wash off excess penetrating medium.To do this, hold the panel vertically and remove the medium using the camelhair brush wet with odorless mineral spirits. Repeat the process until most of the excess is removed. Then continue to remove more of the excess by applying mineral spirits directly from the wash bottle to the area above the stain so that it flows across the stained area. Pause to observe the bead that forms at the bottom of the panel. If the bead is not clear, continue washing with mineral spirits until the bead is essentially clear. Test with filter paper to be sure no dye remains in the bead.

5.5 Hang the panel in a vertical position and air dry for 3 h. As before, read the percent reflectance over the same area

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[1] This test method is under the jurisdiction of ASTM Committee D-1 on Paint and Related Coatings and Materials and is the direct responsibility of Subcommittee D01.42 on Architectural Finishes.

Current edition approved Oct. 14, 1980. Published December 1980. Originally published as D 3258 – 73. Last previous edition D 3258 – 79.

[2] Discontinued; see *1992 Annual Book of ASTM Standards,* Vol 06.01.

[3] Bird film applicators or their equivalent have been found satisfactory for this purpose. Available from BYK-Gardner, Inc., Gardner Laboratory, 2435 Linden Lane, Silver Spring, MD 20910.

[4] The Dow latex film caster has been found satisfactory for this purpose. Available from BYK-Gardner, Inc., Gardner Laboratory, 2435 Linden Lane, Silver Spring, MD 20910.

[5] Available from: K & N Laboratories, Inc., 5331 Dansher Rd., Countryside, IL 60525.

of the panel with the same flat rigid opaque object behind the panel.

6. Report

6.1 Report the difference between the percent reflectance of the untested film and that of the penetrated film.

7. Precision

7.1 On the basis of an interlaboratory study of this test method in which one operator in each of ten laboratories tested paint films of two nominally different levels of porosity, the within-laboratory and between-laboratories standard deviations were found to be:

Nominal Difference in Reflectance, %	Standard Deviations	
	Within-Laboratory	Between-Laboratories
7	0.27	1.26
35	0.60	4.22

Based on these standard deviations the following criteria should be used to judge the precision or results at the 95 % confidence level:

7.1.1 *Repeatability*—Duplicate results, obtained by a single operator, should be considered suspect if they differ by more than 0.8 % relative for difference in reflectance levels of about 7 % and more than 1.8 % relative for difference in reflectance levels of about 35 %.

7.1.2 *Reproducibility*—Two results, each the mean of duplicate measurements obtained in different laboratories should be considered suspect if they differ by more than 4.0 % relative for difference in reflectance levels of about 7 % and 14 % relative for difference in reflectance levels of about 35 %.

8. Keywords

8.1 film porosity; porosity; resistance—penetration (into paint films)

Designation: D 3259 – 84 (Reapproved 1990)$^{\epsilon 1}$

Standard Practice for Infrared Determination of the Temperature of Applied Coatings on Wood Products During the Curing Cycle[1]

This standard is issued under the fixed designation D 3259; 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.

$^{\epsilon 1}$ NOTE—Section 5 was editorially changed in May 1990.

1. Scope

1.1 This practice is intended to serve as a guide in measuring with infrared instruments the temperature during the curing process of coatings applied to wood products.

1.2 *This standard does not purport to address the safety problems 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. Significance and Use

2.1 The forest products finishing industry has encountered difficulties in measuring the temperature of painted surfaces during the curing process. The use of thermocouples is not entirely satisfactory because the thermocouple wires tend to conduct heat away too rapidly from the area where the temperature is being measured. Infrared radiation thermometers that are simple to operate can circumvent this difficulty. After calibration they are aimed at the surface, switched on, and the temperature read directly from an indicating gage.

NOTE 1—Temperature-sensitive crayons, papers, and pellets may be successfully used to measure only the highest temperature reached by painted surfaces during the curing cycle.

2.2 There are several different types of infrared radiation thermometers, including those based on lead sulfide or thermistor sensors and those that are simple thermal voltaic transducers. As such they respond to different wavelengths of infrared radiation and have different areas of applicability. Only instruments that have been evaluated are included in this practice.

3. Apparatus

3.1 *Lead Salt Types*[2] (Note 2)—Two lead salts are commonly used. Lead sulfide that responds to wavelengths between 1.0 and 3.0 µm and lead selenide that responds to wavelengths between 15 and 4.5 µm.

3.2 *Thermistor Type*—Thermistors are sensitive to longer wavelength infrared of 3 to 20 µm. Instruments may be designed with a narrow or broad band pass and may compensate for changes in ambient temperatures. One instrument[3] with the latter feature has a band pass of 8 to 14 µm. Another instrument[4] that must be rezeroed to compensate for changes in ambient temperatures has a band pass of 3 to 20 µm. However, this instrument can be completely portable and requires essentially no warm up time.

3.3 *Thermalvoltaic Type*[5]—These instruments are equipped with collection chambers for radiated energy that then heat a thermocouple to the temperature of the surface measured. As such, they require a minimum target area of 1 in. (25 mm) in diameter and have a delay time that averages about 1.5 s.

3.4 Instrumentation is available for on-line process monitoring control of product temperatures. These units have long term stability that permits operation in varying ambients encountered in plants or mills without periodic calibration. The instruments also have output signals to operate recorders and controllers.

4. Procedure

4.1 *Calibration*—Calibrate each instrument according to the instructions of the manufacturer. A standard blackbody capable of being controlled at various temperatures is almost essential for calibration. One such blackbody[6] is a modified hot plate with a ½-in. (13-mm) thick aluminum plate and a ventilated cowling to minimize the effects of ambient drafts. A dial thermometer with its stem within the aluminum plate serves to monitor the temperature of the blackbody.

4.2 *Operation:*

4.2.1 Detailed instructions on the operation of each instrument are not included in this practice. Unless otherwise agreed follow the manufacturer's instructions in operating the equipment.

4.2.2 One general precaution is that the instrument must observe only the surface being measured and not stray radiation from infrared heaters, sunlight, electric lights, or other sources. The permissible distance from the surface to the sensor depends upon the area of surface, the viewing

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[1] This practice is under the jurisdiction of ASTM Committee D-1 on Paint and Related Coatings and Materials and is the direct responsibility of D01.52 on Factory Coated Wood Products.

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[2] The Williamson 1200 manufactured by the Williamson Development Co., Inc., West Concord, MA 01781, is an example of this type.

[3] Optitherm II Model 8014 manufactured by Barnes Engineering Co., Stamford, CO 06904, is an example of this type of instrument.

[4] Rayngнer R2LT manufactured by Raytek, Inc., Santa Cruz, CA 95060, is an example of this type of instrument.

[5] Kustotherm B distributed by Epic Inc., New York, NY 10038, is an example of this type of instrument.

[6] Field Calibration Source, Model 11-101 manufactured by Barnes Engineering Co., Stamford, CO 06904.

angle of the instrument and the wavelength that the sensor responds to. Instruments operating only in the long wavelength region of the infrared spectrum are affected much less by stray radiation and by color variations.

5. Keywords

5.1 cure temperature; infrared; paint surface temperature; temperature measurement; wood coating

Designation: D 3260 – 82 (Reapproved 1991)

Standard Test Method for Acid and Mortar Resistance of Factory-Applied Clear Coatings on Extruded Aluminum Products[1]

1. Scope

1.1 This test method covers the evaluation of the mortar and acid resistance of clear protective coating factors applied to extended aluminum substrates.

2. Referenced Documents

2.1 *ASTM Standards:*

C 207 Specification for Hydrated Lime for Masonry Purposes[2]

D 823 Test Method for Producing Films of Uniform Thickness of Paint, Varnish, and Related Products on Test Panels[3]

3. Summary of Test Method

3.1 Panels that have been buffed, cleaned, neutralized, and coated with the material being evaluated are exposed to freshly prepared mortar and to a hydrochloric acid solution.

4. Significance and Use

4.1 This test method will provide differentiation between types of coatings for acid and motor resistance providing the coating is applied in a uniform continuous film with a specified film thickness.

5. Reagents

5.1 *Acid*—Ten volume percent solution of commercial grade hydrochloric acid (31.4 to 31.8 % HCl, 20°Bé) in distilled water.

5.2 *Cleaning Solution*—An alkaline cleaner[4] in the concentration recommended by the manufacturer, usually 6 to 8 oz/gal (45 to 60 g/L) of water. The pH of the solution should be between 11.4 and 12.2.

5.3 *Lime*—Building lime complying with Specification C 207.

5.4 *Neutralizing Solution*—Prepare from a stable free-flowing, granular material having a chromate base[5] as recommended by the supplier, usually at a concentration of 12 to 16 oz/gal (90 to 120 g/L) of water.

5.5 *Sand*—Dry sand capable of passing through a 10-mesh wire screen.

6. Test Panels

6.1 Panels of extruded aluminum alloy No. 6063-T5 with dimensions 6 by 3 by ¼ in. (150 by 75 by 6.3 mm) shall be used for the test.

7. Procedure

7.1 *Preparation of Test Panels:*

7.1.1 Buff the aluminum panels and remove the buffing compound with an organic solvent.

7.1.2 Immerse the panels in cleaning solution (5.2) for 1 h at a temperature of 200°F (93°C).

7.1.3 Rinse the panels in tap water having a pH of 6.5 to 7.5 until the surface is free of water break. Use reagent water for rinsing if the pH of the tap water is outside the specified limits. The panels shall be free from evidence of corrosion or surface attack.

7.1.4 Immerse the panels in neutralizing solution (5.4) at 75 ± 2°F (24 ± 1°C) for 30 s to neutralize any retained alkalinity and to promote adhesion of the applied coatings.

7.1.5 Rinse the panels in reagent water and allow them to dry a minimum of 1 h before coating.

7.2 *Coating of Test Panels:*

7.2.1 Apply the coatings being evaluated to the test panels in a uniform continuous film by automatic spray equipment in accordance with Method A of Test Method D 823.

7.2.2 For the mortar test, spray two panels on one side with two or more full wet coats to produce a minimum dry film thickness of 0.6 mils (15 µm) and two panels with one or more full wet coats to produce a minimum dry film thickness of 0.3 mils (7.5 µm).

7.2.3 For the acid test, spray two panels with two or more full wet coats, on both sides, to produce a minimum dry film thickness of 0.6 mils (15 µm) and two panels with one or more full wet coats on *both* sides to a minimum dry film thickness of 0.3 mils (7.5 µm).

7.2.4 Allow the panels to dry for 7 days at 73 ± 3.5°F (23 ± 2°C) and 50 ± 5 % relative humidity.

7.3 *Mortar Test:*

7.3.1 Prepare freshly mixed mortar by dry mixing 75 g of building lime (5.3) and 225 g of sand (5.5) and adding sufficient reagent water while stirring to make a soft paste that can be formed into a firm mortar patty approximately 1½ in. (40 mm) in diameter and ¼ in. (6 mm) thick.

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[1] This test method is under the jurisdiction of ASTM Committee D-1 on Paint and Related Coatings and Materials and is the direct responsibility of Subcommittee D01.55 on Factory-Applied Coatings on Preformed Products.

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[2] *Annual Book of ASTM Standards*, Vol 04.01.

[3] *Annual Book of ASTM Standards*, Vol 06.01.

[4] Diversey No. 808 has been found satisfactory for this purpose.

[5] Diversey No. 814 has been found satisfactory for this purpose.

7.3.2 Apply the mortar to the top and bottom areas of the test panels and, without drying, immediately expose them for 7 days at 95 to 98 % relative humidity at a temperature of 70 ± 3.5°F (21 ± 2°C) in an automatically controlled cabinet.

7.3.3 At the end of 7 days take the panels from the test cabinet and immediately dislodge the mortar patties from the panels using a damp cloth to remove any residue.

7.3.4 View the surface of the panels perpendicular to the surface under a diffused light source providing a minimum light intensity at the surface of 200 ft-candles (2150 lx). Examine for blistering, peeling, lifting, crazing, flaking, or discoloration of the coating, and for corrosion of the coated part of the aluminum panel. Three observers shall evaluate each panel and the majority assessment shall govern.

7.4 *Acid Test:*

7.4.1 Apply a mixture of 50 parts beeswax and 50 parts paraffin to protect the raw edges to a distance of ⅜ in. (10 mm).

7.4.2 Immerse the panels in the acid bath (5.1) at 70 ± 3.5°F (21 ± 2°C) for 6 h. Remove the panels, rinse in water, and allow to dry.

7.4.3 Examine and evaluate as in 7.3.4.

8. Precision

8.1 The effect of acid and mortar on the coatings is expressed in terms of appearance and numerical values are not generally assigned.

8.2 In a cooperative test program, consistent results were obtained by all cooperators when all of the test variables were controlled closely. The success of the procedure depends particularly on having a continuous film of the coating on the panels, the proper pH value when rinsing the panels, and proper protection of the edges of the panels in the acid test.