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Standard Guide for Testing Water-Borne Architectural Coatings[1]

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1. Scope

1.1 This guide covers the selection and use of procedures for testing water-borne coatings to be used on exterior, interior or both types of surfaces (Note 1). The properties that can be examined or, in some cases, the relevant test procedures are listed in Table 1 and Table 2.

NOTE 1—The term "architectural coating" as used here combines the definition in Terminology D16 with that in the *FSCT Paint/Coatings Dictionary*[2], as follows: "Organic coatings intended for on-site application to interior or exterior surfaces of residential, commercial, institutional, or industrial buildings, in contrast to industrial coatings. They are protective and decorative finishes applied at ambient temperatures. Often called Trade Sales Coatings."

NOTE 2—Architectural coatings that are designed to give better performance than most conventional coatings because they are tougher and more stain and abrasion resistant are covered by Guide D3730.

1.2 The types of organic coatings covered by this guide are as follows:

(1) Type 1 Interior Latex Flat Wall Paints,
(2) Type 2 Exterior Latex House Paints,
(3) Type 3 Water-Borne Floor Paints, and
(4) Type 4 Interior Latex Semigloss and Gloss Paints.

1.2.1 Each is intended for application by brushing, rolling, spraying or other means to the material appropriate for its type, which may include plaster, masonry, wallboard, wood, steel, previously painted surfaces, and other architectural substrates.

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

1.4 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[3]

D16 Terminology for Paint, Related Coatings, Materials, and Applications
D185 Test Methods for Coarse Particles in Pigments
D215 Practice for the Chemical Analysis of White Linseed Oil Paints (Withdrawn 2005)[4]
D344 Test Method for Relative Hiding Power of Paints by the Visual Evaluation of Brushouts
D358 Specification for Wood to Be Used as Panels in Weathering Tests of Coatings (Withdrawn 2014)[4]
D522 Test Methods for Mandrel Bend Test of Attached Organic Coatings
D523 Test Method for Specular Gloss
D562 Test Method for Consistency of Paints Measuring Krebs Unit (KU) Viscosity Using a Stormer-Type Viscometer
D660 Test Method for Evaluating Degree of Checking of Exterior Paints
D661 Test Method for Evaluating Degree of Cracking of Exterior Paints
D662 Test Method for Evaluating Degree of Erosion of Exterior Paints
D772 Test Method for Evaluating Degree of Flaking (Scaling) of Exterior Paints
D869 Test Method for Evaluating Degree of Settling of Paint
D968 Test Methods for Abrasion Resistance of Organic Coatings by Falling Abrasive
D1006 Practice for Conducting Exterior Exposure Tests of Paints on Wood
D1014 Practice for Conducting Exterior Exposure Tests of Paints and Coatings on Metal Substrates
D1210 Test Method for Fineness of Dispersion of Pigment-Vehicle Systems by Hegman-Type Gage
D1296 Test Method for Odor of Volatile Solvents and Diluents
D1308 Test Method for Effect of Household Chemicals on

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[2] Available from Federation of Societies for Coatings Technology (FSCT), 492 Norristown Rd., Blue Bell, PA 19422-2350, http://www.coatingstech.org.

[3] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[4] The last approved version of this historical standard is referenced on www.astm.org.

TABLE 1 List of Standards in Sectional Order

Property (or related test)	Section	ASTM Standard	Federal Test Method Standard 141D
Sampling	6.2	D3925	
Liquid Coating Properties			
Condition in container	7.1		3011
Coarse particles and foreign matter	7.2	D185	
Density or weight per gallon	7.3	D1475	
Fineness of dispersion	7.4	D1210	
Odor	7.5	D1296	
Colorant acceptance	7.6	D5326	
pH	7.7	E70	
Package stability	7.8		
Heat stability	7.8.1	D1849	
Freeze-thaw stability	7.8.2	D2243	
Settling	7.8.3	D869	
Microorganism resistance	7.8.4	D2574, D3273	
Coating Application and Film Formation			
Application properties	8.1		
Brush application	8.1.1	D5068	
Brush drag	8.1.1.1	D4958	
Roller application	8.1.2		2112
Roller spatter	8.1.2.1	D4707	
Spray application	8.1.3		2131
Touch-up uniformity	8.2	D3928, D7489	
Low-temperature coalescence	8.3	D3793, D7306	
Rheological properties	8.4		
Consistency (Low-shear viscosity)	8.4.1	D562	
Rheological properties of non-Newtonian materials	8.4.2	D2196, D4287	
Sag resistance	8.4.3	D4400	4494
Levelling properties	8.4.4	D4062	
Drying properties	8.5	D1640, D5895	
Wet-to-Dry Hiding Change	8.5.1	D5007	
Appearance of Dry Film			
Color difference	9.1	. . .	
Color appearance	9.1.1		
Color differences by visual comparison	9.1.2	D1729	
Color differences using instrumental measurements	9.1.3	D2244	
Directional reflectance	9.2	E1347	
Gloss	9.3		
Gloss, 60°	9.3.1	D523	
Sheen (85° gloss)	9.3.2	D523	
Hiding power	9.4	D344, D2805, D5150	
Burnish Resistance	9.5	D6736	
Properties of Dry Film			
Interior and Exterior Coatings	10.1		
Abrasion resistance	10.1.1	D968, D4060, D6037	6192
Adhesion	10.1.2	D2197, D3359, D5179	
Wet adhesion	10.1.3	D6900	6301
Flexibility	10.1.4	D522, D2370	6221[A]
Resistance to household chemicals	10.1.5	D1308	
Efflorescence from the film	10.1.6		
Efflorescence from the substrate	10.1.7	D7072	
Surfactant Stain Resistance	10.1.8	D7190	
Interior Finishes	10.2		
Block resistance	10.2.1	D4946	
Print resistance	10.2.2	D2064	
Film porosity	10.2.3	D3258, D6583	
Washability and cleansability	10.2.4		
Washability	10.2.4.1	D2486, D4213	
Cleansability	10.2.4.2	D3450, D4828	6141[B]
Ink Stainblocking	10.2.5	D7514	
Exterior Coatings	10.3		
Adhesion to chalky surfaces	10.3.1		6301
Dirt pick-up	10.3.2	D3719	
Fume resistance	10.3.3		
Fume resistance test	10.3.3.1		
Blister resistance	10.3.4	D4585	
Exposure resistance	10.3.5	D1006, D1014	
Chalking	10.3.5.2	D4214	
Checking	10.3.5.3	D660	
Cracking	10.3.5.4	D661	
Erosion	10.3.5.5	D662	
Flaking	10.3.5.6	D772	
Fade resistance	10.3.5.8	D2244	
Stain resistance	10.3.6		

TABLE 1 *Continued*

Property (or related test)	Section	ASTM Standard	Federal Test Method Standard 141D
Tannin Stain Resistance	10.3.6.1	D6686	
Coating Analysis			
Chemical analysis	11.1	D215	
Volatile content	11.2	D2369	
Volatile organic content	11.3	D3960	
Water content	11.4	D3792, D4017	
Pigment content	11.5	D3723	
Pigment analysis	11.6	D215	7261
Nonvolatile vehicle identification	11.7	D3168	

[A] Equivalent only to Method B of Test Method D522.
[B] Except for scrub medium.

Clear and Pigmented Organic Finishes
D1475 Test Method For Density of Liquid Coatings, Inks, and Related Products
D1554 Terminology Relating to Wood-Base Fiber and Particle Panel Materials
D1640 Test Methods for Drying, Curing, or Film Formation of Organic Coatings
D1729 Practice for Visual Appraisal of Colors and Color Differences of Diffusely-Illuminated Opaque Materials
D1849 Test Method for Package Stability of Paint
D2064 Test Method for Print Resistance of Architectural Paints
D2196 Test Methods for Rheological Properties of Non-Newtonian Materials by Rotational Viscometer
D2197 Test Method for Adhesion of Organic Coatings by Scrape Adhesion
D2243 Test Method for Freeze-Thaw Resistance of Water-Borne Coatings
D2244 Practice for Calculation of Color Tolerances and Color Differences from Instrumentally Measured Color Coordinates
D2369 Test Method for Volatile Content of Coatings
D2370 Test Method for Tensile Properties of Organic Coatings
D2486 Test Methods for Scrub Resistance of Wall Paints
D2574 Test Method for Resistance of Emulsion Paints in the Container to Attack by Microorganisms
D2805 Test Method for Hiding Power of Paints by Reflectometry
D3168 Practice for Qualitative Identification of Polymers in Emulsion Paints
D3258 Test Method for Porosity of White or Near White Paint Films by Staining
D3273 Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber
D3359 Test Methods for Measuring Adhesion by Tape Test
D3450 Test Method for Washability Properties of Interior Architectural Coatings
D3456 Practice for Determining by Exterior Exposure Tests the Susceptibility of Paint Films to Microbiological Attack
D3719 Test Method for Quantifying Dirt Collection on Coated Exterior Panels (Withdrawn 2009)[4]
D3723 Test Method for Pigment Content of Water-Emulsion Paints by Low-Temperature Ashing
D3730 Guide for Testing High-Performance Interior Architectural Wall Coatings
D3792 Test Method for Water Content of Coatings by Direct Injection Into a Gas Chromatograph
D3793 Test Method for Low-Temperature Coalescence of Latex Paint Films by Porosity Measurement (Withdrawn 2012)[4]
D3925 Practice for Sampling Liquid Paints and Related Pigmented Coatings
D3928 Test Method for Evaluation of Gloss or Sheen Uniformity
D3960 Practice for Determining Volatile Organic Compound (VOC) Content of Paints and Related Coatings
D4017 Test Method for Water in Paints and Paint Materials by Karl Fischer Method
D4060 Test Method for Abrasion Resistance of Organic Coatings by the Taber Abraser
D4062 Test Method for Leveling of Paints by Draw-Down Method
D4213 Test Method for Scrub Resistance of Paints by Abrasion Weight Loss
D4214 Test Methods for Evaluating the Degree of Chalking of Exterior Paint Films
D4287 Test Method for High-Shear Viscosity Using a Cone/Plate Viscometer
D4400 Test Method for Sag Resistance of Paints Using a Multinotch Applicator
D4585 Practice for Testing Water Resistance of Coatings Using Controlled Condensation
D4707 Test Method for Measuring Paint Spatter Resistance During Roller Application
D4828 Test Methods for Practical Washability of Organic Coatings
D4946 Test Method for Blocking Resistance of Architectural Paints
D4958 Test Method for Comparison of the Brush Drag of Latex Paints
D5007 Test Method for Wet-to-Dry Hiding Change
D5068 Practice for Preparation of Paint Brushes for Evaluation
D5069 Practice for Preparation of Paint-Roller Covers for

TABLE 2 Alphabetical List of Properties

Property (or related test)	Section	ASTM Standard	Federal Test Method Standard 141D
Abrasion Resistance	10.1.1	D968, D4060, D6037	6192
Adhesion	10.1.2	D2197, D3359	
Adhesion to chalky surfaces	10.3.1		6301
Analysis, chemical	11.1	D215	
Application properties	8.1		
Blister resistance	10.3.4	D4585	
Block resistance	10.2.1	D4946	
Brush application	8.1.1	D5068	
Brush drag	8.1.1.1	D4958	
Burnish Resistance	9.5	D6736	
Chalking	10.3.5.2	D4214	
Checking	10.3.5.3	D660	
Cleansability	10.2.4.2	D3450, D4828	6141[A]
Coarse particles and foreign matter	7.2	D185	
Colorant acceptance	7.6	D5326	
Color appearance	9.1.1		
Color differences by visual comparison	9.1.2	D1729	
Color differences using instrumental measurements	9.1.3	D2244	
Condition in container	7.1		3011
Consistency (Low-shear viscosity)	8.4.1	D562	
Cracking	10.3.5.4	D661	
Density or weight per gal	7.3	D1475	
Dirt pick-up	10.3.2	D3719	
Drying properties	8.5	D1640, D5895	
Efflorescence from the film	10.1.6		
Efflorescence from the film substrate	10.1.7	D7072	
Erosion	10.3.5.5	D662	
Exposure resistance	10.3.5	D1006, D1014	
Fade resistance	10.3.5.8	D2244	
Film porosity	10.2.3	D3258, D6583	
Fineness of dispersion	7.4	D1210	
Flaking	10.3.5.6	D772	
Flexibility	10.1.4	D522, D2370	6221[B]
Freeze-thaw stability	7.8.2	D2243	
Fume resistance	10.3.3		
Gloss	9.3		
Gloss, 60°	9.3.1	D523	
Heat stability	7.8.1	D1849	
Hiding power	9.4	D344, D2805, D5150	
Ink Stainblocking	10.2.5	D7514	
Levelling properties	8.4.4	D4062	
Low-temperature coalescence	8.3	D3793, D7306	
Microorganism resistance	7.8.4	D2574, D3273	
Nonvolatile vehicle identification	11.7	D3168	
Odor	7.5	D1296	4401
Package Stability	7.8		
pH	7.7	E70	
Pigment analysis	11.6	D215	7261
Pigment content	11.5	D3723	
Reflectance, directional	9.2	E1347	
Resistance to household chemicals	10.1.5	D1308	
Rheological properties of non-Newtonian materials	8.4.2	D2196, D4287	
Roller application	8.1.2	D5069	
Roller spatter	8.1.2.1	D4707	
Sag resistance	8.4.3	D4400	4494
Sampling	6.2	D3925	1022
Settling	7.8.3	D869	
Sheen (85° gloss)	9.3.2	D523	
Spray application	8.1.3		2131
Stain resistance	10.3.6		
Surfactant Staining	10.1.8	D7190	
Tannin Stain Resistance	10.3.6.1	D6686	
Touch-up uniformity	8.2	D3928, D7489	
Volatile content	11.2	D2369	
Volatile organic content (VOC)	11.3	D3960	
Washability	10.2.4.1	D2486, D4213	
Water content	11.4	D3792, D4017	
Wet adhesion	10.1.3		6301
Wet-to-Dry Hiding Change	8.5.1	D5007	

[A] Except for scrub medium.
[B] Equivalent only to Method B of Test Methods D522.

Evaluation of Architectural Coatings
D5150 Test Method for Hiding Power of Architectural Paints Applied by Roller
D5179 Test Method for Measuring Adhesion of Organic Coatings to Plastic Substrates by Direct Tensile Testing
D5326 Test Method for Color Development in Tinted Latex Paints
D5895 Test Methods for Evaluating Drying or Curing During Film Formation of Organic Coatings Using Mechanical Recorders
D6037 Test Methods for Dry Abrasion Mar Resistance of High Gloss Coatings
D6583 Test Method for Porosity of Paint Film by Mineral Oil Absorption
D6686 Test Method for Evaluation of Tannin Stain Resistance of Coatings
D6736 Test Method for Burnish Resistance of Latex Paints
D6900 Test Method for Wet Adhesion of Latex Paints to a Gloss Alkyd Enamel Substrate
D7072 Practice for Evaluating Accelerated Efflorescence of Latex Coatings
D7190 Practice to Evaluate Leaching of Water-Soluble Materials from Latex Paint Films
D7306 Practice for Testing Low Temperature Film-Formation of Latex Paints by Visual Observation
D7489 Practice for Evaluating Touch-Up Properties of Architectural Coatings under Various Environmental Conditions
D7514 Test Method for Evaluating Ink Stainblocking of Architectural Paint Systems by Visual Assessment
E70 Test Method for pH of Aqueous Solutions With the Glass Electrode
E105 Practice for Probability Sampling of Materials
E1347 Test Method for Color and Color-Difference Measurement by Tristimulus Colorimetry

2.2 *U.S. Federal Test Method Standard No. 141D:*[5]
2131 Application of Sprayed Films
3011 Condition in Container
4541 Working Properties and Appearance of Dried Film
6301 Wet Adhesion (Tape Test)

3. Terminology

3.1 For definitions of terms in this guide refer to Terminology D16 and D1554.

4. Conditions Affecting Water-Reducible Coatings

4.1 *Interior and Exterior Coatings:*

4.1.1 *Substrate Type*—The substrate to be painted can affect not only the application properties of a coating, such as gloss and uniformity, but is also a factor in determining the type of coating to use. For instance, a primer-sealer may be required for porous substrates, such as new drywall, bare plaster, new wood or porous masonry. Other factors are the type and quality of metal, wood or wood composite (plywood, particle board or hardboard), the type, quality and alkalinity of concrete, plaster and joint cement systems, and the type and condition of any previous coatings.

4.1.2 *Substrate Conditions*—Conditions such as porosity and hardness determine the kind of coating that can be applied. The condition of previously painted substrates, such as degree of chalk, presence of grease, dirt, mold, and water-soluble or oily contaminants, film adhesion and porosity, all influence the performance of coatings. Smoothness of the substrate affects the spreading rate, final appearance, and texture.

4.1.3 Preparation of previously painted substrates, including cleaning, solvent cleaning, and sanding.

4.1.4 Type and quality of primer or undercoat and time of drying before topcoating.

4.1.5 The application properties, even of interior water-reducible coatings, are affected by temperature and humidity at the time of application and during drying. As these materials contain water, surfaces do not have to be completely dry before application. However, low temperature during drying may cause poor film formation.

4.2 *Exterior Finishes:*

4.2.1 *Substrate Weathering*—Weathering of wood before painting will probably adversely affect the performance of exterior coatings. Some weathering of masonry surfaces may have beneficial effects on the performance.

4.2.2 *Substrate Aspects of the Building*—If construction defects or defects due to age are such that excessive moisture from the inside or the outside makes its way through the substrate or if the substrate is in direct contact with damp ground, blistering, flaking or peeling may result.

4.2.3 Environmental conditions after application, both general for the area and specific, such as under eaves, behind shrubbery, northside and southside exposure.

5. Selection of Tests

5.1 Because the conditions to which a coating is subjected vary with (*a*) the surface type: wall, floor, ceiling, and (*b*) the service environment: exterior or interior, specialized types of water-borne coatings have been developed for the different locations. The recommended test methods presented in Table 1 and Table 2 cover practically all of the properties of water-reducible coatings but all of them are not required with each type. Coatings intended for exterior use only or both exterior and interior use require certain properties not relevant to those for interior use only. Selection of the 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.

5.2 The purchaser should first determine the properties a coating should have and then select only those test methods that measure or evaluate those properties. After selecting the desired tests, the purchaser should then decide which properties are the most important and establish the requirements or specifications accordingly. Since coating properties frequently tend to oppose each other, such as low sheen versus good cleansability, some properties may need to be less emphasized if others are to be accentuated. This balance of properties must be considered when selecting the tests and establishing the

[5] Available from U.S. Government Printing Office Superintendent of Documents, 732 N. Capitol St., NW, Mail Stop: SDE, Washington, DC 20401, http://www.access.gpo.gov.

requirements. The significance of the tests and the normal range of values are presented in the different sections, in most cases.

5.3 This guide does not indicate relative importance of the various tests nor does it recommend specific test values because properties very important to one purchaser may be less so to another.

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 on the coating.

6.2 Sample in accordance with Practice D3925. Determine the density in pounds per kilograms/litre (gallon) in accordance with Test Method D1475. Continue sampling and determining density until successive results agree within 45 g (0.1lb) or as agreed upon between the purchaser and seller. Then take samples for testing.

6.3 Specify the amount required for a representative sample, the package sizes, and an identification code. A or 4-L (1-U.S. gal) sample is usually sufficient for the recommended tests, but for guidance in selecting a sampling plan consult Practice E105.

7. Liquid Coating Properties

7.1 *Condition in Container*—Thickening, pigment settling, and liquid separation are undesirable and objectionable if material that has been stored cannot be readily reconditioned and made suitable for application with a reasonable amount of stirring. The referenced method covers procedures for determining changes in properties after storage and lists characteristics that are undesirable and objectionable in a stored paint. Determine condition in the container in accordance with Method 3011 of Federal Test Method Standard No.141D. (See also 7.8 Package Stability.)

7.2 *Coarse Particles and Foreign Matter*—Liquid coatings must be free of coarse particles and foreign matter to be able to form uniform films of good appearance, a typical maximum being 0.5 weight % of the total material. The referenced method with a 325-mesh (45-µm) screen gives the percent of these particles. Determine content of coarse particles and foreign matter in accordance with Test Method D185.

7.2.1 Another test method used in industry to determine whether coarse particles are present in the dry film of a low-gloss finish 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 or Weight per Gallon*—The density measured in pounds per kilograms per litre = g/ml (gallon) is used to ensure product uniformity from batch to batch, provides a check against the theoretical weight calculated from the formula, and is useful for determining the similarity of two samples. The referenced method gives a procedure for measuring the density of the coating at a specified temperature. Most paints have densities of about 1.2 to 1.4 kg/L (10 to 12 lb/gal). Determine density in accordance with Test Method D1475, using a calibrated weight per gallon cup.

7.4 *Fineness of Dispersion*—Generally, the more finely a pigment is dispersed the more efficiently it is being utilized. One method for measuring the degree of dispersion (commonly referred to as "fineness of grind") is to draw the liquid coating down a calibrated tapered groove varying in depth from 100 to 0 µm (0 to 8 Hegman units) (4 to 0 mils) . The depth at which continuous groupings of particles or agglomerates, or both, protrude through the surface of the wet film is taken as the fineness of dispersion value. Higher readings in Hegman units or lower readings in mils or micrometres indicate finer dispersion. Most interior semigloss and gloss latex coatings have a fineness of about 5 to 7.5 Hegman or 40 to 7 µm (1.5 to 0.3 mils) while lower gloss finishes do not generally require a dispersion finer than 2 to 3 Hegman (3 to 2.5 mils). Some interior flat latex paints have finenesses as low as 1 Hegman or 90 µm (3.5 mils). Determine fineness of dispersion in accordance with Test Method D1210.

7.4.1 The referenced method was designed primarily for coatings with good fineness of dispersion, such as high gloss finishes. Some interior flat paints contain pigments so coarse that it is impractical to measure the fineness with a grindgage because the agglomerates are carried along by the scraper.

NOTE 3—The fast drying of latex paints makes it difficult to make measurements of this type.

7.5 *Odor*—One of the advantages of latex paints is that they contain little if any organic solvent. Thus interior latex paints do not have odors characteristic of solvent-borne coatings. However, other ingredients, such as ammonia, may be used that might also be objectionable in confined spaces. Hence, interior latex paints should be tested for odor acceptability. Although there is no specific ASTM test method for evaluating odor of water-borne coatings, the industry does attempt to measure this property. Determine whether the paint has an unpleasant or irritating odor as agreed upon between the purchaser and seller, taking adequate precautions to ensure the safety of the operator. Test Method D1296 may be suitable as the basis for a test.

7.6 *Colorant Acceptance*—Tintability of white bases with colorants of standardized tinting strength is a trade requirement. If tinting colors are not adequately compatible with tint bases, lighter, darker, or nonuniform shades of colors are produced. Determination of color development of a tinted paint may be accomplished by following Test Method D5326.

7.7 *pH*—Latex paints with low (acidic) pH may corrode metal containers. To avoid this problem, the pH is normally stabilized within the range from about 5 to 10, depending upon the type of latex used and the general formulation. The pH does not determine the quality of a latex paint and should be used only to ensure product uniformity. However, a change in pH during storage may indicate poor stability and an unacceptable change in the properties of a latex paint. Determine pH in accordance with Test Method E70.

7.8 *Package Stability*—Since paints are normally not used immediately after manufacture, they must remain stable in the can for some time. At normal temperatures most water-borne coatings can be stored for over a year with little change in properties. However, exposure in uninsulated warehouses or during shipping to high temperatures in the summer or to low temperatures in the winter may cause unacceptable changes in these products. Other unsatisfactory conditions that may occur during storage are excessive settling and microbiological attack.

7.8.1 *Heat Stability*—Exposure in service to high temperatures can be used to test for the stability of a packaged coating that frequently encounters such conditions in service, or as an accelerated test to predict stability when stored at temperatures above freezing. Although indications of long term package stability can usually be obtained in several days or weeks at an elevated temperature, such as 50°C (125°F) or 60°C (140°F), occasionally the results of the accelerated test do not agree with those at prolonged normal storage conditions. In the referenced method the changes in consistency and certain other properties of the accelerated aged material are compared to those occurring in a control kept at normal temperatures for a longer period. When testing for heat stability, as such, changes in viscosity, flow, gloss, pH, foam resistance, color uniformity, and wet adhesion are usually checked. Determine heat stability in accordance with Test Method D1849.

7.8.2 *Freeze-Thaw Stability*—Water-borne coatings may be subjected to freezing conditions during shipping and storage. Suitably stabilized products can resist several cycles of freezing and thawing without showing deleterious changes such as coagulation, graininess (seeding), or excessive viscosity increase. Many latex paints that increase in viscosity can still be considered usable, if other properties that may be affected by a higher viscosity, such as levelling and brushability, are satisfactory. Determine freeze-thaw stability in accordance with Test Method D2243.

7.8.3 *Settling*—Modern coatings are generally resistant to hard settling, but do at times show separation and soft settling. The referenced method covers the degree of pigment suspension in and ease of remixing of a shelf-aged specimen to a homogeneous condition suitable for the intended use. Determine settling in accordance with Test Method D869.

7.8.4 *Microorganism Resistance*—Microorganisms in a water-borne coating 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 D2574. Determine the resistance to mold growth on the surface of interior coatings in accordance with Test Method D3273.

8. Coating Application and Film Formation

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

8.1.1 *Brush Application*—Brushed films should be smooth and free of seeds and on vertical surfaces should show no sagging, color streaking, nor excessive brush marks. Brush drag should not be excessive although some degree of drag may be desirable for adequate film thickness application. Wall finishes are tested on vertical surfaces and floor coatings on horizontal surfaces, although evaluation of the latter on vertical surfaces may be necessary to determine performance on stair risers, railings, posts, etc. The referenced method covers a means for the determination of the brushing properties of a coating. Even though the test is subjective, someone experienced in the art can produce quite consistent results. Determine brushing properties in accordance with Practice D5068.

8.1.1.1 *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 D4287 (see 8.4.2), 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 D4958.

8.1.2 *Roller Application*—Both wall and floor coatings are frequently applied by roller. This type of application tends to produce some stipple pattern. The referenced method covers the evaluation of a material's characteristics when applied by roller. Since foaming often occurs when water-borne coatings are roller applied, the amount of foam produced, and the number of craters that remain after the bubbles have broken should be determined during the test. Determine roller coating properties in accordance with Practice D5069.

8.1.2.1 Some coatings spatter more than others when applied by roller. The degree to which a paint spatters when roller applied can be determined by the density of the spatter. In the referenced method a specially designed notched spool is rolled through a film of the test material that has been applied to a plastic panel. Any spatter generated falls upon a catch paper and after drying is rated against photographic standards. This procedure eliminates the influence of the roller cover, thus determining the spattering characteristics of the paint alone. Determine spatter resistance in accordance with Test Method D4707.

8.1.3 *Spray Application*—Architectural coatings are sometimes applied by spray. Both air and airless spray are used on commercial work. Determine spray application properties in accordance with Method 2131 of Federal Test Method Standard No. 141D. Manual application is very subjective and should be performed only by an individual skilled in the art of using spray equipment.

8.2 *Touch-Up Uniformity*—Coatings applied to large, flat surfaces may exhibit localized areas of noticeably different appearance due to variation in film thickness, different methods of application, or localized damage in service. With a coating of suitable touch-up properties, additional material of the same batch or lot can be applied only to these localized areas to provide uniformity of color, gloss, and levelling over the entire surface. Determine touch-up properties in accordance with Test

Method D3928. Variations in drying conditions effect architectural coatings in field application and are also known to impact touch-up uniformity. Determining touch-up uniformity under a variety of laboratory-controlled temperature and humidity scenarios may be accomplished by following Practice D7489.

8.3 *Low-Temperature Coalescence*—If a latex paint is applied at too low a temperature it will not form a coherent film. The referenced test method determines how well the latex particles fuse together or coalesce to form a continuous film at low temperatures. Determine low-temperature coalescence of a series of coatings or reformulations in accordance with Test Method D3793. If staining media is not available or staining of films is not possible due to testing restrictions, a visual method of determining the coalescent level is covered in Practice D7306.

NOTE 4—Because of the poor reproducibility of this method with numerical values, Test Method D3793 cannot be used to compare such results from different laboratories. Interlaboratory agreement is improved significantly when rankings are used.

8.4 *Rheological Properties:*

8.4.1 *Consistency (Low-Shear Viscosity)*—Consistency is important, relating to application and flow, and should fall within a stated range for satisfactory reproduction of a specific formula. While consistency is an important property it does not determine the quality of a coating and should be used mainly to ensure product uniformity. In the referenced method, consistency is defined as the load in grams to produce a specified rate of shear. The load value is frequently converted to Krebs Units (KU) and the Stormer consistency reported on that basis. Although the consistency of most latex paints is about 150 to 300 g/100 revolutions, a much wider range is possible because of the great variation that may occur in the rheological properties of these paints. Two paints of the same consistency may have quite different rheological properties during application. Determine consistency in accordance with Test Method D562.

8.4.2 *Rheological Properties of Non-Newtonian Materials*—Rheological properties are related to application and flow characteristics of the liquid coating. The referenced methods cover the determination of rheological properties and are particularly suited for coatings that display thixotropic characteristics. However, they measure viscosity under different shear rates. In Test Method D4287 there is only one rate but it is similar to that occurring during brush application so that the measured viscosity is related to brush drag, spreading rate and film build. Test Method D2196 includes procedures for measuring viscosity at several shear rates to determine the amount of shear thinning and the viscosity change at low shear rates. The results can be used to evaluate sag resistance and levelling ability. Determine rheological properties in accordance with Test Methods D2196 or D4287 or both.

8.4.3 *Sag Resistance*—Some coatings sag and form curtains before the film sets. Resistance to this type of flow is an important property particularly for semigloss and gloss finishes because of the unsightly film appearance. Determine sag resistance in accordance with Test Method D4400.

8.4.4 *Levelling Properties*—Levelling is an important property when smooth, uniform surfaces are to be produced, because it affects hiding and appearance. Brush marks and imperfections are much more conspicuous in semigloss and gloss finishes than they are in low gloss materials. In the referenced method a series of ridges is produced using a levelling rod and after drying they are compared to levelness standards. Determine levelling in accordance with Test Method D4062.

8.5 *Drying Properties*—The drying time of a coating is important in determining when a freshly painted room, floor or stair can be put back in use. Slow drying may result in dirt or insect pickup causing a poor appearance or, if on an exterior surface, rain or dew may cause a nonuniform appearance. The drying time of a coating is determined by its composition and by atmospheric conditions during drying. Most latex paints dry to touch in 1 to 2 h when the water has evaporated from the film. Low gloss finishes can usually be recoated from within a few hours to 18 h. Because of the glycols present in semigloss and gloss latex coatings it is prudent not to recoat before at least 18 h drying. 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 upon the composition. Any one of the several methods for determining the various stages of film formation in the drying or curing of organic coatings may be used. For example, if two coats are specified the determination of "dry-to-recoat" time is important. Determine appropriate drying time(s) in accordance with Test Methods D1640 or D5895.

8.5.1 *Wet-to-Dry Hiding Change*—Some highly pigmented coatings will have a tendency to have better hiding properties once they have dried than when they are still in the wet state. Usually the greater this difference, the lower the quality of paint. Determine the visual difference between wet and dry hide of white or off-white paints using Test Method D5007.

9. Appearance of Dry Film

9.1 *Color Difference:*

9.1.1 The appearance of color is greatly influenced by several factors. A color next to a yellow wall looks different than the same color next to a blue wall. The visual appearance of a colored object illuminated by incandescent light, fluorescent light, and natural light differs because the spectral composition of the incident lights vary. Gloss also affects color appearance. Low and high gloss coatings frequently look different in color, even though instrumentally their colors may be identical.

9.1.2 *Color Differences by Visual Comparison*—Visual comparison of colors 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 relative to their standards. Determine color difference in accordance with Practice D1729.

9.1.3 *Color Differences Using Instrumental Measurements*—The difference in color between a product and its standard can be measured by instrument. Generally the tolerance is agreed upon by the purchaser and seller and may also be required if a product specification is involved. Color measuring instruments provide numerical values that can be compared to subsequent measurements. The referenced method covers the calculation of instrumental determinations 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. Calculate in accordance with Practice D2244 the color differences that have been measured instrumentally.

9.2 *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 range being 76 to 92 % for white finishes. In the referenced method the directions of illumination and viewing are specified so as to eliminate the effect of gloss. Determine daylight directional reflectance in accordance with Test Method E1347.

9.3 *Gloss*—This property is a measure of the capability of a coating surface to reflect light in a mirror-like (specular) manner, that is, light strikes the surface and is reflected at the equal but opposite angle. In the referenced method the numerical gloss units are the ratio of light reflected by a specimen to that reflected by the primary black glass that is assigned a gloss value of 100. The gloss of some coatings varies greatly with the angle of incidence so that a complete description of their gloss would require measurements over a wide range of angle. In practice, the gloss of architectural finishes is adequately characterized by measurements at 60° or 85°, or both, from a line perpendicular (normal) to the surface. The 85° angle is a very low "grazing" angle (5°) of illuminating and viewing the surface and the gloss at this angle is called" sheen". Attempts to standardize the levels of gloss associated with the several descriptive terms have not been very successful since the gloss scale is continuous with no distinct boundaries. Hence, there is some overlap at the ends of some classifications in common usage.

9.3.1 *Gloss, 60°*—Semigloss finishes are particularly sensitive to poor enamel hold-out of primers and undercoats. Low or uneven gloss readings are indicative of this defect. Low gloss finishes range from 0 to 20 while exterior latex house paints may vary from 5 to 60. A range from 20 to 40 is typical of water-borne floor finishes after drying for a few days. Interior semiglosses vary from 35 to 70 but measurements taken shortly after drying should be repeated after one week because the gloss can drop considerably in the first few days of drying. Determine the 60° gloss in accordance with Test Method D523.

9.3.2 *Sheen (85° Gloss)*—Although low-gloss paints with good uniformity of appearance at low angles of viewing often have little sheen while those with good cleansability usually have moderate sheen, this is not always the case so that sheen should not be used as a measure of other paint properties. The referenced method, using the 85° geometry, is useful in characterizing the low-angle appearance of low-gloss coatings. Nominally flat wall paints have a sheen of 1 to 10 whereas velvets or eggshells range from 15 to 35. Determine the sheen (85° gloss) in accordance with Test Method D523.

9.4 *Hiding Power*—Hiding power is a measure of the ability of a coating to obscure the substrate, and is usually expressed as the spreading rate for a specified level of opacity. It is, however, dependent on uniformity of film thickness, which in practical applications is influenced by the flow, levelling and application properties of the coating. Test Method D2805 is precise, and gives an absolute rather than a comparative result. Paint is applied with an applicator bar to minimize the effects of flow and levelling, film thickness is rigorously measured, and film opacity is determined instrumentally. Test Methods D344 is a practical test in which paint is applied with a brush, wet-film thickness is approximately controlled by spreading rate, and hiding power is evaluated visually by comparison with a standard paint, but results are affected by flow and levelling of the materials. Test Method D5150 is a practical test in which paint is applied with a roller, wet-film thickness is approximately controlled by spreading rate, and hiding power is evaluated visually by comparison with a standard paint, but results are affected by flow and leveling of the materials and drying rate of the paint. Determine hiding power in accordance with Test Methods D344, D2805, or D5150.

9.5 *Burnish Resistance*—Interior flat paints may become burnished in areas where clothing or upholstered furniture rub against a wall. This rubbing may cause a smoother, glossier surface at the contacted area, depending on the level or type of pigments in the paint and binder hardness. Determine the burnish resistance of a paint by the use of Test Method D6736.

10. Properties of the Dry Film

10.1 *Interior and Exterior Coatings:*

10.1.1 *Abrasion Resistance*—Abrasion resistance is a measure of the ability of a dried film to withstand wear from foot traffic and marring from objects rolled or pulled across the surface. In the referenced methods, dry abrasive is applied to a coated panel using the force of gravity or a jet blast for free-flowing abrasive or a weighted wheel for abrasive embedded in a resilient rubber matrix. Determine dry abrasion resistance in accordance with Test Methods D968, D4060, or D6037. (See 10.2.4.1 for wet abrasion resistance.)

NOTE 5—Because of the poor reproducibility of abrasion test methods, testing should be restricted to only one laboratory when numerical abrasion resistance values are to be used. Interlaboratory agreement is improved significantly when rankings are used in place of numerical values.

10.1.2 *Adhesion*—Adhesion, the ability of a film to resist removal from the substrate, is an important property of a coating. Determine adhesion in accordance with Test Method D2197, D3359, or D5179.

10.1.3 *Wet Adhesion*—It is essential that a finish adhere tightly to a given substrate or primer under the wet conditions of washing or scrubbing. There is no adequate test method published by ASTM. Determine the wet adhesion of exterior latex paints in accordance with Method 6301 of Federal Test Method Standard No. 141D.

10.1.4 *Flexibility*—Elongation is a measure of the flexibility of a coating film. Most semigloss and full gloss water-borne coatings can be bent over a 3.2-mm (1⁄8-in.) mandrel without affecting the film. However, interior flat and eggshell finishes usually pass at 6.4-mm (1⁄4-in.). For exterior coatings Test

Method D2370 is a much more discriminating method.[6] Determine flexibility in accordance with Test Methods D522 or elongation with Test Method D2370.

10.1.5 *Resistance to Household Chemicals*—An important property of some finishes is their ability to resist spotting, softening or removal when subjected to household chemicals or strong cleaners. Determine resistance to these chemicals in accordance with Test Method D1308.

10.1.6 *Efflorescence from the Film*—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. However, because of the improvements in latex and latex paint formulations few interior latex paints effloresce.

10.1.7 *Efflorescence from the Substrate*—Cementitious substances may contain sufficient solid water-soluble materials to cause a surface deposit through leaching and evaporation. Determine efflorescence resistance by use of Practice D7072.

10.1.8 *Surfactanct Stain Resistance*—Surfactant staining is a common problem with exterior house paints, particularly when subjected to humid environments (such as morning dew) shortly after application. Interior paints used in humid areas such as kitchens and bathrooms may also experience surfactant staining. Leaching of water-soluble materials may be dependent on colorant dispersions that are mixed into tint base paints. Other paint components may also affect the leaching of water-soluble materials. Determine surfactant staining by use of Practice D7190.

10.2 *Interior Finishes:*

10.2.1 *Block Resistance*—This property is important for interior semigloss and gloss finishes since it governs the resistance of surfaces of dried coatings to sticking together when stacked or placed in contact with each other. An interior finish often comes in contact with itself, especially on doors, windows and drawers where it sometimes sticks to itself (blocks) depending on the hardness of the coating, the pressure, temperature, humidity, and time that the surfaces are in contact. The referenced method covers an accelerated blocking resistance procedure developed especially for architectural coatings. Determine blocking resistance in accordance with Test Method D4946.

10.2.2 *Print Resistance*—The ability of a coating to resist printing is important because its appearance is adversely affected if the surface texture is modified by contact with another surface, particularly one with a pattern. Interior gloss and semigloss systems on window sills and other horizontal surfaces often have flower pots placed on them that may tend to leave a permanent impression from the pressure. This tendency for a paint film to "print" is often a function of the hardness of the coating, the pressure, temperature, humidity, and time that the two surfaces are in contact. Test for print resistance in accordance with Test Method D2064.

10.2.3 *Film Porosity*—The more porous a paint film is, the worse its cleansability and enamel holdout. In the referenced method a special, colored penetrating medium is applied to the coating and the change in reflectance indicates the degree of porosity. Determine film porosity in accordance with Test Methods D3258 or D6583.

10.2.4 *Washability and Cleansability*—The capability of satisfactorily removing marks without damaging the film is essential for good performance of interior finishes. A coating may be washable, that is, unaffected by the detergent solution, but may not have good cleansability. Frequently the difference between the two terms, "cleansability" and "washability" is not clearly understood so that there is confusion as to what is really being tested; for example, the title of Test Method D3450. Cleansability is evaluated by applying one or more stains and soils and determining how readily they are removed. Washability is evaluated by determining the resistance of the film to wet erosion either by visual assessment or measured film loss. In general, the precision of both types of test is poor because several properties, such as hardness, water and detergent resistance, cohesion and adhesion, are involved and the endpoint, except for the wet abrasion method, is rather indefinite.

10.2.4.1 *Washability (Also referred to as Scrubbing or Wet Abrasion Resistance)*—The scrubbing method, Test Methods D2486, developed for interior latex flat wall paints can be applied to coatings of almost any type. In it the coating is applied to a black plastic panel that, during scrubbing with a nylon brush and abrasive cleaning agent, is raised by a narrow shim to concentrate the test area. The number of back-and-forth strokes (cycles) required to remove the film over the shim is determined. Interior latex flat paints can vary in scrub resistance from less than 100 to more than 1000 cycles. The wet-abrasion method, Test Method D4213, is similar except that a sponge is used in place of the bristle brush while the shim is not used. This method also provides for the use of a nonabrasive medium with paints having very low abrasion resistance. The weight or volume loss per 100 cycles to erode the film almost to exposure of the black substrate is the measure of scrub resistance. Evaluate washability, as just described, in accordance with Test Methods D2486 or D4213.

10.2.4.2 *Cleansability*—The older referenced method, Test Method D3450, is similar to the wet-abrasion method, Test Method D4213, except that the sponge is used with either the nonabrasive or abrasive cleaning agent to remove a carbon black-oil stain. The ability to remove the stain is expressed as the ratio (in percent relative) of the reflectance of the cleaned area to that of the area before application of the stain. In Test Methods D4828, referred to as a "practical" test, numerous staining and soiling agents found in service and commercial abrasive or nonabrasive cleaners as well as the standardized cleaning agents can be used. In the revised edition the films may be cleansed manually or mechanically, but only the latter is suitable for interlaboratory testing. Evaluate ease of removability in accordance with Test Methods D3450 or D4828.

10.2.5 *Ink Stainblocking*—Many architectural coatings systems are designed to have functionality to both cover stains found on interior household surfaces and block them from penetrating to the surface of subsequent topcoats. This is especially true for architectural primer coatings. Determine the

[6] Ashton, H. E., "Flexibility and its Retention in Clear Coatings Exposed to Weathering," *Journal of Coatings Technology*, Vol 51, No. 653, June 1979, p. 41.

ability of a coating system to block stains from a variety of inks or other household staining materials in accordance with Test Method D7514.

10.3 *Exterior Coatings:*

10.3.1 *Adhesion to Chalky Surfaces*—Latex paints generally have little ability to penetrate powder substrates. Consequently, adhesion to previous coatings that have chalked is poor unless the latex paint has been modified to penetrate and bind the chalk layer to the old coating. However, certain latices do exist that are designed to adhere well to chalky surfaces so do not require modification. There are no directly applicable ASTM or Federal Test Method Standard No. 141 test methods for adhesion to chalky surfaces, although work is still going on. The industry generally uses a pressure-sensitive tape to test for 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 Standard 141D describes a similar method but includes water exposure.

10.3.2 *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 (soffit), should indicate in a relatively short time (about 1 year) a paint's tendency to this defect. Determine degree of dirt collection in accordance with Test Method D3719.

10.3.3 *Fume Resistance*—Some paints exhibit a change in appearance (usually color) when subjected to air containing certain sulfur compounds, notably hydrogen sulfide and sulfur dioxide. This type of atmosphere may be present near industrial or other polluted areas and can cause a paint to yellow or darken in as little time as overnight. There are no ASTM or Federal test methods for evaluating this color change, but one procedure used by the industry is as follows:

10.3.3.1 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 in a moist atmosphere of hydrogen sulfide for 18 h. Compare the color with the unexposed plate. 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 similarly treated.

10.3.4 *Blister Resistance*—Blister resistance is the ability of a dry film on wood to resist the formation of blisters caused by water from the wood substrate. In practice water can come from either the interior of a home or from the structural defects that permit entry of exterior water behind the wood. Moisture blister resistance can be qualitatively evaluated in a laboratory test. Determine resistance to moisture blistering in accordance with Practice D4585.

NOTE 6—Latex paints are frequently promoted on the basis of their ability to allow moisture to escape without causing blisters, so they should be tested for this property.

10.3.5 *Exposure Resistance*—If the coating is intended for exterior use, evaluation of the resistance to weathering may be required. In conducting exterior exposures follow Practice D1006 for wood substrates or Practice D1014 for steel.

10.3.5.1 In establishing exterior performance on wood, use the panels described in Specification D358 or as agreed upon between the purchaser and the seller.

10.3.5.2 *Degree of Chalking*—Determine the rating using Test Methods D4214.

10.3.5.3 *Degree of Checking*—Determine the rating using Test Method D660.

10.3.5.4 *Degree of Cracking*—Determine the rating using Test Method D661.

10.3.5.5 *Degree of Erosion*—Determine the rating using Test Method D662.

10.3.5.6 *Degree of Flaking*—Determine the rating using Test Method D772.

10.3.5.7 *Mildew Resistance*—Many exterior paints are subject to microbiological discoloration on the surface with time. This is especially true in warm, moist climates. Determine mildew resistance in accordance with Practice D3456.

10.3.5.8 *Fade Resistance*—Exterior latex paints usually have good color retention because of their good resistance to chalking. However, the use of improper latex, pigment volume concentration, or pigments can lead to fading. There are no ASTM nor Federal test methods specifically designed for evaluating fade resistance, but the change in color on exposure can be measured in accordance with Practice D2244 (see 9.2).

10.3.6 *Stain Resistance*—There is neither an ASTM nor a Federal test method available for evaluating general 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 rundown from metal surfaces of oxides that disfigure the surface. Different kinds of test methods are required for water-soluble and insoluble stains.

10.3.6.1 *Tannin Stain Resistance*—Architectural coatings that are applied directly to raw wood surfaces are often expected to have the ability to prevent tannins and extractives found within the wood from penetrating into a topcoat. This is especially important for painting wood boards that are more heavily concentrated in tannins, such as cedar or redwood, in humid environments. Determine the ability of a coating to resist tannin staining in accordance with Test Method D6686.

11. Coating Analysis

11.1 *Chemical Analysis*—If a specification requires certain raw materials or certain components in a given amount then analysis is needed to determine whether the specified components are present and in what amounts. Analysis is primarily a measure of uniformity and does not necessarily establish quality that can also be greatly affected by manufacturing techniques. No single schematic analysis is comprehensive enough to cover the wide variety of paint compositions. Most ASTM analytical methods apply to solvent-borne coatings. However, some of them can be adapted to analysis of the water-reducible type. Select test procedures from Practice D215 and ASTM methods that are pertinent to the components of water-borne coatings.

11.2 *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 the coating. It is useful, however, for determining the similarity of two batches. The referenced method covers the determination of the volatile content by weight of solvent- and water-reducible coatings. The quantity determined subtracted from 100 % gives the nonvolatile content of the coating. Determine the volatile content in accordance with Test Method D2369.

11.3 *Volatile Organic Compound (VOC) Content*—Several local jurisdictions have adopted air pollution controls that severely limit the amount of VOC permitted in architectural coatings, including interior latex gloss and semigloss paints. Since these paints may contain solvent such as coalescent and co-solvent wet-edge aids, it is essential that these products not exceed the established VOC limits. Determine VOC content in accordance with Practice D3960.

11.4 *Water Content*—The amount of water may be required in the calculation of the VOC of coatings. The referenced methods cover the determination of the total water content of water-borne coatings, one using gas-liquid chromatography and the other the Karl Fischer reaction. Determine water content in accordance with Test Methods D3792 or D4017.

11.5 *Pigment Content*—Pigment provides the hiding and color and influences many other properties of a coating. The referenced method describes the procedure for the low temperature ashing of water-borne coatings. Some of these coatings may contain ingredients that lose water of hydration or decompose at the test temperature. Consequently, caution must be exercised in applying the method to materials containing unknown pigment compositions. If difficulties or disagreements are encountered with this procedure, the pigment should be separated from the binder using a centrifuge. Determine the pigment content in accordance with Test Method D3723.

11.6 *Pigment Analysis*—The analysis of pigment may be required if the product is covered by a specification or upon agreement between the purchaser and seller. Analyze the pigment in accordance with selected test procedures from Practice D215 and appropriate ASTM methods.

11.7 *Identification of Nonvolatile Vehicle*—The type of binder used in a coating has a great influence on its properties. The referenced method covers the qualitative characterization or identification of the extracted vehicle by infrared spectroscopy and pyrolysis of the paint followed by gas-liquid chromatography. It is useful in detecting batch to batch uniformity and the presence of major adulterants. Identify the nonvolatile vehicle in accordance with Practice D3168.

12. Field Testing

12.1 Although many of the recommended test methods attempt to simulate conditions under which water-reducible coatings are applied and used, it is not possible to duplicate accurately all possible conditions. Testing materials under field conditions is recommended for the final evaluation of suitability.

13. Keywords

13.1 architectural coatings; coating tests; water-borne coatings