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

This standard is issued under the fixed designation D5324; 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 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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

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

2. Referenced Documents

2.1 *ASTM Standards:*[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 (Withdrawn 2018)[4]
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 Hand and Factory Applied Paints on Wood and Wood Composite Materials
D1014 Practice for Conducting Exterior Exposure Tests of Paints and Coatings on Metal Substrates

[1] This guide is under the jurisdiction of ASTM Committee D01 on Paint and Related Coatings, Materials, and Applications and is the direct responsibility of Subcommittee D01.42 on Architectural Coatings.

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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	
Enamel Holdout	9.6	D7786	
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		
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	

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	
Enamel Holdout	9.6	D7786	
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.

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 (Withdrawn 2021)[4]
D1308 Test Method for Effect of Household Chemicals on Clear and Pigmented Coating Systems
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 Rating 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 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 in the Laboratory by Direct Tensile Method
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
D7786 Test Method for Determining Enamel Holdout
E70 Test Method for pH of Aqueous Solutions With the Glass Electrode
E105 Guide 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 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.

[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.

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 kg⁄L to 1.4 kg/L (10 lb⁄gal 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 µm to 0 µm (0 Hegman units to 8 Hegman units) (4 mils 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 Hegman to 7.5 Hegman or 40 µm to 7 µm (1.5 mils to 0.3 mils) while lower gloss finishes do not generally require a dispersion finer than 2 Hegman to 3 Hegman (3 mils 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.