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Standard Guide to Testing Solvent-Borne Architectural Coatings¹

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1. Scope

1.1 This guide covers the selection and use of procedures for testing solvent-borne coatings to be used on exterior, interior or both types of surfaces (see 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, 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 Low-Gloss Wall Finish,
- (2) Type 2 Interior Gloss and Semigloss Wall and Trim Enamels,
- (3) Type 3 Exterior House and Trim Coatings, and
- (4) Type 4 Floor Enamel, Exterior and/or Interior.

1.2.1 Each is intended for application by brushing, rolling, spraying, or other means to the materials appropriate for its type, which may include wood, plaster, wallboard, masonry, 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:*²

D16 Terminology for Paint, Related Coatings, Materials, and Applications

D56 Test Method for Flash Point by Tag Closed Cup Tester

D93 Test Methods for Flash Point by Pensky-Martens Closed Cup Tester

D154 Guide for Testing Varnishes

D185 Test Methods for Coarse Particles in Pigments

D215 Practice for the Chemical Analysis of White Linseed Oil Paints

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

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

~~D658 Test Method for Abrasion Resistance of Organic Coatings by Air Blast Abrasive~~

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

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² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For Annual Book of ASTM Standards volume information, refer to the standard's Document Summary page on the ASTM website.

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 Paint Properties			
Skinning	7.1	D154	3021
Condition in container	7.2		3011
Coarse particles and foreign matter	7.3	D185	
Density or Weight per gallon	7.4	D1475	
Fineness of dispersion	7.5	D1210	
Flash point	7.6	D56, D93, D3278	
Odor	7.7	D1296	
Absorption	7.8		4421
Colorant acceptance	7.9		
Dilution stability	7.10		4203
Package stability	7.11		
Heat stability	7.11.1	D1849	
Settling	7.11.2	D869	
Coating Application and Film Formation			
Application properties	8.1		4541
Brush application	8.1.1	D5068	
Brush drag	8.1.1.1	D4958	
Roller application	8.1.2	D5069	
Roller spatter	8.1.2.1	D4707	
Spray application	8.1.3		2131
Touch-up uniformity	8.2	D3928	
Touch-up uniformity	8.2	D3928, D7489	
Rheological properties	8.3		
Consistency (Low-shear viscosity)	8.3.1	D562	
Rheological properties of non-Newtonian liquids	8.3.2	D2196, D4287	
Sag resistance	8.3.3	D4400	4494
Levelling properties	8.3.4	D4062	
Drying properties	8.4	D1640	4061
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	
Yellowness index	9.5	E313	6131
Properties of Dry Film			
Interior and Exterior Coatings	10.1		
Abrasion resistance	10.1.1	D968, D4060	6192
Adhesion	10.1.2	D2197, D3359, D5179	
Flexibility	10.1.4	D522, D2370	6221 ^A
Resistance to household chemicals	10.1.5	D1308	
Interior Coatings	10.2		
Color change of white enamels	10.2.1		6132
Ink Stainblocking	10.2.5	D7514	
Washability and cleansability	10.2.2		
Washability	10.2.2.1	D2486, D4213	
Cleansability	10.2.2.2	D3450, D4828	6141 ^B
Exterior Coatings	10.3		
Blister resistance	10.3.1	D4585	
Exposure resistance	10.3.2	D1006, D1014	
Chalking	10.3.2.2	D4214	
Checking	10.3.2.3	D660	
Cracking	10.3.2.4	D661	
Erosion	10.3.2.5	D662	
Flaking	10.3.2.6	D772	
Mildew resistance	10.3.3	D3456	^C
Fume resistance	10.3.4		
Tannin Stain Resistance	10.3.6	D6686	
Coating Analysis			
Chemical analysis	11.1	D215	
Volatile content	11.2	D2369	
Nonvolatile volume content	11.3	D2697, D6093	
Water content	11.4	D3792, D4017	
Pigment content	11.5	D2371	4021
Pigment analysis	11.6	D215	7261
Nonvolatile vehicle content	11.7	D215	
Vehicle separation	11.8	D2372	
Nonvolatile vehicle identification	11.9	D2621, D2245	

^A Equivalent only to Method B of Test Methods D522.

^B Except for scrub medium.

^C 6271 is not equivalent.

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
Absorption	7.8		4421
Adhesion	10.1.2	D2197, D3359	
Analysis, chemical	11.1	D215	
Application properties	8.1		4541
Blister resistance	10.3.1	D4585	
Brush application	8.1.1	D5068	
Brush drag	8.1.1.1	D4958	
Chalking	10.3.2.2	D4214	
Checking	10.3.2.3	D660	
Cleansability	10.2.2.2	D3450, D4828	6141 ^A
Coarse particles and foreign matter	7.3	D185	
Colorant acceptance	7.9		
Color appearance	9.1.1	...	
Color change	10.2.1	...	6132
Color differences by visual comparison	9.1.2	D1729	
Color differences using instrumental measurements	9.1.3	D2244	
Condition in container	7.2		3021
Consistency	8.3.1	D562	
Cracking	10.3.2.4	D661	
Density or weight per gal	7.4	D1475	
Dilution stability	7.10		4203
Drying properties	8.4	D1640, D5895	
Erosion	10.3.2.5	D662	
Exposure resistance	10.3.2	D1006, D1014	
Fineness of Dispersion	7.5	D1210	
Flaking	10.3.2.6	D772	
Flash point	7.6	D56, D93, D3278	
Flexibility	10.1.4	D522, D2370	6221 ^B
Fume resistance	10.3.4		
Gloss	9.3		
Gloss, 60°	9.3.1	D523	
Heat stability	7.11.1	D1849	
Hiding power	9.4	D344, D2805	
Ink Stainblocking	10.2.5	D7514	
Levelling properties	8.3.4	D4062	
Mildew resistance	10.3.3	D3456	^C
Nonvolatile vehicle content	11.7	D215	4053
Nonvolatile vehicle identification	11.9	D2621, D2245	
Nonvolatile volume content	11.3	D2697, D6093	
Odor	7.7	D1296	
Package stability	7.11	D1849	
Pigment analysis	11.6	D215	7261 ^D
Pigment content	11.5	D2371	4021
Reflectance, directional	9.2	E1347	
Resistance to household chemicals	10.1.5	D1308	
Rheological properties of non-Newtonian liquids	8.3.2	D2196, D4287	
Roller application	8.1.2		2112
Roller spatter	8.1.2.1	D4707	
Sag resistance	8.3.3	D4400	4494
Sampling	6.2	D3925	
Settling	7.11.2	D869	
Sheen (85° gloss)	9.3.2	D523	
Skinning	7.1	D154	3021
Spray application	8.1.3		2131
Tannin Stain Resistance	10.3.6	D6686	
Touch-up uniformity	8.2	D3928	
Touch-up uniformity	8.2	D3928, D7489	
Vehicle separation	11.8	D2372	
Volatile content	11.2	D2369	
Washability	10.2.2.1	D2486, D4213	
Water content	11.4	D1208, D3792, D4017	4081
Yellowness index	9.5	E313	6131

^A Except for scrub medium.

^B Equivalent only to Method B of D522.

^C 6271 is not equivalent.

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](#)

- D1038 Terminology Relating to Veneer and Plywood
 D1208 Test Methods for Common Properties of Certain Pigments
 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 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 at Room Temperature
 D1729 Practice for Visual Appraisal of Colors and Color Differences of Diffusely-Illuminated Opaque Materials
 D1849 Test Method for Package Stability of Paint
 D2196 Test Methods for Rheological Properties of Non-Newtonian Materials by Rotational (Brookfield type) Viscometer
 D2197 Test Method for Adhesion of Organic Coatings by Scrape Adhesion
 D2244 Practice for Calculation of Color Tolerances and Color Differences from Instrumentally Measured Color Coordinates
 D2245 Test Method for Identification of Oils and Oil Acids in Solvent-Reducible Paints
 D2369 Test Method for Volatile Content of Coatings
 D2370 Test Method for Tensile Properties of Organic Coatings
 D2371 Test Method for Pigment Content of Solvent-Reducible Paints
 D2372 Practice for Separation of Vehicle From Solvent-Reducible Paints
 D2486 Test Methods for Scrub Resistance of Wall Paints
 D2621 Test Method for Infrared Identification of Vehicle Solids From Solvent-Reducible Paints
 D2697 Test Method for Volume Nonvolatile Matter in Clear or Pigmented Coatings
~~D2698 Test Method for Determination of the Pigment Content of Solvent-Reducible Paints by High-Speed Centrifuging~~
 D2805 Test Method for Hiding Power of Paints by Reflectometry
 D3273 Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber
 D3278 Test Methods for Flash Point of Liquids by Small Scale Closed-Cup Apparatus
 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
 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
 D3925 Practice for Sampling Liquid Paints and Related Pigmented Coatings
 D3928 Test Method for Evaluation of Gloss or Sheen Uniformity
~~D3960~~
 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
~~D4541 Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers~~
 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
 D5068 Practice for Preparation of Paint Brushes for Evaluation
 D5069 Practice for Preparation of Paint-Roller Covers for Evaluation of Architectural Coatings
 D5179 Test Method for Measuring Adhesion of Organic Coatings to Plastic Substrates by Direct Tensile Testing
 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
 D6093 Test Method for Percent Volume Nonvolatile Matter in Clear or Pigmented Coatings Using a Helium Gas Pycnometer
 D6686 Test Method for Evaluation of Tannin Stain Resistance of Coatings
 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
 E105 Practice for Probability Sampling of Materials
 E313 Practice for Calculating Yellowness and Whiteness Indices from Instrumentally Measured Color Coordinates

E1347 [Test Method for Color and Color-Difference Measurement by Tristimulus Colorimetry](#)

2.2 *U.S. Federal Standard:*

Federal Test Method Standard No. 141D³

2131 Application of Sprayed Films

3011 Condition in Container

4203 Reducibility and Dilution Stability

4421 Absorption Test

4541 Working Properties and Appearance of Dried Film

6132 Accelerated Yellowness

2.3 *Other Document:*

Paint/Coatings Dictionary of the Federation of Societies for Coatings Technology⁴

3. Terminology

3.1 For definitions of terms in this guide refer to Terminology D16, D1038, and D1554 and to the FSCT Paint/Coatings Dictionary.

4. Conditions Affecting Solvent-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, low-gloss wall finishes do not have the abrasion resistance required on floors, whereas finishes intended only for interior service probably do not have adequate resistance to weather factors. 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, hardness or, in the case of unpainted concrete, alkalinity determine the kind of coating that can be applied. The condition of previously painted substrates, such as degree of chalk, presence of grease, dirt, and mold, 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 detergent cleaning, solvent cleaning, and sanding.

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

4.1.5 Environmental conditions such as temperature and humidity at the time of coating application and during drying.

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 solvent-borne coatings have been developed for the different locations. The recommended test methods presented in Table 1 and Table 2 cover practically all the properties of solvent-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.

³ Available from Standardization Documents Order Desk, DODSSP, Bldg. 4, Section D, 700 Robbins Ave., Philadelphia, PA 19111-5098, <http://dodssp.daps.dla.mil>.

⁴ Available from Standardization Documents Order Desk, DODSSP, Bldg. 4, Section D, 700 Robbins Ave., Philadelphia, PA 19111-5098, <http://dodssp.daps.dla.mil>.

⁴ Available from Federation of Societies for Coatings Technology (FSCT), 492 Norristown Rd., Blue Bell, PA 19422-2350, <http://www.coatingstech.org>.

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 checked 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 (0.1 lb) 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 4-L (or 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 *Skimming*—Coatings that contain a binder that dries by oxidation may be subject to skin formation in a partially-filled can. Since skins are insoluble in the material, they must be removed before use. The referenced test in a partially-filled container indicates the tendency of the material to skin. A typical minimum time for skinning in accordance with this method is 48 h. Examine the original sample for skins, both on and below the surface. Using a well-mixed skin-free portion of the sample, perform a skinning test in accordance with Guide D154.

7.2 *Condition in Container*—Thickening, pigment settling, and 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 7.11, Package Stability.)

7.3 *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 Methods D185.

7.4 *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 interior 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.

7.5 *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 (0–8 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. Low sheen finishes may have a dispersion value of 50 μm or 4 Hegman (2 mils) while gloss enamels might be near zero (8 Hegman) indicating that the pigment agglomerates are too small to be detected by the referenced method. Determine fineness of dispersion in accordance with Test Method D1210.

7.6 *Flash Point*—Organic solvents used in these coatings have characteristic temperatures at which they support combustion. This temperature is known as the flash point and is often used for danger classification in shipping by common carrier. It is also used to determine conditions of storage to meet fire regulations and the safety requirements of the U.S. Occupational Safety and Health Act (OSHA). Determine flash point in accordance with Test Methods D56, D93, Part B, or D3278.

7.7 *Odor*—Some solvent combinations produce obnoxious odors, particularly when painting indoors with inadequate ventilation and at elevated temperatures. Interior solvent-borne coatings usually contain low-odor or odorless mineral spirits. Nevertheless, they should be evaluated to ensure that they are acceptable. Although not specifically designed for liquid coatings Test Method D1296 may be used with the solvent-reducible type.

7.8 *Absorption*—On porous surfaces, binder penetration can result in pigment volume concentration changes as the film dries. This may cause appearance to vary. The referenced method provides a rough measure of the wetting and penetrating properties of the binder on a porous surface. Determine the absorption in accordance with Method 4421 of Federal Test Method Standard No.141D.

7.9 *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. There is no accepted ASTM test method at present. Test methods may be agreed upon between the purchaser and seller.

7.10 *Dilution Stability*—Dilution with a specified thinner shows whether the materials are compatible and whether the reduced coating is stable. Consequently the suggested diluent should be readily incorporated into the coating without excessive stirring or shaking. The referenced method evaluates the stability of the material that has been reduced by a given amount or to a specified viscosity. Determine dilution stability in accordance with Method 4203 of Federal Test Method Standard No. 141D.