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Standard Guide for Testing Industrial Water-Reducible Coatings¹

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1. Scope

1.1 This guide covers the selection and use of procedures for testing water-reducible coatings, both pigmented and clear, utilizing synthetic latices, synthetic resin emulsions, or water-reducible alkyds. The methods included are listed in [Table 1](#). Where more than one standard is listed for the same characteristic, no attempt is made to indicate superiority of one standard over another. Selection of the standards to be followed must be governed by experience and the requirements in each individual case, together with agreement between producer and user.

1.2 This guide covers the testing of liquid coatings as applied by conventional spray, airless spray, electrostatic spray, dip, fancoat, flowcoat, roller coat, and curtain coat.

1.3 This guide includes procedures relating to proper and safe packaging, shipping and receiving, and storage and handling during use and application.

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

1.5 *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

[B117 Practice for Operating Salt Spray \(Fog\) Apparatus](#)

[B287 Method of Acetic Acid-Salt Spray \(Fog\) Testing \(Withdrawn 1987\)](#)³

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 D01.55 on Factory Applied Coatings on Preformed Products.

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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.

³ The last approved version of this historical standard is referenced on www.astm.org.

[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](#)

[D185 Test Methods for Coarse Particles in Pigments](#)

[D215 Practice for the Chemical Analysis of White Linseed Oil Paints \(Withdrawn 2005\)](#)³

[D344 Test Method for Relative Hiding Power of Paints by the Visual Evaluation of Brushouts](#)

[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](#)

[D609 Practice for Preparation of Cold-Rolled Steel Panels for Testing Paint, Varnish, Conversion Coatings, and Related Coating Products](#)

[D610 Practice for Evaluating Degree of Rusting on Painted Steel Surfaces](#)

[D658 Test Method for Abrasion Resistance of Organic Coatings by Air Blast Abrasive \(Withdrawn 1996\)](#)³

[D659 Method for Evaluating Degree of Chalking of Exterior Paints \(Withdrawn 1990\)](#)³

[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](#)

[D714 Test Method for Evaluating Degree of Blistering of Paints](#)

[D772 Test Method for Evaluating Degree of Flaking \(Scaling\) of Exterior Paints](#)

[D822 Practice for Filtered Open-Flame Carbon-Arc Exposures of Paint and Related Coatings](#)

[D823 Practices for Producing Films of Uniform Thickness of Paint, Varnish, and Related Products on Test Panels](#)

[D869 Test Method for Evaluating Degree of Settling of Paint](#)

[D870 Practice for Testing Water Resistance of Coatings Using Water Immersion](#)

[D968 Test Methods for Abrasion Resistance of Organic Coatings by Falling Abrasive](#)

TABLE 1 List of Test Methods by Properties

Test Method	Section	ASTM Standard	Federal Test Method Standard 141
I. Liquid Coating Properties:	9		
Coarse particles and foreign matter	9.2	D185	
Condition in container	9.1	...	3011.1
Conductivity	9.14	D1125 or D4399	...
Consistency	9.7	D562	...
Density or weight per gallon	9.3	D1475	...
Fineness of dispersion	9.4	D1210	...
Flash point	9.13	D56, D93 or D3278	...
Freeze-thaw stability	9.9	D2243	...
Microorganism resistance	9.11	D2574	...
pH	9.8	E70	...
Package stability	9.10	D1849	...
Pigment suspension	9.5	D869	...
Surface tension	9.12
Viscosity	9.6	D1200 or D2196	...
II. Application and Film Formation:	10		
Panel preparation	10.1	D609, D1730, D1731, D1732, D2092D2201	...
Drying properties	10.2.2	D1640	...
Leveling properties	10.3	D4062, D2353	...
Low temperature coalescence	10.5	D3793, D2354	...
Spray properties	10.2.1	...	2131.1, 4331.1
Touch-up	10.6	D3928	...
Uniform film preparation	10.4	D823	...
Wet film thickness	10.3	D1212	...
III. Appearance of Dry Film:	11		
Color difference by visual evaluation	11.1.1	D1729, D2616	...
Color difference by instrumental evaluation	11.1.2	D2244 and D3134	...
Color description by visual evaluation	11.1.3	D1535	...
Color description by instrumental evaluation	11.1.4	D2244	...
Gloss	11.2	D523	...
Hiding power	11.3	D344, D2805	...
IV. Properties of Dry Film:	12		
Abrasion resistance	12.1	D658, D968, D4060	...
Adhesion	12.2	D2197, D3359	...
Elongation	12.3	D522, D1737, D3281	...
Exterior exposure	12.4		...
Blistering	12.4.1	D714	...
Chalking	12.4.2	D659	...
Checking	12.4.3	D660	...
Cracking	12.4.4	D661	...
Erosion	12.4.5	D662	...
Flaking	12.4.6	D772	...
Rusting	12.4.7	D610, D2933	...
Accelerated weathering	12.4.8	D822, D3361, D4587	...
Corrosive environments	12.4.9	D1654	...
Hardness	12.5	D1474	...
Impact resistance	12.6	D2794, D3170	...
Resistance to various forms of water	12.8		...
Water immersion	12.8.1	D870	...
Water fog	12.8.2	D1735	...
Humidity resistance	12.8.3	D2247	...
Moisture vapor permeability	12.8.4	D1653	...
Salt spray	12.8.5	B117, B287	...
Humidity-thermal cycling	12.8.6	D2246	...
Filliform corrosion	12.8.7	D2803	...
Condensation	12.8.8	D4585	...
Detergent resistance	12.8.9	D2248	...
Resistance to chemicals	12.7	D1308, D1540, D3023	...
Overbaking	12.9	D2454	...
Print resistance	12.10	D2091	...
Reporting results	12.4.10	D1848	...
Dry film thickness	12.11	D1186, D1400	...
V. Analysis of Paint:	13		
Volatile content	13.2	D2369	...
Volume of nonvolatile	13.3	D2697	...
Weight of nonvolatile	13.3	D2369	...
Pigment content	13.4	D2371	...
Identification of vehicle solids	13.6	D3168	...

- D1005** Test Method for Measurement of Dry-Film Thickness of Organic Coatings Using Micrometers
- D1014** Practice for Conducting Exterior Exposure Tests of Paints and Coatings on Metal Substrates
- D1125** Test Methods for Electrical Conductivity and Resistivity of Water
- D1150** Single and Multi-Panel Forms for Recording Results of Exposure Tests of Paints (Withdrawn 1992)³
- D1186** Test Methods for Nondestructive Measurement of Dry Film Thickness of Nonmagnetic Coatings Applied to a Ferrous Base (Withdrawn 2006)³
- D1200** Test Method for Viscosity by Ford Viscosity Cup
- D1210** Test Method for Fineness of Dispersion of Pigment-Vehicle Systems by Hegman-Type Gage
- D1212** Test Methods for Measurement of Wet Film Thickness of Organic Coatings
- D1308** Test Method for Effect of Household Chemicals on Clear and Pigmented Organic Finishes
- D1400** Test Method for Nondestructive Measurement of Dry Film Thickness of Nonconductive Coatings Applied to a Nonferrous Metal Base (Withdrawn 2006)³
- D1474** Test Methods for Indentation Hardness of Organic Coatings
- D1475** Test Method For Density of Liquid Coatings, Inks, and Related Products
- D1535** Practice for Specifying Color by the Munsell System
- D1540** Method of Test for Effect of Chemical Agents on Organic Finishes Used in the Transportation Industry (Withdrawn 1992)³
- D1640** Test Methods for Drying, Curing, or Film Formation of Organic Coatings at Room Temperature
- D1653** Test Methods for Water Vapor Transmission of Organic Coating Films
- D1654** Test Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments
- D1729** Practice for Visual Appraisal of Colors and Color Differences of Diffusely-Illuminated Opaque Materials
- D1730** Practices for Preparation of Aluminum and Aluminum-Alloy Surfaces for Painting
- D1731** Practices for Preparation of Hot-Dip Aluminum Surfaces for Painting
- D1732** Practices for Preparation of Magnesium Alloy Surfaces for Painting
- D1735** Practice for Testing Water Resistance of Coatings Using Water Fog Apparatus
- D1737** Method of Test for Elongation of Attached Organic Coatings with Cylindrical Mandrel Apparatus (Withdrawn 1988)³
- D1848** Classification for Reporting Paint Film Failures Characteristic of Exterior Latex Paints (Withdrawn 2003)³
- D1849** Test Method for Package Stability of Paint
- D2091** Test Method for Print Resistance of Lacquers
- D2092** Guide for Preparation of Zinc-Coated (Galvanized) Steel Surfaces for Painting (Withdrawn 2008)³
- 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
- D2201** Practice for Preparation of Zinc-Coated and Zinc-Alloy-Coated Steel Panels for Testing Paint and Related Coating Products
- 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
- D2246** Test Method for Finishes on Primed Metallic Substrates for Humidity-Thermal Cycle Cracking (Withdrawn 1992)³
- D2247** Practice for Testing Water Resistance of Coatings in 100 % Relative Humidity
- D2248** Practice for Detergent Resistance of Organic Finishes
- D2353** Method of Test for Flow Ratings of Organic Coatings Using the Shell Flow Comparator (Withdrawn 1990)³
- D2354** Test Method for Minimum Film Formation Temperature (MFFT) of Emulsion Vehicles
- D2369** Test Method for Volatile Content of Coatings
- D2371** Test Method for Pigment Content of Solvent-Reducible Paints
- D2454** Practice for Determining the Effect of Overbaking on Organic Coatings
- D2574** Test Method for Resistance of Emulsion Paints in the Container to Attack by Microorganisms
- D2616** Test Method for Evaluation of Visual Color Difference With a Gray Scale
- D2691** Method for Microscopical Measurement of Dry Film Thickness of Coatings on Wood Products (Withdrawn 1992)³
- D2697** Test Method for Volume Nonvolatile Matter in Clear or Pigmented Coatings
- D2794** Test Method for Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact)
- D2803** Guide for Testing Filiform Corrosion Resistance of Organic Coatings on Metal
- D2805** Test Method for Hiding Power of Paints by Reflectometry
- D2933** Test Method for Corrosion Resistance of Coated Steel Specimens (Cyclic Method) (Withdrawn 1990)³
- D3002** Guide for Evaluation of Coatings Applied to Plastics
- D3023** Practice for Determination of Resistance of Factory-Applied Coatings on Wood Products to Stains and Reagents
- D3134** Practice for Establishing Color and Gloss Tolerances
- D3168** Practice for Qualitative Identification of Polymers in Emulsion Paints
- D3170** Test Method for Chipping Resistance of Coatings
- D3278** Test Methods for Flash Point of Liquids by Small Scale Closed-Cup Apparatus
- D3281** Test Method for Formability of Attached Organic Coatings with Impact-Wedge Bend Apparatus (Withdrawn 1995)³
- D3359** Test Methods for Measuring Adhesion by Tape Test
- D3361** Practice for Unfiltered Open-Flame Carbon-Arc Exposures of Paint and Related Coatings

D3793 Test Method for Low-Temperature Coalescence of Latex Paint Films by Porosity Measurement (Withdrawn 2012)³

D3924 Specification for Environment for Conditioning and Testing Paint, Varnish, Lacquer, and Related Materials

D3925 Practice for Sampling Liquid Paints and Related Pigmented Coatings

D3928 Test Method for Evaluation of Gloss or Sheen Uniformity

D4060 Test Method for Abrasion Resistance of Organic Coatings by the Taber Abraser

D4062 Test Method for Leveling of Paints by Draw-Down Method

D4399 Test Method for Measuring Electrical Conductivity of Electrocoat Baths

D4585 Practice for Testing Water Resistance of Coatings Using Controlled Condensation

D4587 Practice for Fluorescent UV-Condensation Exposures of Paint and Related Coatings

E70 Test Method for pH of Aqueous Solutions With the Glass Electrode

2.2 U.S. Federal Test Method Standard No. 141c.⁴

2131.1 Application of Sprayed Films

3011.1 Test Method

3011.2 Condition in Container

4331.1 Test Method

3. Terminology

3.1 *Definitions:*

3.1.1 For definitions of terms used in this guide, refer to Terminology **D16**.

4. Significance and Use

4.1 This compilation of standards is intended to provide assistance in selecting appropriate tests for evaluating water-reducible coatings and for determining what characteristics should be considered for a given end use. Either single-coat operations or multicoat systems may be addressed by the proper selection of tests. Results from the various tests are not all necessarily useful in evaluating the performance of different systems for various end uses. The list can be useful to those developing coatings and coating systems and to those seeking coating systems for products.

5. Equipment

5.1 Use the equipment as specified in each standard.

6. General Requirements

6.1 Tests and observations shall be at standard laboratory conditions as specified in Specification **D3924** unless otherwise specified or agreed upon by the producer and user.

7. Sampling and Specimen Preparation

7.1 Sample the water-reducible coatings in accordance with Practice **D3925**.

7.2 Prepare specimens as required for the specific tests on the liquid coating and the dry coating.

8. Conditions Affecting Performance

8.1 Practical requirements and performance of water-reducible coatings may vary with:

8.1.1 Type of substrate.

8.1.2 Substrate condition, for example, porosity, hardness, smoothness, flexibility, etc.

8.1.3 Type, quality, and suitability of the surface treatment or primer used under the water-reducible coating and the time before coating application.

8.1.4 Application methods and techniques.

8.1.5 Contaminants on the surface of the substrate.

8.1.6 Environmental conditions such as temperature and relative humidity.

8.1.7 Damage to container, size, and type of container.

8.1.8 Storage variables, for example storage time, excessive temperature fluctuations that may cause physical or chemical change. Special needs arise due to carbon dioxide absorption, dissolved metal compatibility, and ultrafiltration treatments.

9. Liquid Coatings Properties

9.1 *Condition in Container*—Thickening, settling, and separation are undesirable and objectionable if a liquid coating cannot be reconditioned and made suitable for application with a reasonable amount of stirring. The referenced method covers procedures for determining changes in properties after storage. Determine the condition in the container in accordance with Test Method 3011.1 of U.S. Federal Test Method Standard No. 141c.

9.2 *Coarse Particles and Foreign Matter*—To form uniform films of good appearance, the liquid coating must be free of coarse particles as agreed upon between the producer and the user, a typical maximum being 1 % by weight of the total paint. Determine coarse particles and foreign matter in accordance with Test Methods **D185**.

9.3 *Density or Weight Per Gallon*—The density as measured by weight per gallon is used to help assure product uniformity from batch to batch. In the referenced test method, the density is expressed as the weight in pounds avoirdupois of 1 U.S. gal or the weight in kilograms of 1 L of the paint at a specified temperature. A calibrated weight-per-gallon cup is used. Determine the density in accordance with Test Method **D1475**.

9.4 *Fineness of Dispersion*—The more finely a pigment is dispersed, the more efficiently it is being used. One test method for measuring the degree of dispersion (commonly referred to as “fineness of grind”) is to draw the material down a calibrated, tapered groove in a hardened steel block with the groove varying in depth from 100 to 0 μm (4 to 0 mils). The point at which continuous groupings of particles or agglomerates, or both, protrude through the surface of the liquid is taken as the fineness reading. Lower readings in mils or μm or higher readings in Hegman units indicate better fineness of dispersion. Determine fineness of dispersion in accordance with Test Method **D1210**.

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