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StandardGuide for Testing Exterior Wood Stains and Clear Water Repellents[1]

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1. Scope

1.1 This guide covers the selection and use of procedures for testing exterior wood stains and clear water repellents. This includes both water borne and solvent borne semitransparent and opaque stains and clear water repellents. The properties that can be examined or, in some cases, the relevant test procedures are listed in 2.1 and 2.2.

NOTE 1—The term "opaque stain" is defined as a pigmented composition intended for use on wooden surfaces to produce a uniform finish that obscures the grain and color of the wood, but not its surface texture; also called solid color or solid hide.

NOTE 2—The term "semitransparent" is defined as a pigmented composition intended for use on wooden surfaces to produce a uniform finish that does not fully obscure the grain or the texture of the wood.

NOTE 3—The term "clear" is defined as a transparent composition intended for use on wooden surfaces to produce a uniform finish that does not obscure the grain or texture of the wood.

1.1.1 *Discussion*—When applied to woods that differ in color, there is a color difference between stained substrates.

1.2 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.3 *This standard may involve hazardous materials, operations, and equipment. 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 requirements 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D215 Practice for the Chemical Analysis of White Linseed Oil Paints (Withdrawn 2005)[3]

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

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

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

D1038 Terminology Relating to Veneer and Plywood

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

D1475 Test Method For Density of Liquid Coatings, Inks, and Related Products

D1554 Terminology Relating to Wood-Base Fiber and Particle Panel Materials

[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] 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.

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
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
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
D2574 Test Method for Resistance of Emulsion Paints in the Container to Attack by Microorganisms
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
D2805 Test Method for Hiding Power of Paints by Reflectometry
D3168 Practice for Qualitative Identification of Polymers in Emulsion Paints
D3273 Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber
D3274 Test Method for Evaluating Degree of Surface Disfigurement of Paint Films by Fungal or Algal Growth, or Soil and Dirt Accumulation
D3278 Test Methods for Flash Point of Liquids by Small Scale Closed-Cup Apparatus
D3359 Test Methods for Measuring Adhesion by Tape Test
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)[3]
D3723 Test Method for Pigment Content of Water-Emulsion Paints by Low-Temperature Ashing
D3793 Test Method for Low-Temperature Coalescence of Latex Paint Films by Porosity Measurement (Withdrawn 2012)[3]
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
D4141 Practice for Conducting Black Box and Solar Concentrating Exposures of Coatings
D4212 Test Method for Viscosity by Dip-Type Viscosity Cups
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
D4446 Test Method for Anti-Swelling Effectiveness of Water-Repellent Formulations and Differential Swelling of Untreated Wood When Exposed to Liquid Water Environments
D4585 Practice for Testing Water Resistance of Coatings Using Controlled Condensation
D4587 Practice for Fluorescent UV-Condensation Exposures of Paint and Related Coatings
D4958 Test Method for Comparison of the Brush Drag of Latex Paints
D5326 Test Method for Color Development in Tinted Latex Paints
D5401 Test Method for Evaluating Clear Water Repellent Coatings on Wood
D6686 Test Method for Evaluation of Tannin Stain Resistance of Coatings
D6695 Practice for Xenon-Arc Exposures of Paint and Related Coatings
E70 Test Method for pH of Aqueous Solutions With the Glass Electrode
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
G90 Practice for Performing Accelerated Outdoor Weathering of Nonmetallic Materials Using Concentrated Natural Sunlight

2.2 *U.S. Federal Standards:*
U. S. Federal Test Method Standard No. 141 C
2131 Application of Sprayed Films
2141 Application of Brushed Films
3011 Condition in Container
4203 Reducibility and Dilution Stability
4421 Absorption Test
4541 Working Properties and Appearance of Dried Film

6301 Wet Adhesion (Tape Test)

2.3 *Other Documents:*

Paint/Coatings Dictionary of the Federation of Societies for Coatings Technology[4]

Paint and Coatings Testing Manual

3. Terminology

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

4. Conditions Affecting Coatings

4.1 *Moisture*—Wood is porous and will absorb moisture, causing it to swell. As it dries, it will shrink. It is this cycle of shrinking and swelling that causes warping and cracking in the wood substrate. This dimensional instability stresses a coating, affecting its durability. Many semitransparent, opaque, or solid color exterior stains are formulated to repel water to protect wood from ingress of moisture, thereby reducing the tendency of the wood to warp and crack.

4.2 *Substrate Type*—The substrate to be coated 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 may be required for previously coated wood that will receive opaque stain; or a primer-sealer on previously uncoated wood. Other factors include the type and quality of wood or wood composite (plywood, particle board or hardboard) or pressure treated wood.

4.3 *Substrate Conditions*—Conditions such as species of wood, porosity, degree of weathering, and previous coatings determine the kind of coating that can be applied. The performance of coatings on uncoated new wood can be influenced by the presence of mill glaze and wood grain orientation. The condition of previously stained substrates such as degree of chalk, presence of dirt, mold, and water-soluble or oily contaminants, extractives, film adhesion, and porosity also influence the performance of coatings. Smoothness of the substrate affects the spreading rate, final appearance, and texture.

4.4 Preparation of previously coated or weathered substrates including cleaning, sanitizing, and sanding.

4.5 The application properties are affected by temperature and humidity at the time of application and during drying.

4.5.1 *For Water Reducible*—As these materials contain water, surfaces do not have to be completely dry before application. However, application and surface temperatures lower than 50°F may cause poor film formation.

4.5.2 *For Solvent Reducible*—Surface dampness may adversely effect film uniformity, wetting, and adhesion. Humidity and low temperature have relatively little effect except for slowing the drying.

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

4.6 *Substrate Weathering*—Weathering of wood before staining will adversely affect the performance of exterior coatings.

4.6.1 *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.

4.6.2 Environmental conditions after application, both general for the area and specific, such as under eaves, behind shrubbery, north side and south side exposure are significant weathering factors.

5. Selection of Tests

5.1 Because the conditions to which a coating is subjected vary with (*1*) the surface type: deck, siding, species of wood and (*2*) the service environment; sheltered, exposed, and horizontal, specialized types of solvent-borne and water-borne coatings have been developed for the different locations. Selection of the referenced 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 which properties are the most important. After establishing the requirements or specifications, select the test methods that measure or evaluate those properties. The balance of properties must be considered when establishing the requirements and selecting the tests. The significance of the tests and the normal range of values are presented in the different sections, in most cases.

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 coatings.

6.2 Sample in accordance with Practice D3925. Determine the density in pounds per gallon (kilograms/litre) in accordance with Test Method D1475. Continue sampling and determining density until successive results agree within 0.1 lb (45 g) 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 1-US gal (or 4-L) 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 *Skinning*—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, 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 stain. Determine condition in the container in accordance with Method 3011 of U. S. Federal Test Method Standard No. 141. (See also 7.12, 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 gallon (kilograms per litre = g/mL) 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 reference method gives a procedure for measuring the density of the coating at a specified temperature. Most stains have densities of about 8 to 11 lb/gal (1.2 to 1.4 kg/L). 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 4 to 0 mils (100 to 0 µm) (0-8 Hegman units). 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 micrometers indicate finer dispersion. Low sheen finishes may have a dispersion value of 2 mils (50 µm or 4 Hegman). Determine fineness of dispersion and cleanliness in accordance with Test Method D1210.

7.5.1 The referenced method was designed primarily for coatings with good fineness of dispersion, such as high gloss finishes. Some exterior stains, which are typically flat finishes, may contain pigments so coarse that it is impractical to measure the fineness with a grind gage because the agglomerates are carried along by the scraper. The best stains for appearance do not have Hegman readings below 2.

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 US Occupational Safety and Health Act (OSHA). Suitable methods include Test Methods D56, D93, Part B, or D3278.

7.7 *Odor*—Some solvent combinations produce obnoxious odors. Although not specifically designed for liquid coatings Test Method D1296 may be used with the solvent-reducible type. One of the advantages of latex coatings is that they contain little if any organic solvent. Thus latex stains do not have odors characteristic of solvent-borne coatings. However, other ingredients that may be used, such as ammonia, might also be objectionable. 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 stain has an unpleasant or irritating odor as agreed upon between the purchaser and seller, taking adequate precautions to ensure the safety of the operator.

7.8 *Penetration*—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 U. S. Federal Test Method Standard No. 141. Stains are formulated to penetrate into the wood substrate in order to help protect the wood. Test methods for penetration are not yet available.

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. Test Method D5326 may be used. Test methods may be agreed upon between the purchaser and seller.

7.10 *pH*—Latex stains 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 necessarily determine the quality of a latex stain and should be used primarily to ensure product uniformity. The pH of a stain can also effect package stability and in-can corrosion. Change in pH during storage may indicate poor stability and an unacceptable change in the properties of a latex stain. Determine pH in accordance with Test Method E70.

7.11 *Dilution Stability*—Dilution with a specified thinner shows whether the materials are compatible and whether the reduced coating is stable. Consequently the suggested diluents 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 U. S. Federal Test Method Standard No. 141.

7.12 *Package Stability*—Since stains cannot normally be used immediately after manufacture, they must remain stable in the can for some time. At normal temperatures most stains can be stored for over a year with little change in properties. Although indications of long term package stability can usually be obtained in several days or weeks at an elevated temperature, such as 125°F (50°C) or 140°F (60°C), occasionally the results of the accelerated test do not agree with those at prolonged normal storage conditions. The referenced method predicts the change in consistency and certain other properties