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Standard Guide for Testing High-Performance Interior Architectural Wall Coatings¹

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1. Scope

1.1 This guide covers the selection and use of test methods for high-performance interior architectural wall coatings (HIPAC) that differ from more conventional coatings by being tougher, more stain-resistant, more abrasion-resistant and, ordinarily, designed to be applied to wall surfaces of steel, masonry (poured concrete, concrete block, or cinder block), and plaster or gypsum wallboard. The tests that are listed in [Table 1](#) and [Table 2](#) are designed to measure performance properties. These tests may not all be required for each HIPAC system. Selection of the test 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.

1.2 High-performance architectural coatings are tough, extra-durable organic coating systems that are applied as a continuous (seamless) film and cure to a hard finish. The finish can be high gloss, semigloss, or low gloss as desired. These coatings are resistant to persistent heat, humidity, abrasion, staining, chemicals, and fungus growth. They are used in areas where humidity, wear, or unusual chemical resistance requirements, particularly to soiling, are required and where strong detergents are used to maintain sanitary conditions. Halls and stairways in public buildings, lavatories, stall showers, locker areas, animal pens, and biological laboratories are typical applications. In addition, food processing plants, dairies, restaurants, schools, and transport terminals frequently use HIPAC systems. These are effective in many areas of building interiors compared with tile and are of low materials and maintenance costs. They are used as a complete system only as recommended by the manufacturer since the individual coats in a system are formulated to be compatible with each other. HIPAC systems should be applied only to properly prepared surfaces such as steel or masonry, including cinder

blocks and cement blocks. They can be applied over plaster and gypsum wallboard. Ordinarily, a prime or fill coat, if required, is part of the system.

1.3 While they are excellent for walls, HIPAC are not usually intended for ceilings and floors. They would not ordinarily be used in homes, although parents with small children might want to use HIPAC coatings on some walls.

1.4 The types of resin ordinarily used are the following: epoxy-polyamide, two-package; polyester-epoxy, two-package; polyurethane, one-package or two-package. However, other resin types are not excluded provided they can meet the requirements (performance specifications) laid down by the purchaser.

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

1.6 *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.* For a specific hazard statement, see the note in [7.6](#).

2. Referenced Documents

2.1 *ASTM Standards:*²

[D16 Terminology for Paint, Related Coatings, Materials, and Applications](#)

[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](#)

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

[D523 Test Method for Specular Gloss](#)

[D562 Test Method for Consistency of Paints Measuring Krebs Unit \(KU\) Viscosity Using a Stormer-Type Viscometer](#)

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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.

- D869 Test Method for Evaluating Degree of Settling of Paint
- D1005 Test Method for Measurement of Dry-Film Thickness of Organic Coatings Using Micrometers
- D1186 Test Methods for Nondestructive Measurement of Dry Film Thickness of Nonmagnetic Coatings Applied to a Ferrous Base (Withdrawn 2006)³
- D1210 Test Method for Fineness of Dispersion of Pigment-Vehicle Systems by Hegman-Type Gage
- D1211 Test Method for Temperature-Change Resistance of Clear Nitrocellulose Lacquer Films Applied to Wood (Withdrawn 2006)³
- D1212 Test Methods for Measurement of Wet Film Thickness of Organic Coatings
- D1296 Test Method for Odor of Volatile Solvents and Diluents
- 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
- D1475 Test Method For Density of Liquid Coatings, Inks, and Related Products
- 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
- D2244 Practice for Calculation of Color Tolerances and Color Differences from Instrumentally Measured Color Coordinates
- D2247 Practice for Testing Water Resistance of Coatings in 100 % Relative Humidity
- D2369 Test Method for Volatile Content of Coatings
- D2486 Test Methods for Scrub Resistance of Wall Paints
- D2794 Test Method for Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact)
- 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
- D3432 Test Method for Unreacted Toluene Diisocyanates in Urethane Prepolymers and Coating Solutions by Gas Chromatography (Withdrawn 2004)³
- D3450 Test Method for Washability Properties of Interior Architectural Coatings
- 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
- 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
- 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
- D4958 Test Method for Comparison of the Brush Drag of Latex Paints
- D5150 Test Method for Hiding Power of Architectural Paints Applied by Roller
- D5326 Test Method for Color Development in Tinted Latex Paints
- D6736 Test Method for Burnish Resistance of Latex Paints
- D6900 Test Method for Wet Adhesion of Latex Paints to a Gloss Alkyd Enamel Substrate
- 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
- E84 Test Method for Surface Burning Characteristics of Building Materials
- 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. 141⁴
 2112 Application by Roller
 2131 Application of Sprayed Films
 2141 Application of Brushed Films
 3011 Condition in Container
 4203 Reducibility and Dilution Stability
 4541 Working Properties and Appearance of Dried Film
 6141 Washability of Paints
 6142 Scrub Resistance
 6301 Wet Adhesion
- 2.3 *U. S. Federal Specification:*
TT-F-1098 Filler, Block Solvent-Thinned for Porous Surfaces⁴

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

⁴ 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>.

TABLE 1 List of Standards in Sectional Order

Property (or Related Test)	Section	ASTM Test Method	Federal Test Method Standard No. 141
Sampling:	5.2	D3925	...
Liquid Paint Properties:			
Skinning	7.1	D154	
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	7.7	D93, D3278	
Dilution stability	7.8	...	4203
Volatile content	7.9	D2369	...
Free diisocyanate content	7.10	D3432	...
Package stability	7.11		
Heat stability	7.11.1	D1849	
Settling	7.11.2	D869	
Color Acceptance	7.12	D5326	
Coating Application and Film Formation:			
Application properties	8.1	...	4541
Brush application	8.1.1	...	2141
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
Rheological properties	8.2	...	...
Consistency (low-shear viscosity)	8.2.1	D562	...
Rheological properties of non-Newtonian liquids	8.2.2	D2196, D4287	...
Sag resistance	8.2.3	D4400	...
Leveling properties	8.2.4	D4062	...
Curing properties	8.3	...	...
Wet-film thickness	8.4	D1212	...
Touch-up uniformity	8.5	D3928, D7489	...
Low Temperature Coalescence	8.6	D3793, D7306	...
Appearance of Dry Coating:			
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, 60°	9.3	D523	...
Hiding power	9.4	D344, D2805, D5150	...
Yellowness index	9.5	E313	...
Properties of Dry Film:			
Abrasion resistance	10.1	D4060	...
Adhesion	10.2	D4541	...
Wet Adhesion	10.2.1	D6900	6301
Impact resistance	10.3	D2794	...
Chemical resistance	10.4	D1308	...
Washability and cleansability	10.5	...	...
Washability	10.5.1	D2486, D4213	...
Cleansability	10.5.2	D3450, D4828	...
Mildew resistance	10.6	D3273	...
Perspiration resistance	10.7	...	...
Heat and cold resistance	10.8	D1211	...
Heat and humidity resistance	10.9	D2247	...
Fire hazards	10.10	E84	...
Dry-film thickness	10.11	D1005, D1186, D1400	...
Burnish Resistance	10.12	D6736	...

3. Terminology

3.1 Definitions:

3.1.1 For definitions of terms used in these practices, refer to Terminology **D16**.

4. Conditions Affecting Performance of HIPAC Coating Systems

4.1 Practical requirements for high performance coatings may vary with:

TABLE 2 Alphabetical List of Test Methods

Test Method	Section	ASTM Test Method	Federal Test Method Standard No. 141
Abrasion resistance	10.1	D4060	
Adhesion	10.2	D4541	
Application properties	8.1	...	4541
Brush application	8.1.1	...	2141
Brush drag	8.1.1.1	D4958	
Burnish Resistance	10.12	D6736	
Chemical resistance	10.4	D1308 ^A	
Cleansability	10.5.2	D3450, D4828	
Coarse particles and foreign matter	7.3	D185	
Color Acceptance	7.12	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	7.2	...	3011
Consistency (low-shear viscosity)	8.2.1	D562	
Curing properties	8.3	...	
Density or weight per gallon	7.4	D1475	
Dilution stability	7.8	...	4203
Directional reflectance	8.2	E1347	
Dry-film thickness	10.11	D1005, D1186, D1400	
Fineness of dispersion	7.5	D1210	
Fire hazards	10.10	E84	
Flash point	7.7	D93, D3278	
Free diisocyanate content	7.10	D3432	
Gloss (60-deg specular)	9.3	D523	
Heat and cold resistance	10.8	D1211 ^A	
Heat and humidity resistance	10.9	D2247 ^A	
Heat stability	7.11.1	D1849	
Hiding power	9.4	D344, D2805, D5150	
Impact resistance	10.3	...	
Leveling properties	8.2.4	D4062	
Low Temperature Coalescence	8.6	D3793, D7306	
Mildew resistance	10.6	D3273	
Package stability	7.11	...	
Perspiration resistance	10.7	...	
Rheological properties of non-Newtonian liquids	8.2.2	D2196, D4287	
Roller application	8.1.2	...	2112
Roller spatter	8.1.2.1	D4707	
Sag resistance	8.2.3	D4400	
Sampling	5.2	D3925	
Settling	7.11.2	D869	
Skinning	7.1	D154	
Spray application	8.3	...	2131
Touch-up uniformity	8.5	D3928, D7489	
Volatile content	7.9	D2369	
Washability	10.5.1	D2486, D4213	
Wet Adhesion	10.2.1	D6900	6301
Wet-film thickness	8.4	D1212	
Yellowness index	9.5	E313	

^A Modified.

4.1.1 Substrate type such as concrete, poured or precast block, lime-gypsum plaster, etc.

4.1.2 Climatic conditions, both generally and specifically, at the time of coating application. ASTM standard conditions for laboratory testing are 73.5 ± 3.5°F (23 ± 2°C) and 50 ± 5 % relative humidity.

5. Sampling

5.1 Prior to sampling, establish the condition of the container since damage to it may cause evaporation, skinning, or other undesirable effects. Excessive storage time and temperature fluctuations may cause settling or changes in viscosity.

5.2 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.

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

6. Laboratory Tests

6.1 Preparation of Test Panels:

6.1.1 Unless otherwise specified, test panels shall be 40 by 190 by 395-mm (1½ by 7½ by 15½-in.) masonry units made from standard lightweight concrete block, having an apparent specific gravity of 1.60 to 1.62.

6.1.2 One face only of the test panel shall be coated with the complete system, in a vertical position. The filler shall either comply with U.S. Federal Specification TT-F-1098 or be the material specified and supplied by the manufacturer. The filler coat shall be applied in conformance with the manufacturer's printed directions for surface preparation, mixing, application, coverage, and curing time under standard conditions of temperature and humidity.

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**, Section 10.

7.2 *Condition in Container*—Thickening, pigment settling, and separation are undesirable and objectionable if a coating, after storage, 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 coating. Determine the condition in the container in accordance with Method 3011 of Federal Test Method Standard No. 141.

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- μ m) screen gives the percent of these particles. Determine content of coarse particles and foreign matter in accordance with Test Methods **D185**, except using methyl ethyl ketone, xylene or other appropriate solvent as agreed upon between the manufacturer and the purchaser.

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 referenced method gives a procedure for measuring the density of the coating at a specified temperature. Most coatings have densities of about 10 to 12 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 effectively 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 μ m) (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 micrometres indicate finer dispersion. A typical fineness requirement for HIPAC is 1.5 mils (5 Hegman or 40 μ m). Determine fineness of dispersion in accordance with Test Method **D1210**.

7.6 *Odor*—Some solvent combinations produce obnoxious odors, particularly when painting indoors with inadequate ventilation and at elevated temperatures. Although not specifically designed for liquid coatings, Test Method **D1296** may be used with the solvent-reducible type. (**Warning**— Even though the odor may be pleasant, the fumes may be dangerously toxic.)

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

7.8 *Dilution Stability*—Dilution with a specific 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. 141.

7.9 *Volatile Content (Weight Percent)*—Calculate the volatile content of the coating by difference after determining the nonvolatile content in accordance with Test Methods **D2369**.

7.10 *Free Diisocyanate Content*—It is generally recognized that diisocyanate vapors from polyurethane-type HIPAC coatings are potential health hazards. Therefore, the free diisocyanate content of urethane coating systems must be controlled at an acceptable maximum level, the present accepted maximum being 0.5 % based on total coating weight, which is applicable only to toluene diisocyanate (TDI) and hexamethylene diisocyanate (HMDI). It has not been shown that this level is applicable to all diisocyanates. Determine free toluene diisocyanate content in accordance with Test Method **D3432**. See Note 1 in Test Method **D3432** about other diisocyanates.

7.11 *Package Stability*—Since coatings are normally not used immediately after manufacture, they must remain stable in the can for some time. At normal temperatures most solvent-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,

may cause unacceptable changes in these products. Another unsatisfactory condition that may occur during storage is excessive settling.

7.11.1 *Heat Stability*—Exposure 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 at normal temperatures. 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. 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, foam resistance, color uniformity, and wet adhesion are usually checked. Determine heat stability in accordance with Test Method **D1849**.

7.11.2 *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**.

7.12 *Colorant Acceptance*—Tintability of paint bases with colorants of standardized tinting strength is a trade requirement. If tinting colors are not adequately compatible with tint bases, lighter, darker, or non-uniform shades of colors are produced. Suitable test methods should be agreed upon between the purchaser and the seller. Determination of color development of a tinted paint may be accomplished by following Test Method **D5326**.

8. HIPAC Application and Film Formulation

8.1 *Application Properties*—Application or working properties of a coating 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. 141.

8.1.1 *Brush Application*—Brushed films should be smooth and free of seeds and on vertical surfaces should show no sagging, color streaking, or 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 Method 2141 of Federal Test Method Standard No. 141.

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 material 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 coating easily and uniformly, leading to excessive sagging, prolonged drying time and, in highly-pigmented coatings, 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. The coatings in a series, however, must be all of the same type—either water-borne or solvent-borne. It has been established that the subjective ratings thus obtained correlate well with high-shear viscosities obtained instrumentally using Test Method **D4287** (see 8.2.2), provided that the materials 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 Method 2112 of Federal Test Method Standard No. 141.

8.1.2.1 Some coatings spatter more than others when applied by roller. The degree to which a material 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. 141. Manual application is very subjective and should be performed only by an individual skilled in the art of using spray equipment.

8.2 Rheological Properties:

8.2.1 *Consistency (Low-Shear Viscosity)*—Consistency is important, relating to application and flow, and should fall within a stated range for satisfactory reproduction of a specific formula. While consistency is an important property it does not determine the quality of a coating and should be used mainly to ensure product uniformity. In the referenced method, consistency is defined as the load in grams to produce a specified rate of shear. The load value is frequently converted to Krebs units (KU) and the Stormer consistency reported on that basis. A typical range is 85 to 135 KU for base coats and 70 to 95 KU for glaze coats. Two coatings of the same consistency may have quite different rheological properties during application. Determine consistency in accordance with Test Method **D562**.