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Standard Guide for Testing High-Performance Interior Architectural Wall Coatings[1]

This standard is issued under the fixed designation D3730; 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 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 ~~Tables 1 and 2~~ Table 1 and Table 1 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

[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.

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
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
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
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
D3450 Test Method for Washability Properties of Interior Architectural Coatings
D3793 Test Method for Low-Temperature Coalescence of Latex Paint Films by Porosity Measurement
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. 141[3]
2112 Application by Roller
2131 Application of Sprayed Films
2141 Application of Brushed Films
3011 Condition in Container

[3] 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.

4203 Reducibility and Dilution Stability
4541 Working Properties and Appearance of Dried Film
6141 Washability of Paints
~~6142Scrub Resistance~~
6142 Scrub Resistance
6301 Wet Adhesion
2.3 *U. S. Federal Specification:*
TT-F-1098 Filler, Block Solvent-Thinned for Porous Surfaces[3]

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:
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 *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, 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-μm) screen gives the percent of these particles. Determine content of coarse particles and foreign matter in accordance with Test Methods D185~~, Section 10~~, 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.

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~~	~~...~~
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~~	
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~~	~~...~~
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~~	~~...~~
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~~	
Dry-film thickness	10.11	D1005, D1186, D1400	
Burnish Resistance	10.12	D6736	

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 uisng instrumental measurements~~	~~9.1.3~~	~~D2244~~	~~...~~
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~~	~~...~~
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~~	~~...~~
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~~	~~...~~
Rheological properties of non-Newtonian liquids	8.2.2	D2196, D4287	...
Roller appliation	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~~	
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.

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 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 micrometres indicate finer dispersion. A typical fineness requirement for HIPAC is 1.5 mils (5 Hegman or 40 μm). 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