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Standard Guide for Testing Coating Powders and Powder Coatings¹

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1. Scope

1.1 This guide covers the selection and use of procedures for testing coating powders and powder coatings. The test methods included are listed in [Table 1](#). Where more than one test method is listed for the same characteristic, no attempt is made to indicate superiority of one method over another. 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.

1.2 This guide also refers to methods developed specifically for the coating powder industry by the Powder Coating Institute, PCI, and the International Organization for Standards, ISO.

1.3 This guide describes the testing of coating powders as applied by electrostatic spray, fluidized bed, or any other applicable method.

1.4 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.6 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 ASTM Standards:²

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

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 D01.51 on Powder Coatings.

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

[D522 Test Methods for Mandrel Bend Test of Attached Organic Coatings](#)
[D523 Test Method for Specular Gloss](#)
[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](#)
[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](#)
[D870 Practice for Testing Water Resistance of Coatings Using Water Immersion](#)
[D968 Test Methods for Abrasion Resistance of Organic Coatings by Falling Abrasive](#)
[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](#)
[D1308 Test Method for Effect of Household Chemicals on Clear and Pigmented Coating Systems](#)
[D1474 Test Methods for Indentation Hardness of Organic Coatings](#)
[D1535 Practice for Specifying Color by the Munsell System](#)
[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](#)

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

TABLE 1 List of Test Methods

	Section	ASTM Method	PCI Procedure	ISO
Coating Powder Properties:				
Sampling	6	D1898		8130-9
Compatibility	9		#2	8130-12
Lower explosion limit	10			8130-4
Particle size and distribution	11.2	D5861		
Multiple sieve and analysis	11.4	D1921, E11		8130-13
Accelerated storage stability	12			
Glass vial method	12.2		#1	8130-8
Pourability	13	D1895		8130-5
Fluidity	14			
Cured weight loss for thermosetting coating powders	15		#9	8130-7
Gel time (stroke cure)	16	D4217	#6	8130-6
Flow test (incline method)	17	D4242	#7	8130-11
Specific gravity (density)	18	D5965	#4	8130-2; 8130-3
Melting point determination	19			
Application Properties:				
Deposition/transfer efficiency of powder coating process	20			8130-10
Powder Coating Properties:				
Abrasion resistance	22			
Air blast abrasion tester	22.2	D658		
Falling sand method	22.2	D968		
Taber abraser	22.2	D4060		
Adhesion	23			
Tape adhesion	23.2	D3359		
Chemical resistance	24			
Household chemical resistance	24.2	D1308		
Detergent resistance	24.3	D2248		
Acid resistance	24.4	D3260		
Stains or reagents on wood substrates	24.5	D3023		
Chip resistance	25			
Gravimeter	25.2	D3170		
Corner coverage	26.2	D2967		
Elongation (flexibility)	27			
Conical/cylindrical mandrel	27.2	D522		
T-Bend	27.2	D4145		
Film thickness	21.5			
Nonmagnetic coatings on ferrous metals		D7091		
Nonmagnetic, nonconductive coatings on non-ferrous metals		D7091		
On nonmetal base		D6132		
Destructive method		D1005		
Hardness	28			
Pencil	28.2	D3363		
Knoop Indention	28.3	D1474 Method A		
Impact resistance	29	D2794		
Molting/blocking resistance	30	D3003		
On Metal substrates	30.2	D3003		
In Wood substrates	30.3	D2793		
Print resistance	31	D2091		
Optical properties	32			
Guide To:	32.1	D5382		
Color pigmented coatings	32.2			
Visual	32.2.2	D1535, D1729		
Instrumental	32.3.3	D2244, E308, E1164, E1331, E1345, E1347, E1349		
Color difference	32.3			
Visual	32.3.2	D1729, D2616		
Instrumental	32.3.3	D2244, E308, E1164, E1331, E1345, E1347, E1349		
Metamerism (visual)	32.4.1	D4086		
Distinction of image (DOI)	32.5.1	D5767, E430		
Hiding power/opacity	32.6.2	D6441	#3	
Gloss	32.7.2	D523		
Surface profile (orange peel)	32.8.2			
Color/Gloss/Texture Standards	32.9			
Preparation, Maintenance, and Distribution	32.9.1			
Tolerances	32.9.2	D5531		
Outdoor exposure (natural)	32.9.3	D3134		
Adhesion	33	D1014, D4141		
Blistering	33.2.1	D3359		
Chalking	33.2.2	D714		
Checking	33.2.3	D4214		
Cracking	33.2.4	D660		
	33.2.5	D661		

TABLE 1 *Continued*

	Section	ASTM Method	PCI Procedure	ISO
Rusting	33.2.6	D610		
Erosion	33.2.7	D662		
Flaking	33.2.8	D772		
Gloss	33.2.9	D523		
Color	33.2.10	D1729, D2244, D4086		
Accelerated artificial weathering	34.3	D822, D4587, D5031, D6695, G141, G147, G151, G152, G153, G154, G155		
Accelerated environmental exposures	35			
Filiform corrosion	35.2.1	D2803		
Salt spray	35.2.2	B117, D1654		
SCAB corrosion	35.2.3			
Water resistance	35.2.4			
High humidity/100 % humidity	35.2.4.1	D1735, D2247		
Condensation	35.2.4.2	D4585		
Water immersion	35.2.4.3	D870		

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

D1895 Test Methods for Apparent Density, Bulk Factor, and Pourability of Plastic Materials

D1898 Practice for Sampling of Plastics (Withdrawn 1998)³

D1921 Test Methods for Particle Size (Sieve Analysis) of Plastic Materials

D2091 Test Method for Print Resistance of Lacquers

D2092 Guide for Preparation of Zinc-Coated (Galvanized) Steel Surfaces for Painting (Withdrawn 2008)³

D2201 Practice for Preparation of Zinc-Coated and Zinc-Alloy-Coated Steel Panels for Testing Paint and Related Coating Products

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

D2248 Practice for Detergent Resistance of Organic Finishes

D2369 Test Method for Volatile Content of Coatings

D2454 Practice for Determining the Effect of Overbaking on Organic Coatings

D2616 Test Method for Evaluation of Visual Color Difference With a Gray Scale

D2793 Test Method for Block Resistance of Organic Coatings on Wood Panel Substrates

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

D2967 Test Method for Corner Coverage of Powder Coatings

D3003 Test Method for Pressure Mottling and Blocking Resistance of Organic Coatings on Metal Substrates

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

D3170 Test Method for Chipping Resistance of Coatings

D3260 Test Method for Acid and Mortar Resistance of Factory-Applied Clear Coatings on Extruded Aluminum Products

D3359 Test Methods for Rating Adhesion by Tape Test

D3363 Test Method for Film Hardness by Pencil Test

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

D4086 Practice for Visual Evaluation of Metamerism

D4141 Practice for Conducting Black Box and Solar Concentrating Exposures of Coatings

D4145 Test Method for Coating Flexibility of Prepainted Sheet

D4214 Test Methods for Evaluating the Degree of Chalking of Exterior Paint Films

D4217 Test Method for Gel Time of Thermosetting Coating Powder

D4242 Test Method for Inclined Plate Flow for Thermosetting Coating Powders

D4585 Practice for Testing Water Resistance of Coatings Using Controlled Condensation

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

D5031 Practice for Enclosed Carbon-Arc Exposure Tests of Paint and Related Coatings

D5382 Guide to Evaluation of Optical Properties of Powder Coatings

D5531 Guide for Preparation, Maintenance, and Distribution of Physical Product Standards for Color and Geometric Appearance of Coatings

D5767 Test Method for Instrumental Measurement of Distinctness-of-Image (DOI) Gloss of Coated Surfaces

D5861 Guide for Significance of Particle Size Measurements of Coating Powders

D5965 Test Method for Density of Coating Powders

D6132 Test Method for Nondestructive Measurement of Dry Film Thickness of Applied Organic Coatings Using an Ultrasonic Coating Thickness Gage

D6441 Test Methods for Measuring the Hiding Power of Powder Coatings

D6695 Practice for Xenon-Arc Exposures of Paint and Related Coatings

D7091 Practice for Nondestructive Measurement of Dry Film Thickness of Nonmagnetic Coatings Applied to Ferrous Metals and Nonmagnetic, Nonconductive Coatings Applied to Non-Ferrous Metals

E11 Specification for Woven Wire Test Sieve Cloth and Test Sieves

E284 Terminology of Appearance

E308 Practice for Computing the Colors of Objects by Using the CIE System

E430 Test Methods for Measurement of Gloss of High-Gloss Surfaces by Abridged Goniophotometry

E1164 Practice for Obtaining Spectrometric Data for Object-Color Evaluation

E1331 Test Method for Reflectance Factor and Color by Spectrophotometry Using Hemispherical Geometry

E1345 Practice for Reducing the Effect of Variability of Color Measurement by Use of Multiple Measurements

E1347 Test Method for Color and Color-Difference Measurement by Tristimulus Colorimetry

E1349 Test Method for Reflectance Factor and Color by Spectrophotometry Using Bidirectional (45°:0° or 0°:45°) Geometry

G141 Guide for Addressing Variability in Exposure Testing of Nonmetallic Materials

G147 Practice for Conditioning and Handling of Nonmetallic Materials for Natural and Artificial Weathering Tests

G151 Practice for Exposing Nonmetallic Materials in Accelerated Test Devices that Use Laboratory Light Sources

G152 Practice for Operating Open Flame Carbon Arc Light Apparatus for Exposure of Nonmetallic Materials

G153 Practice for Operating Enclosed Carbon Arc Light Apparatus for Exposure of Nonmetallic Materials

G154 Practice for Operating Fluorescent Ultraviolet (UV) Lamp Apparatus for Exposure of Materials

G155 Practice for Operating Xenon Arc Lamp Apparatus for Exposure of Materials

2.2 *ISO Standards*:⁴

ISO 8130-1 Determination of particle size distribution by sieving

ISO 8130-2 Determination of density by gas comparison pycometer (referee method)

ISO 8130-3 Determination of density by liquid displacement pycometer

ISO 8130-4 Calculation of lower explosion limit

ISO 8130-5 Determination of flow properties of a powder/air mixture

ISO 8130-6 Determination of gel time of thermosetting coating powders at a given temperature

ISO 8130-7 Determination of loss of mass on stoving

ISO 8130-8 Assessment of the storage stability of thermosetting powders

ISO 8130-9 Sampling

ISO 8130-10 Deposition efficiency of coating powders

ISO 8130-11 Inclined-plane flow test

ISO 8130-12 Determination of compatibility

ISO 8130-13 Coating Powder – Part B; Particle size analysis by laser diffraction

ISO 8130-14 Powder Coating Terminology

2.3 *PCI Recommended Procedures*:⁵

PCI #1 Accelerated Stability Test – Powder Coatings

PCI #2 Compatibility of Powder Coatings

PCI #3 Contrast Ratio – Powder Coatings

PCI #4 Density of Powder Coating Materials

PCI #6 Gel Time Reactivity

PCI #7 Inclined Plate Flow

PCI #9 Cured Weight Loss for Thermosetting Coating Powders

3. Terminology

3.1 *Definitions*:

3.1.1 *contrast ratio, n*—a value related to the hiding powder of a coating.

3.1.1.1 *Discussion*—The ratio of the reflectance of the coating over black and white backgrounds at equal film thickness. In the coatings industry 98 % contrast ratio is by convention characterized as being visually opaque, for hiding power measurement purposes, although it is recognized that visually (just as photometrically) the opacity is actually somewhat less than complete. For the reported hiding power to be significant, the contrast ratio value must be reported at a specific film thickness.

3.1.2 *hiding power, n*—the spreading rate of a coating at a specified level of hiding, which is conventionally 0.98 contrast ratio representing photometric “complete hiding.”

3.1.2.1 *Discussion*—Practically speaking, hiding power is the extent to which a powder coating masks the color and pattern of the substrate at a given film thickness.

3.1.3 *minimum explosive concentration (MEC), n*—the lower point for a range of concentrations of organic particles suspended in air that can be ignited by a sufficient energy source.

3.1.3.1 *Discussion*—Also referred to as *LEL or Lower Explosive Level*.

3.1.4 *orange peel, n*—the appearance of irregularity of a surface resembling the skin of an orange.

3.1.5 *pourability, n*—the ability of a dry coating to flow uniformly or to be continuously poured from a container at a steady rate.

3.1.6 *specific gravity, n*—an expression of ratio of the density of a material to that of water at a given temperature and pressure.

3.2 *Definitions of Terms Specific to This Standard*:

3.2.1 Many of the following definitions specific to this guide were taken from the Powder Coating Institute’s

⁴ ISO standards are available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, <http://www.ansi.org>.

⁵ The PCI Recommended Procedures are available from the Powder Coating Institute (PCI), 2121 Eisenhower Avenue, Suite 401, Alexandria, VA 22314, <http://powdercoating.org>.