Designation: D6132 – 08

Standard Test Method for Nondestructive Measurement of Dry Film Thickness of Applied Organic Coatings Using an Ultrasonic Gage[1]

This standard is issued under the fixed designation D6132; 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 test method covers the use of ultrasonic film thickness gages to measure accurately and nondestructively the dry film thickness of organic coatings applied over a substrate of dissimilar material. Measurements may be made on field structures, on commercially manufactured products, or on laboratory test specimens. These types of gages can accurately measure the dry film thickness of organic coatings on concrete, wood and wallboard substrates.

1.2 This test method is not applicable to coatings that will be readily deformable under load of the measuring instrument as the instrument probe is placed directly on the coating surface to take a reading.

1.3 The effective range of instruments using the principle of ultrasonics is limited by gage design. A thickness range of 0.3 to 600 mils (8 µm to 15 mm) has been demonstrated.

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 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]

D823 Practices for Producing Films of Uniform Thickness of Paint, Varnish, and Related Products on Test Panels

D1005 Test Method for Measurement of Dry-Film Thickness of Organic Coatings Using Micrometers

D4138 Practices for Measurement of Dry Film Thickness of Protective Coating Systems by Destructive, Cross-Sectioning Means

E177 Practice for Use of the Terms Precision and Bias in ASTM Test Methods

E691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method

2.2 *SSPC—The Society for Protective Coatings Standards:*[3]

SSPC-PA2 Measurement of Dry Coating Thickness with Magnetic Gages

SSPC-PA9 Measurement of Dry Organic Coating Thickness on Cementitious Substrates Using Ultrasonic Gages

3. Summary of Test Method

3.1 Instruments complying with this test method measure thickness by emitting an ultrasonic pulse into the coating that is reflected back from the substrate to the probe. The travel time is converted into a thickness reading. The instrument must be placed directly on the coating surface to take a reading.

3.2 After verifying accuracy on a known coated part of the object or material of the same kind, the instrument probe is coupled with the coated specimen, after proper cure and conditioning according to the coating manufacturer's instructions.

3.3 It should be recognized that the accuracy of the measurements can be influenced when:

3.3.1 The coated object to be measured is not planar with respect to the transducer face at the point of measurement,

3.3.2 The surface roughness of the coated specimen exceeds the coating thickness, and

3.3.3 Coating density is not uniform.

4. Significance and Use

4.1 Many coating properties are markedly affected by the film thickness of the dry film such as adhesion, flexibility, and hardness. To be able to compare results obtained by different operators, it is essential to measure film thickness carefully.

[1] This test method is under the jurisdiction of ASTM Committee D01 on Paint and Related Coatings, Materials, and Applications and is the direct responsibility of Subcommittee D01.23 on Physical Properties of Applied Paint Films.

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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] Available from Society for Protective Coatings (SSPC), 40 24th St., 6th Floor, Pittsburgh, PA 15222-4656, http://www.sspc.org.

***A Summary of Changes section appears at the end of this standard**

4.2 Most protective and high performance coatings are applied to meet a requirement or a specification for the dry-film thickness of each coat, or for the complete system, or both. Coatings must be applied within certain minimum and maximum thickness tolerances in order that they can fulfill their intended function. In addition to potential performance deficiencies, it is uneconomical to apply more material than necessary when coating large areas such as floors and walls.

4.3 Surface roughness can affect the accuracy of this test method. A rough surface has a tendency to scatter the ultrasonic pulse and odd readings may occur occasionally.

4.4 This test method may not be applicable to measure organic coating thickness on all substrates. The instrument's ability to detect a distinct interface between the coating and the substrate may be impeded if the coating and the substrate are of similar composition or if the coating is non-homogeneous. Verify operation on a known thickness of the coating/substrate combination if these circumstances are thought to exist.

4.5 Multilayered coatings have many interfaces and the instrument will measure to the interface separating the two most acoustically different materials. Some instruments have the ability to detect and measure the individual layer thicknesses in a multi-layer system.

4.6 The use of this test method is not necessarily limited by the type of substrate material as nondestructive magnetic-type or eddy current means.

5. Apparatus

5.1 *Ultrasonic Gage*—an electronic gage with a transducer using an ultrasonic principle and numerical techniques.

6. Test Specimen

6.1 When this test method is used in the field, the specimen is the coated structure or article on which the dry film thickness is to be evaluated.

6.2 For laboratory use, apply the materials to be tested to panels of the same composition, structure or article on which the dry film thickness is to be evaluated. Cure the organic coating in accordance with the coating manufacturer's instruction.

NOTE 1—Coatings should be applied in accordance with Practices D823, or as agreed upon between the purchaser and the seller.

7. Calibration, Verification and Adjustment of Apparatus

7.1 Although most ultrasonic instruments are pre-calibrated, accuracy should be verified by measuring a known thickness of the coating (reference standard) as determined by:

7.1.1 Using a cross-sectioning method, or

7.1.2 Nondestructively (that is, not destroying film integrity) removing and measuring the coating with a micrometer in accordance with Test Method D1005, or

7.1.3 Cutting the product and comparing it to a shim of known thickness.

7.2 Roughness adversely affects accuracy. Therefore the reference standard should be smooth.

7.3 Best calibration adjustment results are achieved on coatings with a thickness equal to or greater than the coating thickness range to be measured.

NOTE 2—The thickness of an organic coating can be determined in accordance with the Test Method D4138. While this is a destructive test method, it will provide an alternative test method to ensure measurements made in accordance with this test method are in the correct range.

8. Procedure

8.1 Use the instrument only after calibration has been verified in accordance with Section 7.

8.2 Ensure that the coating is cured prior to use of the instrument.

8.3 Unless the coating is soft, a couplant may be required to transmit the ultrasonic pulse from the instrument's probe into the coating. Water is ideal for smooth, thin coatings. For rough coatings, a glycol gel is best, provided it is not a contaminant for the coating to be measured. Other liquids such as liquid soap may be used. For specific information regarding the use of couplants, refer to the gage manufacturer's instructions.

8.4 Place the instrument's probe flat on the surface and apply constant pressure. Hold the probe steady during the measurement.

8.5 Take a sufficient number of readings to characterize the surface.

NOTE 3—SSPC-PA2 specifies the location and number of readings needed to characterize a coated steel surface and SSPC-PA9 specifies the location and number of readings needed to characterize a coated cementitious surface. Select the method most appropriate for the material being tested.

9. Report

9.1 Record the following information at the time of the measurements and include in the report:

9.1.1 Type of substrate,

9.1.2 Type of coating, coating thickness,

9.1.3 Instrument used, serial number, and any special calibration adjustment, and

9.1.4 Mean, and standard deviation of the thickness readings found.

9.2 Depending upon the application, it may be useful to record the individual readings as well. For rough substrates or coatings, it is recommended to measure the coating in accordance with SSPC-PA2 or SSPC-PA9.

10. Precision and Bias[4]

10.1 *Precision*—Table 2The precision of this test method is based on an interlaboratory study of Test Method D6132 - 04, conducted in 2007. Each of eight laboratories tested seven different coated panels using two types of instrumentation. Every "test result" represents an individual determination. All laboratories reported two replicate test results for every panel with each instrument. Practice E691 was followed for the

[4] Supporting data have been filed at ASTM International Headquarters and may be obtained by requesting Research Report RR:D01-1144.

TABLE 1 PosiTector 200 — Coating Thickness (*μm*)

Panel	Average[A]	Repeatability Standard Deviation	Reproducibility Standard Deviation	Repeatability Limit	Reproducibility Limit
	$\bar{X}$	S_r	S_R	r	R
1	77.05	2.31	2.69	6.47	7.52
2	52.86	2.52	4.16	7.05	11.66
3	59.48	1.25	2.65	3.51	7.43
4	51.73	2.09	2.64	5.85	7.39
5	66.01	1.64	1.70	4.59	4.76
6	81.50	1.89	4.08	5.30	11.43
7	139.5	2.03	7.47	5.70	20.91

[A] The average of the laboratories' calculated averages.

TABLE 2 Quintsonic — Coating Thickness (*μm*)

Panel	Average[A]	Repeatability Standard Deviation	Reproducibility Standard Deviation	Repeatability Limit	Reproducibility Limit
	$\bar{X}$	S_r	S_R	r	R
1	71.92	2.54	3.21	7.11	8.98
2	41.55	1.81	6.93	5.08	19.41
3	55.63	1.94	3.90	5.44	10.92
4	47.53	0.89	1.35	2.50	3.79
5	64.73	1.00	1.80	2.80	5.04
6	75.20	0.87	3.21	2.44	9.00
7	114.9	1.50	5.44	4.19	15.24

[A] The average of the laboratories' calculated averages.

design and analysis of the data; the details are given in Research Report No. D01–1144.

10.1.1 *Repeatability Limit (r)*—Two test results obtained within one laboratory shall be judged not equivalent if they differ by more than the "*r*" value for that material; "*r*" is the interval representing the critical difference between two test results for the same material, obtained by the same operator using the same equipment on the same day in the same laboratory.

10.1.1.1 Repeatability limits are listed in Table 1 and Table 2.

10.1.2 *Reproducibility Limit (R)*—Two test results shall be judged not equivalent if they differ by more than the "*R*" value for that material; "*R*" is the interval representing the critical difference between two test results for the same material, obtained by different operators using different equipment in different laboratories.

10.1.2.1 Reproducibility limits are listed in Table 1 and Table 2.

10.1.3 The above terms (repeatability limit and reproducibility limit) are used as specified in Practice E177.

10.1.4 Any judgment in accordance with statements 10.1.1 and 10.1.2 would have an approximate 95 % probability of being correct.

10.2 *Bias*—At the time of the study, there was no accepted reference material suitable for determining the bias for this test method, therefore no statement on bias is being made.

10.3 The precision statement was determined through statistical examination of 224 results, from eight laboratories, on seven coated panels. These seven coated panels were described as the following:

Panel 1: UV cured coating on hickory
Panel 2: water borne acrylic primer on plywood
Panel 3: factory primer on untextured molded hardboard
Panel 4: UV cured coating on unfilled maple
Panel 5: a roll and curtain coated acrylic filler/base/top coats on hardboard
Panel 6: sprayed lacquer on oak
Panel 7: powder coating on medium-density fiberboard

10.4 Each instrument's default calibration setting was used. For best accuracy, each instrument should be checked against a known thickness of the particular coating being measured and adjusted if necessary. To judge the equivalency of two test results, it is recommended to choose the coating/panel combination closest in characteristics to the test panel and coating.

11. Keywords

11.1 coating thickness; dry film thickness; nondestructive thickness; paint thickness; ultrasonic thickness gage

SUMMARY OF CHANGES

Committee D01 has identified the location of selected changes to this standard since the last issue (D6132 - 04) that may impact the use of this standard. (Approved July 1, 2008.)

(1) Section 2 — Referenced Documents was expanded to include a new paint application standard from SSPC entitled SSPC-PA9.

(2) Section 10 — A precision and bias statement based on the results of a round-robin study was added.