Designation: D 1400 – ~~94~~00

Standard Test Method for Nondestructive Measurement of Dry Film Thickness of Nonconductive Coatings Applied to a Nonferrous Metal Base[1]

This standard is issued under the fixed designation D 1400; 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 nondestructive measurement of the dry film thickness of electrically nonconductive coatings applied over a nonferrous metal base using commercially available eddy current instruments. This test method is intended to supplement manufacturers' instructions for the manual operation of the gages, and is not intended to replace them.

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

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

1.4 *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.*

2. Referenced Documents

2.1 *ASTM Standards:*

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[1] This test method is under the jurisdiction of ASTM Committee ~~D-1~~ 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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D 823 Practices for Producing Films of Uniform Thickness of Paint, Varnish, and Related Products on Test Panels[2]
D 1005 Test Method for Measurement of Dry-Film Thickness of Organic Coatings Using Micrometers[2]
D 1730 Practices for Preparation of Aluminum and Aluminum-Alloy Surfaces for Painting[3]
D 3980 Practice for Interlaboratory Testing of Paint and Related Materials[2]

3. Summary of Test Method

3.1 After calibrating the instrument using shims of known thickness and either a bare part of the metal object or metal of the same kind, the instrument probe is placed in contact

3.1 Instruments complying with the coated metal. In instruments of this type, electrical characteristics of a coil and the probe are changed test method measure coating thickness by the eddy currents created in substrates by the alternating flux use of the coil. eddy currents. The extent of such changes varies with the distance between the probe and the metal, the distance being the thickness of the dry coating film.

3.2 It should instrument must be recognized that placed directly on the accuracy of the measurements can be influenced or affected when measurements are made closer than 1 in. (25 mm) coating surface to an edge or 3 in. (75 mm) to another mass of metal. take a reading.

4. Significance and Use

4.1 The results of many test methods applicable to coatings are markedly affected instrument probe is energized by alternating current that induces eddy currents in the metal substrate. The eddy currents in turn create opposing alternating magnetic fields in the substrate that modify the electricknal characteristics of the dry film, some examples being adhesion, flexibility, and hardness to name a few. To be able to compare results obtained by different operators, it probe coil. The extent of such changes is essential to measure film thickness closely.

4.2 Most protective and high performance coatings are applied to meet a requirement or a specification for dependent upon the dry film thickness of each coat, or for distance between the complete system, or both. Coatings must be applied within certain minimum probe 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 metal structures the metal, and coils. This test method is used to measure film the distance being shown on the instrument meter as thickness (mils or microns) of coatings on nonferrous metals. the intervening coating.

5. Apparatus

5.1 *Eddy Current Thickness Gages*, commercially available, suitable to measure coating thickness accurately.

5.2 *Nonconductive Coating Thickness Shims for Calibration*—Shims Standards, with assigned values traceable to N national S standards are available, but when shims are used that are not traceable to National Standards, thickness must be measured to the nearest 0.1 mil (2.5 μm) using a micrometer using a method such as Procedure D in Test Method D 1005. available.

6. Test Specimens

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 composition similar roughness, shape, thickness, and surface conditions composition on which it is desired to determine the thickness.

NOTE 1—Applicable test panel description and surface preparation methods are given in Practices D 1730.
NOTE 2—Coatings should be applied in accordance with Practices D 823, or as agreed upon between the purchaser and the seller.

7. Verification of Calibration of Apparatus

7.1 Calibrate the instrument in an area free

7.1 Different gage manufacturers follow different methods of stray magnetic fields, such as power lines, generators, calibration or welding equipment. There shall be no vibration apparent on the test piece when the instrument is being calibrated. adjustment. Verify calibration according to manufacturer's instructions.

7.2 Use a bare section of the substrate after the specified surface preparation method has been accomplished. If an uncoated section of the substrate is not available, an uncoated test panels similar to panel of the same metal type on over which the specified preparation has been performed may be used.

7.3 Select calibration shims in the expected

7.3 Use nonconductive thickness range to be measured. For example, a coating is approximately 3 mils (75 μm) in thickness, calibrate the instrument at 3 mils. Then check the calibration using shims of both a lesser and greater thickness to determine the thickness range over which the instrument is calibrated. The limits of this range verify calibration or test blocks bearing calibrated

[2] *Annual Book of ASTM Standards*, Vol 06.01.
[3] *Annual Book of ASTM Standards*, Vol 02.05.

nonconductive coatings that are ~~set at the points where the gage no longer registers the shim thicknesses within the manufacturer's stated accuracy (for example, ±10 %).~~ traceable to a suitable national standard.

7.4 Follow the manufacturer's instructions for the specific adjustment of the instrument.

7.5 Measure the thickness of a series of calibration standards covering the expected range of coating thickness. To guard against measuring with an inaccurate gage, recheck the gage at regular intervals. That interval should be set and maintained throughout the control process.

7.6 If the substrate material to be tested changes in roughness, shape, thickness or composition, re-verify calibration and adjust as necessary.

8. Procedure

8.1 Use the instrument only after it has been calibrated in accordance with Section 7.

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

8.3 Inspect the probe tip and surface to be measured to ~~assure~~ ensure that they are clean~~, o~~. Otherwise erroneous readings can result.

8.4 Take readings in areas free of ~~vibration, electrical,~~ electrical or magnetic fields.

~~8.5 If thickness readings are found to be outside the~~

8.5 Verify calibration ~~range established in 7.3, repeat the calibration procedure in the appropriate range. Check the calibration before, during, and after each use~~ periodically to ensure that the instrument continues to read properly. If the instrument is found to be out of adjustment, remeasure the thicknesses taken since the last satisfactory calibration check was made.

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

8.6.1 For laboratory measurements a recommended minimum ~~is~~ of three—for a ~~3~~ 75 by ~~6 in. (75~~ 150-mm (3 by ~~150 mm) panel~~ 6-in.) panel, and more in proportion to size.

8.6.2 For field measurements a recommended minimum is five determinations at random for every 100 ft^2 (10 m^2) of the surface area. Each of the five determinations should be the mean of three separate gage readings within the area of a ~~½ in. (12 mm)~~ 4-cm (1.5-in.) diameter circle.

8.7 Take measurements ~~no closer than 1 in. (25 mm) to an~~ at least 13 mm (½ in.) away from any edge or ~~3 in. (75 mm) to another mass~~ corner of ~~metal.~~ the specimen. If ~~such measurements are necessary,~~ it is necessary to measure closer than ½-in., recheck the ~~calibration~~ base metal reading in the specific areas to determine the extent of the effect (if any) the edge ~~or mass of metal~~ has on the ~~instrument reading.~~ measurement.

9. Report

9.1 Report the following information: ~~the~~

9.1.1 instrument used, serial numbers~~,~~

9.1.2 range, ~~and~~ mean of the thickness readings ~~fou~~, and

9.~~D~~1.3 depending upon the application, ~~it may be useful to~~ record the individual readings as well.

10. Precision and Bias

10.1 *Precision*—~~On the basis of an interlaboratory~~—A new round-robin study ~~of this test method, conducted to determine~~ was performed recently. Data are being analyzed statistically. When completed, the ~~precision of several types of instrument in measuring a moderate range of coating thicknesses, the intralaboratory~~ required repeatability and ~~interlaboratory coefficients~~ reproducibility sections of ~~variation, calculated using procedures described in Practice D 3980, were found to~~ this test method will be ~~those shown in Table 1 for~~ written and the ~~instrument evaluated. Based upon these coefficients the following criteria should be used for judging, at the 95 % confidence level the acceptability of results:~~

~~10.1.1 *Repeatability*—Two results, each the mean of four measurements, obtained by the same operator using instruments from the same category should be considered suspect if they differ by more than the maximum allowable difference values given~~ round-robin study documented in ~~Table 1 for the appropriate film thickness.~~

~~10.1.2 *Reproducibility*—Two results, each the mean of four measurements, obtained by operators in different laboratories using instruments from the same category should be considered suspect if they differ by more than the maximum allowable difference values given in Table 1 for the appropriate film thickness.~~ an ASTM research report.

10.2 *Bias*—The bias for this test method for measuring dry film thickness cannot be measured at this time, because each instrument has its own bias.

11. Keywords

11.1 coating thickness; dry film thickness; Eddy current thickness gages; nondestructive thickness; paint thickness