Designation: D 4138 – 94 (Reapproved 1999)

Standard Test Methods for Measurement of Dry Film Thickness of Protective Coating Systems by Destructive Means[1]

This standard is issued under the fixed designation D 4138; 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 These test methods cover the measurement of dry film thickness of coating films by microscopical observation of precision angular cuts in the coating film. Use of these methods usually requires repair of the coating film.

1.2 Three test methods are provided for measuring dry film thickness of protective coating system:

1.2.1 *Test Method A*—Using groove cutting instruments.

1.2.2 *Test Method B*—Using grinding instruments.

1.2.3 *Test Method C*—Using drill bit instruments.

1.3 The substrate should be sufficiently rigid to prevent deformation of the coating during the cutting process. The surface may be flat or moderately curved (pipes as small as 1 in. (25 mm) in diameter may be measured in the axial direction).

1.4 The range of thickness measurement is 0 to 50 mils (0 to 1.3 mm).

1.5 The values stated in inch-pound 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.*

2. Referenced Documents

2.1 *ASTM Standards:*

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 Micrometres[2]

D 1186 Test Methods for Nondestructive Measurements of Dry-Film Thickness of Nonmagnetic Coatings Applied to a Ferrous Base[2]

D 1400 Test Method for Nondestructive Measurement of Dry Film Thickness of Nonconductive Coatings Applied to a Nonferrous Metal Base[2]

3. Summary of Test Methods

3.1 The three methods are based on measurement of dry film thickness by observation of angular cuts in the coating through a microscope having a built-in reticle with a scale. Each method employs different instruments to make the cut in the coating.

3.2 *Test Method A*—Uses a carbide tipped wedge to cut a groove in the coating. The groove is cut at a precise angle to the surface. Three wedge angles are available.

3.3 *Test Method B*—Uses a high speed rotary grinding disk or drum type bit to cut partial cylindrical cavities in the coating. Axes of the cavities can be oriented at three angles of inclination to the surface.

3.4 *Test Method C*—Uses a specific angle tip drill bit to cut a conical cavity in the coating.

4. Significance and Use

4.1 The use of these test methods is not necessarily limited by the type of substrate material as are nondestructive magnetic-type means.

4.2 Individual coats or the overall thickness of a coating system can be measured by these methods.

5. Test Method A—Groove Cutting Instruments

5.1 **Apparatus**

5.1.1 *Scribe Cutter and an Illuminated Microscope, with Measuring Reticle*. The scribe cutter and illuminated microscope may be combined as a single instrument (see Fig. 1).[3] The instrument calibration shall be performed by taking measurements on applied films of known thickness (see Test Method D 1005).

5.1.2 *Tungsten Carbide Cutting Tips* shall be designed to provide a very smooth incision in the paint film at a precise angle to the surface (see Fig. 2). Separate tip designs (angles) shall provide cuts of known slopes such as 1 to 1, 1 to 2, and 1 to 10. These tips shall be nominally designated 1×, 2×, and 10× to indicate the ratio of the lateral measurement to vertical depth. The lateral measurement is represented by the reticle markings and this vertical depth is represented by the coating

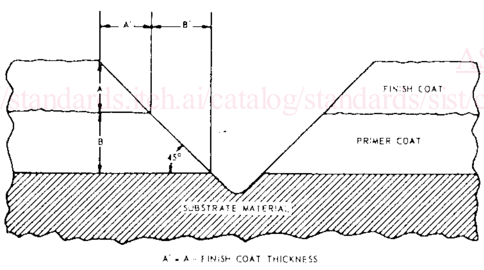
[1] These test methods are under the jurisdiction of ASTM Committee D33 on Protective Coating and Lining work for Power Generating Facilities and is the direct responsibility of Subcommittee D33.03 on Quality Systems.

Current edition approved Jan. 15, 1994. Published March 1994. Originally published as D 4138 – 82. Last previous edition D 4138 – 88.

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

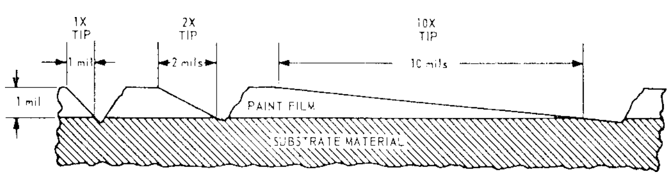
[3] The sole source of supply of the Tooke gage known to the committee at this time is MicroMetrics, P.O. Box 13804, Atlanta, GA 30324. If you are aware of alternative suppliers, please provide this information to ASTM Headquarters. Your commments will receive careful consideration at a meeting of the responsible technical committee,[1] which you may attend.

FIG. 1 Tooke Inspection Gage[3]



(A)

FIG. 2 Geometry of Thickness Measurement



(B)

FIG. 2 Grooves Made by 1×, 2×, and 10× Cutting Tips
(continued)

film thickness. Metal guide studs on the gage body shall, together with the cutting tip, form a firm base to ensure that the tip aligns vertically with the painted surface for a precisely aligned incision.

5.1.3 *Illuminated, 50-Power Microscope* shall contain a reticle scaled from 0 to 100 divisions (see Fig. 3). The total viewing field of the microscope shall be approximately 125 mils (3.18 mm).

NOTE 1—A photomicrographic adapter is available with some microscopic instruments that allows photographs to be taken through the view finder.

5.2 **Test Specimens**

5.2.1 If multiple coats of paint are to be measured, successive contiguous coats should be of contrasting colors to aid sharp discrimination of interfaces.

5.2.2 Generally, test specimens shall be prepared (as test panels) or chosen (as sites on a structure) to be representative of localized coating thickness and variability.

5.2.3 For test panels, if measurement repeatability is desired for a particular paint system, care shall be taken in panel preparation. Coating shall be uniformly applied in accordance with Test Method D 823. Panels shall be placed in a horizontal position during drying. Uniform application thickness shall be verified by another measurement method such as Test Methods D 1005, D 1186, or D 1400.

5.3 **Procedure**

5.3.1 Select a test panel or choose a site for the thickness measurement.

5.3.2 Using an appropriate surface marker of contrasting color, mark a line on the surface approximately 2-in. long (51-mm) where the thickness measurement will be made.

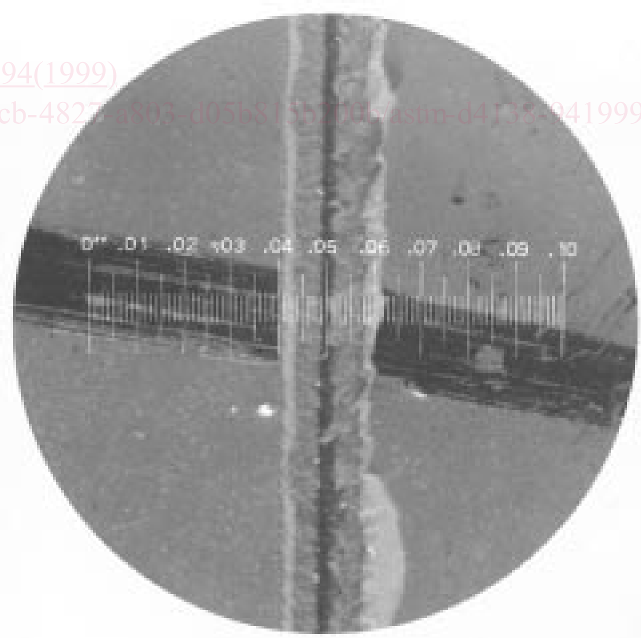


FIG. 3 Typical View Through Microscope of Tooke Inspector Gage Showing Reticle