



Standard Test Method for Nondestructive Measurement of Film Thickness of Pipeline Coatings on Steel¹

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1. Scope

1.1 This test method describes the nondestructive measurement of the thickness of a dry, nonmagnetic coating applied to the external surface of steel pipe. The method is recommended for coating thicknesses up to 6 mm (0.240 in.) and for any diameter pipe, but not smaller than 10 mm (0.5 in.). It does not apply to excessively soft films.

1.2 The values stated in SI units to three significant decimals are to be regarded as the standard. The values given in parentheses are for information only.

1.3 *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. Summary of Test Method

2.1 The coating thickness is determined by an instrument that measures thickness by nondestructive techniques, based on variations in magnetic flux or magnetic attraction between its detection unit and the magnetic base material.

3. Significance and Use

3.1 Measurements of film thickness are an essential part of most ASTM test methods related to coatings on steel pipe. Adequate thickness is important for a coating to fulfill its function of preventing or mitigating corrosion of steel pipelines.

3.2 The accuracy of the thickness measurements may be influenced by the deformability of the coating. This test method is not applicable to coatings that would be readily deformable under the force exerted by the probe of the measuring instrument.

4. Apparatus

4.1 The apparatus shall be a nondestructive-type thickness gage capable of being standardized over its range of intended

use. It shall be designed so that variations in magnetic flux or magnetic attraction between its detection unit and the steel base can be calibrated to indicate the thickness of the coating material.

4.2 It shall be suitable for measuring thicknesses of dry, nonmagnetic coatings on either a flat or a circular base.

5. Standardization of Instruments

5.1 The instrument shall be standardized in accordance with the manufacturer's instructions before use by employing suitable thickness standards. The standardization shall be checked at frequent intervals during use.

5.2 Nonmagnetic standards of uniform thickness are available in either of two types, foil or coated substrate, as supplied or recommended by the manufacturer of the instrument.

5.2.1 *Foils (Shims)*—The thickness of the foil should be as close as possible to the expected thickness of the coating to be measured. The foil should be placed on a smooth, clean, low-carbon, steel plate, making certain that there is intimate contact between the foil and the substrate. It is recommended that single foils of proper thickness be used and that foils be replaced frequently, since they are subject to indentation. Foils are advantageous for standardizing on curved surfaces and are often more readily available than coated standards.

NOTE 1—For some instruments there is an effective depth of penetration of the field created by the instrument probe. This is the critical depth of thickness at which the instrument will no longer be affected by increases of substrate thickness. Since it depends on the instrument and substrate, it should be determined experimentally.

5.2.2 *Coated Substrate Standards*²—These standards consist of nonmagnetic coatings of known thickness permanently bonded to a low-carbon steel (1010 grade) substrate, 8 mm (0.30 in.) thick. The thickness standard should be as close as possible to the expected thickness of the coating to be measured.

NOTE 2—If the curvature of the coating to be measured is sufficient to preclude standardization on a flat surface, the standardization should be done with a standard foil on a substrate with the same curvature as the coating to be measured.

¹ This test method is under the jurisdiction of ASTM Committee D-1 on Paint and Related Coatings, Materials, and Applications and is the direct responsibility of Subcommittee D01.48 on Durability of Pipeline Coatings and Linings.

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² Coated substrate standards may be obtained from the U. S. Department of Commerce, National Bureau of Standards, Standard Materials Unit, Washington, DC 20234.

6. Procedure

6.1 Operate each instrument in accordance with the manufacturer's instructions.

6.2 Take a minimum of twelve readings per piece of pipe as follows: Take three equally spaced readings along the top surface; rotate the pipe 90° three times, taking three equally spaced readings after each rotation. Record the average, minimum, and maximum of the twelve readings as the coating thickness.

NOTE 3—Instruments with two contact poles shall be positioned on the coating surface with the poles in the same plane.

NOTE 4—The anchor pattern of the steel pipe substrate must be considered for its effect on the accuracy of the measurements if the anchor pattern is greater than 25 % of the coating thickness.

Note 5—Foreign materials such as dirt and grease shall be removed by suitable cleaning without removing any coating materials.

Note 6—Measuring instruments and methods may depend on the technique of the operator. For example, the pressure applied to a probe and the rate of applying a balancing force to a magnet will vary from one individual to another. Often such differences can be reduced or eliminated either by having the gage calibrated by the same operator who will make the measurement or by using constant-pressure probes. Probes must be positioned perpendicular to the surface of the specimen at the point of measurement. Some magnetic instruments of the magnetic-attraction type require the pole piece to be in a vertical position. If a magnetic instrument is to be used in a horizontal or upside-down position, its calibration for that position should be verified.

Note 7—Instruments using magnetic attraction are sensitive to the speed with which the magnet is removed from the specimen. The magnet must be removed so that thickness measurements are not affected by speed of removal.

7. Report

7.1 The report shall include the following:

7.1.1 Complete identification of the specimen including: name and code number of the coating; pipe diameter; source; production data, including surface preparation of the substrate and depth of anchor pattern, if known; and production run number.

7.1.2 Name and type of instrument used, and method of standardization, and

7.1.3 Number of thickness measurements taken, and the average, minimum, and maximum value of the measurements.

8. Precision

8.1 The repeatability and reproducibility of thickness measurements will depend on the instrument design, the operator, and the particular measuring application.

8.1.1 *Repeatability*—When the same instrument is used by the same operator, duplicate measurements on the same sample should agree with each other within $\pm 5\%$.

8.1.2 *Reproducibility*—Separate operators using different instruments on a known thickness standard should obtain average results agreeing with each other within 10 % of the thickness standard.

9. Keywords

9.1 coatings; film; nondestructive; nonmagnetic; pipeline; thickness

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