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# Standard Practice for Steel Castings, Stainless, Instrument Calibration, for Estimating Ferrite Content[1]

This standard is issued under the fixed designation A 799/A799M; 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 practice covers the procedure for calibration of instruments to be used for estimating the ferrite content of the microstructure of cast stainless steels by magnetic response or measurement of permeability. This procedure covers both primary and secondary instruments.

1.1.1 A primary instrument is one that has been calibrated using National Institute of Standards and Technology-Standard Reference Material (NIST-SRM) thickness coating standards. It is a laboratory tool to be used with test specimens. Some primary instruments may be used to directly measure the ferrite content of castings.

1.1.2 A secondary instrument is one that has been calibrated by the use of secondary standards that have been measured by a calibrated primary instrument. Secondary instruments are to be used to directly measure the ferrite content of castings.

1.2 The values stated in either inch-pound units or SI units are to be regarded separately as standard. Within the text, the SI units are shown in brackets. The values stated in each system are not exact equivalents; therefore, each system must be used independently of the other. Combining values from the two systems may result in nonconformance with the specification.

1.3 *This standard does not purport to address all of the safety problems, 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:*

B 499 Test Method for Measurement of Coating Thicknesses by the Magnetic Method: Nonmagnetic Coatings on Magnetic Basis Metals[2]

E 562 Practice for Determining Volume Fraction by Systematic Manual Point Count[3]

2.2 *NIST Standard:*

NIST-SRM Coating Thickness Standards, No. 1321 through 1323, 1357 through 1360, and 1361a through 1364a, (All are in sets of three or four standards.)[4]

## 3. Terminology

3.1 *Definitions:*

3.1.1 *ferrite*—the body-centered cubic microconstituent in stainless steel castings.

3.1.2 *ferrite percentage*—a value designating the ferrite content of cast stainless steels. The Steel Founders Society of America (SFSA) has assigned ferrite percentages to the series of NIST coating thickness standards. This assignment was based on the magnetic attraction for a weighted No. 2 magnet by the coating standards when compared with the magnetic attraction of the same magnet by a series of cast stainless steels whose ferrite content had been determined by an accurate metallographic point count. Fig. 1 is a plot of the thickness of these standards and the assigned ferrite percentages. By the use of Fig. 1, any primary instrument will have its calibration traceable to the SFSA's instruments or any other calibrated instrument and thus afford comparable reproducible ferrite percentages. It also allows traceability to NIST.

3.1.3 *secondary standards*—pieces of cast stainless steel whose ferrite percentage has been determined "in house" by a calibrated primary instrument. These are used to calibrate secondary instruments (see Section 8).

## 4. Significance and Use

4.1 The amount of ferrite present in an austenitic stainless steel has been shown to influence the strength, toughness and corrosion resistance of this type of cast alloy. The amount of ferrite present tends to correlate well with the magnetic permeability of the steel. The methods described in this standard cover calibration practice for estimating ferrite by the magnetic permeability of the steel. The practice is inexpensive to use over large areas of the cast part and is non-destructive.

4.2 This practice has been used for research, alloy development, quality control, and manufacturing control.

4.2.1 Many instruments are available having two-point probes, single-point probes, and differing excitation current

[1] This practice is under the jurisdiction of ASTM Committee A-1 on Steel, Stainless Steel, and Related Alloysand is the direct responsibility of Subcommittee A01.18 on Castings.

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

[3] *Annual Book of ASTM Standards*, Vol 03.01.

[4] Available from Office of Standard Reference Materials, Chemistry Building, Room B 311, National Institute of Standards and Technology, Gaithersburg, MD 20899.

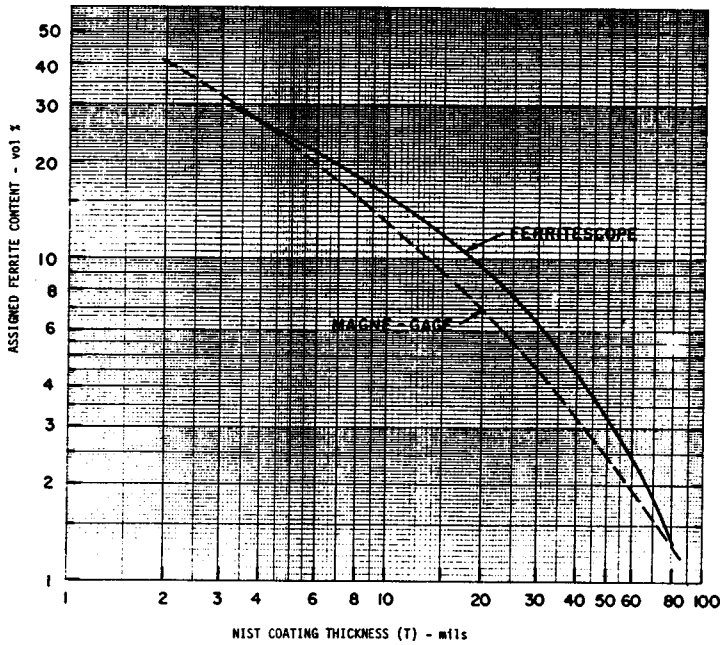


**FIG. 1 Assigned Ferrite Percentages to NIST Coating Thickness Standards**

levels. When the probe is placed on the material being investigated, a closed magnetic circuit is formed and energized by a low-frequency magnetic field. The voltage induced in the probe coil by this field is a measure of the permeability. When calibrated with standards having known ferrite content, this permeability indicates the ferrite content of the material being analyzed. The estimated ferrite content is read from a calibrated dial or from a digital-readout dial. Follow the manufacturer's instructions for proper calibration of the instrument.

4.3 Since this practice measures magnetic attraction and not ferrite directly, it is subject to all of the variables that affect magnetic permeability, such as thermal history.

4.4 Magnetic methods should not be used for arbitration of conflicts on ferrite content except when agreed upon between manufacturer and purchaser.

## 5. Apparatus

5.1 One primary instrument that uses magnetic attraction consists of a spring-loaded balance arm from which a rod-shaped magnet is suspended.[5] The opposite end of the balance arm from the magnet has counterweights that balance most but not all of the weight of the magnet.

5.1.1 When this instrument is used, the spring load is relaxed sufficiently to allow the magnet to make contact with the material being tested.

5.1.2 The spring is then wound until the force of the coiled spring overcomes the magnetic attraction of the magnet for the material being tested, causing the magnet to break contact and the lever arm to rise.

5.1.3 The amount of force that the coiled spring has developed is determined from a marked dial securely attached to the shaft that is used to coil or uncoil the spring.

5.1.3.1 A weighted number 2 is used with this instrument, U5-0664W.

5.2 When using a Feritscope,[6] follow the manufacturer's instructions for calibration. When traceability is required, confirm the calibration using the appropriate NIST standards listed in 2.2.

5.2.1 This instrument has a two-point probe as the sensing device. When this probe is placed on the material being investigated, a closed magnetic circuit is formed and energized by a low-frequency magnetic field. The voltage induced in the probe coil by this field is a measure of the permeability. When calibrated with standards having known ferrite content, this permeability indicates the ferrite content of the material being analyzed. The estimated ferrite content is read from a calibrated dial or from a digital-readout dial.

5.3 One secondary instrument consists of a balance arm that has a rod-shaped magnet attached to one end.[7] The opposite end is counterweighted to balance the magnet.

5.3.1 This arm with its magnet and counterweight is enclosed in a transparent box. The top face of this container has a threaded hole directly over the magnet. Into this hole are screwed-marked inserts that have metal plates on their bottom face. These plates have different strengths of attraction for the magnet.

5.3.2 In use, the bottom end of the magnet is touched to the material being investigated. The other end of the magnet is in contact with the metal plate on the bottom of the insert. The container is then raised. If the material being measured has a greater attraction for the magnet than does the plate on the bottom of the insert, the magnet will be pulled away from the insert. If not, the magnet will pull away from the material being measured. The insert buttons are changed until the ones that are

[5] Magna Gage, produced by Magna Gage Sales and Service, 6417 Chell Rd., Columbia, MD 21044.

[6] Feritscope, produced by Fisher Technology, Inc., Windsor, CT 06708.

[7] Severn Gage, Severn Instrument Co., Annapolis, MD.