Designation: A1086 – 20

Standard Specification for Thin-Gauge Nonoriented Electrical Steel Fully Processed Types[1]

This standard is issued under the fixed designation A1086; 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 specification covers the detailed requirements to which flat-rolled thin-gauge nonoriented fully processed electrical steel shall conform. Nominal thicknesses included in this specification are 0.10 mm (0.004 in.) to 0.30 mm (0.012 in.).

1.1.1 Refer to Specification A677 for properties of flat-rolled nonoriented fully processed electrical steel in nominal thicknesses of 0.36 mm (0.014 in.) to 0.64 mm (0.025 in.).

1.1.2 Refer to Specification A876 for properties of flat-rolled grain-oriented fully processed electrical steel.

1.1.3 Thin-gauge nonoriented electrical steels with a high silicon content (typically 6½ %) manufactured using silicon vapor-deposition or similar processes are not included in this specification.

1.2 The steel covered in this specification is produced to specified maximum core loss values and is intended primarily for use in rotating electrical machinery and other electromagnetic devices operating at moderate to elevated frequencies (100 Hz and greater). Desirable core loss and permeability characteristics are developed during mill processing; however, lamination manufacturing processes may adversely affect these mill-produced properties. Additional stress-relief heat treatment by the user may therefore be helpful in remediating these properties in the manufactured laminations. Stress-relief annealing is discussed further in Appendix X2.

1.3 These thin-gauge nonoriented fully processed electrical steels are low-carbon, silicon-iron, or silicon-aluminum-iron alloys typically containing 2.5 to 3.5 % silicon and a small amount of aluminum.

1.4 The values stated in SI units are to be regarded as standard. The values given in parentheses are mathematical conversions to customary (cgs-emu and inch-pound) units which are provided for information only and are not considered standard.

1.4.1 There are selected values presented in two units, both of which are in acceptable SI units. These are differentiated by the word "or," as in "g/cm^3, or, (kg/m^3)."

1.5 *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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.6 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

A34/A34M Practice for Sampling and Procurement Testing of Magnetic Materials

A340 Terminology of Symbols and Definitions Relating to Magnetic Testing

A343/A343M Test Method for Alternating-Current Magnetic Properties of Materials at Power Frequencies Using Wattmeter-Ammeter-Voltmeter Method and 25-cm Epstein Test Frame

A348/A348M Test Method for Alternating Current Magnetic Properties of Materials Using the Wattmeter-Ammeter-Voltmeter Method, 100 to 10 000 Hz and 25-cm Epstein Frame

A664 Practice for Identification of Standard Electrical Steel Grades in ASTM Specifications

A677 Specification for Nonoriented Electrical Steel Fully Processed Types

A700 Guide for Packaging, Marking, and Loading Methods for Steel Products for Shipment

A717/A717M Test Method for Surface Insulation Resistivity of Single-Strip Specimens

[1] This specification is under the jurisdiction of ASTM Committee A06 on Magnetic Properties and is the direct responsibility of Subcommittee A06.02 on Material Specifications.

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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.

A719/A719M Test Method for Lamination Factor of Magnetic Materials
A876 Specification for Flat-Rolled, Grain-Oriented, Silicon-Iron, Electrical Steel, Fully Processed Types
A927/A927M Test Method for Alternating-Current Magnetic Properties of Toroidal Core Specimens Using the Voltmeter-Ammeter-Wattmeter Method
A937/A937M Test Method for Determining Interlaminar Resistance of Insulating Coatings Using Two Adjacent Test Surfaces
A971/A971M Test Method for Measuring Edge Taper and Crown of Flat-Rolled Electrical Steel Coils
A976 Classification of Insulating Coatings for Electrical Steels by Composition, Relative Insulating Ability and Application
E18 Test Methods for Rockwell Hardness of Metallic Materials
E384 Test Method for Microindentation Hardness of Materials

3. Terminology

3.1 *Definitions*—See Terminology A340.

4. Classification

4.1 The thin-gauge nonoriented electrical steel types described by this specification are as shown in Table 1.

5. Ordering Information

5.1 Orders for material under this specification shall include as much of the following information as necessary to describe the desired material adequately:

5.1.1 ASTM specification number.

5.1.2 Core-loss type designation.

5.1.3 Surface coating type.

5.1.4 Thickness, width, and length (if in cut lengths instead of coils).

5.1.5 Total weight of ordered item.

5.1.6 Limitations in coil size or lift weights.

TABLE 1 Core-Loss Types[A] and Maximum Specific Core Losses[B] at a Magnetic Flux Density of 1.0 T (10 kG) for As-Sheared Epstein Specimens[C]

Thickness mm (in.)	Core-Loss Type	Maximum Core Loss at 400 Hz W/kg (W/lb)	Maximum Core Loss at 1000 Hz W/kg (W/lb)
0.10 (0.004)	10T590	13.0 (5.90)	37.5 (17.0)
0.12 (0.005)	12T610	13.5 (6.10)	39.7 (18.0)
0.15 (0.006)	15T640	14.0 (6.40)	43.0 (19.5)
0.18 (0.007)	18T650	14.4 (6.50)	46.0 (21.0)
0.20 (0.008)	20T680	15.0 (6.80)	49.4 (22.4)
0.22 (0.009)	22T700	15.4 (7.00)	55.1 (25.0)
0.25 (0.010)	25T730	16.0 (7.30)	61.7 (28.0)
0.27 (0.011)	27T770	17.0 (7.70)	66.6 (30.2)
0.30 (0.012)	30T820	18.0 (8.20)	72.3 (32.8)

[A] See Practice A664
[B] The test density shall be the correct ASTM assumed density (in accordance with 13.2) for the chemistry used by the producer to meet the property requirements of the specification.
[C] One half of strips cut parallel to the steel rolling direction, one half of strips cut perpendicular to the steel rolling direction. Refer to Section 13 for applicable test methods.

5.1.7 *End Use*—The user shall disclose as much pertinent information as possible about the intended application to enable the producer to provide material characteristics most suitable for specific fabricating practices.

5.1.8 Special requirements or exceptions to the provisions of this specification shall be negotiated between the user and the producer.

6. Manufacture

6.1 *Typical Melting and Casting:*

6.1.1 These thin-gauge fully processed nonoriented electrical steels may be made by basic-oxygen, electric-furnace, or other steel making practices.

6.1.2 These thin-gauge fully processed nonoriented electrical steels are characterized by low carbon content, usually less than 0.02 %. The principal alloying element is commonly silicon, but aluminum up to about 0.8 % is sometimes used instead of or in addition to silicon, depending on mill-processing practice for the desired magnetic grade. Individual producers will often have different silicon or aluminum contents for a particular grade because of intrinsic mill processing procedures.

6.1.3 Additional alloying elements that may be present depending on mill processing procedures include sulfur, typically less than 0.025 %, manganese in amounts between 0.10 and 0.40 %, and phosphorus, copper, nickel, chromium, molybdenum, antimony, and tin in residual amounts.

6.1.4 The producer is not required to report the chemical composition of each lot except when a clear need for such information has been shown. In such cases, the information to be reported shall be negotiated between the producer and the user.

6.2 *Typical Rolling and Annealing*—The processing sequence for thin-gauge fully processed, nonoriented electrical steel comprises hot-rolling, annealing, pickling, cold-rolling, and decarburizing annealing.

6.2.1 *Commercial Rerolling*—When commercial practice calls for the cold-rolling to finished thickness and the development of the final annealed and coated condition to take place at a production facility other than the original melting and hot-rolling mill, this rerolling facility should prepare final test data and certifications as well as package and ship the finished material to the user in accordance with the requirements for producers stated in this standard.

6.3 When changes in the manufacture of the material are believed to exert possible significant effects upon the user's fabricating practices and upon the magnetic performance to be obtained in the specified end use, the producer shall notify the user before shipment is made so the user has an opportunity to evaluate the effects.

7. Magnetic Properties

7.1 *Specific Core Loss*—Each core-loss type of electrical steel is identified by the maximum core loss requirements as shown in Table 1.

7.2 *Permeability*—The permeability at all magnetic flux density levels shall be as high as possible, consistent with the