



Designation: A 345 – 98

# Standard Specification for Flat-Rolled Electrical Steels for Magnetic Applications<sup>1</sup>

This standard is issued under the fixed designation A 345; 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 reappraisal. A superscript epsilon ( $\epsilon$ ) indicates an editorial change since the last revision or reappraisal.

## 1. Scope

1.1 This specification covers general procedures for specifying requirements in the procurement and delivery of flat-rolled electrical steels for magnetic applications. When an applicable individual specification does not exist, this specification enables the user to order a suitable material to be supplied under controlled conditions with respect to magnetic quality, sampling, testing, packaging, and so forth, by specifying certain requirements on the purchase order and citing this specification.

1.2 Individual specifications that are in conformity with this specification are A677, A677M, A683, A683M, A726, A726M, A840, A840M, A876, and A876M.

1.3 The following safety hazards caveat pertains only to the test methods portion, Section 13, of this specification. *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.*

NOTE 1—For more information on procedures associated with this specification, refer to the following: Test Methods A 341, A 343, A 347, A 348, and A 596, Practice A 664, and Test Methods A 712, A 719, A 720, A 721, A 804, and A 889.

## 2. Referenced Documents

### 2.1 ASTM Standards:

- A 34 Practice for Procurement Testing, and Sampling of Magnetic Materials<sup>2</sup>
- A 340 Terminology of Symbols and Definitions Relating to Magnetic Testing<sup>2</sup>
- A 341 Test Method for Direct-Current Magnetic Properties of Materials Using D-C Permeameters and the Ballistic Test Methods<sup>2</sup>

<sup>1</sup> This specification is under the jurisdiction of ASTM Committee A-6 on Magnetic Properties and is the direct responsibility of Subcommittee A06.02 on Materials Specifications.

Current edition approved April 10, 1998. Published September 1998. Originally published as A 345 – 49 to replace A 310. Last previous edition A 345 – 90 (1995) <sup>$\epsilon$ 1</sup>.

<sup>2</sup> Annual Book of ASTM Standards, Vol 03.04.

- A 343 Test Method for Alternating-Current Magnetic Properties of Materials at Power Frequencies Using Wattmeter-Ammeter-Voltmeter Method and 25-cm Epstein Test Frame<sup>2</sup>
- A 347 Test Method for Alternating-Current Magnetic Properties of Materials Using the Dieterly Bridge Method with 25-cm Epstein Frame<sup>2</sup>
- A 348 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<sup>2</sup>
- A 596 Test Method for Direct-Current Magnetic Properties of Materials Using the Ballistic Method and Ring Specimens<sup>2</sup>
- A 664 Practice for Identification of Standard Electrical and Laminations Steel Grades in ASTM Specifications<sup>2</sup>
- A 677 Specification for Nonoriented Electrical Steel, Fully Processed Types<sup>2</sup>
- A 677M Specification for Nonoriented Electrical Steel, Fully Processed Types (Metric)<sup>2</sup>
- A 683 Specification for Nonoriented Electrical Steel, Semi-processed Types<sup>2</sup>
- A 683M Specification for Nonoriented Electrical Steel, Semi-processed Types (Metric)<sup>2,3</sup>
- A 700 Practices for Packaging, Marking, and Loading Methods for Steel Products for Domestic Shipment<sup>3</sup>
- A 712 Test Method for Electrical Resistivity of Soft Magnetic Alloys<sup>2</sup>
- A 717 Test Method for Surface Insulation Resistivity of Single-Strip Specimens<sup>2</sup>
- A 719 Test Method for Lamination Factor of Magnetic Materials<sup>2</sup>
- A 720 Test Method for Ductility of Nonoriented Electrical Steel<sup>2</sup>
- A 721 Test Method for Ductility of Oriented Electrical Steel<sup>2</sup>
- A 726 Specification for Cold-Rolled Magnetic Lamination Quality Steel, Semiprocessed Types<sup>2</sup>

<sup>3</sup> Annual Book of ASTM Standards, Vol 01.05.

- A 726M Specification for Cold-Rolled Magnetic Lamination Quality Steel, Semiprocessed Types (Metric)<sup>2</sup>
- A 804 Test Methods for Alternating-Magnetic Properties of Materials at Power Frequencies Using Sheet-Type Test Specimens<sup>2</sup>
- A 840 Specification for Fully Processed Magnetic Lamination Steel<sup>2</sup>
- A 840M Specification for Fully Processed Magnetic Lamination Steel (Metric)<sup>2</sup>
- A 876 Specification for Flat-Rolled, Grain-Oriented, Silicon-Iron, Electrical Steel, Fully Processed Types<sup>2</sup>
- A 876M Specification for Flat-Rolled, Grain-Oriented, Silicon-Iron, Electrical Steel, Fully Processed Types [Metric]<sup>2</sup>
- A 889 Test Method for Alternating-Current Magnetic Properties of Materials at Low Inductions Using the Wattmeter-Varmeter-Ammeter-Voltmeter Method and 25-cm Epstein Frame<sup>2</sup>
- A 937 Test Method for Determining Interlaminar Resistance of Insulating Coatings Using Two Adjacent Test Surfaces<sup>2</sup>
- A 976 Classification of Insulating Coatings by Composition, Relative Insulating Ability and Application<sup>2</sup>

### 3. Terminology

3.1 The terms and symbols used in this specification are defined in Terminology A 340.

### 4. Ordering Information

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

4.1.1 Specification A 345 or the individual specification number for the specification that shall govern.

4.1.2 Class of electrical steel, whether grain-oriented electrical steel, nonoriented electrical steel, or magnetic lamination steel.

4.1.3 Whether semi- or fully processed.

4.1.4 Core loss type number or standard grade designation. If an individual specification is not cited, the limiting value of the core loss or other magnetic property that shall control, as well as all applicable test conditions and test methods, shall be stated on the order.

4.1.5 Surface coating type.

4.1.6 Thickness, width, and length, if in cut lengths instead of coils, for the ordered item.

4.1.7 Total weight of ordered item.

4.1.8 Limitations on coil size or lift weight.

4.1.9 End use. Whenever possible, state a single end use for the desired material. For instance, specify whether it is for punched or stamped laminations, sheared laminations, wound cores, formed cores, welded lamination cores, adhesive-bonded cores, and so forth. This will help the supplier to provide material with the most desirable physical characteristics for the user's fabricating practices.

4.1.10 Exceptions to the cited specification or a statement of special requirements.

### 5. Materials and Manufacture

5.1 Normally, these electrical steels are composed principally of iron with relatively small amounts of alloying elements such as silicon and aluminum. Other chemical elements are either in residual amounts or added in small amounts to improve fabrication. The manufacturer shall provide on request a statement of nominal chemistry being supplied.

5.2 The chemical composition and the method of manufacture shall not be unduly prescribed. Any restriction on the conditions of manufacture shall be negotiated between the manufacturer and the purchaser.

5.3 When changes in the manufacture of successive shipments of material because of changing technology are believed to increase the likelihood of adverse effects upon magnetic or fabrication performance in the specified end use, the manufacturer shall notify the purchaser before shipment is made so that he can be afforded an opportunity to evaluate the effects.

### 6. Magnetic Properties

6.1 Electrical steels are normally purchased to specified maximum core-loss requirements. The purchaser shall make clear to the supplier the limiting values of core loss required for the ordered material. The grain direction of the test specimen, whether as sheared or given a specific anneal, the test induction and frequency, the test method, and other information pertinent to the proper qualification of the material shall be specified.

6.2 When the desired end use imposes definite limits on other magnetic properties such as specific power exciting, permeability, coercive force, and so forth, the purchaser is responsible for so specifying on the order. The purchaser shall also state whether specific tests are required for these other properties or whether the specified characteristics are for informational purposes only.

### 7. Electrical Properties

7.1 Electrical steels are normally provided with an electrical resistivity appropriate to the core-loss limit and the specified end use. If the electrical resistivity must be restricted, the limiting value shall be negotiated with the supplier.

7.2 The surface insulation ability inherent in the processing of electrical steels for magnetic applications may differ widely with the class of electrical steel and the intended end use. Several types of applied coatings are available to attain different levels of insulation ability as needed for critical applications. These inherent and applied coating types C-0, C-2, C-3, C-4, C-4AS, C-5, C5-AS, and C-6 are described and characterized in Classification A 976. If the inherent mill-processed surface lacks sufficient insulating ability for the user's purposes, the purchaser shall specify the applied coating type to be used, whether tests shall be made by Test Method A 717 or Test Method A 937, any special test conditions under these test methods, and any limiting value of the insulation ability.

### 8. Mechanical Properties

8.1 Requirements for ductility, lamination factor, tensile or yield strength, and so forth that differ from those inherent in the usual product meeting the magnetic requirements should be