



Designation: A840 – 06

## Standard Specification for Fully Processed Magnetic Lamination Steel<sup>1</sup>

This standard is issued under the fixed designation A840; 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 ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

### 1. Scope

1.1 This specification covers cold-rolled carbon steel coils or strip used in the fully processed condition in magnetic lamination applications.

1.2 This steel is produced to specified maximum core-loss values and is intended primarily for commercial power frequency (50- and 60-Hz) applications in magnetic devices. Desirable core-loss and permeability characteristics are developed during mill processing, so further heat treatment by the purchaser is not necessary for most uses.

1.3 Fully processed magnetic lamination steels are flat-rolled low carbon iron alloys having 1 % maximum silicon and 0.4 % maximum aluminum.

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

### 2. Referenced Documents

2.1 *ASTM Standards*:<sup>2</sup>

[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](#)

[A664 Practice for Identification of Standard Electrical Steel Grades in ASTM Specifications](#)

<sup>1</sup> 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.

Current edition approved Nov. 15, 2006. Published November 2006. Originally approved in 1985. Last previous edition approved in 2006 as A840/A840M – 00 (2006). DOI: 10.1520/A0840-06.

<sup>2</sup> For referenced ASTM standards, visit the ASTM website, [www.astm.org](http://www.astm.org), or contact ASTM Customer Service at [service@astm.org](mailto:service@astm.org). For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[A700 Practices for Packaging, Marking, and Loading Methods for Steel Products for Shipment](#)

[A719/A719M Test Method for Lamination Factor of Magnetic Materials](#)

### 3. Terminology

3.1 The terms and symbols used in this specification are defined in Terminology [A340](#).

### 4. Classification

4.1 The fully processed magnetic lamination 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 Name of material (fully processed magnetic lamination steel).

5.1.3 ASTM core-loss type number.

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.

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

5.1.8 Special requirements or exceptions to the provisions of this specification.

### 6. Manufacture

6.1 *Melting Practice*:

6.1.1 These fully processed magnetic lamination steels may be made by basic oxygen, electric furnace, or other steelmaking practices.

6.1.2 These steels typically contain less than 0.03 % carbon.

6.1.3 The addition of silicon, aluminum, manganese, and phosphorus may be used to enhance punchability and improve magnetic properties by increasing electrical resistivity. The

**TABLE 1 Core-Loss Types<sup>A</sup> and Maximum Core-Loss Values at 15 kG (1.5 T) and 60 Hz<sup>B</sup> for As-Sheared Epstein Specimens<sup>C</sup>**

ASTM Core-Loss Type <sup>A</sup>	Strip Thickness,		Maximum Core Loss		Typical Relative Peak Permeability
	in.	(mm)	W/lb	(W/kg)	
47C550	0.0185	(0.47)	5.50	(12.13)	1150
47C600			6.00	(13.23)	1300
64C700	0.025	(0.64)	7.00	(15.43)	1250
64C750			7.50	(16.53)	1400

<sup>A</sup>See Practice A664.

<sup>B</sup>Maximum core losses at 15 kG (1.5 T) and 50 Hz are 0.79 times maximum core loss at 60 Hz.

<sup>C</sup>One half of the strips cut parallel to and one half of the strips cut perpendicular to the rolling direction.

alloy additions are usually restricted such that the density of these steels is maintained above 7.825 g/cm<sup>3</sup> (7825 kg/m<sup>3</sup>).

6.1.4 Residual elements such as copper, nickel, chromium, molybdenum, and tin should be held as low as practicable.

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

### 6.2 Typical Processing:

6.2.1 Processing sequence for fully processed magnetic lamination steel comprises hot rolling, pickling, cold rolling, and annealing.

6.2.2 The mill annealing operation is typically nondecarburizing or partially decarburizing, resulting in a finished product that can be prone to magnetic aging depending on the carbon content.

6.2.3 Unless otherwise specified, these steels are supplied with a smooth surface finish in the as-annealed condition. The required surface texture is imparted from the roll surface to the steel surface during cold rolling.

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 manufacturer shall notify the purchaser before shipment is made to provide opportunity to evaluate the effects.

## 7. Magnetic Properties

7.1 Core losses are guaranteed and shall conform to the limits given in Table 1.

7.2 Permeability depends on alloy composition and processing. Relative peak permeability is a dimensionless quantity which is the same in all unit systems. Typical relative peak permeability values are found in Table 1.

7.3 Note that fully processed electrical steels do not normally need a user anneal. Therefore, care must be taken to minimize fabrication strain, as magnetic properties can be adversely affected. Examples of such strain are roller leveling and improper slitting practices.

## 8. Mechanical Requirements

8.1 *Lamination Factor*—The lamination factor shall be as high as practicable. It is higher in the thicker gauge and when the surface is smooth, uncoated, and without significant amounts of oxide. Lamination factors determined in accordance with Test Method A719/A719M at 50 psi (345 MPa) are typically in the range from 95 to 98 %.

8.2 *Hardness*—Typical hardness for this steel is between 45 to 75 HRB. Specific hardness requirements shall be negotiated between the steel producer and user.

## 9. Dimensions and Permissible Variations

9.1 *Thickness*—Specified thickness should be one of the common thicknesses as follows:

Thickness, in.	(mm)
0.0185	(0.47)
0.025	(0.64)

9.2 *Thickness Variations*—The average thickness of the material supplied shall be as close as possible to the ordered thickness. Measurements made with a contacting micrometer at points no closer than 3/8 in. (10 mm) from the edge of a sheet or coil of specified width shall not differ from the specified thickness by more than the value (which include taper) shown in Table 2.

9.3 *Taper*—The rolling of flat rolled coils inherently produces an edge which is thinner than the rest of the coil width. This characteristic is termed tapered edge or feather or gamma and occurs primarily within 1 or 2 in. (25 or 50 mm) from the as-rolled edge of the material. The thickness variation involved in edge taper sometimes is the major portion of the total overall thickness variation permitted in 9.2. It may be expected that in the case of edge slit coils, the following limits on the differences in thickness measured within the first 2 in. (50 mm) or less from either edge of the ordered width will apply:

Ordered Thickness,		Maximum Taper,	
in.	(mm)	in.	(mm)
0.0185	0.47	0.0012	0.030
0.025	0.64	0.0014	0.036

More restricted taper tolerances or tolerances on mill edge coils shall be negotiated between the manufacturer and the purchaser.

9.4 *Width Tolerances*—Maximum deviations from the ordered width shall be as shown in Table 3.

**TABLE 2 Thickness Tolerances, Cold-Rolled Sheet, Fully Processed Magnetic Lamination Steel for Specified Width 2 to 60 in. (50 to 1520 mm) Inclusive<sup>A</sup>**

Specified Thickness		Thickness Tolerance, Over and Under	
in.	(mm)	in.	(mm)
Over 0.019 to 0.039, incl	(over 0.48 to 0.99 incl)	0.003	(0.08)
Over 0.014 to 0.019, incl	(over 0.36 to 0.48 incl)	0.002	(0.05)

<sup>A</sup>Thickness is measured at any point across the width not less than 3/8 in. (10 mm) from a side edge.