Designation: A664 – 15 (Reapproved 2022)

Standard Practice for Identification of Standard Electrical Steel Grades in ASTM Specifications[1]

This standard is issued under the fixed designation A664; 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 designating (within ASTM specifications) standard grades of flat-rolled electrical steels made to specified maximum values of specific core loss. This practice applies to magnetically soft irons and steel (low-carbon steels and alloys of iron with silicon, aluminum, and other alloying elements) where a core loss measurement at a stated peak value of alternating induction and a stated frequency, such as 1.5 T (15 kG) and 60 Hz, is normally used to grade the material. This practice also applies when some other property is specified (or a different induction or frequency, or both) as the limiting characteristic, provided the material also meets all the requirements of the ASTM specification.

1.2 Individual specifications that are in conformity with this practice are Specifications A677, A683, A726, A876, and A1086.

1.3 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 *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.*

1.5 *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]

A340 Terminology of Symbols and Definitions Relating to Magnetic Testing

A677 Specification for Nonoriented Electrical Steel Fully Processed Types

A683 Specification for Nonoriented Electrical Steel, Semiprocessed Types

A726 Specification for Cold-Rolled Magnetic Lamination Quality Steel, Semiprocessed Types

A876 Specification for Flat-Rolled, Grain-Oriented, Silicon-Iron, Electrical Steel, Fully Processed Types

A976 Classification of Insulating Coatings for Electrical Steels by Composition, Relative Insulating Ability and Application

A1086 Specification for Thin-Gauge Nonoriented Electrical Steel Fully Processed Types

3. Terminology

3.1 The terms and symbols used in this practice are defined in Terminology A340.

4. Procedure

4.1 *General Requirements of the Core-Loss-Type Designations*—The core-loss-type designations to be used for ordering purposes and for identification of the shipped material in ASTM specifications for electrical steels shall follow a six-character protocol (for example, 35H094) comprised of the elements described in 4.2, 4.3, and 4.4:

4.2 *First Two Digits*—The first two digits of the grade designation shall represent the nominal thickness of the material in millimetres to the nearest one hundredth millimetre multiplied by 100. For instance, the number 36 represents a thickness of 0.36 mm (0.014 in.).

4.2.1 Designation of nominal thickness by Electrical Sheet Gauge Number does not conform to the requirements of this practice or of specifications referred to herein. Refer to

[1] This practice 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.

Appendix X1 for the relationship between Electrical Sheet Gauge Number and nominal thickness in millimetres and inches.

4.3 *Code Letters*—A code letter shall designate the general category of magnetic material and the standard sampling and testing practices that apply. The precise conditions of sampling and testing are given in the ASTM specification covering each class of material. The code letter to be used and the sampling and testing conditions associated with that letter shall be as in Table 1.

4.4 *Last Three Digits*—The last three digits of the grade designation provide a reference to the general specific core loss values and testing conditions of the material. These digits are based on the reference value for maximum permissible specific core loss in W/lb corresponding to the standardized acceptance value in W/kg. The three digit designation presents the reference value in watt per pound, at the test conditions indicated by the code letter, to the nearest one-hundredth watt per pound multiplied by 100. Examples of the use of the three digit code with selected Code Letters are presented in 4.4.1.

4.4.1 *Examples of Three Digit Grade Designations:*

4.4.1.1 *Example 1*—The 155 designation in an ASTM specification used in conjunction with the Code Letter F represents material with a maximum specific core loss value of 3.42 W/kg (1.55 W/lb) determined at 1.5 T (15 kG) and 60 Hz on an as-sheared Epstein specimen consisting of one half of the strips cut parallel to the rolling direction and the other half cut perpendicular to the rolling direction. The three digit designation 155 is based on the reference value of 1.55 W/lb for the maximum value of specific core loss.

4.4.1.2 *Example 2*—The 094 designation in an ASTM specification used in conjunction with the Code Letter H represents material with a maximum specific core loss value of 2.07 W/kg (0.940 W/lb) determined at 1.7 T (17 kG) and 60 Hz on a parallel grain Epstein specimen annealed after shearing. The three digit designation 094 is based on the reference value of 0.940 W/lb for the maximum value of specific core loss.

4.4.1.3 *Example 3*—The 650 designation in an ASTM specification used in conjunction with the Code Letter T represents material with a maximum specific core loss value of 14.3 W/kg

TABLE 1 Code Letters and Sampling and Testing Conditions

Code Letter	ASTM Specification	Class of Material and Core-Loss Testing Conditions
D	A726	Magnetic lamination steel, semiprocessed, with specific core-loss value determined in W/kg at 1.5 T (15 kG) and 60 Hz on Epstein specimens[A] after a quality development anneal at 790 °C (1450 °F) with a 1-h soak period. The three digit grade designation is based on the specific core loss reference value in W/lb at 1.5 T (15 kG) and 60 Hz.
F	A677	Nonoriented electrical steel, fully processed, with specific core-loss value determined in W/kg at 1.5 T (15 kG) and 60 Hz on as-sheared Epstein specimens.[A] The three digit grade designation is based on the specific core loss reference value in W/lb at 1.5 T (15 kG) and 60 Hz.
S	A683	Nonoriented electrical steel, semiprocessed, with specific core-loss value determined in W/kg at 1.5 T (15 kG) and 60 Hz on Epstein specimens[A] after a quality development anneal at 845 °C (1550 °F) with a 1-h soak period, except that the temperature shall be 790 °C (1450 °F) for alloy contents less than 1.3 % silicon plus aluminum. The three digit grade designation is based on the core loss reference value in W/lb at 1.5 T (15 kG) and 60 Hz.
T	A1086	Thin-gauge nonoriented electrical steel, fully processed, with specific core-loss value determined in W/kg at 1.0 T (10 kG) and both 400 Hz and 1000 Hz on as-sheared Epstein specimens.[A] The three digit grade designation is based on the specific core loss reference value in W/lb at 1.0 T (10 kG) and 400 Hz.
G	A876	Grain-oriented electrical steel, fully processed, with specific core-loss value determined in W/kg at 1.5 T (15 kG) and 60 Hz on Epstein specimens[B] stress-relief annealed usually in the range from 790 to 845 °C (1450 to 1550 °F) with a 1-h soak period. The three digit grade designation is based on the specific core loss reference value in W/lb at 1.7 T (17 kG) and 60 Hz.
H	A876	Grain-oriented electrical steel, fully processed, with specific core-loss value determined in W/kg at 1.7 T (17 kG) and 60 Hz on Epstein specimens[B] stress-relief annealed usually in the range from 790 to 845 °C (1450 to 1550 °F) with a 1-h soak period. The three digit grade designation is based on the specific core loss reference value in W/lb at 1.7 T (17 kG) and 60 Hz.
P	A876	Grain-oriented electrical steel, fully processed, high permeability, with specific core-loss value determined in W/kg at 1.7 T (17 kG) and 60 Hz on Epstein specimens,[B] stress-relief annealed usually in the range from 790 to 845 °C (1450 to 1550 °F) with a 1-h soak period. Relative peak permeability at 796 A/m (10 Oe) typically exceeds 1880. The three digit grade designation is based on the specific core loss reference value in W/lb at 1.7 T (17 kG) and 60 Hz.
Q	A876	Grain-oriented electrical steel, fully processed, high permeability, laser scribed, with specific core-loss value determined in W/kg at 1.7 T (17 kG) and 60 Hz on an as-sheared sheet-type test specimen. Relative peak permeability at 796 A/m (10 Oe) typically exceeds 1880. The three digit grade designation is based on the specific core loss reference value in W/lb at 1.7 T (17 kG) and 60 Hz.

[A] Test specimen with one half of the strips cut parallel to the rolling direction and the other half cut perpendicular to the rolling direction.
[B] Test specimen with all strips cut parallel to the rolling direction.

(6.50 W/lb) determined at 1.0 T (10 kG) and 400 Hz, and 43.0 W/kg (19.5 W/lb) determined at 1.0 T (10 kG) and 1000 Hz, on an as-sheared Epstein specimen consisting of one half of the strips cut parallel to the rolling direction and the other half cut perpendicular to the rolling direction. The three digit designation 650 is based on the 400 Hz reference value of 6.50 W/lb for the maximum value of specific core loss.

5. Use of Standard Electrical Steel Grade Designations

5.1 The standard grade designation, formulated as described herein, shall be used together with the appropriate ASTM specification to designate specifically the desired material. For instance, a material designated ASTM Specification A876 Type 35H094 signifies grain-oriented electrical steel, fully processed, in a thickness of 0.35 mm (0.014 in.) with a maximum specific core loss of 2.07 W/kg (0.940 W/lb) measured at 1.7 T (17 kG) and 60 Hz on Epstein specimens with all strips cut parallel to the rolling direction, stress-relief annealed at 790 to 845 °C (1450 to 1550 °F) with a 1-h soak period.

5.2 The ASTM grade designations for electrical steel shall be assigned only by ASTM. They shall apply only when an ASTM specification incorporating that grade designation has become effective through the normal standardizing activities of the Society. The ASTM grade designations shall be used to identify electrical steel grades only when the material so identified complies with the requirements of the ASTM specification of which the grade designation is a part.

6. Keywords

6.1 core loss; electrical steel; fully processed; grain-oriented electrical steel; identification; laser scribed; magnetic lamination steel; nonoriented electrical steel; semiprocessed; thin-gauge electrical steel

APPENDIXES

(Nonmandatory Information)

X1. ELECTRICAL SHEET GAUGE NUMBERS

X1.1 Table X1.1 shows the relationship between Electrical Sheet Gauge Number and nominal thickness in millimetre and inch. This table is provided for information only.

TABLE X1.1 Electrical Sheet Gauge Number

Electrical Sheet Gauge Number	Nominal Thickness	
	mm	in.
16	1.59	0.0625
17	1.42	0.0560
18	1.27	0.0500
19	1.15	0.0453
20	0.952	0.0375
21	0.864	0.0340
22	0.787	0.0310
23	0.711	0.0280
24	0.635	0.0250
25	0.559	0.0220
26	0.470	0.0185
27	0.432	0.0170
28	0.394	0.0155
29	0.356	0.0140
30	0.318	0.0125
31	0.254	0.0100