



Designation: ~~F 1—94 (Reapproved 2000)~~ 1 – 03

Standard Specification for Nickel-Clad and Nickel-Plated Steel Strip for Electron Tubes¹

This standard is issued under the fixed designation F 1; 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 steel strip, nickel-clad or nickel-plated on both sides, for use in electron tubes.

1.2 The values stated in inch-pound units are to be regarded as the standard. The metric equivalents of inch-pound units may be approximate.

¹ This specification is under the jurisdiction of ASTM Committee ~~F-T~~ F01 on Electronics and is the direct responsibility of Subcommittee F01.03 on Metallic Materials. Current edition approved ~~Aug. 15, 1994~~, Dec. 1, 2003. Published ~~October 1994~~, January 2004. Originally published as ~~F 1—57~~, approved in 1957. Last previous edition ~~F 1—68 (Reapproved 1989)~~ ϵ 1, approved in 1994 as F 1—94 (2000).

2. Referenced Documents

2.1 ASTM Standards:²

- B 487 Test Method for Measurement of Metal and Oxide Coating Thickness by Microscopical Examination of a Cross Section
- E 30 Test Methods for Chemical Analysis of Steel, Cast Iron, Open-Hearth Iron, and Wrought Iron³
- E 39 Test Methods for Chemical Analysis of Nickel³
- F 155 Test Method for Temper of Strip and Sheet Metals for Electronic Devices (Spring-Back Method)⁴
- F 239 Specification for Nickel Alloy Cathode Sleeves for Electron Devices⁵

3. Chemical Analysis

- 3.1 The chemical analysis of the steel shall be in accordance with Methods E 30.
- 3.2 The chemical analysis of the nickel shall be made in accordance with Methods E 39.

4. Bonding of Cladding or Plating

- 4.1 The nickel cladding may be bonded to the steel base by any process that will permit conformance to the requirements of this specification, except that no other material shall be employed as a bonding agent. In the preparation of nickel-plated steel no underplate shall be applied and no brighteners shall be used in the electroplating bath.
- 4.2 The material when fully annealed shall be capable of being bent flat upon itself without cracking, chipping, or separating. This test shall be made with 0.5-in. (13-mm) wide samples taken both lengthwise and crosswise to the grain of the strip. Examination shall be made under 10× magnification.

5. Thickness of Cladding or Plating

- 5.1 *Nickel Cladding*—The nickel cladding on each side shall conform to one of the following thickness requirements:
 - 5.1.1 *Type I*—A thickness of $10 \pm 1\%$ of the total thickness of the strip.
 - 5.1.2 *Type II*—A thickness of $15 \pm 1\%$ of the total thickness of the strip.
- 5.2 *Nickel Plating*—The nickel plating on each side shall conform to one of the following thickness requirements:
 - 5.2.1 *Type I*—A thickness of 0.00012 in. (0.0030 mm), min.
 - 5.2.2 *Type II*—A thickness of 0.00025 in. (0.0064 mm), min.
- 5.3 The thickness of the plating or cladding shall be determined by metallographic examination of a transverse section as described in Test Method B 487, or by any method agreed upon by the producer and the consumer.

NOTE 1—A metallographic technique may be found in the Symposium on Methods of Metallographic Specimen Preparation.⁶

6. Temper

- 6.1 The temper of the strip shall conform to limits agreed upon by the producer and the consumer, and shall be determined in accordance with Test Method F 155.

7. Dimensions, Mass and Permissible Variations

- 7.1 *Thickness*—The thickness of the material shall conform to the following tolerances:

Thickness, in. (mm)	Thickness Tolerance, in. (mm)
Under 0.010 (0.25)	± 0.0005 (0.013)
0.010 to 0.020 (0.25 to 0.50), incl	± 0.0008 (0.0203)

The thickness shall be measured 0.375 in. (9.5 mm) from the edge on 1-in. (25.4-mm) or wider strip, or at any point on narrower strip.

- 7.2 *Width*—For strip less than 3.0 in. (76 mm) wide and less than 0.020 in. (0.5 mm) thick, the width tolerance shall be ± 0.005 in. (0.13 mm).
- 7.3 *Edgewise Bow* shall be a maximum of 0.5 in. (13 mm) in 8 ft (2.4 m).
- 7.4 *Edge*—The edge shall be such as would result from a standard slitting operation.
- 7.5 *Burr*—The burr shall not exceed one half the strip thickness or 0.0025 in. (0.064 mm) whichever is smaller, as measured in accordance with the procedure described in the Appendix.

8. Workmanship, Finish, and Appearance

- 8.1 The surface shall be as smooth and free of dirt, oxide, pits, scratches, seams, slivers, streaks, stains, scale, blisters, edge

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*, Vol 02.05, volume information, refer to the standard's Document Summary page on the ASTM website.

³ Discontinued; see *1994 Annual Book of ASTM Standards*, Vol 03.05.

⁴ Discontinued; see *1983 Annual Book of ASTM Standards*, Vol 10.04.

⁵ Discontinued; see *1990 Annual Book of ASTM Standards*, Vol 10.04.

⁶ H. S. Link, "Mechanical Polishing of Metallographic Specimens," *Symposium on Methods of Metallographic Specimen Preparation*, ASTM STP 285, ASTTA, ASTM, 1961, pp. 8–11.

cracks, trimming burrs, and other defects, as best commercial practice will permit. Examination shall be made at 10× magnification.

9. Coiling and Spooling

- 9.1 Each coil or spool shall have only one continuous length of strip, free from joints of any kind, unless otherwise agreed.
- 9.2 The strip shall be so coiled that the normal curvature is not reversed.

10. Chemical Requirements

10.1 The base metal shall be an aluminum-deoxidized low-carbon steel conforming to the requirements as to chemical composition as prescribed in Table 1.

10.2 The nickel plating shall conform to the following requirements as to chemical composition:

Nickel plus cobalt, min, %	99.95
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10.3 The nickel cladding shall conform to the requirements of Table 2, Grades 1, 2, or 3 as required.

11. Rejection

11.1 Any spools or coils not conforming to the specified requirements may be rejected. If 15 % of the spools or coils in any shipment do not conform to the specified requirements, the entire shipment may be rejected.

12. Product Marking

- 12.1 Each coil or spool shall be marked plainly as follows:
 - 12.1.1 Name of material,
 - 12.1.2 Name of manufacturer,
 - 12.1.3 Lot or manufacturer’s identification number,
 - 12.1.4 Gross, tare, and net weight,
 - 12.1.5 Thickness and width of strip,
 - 12.1.6 Shipping date, and
 - 12.1.7 Inspector’s number or designation.

13. Packaging

13.1 The packaging shall be adequate to protect the spools or coils from contamination and damage during shipment. If a protective coating is used, it shall be completely removable by trichloroethylene degreasing.

14. Keywords

- 14.1 electron tubes; electroplated nickel; nickel-clad steel strip; steel strip; UNS N02205; UNS N02233; UNS N02253

TABLE 1 Chemical Requirements of Steel Strip

Element	Low-Carbon Steel ^A Composition, %
Iron	99.1 min
Carbon, max	0.11
Manganese, max	0.50
Phosphorus, max	0.040
Sulfur, max	0.050
Others	0.10 max, each, 0.20 total

^AThe material intended is AISI Grade 1008 (or lower carbon) aluminum-deoxidized steel.

TABLE 2 Chemical Requirements of Nickel

Element	Composition, %		
	UNS N02233 Grade 1 ^A	UNS N02205 Grade 2	UNS N02253 Grade 3 ^{B, A}
Nickel (plus cobalt), min	99.0	99.0	99.9
Carbon, max	0.10 ^C	0.15 ^D	0.02
Carbon, max	0.10 ^B	0.10 ^C	0.02
Copper, max	0.10	0.15	0.04
Copper, max	0.10	0.10	0.01
Iron, max	0.10	0.20	0.05
Iron, max	0.10	0.10	0.05
Magnesium	0.01–0.10	0.01–0.08	0.005 max
Magnesium	0.10 max	0.01–0.08	0.005 max
Manganese,	0.30	0.35	0.003
Manganese,	0.30	0.30	0.003
max			
Silicon, max	0.10	0.15	0.005
Silicon, max	0.10	0.10	0.005
Sulfur, max	0.008	0.008	0.003
Sulfur, max	0.005	0.005	0.003
Titanium	0.005 max	0.01–0.05	0.005 max
Titanium	0.005 max	0.005 max	0.005 max
Cobalt, max	0.10
Chromium,	0.005
max			

^ADuplicates chemistry of cathode Grade 23 in Specification F 239.

^BDuplicates chemistry of cathode Grade 23 in Specification F 239.

^CFor rerolling, 0.15 max % carbon is allowed.

^DCarbon of 0.02 % available in request.

APPENDIX

(Nonmandatory Information)

X1. PROCEDURE FOR MEASURING BURR ON STRIP

X1.1 Apparatus

X1.1.1 The instrument used to measure the burr on strip shall be a bench micrometer with a dial indicator and an adjustable anvil pressure or equivalent. The anvil diameter shall be 0.25 in. (6.4 mm) and the pressure used shall be 200 to 250 g.

X1.2 Procedure

X1.2.1 Measure the body thickness of strip as close to the edge as possible. Jog the specimen between the anvils of the micrometer until the reading settles. Then open the anvils and insert the edge of the strip. Close the anvils and take the reading. The difference between the body and edge reading is the height of the burr.

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