



# Standard Specification for Nickel-Chromium-Iron Sealing Alloys<sup>1</sup>

This standard is issued under the fixed designation F31; 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 two iron-nickel-chromium alloys (UNS K94760 and UNS K95150) used primarily for glass-sealing applications in electronic devices.

1.2 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.3 *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.*

## 2. Referenced Documents

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

[E18 Test Methods for Rockwell Hardness of Metallic Materials](#)

[E29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications](#)

[E112 Test Methods for Determining Average Grain Size](#)

[E228 Test Method for Linear Thermal Expansion of Solid Materials With a Push-Rod Dilatometer](#)

[E354 Test Methods for Chemical Analysis of High-Temperature, Electrical, Magnetic, and Other Similar Iron, Nickel, and Cobalt Alloys](#)

[F14 Practice for Making and Testing Reference Glass-Metal Bead-Seal](#)

[F140 Practice for Making Reference Glass-Metal Butt Seals and Testing for Expansion Characteristics by Polarimetric Methods](#)

[F144 Practice for Making Reference Glass-Metal Sandwich Seal and Testing for Expansion Characteristics by Polarimetric Methods](#)

<sup>1</sup> This specification is under the jurisdiction of ASTM Committee F01 on Electronics and is the direct responsibility of Subcommittee F01.03 on Metallic Materials, Wire Bonding, and Flip Chip.

Current edition approved May 1, 2016. Published May 2016. Originally approved in 1963 as F31 – 63 T. Last previous edition approved in 2012 as F31 – 12. DOI: 10.1520/F0031-16.

<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.

## 3. Ordering Information

3.1 Orders for material under this specification shall include the following information:

3.1.1 Size,

3.1.2 Temper (Section 6),

3.1.3 Surface finish (Section 8),

3.1.4 Marking and packaging (Section 13), and

3.1.5 Certification if required.

## 4. Chemical Composition

4.1 The material shall conform to the requirements of [Table 1](#) as to chemical composition.

NOTE 1—The major constituents of this alloy may be adjusted by the manufacturer so that the alloy meets the requirement for thermal expansion.

## 5. Chemical Analysis

5.1 Chemical analysis shall be made, when desired, in accordance with Test Methods [E354](#).

## 6. Surface Lubricants

6.1 All lubricants used during cold-working operations such as drawing, rolling, or spinning, shall be capable of being removed readily by any of the common organic degreasing solvents.

## 7. Temper

7.1 The desired temper of the material shall be specified on the purchase order. Unless otherwise specified, wire, rod, and tubing shall be given a final bright anneal by the manufacturer. Strip and sheet shall be annealed properly to develop drawing properties. For deep drawing, the hardness shall not exceed Rockwell B90 when determined in accordance with Test Methods [E18](#).

## 8. Grain Size

8.1 Strip and sheet for deep drawing applications shall have an average grain size not larger than ASTM No. 5 ([Note 2](#)), with no more than 10 % of the grains larger than No. 5 when measured in accordance with Test Methods [E112](#). For materials less than 0.005 in. (0.13 mm) in thickness, the grain size shall be such that there are no less than 4 grains across the thickness.

NOTE 2—This corresponds to a grain size finer than 0.065 mm or 16

**TABLE 1 Chemical Composition**

Element	42Ni-6Cr(UNS K94760)	47Ni-6Cr(UNS K95150)
	Composition, %	Composition, %
Nickel, nominal	42.0	47.0
Chromium, nominal	5.6	6.0
Carbon, max	0.07	0.02
Manganese, max	0.25	0.30
Phosphorus, max	0.025	0.025
Sulfur, max	0.025	0.025
Silicon, max	0.30	0.30
Aluminum, max	0.20	-
Iron	remainder	remainder

grains/in. <sup>2</sup> of image at 100x.

## 9. Dimensional Tolerances

9.1 *Cold-Rolled Strip*—Cold-rolled strip shall conform to the permissible variations in dimensions prescribed in [Table 2](#), [Table 3](#), and [Table 4](#).

9.2 *Round Wire and Rod*—Wire and rod shall conform to the permissible variations in dimension prescribed in [Table 5](#).

9.3 *Cold-Drawn Tubing*—Cold-drawn tubing, available either as seamless or welded, shall conform to the permissible variations prescribed in [Table 6](#).

## 10. Surface Finish

10.1 The standard surface finishes available shall be those resulting from the following operations:

- 10.1.1 Hot rolling,
- 10.1.2 Forging,
- 10.1.3 Centerless grinding (rod),

10.1.4 Belt polishing,

10.1.5 Cold rolling, and drawing, and

10.1.6 Wire drawing.

10.2 Care shall be taken to prevent the depletion of surface chromium during processing.

## 11. Thermal Expansion Characteristics

11.1 The average linear coefficient of thermal expansion shall be within limits specified in [Table 7](#).

## 12. Test Method for Thermal Expansion

12.1 Heat the specimen for 15 min at 1100°C in a hydrogen or cracked-ammonia atmosphere with a dew point of –40°C and cool to room temperature at a rate not exceeding 5°C/min.

12.2 Determine the thermal expansion characteristics in accordance with Test Method [E228](#).

12.3 The thermal expansion match between the alloy and a glass may be evaluated by preparing and testing an assembly in accordance with Practice [F14](#), Practice [F140](#), or Practice [F144](#).

## 13. Test Results

13.1 Observed or calculated values obtained from analysis, measurements, or tests shall be rounded off in accordance with the rounding-off method of Practice [E29](#), to the nearest unit in the last right-hand place of figures used in expressing the specified limit.

**TABLE 2 Permissible Variations in Thickness of Cold-Rolled Strip**

NOTE 1— Measurement shall be made at least 3/8 in. (9.5 mm) from the edge of strip over 1-in. (25.4 mm) wide.

Specified Thickness		Permissible Variations in Thickness for Width Given, ±							
in.	(mm)	Under 3 in.	(Under 76 mm)	Over 3 to 6 in.	(76 to 150 mm)	Over 6 to 12 in.	(150 to 300 mm)	Over 12 to 16 in.	(300 to 400 mm)
0.160 to 0.100, incl	(4.06 to 2.54)	0.002	(0.05)	0.003	(0.076)	0.004	(0.10)	0.004	(0.10)
0.099 to 0.069, incl	(2.51 to 1.75)	0.002	(0.05)	0.003	(0.076)	0.003	(0.076)	0.004	(0.10)
0.068 to 0.050, incl	(1.73 to 1.27)	0.002	(0.05)	0.003	(0.076)	0.003	(0.076)	0.003	(0.076)
0.049 to 0.035, incl	(1.24 to 0.89)	0.002	(0.05)	0.0025	(0.064)	0.003	(0.076)	0.003	(0.076)
0.034 to 0.029, incl	(0.86 to 0.74)	0.0015	(0.038)	0.002	(0.05)	0.0025	(0.064)	0.0025	(0.064)
0.028 to 0.026, incl	(0.71 to 0.66)	0.0015	(0.038)	0.0015	(0.038)	0.002	(0.05)	0.002	(0.05)
0.025 to 0.020, incl	(0.64 to 0.51)	0.001	(0.025)	0.0015	(0.038)	0.002	(0.05)	0.002	(0.05)
0.019 to 0.017, incl	(0.48 to 0.43)	0.001	(0.025)	0.001	(0.025)	0.0015	(0.038)	0.002	(0.05)
0.016 to 0.012, incl	(0.41 to 0.30)	0.001	(0.025)	0.001	(0.025)	0.0015	(0.038)	0.0015	(0.038)
0.011 to 0.0101, incl	(0.28 to 0.256)	0.001	(0.025)	0.001	(0.025)	0.001	(0.025)	0.0015	(0.038)
0.010 to 0.0091, incl	(0.254 to 0.231)	0.001	(0.025)	0.001	(0.025)	0.001	(0.025)	0.001	(0.025)
0.009 to 0.006, incl	(0.228 to 0.152)	0.00075	(0.019)	0.00075	(0.019)	...	...	...	...
Under 0.006	(0.152)	0.0005	(0.013)	0.0005	(0.013)	...	...	...	...

**TABLE 3 Permissible Variation in Thickness Across Width of Strip**

Specified Thickness		Maximum Variation in Thickness Across Width of Strip, Within Those Provided for in Table 1 for Edge Measurements for Widths and Thicknesses Given,					
in.	(mm)	5 in. and Under	(127 mm and Under)	Over 5 to 12 in.	(Over 127 to 300 mm)	Over 12 to 24 in., incl	(Over 300 to 600 mm)
0.005 to 0.010, incl	(0.13 to 0.25)	0.00075	(0.019)	0.001	(0.025)	0.0015	(0.038)
Over 0.010 to 0.025, incl	(0.25 to 0.64)	0.001	(0.025)	0.0015	(0.038)	0.002	(0.051)
Over 0.025 to 0.065, incl	(0.64 to 1.65)	0.0015	(0.038)	0.002	(0.051)	0.0025	(0.064)
Over 0.065 to 3/16, excl	(1.65 to 4.74)	0.002	(0.051)	0.0025	(0.064)	0.003	(0.076)

**TABLE 4 Permissible Variations in Width of Cold-Rolled Strip Supplied in Coils**

Specified Thickness		Permissible Variations in Width for Widths Given, ±											
in.	(mm)	Under 1/2 to 3/16 in.	(Under 12.7 to 4.75 mm)	1/2 to 6 in. (12.7 to 150 mm)	Over 6 to 9 in.	(150 to 225 mm)	Over 9 to 12 in.	(225 to 300 mm)	Over 12 to 20 in.	(300 to 500 mm)	Over 20 to 23 15/16 in.	(500 to 600 mm)	
0.187 to 0.161	(4.75 to 4.09)	...	0.016	(0.41)	0.020	(0.51)	0.020	(0.51)	0.031	(0.79)	0.031	(0.79)	
0.160 to 0.100	(4.06 to 2.54)	0.010	(0.25)	0.010	(0.25)	0.016	(0.41)	0.016	(0.41)	0.020	(0.51)	0.020	(0.51)
0.099 to 0.069	(2.51 to 1.75)	0.008	(0.20)	0.008	(0.20)	0.010	(0.25)	0.010	(0.25)	0.016	(0.41)	0.020	(0.51)
0.068 and under	(1.73)	0.005	(0.13)	0.005	(0.13)	0.005	(0.13)	0.010	(0.25)	0.016	(0.41)	0.020	(0.51)

**TABLE 5 Permissible Variations in Diameter of Wire and Rod**

Specified Diameter		Permissible Variations in Diameter, ±	
in.	(mm)	in.	(mm)
Wire (Coiled, Spooled or Straight Lengths)			
0.002 to 0.0043	(0.051 to 0.109)	0.0002	(0.005)
0.0044 to 0.0079	(112 to 0.200)	0.00025	(0.0064)
0.008 to 0.0149	(0.203 to 0.378)	0.0003	(0.0076)
0.015 to 0.0199	(0.381 to 0.505)	0.0004	(0.0102)
0.020 to 0.0309	(0.508 to 0.785)	0.0005	(0.0127)
0.031 to 0.0409	(0.787 to 1.039)	0.0006	(0.0152)
0.041 to 0.0609	(1.041 to 1.547)	0.0007	(0.0178)
0.061 to 0.0809	(1.549 to 2.055)	0.0008	(0.0203)
0.081 to 0.1259	(2.057 to 3.198)	0.001	(0.0254)
0.126 to 0.1569	(3.200 to 3.985)	0.0015	(0.038)
0.157 to 0.250	(3.988 to 6.35)	0.002	(0.051)
Rod, Centerless Ground Finish (Straight Lengths)			
0.030 to 0.0549	(0.766 to 1.394)	0.0005	(0.0127)
0.055 to 0.1249	(1.397 to 3.172)	0.001	(0.0254)
0.125 to 0.499	(3.175 to 12.67)	0.0015	(0.038)
0.500 to 0.999	(12.70 to 25.37)	0.002	(0.051)
1.000 to 1.625	(25.4 to 41.27)	0.0025	(0.064)
1.626 to 1.749	(41.3 to 44.42)	0.003	(0.076)
1.750 to 1.999	(44.45 to 50.17)	0.004	(0.010)
2.000 to 4.000	(50.8 to 101.6)	0.005	(0.013)

**TABLE 6 Permissible Variations in Dimensions of Standard Tubing**

Specified Outside Diameter,		Permissible Variations <sup>A</sup>				
in.	(mm)	Outside Diameter		Inside Diameter		Wall Thickness, plus or minus, %
		in.	(mm)	in.	(mm)	
Under 0.093	(2.36)	+ 0.002	(+ 0.051)	+ 0.000	(+ 0.000)	10
		-0.000	(-0.000)	-0.002	(-0.051)	
0.093 to 0.187, excl	(2.36 to 4.75)	+ 0.003	(+ 0.076)	+ 0.000	(+ 0.000)	10
		-0.000	(-0.000)	-0.003	(-0.076)	
0.187 to 0.550, excl	(4.75 to 12.7)	+ 0.004	(+ 0.102)	+ 0.000	(+ 0.000)	10
		-0.000	(-0.000)	-0.004	(-0.102)	
0.500 to 1.500, excl	(12.7 to 38.1)	+ 0.005	(+ 0.13)	+ 0.000	(+ 0.000)	10
		-0.000	(-0.00)	-0.005	(-0.13)	

<sup>A</sup> Any two of the three dimensional tolerances listed may be specified.

## 14. General Requirements

14.1 The material shall be commercially smooth, uniform in cross section, in composition, and in temper; it shall be free of

scale, corrosion, cracks, seams, scratches, slivers, and other defects as best commercial practice will permit.

**TABLE 7 Coefficient of Thermal Expansion<sup>A</sup>**

Temperature Range, °C	42Ni-6Cr (UNS K94760) Coefficient, 10 <sup>-6</sup> /°C	47Ni-6Cr (UNS K95150) Coefficient, 10 <sup>-6</sup> /°C
30 to 425	9.7 to 10.7	9.9 to 10.9
30 to 350	8.5 to 9.5	8.7 to 9.7

<sup>A</sup> Typical expansion data up to 700°C are given in the Appendix.

## 15. Packaging and Package Marking

15.1 Packaging shall be subject to agreement between the purchaser and seller.

15.2 The material as furnished under this specification shall be identified by the name or symbol of the manufacturer and by melt number. The lot size for determining compliance with the requirements of this specification shall be one heat.

## 16. Investigation of Claims

16.1 Where any material fails to meet the requirements of this specification, the material so designated shall be handled in

accordance with the agreement mutually agreed upon between the purchaser and the seller.

## 17. Keywords

17.1 glass-to-metal sealing; iron-nickel-chromium alloy; UNS K94760 ; UNS K95150

## APPENDIX

### (Nonmandatory Information)

#### X1. THERMAL EXPANSION DATA

X1.1 The following typical thermal expansion data for 42 % nickel-6 % and 47 % nickel-6 % chromium-iron sealing alloys (UNS K94760 and UNS K95150) are given for information only.

Temperature Range, °C	42Ni-6Cr (UNS K94760) Average Linear Coefficient of Thermal Expansion, $\mu\text{m}/\text{m}\cdot^{\circ}\text{C}$	47Ni-6Cr (UNS K95150) Average Linear Coefficient of Thermal Expansion, $\mu\text{m}/\text{m}\cdot^{\circ}\text{C}$
30 to 300	7.9	9.2
30 to 400	9.8	10.4
30 to 500	11.2	11.6
30 to 600	12.1	12.5
30 to 700	13.0	—

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