



Designation: ~~F31–16~~ F31 – 21

Standard Specification for Nickel-Chromium-Iron Sealing Alloys¹

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 (ϵ) 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~~ SI units are to be regarded as standard. The values given in parentheses ~~are mathematical conversions to after~~ 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~~ safety, health, and ~~health~~ environmental practices and determine the applicability of regulatory limitations prior to use.*

1.4 *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

E18 Test Methods for Rockwell Hardness of Metallic Materials

E29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications [3/astm-f31-21](#)

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

3. Ordering Information

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

3.1.1 Size,

¹ 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.

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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.

- 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.

TABLE 1 Chemical Composition

Element	42Ni-6Cr(UNS K94760) Composition, %	47Ni-6Cr(UNS K95150) 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

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~~HRB 90 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)~~0.13 mm (0.005 in.) 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 grains/in.~~16 grains/mm.² of image at 100 \times .

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**.

TABLE 2 Permissible Variations in Thickness of Cold-Rolled Strip

NOTE 1—Measurement shall be made at least $\frac{3}{8}$ 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, ±				
	(mm)	Under 3 in.	(Under 76 mm)	Over 3 to 6 in.	(76 to 150 mm)
0.160 to 0.100, incl	(4.06 to 2.54)	0.002	(0.05)	0.003	(0.076)
0.099 to 0.069, incl	(2.51 to 1.75)	0.002	(0.05)	0.003	(0.076)
0.068 to 0.050, incl	(1.73 to 1.27)	0.002	(0.05)	0.003	(0.076)
0.049 to 0.035, incl	(1.24 to 0.89)	0.002	(0.05)	0.0025	(0.064)
0.034 to 0.029, incl	(0.86 to 0.74)	0.0015	(0.038)	0.002	(0.05)
0.028 to 0.026, incl	(0.71 to 0.66)	0.0015	(0.038)	0.0015	(0.038)
0.025 to 0.020, incl	(0.64 to 0.51)	0.001	(0.025)	0.0015	(0.038)
0.019 to 0.017, incl	(0.48 to 0.43)	0.001	(0.025)	0.001	(0.025)
0.016 to 0.012, incl	(0.41 to 0.30)	0.001	(0.025)	0.001	(0.025)
0.011 to 0.0101, incl	(0.28 to 0.256)	0.001	(0.025)	0.001	(0.025)
0.010 to 0.0091, incl	(0.254 to 0.231)	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 2 Permissible Variations in Thickness of Cold-Rolled Strip

NOTE 1—Measurement shall be made at least 9.5 mm ($\frac{3}{8}$ in.) from the edge of strip over 25.4 mm (1-in.) in width.

Specified Thickness	Permissible Variations in Thickness for Width Given, ±			
	Under 76 mm (3 in.)	Over 76 to 150 mm (3 to 6 in.)	Over 150 to 300 mm (6 to 12 in.)	Over 300 to 400 mm (12 to 16 in.)
4.06 to 2.54, incl (0.160 to 0.100)	0.05 (0.002)	0.076 (0.003)	0.10 (0.004)	0.10 (0.004)
2.53 to 1.75, incl (0.100 to 0.069)	0.05 (0.002)	0.076 (0.003)	0.076 (0.003)	0.10 (0.004)
1.74 to 1.27, incl (0.068 to 0.050)	0.05 (0.002)	0.076 (0.003)	0.076 (0.003)	0.076 (0.003)
1.26 to 0.89, incl (0.050 to 0.035)	0.05 (0.002)	0.064 (0.0025)	0.076 (0.003)	0.076 (0.003)
0.88 to 0.74, incl (0.035 to 0.029)	0.038 (0.0015)	0.05 (0.002)	0.064 (0.0025)	0.064 (0.0025)
0.73 to 0.66, incl (0.029 to 0.026)	0.038 (0.0015)	0.038 (0.0015)	0.05 (0.002)	0.05 (0.002)
0.65 to 0.51, incl (0.026 to 0.020)	0.025 (0.001)	0.038 (0.0015)	0.05 (0.002)	0.05 (0.002)
0.50 to 0.43, incl (0.020 to 0.017)	0.025 (0.001)	0.025 (0.001)	0.038 (0.0015)	0.05 (0.002)
0.42 to 0.30, incl (0.017 to 0.012)	0.025 (0.001)	0.025 (0.001)	0.038 (0.0015)	0.038 (0.0015)
0.29 to 0.256, incl (0.011 to 0.010)	0.025 (0.001)	0.025 (0.001)	0.025 (0.001)	0.038 (0.0015)
0.255 to 0.231, incl (0.010 to 0.0091)	0.025 (0.001)	0.025 (0.001)	0.025 (0.001)	0.025 (0.001)
0.230 to 0.152, incl (0.0091 to 0.006)	0.019 (0.00075)	0.019 (0.00075)
Under 0.152 (0.006)	0.013 (0.0005)	0.013 (0.0005)

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,			
	(mm)	5 in. and Under	(127 mm and Under)	Over 5 to 12 in. (Over 127 mm)
0.005 to 0.010, incl	(0.13 to 0.25)	0.00075	(0.019)	0.001
Over 0.010 to 0.025, incl	(0.25 to 0.64)	0.001	(0.025)	0.0015
Over 0.025 to 0.065, incl	(0.64 to 1.65)	0.0015	(0.038)	0.002
Over 0.065 to $\frac{3}{16}$, excl	(1.65 to 4.74)	0.002	(0.051)	0.0025

TABLE 3 Permissible Variation in Thickness Across Width of Strip

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

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,

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 ½ to ¾ in.	(Under 12.7 to 4.75 mm)	½ to 6 in.	(12.7 to 150 mm)	Over 6 to 9 in.	(150 to 225 mm)
0.187 to 0.161	(4.75 to 4.09)	...		0.016	(0.41)	0.020	(0.51)
0.160 to 0.100	(4.06 to 2.54)	0.010	(0.25)	0.010	(0.25)	0.016	(0.41)
0.099 to 0.069	(2.51 to 1.75)	0.008	(0.20)	0.008	(0.20)	0.010	(0.25)
0.068 and under	(1.73)	0.005	(0.13)	0.005	(0.13)	0.005	(0.13)

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

Specified Thickness		Permissible Variations in Width in mm (in.) for Widths Given, ±					
mm (in.)	Under 12.7 to 4.75 Under (½ to ¾)	12.7 to 150 (½ to 6)	Over 150 to 225 Over (6 to 9)	Over 225 to 300 Over (9 to 12)	Over 300 to 500 Over (12 to 20)	Over 500 to 600 Over (20 to 24)	
4.75 to 4.09 (0.187 to 0.161)	...	0.41 (0.016)	0.51 (0.020)	0.51 (0.020)	0.79 (0.031)	0.79 (0.031)	
4.08 to 2.54 (0.160 to 0.100)	0.25 (0.010)	0.25 (0.010)	0.41 (0.016)	0.41 (0.016)	0.51 (0.020)	0.51 (0.020)	
2.53 to 1.75 (0.0996 to 0.0689)	0.20 (0.008)	0.20 (0.008)	0.25 (0.010)	0.25 (0.010)	0.41 (0.016)	0.51 (0.020)	
1.74 (0.0685) and under	0.13 (0.005)	0.13 (0.005)	0.13 (0.005)	0.25 (0.010)	0.41 (0.016)	0.51 (0.020)	

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)
0.0508 to 0.109 (0.002 to 0.00429)	0.0051 (0.0002)		
0.0044 to 0.0079	(1.12 to 0.200)	0.00025	(0.0064)
0.110 to 0.200 (0.0043 to 0.0079)	0.0064 (0.00025)		
0.008 to 0.0149	(0.203 to 0.378)	0.0003	(0.0076)
0.201 to 0.378 (0.00791 to 0.0149)	0.0076 (0.0003)		
0.015 to 0.0199	(0.381 to 0.505)	0.0004	(0.0102)
0.379 to 0.505 (0.0149 to 0.0199)	0.0102 (0.0004)		
0.020 to 0.0309	(0.508 to 0.785)	0.0005	(0.0127)
0.506 to 0.785 (0.0199 to 0.0309)	0.0127 (0.0005)		
0.031 to 0.0409	(0.787 to 1.039)	0.0006	(0.0152)
0.786 to 1.039 (0.0309 to 0.0409)	0.0152 (0.0006)		
0.041 to 0.0609	(1.041 to 1.547)	0.0007	(0.0178)
1.040 to 1.547 (0.0409 to 0.0609)	0.0178 (0.0007)		
0.061 to 0.0809	(1.549 to 2.055)	0.0008	(0.0203)
1.548 to 2.055 (0.0609 to 0.0809)	0.0203 (0.0008)		
0.081 to 0.1259	(2.057 to 3.198)	0.001	(0.0254)
2.056 to 3.198 (0.0809 to 0.126)	0.0254 (0.001)		
0.126 to 0.1569	(3.200 to 3.985)	0.0015	(0.038)
3.199 to 3.985 (0.126 to 0.157)	0.038 (0.0015)		
0.157 to 0.250	(3.988 to 6.35)	0.002	(0.051)
3.986 to 6.35 (0.157 to 0.250)	0.051 (0.002)		
Rod, Centerless Ground Finish (Straight Lengths)			
0.030 to 0.0549	(0.766 to 1.394)	0.0005	(0.0127)
0.762 to 1.394 (0.030 to 0.0549)	0.0127 (0.0005)		
0.055 to 0.1249	(1.397 to 3.172)	0.001	(0.0254)
1.395 to 3.172 (0.0549 to 0.125)	0.0254 (0.001)		
0.125 to 0.499	(3.175 to 12.67)	0.0015	(0.038)
3.173 to 12.67 (0.125 to 0.499)	0.038 (0.0015)		
0.500 to 0.999	(12.70 to 25.37)	0.002	(0.051)
12.68 to 25.37 (0.499 to 0.999)	0.051 (0.002)		
1.000 to 1.625	(25.4 to 41.27)	0.0025	(0.064)
25.38 to 41.27 (0.999 to 1.625)	0.064 (0.0025)		
1.626 to 1.749	(41.3 to 44.42)	0.003	(0.076)
41.28 to 44.42 (1.626 to 1.749)	0.076 (0.003)		
1.750 to 1.999	(44.45 to 50.17)	0.004	(0.010)
44.43 to 50.17 (1.749 to 2.000)	0.010 (0.004)		
2.000 to 4.000	(50.8 to 101.6)	0.005	(0.013)
50.80 to 101.6 (2.000 to 4.000)	0.013 (0.005)		

10.1.2 Forging,

10.1.3 Centerless grinding (rod),

10.1.4 Belt polishing,