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400 COMMONWEALTH DRIVE, WARRENDALE, PA 15096

AEROSPACE MATERIAL SPECIFICATION

Submitted for recognition as an American National Standard

AMS 7728E

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Superseding AMS 7728D

ALLOY SHEET, STRIP, AND PLATE, LOW EXPANSION, GLASS SEALING
53Fe - 29Ni - 17Co
Annealed

UNS K94610

1. SCOPE:

1.1 Form: This specification covers a low-expansion iron-nickel-cobalt alloy in the form of sheet, strip, and plate.

1.2 Application: Primarily for electronic elements to be sealed to hard glasses during assembly of electronic components.

2. APPLICABLE DOCUMENTS: The following publications form a part of this specification to the extent specified herein. The latest issue of Aerospace Material Specifications shall apply. The applicable issue of other documents shall be as specified in AMS 2350.

2.1 SAE Publications: Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096

2.1.1 Aerospace Material Specifications:

AMS 2350 - Standards and Test Methods
AMS 2371 - Quality Assurance Sampling of Corrosion and Heat Resistant Steels and Alloys, Wrought Products Except Forgings and Forging Stock

2.2 ASTM Publications: Available from American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.

ASTM E18 - Rockwell Hardness and Rockwell Superficial Hardness of Metallic Materials
ASTM E112 - Determining Average Grain Size
ASTM E228 - Linear Thermal Expansion of Solid Materials with a Vitreous Silica Dilatometer
ASTM E354 - Chemical Analysis of High-Temperature, Electrical, Magnetic, and Other Similar Iron, Nickel, and Cobalt Alloys

2.3 U.S. Government Publications: Available from Commanding Officer, Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, PA 19120.

2.3.1 Military Standards:

MIL-STD-163 - Steel Mill Products, Preparation for Shipment and Storage

3. TECHNICAL REQUIREMENTS:

3.1 Composition: Shall be approximately 53% iron, 29% nickel, and 17% cobalt by Ø weight with impurities not exceeding the following percentages by weight; composition shall be determined by wet chemical methods in accordance with ASTM E354, by spectrochemical methods, or by other analytical methods acceptable to purchaser:

	max
Carbon	0.04
Manganese	0.50
Silicon	0.20
Chromium	0.20
Molybdenum	0.20
Copper	0.20
Titanium	0.10
Aluminum	0.10
Magnesium	0.10
Zirconium	0.10

3.2 Condition: Cold rolled and bright annealed.

3.3 Properties: The product shall conform to the following requirements:

3.3.1 As Received:

3.3.1.1 Grain Size: Shall be predominantly 5 or finer with occasional grains as large as 3 permissible, determined by comparison of a polished and etched specimen with the chart in ASTM E112.

3.3.1.2 Hardness: Shall be not higher than 82 HRB or equivalent for product 0.100 inch (2.54 mm) and under in nominal thickness and not higher than 85 HRB or equivalent for product over 0.100 inch (2.54 mm) in nominal thickness, determined in accordance with ASTM E18.

3.3.2 After Reannealing: Specimens to determine conformance to the following requirements shall be reannealed by heating in a hydrogen atmosphere to 900°C ± 15 (1652°F ± 27), holding at heat for 60 minutes ± 5, further heating to 1100°C ± 15 (2012°F ± 27), holding at heat for 15 minutes ± 3, cooling from 1100°C ± 15 (2012°F ± 27) to 200°C (392°F) or below in the hydrogen atmosphere at a rate not greater than 5°C (9°F) per minute, and air cooling to room temperature; specimens may be cooled to room temperature between the 900°C (1652°F) and 1100°C (2012°F) heating periods.

3.3.2.1 Ø Coefficient of Thermal Expansion: Shall be as specified in Table I, determined in accordance with ASTM E228.

TABLE I

Temperature Range	Average Linear Coefficient of Thermal Expansion mm/mm per Deg Celsius
30°C to 400°C	4.60 to 5.20 x 10^{-6}
30°C to 450°C	5.10 to 5.50 x 10^{-6}

TABLE I (IP)

Temperature Range	Average Linear Coefficient of Thermal Expansion Inch/Inch per Deg Fahrenheit
86°F to 752°F	2.56 to 2.89 x 10^{-6}
86°F to 842°F	2.83 to 3.06 x 10^{-6}

3.3.2.2 Ø Temperature of Transformation: The temperature of transformation from gamma to alpha phase shall be not higher than -78°C (-108°F), determined by metallographic examination.

3.4 Quality: The product, as received by purchaser, shall be uniform in quality and condition, sound, and free from foreign materials and from imperfections detrimental to usage of the product.

3.5 Tolerances: Shall conform to the following:

3.5.1 Thickness: Product over 1 inch (25 mm) wide shall be measured at least 3/8 inch (9.5 mm) from the edge.

TABLE II

Nominal Thickness Inch	Tolerance, Inch Plus and Minus Except As Shown Width Ranges, Inches			
	Up to 3.0, excl	3.0 to 6.0, incl	Over 6.0 to 12.0, incl	Over 12.0 to 16.0, incl
Up to 0.006, excl	0.0005	0.0005	--	--
0.006 to 0.009, incl	0.00075	0.00075	--	--
Over 0.009 to 0.010, incl	0.001	0.001	0.001	0.001
Over 0.010 to 0.011, incl	0.001	0.001	0.001	0.0015
Over 0.011 to 0.016, incl	0.001	0.001	0.0015	0.0015
Over 0.016 to 0.019, incl	0.001	0.001	0.0015	0.002
Over 0.019 to 0.025, incl	0.001	0.0015	0.002	0.002
Over 0.025 to 0.028, incl	0.0015	0.0015	0.002	0.002
Over 0.028 to 0.034, incl	0.0015	0.002	0.0025	0.0025
Over 0.034 to 0.049, incl	0.002	0.0025	0.003	0.003
Over 0.049 to 0.068, incl	0.0025	0.003	0.003	0.003
Over 0.068 to 0.099, incl	0.003	0.003	0.003	0.004
Over 0.099 to 0.160, incl	0.004	0.004	0.004	0.004
Over 0.160 to 0.189, incl	0.005	0.005	+0.020	+0.020
Over 0.189 to 0.250, incl	--	--	+0.046	+0.046
Over 0.250 to 0.375, incl	--	--	+0.046	+0.046
Over 0.375 to 0.500, incl	--	--	+0.054	+0.054
Over 0.500 to 0.750, incl	--	--	+0.054	+0.054
Over 0.750 to 1.000, incl	--	--	+0.060	+0.060

TABLE II (SI)

Nominal Thickness Millimetres	Tolerance, Millimetres Plus and Minus Except As Shown Width Ranges, Millimetres			
	Up to 7.5, excl	75 to 152, incl	Over 152 to 305, incl	Over 305 to 406, incl
Up to 0.15, excl	0.013	0.013	--	--
0.15 to 0.23, incl	0.0190	0.0190	--	--
Over 0.22 to 0.25, incl	0.03	0.03	0.03	0.03
Over 0.25 to 0.28, incl	0.03	0.03	0.03	0.038
Over 0.28 to 0.41, incl	0.03	0.03	0.038	0.038
Over 0.41 to 0.48, incl	0.03	0.03	0.038	0.05
Over 0.48 to 0.64, incl	0.03	0.038	0.05	0.05
Over 0.64 to 0.71, incl	0.038	0.038	0.05	0.05
Over 0.71 to 0.86, incl	0.038	0.05	0.064	0.064
Over 0.86 to 1.24, incl	0.05	0.064	0.08	0.08
Over 1.24 to 1.73, incl	0.064	0.08	0.08	0.08
Over 1.73 to 2.51, incl	0.08	0.08	0.08	0.10
Over 2.51 to 4.06, incl	0.10	0.10	0.10	0.10
Over 4.06 to 4.80, incl	0.13	0.13	+0.51	+0.51
Over 4.80 to 6.35, incl	--	--	+1.17	+1.17
Over 6.35 to 9.52, incl	--	--	+1.17	+1.17
Over 9.52 to 12.70, incl	--	--	+1.37	+1.37
Over 12.57 to 19.05, incl	--	--	+1.37	+1.37
Over 19.05 to 25.40, incl	--	--	+1.52	+1.52

3.5.1.1 For widths over 6.00 inch (152 mm) to 16.00 inch (406 mm), incl, the minus tolerance for nominal thicknesses over 0.160 to 0.189 inch (4.06 to 4.80 mm), incl, shall be 0.000 and for nominal thicknesses over 0.189 inch (4.80 mm) shall be -0.010 inch (-0.25 mm).

4. QUALITY ASSURANCE PROVISIONS:

4.1 Responsibility for Inspection: The vendor of the product shall supply all samples for vendor's tests and shall be responsible for performing all required tests. Results of such tests shall be reported to the purchaser as required by 4.4. Purchaser reserves the right to sample and to perform any confirmatory testing deemed necessary to ensure that the product conforms to the requirements of this specification.

4.2 Classification of Tests: Tests to determine conformance to all technical requirements of this specification are classified as acceptance tests and shall be performed on each heat or lot as applicable.

4.3 Sampling: Shall be in accordance with AMS 2371 and the following; a lot shall be all product of the same nominal size from the same heat of alloy processed at the same time:

4.3.1 Composition: One sample from each heat.

4.3.2 Hardness: The number, location, and orientation of samples from each lot shall be as agreed upon by purchaser and vendor.

4.3.3 Sampling for coefficient of thermal expansion (3.3.2.1) and temperature of transformation (3.3.2.2) shall be as agreed upon by purchaser and vendor.

4.4 Reports:

4.4.1 The vendor of the product shall furnish with each shipment a report showing the results of tests for chemical composition of each heat and the results of tests on each lot to determine conformance to the other technical requirements of this specification. This report shall include the purchase order number, AMS 7728E, size, and quantity.

4.4.2 The vendor of finished or semi-finished parts shall furnish with each shipment a report showing the purchase order number, AMS 7728E, contractor or other direct supplier of product, part number, and quantity. When product for making parts is produced or purchased by the parts vendor, that vendor shall inspect each lot of product to determine conformance to the requirements of this specification and shall include in the report either a statement that the product conforms or copies of laboratory reports showing the results of tests to determine conformance.

4.5 Resampling and Retesting: Shall be in accordance with AMS 2371.