

ALLOY STRIP  
49Fe - 5.3Cr - 42Ni - 2.5Ti - 0.55Al  
Solution Heat Treated

UNS N09902

1. SCOPE:

1.1 Form: This specification covers an iron-nickel alloy in the form of strip.

1.2 Application: Primarily for diaphragms, leaf springs, and helical springs, requiring a precipitation-hardenable alloy with a coefficient of modulus of elasticity of  $-20$  to  $+20 \times 10^{-6}$  per degree Fahrenheit from  $-50^{\circ}$  to  $+150^{\circ}\text{F}$  ( $-36$  to  $+36 \times 10^{-6}$  per degree Celsius from  $-45^{\circ}$  to  $+65^{\circ}\text{C}$ ) after suitable heat treatment.

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 2248 - Chemical Check Analysis Limits-Wrought Corrosion and Heat Resistant Steels and Alloys, Maraging, and Other Highly-Alloyed Steels, and Iron Alloys

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

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

ASTM E8 - Tension Testing of Metallic Materials

ASTM E18 - Rockwell Hardness and Rockwell Superficial Hardness of Metallic Materials

ASTM E112 - Determining Average Grain Size

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 Federal Standards:

Federal Test Method Standard No. 151 - Metals; Test Methods

2.3.2 Military Standards:

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

3. TECHNICAL REQUIREMENTS:

3.1 Composition: Shall conform to the following percentages by weight,  $\emptyset$  determined by wet chemical methods in accordance with ASTM E354, by spectrographic methods in accordance with Federal Test Method Standard No. 151, Method 112, or by other analytical methods approved by purchaser:

	min	max
Carbon	--	0.06
Manganese	--	0.80
Silicon	--	1.00
Phosphorus	--	0.04
Sulfur	--	0.04
Chromium	4.90 -	5.75
Nickel + Cobalt	41.00 -	43.50
Titanium	2.20 -	2.75
Aluminum	0.30 -	0.80
Chromium + (Titanium - 4 x Carbon)	7.10 -	8.10
Cobalt (3.1.1)	--	1.00
Iron		remainder

3.1.1 Determination not required for routine acceptance.

3.1.2 Check Analysis: Composition variations shall meet the requirements of AMS 2248.

3.2 Condition: Solution heat treated.

3.3 Heat Treatment: Strip shall be solution heat treated by heating to  $1750^{\circ}\text{F} \pm 25$  ( $955^{\circ}\text{C} \pm 15$ ), holding at heat for a time commensurate with section thickness but not more than 30 min., and cooling as required.

3.4 Properties: Strip shall conform to the following requirements:

3.4.1 As Solution Heat Treated:

3.4.1.1 Tensile Properties: Shall be as follows, determined in accordance with  
 Ø ASTM E8, on specimens as in 4.3.1 from strip 0.020 to 0.250 in. (0.50 to 6.25 mm), incl, in nominal thickness:

Tensile Strength, max	95,000 psi (655 MPa)
Elongation in 2 in. (50 mm), min	35%

3.4.1.1.1 Properties of strip less than 0.020 in. (0.50 mm) or over 0.250 in. (6.25 mm) in nominal thickness shall be as agreed upon by purchaser and vendor:

3.4.1.2 Hardness: Should be not higher than 80 HRB or equivalent, determined in  
 Ø accordance with ASTM E18 but strip shall not be rejected on the basis of hardness if the tensile properties requirement of 3.4.1.1 are met.

3.4.1.3 Grain Size: Predominantly 5 or finer with occasional grains as large as  
 Ø 3 permissible, determined in accordance with ASTM E112.

3.4.2 After Precipitation Heat Treatment: Specimens as in 4.3.1 from strip 0.020 to 0.250 in. (0.50 to 6.25 mm), incl, in nominal thickness shall conform to the following requirements after being precipitation heat treated by heating to  $1300^{\circ}\text{F} \pm 15$  ( $705^{\circ}\text{C} \pm 8$ ), holding at heat for 180 min.  $\pm 5$ , and cooling in air; properties of strip less than 0.020 in. (0.50 mm) or over 0.250 in. (6.25 mm) in nominal thickness shall be as agreed upon by purchaser and vendor:

3.4.2.1 Tensile Properties: Shall be as follows, determined in accordance with  
 Ø ASTM E8:

Tensile Strength, min	150,000 psi (1035 MPa)
Yield Strength at 0.2% Offset, min	90,000 psi (620 MPa)
Elongation in 2 in. (50 mm), min	5%

3.4.2.2 Hardness: Should be 27 - 35 HRC or equivalent, determined in accordance  
 Ø with ASTM E18 but strip shall not be rejected on the basis of hardness if the tensile property requirements of 3.4.2.1 are met.

3.5 Quality: Strip, 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 strip.

3.6 Tolerances: Unless otherwise specified, the following tolerances shall apply:

3.6.1 Thickness:

TABLE I

Nominal Thickness (T) Inch	Thickness Tolerance, Inch plus and minus	
	Width Ranges, Inches	
	Up to 4.00, incl	Over 4.00 to 5.00, incl
Up to 0.015, incl	0.0005	0.0006
Over 0.015 to 0.025, incl	0.00075	0.0008
Over 0.025 to 0.040, incl	0.001	0.001
Over 0.040	0.025T	0.025T

TABLE I (SI)

Nominal Thickness (T) Inch	Thickness Tolerance, Millimetre plus and minus	
	Width Ranges, Millimetres	
	Up to 100, incl	Over 100 to 125.0, incl
Up to 0.38, incl	0.012	0.015
Over 0.38 to 0.62, incl	0.188	0.020
Over 0.62 to 1.00, incl	0.02	0.02
Over 1.00	0.025T	0.025T

3.6.1.1 When premium tolerances for thickness are specified, product shall conform to Table II.

TABLE II

Nominal Thickness (T) Inch	Thickness Tolerance, Inch plus and minus	
	Width Ranges, Inches	
	Up to 4.00, incl	Over 4.00 to 5.00, incl
Up to 0.005, incl	0.0002	0.0003
Over 0.005 to 0.010, incl	0.0003	0.0004
Over 0.010 to 0.015, incl	0.0004	0.0005
Over 0.015 to 0.025, incl	0.0005	0.0005
Over 0.025	0.02T	0.02T

TABLE II (SI)

Nominal Thickness (T) Millimetre	Thickness Tolerance, Millimetre plus and minus	
	Width Ranges, Millimetres	
	Up to 100, incl	Over 100 to 125.0, incl
Up to 0.12, incl	0.005	0.008
Over 0.12 to 0.25, incl	0.008	0.010
Over 0.25 to 0.38, incl	0.010	0.012
Over 0.38 to 0.62, incl	0.012	0.012
Over 0.62	0.02T	0.02T

3.6.2 Width:

TABLE III

Nominal Width Inches	Width Tolerances, Inch			
	Thickness Ranges, Inch			
	Up to 0.010, incl	Over 0.010 to 0.040, incl	Over 0.040 to 0.075, incl	Over 0.075
Up to 3.00, incl	+0.010 -0.000	+0.010 -0.000	+0.015 -0.000	+0.015 -0.000
Over 3.00 to 4.00, incl	+0.010 -0.000	+0.012 -0.000	+0.015 -0.000	+0.015 -0.000
Over 4.00 to 5.00, incl	+0.010 -0.000	+0.015 -0.000	+0.015 -0.005	+0.015 -0.015

TABLE III (SI)

Nominal Width Millimetres	Width Tolerance, Millimetre			
	Thickness Range, Millimetres			
	Up to 0.25, incl	Over 0.25 to 1.00, incl	Over 1.00 to 1.90, incl	Over 1.90
Up to 75.0, incl	+0.25 -0.00	+0.25 -0.00	+0.38 -0.00	+0.38 -0.00
Over 75 to 100.0, incl	+0.25 -0.00	+0.30 -0.00	+0.38 -0.00	+0.38 -0.00
Over 100.0 to 125.0, incl	+0.25 -0.00	+0.38 -0.00	+0.38 -0.12	+0.38 -0.38

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## 4. QUALITY ASSURANCE PROVISIONS:

4.1 Responsibility for Inspection: The vendor of strip 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 strip 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:

4.3.1 Tensile specimens shall be taken with the axis of the specimen parallel to the direction of rolling.

4.4 Reports:

4.4.1 The vendor of strip shall furnish with each shipment a report showing the results of tests for chemical composition and grain size 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, heat number, AMS 5221C, size, and quantity from each heat.

4.4.2 The vendor of finished or semi-finished parts shall furnish with each shipment a report showing the purchase order number, AMS 5221C, contractor or other direct supplier of strip, part number, and quantity. When strip for making parts is produced or purchased by the parts vendor, that vendor shall inspect each lot of strip to determine conformance to the requirements of this specification and shall include in the report either a statement that the strip 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.

## 5. PREPARATION FOR DELIVERY:

5.1 Identification: Each flat strip shall be marked on one face, in the respective location indicated below, with AMS 5221C, heat number, manufacturer's identification, and nominal thickness. The characters shall be of such size as to be legible, shall be applied using a suitable marking fluid, and shall be removable in hot alkaline cleaning solution without rubbing. The markings shall have no deleterious effect on the product or its performance and shall be sufficiently stable to withstand normal handling.