SAE Aerospace
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AEROSPACE MATERIAL SPECIFICATION

SAE AMS5604 REV. G

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Superseding AMS5604F

Steel, Corrosion Resistant, Sheet, Strip, and Plate 16.5Cr - 4.0Ni - 4.0Cu - 0.30Cb Solution Heat Treated, Precipitation Hardenable (Composition similar to UNS S17400)X

RATIONALE

AMS5604G results from a limited scope ballot to revise Solution Heat Treatment (3.3).

1. SCOPE

1.1 Form

This specification covers a corrosion-resistant steel in the form of sheet, strip, and plate.

1.2 Application

These products have been used typically for parts requiring corrosion resistance and high strength up to 600 °F (316 °C) and where such parts may require welding during fabrication, but usage is not limited to such applications.

1.2.1 Certain processing procedures and service conditions may cause these products to become subject to stress-corrosion cracking; ARP1110 recommends practices to minimize such conditions.

2. APPLICABLE DOCUMENTS

The issue of the following documents in effect on the date of the purchase order forms a part of this specification to the extent specified herein. The supplier may work to a subsequent revision of a document unless a specific document issue is specified. When the referenced document has been cancelled and no superseding document has been specified, the last published issue of that document shall apply.

2.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or 724-776-4970 (outside USA), www.sae.org.

AMS2242 Tolerances, Corrosion and Heat Resistant Steel, Iron Alloy, Titanium, and Titanium Alloy Sheet, Strip, and Plate

AMS2248 Chemical Check Analysis Limits, Corrosion and Heat-Resistant Steels and Alloys, Maraging and Other Highly-Alloyed Steels, and Iron Alloys

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AMS2315 Determination of Delta Ferrite Content

AMS2371 Quality Assurance Sampling and Testing, Corrosion and Heat-Resistant Steels and Alloys, Wrought Products and Forging Stock

AMS2750 Pyrometry

AMS2807 Identification, Carbon and Low-Alloy Steels, Corrosion and Heat-Resistant Steels and Alloys, Sheet, Strip, Plate, and Aircraft Tubing

AS4194 Sheet and Strip Surface Finish Nomenclature

ARP1110 Minimizing Stress Corrosion Cracking in Wrought Forms of Steels and Corrosion Resistant Steels and Alloys

2.2 ASTM Publications

Available from ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959, Tel: 610-832-9585, www.astm.org.

ASTM A 480/A 480M Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip

ASTM A 370 Mechanical Testing of Steel Products

ASTM E 290 Bend Testing of Material for Ductility

ASTM E 353 Chemical Analysis of Stainless, Heat-Resisting, Maraging, and Other Similar Chromium-Nickel-Iron Alloys

3. TECHNICAL REQUIREMENTS

3.1 Composition

Shall conform to the percentages by weight shown in Table 1, determined by wet chemical methods in accordance with ASTM E 353, by spectrochemical methods, or by other analytical methods acceptable to purchaser.

TABLE 1 - COMPOSITION

Element	min	max
Carbon	--	0.07
Manganese	--	1.00
Silicon	--	1.00
Phosphorus	--	0.040
Sulfur	--	0.030
Chromium	15.00	17.50
Nickel	3.00	5.00
Columbium	5xC	0.45
Copper	3.00	5.00
Molybdenum	--	0.50

3.1.1 Check Analysis

Composition variations shall meet the applicable requirements of AMS2248.

3.2 Condition

The product shall be supplied in the following condition:

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3.2.1 Sheet and Strip

Cold rolled, solution heat treated, and, unless solution heat treatment is performed in an atmosphere yielding a bright finish, descaled having a surface appearance comparable to the commercial corrosion-resistant finishes described in ASTM A 480/A 480M and AS4194 and 3.2.1.1 or 3.2.1.2, as applicable.

3.2.1.1 Sheet

No. 2D finish.

3.2.1.2 Strip

No, 1 strip finish.

3.2.2 Plate

Hot rolled, solution heat treated, and descaled.

3.3 Solution Heat Treatment

Except as specified in 3.3.1, the product shall be solution heat treated by heating to 1900 °F ± 25 (1038 °C ± 14), holding at heat for a time commensurate with the thickness and the heating equipment and procedure used, and cooling to below 90 °F (32 °C). Pyrometry shall conform to AMS2750.

3.3.1 Continuous Heat Treating of Sheet and Strip

Process parameters (e.g., furnace temperature set points, heat input, travel rate, etc.) for continuous heat treating lines shall be established by the material producer and validated by testing of product to requirements of 3.4. Plate shall not be subjected to continuous heat treating.

3.4 Properties

The product shall conform to the following requirements; tensile, hardness, and bend testing shall be performed in accordance with ASTM A 370:

3.4.1 As Solution Heat Treated

3.4.1.1 Tensile Properties

Shall be as shown in Table 2 for nominal thickness 0.015 to 0.1874 inch (0.38 to 4.760 mm), inclusive.

TABLE 2 - SOLUTION TREATED TENSILE PROPERTIES

Property	Value
Tensile Strength, max	185 ksi (1276 MPa)
Yield Strength at 0.2% Offset, max	160 ksi (1103 MPa)
Elongation in 2 Inches (50.8 mm), min	3%

3.4.1.2 Hardness

Shall be not higher than 38 HRC, or equivalent (See 8.2).

3.4.1.3 Microstructure

The product shall contain not more than 5% ferrite, determined in accordance with AMS2315.

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3.4.1.4 Bending

Product 0.109 inch (2.77 mm) and under in nominal thickness shall be tested in accordance with ASTM E 290 using a sample prepared nominally 0.75 inch (19.0 mm) in width with its axis of bending parallel to the direction of rolling and shall withstand, without cracking, bending through an angle of 180 degrees around a diameter equal to 18 times the nominal thickness of the product. In case of dispute, the results of tests using the guided bend test of ASTM E 290 shall govern.

3.4.2 After Precipitation Heat Treatment

The solution heat treated product 4.0 inches (102 mm) and under in nominal thickness shall have tensile properties specified in 3.4.2.1 and hardness specified in 3.4.2.2 after being precipitation heat treated to a particular condition in accordance with the corresponding temperature and times shown in Table 3 and cooled as required. Tensile and hardness tests shall be made in only the H900 condition unless purchaser specifies another heat treated condition.

TABLE 3 - PRECIPITATION HARDENING CONDITIONS

Condition	Temperature	Time
H900	900 °F ± 10 (482 °C ± 6)	60 minutes ± 5
H925	925 °F ± 10 (496 °C ± 6)	4 hours ± 0.25
H1025	1025 °F ± 10 (552 °C ± 6)	4 hours ± 0.25
H1075	1075 °F ± 10 (579 °C ± 6)	4 hours ± 0.25
H1100	1100 °F ± 10 (593 °C ± 6)	4 hours ± 0.25
H1150	1150 °F ± 10 (621 °C ± 6)	4 hours ± 0.25

3.4.2.1 Tensile Properties

Shall be as shown in Table 4.

TABLE 4A - MINIMUM TENSILE PROPERTIES AFTER PRECIPITATION HEAT TREATMENT, INCH/POUND UNITS

Condition	Nominal Thickness Inches			Tensile Strength ksi	Yield Strength at 0.2% Offset ksi	Elongation in 2 Inches or 4D %	Reduction of Area %
H900	Up	to 0.1874,	incl	190	170	5	--
	0.1875	to 0.625,	incl	190	170	8	30
	Over 0.625	to 4.000,	incl	190	170	10	35
H925	Up	to 0.1874,	incl	170	155	5	--
	0.1875	to 0.625,	incl	170	155	8	30
	Over 0.625	to 4.000,	incl	170	155	10	35
H1025	Up	to 0.1874,	incl	155	145	5	--
	0.1875	to 0.625,	incl	155	145	8	35
	Over 0.625	to 4.000,	incl	155	145	12	40
H1075	Up	to 0.1874,	incl	145	125	5	--
	0.1875	to 0.625,	incl	145	125	9	35
	Over 0.625	to 4.000,	incl	145	125	13	45
H1100	Up	to 0.1874,	incl	140	115	5	--
	0.1875	to 0.625,	incl	140	115	10	35
	Over 0.625	to 4.000,	incl	140	115	14	45
H1150	Up	to 0.1874,	incl	135	105	8	--
	0.1875	to 0.625,	incl	135	105	10	40
	Over 0.625	to 4.000,	incl	135	105	16	50

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TABLE 4B - MINIMUM TENSILE PROPERTIES AFTER PRECIPITATION HEAT TREATMENT, SI UNITS

Condition	Nominal Thickness Millimeters	Tensile Strength MPa	Yield Strength at 0.2% Offset MPa	Elongation in 50.8 mm or 4D %	Reduction of Area %
H900	Up to 4.760, incl	1310	1172	5	--
	4.761 to 15.88, incl	1310	1172	8	30
	Over 15.88 to 101.60, incl	1310	1172	10	35
H925	Up to 4.760, incl	1172	1069	5	--
	4.761 to 15.88, incl	1172	1069	8	30
	Over 15.88 to 101.60, incl	1172	1069	10	35
H1025	Up to 4.760, incl	1069	1000	5	--
	4.761 to 15.88, incl	1069	1000	8	35
	Over 15.88 to 101.60, incl	1069	1000	12	40
H1075	Up to 4.760, incl	1000	862	5	--
	4.761 to 15.88, incl	1000	862	9	35
	Over 15.88 to 101.60, incl	1000	862	13	45
H1100	Up to 4.760, incl	965	793	5	--
	4.761 to 15.88, incl	965	793	10	35
	Over 15.88 to 101.60, incl	965	793	14	45
H1150	Up to 4.760, incl	931	724	8	--
	4.761 to 15.88, incl	931	724	10	40
	Over 15.88 to 101.60, incl	931	724	16	50

3.4.2.2 Hardness

Shall be within the range shown in Table 5 for the corresponding precipitation heat treatment condition.

TABLE 5 - HARDNESS

Condition	HB	HRC	HV
H900	375 to 444	40 to 47	411 to 510
H925	352 to 415	38 to 45	392 to 473
H1025	331 to 388	35 to 42	364 to 431
H1075	311 to 363	33 to 39	344 to 401
H1100	302 to 352	32 to 38	333 to 392
H1150	269 to 341	28 to 37	280 to 383

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3.5 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.

3.6 Tolerances

Shall conform to all applicable requirements of AMS2242; flatness tolerance for sheet shall be as specified for cold worked austenitic sheet in half-hard temper.