SAE Aerospace
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AEROSPACE MATERIAL SPECIFICATION

SAE AMS 4221B

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Superseding AMS 4221A

Aluminum Alloy, Plate
4.4Cu - 1.5Mg - 0.60Mn (2124-T8151)
Solution Heat Treated, Stress Relieved, and Precipitation Heat Treated

(Composition similar to UNS A92124)

1. SCOPE:

1.1 Form:

This specification covers an aluminum alloy in the form of plate 1.5 inches (38 mm) and over in nominal thickness.

1.2 Applications:

This plate has been used typically for parts requiring a high level of mechanical properties up to 300 °F (149 °C), but usage is not limited to such applications.

1.2.1 Certain design and fabrication procedures may cause plate to become susceptible to stress-corrosion cracking; ARP823 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.

TO PLACE A DOCUMENT ORDER:
Tel: 877-606-7323 (inside USA and Canada)
Tel: 724-776-4970 (outside USA)
Fax: 724-776-0790
Email: custsvc@sae.org
SAE WEB ADDRESS: **http://www.sae.org**

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2.1 SAE Publications:

Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001 or www.sae.org.

AMS 2355	Quality Assurance Sampling and Testing, Aluminum Alloys and Magnesium Alloys, Wrought Products, Except Forging Stock, and Rolled, Forged, or Flash Welded Rings
AMS 2772	Heat Treatment of Aluminum Alloy Raw Materials
ARP823	Minimizing Stress-Corrosion Cracking in Wrought Heat-Treatable Aluminum Alloy Products

2.2 ASTM Publications:

Available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959 or www.astm.org.

ASTM B 594	Ultrasonic Examination of Aluminum-Alloy Wrought Products for Aerospace Applications
ASTM B 645	Plane-Strain Fracture Toughness Testing of Aluminum Alloys
ASTM B 660	Packaging/Packing of Aluminum and Magnesium Products
ASTM B 666/B 666M	Identification Marking of Aluminum Products
ASTM E 399	Plane-Strain Fracture Toughness of Metallic Materials
ASTM E 602	Sharp-Notch Tension Testing with Cylindrical Specimens
ASTM E 1304	Plain-Strain (Chevron Notch) Fracture Toughness of Metallic Materials
ASTM G 47	Standard Test Method for Determining Susceptability to Stress-Corrosion Cracking of 2XXX and 7XXX Aluminum Alloy Products

2.3 ANSI Publications:

Available from ANSI, 25 West 43rd Street, New York, NY 10036 or www.ansi.org.

ANSI H35.2	Dimensional Tolerances for Aluminum Mill Products
ANSI H35.2M	Dimensional Tolerances for Aluminum Mill Products (Metric)

3. TECHNICAL REQUIREMENTS:

3.1 Composition:

Shall conform to the percentages by weight shown in Table 1, determined in accordance with AMS 2355.

TABLE 1 - Composition

Element	min	max
Silicon	--	0.20
Iron	--	0.30
Copper	3.8	4.9
Manganese	0.30	0.9
Magnesium	1.2	1.8
Chromium	--	0.10
Zinc	--	0.25
Titanium	--	0.15
Other Elements, each	--	0.05
Other Elements, total	--	0.15
Aluminum	remainder	

3.2 Condition:

Solution heat treated, stress relieved by stretching to produce a nominal permanent set of 2% but not less than 1-1/2% nor more than 3%, and precipitation heat-treated; heat treatment shall be in accordance with AMS 2772.

3.2.1 Plate shall receive no further straightening operations after stretching.

3.3 Properties:

Plate shall conform to the following requirements in accordance with AMS 2355 except that fracture toughness (3.3.3) and/or alternate fracture toughness testing (3.3.4) shall be performed as indicated in the appropriate paragraph; tests are to be performed on the mill produced size.

3.3.1 Tensile Properties: Shall be as shown in Table 2, determined in accordance with AMS 2355; tensile properties apply in the long-transverse direction and, when specified, in the longitudinal and/or short-transverse direction.

TABLE 2A - Minimum Tensile Properties, Inch/Pound Units

Nominal Thickness Inches	Specimen Orientation	Tensile Strength ksi	Yield Strength at 0.2% Offset ksi	Elongation in 2 Inches or 4D %
1-1/2 to 2, incl	Longitudinal	68.0	62.0	8
	Long-Trans	68.0	62.0	7
	Short-Trans.	65.0	57.0	2
Over 2 to 3, incl	Longitudinal	67.0	60.0	8
	Long-Trans	67.0	60.0	7
	Short-Trans.	64.0	57.0	2
Over 3 to 4, incl	Longitudinal	67.0	59.0	7
	Long-Trans	67.0	59.0	6
	Short-Trans.	64.0	57.0	2
Over 4 to 5, incl	Longitudinal	66.0	58.0	6
	Long-Trans	66.0	58.0	6
	Short-Trans.	63.0	55.0	2
Over 5 to 6, incl	Longitudinal	65.0	57.0	6
	Long-Trans	65.0	56.0	5
	Short-Trans.	62.0	54.0	2

TABLE 2B - Minimum Tensile Properties, SI Units

Nominal Thickness Millimeters	Specimen Orientation	Tensile Strength MPa	Yield Strength at 0.2% Offset MPa	Elongation in 50.8 mm or 4D %
38 to 51, incl	Longitudinal	469	427	8
	Long-Trans	469	427	7
	Short-Trans.	448	393	2
Over 51 to 76, incl	Longitudinal	462	414	8
	Long-Trans	462	414	7
	Short-Trans.	441	393	2
Over 76 to 102, incl	Longitudinal	462	407	7
	Long-Trans	462	407	6
	Short-Trans.	441	393	2
Over 102 to 127, incl	Longitudinal	455	400	6
	Long-Trans	455	400	6
	Short-Trans.	434	379	2
Over 127 to 152, incl	Longitudinal	448	393	6
	Long-Trans	448	386	5
	Short-Trans.	427	372	2

3.3.2 Stress-Corrosion Resistance: When specified, specimens as in 4.3.2 from plate 1.5 to 6 inches (38 to 152 mm), inclusive, in nominal thickness shall show no evidence of stress-corrosion cracking when stressed to 50% of the specified minimum long-transverse yield strength and tested in accordance with ASTM G 47.

3.3.3 Fracture Toughness: For product 1.500 to 6.000 inches (38.10 to 152.40) thick, plane-strain fracture toughness (K_{Ic}) shall be determined in accordance with ASTM E 399 and ASTM B 645 in the L-T specimen orientation, and other orientations as specified by the purchaser. Values shall conform to minimum values in Table 3.

TABLE 3A - Minimum Fracture Toughness Parameters, Inch/Pound Units

Nominal Thickness Inches	Specimen Orientation L – T $\frac{}{ksi\sqrt{inch}}$	Specimen Orientation T – L $\frac{}{ksi\sqrt{inch}}$	Specimen Orientation S – L $\frac{}{ksi\sqrt{inch}}$
1.500 to 2.000, incl	26	23	19
Over 2.000 to 4.000, incl	26	22	20
Over 4.000 to 6.000, incl	25	21	21

TABLE 3B - Minimum Fracture Toughness Parameters, SI Units

Nominal Thickness Millimeters	Specimen Orientation L – T $\frac{}{MPa\sqrt{m}}$	Specimen Orientation T – L $\frac{}{MPa\sqrt{m}}$	Specimen Orientation S – L $\frac{}{MPa\sqrt{m}}$
38.10 to 50.80, incl	28.6	25.3	20.9
Over 50.80 to 101.60, incl	28.6	24.2	22.0
Over 101.60 to 152.40, incl	27.5	23.1	23.1

3.3.4 Alternate Testing for Demonstration of Fracture Toughness: When specified, the producer shall guarantee that sheet meets the fracture toughness requirements based on correlation of notch tensile strength/tensile yield strength (NTS/TYS) ratio, determined in accordance with 3.3.4.1 or correlation with K_{Iv} or K_{Ivj} plane-strain chevron notch (short-bar) values determined in accordance with 3.3.4.2 in lieu of fracture toughness testing (3.3.3). Sampling and testing requirements, and lot acceptance criteria shall be as agreed upon by purchaser and vendor.

3.3.4.1 Notch Tensile Strength/Tensile Yield Strength (NTS/TYS) Ratio: Notch tensile strength values shall be divided by the tensile yield strengths representing the appropriate orientation to obtain the NTS/TYS ratios in the longitudinal or other specified orientations. Acceptance values for NTS/TYS values shall be specified based on evidence of documented correlation between the appropriate NTS/TYS ratios and fracture toughness values (3.3.3) as demonstrated and maintained by the producer.

3.3.4.2 Plane-Strain Chevron Notch (short bar) Testing: Plane-strain chevron notch fracture toughness, K_{Iv} or K_{Ivj} shall be determined in accordance with ASTM E 1304 on specimens taken in the L-T test orientation and other orientations as required. Acceptance values for K_{Iv} or K_{Ivj} shall be specified based on evidence of documented correlation between K_{Iv} or K_{Ivj} and fracture toughness values in the appropriate test orientations (3.3.3) as demonstrated and maintained by the producer.

3.4 Quality:

Plate, 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 plate.

3.4.1 Each plate shall be ultrasonically inspected in accordance with ASTM B 594 and shall meet the requirements for Class A.

3.5 Tolerances:

Shall conform to all applicable requirements of ANSI H35.2 or ANSI H35.2M.

4. QUALITY ASSURANCE PROVISIONS:

4.1 Responsibility for Inspection:

The vendor of plate shall supply all samples for vendor's tests and shall be responsible for the performance of all required tests. Purchaser reserves the right to sample and to perform any confirmatory testing deemed necessary to ensure that the plate conforms to specified requirements.

4.2 Classification of Tests:

Composition (3.1), long-transverse tensile properties and, when specified, longitudinal and/or short-transverse tensile properties (3.3.1), stress-corrosion resistance (3.3.2) when specified, fracture toughness (3.3.3), ultrasonic soundness (3.4.1), and tolerances (3.5) are acceptance tests and, except for composition, shall be performed on each inspection lot.

4.2.1 Acceptance Tests: Composition (3.1), tensile properties in the long-transverse and other specified orientations (3.3.1), when specified stress corrosion resistance (3.3.2), fracture toughness (3.3.3) or when specified alternate testing for demonstration of fracture toughness (3.3.4), when specified ultrasonic inspection (3.4.1), and dimensional tolerances (3.5) are acceptance tests and except for composition shall be performed on each inspection lot.