SAE Aerospace
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AEROSPACE MATERIAL SPECIFICATION

SAE AMS 4413

Issued 2007-10

Aluminum Alloy, Plate
3.5 Cu - 1.0Li - .40Mg - .35 Mn - .45Ag - 0.12Zr (2050-T84)
Solution Heat Treated, Stress Relieved, and Artificially Aged

(Composition similar to UNS A92050)

RATIONALE

AMS 4413 is a proposed draft of a new material specification which covers aluminum-lithium alloy 2050-T84.

1. SCOPE

1.1 Form

This specification covers an aluminum-lithium alloy in the form of plate.

1.2 Application

This plate has been used typically for parts where low density is needed in combination with a high level of mechanical properties and very good resistance to stress-corrosion cracking, but usage is not limited to such applications.

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.

AMS 2355	Quality Assurance Sampling and Testing, Aluminum Alloys and Magnesium Alloys, Wrought Products (Except Forging Stock) and Flash Welded Rings
AMS 2772	Heat Treatment of Aluminum Alloy Raw Materials
AS1990	Aluminum Alloy Tempers

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 B 594	Ultrasonic Inspection of Aluminum-Alloy Products for Aerospace Applications
ASTM B 660	Packing/Packaging of Aluminum and Magnesium Products

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

ASTM B 666/B 666M Identification Marking of Aluminum and Magnesium Products
ASTM G 47 Determining Susceptibility to Stress Corrosion Cracking of High Strength Aluminum Alloy Products
ASTM E 399 Standard Test Method for Linear-Elastic Plane-Strain Fracture Toughness of Metallic Materials

2.3 ANSI Publications

Available from American National Standards Institute, 25 West 43rd Street, New York, NY 10036, Tel: 212-642-4900, 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

TABLE 1 - COMPOSITION

Element	min	max
Silicon	--	0.08
Iron	--	0.10
Copper	3.2	3.9
Manganese	0.20	0.50
Magnesium	0.20	0.60
Chromium	--	0.05
Zinc	--	0.25
Titanium	--	0.10
Zirconium	0.06	0.14
Silver	0.20	0.70
Lithium	0.7	1.3
Other Elements, each	--	0.05
Other Elements, total	--	0.15
Aluminum	remainder	

3.2 Condition

Solution heat-treated, stretched to produce a nominal permanent set of 3.5% but not less than 3.0% nor more than 4.5%, and precipitation heat treated to the T84 temper (see AS1990). Solution and precipitation heat treatment shall be performed in accordance with AMS 2772. Actual solution heat treatment temperatures and aging time/temperatures are proprietary.

3.2.1 Plate shall receive no further straightening operations after stretching.

3.3 Properties

Plate shall conform to the following requirements, determined in accordance with AMS 2355 on the mill produced size and as specified herein.

3.3.1 Tensile Properties

Shall be as specified in Table 2.

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 %
.500 to 1.500, incl	Longitudinal	73.0	69.0	9
	Long Trans.	74.0	67.0	7
Over 1.500 to 2.000, incl	Longitudinal	72.0	67.0	9
	Long Trans.	73.0	65.0	7
	Short Trans.	71.0	61.0	2
Over 2.000 to 3.000, incl	Longitudinal	72.0	67.0	8
	Long Trans.	72.0	65.0	6
	Short Trans.	71.0	61.0	2
Over 3.000 to 4.000, incl	Longitudinal	71.0	67.0	7
	Long Trans.	72.0	65.0	4
	Short Trans.	70.0	60.0	1.5
Over 4.000 to 5.000, incl	Longitudinal	71.0	66.0	6
	Long Trans.	71.0	64.0	3
	Short Trans.	69.0	59.0	1.5

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 %
12.7 to 38.1, incl	Longitudinal	503	476	8
	Long Trans.	510	462	6
Over 38.1 to 50.8, incl	Longitudinal	496	462	8
	Long Trans.	503	448	6
	Short Trans.	490	421	2
Over 50.8 to 76.2, incl	Longitudinal	496	462	7
	Long Trans.	496	448	5
	Short Trans.	490	421	2
Over 76.2 to 101.6, incl	Longitudinal	490	462	6
	Long Trans.	496	448	3
	Short Trans.	483	414	1.5
Over 101.6 to 127, incl	Longitudinal	490	455	5
	Long Trans.	490	441	3
	Short Trans.	476	407	1.5

3.3.2 Stress-Corrosion Test

Specimens machined and tested in accordance with ASTM G47 from plate 0.750 inch (19.05 mm) and over in nominal thickness, shall show no evidence of stress-corrosion cracking when stressed in the short- transverse direction at 45.0 Ksi (310 MPa) for 30 days.

3.3.3 Fracture Toughness

Fracture toughness shall be determined in accordance with ASTM E 399 and when specified, shall meet the values for K_{1c} specified in Table 3. For T-L and L-T test directions on plate 2 inches (51 mm) and under in nominal thickness, use full-thickness specimens; for plate over 2 to 4 inches (51 to 102 mm), inclusive, in nominal thickness, use specimens 2-inch (51-mm) minimum thickness centered at T/2; and for plate over 4 inches (102 mm) in nominal thickness, use specimens 2-inch (51-mm) minimum thickness centered at T/4. For the S-L test direction, the test specimen shall be centered at T/2. Required specimen orientation(s) shall be specified by purchaser.

TABLE 3A - MINIMUM FRACTURE TOUGHNESS PARAMETERS, INCH/POUND UNITS

Nominal Thickness Inches	L-T Ksi $\sqrt{inch}$	T-L Ksi $\sqrt{inch}$	S-L Ksi $\sqrt{inch}$
0.500 to 1.500, incl	33	29	25
Over 1.500 to 2.000, incl	31	27	23
Over 2.000 to 3.000, incl	28	25	23
Over 3.000 to 4.000, incl	26	23	21
Over 4.000 to 5.000, incl	25	21	21

TABLE 3B - MINIMUM FRACTURE TOUGHNESS PARAMETERS, SI UNITS

Nominal Thickness Millimeters	L-T MPa $\sqrt{m}$	T-L MPa $\sqrt{m}$	S-L MPa $\sqrt{m}$
12.50 to 38.10, incl	36	32	28
Over 38.10 to 50.80, incl	34	30	25
Over 50.80 to 76.20, incl	31	28	25
Over 76.20 to 101.60, incl	29	25	23
Over 101.60 to 127.00, incl	28	23	23

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 Plate shall be ultrasonically inspected in accordance with ASTM B 594 and shall meet the requirements of 3.4.1.1.

3.4.1.1 Plates shall meet the requirements for ultrasonic class A.

3.5 Tolerances

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

4.2.1 Acceptance Tests

Composition (3.1), tensile properties (3.3.1), tolerances (3.5), ultrasonic soundness (3.4.1) and, when specified, fracture toughness (3.3.4) are acceptance tests and except for composition, shall be performed on each inspection lot.

4.2.2 Periodic Tests

Stress-corrosion resistance (3.3.2) is a periodic test and shall be performed at a frequency selected by the vendor unless frequency of testing is specified by purchaser.

4.3 Sampling and Testing

Shall be in accordance with AMS 2355 and the following:

4.3.1 Tensile specimens shall be taken with axis of specimens parallel to each applicable grain flow direction specified in Table 2.

4.3.2 When fracture toughness testing is specified, specimens shall be taken from at least one plate in each lot for each specimen orientation specified by purchaser.

4.4 Reports

The vendor of plate shall furnish with each shipment a report stating that the plate conforms to the composition, tolerances and ultrasonic inspection, and showing the numerical results of tests on each inspection lot to determine conformance to the other acceptance test requirements. This report shall include the purchase order number, inspection lot number(s), AMS 4413, size, and quantity. The report shall also identify the producer, the product form, and the size of the mill product.

4.5 Resampling and Retesting

Shall be in accordance with AMS 2355.

5. PREPARATION FOR DELIVERY

5.1 Identification

Shall be in accordance with ASTM B 666/B 666M.

5.1.1 Product shall be protected from damage during storage and shipment by a method determined by vendor unless specified by purchaser. Examples of typical protective methods include but are not limited to interleaving with paper or oiling of the surfaces.

5.1.2 Plate shall be prepared for shipment in accordance with ASTM B660 and in compliance with applicable rules and regulations pertaining to the handling, packaging, and transportation of the plate to ensure carrier acceptance and safe delivery.

6. ACKNOWLEDGMENT

A vendor shall note this specification number and its revision letter in all quotations and when acknowledging purchase orders.

7. REJECTIONS

Plate not conforming to this specification, or to modifications authorized by purchaser, will be subject to rejection.

8. NOTES

8.1 A change bar (|) located in the left margin is for the convenience of the user in locating areas where technical revisions, not editorial changes, have been made to the previous issue of a specification. An (R) symbol to the left of the document title indicates a complete revision of the specification, including technical revision. Change bars and (R) are not used in original publications, or in specifications that contain editorial changes only.

8.2 Terms used in AMS are clarified in ARP1917.

8.3 Dimensions and properties in inch/pound units and the Fahrenheit temperatures are primary; dimensions and properties in SI units and the Celsius temperatures are shown as the approximate equivalents of the primary units and are presented only for information.

8.4 Purchase documents should specify not less than the following:

AMS 4413
Size of plate desired
Quality of plate desired
Fracture toughness testing (if required) and specimen orientation (See 3.3.4)
Ultrasonic inspection (See 3.4.1).