

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

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SAE WEB ADDRESS:

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 $\sqrt{\text{inch}}$	T-L Ksi $\sqrt{\text{inch}}$	S-L Ksi $\sqrt{\text{inch}}$
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 $\sqrt{\text{m}}$	T-L MPa $\sqrt{\text{m}}$	S-L MPa $\sqrt{\text{m}}$
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.