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400 Commonwealth Dr., Warrendale, PA 15096

AEROSPACE MATERIAL SPECIFICATION

Submitted for recognition as an American National Standard

SAE AMS 4201A

Issued 1-15-80
Revised 7-1-86

Superseding AMS 4201

ALUMINUM ALLOY PLATE
6.2Zn - 2.3Cu - 2.2Mg - 0.12Zr (7050-T7651)
Solution Heat Treated, Stress Relieved and Overaged

UNS A97050

1. SCOPE:

1.1 Form: This specification covers an aluminum alloy in the form of plate.

1.2 Application: Primarily for parts requiring a high level of mechanical properties and resistance to exfoliation corrosion and moderate resistance to stress-corrosion cracking.

2. APPLICABLE DOCUMENTS: The following publications form a part of this specification to the extent specified herein. The latest issue of Aerospace Material Specifications and Aerospace Recommended Practices 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 2202 - Tolerances, Aluminum Alloy and Magnesium Alloy Sheet and Plate
MAM 2202 - Tolerances, Metric, Aluminum Alloy and Magnesium Alloy Sheet and Plate
AMS 2350 - Standards and Test Methods
AMS 2355 - Quality Assurance Sampling and Testing of Aluminum Alloys and Magnesium Alloys, Wrought Products (Except Forging Stock) and Flash Welded Rings
MAM 2355 - Quality Assurance Sampling and Testing of Aluminum Alloys and Magnesium Alloys, Wrought Products (Except Forging Stock) and Flash Welded Rings, Metric (SI) Units

2.1.2 Aerospace Recommended Practices:

ARP 1704 - Short-Bar Fracture Toughness of Metallic Materials

REAFFIRMED

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

ASTM E399 - Plane-Strain Fracture Toughness of Metallic Materials
ASTM E602 - Sharp-Notch Tension Testing with Cylindrical Specimens

2.3 U.S. Government Publications: Available from Commanding Officer, Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, PA 19120.

2.3.1 Military Specifications:

MIL-H-6088 - Heat Treatment of Aluminum Alloys

2.3.2 Military Standards:

MIL-STD-649 - Aluminum and Magnesium Products, Preparation for Shipment and Storage

3. TECHNICAL REQUIREMENTS:

3.1 Composition: Shall conform to the following percentages by weight, determined in accordance with AMS 2355 or MAM 2355:

	min	max
Zinc	5.7	6.7
Copper	2.0	2.6
Magnesium	1.9	2.6
Zirconium	0.08	0.15
Iron	-	0.15
Silicon	-	0.12
Manganese	-	0.10
Titanium	-	0.06
Chromium	-	0.04
Other Impurities, Each	-	0.05
Other Impurities, Total	-	0.15
Aluminum	remainder	

3.2 Condition: Solution heat treated, stretched to produce a nominal permanent set of 2% but not less than 1-1/2% nor more than 3%, and overaged. Solution heat treatment shall be performed in accordance with MIL-H-6088.

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 or MAM 2355 except as specified in 3.3.4.1 and 3.3.5:

3.3.1 Tensile Properties: Shall be as specified in Table I and 3.3.1.1.

TABLE I

Nominal Thickness Inches	Specimen Orientation	Tensile Strength psi, min	Yield Strength at 0.2% Offset psi, min	Elongation in 2 in. or 4D %, min
0.250 to 1.000, incl	Longitudinal	76,000	66,000	9
	Long-Trans.	76,000	66,000	8
Over 1.000 to 1.500, incl	Longitudinal	77,000	67,000	9
	Long-Trans.	77,000	67,000	8
Over 1.500 to 2.000, incl	Longitudinal	76,000	66,000	9
	Long-Trans.	76,000	66,000	8
Over 2.000 to 3.000, incl	Longitudinal	76,000	66,000	8
	Long-Trans.	76,000	66,000	7
	Short-Trans.	70,000	60,000	1.5

TABLE I (SI)

Nominal Thickness Millimetres	Specimen Orientation	Tensile Strength MPa, min	Yield Strength at 0.2% Offset MPa, min	Elongation in 50 mm or 4D %, min
6.25 to 25.00, incl	Longitudinal	525	455	9
	Long-Trans.	525	455	8
Over 25.00 to 37.50, incl	Longitudinal	530	460	9
	Long-Trans.	530	460	8
Over 37.50 to 50.00, incl	Longitudinal	525	455	9
	Long-Trans.	525	455	8
Over 50.00 to 75.00, incl	Longitudinal	525	455	8
	Long-Trans.	525	455	7
	Short-Trans.	485	415	1.5

3.3.1.1 Tensile property requirements for plate over 3.000 in. (75.00 mm) in nominal thickness shall be as agreed upon by purchaser and vendor.

3.3.2 Corrosion Resistance: Resistance to exfoliation corrosion and stress-corrosion cracking shall be demonstrated by meeting the following criteria:

3.3.2.1 Stress-Corrosion Resistance: Will be acceptable if plate meets the following requirements:

3.3.2.1.1 If the electrical conductivity (E.C.) is not lower than 37.0% IACS (International Annealed Copper Standard) (21.5 MS/m), the plate is acceptable.

3.3.2.1.2 Stress-corrosion suspectability factor, SCF, determined by deducting electrical conductivity, XX.X% IACS (12 times XX.X MS/m), from long transverse yield strength, XX.X ksi (XXX MPa), shall not be greater than 36.0 (248).

Examples: for 1.250 in. (31.25 mm) nominal thickness:

Inch/Pound Units	74.4 ksi - 37.3% IACS = 37.1	Unacceptable.
	69.4 ksi - 38.2% IACS = 31.2	Acceptable.
SI Units	513 MPa - 12 X 21.6 MS/m = 254	Unacceptable.
	480 MPa - 12 X 22.2 MS/m = 214	Acceptable.

3.3.2.1.3 Plate not meeting the requirements of 3.3.1, 3.3.2.1.1 and 3.3.2.1.2 may be given additional overaging heat treatment after which it shall be retested to determine conformance to requirements of 3.3.1 and 3.3.2.1.

3.3.2.2 Exfoliation Corrosion Resistance: Plate shall show exfoliation corrosion not greater than that pictured in Photo B, Fig. 2, of ASTM G34-72 at a T/10 plane.

3.3.2.3 Stress-Corrosion Resistance: Specimens cut from plate 0.750 in. (18.75 mm) and over in nominal thickness and stressed in the short-transverse direction to 25,000 psi (170 MPa) shall show no evidence of stress-corrosion cracking.

3.3.3 Fracture Toughness: Plate shall meet the values of K_{Ic} specified in Table II, determined using specimen configurations conforming to ASTM E399. For T-L and L-T test directions on plate 2 in. (50 mm) and under in nominal thickness, use full thickness specimens; for plate over 2 to 4 in. (50 to 100 mm), incl, in nominal thickness, use 2-in. (50-mm) thick specimens centered at T/2; and for plate over 4 in. (100 mm) in nominal thickness, use 2-in. (50-mm) thick specimens centered at T/4. For the S-L test direction, the test specimens shall be centered at T/2. Required specimen orientation(s) shall be specified by purchaser.

TABLE II

Specimen Orientation	Nominal Thickness, Inches	Nominal Thickness, Millimetres	Minimum K_{Ic}, ksi$\sqrt{in.}$	Minimum K_{Ic}, MPa$\sqrt{m}$
L-T	1.000 to 2.000, incl	25.00 to 50.00, incl	26	28
	Over 2.000 to 3.000, incl	Over 50.00 to 75.00, incl	24	26
T-L	1.000 to 2.000, incl	25.00 to 50.00, incl	24	26
	Over 2.000 to 3.000, incl	Over 50.00 to 75.00, incl	23	25
S-L	2.000 to 3.000, incl	50.00 to 75.00, incl	20	22

3.3.4 Notch Tensile Strength/Tensile Yield Strength (NTS/TYS) Ratio: The producer may guarantee that plate meets the fracture toughness (K_{Ic}) requirements based on correlation with notch tensile strength/tensile Ø yield strength (NTS/TYS) ratio, determined in accordance with 3.3.4.1, or correlation with the short-bar fracture toughness results, determined in accordance with 3.3.5 in lieu of determining fracture toughness (3.3.3) provided that he has established correlation between the two tests for his plate.

3.3.4.1 NTS/TYS Ratio: For plate 0.750 to 3.000 in. (18.75 to 75.00 mm), incl, in nominal thickness, notch tensile strength shall be determined in Ø accordance with ASTM E602 on specimens taken in both the longitudinal and long-transverse directions. The values for each direction shall be divided by the tensile yield strength, determined for the same direction, to obtain the NTS/TYS ratios.

3.3.5 Short-Bar Fracture Toughness: Shall be not lower than the values for Ø K_{Ic} specified in Table II, determined in accordance with ARP 1704 on specimens from plate 1.000 to 3.000 in. (25.00 to 75.00 mm), incl, in nominal thickness.

3.4 Quality: Plate, as received by purchaser, shall be uniform in quality and Ø 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 B594 Ø and shall meet the following requirements:

3.4.1.1 Plates weighing 2000 lb (900 kg) and under shall meet the following requirements for ultrasonic class:

Nominal Thickness, Inches	Nominal Thickness, Millimetres	Ultrasonic Class
0.500 to 1.500, excl	12.50 to 37.50, excl	B
1.500 to 3.000, incl	37.50 to 75.00, incl	A

3.4.1.2 The ultrasonic class for plates under 0.500 in. (12.50 mm) or over 3.000 in. (75.00 mm) in nominal thickness or weighing over 2000 lb (900 kg) shall be as agreed upon by purchaser and vendor.

3.5 Tolerances: Shall conform to all applicable requirements of AMS 2202 or MAM 2202.

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 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 plate conforms to the requirements of this specification.

4.2 Classification of Tests:

4.2.1 Acceptance Tests: Tests to determine conformance to requirements for composition (3.1), long-transverse tensile properties (3.3.1), corrosion resistance (3.3.2.1), fracture toughness (3.3.3), ultrasonic soundness (3.4.1), tolerances (3.5) and, when specified, longitudinal, short-transverse, or both, tensile properties (3.3.1) are classified as acceptance tests and shall be performed on each lot.

4.2.2 Periodic Tests: Tests to determine conformance to requirements for exfoliation resistance (3.3.2.2) and stress-corrosion resistance (3.3.2.3) are classified as periodic tests and shall be performed at a frequency selected by the vendor unless frequency of testing is specified by purchaser.

4.3 Sampling: Shall be in accordance with AMS 2355 or MAM 2355 and the following:

4.3.1 Tensile specimens shall be taken with the axis of specimens in the long-transverse direction and, when specified, in the longitudinal, short-transverse, or both, directions.

4.3.2 Specimens for conductivity testing shall be taken from the samples used for long-transverse tensile testing.

4.4 Reports:

4.4.1 The vendor of plate shall furnish with each shipment a report stating that the plate conforms to the chemical composition, showing the results of tests on each inspection lot to determine conformance to the other acceptance test requirements, and stating that the plate conforms to the other technical requirements of this specification. This report shall include the purchase order number, inspection lot number, AMS 4201A, size, and quantity.