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INTERNATIONAL
400 Commonwealth Drive, Warrendale, PA 15096-0001

AEROSPACE MATERIAL SPECIFICATION

SAE AMS 4201B

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Superseding AMS 4201A

Submitted for recognition as an American National Standard

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:

This plate has been used typically for parts requiring a high level of mechanical properties and resistance to exfoliation corrosion and moderate resistance to stress-corrosion cracking, but usage is not limited to such applications.

2. APPLICABLE DOCUMENTS:

The following publications form a part of this specification to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other publications shall be the issue in effect on the date of the purchase order.

2.1 SAE Publications:

Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

AMS 2202 Tolerances, Aluminum Alloy and Magnesium Alloy Sheet and Plate
MAM 2202 Tolerances, Metric, Aluminum Alloy and Magnesium Alloy Sheet and Plate
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
AMS 2811 Identification, Aluminum and Magnesium Alloy Wrought Products
ARP1704 Short-Bar Fracture Toughness of Metallic Materials

2.2 ASTM Publications:

Available from ASTM, 1916 Race Street, Philadelphia, PA 19103-1187.

ASTM B 594 Ultrasonic Inspection of Aluminum-Alloy Products for Aerospace Applications
ASTM B 660 Packing/Packaging of Aluminum and Magnesium Products
ASTM E 399 Plane-Strain Fracture Toughness of Metallic Materials
ASTM E 602 Sharp-Notch Tension Testing with Cylindrical Specimens
ASTM G 34 Exfoliation Corrosion Susceptibility in 2XXX and 7XXX Series Aluminum Alloys (EXCO Test)

2.3 U.S. Government Publications:

Available from Standardization Documents Order Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.

MIL-H-6088 Heat Treatment of Aluminum Alloys

3. TECHNICAL REQUIREMENTS:

3.1 Composition:

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

TABLE 1 - Composition

Element	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:
(R)

Solution heat treated, stretched to produce a nominal permanent set of 2% but not less than 1-1/2% nor more than 3%, and precipitation heat treated. Solution and precipitation 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:
(R)

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 2 and 3.3.1.1.

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 %
0.250 to 1.000, incl	Longitudinal	76.0	66.0	9
	Long-Trans.	76.0	66.0	8
Over 1.000 to 1.500, incl	Longitudinal	77.0	67.0	9
	Long-Trans.	77.0	67.0	8
Over 1.500 to 2.000, incl	Longitudinal	76.0	66.0	9
	Long-Trans.	76.0	66.0	8
Over 2.000 to 3.000, incl	Longitudinal	76.0	66.0	8
	Long-Trans.	76.0	66.0	7
	Short-Trans.	70.0	60.0	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 %	Elongation in 50.8 mm or 5D %
6.35 to 25.40, incl	Longitudinal	524	455	9	8
	Long-Trans.	524	455	8	7
Over 25.40 to 38.10, incl	Longitudinal	531	462		8
	Long-Trans.	531	462		7
Over 38.10 to 50.80, incl	Longitudinal	524	455		8
	Long-Trans.	524	455		7
Over 50.80 to 76.20, incl	Longitudinal	524	455		7
	Long-Trans.	524	455		6
	Short-Trans.	483	414		1.5

3.3.1.1 Tensile property requirements for plate over 3.000 inches (76.20 mm) in nominal thickness shall be as agreed upon by purchaser and vendor.

3.3.2 Corrosion Resistance: Resistance to stress-corrosion cracking and to exfoliation corrosion shall be acceptable if the plate conforms to the requirements of 3.3.2.1, 3.3.2.2, and 3.3.2.3.

3.3.2.1 (R) Electrical Conductivity (EC): Shall be not lower than 37.0% IACS (International Annealed Copper Standard) (21.5 MS/m), determined on the surface of the long-transverse tensile specimen.

3.3.2.2 Stress-Corrosion Susceptibility Factor (SCF): Shall be not greater than 36.0 (248), determined by subtracting the electrical conductivity, XX.X% IACS (12 times XX.X MS/m), from long-transverse yield strength, XX.X ksi (XXX MPa).

Examples: for 1.250 inches (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.

3.3.2.3 Plate not meeting the requirements of 3.3.1, 3.3.2.1 and 3.3.2.2 may be given additional precipitation heat treatment or re-heat treated. After such treatment, if all specified properties are met, plate is acceptable.

3.3.3 Exfoliation Corrosion Test: Plate shall exhibit exfoliation-corrosion at a T/10 plane not greater than that illustrated by Photo B, Figure 2, of ASTM G 34.

3.3.4 Stress-Corrosion Test: Specimens, cut 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 to 25.0 ksi (172 MPa).

3.3.5 Fracture Toughness: Plate shall meet the values of K_{Ic} specified in Table 3, determined using specimen configurations conforming to ASTM E 399. 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 2-inch (51-mm) thick specimens centered at T/2; and for plate over 4 inches (102 mm) in nominal thickness, use 2-inch (51-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 3 - Fracture Toughness Parameters

Specimen Orientation	Nominal Thickness Inches	Nominal Thickness Millimeters	Minimum K_{Ic} ksi $\sqrt{inch}$	Minimum K_{Ic} MPa $\sqrt{m}$
L-T	1.000 to 2.000, incl	25.40 to 50.80, incl	26	28
	Over 2.000 to 3.000, incl	Over 50.80 to 76.20, incl	24	26
T-L	1.000 to 2.000, incl	25.40 to 50.80, incl	24	26
	Over 2.000 to 3.000, incl	Over 50.80 to 76.20, incl	23	25
S-L	2.000 to 3.000, incl	50.80 to 76.20, incl	20	22

3.3.6 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 yield strength (NTS/TYS) ratio, determined in accordance with 3.3.6.1, or correlation with the short-bar fracture toughness results, determined in accordance with 3.3.7, in lieu of determining fracture toughness (3.3.5) provided that he has established correlation between the two tests for the plate.

3.3.6.1 NTS/TYS Ratio: For plate 0.750 to 3.000 inches (19.05 to 76.20 mm), inclusive, in nominal thickness, notch tensile strength shall be determined in accordance with ASTM E 602 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.

3.3.7 Short-Bar Fracture Toughness: Shall be not lower than the values for K_{Ic} specified in Table 3, determined in accordance with ARP1704 on specimens from plate 1.000 to 3.000 inches (25.40 to 76.20 mm), inclusive, in nominal thickness.

3.4 Quality:
(R)

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 following requirements:

3.4.1.1 Plates weighing 2000 pounds (907 kg) and under shall meet the requirements for ultrasonic class shown in Table 4.

TABLE 4 - Ultrasonic Parameters

Plate Thickness Inches	Plate Thickness Millimeters	Ultrasonic Class
0.500 to 1.500, excl	12.70 to 38.10, excl	B
1.500 to 3.000, incl	38.10 to 76.20, incl	A

3.4.1.2 The ultrasonic class for plates under 0.500 inch (12.70 mm) or over 3.000 inches (76.20 mm) in nominal thickness or weighing over 2000 pounds (907 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:
(R)

The vendor of plate shall supply all samples for vendor's tests and shall be responsible for performing all required tests. 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 for composition (3.1), long-transverse tensile properties (3.3.1), corrosion resistance (3.3.2), fracture toughness (3.3.5), ultrasonic soundness (3.4.1), tolerances (3.5) and when specified, longitudinal, short-transverse, or both, tensile properties (3.3.1) are acceptance tests and shall be performed on each lot.

4.2.2 Periodic Tests: Tests for exfoliation corrosion resistance (3.3.3) and stress-corrosion resistance (3.3.4) are periodic tests and shall be performed at a frequency selected by the vendor unless frequency of testing is specified by purchaser.

4.3 Sampling and Testing:
(R)

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 and/or short-transverse directions.