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400 Commonwealth Drive, Warrendale, PA 15096-0001

AEROSPACE MATERIAL SPECIFICATION

SAE AMS 4201C

Issued JAN 1980
Revised AUG 2000

Superseding AMS 4201B

Aluminum Alloy Plate
6.2Zn - 2.3Cu - 2.2Mg - 0.12Zr (7050-T7651)
Solution Heat Treated, Stress Relieved, and Overaged

UNS A97050

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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 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 canceled and no superseding document has been specified, the last published issue of that document shall apply.

2.1 SAE Publications:

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

AMS 2355	Quality Assurance Sampling and Testing, Aluminum Alloys and Magnesium Alloys, Wrought Products, Except Forging Stock, and Rolled, Forged, or Flash Welded Rings
MAM 2355	Quality Assurance Sampling and Testing, Aluminum Alloys and Magnesium Alloys, Wrought Products, Except Forging Stock, and Rolled, Forged, or Flash Welded Rings, Metric (SI) Units
AMS 2772	Heat Treatment of Aluminum Alloy Raw Materials

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2.2 ASTM Publications:

Available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.

ASTM B 557	Tension Testing of Wrought and Cast Aluminum and Magnesium Alloy Parts
ASTM B 594	Ultrasonic Inspection of Aluminum-Alloy Products for Aerospace Applications
ASTM B 660	Packing/Packaging of Aluminum-Alloy Products for Aerospace Applications
ASTM B 666/666M	Identification Marking 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 E 1304	Plane-Strain (Chevron-Notch) Fracture Toughness of Metallic Materials
ASTM G 34-72	Exfoliation Corrosion Susceptibility in 2XXX and 7XXX Series Aluminum Alloys (EXCO Test)
ASTM G 47	Determining Susceptibility to Stress-Corrosion Cracking of High-Strength Aluminum Alloy Products

2.3 ANSI Publications:

Available from American National Standards Institute, 11 West 42nd Street, New York, NY 10036.

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 or MAM 2355.

TABLE 1 - Composition

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

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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 precipitation heat treated to the -T7651 temper 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, determined on the mill product in accordance with AMS 2355 or MAM 2355 except as specified in 3.3.6:

3.3.1 Tensile Properties: Shall be as specified in Table 2, when tested in accordance with ASTM B 557.

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	66.0	1.5

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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	9	8
	Long-Trans.	531	462	8	7
Over 38.10 to 50.80, incl	Longitudinal	524	455	9	8
	Long-Trans.	524	455	8	7
Over 50.80 to 76.20, incl	Longitudinal	524	455	8	7
	Long-Trans.	524	455	7	6
	Short-Trans.	483	414	1.5	1.5

3.3.2 Corrosion Resistance Indicator Test: 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 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 34-72.

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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 tested in accordance with ASTM G 47 and 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 3 inches (51 to 76 mm), inclusive, in nominal thickness, use 2-inch (51-mm) thick specimens centered at T/2. 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	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	50.80 to 76.20, incl	23	25
S-L	Over 2.000 to 3.000, incl	50.80 to 76.20, incl	20	22

3.3.6 Alternate Testing for Demonstration of Fracture Toughness: When specified, the producer shall guarantee that plate meets the fracture toughness 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 3.3.6.2, in lieu of fracture toughness testing (3.3.5). Sampling and testing requirements, and lot acceptance criteria shall be as agreed upon.

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. Acceptance values for NTS/TYS shall be specified based on evidence of documented correlation between the NTS/TYS ratio and fracture toughness values (3.3.5) as demonstrated and maintained by the producer.

3.3.6.2 Short-Bar Fracture Toughness: For plate 1.000 to 3.000 inches (25.40 to 76.20 mm), inclusive, in nominal thickness, 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 T-L and L-T test directions. 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 toughenss values (3.3.5) as demonstrated and maintained by the producer.

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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 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 acceptable to purchaser.

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 the specified requirements.

4.2 Classification of Tests:

4.2.1 Acceptance Tests: Composition (3.1), long-transverse tensile properties (3.3.1), corrosion resistance (3.3.2), ultrasonic inspection (3.4.1), tolerances (3.5), fracture toughness (3.3.5) or when specified alternate testing for demonstration of fracture toughness and when specified, longitudinal, short-transverse, or both, tensile properties (3.3.1) are acceptance tests and except for composition, shall be performed on each lot.

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