

ALUMINUM ALLOY PLATE

6.2Zn - 1.8Cu - 2.4Mg - 0.13Zr (7010-T7651)

Solution Heat Treated, Stress Relieved, and Precipitation Heat Treated

1. SCOPE:

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

1.2 Application: Primarily for parts requiring higher tensile strength than AMS 4203 or AMS 4205 and resistance to exfoliation corrosion.

2. APPLICABLE DOCUMENTS: The following publications form a part of this specification to the extent specified herein. The latest issue of Aerospace Material Specifications (AMS) 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

AMS 2350 - Standards and Test Methods

AMS 2355 - Quality Assurance Sampling and Testing of Aluminum-Base and Magnesium-Base Alloys, Wrought Products (Except Forgings and Forging Stock) and Flash Welded Rings

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

ASTM B645 - Plane-Strain Fracture Toughness Testing of Aluminum Alloys

ASTM G47 - Determining Susceptibility to Stress-Corrosion Cracking of High-Strength Aluminum Alloy Products

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

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2.3.1 Military Specifications:

MIL-H-6088 - Heat Treatment of Aluminum Alloys
MIL-I-8950 - Inspection, Ultrasonic, Wrought Metals, Process for

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:

	min	max
Zinc	5.7	6.7
Copper	1.5	2.0
Magnesium	2.1	2.6
Zirconium	0.10	0.16
Iron	--	0.15
Silicon	--	0.12
Manganese	--	0.10
Titanium	--	0.06
Nickel	--	0.05
Chromium	--	0.05
Other Impurities, each	--	0.05
Other Impurities, total	--	0.15
Aluminum		remainder

3.2 Condition: Solution heat treated, stress relieved by stretching to produce a nominal permanent set of 2% but not less than 1-1/2% nor more than 3%, and precipitation heat treated. Heat treatments shall be performed at the proper temperatures and for the proper times to produce plate meeting the requirements of 3.3 using equipment and procedural controls 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 and as specified herein:

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
Up to 2.000, incl	Longitudinal	76,000	66,000	8
	Long Trans.	76,000	66,000	6
Over 2.000 to 2.500, incl	Longitudinal	75,000	65,000	8
	Long Trans.	75,000	65,000	6
	Short Trans.	71,000	59,000	2.5
Over 2.500 to 3.000, incl	Longitudinal	73,000	64,000	7
	Long Trans.	74,000	64,000	5
	Short Trans.	70,000	58,000	2.5
Over 3.000 to 4.000, incl	Longitudinal	72,000	64,000	7
	Long Trans.	73,000	63,000	5
	Short Trans.	69,000	56,000	2
Over 4.000 to 5.000, incl	Longitudinal	72,000	63,000	7
	Long Trans.	72,000	62,000	5
	Short Trans.	68,000	55,000	2
Over 5.000 to 5.500, incl	Longitudinal	71,000	62,000	6
	Long Trans.	72,000	61,000	4
	Short Trans.	66,000	53,000	2

TABLE I (SI)

Nominal Thickness Millimetres	Specimen Orientation	Tensile Strength MPa, min	Yield Strength at 0.2% Offset MPa, min	Elonga- tion in 50 mm or 4D %, min
Up to 50, incl	Longitudinal	525	455	8
	Long Trans.	525	455	6
Over 50 to 62.5, incl	Longitudinal	515	450	8
	Long Trans.	515	450	6
	Short Trans	490	405	2.5
Over 62.5 to 75, incl	Longitudinal	505	440	7
	Long Trans.	510	440	5
	Short Trans.	485	400	2.5
Over 75 to 100, incl	Longitudinal	495	440	7
	Long Trans.	505	435	5
	Short Trans.	475	385	2
Over 100 to 125, incl	Longitudinal	495	435	7
	Long Trans.	495	425	5
	Short Trans.	470	380	2
Over 125 to 140, incl	Longitudinal	490	425	6
	Long Trans.	495	420	4
	Short Trans.	455	365	2

3.3.1.1 Tensile property requirements for plate over 5.500 in. (140 mm) in nominal thickness shall be as agreed upon by purchaser and vendor.

3.3.2 Conductivity: Shall be not lower than 39.0% IACS (International Annealed Copper Standard), determined on specimens as in 4.3.1.

3.3.2.1 If the conductivity is below 39.0% IACS, the plate is not acceptable.

3.3.2.2 Plate found to be unacceptable may be given additional precipitation heat treatment and if, upon completion of such treatment, it develops tensile property/conductivity relationships conforming to 3.3.1 and 3.3.2, it shall be acceptable.

3.3.3 Fracture Toughness: When specified, plate shall meet the values of K_{Ic} specified in Table II, determined in accordance with ASTM B645 on specimens as in 4.3.2. The required test directions shall be as specified by purchaser.

TABLE II

Nominal Thickness Inches	Test Direction	K_{Ic} , min Ksi $\sqrt{\text{in.}}$
Over 1 to 2 incl	L-T	25.0
	T-L	23.0
Over 2 to 3 incl	L-T	24.0
	T-L	22.0
	S-L	20.0
Over 3 to 5 incl	L-T	22.0
	T-L	20.0
	S-L	18.0
Over 5 to 5.5 incl	L-T	20.0
	T-L	18.0
	S-L	17.0

TABLE II (SI)

Nominal Thickness Millimetres	Test Direction	K_{Ic} , min MPa $\sqrt{\text{m}}$
25 to 50 incl	L-T	27.5
	T-L	25.3
Over 50 to 75 incl	L-T	26.4
	T-L	24.2
	S-L	22.0
Over 75 to 125 incl	L-T	24.2
	T-L	22.0
	S-L	19.8
Over 125 to 140 incl	L-T	22.0
	T-L	19.8
	S-L	18.7

3.3.4 Exfoliation Resistance: Plate, processed to meet the requirements of 3.3.1 and 3.3.2, shall exhibit exfoliation corrosion not worse than an EA rating.

3.3.5 Stress-Corrosion Resistance: Specimens from plate 0.750 in. (19 mm) and over in nominal thickness, processed to meet the requirements of 3.3.1 and 3.3.2, shall meet the requirements of ASTM G47 when stressed in the short-transverse direction to 25,000 psi (172 MPa).

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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 internal and external imperfections detrimental to usage of the plate.

3.4.1 Plates weighing 2000 lb (900 kg) and under, inspected in accordance with MIL-I-8950, shall meet the following requirements for ultrasonic class, unless waived by purchaser:

<u>Nominal Thickness</u>		<u>Ultrasonic Class</u>
<u>Inches</u>	<u>(Millimetres)</u>	
0.500 to 1.500, excl	(12.50 to 37.50, excl)	B
1.500 to 2.000, incl	(37.50 to 50.00, incl)	A

3.4.1.1 The ultrasonic class for plates under 0.500 in. (12.50 mm) or over 2.000 in. (50.00 mm) in nominal thickness or weighing over 2000 lb (900 kg) shall be as agreed upon by purchaser and vendor.

3.5 Tolerances: Unless otherwise specified, tolerances shall conform to all applicable requirements of AMS 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 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), tensile properties (3.3.1), conductivity (3.3.2), ultrasonic soundness (3.4.1) unless waived by purchaser, and tolerances (3.5) are classified as acceptance tests and shall be performed on each lot.

4.2.2 Periodic Tests: Tests to determine conformance to requirements for fracture toughness (3.3.3) when specified, exfoliation resistance (3.3.4), and stress-corrosion resistance (3.3.5) 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 and the following:

4.3.1 Specimens for conductivity testing shall be taken from the samples used for tensile testing.

4.3.2 When fracture toughness testing is required, specimens for testing shall, unless otherwise specified, be taken from the center width of at least one plate in each inspection lot for each test direction specified.

4.4 Reports:

- 4.4.1 The vendor of plate shall furnish with each shipment three copies of a report stating that the plate conforms to the chemical composition specified, 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 4204, size, and quantity.
- 4.4.2 The vendor of finished or semi-finished parts shall furnish with each shipment three copies of a report showing the purchase order number, AMS 4204, contractor or other direct supplier of plate, part number, and quantity. When plate for making parts is produced or purchased by the parts vendor, that vendor shall inspect each lot of plate to determine conformance to the requirements of this specification and shall include in the report either a statement that the plate conforms or copies of laboratory reports showing the results of tests to determine conformance.

4.5 Resampling and Retesting: Shall be in accordance with AMS 2355.

5. PREPARATION FOR DELIVERY:

5.1 Identification: Each plate shall be marked on one face, in the respective location indicated below, with the alloy number and temper, AMS 4204, inspection lot number, manufacturer's identification, and nominal thickness. The characters shall be of such size as to be legible, shall be applied using a suitable marking fluid, and shall be sufficiently stable to withstand normal handling. The markings shall have no deleterious effect on the plate or its performance.

5.1.1 Plate Under 6 In. (150 mm) Wide: Shall be marked in one or more lengthwise rows of characters recurring at intervals not greater than 3 ft (900 mm). The inspection lot number may appear in the row marking or may appear at only one location on each piece.

5.1.2 Plate 0.375 In. (9.50 mm) and Under Thick, 6 - 60 In. (150 - 1500 mm), Incl, Wide, and 36 - 200 In. (900 - 5000 mm), Incl, Long: Shall be marked in lengthwise rows of characters recurring at intervals not greater than 3 ft (900 mm), the rows being spaced approximately 6 in. (150 mm) on centers across the width and staggered. Every third row shall show the manufacturer's identification and nominal thickness. The other rows shall show the alloy number and temper and AMS 4204. The inspection lot number may be included in the rows with the alloy number, temper, and specification designations or may appear at only one location on each piece.