Society of Automotive Engineers, Inc.
400 COMMONWEALTH DRIVE, WARRENDALE, PA. 15096

AEROSPACE MATERIAL SPECIFICATION

AMS 4089A
Superseding AMS 4089

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UNS A97475

ALUMINUM ALLOY PLATE
5.7Zn - 2.2Mg - 1.6Cu - 0.22Cr (7475-T7651)

1. SCOPE:

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

1.2 Application: Primarily for structural applications requiring material with high strength and resistance to exfoliation-corrosion, moderate fatigue strength, and high fracture-toughness.

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 Society of Automotive Engineers, Inc., 400 Commonwealth Drive, Warrendale, PA 15096.

2.1.1 Aerospace Material Specifications:

AMS 2202 - Tolerance, Aluminum-Base and Magnesium-Base 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 E338 - Sharp-Notch Tension Testing of High-Strength Sheet Materials
ASTM E399 - Plane-Strain Fracture Toughness of Metallic Materials
ASTM G34 - Exfoliation Corrosion Susceptibility in 7XXX Series Copper Containing Aluminum Alloys (EXCO Test)
ASTM G47 - Determining Susceptibility to Stress-Corrosion Cracking of High-Strength 7XXX Aluminum Alloy Products

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

2.3.1 Military Specifications:

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

2.4 ANSI Publications: Available from American National Standards Institute, Inc., 1430 Broadway, New York, NY 10018.

ANSI B46.1 - Surface Texture

Printed in U.S.A.

3. TECHNICAL REQUIREMENTS:

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

	min	max
Zinc	5.2	6.2
Magnesium	1.9	2.6
Copper	1.2	1.9
Chromium	0.18	0.25
Iron	--	0.12
Silicon	--	0.10
Manganese	--	0.06
Titanium	--	0.06
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.

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 except that notch tensile testing shall be performed as in 3.3.3.1:

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 0.499, incl	Longitudinal	70,000	60,000	9
	Long Transverse	71,000	60,000	9
Over 0.499 to 1.000, incl	Longitudinal	69,000	59,000	8
	Long Transverse	70,000	59,000	8
Over 1.000 to 1.500, incl	Longitudinal	69,000	59,000	6
	Long Transverse	70,000	59,000	6

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
6.35 to 12.67, incl	Longitudinal	483	414	9
	Long Transverse	490	414	9
Over 12.67 to 25.40, incl	Longitudinal	476	407	8
	Long Transverse	483	407	8
Over 25.40 to 38.10, incl	Longitudinal	476	407	6
	Long Transverse	483	407	6

3.3.1.1 Tensile property requirements for plate over 1.500 in, (38.10 mm) in nominal thickness shall be as agreed upon by purchaser and vendor.

3.3.2 Fracture Toughness: Plane-strain fracture toughness (K_{Ic}), determined in accordance with 3.3.2.1, ø shall be not lower than the values specified in Table II.

TABLE II

Specimen Orientation (See 8.4)	K_{Ic} Ksi $\sqrt{in.}$	K_{Ic} (MPa $\sqrt{m}$)
L-T	33	36.3
T-L	30	33

3.3.2.1 Fracture toughness shall be determined in accordance with ASTM E399. The L-T and T-L specimens of the standard proportions shown in ASTM E399 shall have crack length of not less ø than 1.50 in. (38.1 mm), i.e., W = 3.00 in. (76.2 mm), and be full thickness. All K_Q values obtained shall meet all validity requirements of ASTM E399 for K_{Ic} except that K_Q values which are invalid for the following reasons shall be considered meaningful and, if equal to or greater than the applicable values in Table II, shall be evidence of acceptable fracture toughness:

3.3.2.1.1 Insufficient specimen thickness.

3.3.2.1.2 Excessive plasticity as indicated by the ratio of P_{max}/P_Q exceeding 1.1.

3.3.2.1.3 Stress level during last step of fatigue cracking exceeding the maximum level of 0.6 K_Q by no more than 0.1 K_Q.

3.3.2.1.4 The difference between any two of the three center dimensions required for measuring fatigue crack front curvature may vary as much as 10%.

3.3.3 Notch Tensile Strength/Tensile Yield Strength (NTS/TYS) Ratio: Unless otherwise specified, the ø 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 in lieu of determining fracture toughness provided that he has established correlation between the two tests for his plate.

3.3.3.1 Notch tensile strength shall be determined in accordance with ASTM E338 except that specimens for plate 0.250 to 0.749 in. (6.35 to 19.02 mm), incl, in nominal thickness shall conform to Fig. 1 of this specification and for plate over 0.749 in. (19.02 mm) in nominal thickness specimens shall conform to Fig. 2 of this specification (See 8.3). Notch tensile tests shall be made in both the longitudinal and long-transverse directions, and the notch tensile strength values determined for each direction shall be divided by the tensile yield strength determined for the same direction to obtain NTS/TYS ratios.

3.3.4 Conductivity:

3.3.4.1 If the conductivity is 39% (International Annealed Copper Standard) or higher and the longitudinal yield strength does not exceed the specified minimum by 9000 psi (62 MPa) or more, the plate is acceptable.

3.3.4.2 If the conductivity is 39% IACS or higher and the longitudinal yield strength exceeds the specified minimum by 9000 psi (62 MPa) or more, the plate shall also meet the requirements of 3.3.5 to be acceptable.

3.3.4.3 If the conductivity is at least 38% but lower than 39% IACS, the plate shall also meet the requirements of 3.3.5 to be acceptable.

3.3.4.4 If the conductivity is lower than 38% IACS, the plate is not acceptable.

3.3.4.4.1 Plate found to be unacceptable may be given additional precipitation heat treatment and if, after completion of such treatment, it meets the criteria of 3.3.4.1, 3.3.4.2, or 3.3.4.3, it shall be acceptable.

3.3.5 Exfoliation Resistance: Plate examined at a T/10 plane shall not show exfoliation equal to or greater than that illustrated by Photo B, Fig. 2 of ASTM G34 after being subjected to the exfoliation test of ASTM G34.

3.3.6 Stress-Corrosion Resistance: Plate 0.750 in. (19 mm) and over in nominal thickness, stressed in the short-transverse direction to 25,000 psi (172 MPa), shall meet the requirements of ASTM G47.

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 Plate 0.500 in. (12.70 mm) and over in nominal thickness, inspected in accordance with MIL-I-8950, shall meet the Class B acceptance limits of that specification.

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 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 such confirmatory testing as he deems 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), fracture toughness (3.3.2), notch tensile strength/tensile yield strength ratio (3.3.3), conductivity (3.3.4), quality (3.4), and tolerances (3.5) are classified as acceptance tests and shall be performed on each lot of plate except that fracture toughness need not be determined if the notch tensile strength/tensile yield strength ratio indicates that the established correlation is met.

4.2.2 Periodic Tests: Tests to determine conformance to requirements for exfoliation resistance (3.3.5) and stress-corrosion resistance (3.3.6) 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; an inspection lot for tensile properties, fracture toughness, notch tensile strength/tensile yield strength ratio, and Ø conductivity shall be all plate of the same alloy, temper, section and size traceable to a heat treatment lot and submitted for vendor's inspection at one time.

4.3.1 Specimens for conductivity testing shall be the tensile test samples.

4.3.2 At least one sample shall be taken from each lot for exfoliation-resistance testing or for stress-Ø corrosion resistance testing, as applicable, when the yield strength exceeds the specified minimum by more than 9000 psi (62 MPa), or when the conductivity is between 38% and 39% IACS.

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 and other technical requirements of this specification. This report shall include the purchase order number, material specification number and its revision letter, 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, material specification number and its revision letter, 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 a statement that the plate conforms, or shall include 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 4089, inspection lot number, manufacturer's identification, and nominal thickness. The characters shall be of such size as to be clearly 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. (152 mm) Wide: Shall be marked in one or more lengthwise rows of characters recurring at intervals not greater than 3 ft (914 mm). The inspection lot number may appear in the row marking or may appear at only one location on each plate.

5.1.2 Flat Plate 0.375 In. (9.52 mm) and Under Thick, 6 - 60 In. (152 - 1524 mm), Incl, Wide, and 36 - 200 In. (914 - 5080 mm), Incl, Long: Shall be marked in lengthwise rows of characters recurring at intervals not greater than 3 ft (914 mm), the rows being spaced approximately 6 in. (152 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 4089. The inspection lot number may be included in the rows with the alloy, temper, and specification designations or may appear at only one location on each plate.

5.1.3 Flat Plate Over 0.375 In. (9.52 mm) Thick or Over 60 In. (1524 mm) Wide or Over 200 In. (5080 mm) Long: Shall be marked as in 5.1.2 or, at vendor's discretion, shall be marked in one or two rows of characters recurring at intervals not greater than 3 ft (914 mm) and running around the periphery of the piece. If one row is used, it shall show all information of 5.1 except that the inspection lot number may be omitted. If two rows are used, one row shall show the alloy number and temper and AMS 4089; the second row shall show the manufacturer's identification and nominal thickness. The inspection lot number may be included in the line with the manufacturer's identification and nominal thickness or may appear at only one location on each plate.

5.1.3.1 If peripheral marking is applied to the full plate as produced but partial plates are supplied, an arrow shall also be applied near one corner indicating the direction of rolling.

5.2 Protective Treatment: Flat plate shall be protected, during shipment and storage, by interleaving with suitable paper sheets.

5.3 Packaging:

5.3.1 Plate shall be prepared for shipment in accordance with commercial practice and in compliance Ø with applicable rules and regulations pertaining to the handling, packaging, and transportation of the plate to ensure carrier acceptance and safe delivery. Packaging shall conform to carrier rules and regulations applicable to the mode of transportation.

5.3.2 For direct U.S. Military procurement, packaging shall be in accordance with MIL-STD-649, Level A or Level C, as specified in the request for procurement. Commercial packaging as in 5.3.1 will be acceptable if it meets the requirements of Level C.

6. ACKNOWLEDGMENT: A vendor shall mention this specification number and its revision letter in all quotations and when acknowledging purchase orders.

7. REJECTIONS: Plate not conforming to this specification or to authorized modifications will be subject to rejection.

8. NOTES:

8.1 Marginal Indicia: The phi (Ø) symbol is used to indicate technical changes from the previous issue of this specification.

8.2 Dimensions and properties in U.S. Conventional units are primary; dimensions and properties in SI units are shown as the equivalents of the U.S. Conventional units and are not to be construed as standard for plate produced to SI dimensions.

8.3 The notch tensile strength is directly dependent upon specimen shape and thickness so it is imperative that the geometry shown in Figs. 1 and 2 be used. In addition, the results of notch tensile tests are extremely susceptible to eccentricity and every effort should be made to control alignment.

8.4 Specimen Orientation for Fracture Toughness Tests: L-T stress is applied in the longitudinal grain direction with crack propagating in the long-transverse grain direction and T-L stress is applied in the long-transverse grain direction with crack propagating in the longitudinal direction.

8.5 For direct U.S. Military procurement, purchase documents should specify not less than the following:

Title, number, and date of this specification
Size of plate desired
Quantity of plate desired
Applicable level of packaging (See 5.3.2).