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AEROSPACE MATERIAL SPECIFICATION

Submitted for recognition as an American National Standard

AMS 4089B

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Superseding AMS 4089A

ALUMINUM ALLOY PLATE
5.7Zn - 2.2Mg - 1.6Cu - 0.22Cr (7475-T7651)
Solution Heat Treated, Stress Relieved by Stretching,
and Precipitation Heat Treated

UNS A97475

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 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 - Tolerance, 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

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

ASTM B594 - Ultrasonic Inspection of Aluminum-Alloy Products for Aerospace Applications

ASTM E338 - Sharp-Notch Tension Testing of High-Strength Sheet Materials

ASTM G34 - Exfoliation Corrosion Susceptibility in 2XXX and 7XXX Series Aluminum Alloys (EXCO Test)

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

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

ANSI B46.1 - Surface Texture

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 | 5.2 | - 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. Furnace surveys and calibration of temperature controllers and recorders shall be 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 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 |
|----------------------------------|----------------------|------------------------------|--|--|
| 6.25 to 12.50, incl | Longitudinal | 485 | 415 | 9 |
| | Long-Transverse | 490 | 415 | 9 |
| Over 12.50 to 25.00, incl | Longitudinal | 475 | 405 | 8 |
| | Long-Transverse | 485 | 405 | 8 |
| Over 25.00 to 37.50, incl | Longitudinal | 475 | 405 | 6 |
| | Long-Transverse | 485 | 405 | 6 |

3.3.1.1 Tensile property requirements for plate over 1.500 in. (37.50 mm) in nominal thickness shall be as agreed upon by purchaser and vendor.

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

TABLE II

| Specimen Orientation | K_{Ic} | |
|----------------------|-------------------------|-----------------------|
| (See 8.3) | ksi $\sqrt{\text{in.}}$ | MPa $\sqrt{\text{m}}$ |
| L-T | 33 | 36.3 |
| T-L | 30 | 33 |

3.3.3 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 in lieu of determining fracture toughness provided that correlation has been established between the two tests for the 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. (6.25 to 18.75 mm), incl, in nominal thickness shall conform to Fig. 1 of this specification and for plate over 0.749 in. (18.75 mm) in nominal thickness specimens shall conform to Fig. 2 of this specification (See 8.2). 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 Corrosion Resistance Indicator Test:

3.3.4.1 If the conductivity is 39.0% IACS (International Annealed Copper Standard) (22.6 MS/m) or higher and the long-transverse yield strength does not exceed the specified minimum by 9000 psi (60 MPa) or more, the plate is acceptable.

3.3.4.2 If the conductivity is 39.0% IACS (22.6 MS/m) or higher and the long-transverse yield strength exceeds the specified minimum by 9000 psi (60 MPa) or more, or if the conductivity is at least 38.0% IACS (22.0 MS/m) but less than 39.0% IACS (22.6 MS/m) and tensile properties meet specified requirements, plate shall be given additional precipitation heat treatment and then retested.

3.3.4.3 If the conductivity is lower than 38.0% IACS (22.0 MS/m), the plate is not acceptable and shall be reheat treated or additionally precipitation heat treated and retested.

3.3.5 Exfoliation Resistance: Plate shall not exhibit exfoliation corrosion at any plane greater than that illustrated by Photo B, Fig. 2, of ASTM G34.

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

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 Plate 0.500 in. (12.50 mm) and over in nominal thickness, inspected in accordance with ASTM B594, shall meet the Class B acceptance limits of that specification.

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), tensile properties (3.3.1), fracture toughness (3.3.2) or notch tensile strength/tensile yield strength ratio (3.3.3), corrosion resistance indicator test (3.3.4), quality (3.4), and tolerances (3.5) are classified as acceptance tests and shall be performed on each lot 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 or MAM 2355 and the following:

4.3.1 Specimens for corrosion resistance indicator test shall be the tensile specimens.

4.3.2 At least one sample shall be taken from each lot exfoliation-resistance testing or for stress-corrosion resistance testing, as applicable, when the yield strength exceeds the specified minimum by more than 9000 psi (60 MPa), or when the conductivity is between 38.0% and 39.0% IACS (22.0 and 22.6 MS/m).

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 and other technical requirements of this specification. This report shall include the purchase order number, AMS 4089B, lot number, size, and quantity.

- 4.4.2 The vendor of finished or semi-finished parts shall furnish with each shipment a report showing the purchase order number, AMS 4089B, 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 or FAM 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 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 plate.
- 5.1.2 Flat 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 4089. 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 plate.
- 5.1.3 Flat Plate Over 0.375 In. (9.50 mm) Thick, or Over 60 In. (1500 mm) Wide, or Over 200 In. (5000 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 (900 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 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 modifications authorized by purchaser will be subject to rejection.
8. NOTES:
- 8.1 Marginal Indicia: The phi (ϕ) symbol is used to indicate technical changes from the previous issue of this specification.
- 8.2 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.
- 8.3 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.
- 8.4 Dimensions and properties in inch/pound units are primary; dimensions and properties in SI units are shown as the approximate equivalents of the primary units and are presented only for information.
- 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)

8.6 Plate meeting the requirements of this specification has been classified under Federal Supply Classification (FSC) 9535.

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