

**AEROSPACE  
MATERIAL  
SPECIFICATION**

Submitted for recognition as an American National Standard

MAM 4208

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**ALUMINUM ALLOY SHEET  
6.0Cu - 0.40Zr (2004-F)  
As Rolled**

**1. SCOPE:**

1.1 Form: This specification covers an aluminum alloy in the form of sheet procured to metric dimensions and properties.

1.2 Application: Primarily for parts requiring a high degree of formability (superplasticity) and response to heat treatment.

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:

MAM 2202 - Tolerances, Metric, Aluminum Alloy and Magnesium Alloy Sheet and Plate

AMS 2350 - Standards and Test Methods

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

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

ASTM E21 - Elevated Temperature Tension Tests of Metallic Materials

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 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 MAM 2355:

	min	max
Copper	5.5	6.5
Zirconium	0.30	0.50
Magnesium	--	0.50
Silicon	--	0.20
Iron	--	0.20
Manganese	--	0.10
Zinc	--	0.10
Titanium	--	0.05
Other Impurities, each	--	0.05
Other Impurities, total	--	0.15
Aluminum	remainder	

3.2 Condition: As-rolled (-F temper). Sheet shall not be flattened, leveled, or straightened.

3.3 Properties: Sheet shall conform to the following requirements, determined in accordance with MAM 2355 except as specified in 3.3.1:

3.3.1 As-Rolled (Superplasticity): Specimens, conforming to Fig. 1, shall have the following properties after being heated to  $450^{\circ}\text{C} \pm 5$ , held at heat for 20 - 30 min. before testing, and tested in accordance with ASTM E21 at  $450^{\circ}\text{C} \pm 5$  using a constant crosshead speed of 12.5 mm per minute.

Elongation in 12.5 mm, min	
Individual Test	350%
Average of All Tests	400%

3.3.2 As Pseudo-Formed: Sheet shall have the following properties after being heated to  $450^{\circ}\text{C} \pm 5$ , held at heat for 20 min.  $\pm 2$ , and cooled in air:

Tensile Strength	220 - 270 MPa
Yield Strength at 0.2% Offset	110 - 170 MPa
Elongation in 50 mm	10 - 20%

- 3.3.3 After Solution and Precipitation Heat Treatment: Sheet shall have the following properties after being solution heat treated by heating to  $530^{\circ}\text{C} + 5$ , holding at heat for 30 - 60 min., and quenching in warm (approximately  $40^{\circ}\text{C}$ ) water, with quenching being completed within 20 sec, and precipitation heat treated by heating to  $165^{\circ}\text{C} + 5$ , holding at heat for 16 - 20 hr, and cooling in air or, when permitted by purchaser, heating to  $185^{\circ}\text{C} + 5$ , holding at heat for 3.5 - 5 hr, and cooling in air:

Tensile Strength	370 - 470 MPa
Yield Strength at 0.2% Offset	270 - 330 MPa
Elongation in 50 mm	8 - 20%

- 3.4 Quality: Sheet, 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 sheet.

- 3.5 Tolerances: Shall be as follows:

- 3.5.1 Thickness: Shall conform to all applicable requirements of MAM 2202.

- 3.5.2 Length and Width:  $\pm 12.5$  millimetres.

- 3.5.3 Edge Cracking: Shall be absent.

#### 4. QUALITY ASSURANCE PROVISIONS:

- 4.1 Responsibility for Inspection: The vendor of sheet 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 sheet conforms to the requirements of this specification.

- 4.2 Classification of Tests: Tests to determine conformance to all technical requirements of this specification are classified as acceptance tests and shall be performed on each lot.

- 4.3 Sampling: Shall be in accordance with MAM 2355 and the following; a lot shall be all sheet produced from one ingot processed and rolled to the same nominal thickness in one series of operations:

- 4.3.1 Specimens for as-rolled (superplasticity) elongation (3.3.1) shall be taken in duplicate in the longitudinal direction and in the transverse direction from sheet 58 mm and over in nominal width.

#### 4.4 Reports:

- 4.4.1 The vendor of sheet shall furnish with each shipment a report stating that the sheet conforms to the chemical composition and other technical requirements of this specification. This report shall include the purchase order number, MAM 4208, 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, MAM 4208, contractor or other direct supplier of sheet, part number, and quantity. When sheet for making parts is produced or purchased by the parts vendor, that vendor shall inspect each lot of sheet to determine conformance to the requirements of this specification and shall include in the report either a statement that the sheet conforms or copies of laboratory reports showing the results of test to determine conformance.

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

5. PREPARATION FOR DELIVERY:

5.1 Identification: Each sheet shall be marked on one face, in the respective location indicated below, with the alloy number and temper, MAM 4208, 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 sheet or its performance.

5.1.1 Flat Sheet Under 150 mm Wide: Shall be marked in one or more lengthwise rows of characters recurring at intervals not greater than 900 millimetres. The lot number may appear in the row marking or may appear at only one location on each piece.

5.1.2 Flat Sheet 150 - 1500 mm, Incl, Wide and 900 - 5000 mm, Incl, Long: Shall be marked in lengthwise rows of characters recurring at intervals not greater than 900 mm, the rows being spaced approximately 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 MAM 4208. The 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.

5.1.3 Flat Sheet Over 1500 mm Wide or Over 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 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 lot number may be omitted. If two rows are used, one row shall show the alloy number and temper and MAM 4208; the second row shall show the manufacturer's identification and nominal thickness. The 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 piece.

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