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INTERNATIONAL
400 Commonwealth Drive, Warrendale, PA 15096-0001

AEROSPACE MATERIAL SPECIFICATION

SAE AMS 4090D

Issued JAN 1976
Revised JUN 2000
Reaffirmed APR 2006

Superseding AMS 4090C

Aluminum Alloy, Plate
5.7Zn - 2.2Mg - 1.6Cu - 0.22Cr (7475-T651)
Solution Heat Treated, Stress Relieved, 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:

This plate has been used typically for structural applications requiring plate with high strength, moderate fatigue strength, and high fracture-toughness, 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 form 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

QUESTIONS REGARDING THIS DOCUMENT: (724) 772-7161 FAX: (724) 776-0243
TO PLACE A DOCUMENT ORDER: (724) 776-4970 FAX: (724) 776-0790
SAE WEB ADDRESS: http://www.sae.org

2.2 ASTM Publications:

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

ASTM B 594	Ultrasonic Examination of Aluminum-Alloy Wrought Products for Aerospace Applications
ASTM B 645	Plane-Strain Fracture Toughness Testing of Aluminum Alloys
ASTM B 660	Packaging/Packing of Aluminum and Magnesium Products
ASTM B 666/666M	Identification Marking of Aluminum and Magnesium Products
ASTM E 338	Sharp Notch Tension Testing of High Strength Sheet Materials
ASTM E 399	Plane-Strain Fracture Toughness of Metallic Materials
ASTM E 602	Sharp Notch Tension Testing with Cylindrical Specimens

2.3 ANSI Publications:

Available from American National Standards Institute, Inc., 11 West 42nd Street, New York, NY 10036-8002.

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	--	0.10
Iron	--	0.12
Copper	1.2	1.9
Manganese	--	0.06
Magnesium	1.9	2.6
Chromium	0.18	0.25
Zinc	5.2	6.2
Titanium	--	0.06
Other Elements, each	--	0.05
Other Elements, 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 to the -T651 temper. Heat treatment shall be performed in accordance with AMS 2772.

3.2.1 Plate shall receive no straightening operations after stretching.

3.3 Properties:

Plate shall conform to the following requirements, determined in accordance with AMS 2355 or MAM 2355 on the mill produced product except as specified in 3.3.3.

3.3.1 Tensile Properties: Shall be as shown in Table 2.

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 0.499, incl	Longitudinal	77.0	69.0	10
	Long-Transverse	78.0	67.0	10
Over 0.499 to 1.500, incl	Longitudinal	77.0	70.0	9
	Long-Transverse	78.0	68.0	9

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 %
6.35 to 12.67, incl	Longitudinal	531	476	10
	Long-Transverse	538	462	10
Over 12.67 to 38.10, incl	Longitudinal	531	483	9
	Long-Transverse	538	469	9

3.3.2 Fracture Toughness: Plane-strain fracture toughness (K_{Ic}) shall be not lower than the values shown in Table 3. For plate 0.750 to 1.500 inches (19.05 to 38.10 mm) in nominal thickness, tests shall be conducted in the T-L and L-T directions on the first production lot shipped to a purchaser; tests in the T-L direction shall be performed on subsequent lots, unless otherwise specified. Testing shall be in accordance with ASTM E 399 and ASTM B 645.

TABLE 3 - Plain-Strain Fracture Toughness

Specimen Orientation (See 8.2)	K_{Ic} ksi $\sqrt{inch}$	K_{Ic} MPa $\sqrt{m}$
L-T	30	33
T-L	28	31

3.3.3 Alternate Testing for Demonstration of Fracture Toughness: When specified, the producer shall guarantee that plate meets the fracture toughness requirements based on correlation of notch tensile strength/tensile yield strength (NTS/TYS) ratio, determined in accordance with 3.3.3.1 in lieu of fracture toughness testing (3.3.2). Sampling and testing requirements, and lot acceptance criteria shall be as agreed upon.

3.3.3.1 Notch tensile strength shall be determined in accordance with ASTM E 338 except that specimens from plate 0.250 to 0.750 inch (6.35 to 19.05 mm), exclusive, in nominal thickness shall conform to Figure 1 of this specification and specimens from plate 0.750 inch (19.05 mm) and over in nominal thickness shall conform to Figure 2 of this specification except that, for plate 1.250 to 1.500 inches (31.75 to 38.10 mm) in nominal thickness, a 1.060 inch (26.92 mm) notched cylindrical specimen in accordance with ASTM E 602 may be used (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. Notch tensile tests shall be conducted in both the L and LT directions on the first production lot shipped to the purchaser. Tests in the L direction shall be performed on subsequent lots, unless otherwise specified. 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.

3.4 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 0.5 inch (13 mm) and over in nominal thickness shall be ultrasonically inspected in accordance with ASTM B 594 and shall meet ultrasonic Class B.

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 specified requirements.

4.2 Classification of Tests:

4.2.1 Acceptance Tests: Composition, tensile properties (3.3.1) and fracture toughness (3.3.2) or, when specified, alternate testing for demonstration of fracture toughness (3.3.3), are acceptance tests and except for composition, shall be performed on each inspection lot.

4.2.2 Periodic Tests: When alternate testing for demonstration of fracture toughness (3.3.3) is specified, fracture toughness (3.3.2) is a periodic test and shall be performed at a frequency to maintain statistical correlation as selected by the vendor unless frequency of testing is specified by purchaser.

4.3 Sampling and Testing:

Shall be in accordance with AMS 2355 or MAM 2355, and as follows:

4.3.1 When alternate fracture toughness testing (3.3.3) is specified, sampling and testing requirements for use of notch tensile strength/tensile yield strength (NTS/TYS) ratio (3.3.3.1) must be specified.

4.4 Reports:

The vendor of plate shall furnish with each shipment a report stating that the product conforms to the chemical composition, tolerances, and ultrasonic inspection and showing the numerical results of tests on each inspection lot to determine conformance to the other acceptance test requirements. This report shall include the purchase order number, inspection lot number(s), AMS 4090D, size, and quantity. The report shall also identify the producer, the product form, and the size of the mill product.

4.5 Resampling and Retesting:

Shall be in accordance with AMS 2355 or MAM 2355.

5. PREPARATION FOR DELIVERY:

5.1 Identification:

Shall be in accordance with ASTM B 666/B 666M.

5.2 Packaging:

5.2.1 Flat plate shall be protected, during shipment and storage, by interleaving with paper sheets.

5.2.2 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.

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 A change bar (**l**) located in the left margin is for the convenience of the user in locating areas where technical revisions, not editorial changes, have been made to the previous issue of this specification. An (R) symbol to the left of the document title indicates a complete revision of the specification, including technical revisions. Change bars and (R) are not used in original publications, nor in specifications that contain editorial changes only.

8.2 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.

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

8.4 Terms used in AMS are clarified in AS1917.

8.5 Dimensions and properties in inch/pound units are primary; dimensions and properties in SI units are shown as the approximate equivalents of the inch/pound units and are presented only for information.

8.6 Procurement documents should specify not less than the following:

AMS 4090D
Size of plate desired
Quantity of plate desired
Alternate fracture toughness testing (3.3.3) including sampling, testing and acceptance criteria; if required.