SAE Aerospace
An SAE International Group

AEROSPACE MATERIAL SPECIFICATION

SAE AMS 4089D

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Reaffirmed MAY 2008

Superseding AMS 4089C

Aluminum Alloy, Plate
1.6Cu - 2.2Mg - 0.22Cr - 5.7Zn (7475-T7651)
Solution Heat Treated, Stress Relieved by Stretching, and Precipitation Heat Treated

(Composition similar to 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 material with high strength and resistance to exfoliation-corrosion, 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 forms 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 cancelled and no superseding document has been specified, the last published issue of that document shall apply.

TO PLACE A DOCUMENT ORDER: **Tel: 877-606-7323 (inside USA and Canada)**
Tel: 724-776-4970 (outside USA)
Fax: 724-776-0790
Email: CustomerService@sae.org
SAE WEB ADDRESS: **http://www.sae.org**

2.1 SAE Publications:

Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001 or www.sae.org.

AMS 2355	Quality Assurance Sampling and Testing, Aluminum Alloys and Magnesium Alloys, Wrought Products, Except Forging Stock, and Rolled, Forged, or Flash Welded Rings
AMS 2772	Heat Treatment of Aluminum Alloy Raw Materials
AS 1990	Aluminum Alloy Tempers

2.2 ASTM Publications:

Available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959 or www.astm.org.

ASTM B 594	Ultrasonic Inspection of Aluminum-Alloy Wrought Products for Aerospace Applications
ASTM B 660	Packaging/Packing of Aluminum and Magnesium Products
ASTM B 666/B 666M	Identification Marking of Aluminum Products
ASTM E 338	Sharp-Notch Tension Testing of High-Strength Sheet Materials
ASTM G 34	Exfoliation Corrosion Susceptibility in 2XXX and 7XXX Series Aluminum Alloys (EXCO Test)

2.3 ANSI Publications:

Available from ANSI, 25 West 43rd Street, New York, NY 10036 or www.ansi.org.

ANSI B46.1	Surface Texture
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.

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 T7651 temper (see AS1900) 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 except that notch tensile testing shall be performed as in 3.3.3.1:

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	70.0	60.0	9
	Long-Transverse	71.0	60.0	9
Over 0.499 to 1.000, incl	Longitudinal	69.0	59.0	8
	Long-Transverse	70.0	59.0	8
Over 1.000 to 1.500, incl	Longitudinal	69.0	59.0	6
	Long-Transverse	70.0	59.0	6

TABLE 2B - Minimum Tensile Properties, SI Units

Nominal Thickness mm	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	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

3.3.2 Fracture Toughness: Plane-strain fracture toughness (K_{IC}) shall be not lower than the values shown in Table 3.

TABLE 3 - Minimum Fracture Toughness

Specimen Orientation (See 8.2)	K_{IC} ksi $\sqrt{\text{inch}}$	K_{IC} MPa $\sqrt{\text{m}}$
L-T	33.0	36.3
T-L	30.0	33.0

3.3.3 Notch Tensile Strength/Tensile Yield Strength (NTS/TYS) Ratio: If approved by purchaser, 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. Correlations shall be made available to purchaser upon request.

3.3.3.1 Notch tensile strength shall be determined in accordance with ASTM E 338 except that specimens for plate 0.250 to 0.749 inch (6.35 to 19.02 mm), inclusive, in nominal thickness shall conform to Figure 1 of this specification and for plate over 0.749 inch (19.02 mm) in nominal thickness, specimens shall conform to Figure 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 for the lot to obtain NTS/TYS ratios.

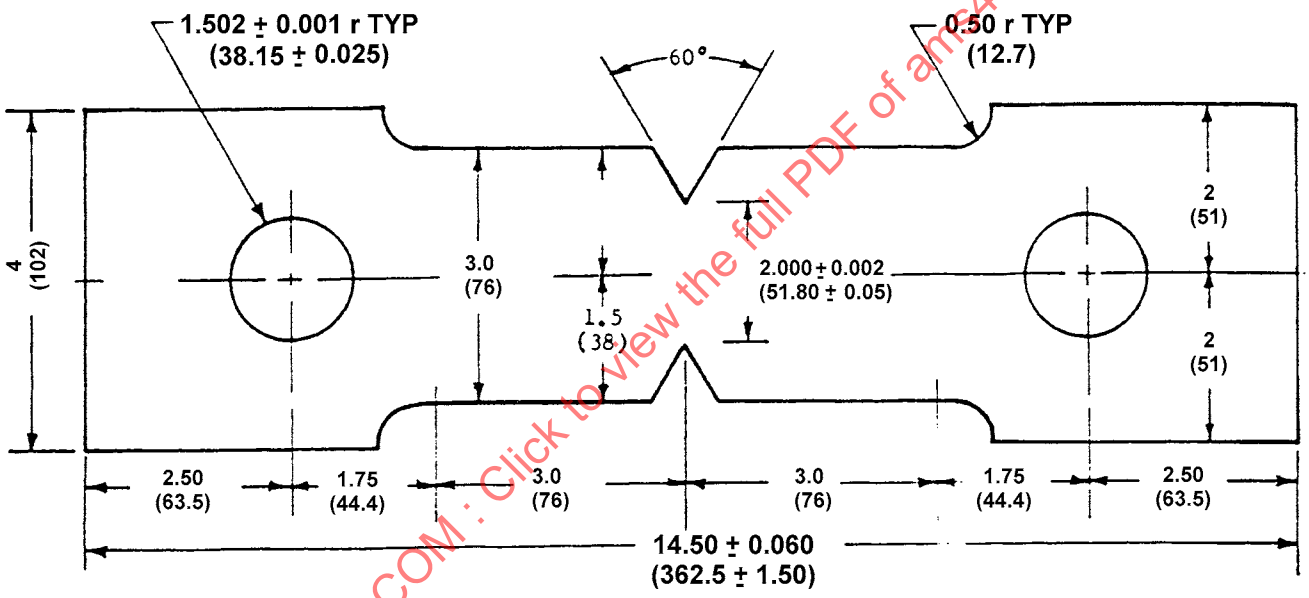
3.3.4 Corrosion Resistance Indicator Test:

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 (62 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 may 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 the T/10 plane greater than that illustrated by Photo B, Figure 2 of ASTM G 34.



ROOT RADIUS 0.0007 (0.18) MAX
NOTCH ROOTS IN LINE WITHIN +0.005 (+0.13)
SYMMETRICAL ABOUT CENTERLINE THROUGH PIN HOLES +0.002 (+0.05)
TOLERANCE +0.010 (+0.25) UNLESS OTHERWISE SPECIFIED

LINEAR DIMENSIONS ARE IN INCHES (MILLIMETERS)

FIGURE 1 - Edge Notched Tensile Specimen

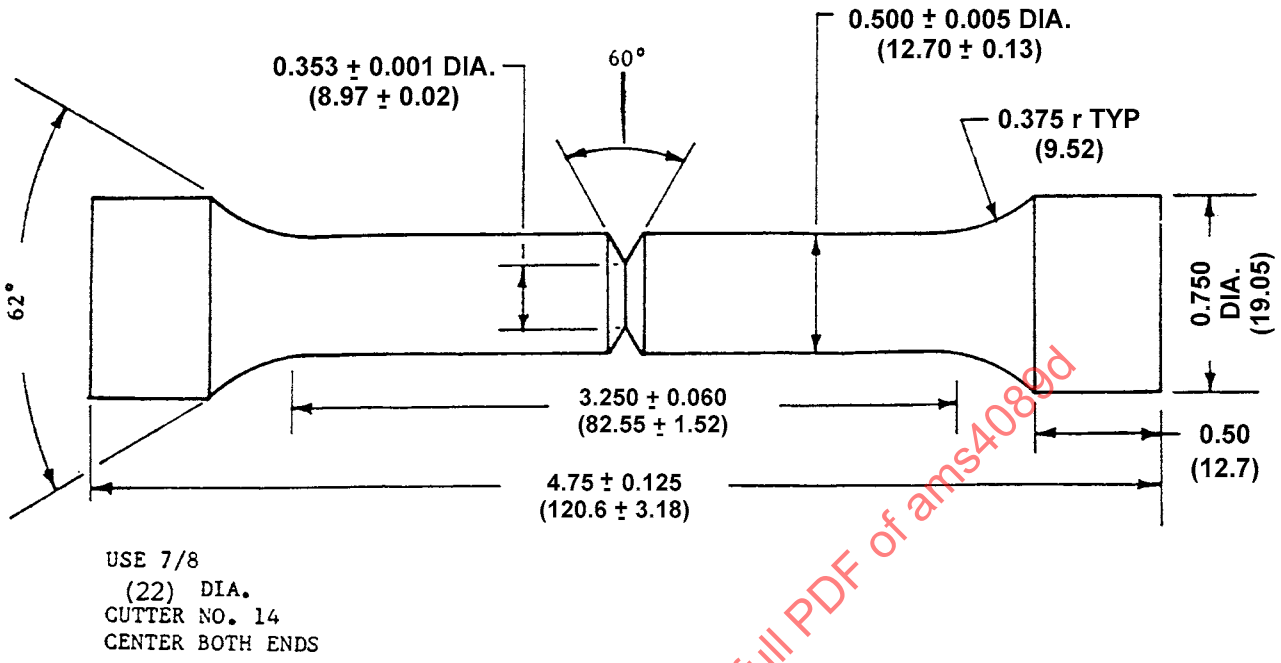


FIGURE 2 - Round Notched Tensile Specimen

3.3.6 Stress-Corrosion Resistance: Specimens cut from plate 0.750 inch (19.05 mm) and over in nominal thickness shall show no evidence of stress-corrosion cracking when stressed in the short- transverse direction to 25.0 ksi (172 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 Each plate, 0.500 inch (12.70 mm) and over in nominal thickness, shall be ultrasonically inspected in accordance with ASTM B 594 and shall meet ultrasonic Class A.

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 (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 acceptance tests and, except for composition, shall be performed on each lot except that fracture toughness need not be determined if use of notched tensile testing is approved by purchaser and if the notch tensile strength/tensile yield strength ratio indicates that the established correlation is met.

4.2.2 Periodic Tests: Exfoliation resistance (3.3.5) and stress-corrosion resistance (3.3.6) are periodic tests and shall be performed at a frequency selected by the vendor unless frequency of testing is specified by purchaser.

4.3 Sampling and Testing:

Shall be in accordance with AMS 2355 and the following:

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

4.4 Reports:

The vendor of plate shall furnish with each shipment a report stating that the product conforms to the chemical composition, ultrasonic inspection, and tolerances, 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 4089D, 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.

5. PREPARATION FOR DELIVERY:

5.1 Identification:

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

5.2 Packaging:

5.2.1 Product shall be protected from damage during storage and shipment by a method determined by vendor unless specified by purchaser. Examples of typical protective methods include but are not limited to interleaving with paper or oiling of the surface.

5.2.2 Plate shall be prepared for shipment in accordance with ASTM B 660 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 (|) 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 a specification. An (R) symbol to the left of the document title indicates a complete revision of the specification, including technical revision. 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 eccentricity 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 primary units and are presented only for information.