SAE The Engineering Resource For Advancing Mobility
400 COMMONWEALTH DRIVE, WARRENDALE, PA 15096

AEROSPACE MATERIAL SPECIFICATION

AMS 4194A
Superseding AMS 4194

Issued 11-1-70
Revised 1-1-83

ALUMINUM ALLOY SHEET AND PLATE, ALCLAD
4.4Cu - 1.5Mg - 0.60Mn (Alclad 2024 and 1-1/2% Alclad 2024-T361 Flat Sheet; 1-1/2% Alclad 2024-T361 Plate)
Solution Heat Treated and Cold Worked

1. SCOPE:

1.1 Form: This specification covers an aluminum alloy in the form of flat sheet and plate 0.500 in. (12.50 mm) and under in nominal thickness.

1.2 Application: Primarily for structural parts requiring a combination of good strength and maximum corrosion resistance. These products, when re-solution heat treated by the user, may not have the tensile properties shown. Certain design and processing procedures may cause these products to become susceptible to stress-corrosion cracking; ARP 823 recommends practices to minimize such conditions.

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) and Aerospace Recommended Practices (ARP) 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 - Tolerances, Aluminum Alloy and Magnesium 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

2.1.2 Aerospace Recommended Practices:

ARP 823 - Minimizing Stress-Corrosion Cracking in Wrought Heat-Treatable Aluminum Alloy Products

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

2.2.1 Military Specifications:

MIL-H-6088 - Heat Treatment of Aluminum Alloys

2.2.2 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, Ø determined in accordance with AMS 2355:

	Core (2024) min	max		Cladding (1230) min	max
Copper	3.8	4.9	Iron + Silicon	--	0.7
Magnesium	1.2	1.8	Copper	--	0.10
Manganese	0.30	0.9	Zinc	--	0.10
Iron	--	0.50	Manganese	--	0.05
Silicon	--	0.50	Magnesium	--	0.05
Zinc	--	0.25	Vanadium	--	0.05
Titanium	--	0.15	Titanium	--	0.03
Chromium	--	0.10	Other Impurities, each	--	0.03
Other Impurities, each	--	0.05	Aluminum, by difference	99.30	--
Other Impurities, total	--	0.15			
Aluminum	remainder				

3.2 Condition: Solution heat treated in accordance with MIL-H-6088 and cold Ø reduced approximately 6% in thickness.

3.3 Properties: The product shall conform to the following requirements, determined in accordance with AMS 2355:

3.3.1 Tensile Properties: Shall be as specified in Table I.

TABLE I

Nominal Thickness Inches	Tensile Strength psi, min	Yield Strength at 0.2% Offset psi, min	Elongation in 2 in. or 4D %, min
0.020 to 0.062, incl	61,000	47,000	8
Over 0.062 to 0.187, incl	64,000	48,000	9
Over 0.187 to 0.249, incl	65,000	49,000	9
Over 0.249 to 0.500, excl	65,000	48,000	9
0.500	66,000	49,000	10

TABLE I (SI)

Nominal Thickness Millimetres	Tensile Strength MPa, min	Yield Strength at 0.2% Offset MPa, min	Elongation in 50 mm or 4D %, min
0.50 to 1.55, incl	420	325	8
Over 1.55 to 4.65, incl	440	330	9
Over 4.65 to 6.25, incl	450	340	9
Over 6.25 to 12.50, incl	450	330	9
12.50	455	340	10

3.3.2 Bending: Product 0.020 to 0.249 in. (0.50 to 6.25 mm), incl, in nominal thickness shall withstand, without cracking, bending at room temperature through an angle of 180 deg around a diameter equal to the bend factor times the nominal thickness of the product with axis of bend parallel to direction of rolling.

Nominal Thickness Inch	Nominal Thickness (Millimetres)	Bend Factor
0.020 to 0.062, incl	(0.50 to 1.55, incl)	4
Over 0.062 to 0.187, incl	(Over 1.55 to 4.65, incl)	6
Over 0.187 to 0.249, incl	(Over 4.65 to 6.25, incl)	8

3.3.2.1 Bending requirements for plate over 0.249 in. (6.25 mm) in nominal thickness shall be as agreed upon by purchaser and vendor.

3.3.3 Cladding Thickness: After rolling, the average cladding thickness shall conform to the requirements of Table II.

TABLE II

Total Thickness of Composite Product		Cladding Thickness Per Side % of Total Thickness	
Inch	(Millimetres)	min	max
0.020 to 0.062, incl	0.50 to 1.55, incl	4.0	--
Over 0.062 to 0.187, incl	Over 1.55 to 4.65, incl	2.0	--
Over 0.187 to 0.500, excl	Over 4.65 to 12.50, excl	1.2	--
0.500	12.50	1.2	3.0

3.4 Quality: The product, as received by purchaser, shall be uniform in quality Ø and condition, sound, and free from foreign materials and from internal and external imperfections detrimental to usage of the product.

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 the product shall supply all samples for vendor's tests and shall be responsible for performing all Ø 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 product conforms to the requirements of this specification.

4.2 Classification of Tests:

4.2.1 Acceptance Tests: Tests to determine conformance to requirements for Ø composition (3.1), tensile properties (3.3.1), and tolerances (3.5) are classified as acceptance tests and shall be performed on each lot.

4.2.2 Periodic Tests: Tests to determine conformance to requirements for Ø bending (3.3.2) and cladding thickness (3.3.3) 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.

4.4 Reports:

4.4.1 The vendor of the product shall furnish with each shipment three copies of a report stating that the product conforms to the chemical composition and other technical requirements of this specification. This report shall include the purchase order number, AMS 4194A, 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, AMS 4194A, contractor or other direct supplier of material, part number, and quantity. When material for making parts is produced or purchased by the parts vendor, that vendor shall inspect each lot of material to determine conformance to the requirements of this specification and shall include in the report either a statement that the material 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.
ø

5. PREPARATION FOR DELIVERY:

5.1 Identification: Each sheet and plate shall be marked on one face, in the respective location indicated below, with the alloy number and temper, AMS 4194, manufacturer's identification, and nominal thickness in inches. The alloy number shall be "Alclad 2024" for sheet 0.187 in. (4.65 mm) and under in thickness and "1-1/2% Alclad 2024" for sheet and plate over 0.187 in. (4.65 mm) thick. 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 product or its performance.

5.1.1 Sheet and 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).

5.1.2 Sheet and 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 4194.

5.1.3 Sheet and Plate Over 0.375 In. (9.50 mm) Thick, or Over 60 In. (1500 mm) Wide, or Over 2000 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. If two rows are used, one row shall show the alloy number and temper and AMS 4194; the second row shall show the manufacturer's identification and nominal thickness.

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