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400 COMMONWEALTH DRIVE, WARRENDALE, PA 15096

AEROSPACE MATERIAL SPECIFICATION

AMS 4022E

Issued 10-1-51
Revised 4-1-85

ALUMINUM ALLOY SHEET AND PLATE, ALCLAD
1.0Mg - 0.60Si - 0.28Cu - 0.20Cr (Alclad 6061; -T4 Sheet, -T451 Plate)

This specification has been declared "NONCURRENT" by the Aerospace Materials Division, SAE, as of 4-6-84. It is recommended that this specification not be specified for new designs.

This cover sheet should be attached to the "E" issue of the subject specification.

G-01-09

Society of Automotive Engineers, Inc.
400 COMMONWEALTH DRIVE, WARRENDALE, PA. 15096

AEROSPACE MATERIAL SPECIFICATION

AMS 4022E
Superseding AMS 4022D
Issued 10-1-51
Revised 1-15-77

ALUMINUM ALLOY SHEET AND PLATE, ALCLAD
1.0Mg - 0.60Si - 0.28Cu - 0.20Cr (Alclad 6061; -T4 Sheet, - T451 Plate)

1. SCOPE:

1.1 Form: This specification covers an aluminum alloy in the form of sheet and plate.

1.2 Application: Primarily for formed, low-strength, structural parts which may be subsequently precipitation heat treated and which are required to exhibit maximum corrosion resistance and to approximate the color and appearance of other clad aluminum alloy parts.

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) shall apply. The applicable issue of other documents shall be as specified in AMS 2350.

2.1 SAE Publications: Available from Society of Automotive Engineers, Inc., 400 Commonwealth Drive, Warrendale, PA 15096.

2.1.1 Aerospace Material Specifications:

AMS 2202 - Tolerances, Aluminum-Base and Magnesium-Base 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
AMS 2770 - Heat Treatment of Aluminum and Aluminum Alloys

2.2 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, determined in accordance with Ø AMS 2355:

Core (6061)	min	max
Magnesium	0.8	1.2
Silicon	0.40	0.8
Copper	0.15	0.40
Chromium	0.04	0.35
Iron	--	0.7
Zinc	--	0.25
Manganese	--	0.15
Titanium	--	0.15
Other Impurities, each	--	0.05
Other Impurities, total	--	0.15
Aluminum	remainder	

Cladding (7072)	min	max
Zinc	0.8	1.3
Silicon + Iron	--	0.7
Magnesium	--	0.10
Copper	--	0.10
Manganese	--	0.10
Other Impurities, each	--	0.05
Other Impurities, total	--	0.15
Aluminum	remainder	

3.2 Condition:

Ø 3.2.1 Sheet: Solution heat treated in accordance with MIL-H-6088.

3.2.2 Plate: Solution heat treated in accordance with MIL-H-6088 and stretched to produce a nominal Ø permanent set of 2% but not less than 1-1/2% nor more than 3%.

3.2.2.1 Plate shall receive no further straightening operations after stretching.

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

3.3.1 As Solution Heat Treated:

3.3.1.1 Tensile Properties: Shall be as specified in Table I and 3.3.1.1.1.

TABLE I

Nominal Thickness Inches	Tensile Strength psi, min	Yield Strength at 0.2% Offset psi, min	Elongation in 2 in. or 4D % min
0.010 to 0.020, incl	27,000	14,000	14
Over 0.020 to 0.249, incl	27,000	14,000	16
Over 0.249 to 0.499, incl	27,000	14,000	18
Over 0.499 to 1.000, incl	30,000	16,000	18
Over 1.000 to 3.000, incl	30,000	16,000	16

TABLE I (SI)

Nominal Thickness Millimetres	Tensile Strength MPa, min	Yield Strength at 0.2% Offset MPa, min	Elongation in 50.8 mm or 4D %, min
0.25 to 0.51, incl	186	97	14
Over 0.51 to 6.32, incl	186	97	16
Over 6.32 to 12.67, incl	186	97	18
Over 12.67 to 25,40, incl	207	110	18
Over 25.40 to 76.20, incl	207	110	16

3.3.1.1.1 Tensile properties of plate over 3.000 in. (76.20 mm) in nominal thickness shall be as agreed upon by purchaser and vendor.

3.3.1.2 Bending: Product 0.010 - 0.499 in. (0.25 - 12.67 mm), incl, in nominal thickness shall withstand, without cracking, bending at room temperature through an angle of 180 deg (3.14 rad) around a diameter equal to the bend factor times the nominal thickness of the product with axis of bend parallel to the direction of rolling.

Nominal Thickness		Bend
Inch	(Millimetres)	Factor
0.010 to 0.249, incl	(0.25 to 6.32, incl)	3
Over 0.249 to 0.499, incl	(Over 6.32 to 12.67, incl)	5

3.3.1.2.1 Bending requirements for plate over 0.499 in. (12.67 mm) in nominal thickness shall be as agreed upon by purchaser and vendor.

3.3.2 After Precipitation Heat Treatment: The product, as received by purchaser, shall have the following properties after precipitation heat treatment in accordance with AMS 2770:

3.3.2.1 Tensile Properties: Shall be as specified in Table II and 3.3.2.1.1.

TABLE II

Nominal Thickness Inches	Tensile Strength psi, min	Yield Strength at 0.2% Offset psi, min	Elongation in 2 in. or 4D %, min
0.010 to 0.020, incl	38,000	32,000	8
Over 0.020 to 0.499, incl	38,000	32,000	10
Over 0.499 to 1.000, incl	42,000	35,000	9
Over 1.000 to 2.000, incl	42,000	35,000	8
Over 2.000 to 3.000, incl	42,000	35,000	6

TABLE II (SI)

Nominal Thickness Millimetres	Tensile Strength MPa, min	Yield Strength at 0.2% Offset MPa, min	Elongation in 50.8 mm or 4D %, min
0.25 to 0.51, incl	262	221	8
Over 0.51 to 12.67, incl	262	221	10
Over 12.67 to 25.40, incl	290	241	9
Over 25.40 to 50.80, incl	290	241	8
Over 50.80 to 76.20, incl	290	241	6

3.3.2.1.1 Tensile properties of plate over 3.000 in. (76.20 mm) in nominal thickness shall be as agreed upon by purchaser and vendor.

3.3.2.2 Bending: Product 0.010 - 0.499 in. (0.25 - 12.67 mm), incl, in nominal thickness shall withstand, without cracking, bending at room temperature through an angle of 180 deg (3.14 rad) around a diameter equal to the bend factor times the nominal thickness of the product with axis of bend parallel to the direction of rolling.

Nominal Thickness		Bend
Inch	(Millimetres)	Factor
0.010 to 0.036, incl	(0.25 to 0.91, incl)	3
Over 0.036 to 0.064, incl	(Over 0.91 to 1.63, incl)	4
Over 0.064 to 0.128, incl	(Over 1.63 to 3.25, incl)	5
Over 0.128 to 0.249, incl	(Over 3.25 to 6.32, incl)	6
Over 0.249 to 0.499, incl	(Over 6.32 to 12.67, incl)	10

3.3.2.2.1 Ø Bending requirements for plate over 0.499 in. (12.67 mm) in nominal thickness shall be as agreed upon by purchaser and vendor.

3.3.3 Cladding Thickness: After rolling, the average cladding thickness per side shall be not less than 4% of the total composite thickness.

3.4 Ø Quality: The product, as received by the purchaser, shall be uniform in quality 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 Ø Responsibility for Inspection: The vendor of the product shall supply all samples 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 perform such confirmatory testing as he deems necessary to ensure that the product conforms to the requirements of this specification.

4.2 Classification of Tests:

4.2.1 Ø Acceptance Tests: Tests to determine conformance to composition (3.1), tensile properties as solution heat treated (3.3.1.1) and after precipitation heat treatment (3.3.2.1), and tolerance (3.5) requirements are classified as acceptance tests.

4.2.2 Ø Periodic Tests: Tests to determine conformance to bending as solution heat treated (3.3.1.2) and after precipitation heat treatment (3.3.2.2) and cladding thickness (3.3.3) requirements are classified as periodic tests.

4.3 Ø Sampling: Shall be in accordance with AMS 2355. Frequency of sampling for periodic tests shall be as agreed upon by purchaser and vendor.

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, material specification number and its revision letter, 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, material specification number and its revision letter, 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 requirments of this specification, and shall include in the report a statement that the material conforms, or shall include copies of laboratory reports showing the results of tests to determine conformance.