

AEROSPACE MATERIAL SPECIFICATION

Aluminum Alloy, Plate (2297-T87)
2.8Cu - 1.5Li - 0.30Mn - 0.25Mg
Solution Heat Treated, Stretched, and Artificially Aged

1. SCOPE:

1.1 Form:

This specification covers an aluminum alloy in the form of plate.

1.2 Application:

These products have been typically used in aerospace applications where low density is needed in combination with moderate strength, high fatigue resistance, good stress corrosion properties, and improved stiffness, 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 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 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

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

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2.2 ASTM Publications:

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

ASTM B 557	Tension Testing Wrought and Cast Aluminum- and Magnesium-Alloy Products
ASTM B 594	Ultrasonic Inspection 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/B 666M	Identification Marking of Aluminum and Magnesium Products
ASTM E 399	Plane-Strain Fracture Toughness of Metallic Materials
ASTM E 1251	Optical Emission Spectrometric Analysis of Aluminum and Aluminum Alloys by the Argon Atmosphere, Point-to-Plane, Unipolar Self-Initiating Capacitor Discharge
ASTM G 34	Exfoliation Corrosion Susceptibility in 2XXX and 7XXX Series Aluminum Alloys (EXCO Test)
ASTM G 47	Determining Susceptibility to Stress-Corrosion Cracking of 2XXX and 7XXX Aluminum Alloy Products

2.3 ANSI Publications:

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

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 Tables 1, determined in accordance with ASTM E 1251.

TABLE 1 - Composition

Element	min	max
Silicon	--	0.10
Iron	--	0.10
Copper	2.5	3.1
Manganese	0.10	0.50
Magnesium	--	0.25
Zinc	--	0.05
Titanium	--	0.12
Lithium	1.1	1.7
Zirconium	0.08	0.15
Other Elements, each	--	0.05
Other Elements, total	--	0.15
Aluminum	remainder	

3.2 Condition:

Solution heat treated by holding at heat for a time commensurate with section thickness (See 8.2) and rapidly cooled in a suitable quenching medium; stretched to produce a nominal permanent set of 2.75% but not more than 6.75%. Artificial aging to temper T87 shall be performed at a temperature, for a time as required to meet requirements of 3.3.

3.2.1 Plate shall receive no further straightening operations after stretching.

3.3 Properties:

Plate shall conform to the following requirements, determined on the mill produced size in accordance with AMS 2355 or MAM 2355 and as specified herein.

3.3.1 Tensile Properties: Shall be determined per ASTM B 557 and as shown in Table 2.

TABLE 2A - Minimum Tensile Properties, Inch/Pound Units

Temper	Thickness, Inclusive (inches)	Grain Direction	Ultimate Tensile Strength (ksi)	Yield Strength 0.2% Offset (ksi)	% Elongation in 2 inches or 4D (percent)
T87	3.001-4.000	L	62.0	57.0	5
		LT	62.0	57.0	4
		ST	59.0	54.0	1.5
	4.001-5.000	L	61.0	56.0	5
		LT	61.0	56.0	4
		ST	58.0	52.0	1.5
	5.001-6.000	L	60.0	55.0	5
		LT	60.0	55.0	4
		ST	57.0	52.0	1.5

TABLE 2B - Minimum Tensile Properties, SI Units

Temper	Thickness, Inclusive (mm)	Grain Direction	Ultimate Tensile Strength (MPa)	Yield Strength 0.2% Offset (MPa)	% Elongation in 50.8 mm or 4D (percent)
T87	76.20-101.60	L	427	393	5
		LT	427	393	4
		ST	407	372	1.5
	101.62-127.00	L	421	386	5
		LT	421	386	4
		ST	400	358	1.5
	127.02-152.40	L	414	379	5
		LT	414	379	4
		ST	393	358	1.5

3.3.2 Corrosion-Resistance:

- 3.3.2.1 Stress-Corrosion Resistance: Direct tension specimens machined and tested in accordance with ASTM G 47 shall show no evidence of stress corrosion failure when stressed in the short-transverse direction at 30.0 ksi (207 MPa) and exposed for 30 days.

- 3.3.2.2 Exfoliation Corrosion Resistance: When required by the purchaser, specimens from preproduction plates shall show exfoliation corrosion resistance equal to or better than EB when tested at the T/10 plane in accordance with ASTM G 34.
- 3.3.2.3 Plate not meeting the requirements of 3.3.2.1 or 3.3.2.2 may be given additional precipitation heat treatment. After such treatment, if all specified properties are met, the plate is acceptable.
- 3.3.2.4 Fracture Toughness: Fracture toughness shall be determined in accordance with ASTM E 399 and ASTM B 645 and shall meet the requirements for K_{Ic} specified in Table 3. For L-T and T-L test directions, use specimens with 1.5 inch (38.1 mm) minimum thickness. For the S-L test direction, specimen thickness should be maximized to the nearest 1/4 inch (6.35 mm). L-T, T-L and S-L specimens shall be centered at T/2 for plate 3.000 inches (76.2 mm) and under in nominal thickness and centered at T/4 for plate over 3.000 inches (76.2 mm) in nominal thickness. If a valid K_{Ic} or meaningful K_Q cannot be obtained due to insufficient specimen thickness or crack length, then the fracture toughness (K_Q) of the specimen will be acceptable for lot release if the following conditions are met.
- 3.3.2.4.1 The B dimension of the specimen tested was the maximum possible up to 2.5 inches (63.5 mm) for the given plate thickness.
- 3.3.2.4.2 The specimen centerline location was maintained at the specified plate thickness location.
- 3.3.2.4.3 All fracture toughness validity checks except specimen thickness, crack length or P_{max}/P_Q shall meet the criteria of ASTM E 399 or ASTM B 645.
- 3.3.2.4.4 If the only invalidity with $B=1.5$ inches (38.1 mm) is P_{max}/P_Q , test result is acceptable for lot release.

TABLE 3A - Minimum Fracture Parameters, Inch/Pound Units

Temper	Thickness, Inclusive (inches)	Specimen Orientation	Required Minimum Plane- Strain Fracture Toughness, K_{Ic} (ksi-in ^{1/2})
T87	3.001-4.000	L-T	31
		T-L	27
		S-L	20
	4.001-5.000	L-T	30
		T-L	26
		S-L	18
	5.001-6.000	L-T	29
		T-L	25
		S-L	18

TABLE 3B - Minimum Fracture Parameters, SI Units

Temper	Thickness, Inclusive (mm)	Specimen Orientation	Required Minimum Plane- Strain Fracture Toughness, K_{Ic} (MPa-m ^{1/2})
T87	76.20-101.60	L-T	34.1
		T-L	29.7
		S-L	22.0
	101.62-127.00	L-T	33.0
		T-L	28.6
		S-L	19.8
	127.02-152.40	L-T	31.9
		T-L	27.5
		S-L	19.8

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. Light scratches and discoloration or streaking shall not be reason for rejection.

- 3.4.1 Plate shall be ultrasonically inspected in accordance with ASTM B 594 and shall meet the requirements of 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) is an acceptance test and shall be performed on each ingot or each group of ingots poured simultaneously from the same source of molten metal. Tensile properties (3.3.1), fracture toughness (3.3.2.4), and ultrasonic inspection (3.4.1) are acceptance tests and shall be performed on each parent plate.