AEROSPACE MATERIAL SPECIFICATION

AMS4361

Issued 2014-09

Aluminum Alloy, Plate (7065-T7451)
7.7Zn - 2.1Cu - 1.65Mg - 0.10Zr
Solution Heat Treated, Stress-Relieved, and Overaged

RATIONALE

AMS4361 is a new specification for 7065-T7451 aluminum plate.

1. SCOPE

1.1 Form

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

1.1.1 This specification covers plate from 1.000 to 6.000 inches (25.40 to 152.40 mm) in thickness (See 8.4)

1.2 Application

This product may be used in aerospace applications requiring high strength and fracture toughness, high resistance to stress-corrosion cracking and good resistance to exfoliation corrosion, 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.

2.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or 724-776-4970 (outside USA), www.sae.org.

AMS2355 Quality Assurance Sampling and Testing, Aluminum Alloys and Magnesium Alloys, Wrought Products (Except Forging Stock), and Rolled, Forged, or Flash Welded Rings

AMS2772 Heat Treatment of Aluminum Alloy Raw Material

AS1990 Aluminum Alloy Tempers

TO PLACE A DOCUMENT ORDER: **Tel: 877-606-7323 (inside USA and Canada)**
Tel: +1 724-776-4970 (outside USA)
Fax: 724-776-0790
Email: CustomerService@sae.org
SAE WEB ADDRESS: **http://www.sae.org**

2.2 ASTM Publications

Available from ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959, Tel: 610-832-9585, www.astm.org.

ASTM B 594 Ultrasonic Inspection of Aluminum-Alloy Wrought Products

ASTM B 645 Linear-Elastic 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 Linear-Elastic Plane-Strain Fracture Toughness K_{IC} of Metallic Materials

ASTM E 466 Conducting Force Controlled Constant Amplitude Axial Fatigue Tests of Metallic Materials

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 American National Standards Institute, 25 West 43rd Street, New York, NY 10036, Tel: 212-642-4900, 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 Table 1, determined in accordance with AMS2355.

In case there is a discrepancy in the values listed in Table 1 with those listed in the “International Alloy Designations and Chemical Composition Limits for Wrought Aluminum and Wrought Aluminum Alloys”(known as the “Teal Sheets”), the composition limits registered with the Aluminum Association and published in the “Teal Sheets” shall be the controlling composition.

TABLE 1 - COMPOSITION

Element	min	max
Silicon	--	0.06
Iron	--	0.08
Copper	1.9	2.3
Manganese	--	0.04
Magnesium	1.5	1.8
Chromium	--	0.04
Zinc	7.1	8.3
Titanium	--	0.06
Zirconium	0.05	0.15
Other Elements, each	--	0.05
Other Elements, total	--	0.15
Aluminum	remainder	

3.2 Condition

Solution heat treated, stretched to produce a permanent set of not less than 1½% nor more than 3%, and precipitation heat treated to the -T7451 temper (See AS1990). Solution and precipitation heat treatment shall be performed in accordance with AMS2772 as applicable to 7XXX alloys. The actual practices are considered proprietary.

Plate shall receive no further straightening operations after stretching.

3.3 Properties

Product shall conform to the following requirements, determined in accordance with AMS2355 on the mill produced size.

Mechanical property requirements for product outside of the range covered by Tables 2 and 3 shall be agreed upon between purchaser and producer.

3.3.1 Tensile Properties shall be as shown in Table 2A and 2B.

TABLE 2A - MINIMUM TENSILE PROPERTIES, INCH/POUND UNITS

Nominal Thickness Inch	Grain Direction	Tensile Strength ksi	Yield Strength at 0.2% Offset ksi	Elongation in 2 Inches or 4D %
1.000 to 1.500, incl	L	77.0	71.0	11
	LT	77.0	70.0	10
1.501 to 2.000, incl	L	76.0	70.0	11
	LT	77.0	69.0	9
	ST	75.0	64.0	6
2.001 to 3.000, incl	L	76.0	70.0	10
	LT	76.0	68.0	8
	ST	74.0	64.0	5
3.001 to 4.000, incl	L	75.0	69.0	9
	LT	75.0	68.0	7
	ST	73.0	63.0	4
4.001 to 5.000, incl	L	75.0	69.0	9
	LT	75.0	68.0	6
	ST	73.0	63.0	3
5.001 to 6.000, incl	L	74.0	69.0	8
	LT	75.0	67.0	5
	ST	73.0	63.0	3

TABLE 2B - MINIMUM TENSILE PROPERTIES, SI UNITS

Nominal Thickness Millimeters	Grain Direction	Tensile Strength MPa	Yield Strength at 0.2% Offset MPa	Elongation in 50.8 mm or 4D %
25.40 to 38.10, incl	L	531	490	11
	LT	531	483	10
38.12 to 50.80, incl	L	524	483	11
	LT	531	476	9
	ST	517	441	6
50.82 to 76.20, incl	L	524	483	10
	LT	524	469	8
	ST	510	441	5
76.22 to 101.60, incl	L	517	476	9
	LT	517	469	7
	ST	503	434	4
101.62 to 127.00, incl	L	517	476	9
	LT	517	469	6
	ST	503	434	3
127.02 to 152.40, incl	L	510	476	8
	LT	517	462	5
	ST	503	434	3

3.3.2 Electrical Conductivity

Shall be not lower than 39.5% IACS (International Annealed Copper Standard) (22.9 MS/m).

3.3.3 Exfoliation Corrosion Resistance

Specimens cut from plate shall not exhibit exfoliation corrosion at the T/2 plane greater than that illustrated by Photograph B, Figure 2, of ASTM G 34.

3.3.4 Stress Corrosion Cracking

When specified, specimens from plate shall be tested in accordance with ASTM G 47 and shall show no evidence of stress corrosion cracking when stressed in the short transverse direction to 35 ksi (241 MPa).

3.3.5 Fracture Toughness

Plane strain fracture toughness shall be tested in accordance with ASTM E 399 and ASTM B 645. A valid K_{Ic} meeting the requirements of ASTM E399, or a K_Q “usable for lot release” in accordance with ASTM B 645 shall meet or exceed the values shown in Table 3A and 3B.

TABLE 3A – MINIMUM K_{IC} AND K_Q “USABLE FOR LOT RELEASE” FRACTURE TOUGHNESS – INCH/POUND UNITS

Nominal Thickness inch	L-T orientation ksi√inch	T-L orientation ksi√inch	S-L orientation ksi√inch
1.000 to 1.500, incl	39	30	---
1.501 to 2.000, incl	36	29	---
2.001 to 3.000, incl	32	27	25
3.001 to 4.000, incl	28	24	23
4.001 to 5.000, incl	26	22	21
5.001 to 6.000, incl	25	21	21

TABLE 3B – MINIMUM K_{IC} AND K_Q "USABLE FOR LOT RELEASE" FRACTURE TOUGHNESS – SI UNITS

Nominal Thickness millimeters	L-T orientation MPa√m	T-L orientation MPa√m	S-L orientation MPa√m
25.40 to 38.10, incl	43	33	---
38.12 to 50.80, incl	40	32	---
50.82 to 76.20, incl	35	30	27
76.22 to 101.60, incl	32	26	25
101.62 to 127.00, incl	29	24	23
127.02 to 152.40, incl	27	23	23

3.3.6 Fatigue Resistance

When specified, 3.000 to 6.000-inch (76.20 to 152.40-mm) thick plate shall be tested in accordance with ASTM E466.

When tested at a stress ratio of R=0.1 at a maximum stress of 35.0 ksi (241 MPa), the fatigue life shall meet the requirements of Table 4.

TABLE 4 - FATIGUE LIFE REQUIREMENTS

Minimum cycles per test	90 000 cycles
Lot Log Average of 4 tests, min	120 000 cycles
Runout	200 000 cycles

3.4 Quality

Products, as received by purchaser, shall be uniform in quality and condition, sound and free from foreign materials and from conditions detrimental to usage of the plate. Any detrimental conditions found during the customer's manufacturing process are subject to rejection.

3.4.1 Each plate shall be subjected to ultrasonic inspection in accordance with ASTM B 594 and shall meet ultrasonic Class A requirements, as described in ASTM B 594.

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 the products 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 products conform to specified requirements.

4.2 Classification of Tests

4.2.1 Acceptance Tests

Composition (3.1), tensile properties (3.3.1), electrical conductivity (3.3.2), tolerances (3.5), ultrasonic inspection (3.4.1), fracture toughness (3.3.5), stress corrosion cracking (when specified) (3.3.4), and fatigue (when specified) (3.3.6), are acceptance tests and, except for composition, shall be performed on each inspection lot.

4.2.2 Periodic Tests

Exfoliation corrosion resistance (3.3.3) is a periodic test 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 AMS2355 and the following:

4.3.1 Specimens for tensile testing shall be taken and tested in both the longitudinal and long-transverse directions. Specimens for tensile testing shall also be taken and tested in the short-transverse direction for plate 1.501 inches (38.12 mm) and thicker.

4.3.2 Electrical conductivity shall be determined on the mill finished surface of the tensile sample from which the tensile test specimen is taken.

4.3.3 Specimens for fracture toughness testing shall be taken and tested in both the L-T and T-L orientations. Specimens for fracture toughness testing shall also be taken and tested in the S-L orientation for plate 2.001 inches (50.82 mm) and thicker. The test specimens shall meet the following requirements:

4.3.3.1 For L-T and T-L test orientations of plate 1.000 to 2.000 inches (25.40 to 50.80 mm) in nominal thickness, use specimens having a width (W) of 4.0 inches (102 mm) and a thickness (B) of the full plate thickness.

4.3.3.2 For L-T and T-L test orientations of plate 2.001 to 6.000 inches (50.82 to 152.40 mm) in nominal thickness, use specimens having a width (W) of 4.0 inches (102 mm) and a thickness (B) of 2.0 inches (50.8 mm).

4.3.3.3 For plate 2.001 to 4.000 inches (50.82 to 101.60 mm) in nominal thickness, the L-T and T-L specimens shall be centered at T/2.

4.3.3.4 For plate 4.001 to 6.000 inches (101.62 to 152.40 mm) in nominal thickness, the L-T and T-L specimens shall be centered at T/4.

4.3.3.5 For the S-L test orientation of plate 2.001 to 2.599 inches (50.80 to 66.01 mm) in nominal thickness, use specimens having a width (W) of 1.5 inches (38.1 mm) and a thickness (B) of 0.75 inches (19.0 mm).

4.3.3.6 For the S-L test orientation of plate 2.600 to 3.199 inches (66.04 to 81.25 mm) in nominal thickness, use specimens having a width (W) of 2.0 inches (50.8 mm) and a thickness (B) of 1.0 inches (25.4 mm).

4.3.3.7 For the S-L test orientation of plate 3.200 to 3.799 inches (81.28 to 96.49 mm) in nominal thickness, use specimens having a width (W) of 2.5 inches (63.5 mm) and a thickness (B) of 1.25 inches (31.7 mm).

4.3.3.8 For the S-L test orientation of plate 3.800 to 5.000 inches (96.52 to 127.00 mm) in nominal thickness, use specimens having a width (W) of 3.0 inches (76.2 mm) and a thickness (B) of 1.5 inches (38.1 mm).

4.3.3.9 For the S-L test orientation of plate 5.001 to 6.000 inches (127.02 to 152.40 mm) in nominal thickness, use specimens having a width (W) of 4.0 inches (101.6 mm) and a thickness (B) of 2.0 inches (50.8 mm).

4.3.3.10 For plate 2.001 to 6.000 inches (50.82 to 152.40 mm) in nominal thickness, the S-L specimens shall be centered at T/2.

4.3.4 Two specimens for fatigue testing shall be taken from each end of the parent plate in the long transverse grain direction. These specimens are to be removed from the T/2, W/2 location. Fatigue testing shall be conducted in air at 70 °F + 5 (21 °C + 3) with a relative humidity of 30 to 50% using a frequency of 10 to 50 Hz. The test specimens shall meet the following requirements:

4.3.4.1 Fatigue samples shall be machined to ASTM E 466, Figure 1. The specimen shall have a 0.500 inch (12.70 mm) gage diameter, a 2.00-inch (50.80 mm) gage section, and 3.0-inch (76.20 mm) fillet radius. The grip section may be varied to fit different grip configurations, but should have no less than a 1.0-inch (25.4 mm) diameter.