



<b>AEROSPACE MATERIAL SPECIFICATION</b>	<b>AMS4351™</b>	<b>REV. B</b>
	Issued	2014-09
	Revised	2024-12
Superseding AMS4351A		
Aluminum Alloy, Plate (7065-T7651), 7.7Zn - 2.1Cu - 1.65Mg - 0.10Zr, Solution Heat Treated, Stress-Relieved, and Overaged (Composition similar to UNS A97065)		

### RATIONALE

AMS4351B results from a Five-Year Review and update of this specification with changes to update wording to prohibit unauthorized exceptions (see 3.3.1.1 and 8.4), relocate Definitions (see 2.4), and update Applicable Documents (see Section 2).

#### 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 8.5).

##### 1.2 Application

This product may be used in aerospace applications requiring high strength and good fracture toughness and good resistance to stress-corrosion cracking and 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 +1 724-776-4970 (outside USA), [www.sae.org](http://www.sae.org).

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

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AMS2772 Heat Treatment of Aluminum Alloy Raw Materials

AS7766 Terms Used in Aerospace Metals Specifications

## 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](http://www.astm.org).

ASTM B594 Ultrasonic Inspection of Aluminum-Alloy Wrought Products

ASTM B645 Linear-Elastic Plane-Strain Fracture Toughness Testing of Aluminum Alloys

ASTM B660 Packaging/Packing of Aluminum and Magnesium Products

ASTM B666/B666M Identification Marking of Aluminum and Magnesium Products

ASTM E399 Linear-Elastic Plane-Strain Fracture Toughness of Metallic Materials

ASTM E466 Conducting Force Controlled Constant Amplitude Axial Fatigue Tests of Metallic Materials

ASTM G34 Exfoliation Corrosion Susceptibility in 2XXX and 7XXX Series Aluminum Alloys (EXCO Test)

ASTM G47 Determining Susceptibility to Stress-Corrosion Cracking of 2XXX and 7XXX Aluminum Alloy Products

## 2.3 ANSI Accredited Publications

Copies of these documents are available online at <https://webstore.ansi.org/>.

ANSI H35.1/H35.1M Standard Alloy and Temper Designation System for Aluminum

ANSI H35.2 Dimensional Tolerances for Aluminum Mill Products

ANSI H35.2M Dimensional Tolerances for Aluminum Mill Products (Metric)

## 2.4 Definitions

Terms used in AMS are defined in AS7766.

## 3. TECHNICAL REQUIREMENTS

### 3.1 Composition

Shall conform to the percentages by weight shown in Table 1, determined in accordance with AMS2355.

**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 1-1/2% nor more than 3%, and precipitation heat treated to the -T7651 temper (refer to ANSI H35.1/H35.1M). Solution and precipitation heat treatment shall be performed in accordance with AMS2772 as applicable to 7XXX alloys. The actual practices are considered proprietary.

3.2.1 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:

3.3.1 Tensile properties shall be as shown in Tables 2A and 2B.

**Table 2A - Minimum tensile properties, inch/pound units**

Nominal Thickness Inches	Grain Direction	Tensile Strength	Yield Strength at 0.2% Offset	Elongation in 2 Inches or 4D
		ksi	ksi	%
1.000 to 1.500, incl	L	80.0	76.0	10
	LT	80.0	73.0	9
1.501 to 2.000, incl	L	79.0	75.0	10
	LT	80.0	73.0	9
2.001 to 3.000, incl	ST	78.0	68.0	6
	L	78.0	74.0	9
3.001 to 4.000, incl	LT	79.0	72.0	8
	ST	77.0	68.0	4
4.001 to 5.000, incl	L	78.0	74.0	9
	LT	78.0	71.0	6
5.001 to 6.000, incl	ST	77.0	67.0	3
	L	77.0	74.0	8
6.001 to 7.000, incl	LT	78.0	71.0	5
	ST	76.0	67.0	3
7.001 to 8.000, incl	L	76.0	74.0	7
	LT	77.0	71.0	5
8.001 to 9.000, incl	ST	75.0	67.0	3
	L	75.0	71.0	7

**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	552	524	10
	LT	552	503	9
38.12 to 50.80, incl	L	545	517	10
	LT	552	503	9
	ST	538	469	6
50.82 to 76.20, incl	L	538	510	9
	LT	545	496	8
	ST	531	469	4
76.22 to 101.60, incl	L	538	510	9
	LT	538	490	6
	ST	531	462	3
101.62 to 127.00, incl	L	531	510	8
	LT	538	490	5
	ST	524	462	3
127.02 to 152.40, incl	L	524	510	7
	LT	531	490	5
	ST	517	462	3

3.3.1.1 Mechanical property requirements for product outside the range covered by 1.1 shall be agreed upon between the purchaser and producer and reported per 4.4.1 (see 8.5).

### 3.3.2 Electrical Conductivity

Shall be not lower than 39.0% IACS (International Annealed Copper Standard) (22.6 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 G34.

### 3.3.4 Stress-Corrosion Cracking

When specified, specimens from plate shall be tested in accordance with ASTM G47 and shall show no evidence of stress-corrosion cracking when stressed in the short-transverse direction to 25 ksi (172 MPa).

### 3.3.5 Fracture Toughness

Plane strain fracture toughness shall be tested in accordance with ASTM E399 and ASTM B645. A valid  $K_{IC}$  meeting the requirements of ASTM E399, or a  $K_Q$  "usable for lot release" in accordance with ASTM B645, shall meet or exceed the values shown in Tables 3A and 3B.

**Table 3A - Minimum  $K_{IC}$  and  $K_Q$  "usable for lot release" fracture toughness, inch/pound units**

Nominal Thickness Inches	L-T Orientation ksi√inch	T-L Orientation ksi√inch	S-L Orientation ksi√inch
1.000 to 1.500, incl	35	27	--
1.501 to 2.000, incl	32	27	--
2.001 to 3.000, incl	29	25	23
3.001 to 4.000, incl	25	23	22
4.001 to 5.000, incl	24	21	21
5.001 to 6.000, incl	23	20	20

**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	38	30	--
38.12 to 50.80, incl	35	30	--
50.82 to 76.20, incl	32	27	25
76.22 to 101.60, incl	27	25	24
101.62 to 127.00, incl	26	23	23
127.02 to 152.40, incl	25	22	22

### 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	90000 cycles
Lot Log Average of Four Tests, Min	120000 cycles
Runout	200000 cycles

### 3.4 Quality

Products, as received by the 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 B594 and shall meet ultrasonic Class A requirements, as described in ASTM B594.

### 3.5 Tolerances

Shall conform to all applicable requirements of ANSI H35.2 or ANSI H35.2M.

### 3.6 Exceptions

Any exceptions shall be authorized by the purchaser and reported as in 4.4.1.

## 4. QUALITY ASSURANCE PROVISIONS

### 4.1 Responsibility for Inspection

The producer of the products shall supply all samples for the producer's tests and shall be responsible for the performance of all required tests. The 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 (see 3.1), tensile properties (see 3.3.1), electrical conductivity (see 3.3.2), tolerances (see 3.5), ultrasonic inspection (see 3.4.1), fracture toughness (see 3.3.5), stress-corrosion cracking (when specified) (see 3.3.4), and fatigue (when specified) (see 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 (see 3.3.3) is a periodic test and shall be performed at a frequency selected by the producer, unless frequency of testing is specified by the 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 °F (21 °C ± 3 °C) 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 E466, Figure 1. The specimen shall have a 0.500-inch (12.70-mm) gauge diameter, a 2.00-inch (50.80-mm) gauge section, and a 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.