AEROSPACE MATERIAL SPECIFICATION

AMS4211™	REV. D

Issued 2000-07
Reaffirmed 2012-09
Revised 2025-04

Superseding AMS4211C

Aluminum Alloy, Plate
6.2Zn - 1.9Cu - 2.1Mg - 0.10Zr (7040-T7451)
Solution Heat Treated, Stress Relieved, and Overaged
(Composition similar to UNS A97040)

RATIONALE

AMS4211D results from a Five-Year Review and update of this specification with changes to prohibit unauthorized exceptions (see 3.3.1.1, 3.6, and 8.4), correct elongation values for consistency with stated units (see Table 2B), update significant figures on thickness values throughout the specification, relocate Definitions (see 2.4), update ultrasonic testing requirements to remove obsolete weight criteria in Quality (see 3.4.1 and 3.4.1.1), and update Applicable Documents (see Section 2).

1. SCOPE

1.1 Form

This specification covers an aluminum alloy in the form of plate 3.001 to 9.000 inches (76 to 229 mm), inclusive, in nominal thickness (see 8.5).

1.2 Application

This plate has been used typically for parts requiring a high level of mechanical properties and good resistance to stress-corrosion cracking, 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.

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**

For more information on this standard, visit
https://www.sae.org/standards/content/AMS4211D/

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.

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

ASTM B594	Ultrasonic Inspection of Aluminum-Alloy Wrought Products
ASTM B660	Packing/Packaging of Aluminum and Magnesium Products
ASTM B666/B666M	Identification Marking of Aluminum and Magnesium Products
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	--	0.10
Iron	--	0.13
Copper	1.5	2.3
Manganese	--	0.04
Magnesium	1.7	2.4
Chromium	--	0.04
Zinc	5.7	6.7
Titanium	--	0.06
Zirconium	0.05	0.12
Other Elements, each	--	0.05
Other Elements, total	--	0.15
Aluminum	remainder	

3.2 Condition

Solution heat treated at 880 to 900 °F (471 to 482 °C), stretched to produce a nominal permanent set of 2%, but not less than 1-1/2% nor more than 3%, and artificially aged to the T7451 temper in accordance with AMS2772 (refer to ANSI H35.1/H35.1M).

3.2.1 Plate shall receive no further straightening operations after stretching.

3.3 Properties

Plate shall conform to the following requirements, determined in accordance with AMS2355 on the mill-produced product and as specified herein.

3.3.1 Tensile Properties

Shall be as specified in Table 2.

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

Nominal Thickness Inches	Specimen Orientation	Tensile Strength ksi	Yield Strength at 0.2% Offset ksi	Elongation in 2 Inches or 4D %
Over 3.000 to 4.000, incl	Longitudinal	70.0	62.0	9
	Long-Trans.	71.0	62.0	6
	Short-Trans.	69.0	59.0	3
Over 4.000 to 5.000, incl	Longitudinal	70.0	62.0	9
	Long-Trans.	71.0	62.0	5
	Short-Trans.	68.0	58.0	3
Over 5.000 to 6.000, incl	Longitudinal	70.0	62.0	8
	Long-Trans.	70.0	61.0	4
	Short-Trans.	68.0	58.0	3
Over 6.000 to 7.000, incl	Longitudinal	69.0	62.0	7
	Long-Trans.	69.0	60.0	4
	Short-Trans.	67.0	57.0	3
Over 7.000 to 8.000, incl	Longitudinal	68.0	61.0	6
	Long-Trans.	69.0	60.0	4
	Short-Trans.	66.0	57.0	3
Over 8.000 to 9.000, incl	Longitudinal	68.0	61.0	6
	Long-Trans.	68.0	59.0	4
	Short-Trans.	66.0	56.0	3

Table 2B - Minimum tensile properties, SI units

Nominal Thickness Millimeters	Specimen Orientation	Tensile Strength MPa	Yield Strength at 0.2% Offset MPa	Elongation in 50.8 mm or 4D %
Over 76 to 102, incl	Longitudinal	483	427	9
	Long-Trans.	490	427	6
	Short-Trans.	476	407	3
Over 102 to 127, incl	Longitudinal	483	427	9
	Long-Trans.	490	427	5
	Short-Trans.	469	400	3
Over 127 to 152, incl	Longitudinal	483	427	8
	Long-Trans.	483	421	4
	Short-Trans.	469	400	3
Over 152 to 178, incl	Longitudinal	476	427	7
	Long-Trans.	476	414	4
	Short-Trans.	462	393	3
Over 178 to 203, incl	Longitudinal	469	421	6
	Long-Trans.	476	414	4
	Short-Trans.	455	393	3
Over 203 to 229, incl	Longitudinal	469	421	6
	Long-Trans.	469	407	4
	Short-Trans.	455	386	3

3.3.1.1 Mechanical property requirements for plate outside the thickness range of 1.1 shall be as agreed upon by the purchaser and producer and reported per 4.4.1 (see 8.5).

3.3.2 Corrosion Resistance

Resistance to stress-corrosion cracking and to exfoliation corrosion shall be considered acceptable if the plate conforms to the requirements of 3.3.2.1 and 3.3.2.2.

3.3.2.1 Electrical Conductivity

Shall be not lower than 38.0% IACS (International Annealed Copper Standard) (22.6 MS/m), determined on the surface of the tensile coupon.

3.3.2.2 Stress-Corrosion Susceptibility Factor (SCF)

Shall be not greater than 32.0 (220), determined by subtracting the electrical conductivity, AA.A% IACS (12 times BB.B MS/m) from the long-transverse yield strength, XX.X ksi (YYY MPa).

3.3.2.2.1 SCF Example

For plate 4.001 inches (102 mm) in nominal thickness:

Table 3A

Inch/Pound Units		
33.5	unacceptable	73.1 ksi - 39.6% IACS
28.6	acceptable	68.8 ksi - 40.2% IACS

Table 3B

SI Units		
MS/m = 228	unacceptable	504 MPa - 12 x 23
MS/m = 194	acceptable	474 MPa - 12 x 23.3

3.3.2.3 Plate not meeting the requirements of 3.3.2.1 shall be given additional precipitation heat treatment or reheat treated. After such treatment, if all specified properties are met, the plate is acceptable.

3.3.3 Exfoliation-Corrosion Test

Plate shall not exhibit exfoliation corrosion greater than that illustrated by Photo B, Figure 2, of ASTM G34.

3.3.4 Stress-Corrosion Test

Specimens shall show no evidence of stress-corrosion cracking when stressed in the short-transverse direction at 35.0 ksi (241 MPa) for 20 days in accordance with ASTM G47.

3.3.5 Fracture Toughness

When specified, plate shall meet the values for K_{Ic} specified in Table 4. For T-L and L-T test directions on plate over 3.001 to 4.000 inches (76 to 102 mm), inclusive, in nominal thickness, use specimens 2.000 inches (51 mm) minimum thickness centered at T/2; and for plate over 4.000 inches (102 mm) in nominal thickness, use specimens 2.000 inch (51 mm) minimum thickness centered at T/4. For the S-L test direction, the test specimen shall be centered at T/2. Required specimen orientation(s) shall be specified by the purchaser.

Table 4A - Minimum fracture toughness parameters, inch/pound units

Nominal Thickness Inches	L-T ksi √inch	T-L ksi √inch	S-L ksi √inch
Over 3.000 to 4.000, incl	31	26	24
Over 4.000 to 5.000, incl	30	25	24
Over 5.000 to 6.000, incl	29	23	24
Over 6.000 to 7.000, incl	27	22	23
Over 7.000 to 8.000, incl	26	22	23
Over 8.000 to 9.000, incl	26	21	22

Table 4B - Minimum fracture toughness parameters, SI units

Nominal Thickness, Millimeters	L-T MPa √m	T-L MPa √m	S-L MPa √m
Over 76 to 102, incl	34	28	26
Over 102 to 127, incl	33	27	26
Over 127 to 152, incl	32	25	26
Over 152 to 178, incl	30	24	25
Over 178 to 203, incl	28	24	25
Over 203 to 229, incl	28	23	24

3.3.6 Fatigue Resistance

When specified, 4.001 to 9.000 inch (102 to 229 mm) thick plate shall meet the values for fatigue life specified in Table 5. Two fatigue specimens from each end of the plate shall be sampled 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) in accordance with ASTM E466. They are to be tested at an R-ratio of 0.1, at a maximum stress of 35.0 ksi (241 MPa), and shall meet the fatigue requirements shown in Table 5.

Table 5 - Fatigue life requirements

Minimum cycles per test	90000 cycles
Average of 4 tests	120000 cycles
Runout	300000 cycles

3.4 Quality

Plate, as received by the purchaser, shall be uniform in quality and condition, sound, and free from foreign materials and from imperfections detrimental to usage of the plate.

3.4.1 Each plate shall be ultrasonically inspected in accordance with ASTM B594 and shall meet the requirements of 3.4.1.1.

3.4.1.1 Plates shall meet the requirements for ultrasonic class A.

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 plate 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 plate conforms to specified requirements.

4.2 Classification of Tests

4.2.1 Acceptance Tests

Composition (see 3.1), tensile properties (see 3.3.1), corrosion resistance (see 3.3.2), tolerances (see 3.5), ultrasonic soundness (see 3.4.1), and, when specified, fracture toughness (see 3.3.5) and fatigue (see 3.3.6) are acceptance tests and shall be performed on each inspection lot.

4.2.2 Periodic Tests

Exfoliation-corrosion resistance (see 3.3.3) and stress-corrosion resistance (see 3.3.4) are periodic tests 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 Tensile specimens shall be taken with axis of specimens parallel to each applicable grain flow direction specified in Table 2.

4.3.2 When fracture toughness testing is specified, specimens shall be taken from the center width of at least one plate in each lot for each specimen orientation specified by the purchaser.

4.3.3 When fatigue testing is specified, specimen shall be taken from at least one plate in each lot at the location given in 3.3.6.