SAE Aerospace
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AEROSPACE MATERIAL SPECIFICATION

SAE AMS4204 | REV. C

Issued 1982-07
Revised 2003-01
Reaffirmed 2013-05

Superseding AMS4204B

Aluminum Alloy, Plate
6.2Zn - 1.8Cu - 2.4Mg - 0.13Zr (7010-T7651)
Solution Heat Treated, Stress Relieved, and Precipitation Heat Treated
(Composition similar to UNS A97010)

RATIONALE

AMS4204C has been reaffirmed to comply with the SAE five-year review policy.

1. SCOPE:

1.1 Form:

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

1.2 Application:

This plate has been used typically for parts requiring higher tensile strength than AMS 4203 (7010-T7351) or AMS 4205 (7010-T7451), resistance to exfoliation corrosion, and fracture toughness, 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, 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

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

SAE values your input. To provide feedback on this Technical Report, please visit
http://www.sae.org/technical/standards/AMS4204C

2.1 (Continued):

AMS 4203	Aluminum Alloy Plate, 6.2Zn - 1.8Cu - 2.4Mg - 0.13Zr (7010-T351), Solution Heat Treated, Stress Relieved, and Precipitation Heat Treated
AMS 4205	Aluminum Alloy, Plate 6.2Zn - 1.8Cu - 2.4Mg - 0.13Zr, Solution Heat Treated, Stress Relieved, and Precipitation Heat Treated
AMS 2772	Heat Treatment of Aluminum Alloy Raw Materials
AS 1990	Aluminum Alloy Tempers

2.2 ASTM Publications:

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

ASTM B 594	Ultrasonic Examination of Aluminum Alloy Wrought Products for Aerospace Applications
ASTM B 660	Packaging/Packing of Aluminum and Magnesium Products
ASTM B 666/B 666M	Identification of Aluminum and Magnesium Alloy Products
ASTM E 399	Plane-Strain Fracture Toughness of Metallic Materials
ASTM E 602	Sharp-Notch Tension Testing with Cylindrical Specimens
ASTM E 1304	Plane-Strain (Chevron-Notch) Fracture Toughness 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 High-Strength Aluminum Alloy Products

2.3 ANSI Publications:

Available from ANSI, 25 West 43rd Street, New York, NY 10036.

ANSI H 35.2	Dimensional Tolerances for Aluminum Mill Products
ANSI H 35.2M	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 AMS 2355 or MAM 2355.

TABLE 1 - Composition

Element	min	max
Silicon	--	0.12
Iron	--	0.15
Copper	1.5	2.0
Manganese	--	0.10
Magnesium	2.1	2.6
Chromium	--	0.05
Zinc	5.7	6.7
Titanium	--	0.06
Nickel	--	0.05
Zirconium	0.10	0.16
Other Elements, each	--	0.05
Other Elements, total	--	0.15
Aluminum	remainder	

3.2 Condition:

Solution heat-treated, stress relieved by stretching to produce a nominal permanent set of 2% but not less than 1-1/2% nor more than 3%, and precipitation heat treated to the T7651 temper (See AS1990) in accordance with AMS 2772.

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 AMS 2355 or MAM 2355 on the mill 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 %
Up to 2.000, incl	Longitudinal	76.0	66.0	8
	Long-Trans.	76.0	66.0	6
Over 2.000 to 2.500, incl	Longitudinal	75.0	65.0	8
	Long-Trans.	75.0	65.0	6
	Short-Trans.	71.0	59.0	2.5
Over 2.500 to 3.000, incl	Longitudinal	73.0	64.0	7
	Long-Trans.	74.0	64.0	5
	Short-Trans.	70.0	58.0	2.5
Over 3.000 to 4.000, incl	Longitudinal	72.0	64.0	7
	Long-Trans.	73.0	63.0	5
	Short-Trans.	69.0	56.0	2
Over 4.000 to 5.000, incl	Longitudinal	72.0	63.0	7
	Long-Trans.	72.0	62.0	5
	Short-Trans.	68.0	55.0	2
Over 5.000 to 5.500, incl	Longitudinal	71.0	62.0	6
	Long-Trans.	72.0	61.0	4
	Short-Trans.	66.0	53.0	2

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 %
Up to 50.80, incl	Longitudinal	524	455	8
	Long-Trans.	524	455	6
Over 50.80 to 63.50, incl	Longitudinal	517	448	8
	Long-Trans.	517	448	6
	Short-Trans.	490	407	2.5
Over 63.50 to 76.20, incl	Longitudinal	503	441	7
	Long-Trans.	510	441	5
	Short-Trans.	483	400	2.5
Over 76.20 to 101.60, incl	Longitudinal	496	441	7
	Long-Trans.	503	434	5
	Short-Trans.	476	386	2
Over 101.60 to 127.00, incl	Longitudinal	496	434	7
	Long-Trans.	496	427	5
	Short-Trans.	469	379	2
Over 127.00 to 139.70, incl	Longitudinal	490	427	6
	Long-Trans.	496	421	4
	Short-Trans.	455	365	2

3.3.2 Conductivity: Shall be not lower than 39.0% IACS (International Annealed Copper Standard) (22.6 MS/m), determined on specimens as in 4.3.1.

3.3.2.1 Plate not meeting the requirement of 3.3.2 may be given additional precipitation heat treatment. After such treatment, if the specified conductivity/property relationships conforming to 3.3.1 and 3.3.2 are met, the plate is acceptable.

3.3.3 Fracture Toughness: Plate shall meet the values of K_{IC} specified in Table 3, determined using specimen configurations conforming to ASTM E 399. For T-L and L-T test directions on plate 2 inches (51 mm) and under in nominal thickness, use full thickness specimens; for plate over 2 to 3 inches (51 to 76 mm), inclusive, in nominal thickness, use 2-inch (51-mm) thick specimens centered at T/2. For the S-L test direction, the test specimens shall be centered at T/2. Required specimen orientation(s) shall be specified by purchaser.

3.3.4 Alternate Testing for Demonstration of Fracture Toughness: When specified, the producer shall guarantee that plate meets the fracture toughness requirements based on correlation with notch tensile strength/tensile yield strength (NTS/TYS) ratio, determined in accordance with 3.3.4.1, or correlation with the short-bar fracture toughness results, determined in accordance with 3.3.4.2, in lieu of fracture toughness testing (3.3.3). Sampling and testing requirements, and lot acceptance criteria shall be as agreed upon.

3.3.4.1 NTS/TYS Ratio: For plate 0.750 to 3.000 inches (1905. to 76.20 mm), inclusive, in nominal thickness, notch tensile strength shall be determined in accordance with ASTM E 602 on specimens taken in both the longitudinal and long-transverse directions. The values for each direction shall be divided by the tensile yield strength, determined for the same direction, to obtain the NTS/TYS ratios. Acceptance values for NTS/TYS shall be specified based on evidence of documented correlation between the NTS/TYS ratio and the fracture toughness values (3.3.5) as demonstrated and maintained by the producer.

3.3.4.2 Short-Bar Fracture Toughness: For plate 1.000 to 3.000 inches (25.40 to 76.20 mm), inclusive, in nominal thickness, plane strain (Chevron-notch) fracture toughness, K_{IV} or K_{IVJ} shall be determined in accordance with ASTM E 1304 on specimens taken in the T-L and L-T test directions. Acceptance values for K_{IV} or K_{IVJ} shall be specified based on evidence of documented correlation between K_{IV} or K_{IVJ} and fracture toughness values (3.3.5) as demonstrated and maintained by the producer.

TABLE 3A - Minimum K_{IC} Values, Inch/Pound Units

Nominal Thickness Inches	Test Direction	ksi $\sqrt{inch}$
Over 1 to 2, incl	L-T	25.0
	T-L	23.0
Over 2 to 3, incl	L-T	24.0
	T-L	22.0
	S-L	20.0
Over 3 to 5, incl	L-T	22.0
	T-L	20.0
	S-L	18.0
Over 5 to 5.5, incl	L-T	20.0
	T-L	18.0
	S-L	17.0

TABLE 3B - Minimum K_{IC} Values, SI Units

Nominal Thickness Millimeters	Test Direction	MPa $\sqrt{m}$
Over 25 to 51, incl	L-T	27.5
	T-L	25.3
Over 51 to 76, incl	L-T	26.4
	T-L	24.2
	S-L	22.0
Over 76 to 127, incl	L-T	24.2
	T-L	22.0
	S-L	19.8
Over 127 to 140, incl	L-T	22.0
	T-L	19.8
	S-L	18.7

3.3.5 Exfoliation Corrosion Resistance: Plate shall achieve an exfoliation rating of EA or better, as illustrated in ASTM G 34 at the T/10 plane.

3.3.6 Stress-Corrosion Cracking Resistance: Specimens from plate, 0.750 inch (19.05 mm) and over in nominal thickness, shall show no evidence of stress-corrosion cracking when tested in accordance with ASTM G 47 and stressed in the short-transverse direction to 25.0 ksi (172 MPa).

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.

3.4.1 Each plate shall be ultrasonically inspected in accordance with ASTM B 594 and shall meet the following requirements:

3.4.1.1 Plate weighing 2000 pounds (907 kg) and under shall meet the requirements for ultrasonic class shown in Table 4.

3.4.1.2 The ultrasonic class for plates under 0.500 inch (12.70 mm) or over 2.000 inches (76.20 mm) in nominal thickness or weighing over 2000 pounds (907 kg) shall be as acceptable to purchaser.

TABLE 4 - Ultrasonic Class

Nominal Thickness Inches	Nominal Thickness Millimeters	Ultrasonic Class
0.500 to 1.500, excl	12.70 to 38.10, excl	B
1.500 to 2.000, incl	38.10 to 50.80, incl	A

3.5 Tolerances:

Shall conform to all applicable requirements of ANSI H 35.2 or ANSI H 35.2M.

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 the specified requirements.

4.2 Classification of Tests:

4.2.1 Acceptance Tests: Composition (3.1), tensile properties (3.3.1), conductivity (3.3.2), fracture toughness (3.3.3) or alternate fracture toughness (3.3.4) when specified, ultrasonic soundness (3.4.1), and tolerances (3.5) are acceptance tests and, except for composition, shall be performed on each inspection lot.

4.2.2 Periodic Tests: Exfoliation corrosion resistance (3.3.5) and stress-corrosion cracking resistance (3.3.6) are periodic tests 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 AMS 2355 or MAM 2355 and the following:

4.3.1 Specimens for conductivity testing shall be taken from the samples used for tensile testing.