

ADOPTION NOTICE

SAE-AMS-QQ-A-250/26, "Aluminum Alloy, 7011 Alclad, 7075 Plate and Sheet", was adopted on 30-JUN-98 for use by the Department of Defense (DoD). Proposed changes by DoD activities must be submitted to the DoD Adopting Activity: Commander, Defense Industrial Supply Center, 700 Robbins Avenue, Philadelphia, PA 19111-5096. DoD activities may obtain copies of this standard from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094. The private sector and other Government agencies may purchase copies from the Society of Automotive Engineers, Inc., 400 Commonwealth Drive, Warrendale, PA 15096.

Custodians:

Army - MR
Navy - AS
Air Force - 11
DLA - IS

Adopting Activities:

DLA - IS
(Project 9535-0628-018)

FSC 9535

DISTRIBUTION STATEMENT A: Approved for public release; distribution is unlimited.

SAE The Engineering Society
For Advancing Mobility
Land Sea Air and Space®
INTERNATIONAL

400 Commonwealth Drive, Warrendale, PA 15096-0001

AEROSPACE MATERIAL SPECIFICATION

Submitted for recognition as an American National Standard

SAE

AMS-QQ-A-250/26

Issued

AUG 1997

ALUMINUM ALLOY, 7011 ALCLAD, 7075 PLATE AND SHEET

UNS A87075

NOTICE

This document has been taken directly from Federal Specification QQ-A-250/26A and contains only minor editorial and format changes required to bring it into conformance with the publishing requirements of SAE technical standards.

The original Federal Specification was adopted as an SAE standard under the provisions of the SAE Technical Standards Board (TSB) Rules and Regulations (TSB 001) pertaining to accelerated adoption of government specifications and standards. TSB rules provide for (a) the publication of portions of unrevised government specifications and standards without consensus voting at the SAE Committee level, (b) the use of the existing government specification or standard format, and (c) the exclusion of any qualified product list (QPL) sections.

The complete requirements for procuring aluminum alloy, 7011 alclad, 7075 plate and sheet described herein shall consist of this document and the latest issue of AMS-QQ-A-250.

1. SCOPE AND CLASSIFICATION:

1.1 Scope:

This specification covers the specific requirements for aluminum alloy, 7011 alclad, 7075 plate and sheet; the general requirements are covered in AMS-QQ-A-250. The plate and sheet covered by this specification shall be an integral composite product consisting of a heat-treatable aluminum alloy 7075 core with thin layers of a 7011 aluminum alloy anodic to the core and of approximately equal thickness, bonded to both surfaces.

SAE Technical Standards Board Rules provide that: "This report is published by SAE to advance the state of technical and engineering sciences. The use of this report is entirely voluntary, and its applicability and suitability for any particular use, including any patent infringement arising therefrom, is the sole responsibility of the user."

SAE reviews each technical report at least every five years at which time it may be reaffirmed, revised, or cancelled. SAE invites your written comments and suggestions.

Copyright 1997 Society of Automotive Engineers, Inc.
All rights reserved.

Printed in U.S.A.

QUESTIONS REGARDING THIS DOCUMENT:
TO PLACE A DOCUMENT ORDER:

(412) 772-7154
(412) 776-4970

FAX: (412) 776-0243
FAX: (412) 776-0790

AMS-QQ-A-250/26**SAE****AMS-QQ-A-250/26****1.2 Classification:**

1.2.1 Tempers: The plate and sheet are classified in one of the following tempers, as specified (See 6.2): O, T6, T62, T651, T76, T7651, or F temper (See 6.3). Definitions of these tempers are specified in AMS-QQ-A-250 and as follows:

- O** - Annealed
- T6** - Solution-heat-treated and artificially aged.
- T62** - Solution-heat-treated from the O or F temper to demonstrate the response to heat-treatment, and artificially aged.
- T651** - Solution-heat-treated, stress relieved by stretching to produce a nominal permanent set of 2 percent but not less than 1-1/2 nor more than 3 percent, and artificially aged. Plate shall receive no further straightening after stretching.
- T76** - Solution-heat-treated and artificially aged sufficient to produce improved resistance to exfoliation.
- T7651** - Solution-heat-treated, stress relieved by stretching to produce a nominal permanent set of 2 percent but not less than 1-1/2 nor more than 3 percent, and artificially aged sufficient to produce improved resistance to exfoliation and stress corrosion cracking. Plate shall receive no further straightening after stretching.
- F** - As fabricated.

2. APPLICABLE DOCUMENTS:

See AMS-QQ-A-250.

3. REQUIREMENTS:**3.1 Chemical Composition:**

The chemical composition of the core ingots or slabs and of the cladding plates used for the manufacture of the clad plates and sheets shall conform to the requirements shown in Table I for core and cladding, respectively.

AMS-QQ-A-250/26

SAE

AMS-QQ-A-250/26

TABLE I. Chemical Composition ^{1/}

Element	Analysis			
	Core alloy (7075) Percent		Cladding alloy (7011) Percent	
	Minimum	Maximum	Minimum	Maximum
Zinc	5.1	6.1	4.0	5.5
Magnesium	2.1	2.9	1.0	1.6
Copper	1.2	2.0	--	0.05
Chromium	0.18	0.35	0.05	0.20
Manganese	--	0.30	0.10	0.30
Iron	--	0.50	--	0.20
Silicon	--	0.40	--	0.15
Titanium	--	0.20	--	0.05
Other Elements, each	--	0.05	--	0.05
Other Elements, total	--	0.15	--	0.15
Aluminum	Remainder		Remainder	

^{1/} Analysis shall routinely be made only for the elements specifically mentioned in Table I. If, however, the presence of other elements is indicated or suspected in amounts greater than the specified limits, further analysis shall be made to determine that these elements are not present in excess of specified limits.

3.2 Mechanical Properties

- 3.2.1 Mechanical Properties of Materials as Supplied: The mechanical properties perpendicular to the direction of final rolling, except for material under 9 inches in width, shall conform to the requirements of Table II for the temper specified. For material under 9 inches in width, the mechanical properties parallel to the direction of final rolling shall conform to the requirements of Table II for the temper specified.

AMS-QQ-A-250/26

SAE

AMS-QQ-A-250/26

TABLE II. Mechanical Properties (See 6.5)

Temper	Thickness Inches	Tensile Strength ksi minimum	Yield Strength at 0.2 percent Offset ksi minimum	Elongation in 2 in. or 4D percent minimum 1/ 2/
O	0.015 thru 0.499	40.0 3/	21.0 3/	10
	0.500 thru 2.000	40.0 3/ 4/	--	10
T6 and T62 5/	0.015 thru 0.039	73.0	63.0	7
	0.040 thru 0.187	75.0	65.0	8
	0.188 thru 0.249	76.0	66.0	8
T651 and T62 5/	0.250 thru 0.499	76.0	66.0	9
	0.500 thru 1.000	78.0 4/	68.0 4/	7
	1.001 thru 2.000	77.0 4/	67.0 4/	6
	2.001 thru 2.500	76.0 4/	64.0 4/	5
	2.501 thru 3.000	72.0 4/	61.0 4/	5
	3.001 thru 3.500	71.0 4/	58.0 4/	5
	3.501 thru 4.000	67.0 4/	54.0 4/	3
T76	0.040 thru 0.062	70.0	59.0	8
	0.063 thru 0.187	71.0	60.0	8
	0.188 thru 0.249	72.0	61.0	8
T7651	0.250 thru 0.499	71.0	60.0	8
	0.500 thru 1.000	71.0 4/	60.0 4/	6
F	All	6/	6/	6/

1/ Not required for material 1/2 inch or less in width.

2/ D represents specimen diameter.

3/ Maximum.

4/ The properties for these thicknesses are those of the core alloy since the tests are made on a round specimen machined from the plate.

5/ Plate in the T62 temper is not available from the material producer. The T62 properties listed indicate those which can usually be obtained by the user, when the material is properly solution- and precipitation-heat-treated from the O (annealed) or F (as fabricated) temper. These properties also apply to samples of material supplied in the O or F tempers which are solution- and precipitation-heat-treated by the producer to determine that the material will respond to proper heat treatment. Properties attained by the user, however, may be lower than those listed if the material has been formed or otherwise cold- or hot-worked, particularly in the annealed temper, prior to solution heat treatment.

6/ No requirements.

AMS-QQ-A-250/26

SAE

AMS-QQ-A-250/26

3.2.2 Mechanical Properties After Heat Treatment: In addition to conforming to the requirements of 3.2.1, material in the annealed (O) and the as-fabricated (F) tempers shall, after proper solution heat-treatment and aging, also conform to the requirements of Table II for the T6 and T62 tempers. Material as received in the T6, T76, T651, and T7651 tempers shall, after proper re-solution heat-treatment and aging, be capable of conforming to the requirements specified in Table II for the T6 and T62 tempers. Material as received in the annealed (O) and the as-fabricated (F) tempers shall, after proper solution heat-treatment and aging, be capable of conforming to the requirements specified in Table II for the T76 temper.

3.2.3 Bend Test: Bend specimens taken from plate and sheet shall be capable of withstanding, without cracking, the bend test specified in AMS-QQ-A-250. The values for bend factor N are given in Table III.

TABLE III. Bend Test Factor "N"

Thickness Inches	Tempers	
	O-annealed	T6, T62, & T76
0.015 thru 0.020	1	7
0.021 thru 0.062	2	8
0.063 thru 0.091	3	9
0.092 thru 0.125	4	10
0.126 thru 0.249	5	11
0.250 thru 0.499	6	14

3.3 Cladding Thickness:

3.3.1 Thickness of Cladding Plates: The 7011 aluminum alloy plates that are bonded to the two sides of the 7075 aluminum alloy ingot or slab to form a composite that is to be rolled to the finished thickness shall each have a thickness as specified in Table IV.

AMS-QQ-A-250/26

SAE

AMS-QQ-A-250/26

TABLE IV. Cladding Thickness

Thickness of Finished Plate or Sheet Inch	Nominal Cladding Thickness per Side; percent of composite thickness	Average Cladding Thickness per Side on Finished Plate or Sheet; min. percent of plate or sheet thickness
Up thru 0.062	4.0	3.2
0.063-0.187	2.5	2.0
0.188 and over 1/	1.5	1.2

1/ For plate 0.500 inch and over in thickness, the average cladding thickness per side shall have a maximum value of 3 percent of the plate thickness.

3.3.2 Thickness of Cladding: If question arises concerning the thickness of cladding of the finished sheet or plate, samples examined in accordance with AMS-QQ-A-250 shall show an average thickness of cladding on each side not less than that specified in Table IV.

3.4 Exfoliation and Stress-Corrosion Cracking:

Material in the T76 and the T7651 tempers, tested in accordance with 4.2.2 and 4.2.3, shall show no exfoliation or stress-corrosion cracking susceptibility beyond the acceptance criteria detailed in 4.2.2.7 and 4.2.3.5.

3.4.1 Lot Acceptance Control Criteria for T76 and T7651 Tempers: Susceptibility to exfoliation and stress-corrosion cracking for each inspection lot of T76 and T7651 temper material shall be determined by the following control criteria (See 4.2.1.2 and 4.2.4):

3.4.1.1 Determine mechanical properties and electrical conductivity.

3.4.1.2 If the sub-surface conductivity is 38 percent IACS or higher, and the tensile properties meet the minimum limits specified herein, the material is acceptable.

3.4.1.3 If the sub-surface conductivity is at least 36 percent IACS but less than 38 percent IACS, the material shall be tested as specified in 4.2.2, or reprocessed.

3.4.1.4 If the sub-surface conductivity is below 36 percent IACS, the material is not acceptable and must be reprocessed.

AMS-QQ-A-250/26

SAE

AMS-QQ-A-250/26

3.5 Internal Defects:

When specified (See 6.2), plate shall be ultrasonically inspected (See AMS-QQ-A-250). Acceptance limits shall be as specified in Table V.

TABLE V. Ultrasonic Discontinuity Acceptance Limits ^{1/}

Thickness Inches	Maximum Weight per Piece in pounds	Discontinuity Class ^{2/}
0.500 thru 1.499	2,000	B
1.500 thru 3.000	2,000	A
3.001 thru 4.000	2,000	B

^{1/} Discontinuities in excess of those listed in Table V may be allowed, subject to approval of the procuring activity, if it is established that they will be removed by machining or that they are in non-critical areas.

^{2/} Discontinuity class limits are defined in MIL-I-8950.

3.6 Marking:

In addition to the marking required in FED-STD-184, plate and sheet in the T6, T76, T651, and T7651 tempers shall be identified by an inspection lot number marked in at least one location on each piece.

4. QUALITY ASSURANCE PROVISIONS:

See AMS-QQ-A-250 and the following:

4.1 Mechanical Tests After Heat Treatment:

- 4.1.1 Number of Tests After Heat Treatment: From material in the annealed (O) and as-fabricated (F) tempers, an additional number of specimens equal to that required by AMS-QQ-A-250 shall be taken and tested after solution-heat treatment and artificial aging to determine compliance with 3.2.2.

AMS-QQ-A-250/26

SAE

AMS-QQ-A-250/26

4.2 Exfoliation and Stress-Corrosion Cracking Tests (T76 and T7651 tempers only):

4.2.1 Sampling:

4.2.1.1 For Exfoliation and Stress-Corrosion Cracking Tests: Two samples shall be taken for each 4,000 pounds or less of the first three production lots for each size range of T76 and T7651 temper sheet and plate listed in Table II. Thereafter, surveillance testing shall be performed on at least one sample per month for each size range of sheet and plate produced during the month which had previously been produced with acceptable exfoliation resistance. The surveillance test samples shall be taken from an inspection lot which has met the requirements of 3.4.1.2. Samples as above shall be taken for the stress-corrosion cracking test when thickness permits (See 4.2.3).

4.2.1.2 Sampling for Conductivity Tests: Sampling shall be in accordance with AMS-QQ-A-250 for mechanical property tests. Mechanical properties and conductivities shall be determined on the same samples except cladding must be removed before testing for conductivity.

4.2.1.3 Records: The producer shall maintain records of the performance of all inspection lots sampled and tested in accordance with 4.2.1.1. Upon request of the procuring activity, such records shall be made available. These records shall be maintained for not less than one year after completion of the contract or purchase order.

4.2.2 Resistance to Exfoliation and Stress-Corrosion Cracking: Tests shall be performed in accordance with the following procedures:

4.2.2.1 Specimens for Exfoliation Test: Full thickness specimens of sheet and plate large enough to provide visual assessment of attack may be used. A minimum panel size of 2 by 4 inches shall be used. Sawed edges need not be machined smooth; however, panels obtained by blanking or shearing shall have edges machined to a depth equal to the thickness of material to remove cold worked metal. For all materials, 0.100 inch or more in thickness, 10 percent of the thickness shall be removed by machining one surface. The machined surface shall be evaluated by exposure to the test solution. Protection by masking of edges and back surface is not required provided compliance with 4.2.2.4 is ensured. Specimens shall be thoroughly degreased prior to testing; however, etching or other pretreatment is not necessary.

AMS-QQ-A-250/26

SAE

AMS-QQ-A-250/26

4.2.2.2 Equipment: The exfoliation test shall be performed in a suitable inert container of glass or plastic, suitable to be used for the solution and the specimens during the period of exposure. The container should be equipped with a cover to reduce evaporation.

4.2.2.3 Corrosive Solution: The corrosive solution shall be prepared by dissolving the following reagent grade chemicals in distilled or deionized ASTM D-1193, Type II, water in the indicated concentrations as follows:

Sodium Chloride (NaCl)	234 g/liter of solution
Potassium Nitrate (KNO ₃)	50 g/liter of solution
Nitric Acid (HNO ₃) (concentrated-70% by weight)	6.3 ml/liter of solution

4.2.2.3.1 The apparent pH of the solution is 0.4. The solution shall be maintained at a temperature of 77 °F ± 5 (25 °C ± 3) during the test. At the start of each test, a fresh solution shall be used.

4.2.2.4 Exposure Procedure: The specimens shall be immersed in a volume of solution sufficient to provide a minimum volume to a specimen surface area ratio of 500 ml per square inch. Unless the edges and the back of the specimen are masked, their area must be included in the determination of the total surface area. The specimens shall be immersed in the solution using rods or racks of glass, plastic, or other inert material to support the specimens above the bottom of the container. The specimens should be exposed in a horizontal position in order to prevent loss of corrosion products from the surface of the specimens.

4.2.2.5 Exposure Period: The specimens shall be immersed in the solution for 48 hours without change of solution. Inspection of specimens, without cleaning, at intermediate periods may be performed to detect early development of exfoliation. The test may be terminated whenever exfoliation becomes evident.

4.2.2.6 Specimen Cleaning: At the conclusion of the 48-hour exposure, specimens shall be removed from the solution, gently rinsed in a container of still water, and then cleaned by immersion in concentrated nitric acid at room temperature for approximately 30 minutes, followed by a water rinse, and air drying.

AMS-QQ-A-250/26

SAE

AMS-QQ-A-250/26

- 4.2.2.7 **Test Results:** Specimens, as exposed above, shall be visually examined. Surfaces will be either generally roughened or show numerous discrete pits, but shall not show any exfoliation or actual delamination. Exfoliation, as used herein, is defined as that form of corrosion which proceeds laterally from the sites of initiation along planes, generally grain boundaries, parallel to the surface. The resulting corrosion products force the metal upwards resulting in a layered appearance to the surface. In some cases the pitting attack will have a tendency to undermine the surface, resulting in tiny slivers of metal protruding around the edges of pits. This form of attack does not progressively worsen with continued exposure and should not be misconstrued as exfoliation. Examples of surfaces which have completed this test without exfoliation are shown in Figure 1. Surfaces showing various degrees of exfoliation failures are shown in Figure 2.
- 4.2.3 **Stress-Corrosion Cracking Test:** Stress-corrosion cracking tests on plate 0.750 inch and over in thickness shall be performed as follows:
- 4.2.3.1 **Specimens:** Specimens shall be selected in a manner such as to permit application of the specific tension stress in the short-transverse direction. Standard "c" rings are preferred. (See Report of ASTM TG-1, Committee B3; ASTM-STP425, 1967, Stress Corrosion Testing.)
- 4.2.3.2 **Exposure Period:** Exposure shall be for 30 days.
- 4.2.3.3 **Tension Stress:** The tensile stress applied in the short-transverse direction (perpendicular to grain flow) shall be 25.0 ksi, and the specimen shall be held at constant strain.
- 4.2.3.4 **Exposure Procedure:** The stressed specimens shall be exposed to a solution of 3.5 percent NaCl prepared with distilled water and reagent grade salt, pH 6.4 to 7.2 at a solution temperature of $75^{\circ}\text{F} \pm 2$, air temperature $80^{\circ}\text{F} \pm 2$ and air relative humidity of 45 percent ± 6 . The alternate immersion cycle shall consist of 10 minutes immersion in solution and 50 minutes in air, with sufficient circulation to dry the specimens slowly before the next immersion.
- 4.2.3.5 **Stress-Corrosion Test Results:** After a 30-day exposure, as described in 4.2.3.4, the specimen shall exhibit no evidence of stress-corrosion cracking. Any highly directional attack which is suspected of concealing a stress-corrosion crack shall be cross sectioned and examined metallographically. An example of stress-corrosion cracking is shown on Figure 3. Figure 4 illustrates pitting-type attack which does not constitute failure.
- 4.24 **Electrical Conductivity Tests:** The conductivity shall be determined by taking three electrical conductivity readings at random on the machined surface after machining one surface of the sample to a depth of approximately 10 percent of the product thickness. The average of each of the three readings shall be used as the conductivity acceptance criteria in 3.4.1.