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# AEROSPACE MATERIAL SPECIFICATION

SAE AMS-QQ-A-250/26A

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Superseding AMS-QQ-A-250/26

Submitted for recognition as an American National Standard

## 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.

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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.



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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.

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.

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 | 0.015 thru 0.039 | 73.0 | 63.0 | 7 |
| and | 0.040 thru 0.187 | 75.0 | 65.0 | 8 |
| T62 5/ | 0.188 thru 0.249 | 76.0 | 66.0 | 8 |
| T651 | 0.250 thru 0.499 | 76.0 | 66.0 | 9 |
| and | 0.500 thru 1.000 | 78.0 4/ | 68.0 4/ | 7 |
| T62 5/ | 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.

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.

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.

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.

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.

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 ($HNO_3$) (con-centrated-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 50 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.

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 °F ± 2, air temperature 80 °F ± 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.

4.2.4 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.