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AEROSPACE MATERIAL SPECIFICATION

SAE AMS-QQ-A-250/19

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Submitted for recognition as an American National Standard

Aluminum Alloy 5086, Plate and Sheet for Sea Water Applications

NOTICE

This document has been taken directly from Federal Specification QQ-A-250/19 and contains only minor editorial and format changes required to bring it into conformance with the publishing requirements of SAE technical standards. The initial release of this document is intended to replace QQ-A-250/19. Any part numbers established by the original specification remain unchanged.

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, and (b) the use of the existing government specification or standard format.

Under Department of Defense policies and procedures, any qualification requirements and associated qualified products lists are mandatory for DOD contracts. Any material relating to qualified products lists (QPL's) has not been adopted by SAE and is not part of this technical report.

The complete requirements for procuring 5086 aluminum 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 5086, plate and sheet for applications requiring a weldable moderate strength alloy having comparatively and corrosive resistance.

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1.2 Classification:

1.2.1 Tempers: The plate and sheets are of the following tempers, as specified (see 6.2). Definitions of these tempers are specified in AMS QQ-A-250.

O-Annealed.
H112 - As rolled, properties as specified in table II.
H116 - Specially treated, properties as specified in table II.
H117 - Specially treated, properties as specified in table II.
H34 - Strain-hardened and stabilized, half-hard temper.
H36 - Strain-hardened and stabilized, three-quarters hard temper.
H38 - Strain-hardened and stabilized, full-hard temper

2. APPLICABLE DOCUMENTS:

See AMS QQ-A-250 and the following:

2.1 ASTM Publications:

Available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.

ASTM B 117 Method of Salt Spray (Fog) Testing
ASTM D 1141 Standard Specifications for Substitute Ocean Water

3. REQUIREMENTS:

3.1 First article sample:

Prior to beginning production a sample shall be tested as specified in 4.1.2 through 4.2.1 (see 6.3).

3.2 Chemical composition:

The chemical composition shall conform to the requirements shown in table I.

TABLE I. Chemical composition[1/]

Element	Percent	
	Minimum	Maximum
Silicon	---	0.04
Iron	---	0.50
Copper	---	0.10
Manganese	0.20	0.7
Magnesium	3.5	4.5
Chromium	0.05	0.25
Titanium	---	0.15
Zinc	---	0.25
Others, each	---	0.05
Others, total	---	0.15
Aluminum	Remainder	

[1/] Analysis shall regularly be made only for the elements specifically mentioned in the table. If, however, the presence of other elements is indicated in the course of routine analysis further analysis shall be made to determine conformance to the limits specified for other elements.

3.3 Mechanical properties:

3.3.1 Mechanical properties of material, as supplied: The mechanical properties parallel to the direction of final rolling, shall be as specified in table II.

3.4 Acceptance control criteria for exfoliation and intergranular corrosion (production lots):

Each production lot of material shall meet all of the requirements specified herein. Tests for susceptibility to exfoliation and intergranular corrosion, as established by metallographic examination in 4.3, shall reveal that:

(a) The microstructure is predominately free of a continuous grain boundary network of aluminum-magnesium precipitate; and
(b) The microstructure is equivalent to or better than the reference first article microstructure established in 4.2.

3.4.1 Excess aluminum-magnesium precipitate: If the microstructure conforms to (a) but shows evidence of aluminum-magnesium precipitate in excess of that established by the reference micrographs, under approved first article inspection, the lot shall be considered suspect and must be subjected to the corrosion test specified in 4.4 for base metal specimen. These specimens shall show no visual evidence of corrosion after testing.

TABLE II. Mechanical properties

Temper	Thickness	Tensile Strength		Yield strength[1/] minimum	Elongation in 2 in. or 4 times D [2/, 3/,] minimum
		Minimum	Maximum		
	Inches	P.s.i.	P.s.i.	P.s.i.	Percent
0	0.020 thru 0.050	35,000	42,000	14,000	15
	0.051 thru 0.249	35,000	42,000	14,000	18
	0.250 thru 2.000	35,000	42,000	14,000	16
H112	0.188 thru 0.499	36,000	-------	18,000	8
	0.500 thru 1,000	35,000	-------	16,000	10
	1.001 thru 2.000	35,000	-------	14,000	14
	2.001 thru 3.000	34,000	-------	14,000	14
H116 and H117	0.188 thru 0.249	40,000	-------	28,000	8
	0.250 thru 2.000	40,000	-------	28,000	10
H34	0.009 thru 0.019	44,000	51,000	34,000	4
	0.020 thru 0.050	44,000	51,000	34,000	5
	0.051 thru 0.249	44,000	51,000	34,000	6
	0.250 thru 1.000	44,000	51,000	34,000	10
H36	0.006 thru 0.019	47,000	54,000	38,000	3
	0.020 thru 0.050	47,000	54,000	38,000	4
	0.051 thru 0.162	47,000	54,000	38,000	6
H38	0.006 thru 0.020	50,000	-------	41,000	3

[1/]At 0.2 percent offset.
[2/]Not required for material 1/2 inch or less in width.
[3/]D represents specimen diameter.

4. QUALITY ASSURANCE PROVISIONS:

See AMS QQ-A-250, in addition to the following requirements:

4.1 Sampling:

4.1.1 Production: Production sampling for metallographic tests shall consist of two samples per lot. The sample locations for this test shall be selected from the midsection at opposite ends of a random sheet or plate. If corrosion tests are required, two samples shall be selected in the same manner specified for metallographic tests and shall be taken from the same sheet or plate used for metallographic samples.

4.1.2 Sampling for first article testing: Sampling for first article testing shall be taken from plates representative of mill production within the following tolerances of nominal plate thicknesses to be produced:

Plate Thickness Inch	Tolerances Inch
1/4	±1/16
3/8	±1/8
1/2	±1/8
5/8	±1/8
3/4	±1/8
1	±1/4
For each 1/2 inch increase in thickness over 1	±1/4

4.1.2.1 Sampling for metallographic and corrosion tests: Sampling for metallographic and corrosion tests shall be similar. For each of these tests, two sample per lot shall be selected based on each of the ranges, as noted above, within the nominal plate thickness or gauge size. The sample locations for each test shall be selected from the midsection at opposite ends of a random plate and all metallographic and corrosion test samples shall be taken from the same plate representative of a particular size range.

4.1.2.1.1 Three samples, 4 inches by 9 inches by gauge, with the rolling direction in the 4 inch dimension (properly identified) shall be furnished to the Naval Ship Engineering Center, Materials Development and Applications Office as part of the first article test report (see 4.2.1).

4.2 Acceptance control criteria for exfoliation and intergranular corrosion (first article lots):

Each first article lot of material shall meet the requirements of 3.4 (a), in addition to the following:

(a) Metallographic examination for the amount and pattern of aluminum-magnesium precipitation to establish reference microstructures for acceptance of production material.
(b) Corrosion tests of the base metal and weldments, as specified in 4.4, to simulate the behavior of the material to seawater environments. The material shall be resistant to corrosion as determined by visual observation.

4.2.1 First article approval: Prespective producers who wish to manufacture sheet or plate conforming to this specification shall demonstrate that their facilities are capable of quantity production of material, meeting all the requirements, by conducting tests prior to production (see 6.3). These tests shall be verified by the local Government inspector and the complete details included in an engineering report to be submitted to the Naval Ship Engineering Center, (Materials Development and Applications Office). The report shall include a description of specific mill practices, aside from those of a proprietary nature, to be used in commercial production of the alloys. Upon approval of this report, a successful bidder shall not deviate from the established production methods unless he retests in accordance with 4.2 and submits an amended engineering report.

4.3 Metallographic examination:

Metallographic samples, selected in accordance with 4.1.1, shall be taken in the longitudinal (rolling) direction, as shown in Figure 1, suitably mounted and metallographically polished on the indicated surface. Regions of plastic deformation or distortion of the grain structure resulting from sawing or shearing shall be removed during specimen preparation. Etching shall be carried out with 40 percent phosphoric acid solution at 95 °F. for three minutes. For standardizing comparison among samples, the microstructure shall be examined at 500 magnification for conformance with 3.4 and 4.2.

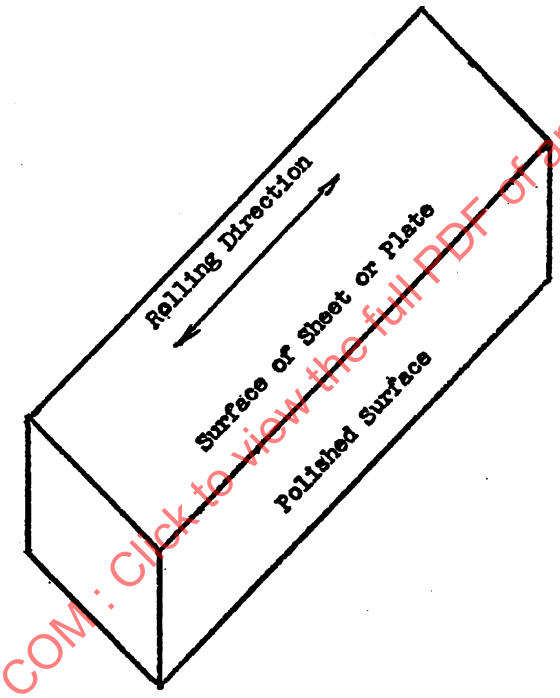

FIGURE 1 - Relationship of polished surface for metallographic examination to rolling direction of the sheet or plate.

4.4 Corrosion tests:

Corrosion tests on base metal specimens shall be conducted using the apparatus and procedures for salt spray (fog) test (see 4.5). Corrosion tests, primarily on weldments, shall be conducted in accordance with the procedures for immersion testing (see 4.6). In the absence of visual corrosion, no further examination is required. Existence of blistering, delamination, or both, are evidence of exfoliation susceptibility. Material exhibiting exfoliation is unacceptable for boat and ship hull construction. Where pitting corrosion, minute blistering, or minute flaking are observed, metallographic examination shall be used to determine type of attack. If attack is predominately intergranular corrosion, material is unacceptable for boat and ship hull construction.

4.5 Salt spray (fog) test:

4.5.1 This test shall be used to determine the exfoliation and intergranular corrosion susceptibility of aluminum-magnesium alloys for boat and ship hull construction.

4.5.2 Apparatus.

4.5.2.1 Laboratory cabinet apparatus shall conform to ASTM B 117, for construction of apparatus.

4.5.2.2 Test specimens.

4.5.2.3 Samples 2 inches by 6 inches shall be tested. The working direction shall be in the 2 inch dimension where practicable. Specimens of 3/8 inch gauge and over shall have three one-inch wide steps machined at depths from the surface of 1/8, 1/4, and 1/2 of the plate thickness. One step shall retain the original rolled surface. Specimens less than 3/8 inches gauge shall be exposed without machining.

4.5.2.4 Preparation of test specimens

4.5.2.4.1 The samples shall be degreased with a suitable solvent. After degreasing, they shall be etched for one minute in 5 percent by weight sodium hydroxide at 180°F. (82°C) and rinsed in water. The samples will then be desmutted 30 seconds in concentrated nitric acid at 80°F. (27°C.), distilled water rinsed, air dried and stored in a desiccator containing activated alumina until placed in test.

4.5.2.5 Position of specimens during test.

4.5.2.5.1 The specimens shall be positioned in the salt spray chamber in conformance with ASTM B 117, except that the specimens shall be supported or suspended with the 6 inch dimension 45 degrees from the vertical.

4.5.2.6 Salt solution.

4.5.2.6.1 The salt solution shall be prepared by dissolving 42 grams of synthetic sea salt which meets the requirements of ASTM D 1141 (see note 1) and 10 ml. of glacial acetic acid in one liter of distilled water (see note 2). The solution shall be made up and completely changed each week (see note 3). Before the solution is atomized, it shall be completely free of suspended solids.

4.5.2.7 Air supply.

4.5.2.7.1 The compressed air supply to the nozzle or nozzles for atomizing the salt solution shall be free of oil and dirt (see note 4) and maintained between 10 and 25 psi.

4.5.2.8 Conditions in the salt spray chamber.

4.5.2.8.1 Conditions in the salt spray chamber shall conform to ASTM B 117, except for the following changes:

4.5.2.8.2 The exposure zone of the salt spray chamber shall be maintained at 120°F. plus or minus 5°F. (50°C ± 2°C). The temperature within the exposure zone of the closed cabinet shall be recorded at least once a day (except on Saturdays, Sundays, and holidays when the salt spray test is not interrupted for exposing, rearranging, or removing test specimens or to check and replenish the solution in the reservoir).

4.5.2.8.3 At least two clean fog collectors shall be so placed within the exposure zone that no drops of solution from the test specimens or any other source shall be collected. The collectors shall be placed in the proximity of the test specimens, one nearest to any nozzle and the other farthest from all nozzles. The fog shall be such that for each 80 sq. cm. of horizontal collecting area, there will be collected in each collector from 1.0 to 2.0 ml of solution per hour based on an average run of at least 16 hours continuous spray (see note 5). The cabinet shall be checked at least once a month. (see notes 6 and 7.)

4.5.2.8.4 The cycle time shall be 30 minutes continuous spraying and 90 minutes with the spray off.

4.5.2.8.5 The salt spray chamber shall be operated under wet-bottom conditions with no forced air purge (see note 8).

4.5.2.9 Period of test.

4.5.2.9.1 The specimens shall be exposed for 7 days (168 hours) continuous exposure. There shall be no intermediate removing of corrosion product or disturbance of the surface.

4.5.2.10 Cleaning of tested specimens.

4.5.2.10.1 Immediately upon removal from test cabinet, the specimens shall be rinsed in running tap water and then soaked in concentrated nitric acid at room temperature until clean. They will then be rinsed in water and air dried.

4.5.2.11 Metallographic examination.

4.5.2.11.1 For metallographic examination, use cold specimen mounting (temperature shall not exceed 158°F. (70°C)).

4.5.2.11.2 Metallographic etching using 3 minutes in 40 percent by volume phosphoric acid at 95°F. (35°C) and viewing at 500 magnifications have been found effective for this examination.

Note 1: Synthetic sea salt may be obtained from Lake Products Company, Inc., 1254 Grover Road, St. Louis, Missouri 63125.

Note 2: This volume of glacial acetic is added to assure complete buffering of the solution and assure that the pH 2.8 remains stable.

Note 3: Storage or use of this solution for periods greater than one week often allows formation of bacteria which greatly reduces the corrosivity.

Note 4: The air supply may be freed from oil and dirt by passing it through a water scrubber or at least two feet of suitable cleaning material such as asbestos, sheep's wool, excelsior, slag wool, or activated alumina.