AEROSPACE MATERIAL SPECIFICATION

AMS2467™	REV. A

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Superseding AMS2467

Hard Anodic Coating of Magnesium Alloys Alkaline Type, High Voltage

RATIONALE

AMS2467A results from a Five-Year Review and update of this specification with the addition of the Notice to purchaser, clarification of surfaces to be coated in Classification (1.3), addition of the definition of Pit (2.4.1), addition of fixture/electrical contact locations, clarification of final rinsing (3.2.3), moved corrosion-resistance specimen configuration to 4.3.3.2 (3.4.2, 3.4.3), clarified wording regarding wear index value and cycle rating in accordance with ASTM D4060, added wording to quality regarding differences in anodize appearance (3.5), added standard wording for suspension of periodic testing when process is not being performed (4.2.2.1), deleted wording requiring preproduction testing when a change is made as this is already covered (4.2.3), added new definition of lot, added standard wording regarding sampling (4.3.1), added wording for when specimen material form is not available (4.3.2), added specimen configuration (4.3.3.2, 4.3.3.3), replaced approval wording with that from recently published anodize AMS's (4.4.1), clarified wording for when changes to approved processing is made (4.4.2), updated control factors (4.4.3), clarified wording regarding resampling and retesting wording for when parts are stripped and recoated (4.6.1 and 4.6.1.1), revised notes 8.2, and added new notes 8.3 and 8.5.

NOTICE

ORDERING INFORMATION: The following information shall be provided to the processor by the purchaser.

1. Purchase order shall specify not less than the following:

   - AMS2467A
   - Specified coating classification (1.3)
   - Basis metal to be anodized, and metal temper and/or basis metal material specification, to be anodized
   - Special features, geometry or processing present on parts that requires special attention by the processor
   - Optional: Fixture/electrical contact locations, when not specified (3.2.2)
   - Optional: Post treatment (see 3.3.5)
   - Optional: Corrosion testing exposure time, for alloys other then AMS4439 and AMS4446 (see 3.4.2)
   - Part number and quantity of pieces to be anodized

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/AMS2467A/

2. Parts manufacturing operations such as heat treating, forming, joining and media finishing, performed prior to anodizing can affect the condition of the substrate and if performed after anodizing, adversely affect the finished part. The sequencing of these types of operations should be specified by the cognizant engineering organization or purchaser and is not controlled by this specification.

1. SCOPE

1.1 Form

This specification establishes the procedures used to produce a hard anodic coating on magnesium alloys and the properties of the coating.

1.2 Application

This coating has been used typically to provide corrosion resistance and abrasion resistance to sand-cast magnesium alloys, but usage is not limited to such applications.

1.3 Classification

Anodic finishes are classified by coating thickness as follows:

Class 1 Thin Coating: Coating thickness shall be in the range of 0.0002 to 0.0004 inch (5 to 10 μm) and produce a dimensional buildup on the part, for each surface coated, of 0.0001 to 0.0002 inch (2.5 to 5 μm). See 3.4.1 and 8.2.

Class 2 Thick Coating: Coating thickness shall be in the range of 0.0008 to 0.0010 inch (20 to 25 μm) and produce a dimensional buildup on the part, for each surface coated, of 0.0004 to 0.0005 inch (10 to 12.7 μm). See 3.4.1 and 8.2.

1.3.1 If a class is not specified, Class 1 shall be supplied.

1.4 Safety-Hazardous Materials

While the materials, methods, applications, and processes described or referenced in this specification may involve the use of hazardous materials, this specification does not address the hazards which may be involved in such use. It is the sole responsibility of the user to ensure familiarity with the safe and proper use of any hazardous materials and to take necessary precautionary measures to ensure the health and safety of all personnel involved.

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 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.

AMS4439	Magnesium Alloy, Sand Castings, 4.2Zn - 1.2 Rare Earths - 0.7Zr (ZE41A-T5) Precipitation Heat Treated
AMS4446	Magnesium Alloy, Sand Castings, 8.7Al - 0.70Zn - 0.26Mn (AZ91E-T6) Solution and Precipitation Heat Treated
ARP4992	Periodic Test for Process Solutions
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 B117 Operating Salt Spray (Fog) Apparatus

ASTM B244 Measurement of Thickness of Anodic Coatings on Aluminum and of Other Nonconductive Coatings on Nonmagnetic Basis Metals With Eddy-Current Instruments

ASTM B487 Measurement of Metal and Oxide Coating Thicknesses by Microscopical Examination of Cross Section

ASTM D1654 Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments

ASTM D4060 Abrasion Resistance of Organic Coatings by the Taber Abraser

2.3 U.S. Government Publications

Copies of these documents are available online at https://quicksearch.dla.mil.

MIL-STD-2073-1 Standard Practice for Military Packaging

2.4 Definitions

Terms used in AMS are defined in AS7766 and as follows:

2.4.1 PIT

A pit is defined as an area of localized corrosion having a depth greater than its width. Pit size may be determined by either direct dimensional measurement or by comparison to known references. A superficial pit or discontinuity in the anodize surface itself, not penetrating thru to the base metal and not showing the presence of white corrosion products is not rejectable. As a general rule, a pit usually displays a characteristic tail or line of white magnesium corrosion products.

3. TECHNICAL REQUIREMENTS

3.1 Equipment

3.1.1 Tanks

Shall be fabricated from, or lined with, a material that is compatible with the baths used for cleaning, pretreatment, anodizing, or post-treatment solutions and shall be equipped with temperature controls capable of controlling the bath temperature within specified limits.

3.1.2 Fixtures

Hooks, clamps, and racks used to suspend parts in the electrolyte, and which are in contact with the electrolyte, shall be fabricated from magnesium or magnesium alloys, or from aluminum alloys containing magnesium (5000 or 6000 series). Such fixtures shall be protected with suitable maskant at the electrolyte-air interface.

3.2 Preparation

3.2.1 All fabrication-type operations, such as forming, heat treating, welding, and machining, shall be completed before parts are coated. Parts shall have all sharp edges broken and shall be free of inserts or other materials.

3.2.2 Fixture/Electrical Contact Locations

Tight electrical contact shall be maintained during the anodic treatment to prevent contact arcing (burning) of parts, but small irregularities of coating at points of electrical contact are acceptable.

3.2.2.1 For parts that are to be anodized/coated all over, and contact locations are not specified, contact locations shall be at the discretion of the processor.

3.2.2.2 For parts that are not to be anodized/coated all over, and contact locations are not specified, locations shall be in areas on which coating is not required.

3.2.3 Parts shall be cleaned free of greases, oils, or other contaminants prior to immersion in the anodizing solution. An alkaline bath is suggested as the final cleaning medium. The alkaline bath shall contain 65 to 69 grams per liter sodium tetraborate (Na2B4O7·10H2O) and 35 to 37 grams per liter sodium pyrophosphate (Na4P2O7) and shall be operated at 150 to 160 °F (66 to 71 °C). Immerse parts in the alkaline bath for 5 to 10 minutes, remove parts from bath, rinse thoroughly. After completion of cleaning, final rinsing shall be in deionized water. The final cleaning shall result in a water-break free surface.

3.3 Procedure

3.3.1 Pretreatment

The cleaned part shall be pretreated, prior to anodization, by immersion for 30 to 90 minutes in an 83 to 102 grams per liter ammonium fluoride solution with a (pH of 6.0 to 6.8) and operated at 160 to 180 °F (71 to 82 °C) followed by a water rinse.

3.3.2 Anodizing

Anodization shall be done in a chromate-free alkaline electrolyte. The electrolyte shall be an aqueous solution of the composition shown in Table 1.

Table 1 - Bath composition

Ingredient	Quantity
Potassium Hydroxide (KOH)	4.4 to 8.5 g/L
Potassium Fluoride (KF)	4.0 to 12.5 g/L
Potassium Silicate Solution (20% SiO_2, 10% K_2O)	18 to 30 mL/L

3.3.3 Processing

3.3.4 The cleaned and pretreated parts shall be immersed in the electrolyte. The coating shall be produced at the designated current densities throughout the process under the conditions shown in Table 2.

Table 2 - Anodizing conditions

Operating Conditions	Class 1 Coating	Class 2 Coating
Bath Temperature	50 to 60 °F (10 to 16 °C)	50 to 60 °F (10 to 16 °C)
Current Density	5 to 15 A/ft^2 (54 to 161 A/m^2)	5 to 15 A/ft^2 (54 to 161 A/m^2)
Voltage	0 to 320 VDC	0 to 380 VDC
Time	15 to 30 minutes	60 to 90 minutes

3.3.5 Post-Treatment

When post-treatment is specified, parts shall be treated for 30 to 60 seconds for Class 1 coatings and 1 to 2 minutes for Class 2 coatings at 115 to 125 °F (46 to 52 °C) in a bath containing 108 to 132 grams per liter sodium dihydrogen phosphate (NaH_2PO_4) in deionized or distilled water maintained at a pH of 4.3 to 4.5.

3.3.6 Rinsing and Drying

After anodization, or after post-treatment when specified, parts shall be rinsed thoroughly in cold running water, rinsed in hot deionized water, and dried.

3.4 Properties

3.4.1 Coating Thickness

Shall be 0.0002 to 0.0004 inch (5 to 10 μm) for Class 1 coatings, and 0.0008 to 0.0010 inch (20 to 25 μm) for Class 2 coatings, determined in accordance with ASTM B244, ASTM B487, or other method acceptable to cognizant engineering organization.

3.4.2 Corrosion Resistance

When the hard coat is applied to AMS4439 and AMS4446 magnesium alloy parts, coated specimens (4.3.3.2) shall withstand exposure to salt spray corrosion testing in accordance with ASTM B117 for times shown in Table 3. The exposed surfaces of the specimens shall show a rating of nine or greater after exposure, determined in accordance with ASTM D1654, procedure B. Corrosion resistance of coatings applied to other alloys, including exposure time and acceptance criteria, shall be specified by cognizant engineering organization.

Table 3 - Corrosion resistance requirements

Panel Material	Coating Class	Salt Spray Resistance Hours
AMS4439	1	24
AMS4439	2	72
AMS4446	1	168
AMS4446	2	336

3.4.3 Wear Resistance

Unsealed, coated specimen (4.3.3.3) shall exhibit a wear Index value less than 30 mg/1000 cycles and a wear cycle rating greater than 5000 cycles per 0.001 inch (12.7 μm) of anodize coating, (i.e., 1000 cycles minimum for every 0.0002 inch (5 μm) of anodize coating thickness) when tested in accordance with ASTM D4060 except that the CS-17 wheel shall be resurfaced after every 1000 cycles by running it for 25 cycles against the resurfacing medium, S-11 abrasive disk. Specimens may be placed in a desiccator prior to and following testing to establish constant weight in lieu of conditioning specified in ASTM D4060. Wear resistance test is applicable to both Class 1 and Class 2 coatings.

3.5 Quality

Surfaces of coated parts, as received by purchaser, shall be uniform in texture and appearance except at the points of electrical contact and in pockets where gas was unavoidably trapped during processing. Powdery areas, laminations, pits, and other evidence of burning are not acceptable. Differences in the anodic coating appearance on castings or wrought components due to welds, or cast versus machined surface textures, or macro grain size and other inherent metallurgical artifacts shall not be cause for rejection of the anodic coating. Darkened corners or edges and excessive buildup are not acceptable. Acceptable standards for such areas shall be agreed upon by cognizant engineering organization and processor.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for Inspection

The processor shall supply all test panels when required for processor's tests and shall be responsible for performing all required tests. Parts, if required for tests shall be supplied by purchaser. Processor may use his own or any other inspection facilities and services acceptable to cognizant engineering organization. The purchaser and the cognizant engineering organization reserves the right to sample and to perform any confirmatory testing deemed necessary to ensure that processing conforms to specified requirements.

4.2 Classification of Tests

4.2.1 Acceptance Tests

Coating thickness (3.4.1) and quality (3.5) are acceptance tests and shall be performed on each lot.

4.2.2 Periodic Tests

Corrosion resistance (3.4.2), wear resistance (3.4.3), are periodic tests and shall be performed at frequency of testing selected by the processor unless frequency of testing is specified by the cognizant engineering organization. Tests of the cleaning and processing solutions are periodic tests and shall be performed at a frequency selected by the processor unless frequency of testing is specified by cognizant engineering organization (see 4.4.3 and 8.3).

4.2.2.1 Periodic testing may be suspended in any test period when parts are not processed but shall be performed before or at time such processing is resumed. Preproduction testing may be required by the cognizant engineering organization, upon resumption of processing.

4.2.3 Preproduction Tests

All technical requirements are preproduction tests and shall be performed prior to or on the initial shipment of coated parts to a purchaser and when the cognizant engineering organization requires confirmatory testing.

4.2.3.1 For direct U.S. Military procurement, substantiating test data, and, when requested, preproduction test material shall be submitted to the cognizant agency as directed by the procuring activity, contracting officer, or request for procurement.

4.3 Sampling and Testing

Sampling shall be not less than the following; a lot is a group of parts, all of the same part number, processed through the same chemical solutions in the same tanks under the same conditions, which have completed the chemical processing within a period of 24 hours of each other and are presented to inspection at one time:

4.3.1 Acceptance Tests

Test samples shall be randomly selected from all parts in the lot. Unless the cognizant engineering organization provides a sampling plan, the minimum number of parts or specimens sampled shall be as shown in Table 4.

Table 4 - Acceptance for sampling tests

Number of Parts in Lot	Quality (Visual)	Thickness	Destructive or Test Specimens
1 to 6	all	3 (when available)	1
7 to 15	7	4	1
16 to 40	10	4	1
41 to 110	15	5	1
111 to 300	25	6	2
301 to 500	35	7	2
501 to 700	50	8	2
701 to 1200	75	10	3
Over 1200	125	15	3

4.3.2 Periodic and Preproduction Tests

Test specimen material form as specified may not be readily available (see 8.5). The test sample quantities and specimen dimensional configuration, unless otherwise specified herein, shall be as agreed upon by the cognizant engineering organization and processor.

4.3.3 Test Specimens

4.3.3.1 When coated parts are of a configuration or size not readily adaptable to the specified tests, separate test specimens of the same generic class of alloy as the parts represented, cleaned, coated, and post treated, as required, with parts represented may be used.

4.3.3.2 Specimens for corrosion resistance (3.4.2) shall be magnesium alloy machined to a minimum of 4 by 5 inches (102 by 127 mm) panel, from AMS4439 alloy when representing parts made from AMS4439, AMS4446 alloy when representing parts made from AMS4446, or magnesium alloy as specified by the cognizant engineering organization. When parts receive the supplementary seal treatment, representative test specimens for corrosion testing shall also receive the same supplementary treatment.

4.3.3.3 Specimens for wear resistance test (3.4.3) shall be either 4-inch (102-mm) nominal diameter round or 4 inches (102 mm) nominal square panel, machined from either AMS4439 or AMS4446, magnesium casting, with a 0.250-inch (6.35-mm) nominal diameter hole in the center and shall not have been given a supplementary sealing treatment.

4.4 Approval

4.4.1 Processes, control factors, or preproduction sample part or test specimen, or any combination thereof specified, shall be approved by the cognizant engineering organization before production parts are supplied.

4.4.2 If the processor makes a significant change to any material, process, or control factor from that which was used for process approval, all preproduction tests shall be performed, and the results submitted to the cognizant engineering organization for process reapproval unless the change is approved by the cognizant engineering organization. A significant change is one which, in the judgment of the cognizant engineering organization, would affect the properties or performance of the part.

4.4.3 Control factors shall include, but not be limited to, the following:

Fixture/electrical contact locations when approval is required by the cognizant engineering organization
Surface preparation, including precleaning, pretreatment(s)
Anodizing bath composition, temperature, and agitation method.
Anodizing current limits, Initial and final voltage
Post treatment time, temperature, composition, and pH
Method of drying parts
Periodic test plan for cleaning and processing solutions (see 8.3)