



AEROSPACE MATERIAL SPECIFICATION	AMS2469™	REV. L
	Issued 1962-06 Revised 2024-05	
Superseding AMS2469K		
Hard Anodic Coating on Aluminum and Aluminum Alloys		

RATIONALE

AMS2469L is the result of updating the ASTM standard for abrasion resistance (see 3.3.4 and 4.3.3.3).

NOTICE

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

- Purchase order shall specify not less than the following:
 - AMS2469L
 - Anodize thickness and tolerance, other than 0.0020 inch ± 0.0005 inch (see 3.3.1)
 - Basis metal alloy group to be anodized or material specification
 - Lot acceptance testing: thickness, coating weight, or both (see 4.2.1)
 - Optional: sealing and the sealing solution to be used (see 3.2.2 and 8.2.7)
 - Optional: fixture/electrical contact locations, when not specified (see 3.1.2)
 - Special features, geometry, or processing present on parts that requires special attention by the processor
 - Part number and quantity of pieces to be anodized
- Parts manufacturing operations such as heat treating, forming, joining, and media finishing performed before anodizing can affect the condition of the substrate and, if performed after anodizing, can adversely affect the finished part. The sequencing of these types of operations should be specified by the cognizant engineering organization or the purchaser and is not controlled by this specification.

1. SCOPE

1.1 Purpose

This specification establishes the requirements for a hard anodic coating on aluminum and aluminum alloys.

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SAE WEB ADDRESS:

For more information on this standard, visit
<https://www.sae.org/standards/content/AMS2469L>

1.2 Application

This process has been used typically to increase, by formation of a dense aluminum oxide, surface hardness and resistance to abrasion and corrosion of aluminum and aluminum alloy parts containing, in general, less than 5% copper or 8% silicon or a total of 8% of both, but usage is not limited to such applications. Alloys with higher alloy content can be coated satisfactorily with proper precautions in processing. Careful consideration should be given when using this process on highly stressed parts because of the resultant marked lowering of fatigue life performance and on parts with sharp corners and edges where chipping may result.

1.3 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 that 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.

AMS2473	Chemical Film Treatment for Aluminum Alloys, General Purpose Coating
AMS4037	Aluminum Alloy, Sheet and Plate, 4.4Cu - 1.5Mg - 0.60Mn (2024; -T3 Flat Sheet, -T351 Plate), Solution Heat Treated
ARP4992	Periodic Test for Processing 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 B137	Measurement of Coating Mass Per Unit Area on Anodically Coated Aluminum
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 Thickness by Microscopical Examination of Cross Section
ASTM B1023	Abrasion Resistance of Hard Anodic Coatings by a Taber-Type Abraser

2.3 U.S. Government Publications

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

MIL-PRF-8625 Anodic Coatings for Aluminum and Aluminum Alloys

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 through 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 aluminum corrosion products.

2.4.2 MOIRÉ PATTERN

As used herein, moiré pattern refers to a visual pattern of interfering lines in the anodize coating giving a wavy appearance that occurs when the coating is burned.

3. TECHNICAL REQUIREMENTS

3.1 Preparation

3.1.1 The coating shall be applied over a surface free from water breaks. The cleaning procedure shall not produce pitting or intergranular attack of the basis metal and shall preserve dimensional requirements.

3.1.2 Fixture/Electrical Contact Locations

Tight fixture/electrical contact shall be maintained during the anodic treatment/conversion coating process in order to prevent damage or contact arcing (burning) of parts, but small irregularities of coating at points of fixture/electrical contact are acceptable.

3.1.2.1 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.

3.1.2.2 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.

3.1.3 Masking

A suitable maskant shall be applied to any area or areas where solution entrapment may occur, such as faying surfaces, where there is another metal such as a thread insert, or features designated by the cognizant engineering organization where the anodize is not allowed.

3.2 Procedure

3.2.1 An anodic potential shall be impressed on the parts while immersed in a suitable electrolyte to produce an aluminum oxide coating. After coating, parts shall be thoroughly rinsed in cold, clean water and then dried. A final short, hot, clean water rinse to aid in drying is permitted.

3.2.2 Sealing of parts for improved corrosion resistance shall be accomplished only when specified by the cognizant engineering organization, which shall also specify or approve the sealing solution to be used (see 4.4 and 8.2.7).

3.2.3 Touch-Up

Fixture contact points, damaged areas of parts, or areas of the anodic hard-coat coating not subject to abrasion wear on which the anodic coating has been scratched or damaged superficially may be coated using AMS2473 or another method acceptable to the cognizant engineering organization. Touch-up, unless otherwise specified, shall not exceed 0.5 inch (13 mm) in its longest dimension, except that scratches that are essentially one dimensional (less than 0.03-inch [0.8-mm] wide) may be reworked. The total reworked area shall not exceed 5% of the total anodized surface area of the part, excluding contact points.

3.3 Properties

Coating on parts shall conform to the following requirements:

3.3.1 Thickness

AMS2469 designates finished coating thickness of 0.0020 inch \pm 0.0005 inch (0.051 mm \pm 0.013 mm). Coating thickness may be specified by use of AMS2469 followed by a suffix number to designate the nominal thickness in thousandths of an inch (25 μ m). A tolerance of \pm 0.0005 inch (\pm 0.013 mm) in thickness of coating will be allowed, unless otherwise specified. For example, AMS2469/3 designates a finished coating thickness of 0.0030 inch \pm 0.0005 inch (0.076 mm \pm 0.013 mm) (see 8.2.2 and 8.2.4).

3.3.1.1 Thickness of coating shall be as specified on the drawing, determined in accordance with any of the following methods: microscopic method, ASTM B244 or ASTM B487, direct dimensional inspection provided the resolution of the measuring instrument is 10 times more precise than the attribute being measured, or other method acceptable to the cognizant engineering organization. Coating thickness requirements shall not apply to blind holes or recesses with depth greater than twice the diameter or in open holes with depth greater than seven times the diameter unless a specific coating thickness is specified in those areas.

3.3.2 Coating Weight

Shall be not less than 0.030 grams per square inch per 0.001 inch (0.18 g/cm²/mm) of coating thickness (see 3.3.1.1), determined on unsealed coatings in accordance with ASTM B137. The coating weight index (weight loss per square inch per 0.001 inch of coating thickness) is determined by dividing the weight loss by the total surface area of the specimen, dividing by the coating thickness, and then multiplying by 0.001.

3.3.3 Color

Shall be substantially uniform on pieces of the same alloy processed to the same nominal coating thickness. Coated surfaces shall not have a sooty appearance or the presence of a moiré pattern.

3.3.4 Abrasion Resistance

Unsealed, coated specimen (see 4.3.3.3) shall have a maximum wear index of 3.5 mg/1000 cycles on aluminum alloys having a copper content of 2% or higher and a wear index not greater than 1.5 mg/1000 cycles for all other alloys, determined as follows; two test specimens weighed to at least the nearest milligram shall be tested in accordance with ASTM B1023 using CS-17 wheels or equivalent designation type, with a 1000-g load for at least 10000 cycles. Specimens may be placed in a desiccator prior to and following testing to establish constant weight in lieu of conditioning specified in ASTM B1023. The abrasive wheels shall be resurfaced prior to the start of any individual test. The wear index (weight loss for 1000 cycles) is determined at the end of the wear test run by dividing the weight loss by the total number of wear cycles then multiplied by 1000.

3.3.5 Corrosion Resistance

Coated specimens that have been given a supplementary sealing treatment shall meet the following requirements, determined after exposure for not less than 336 hours to salt spray corrosion test in accordance with ASTM B117, except that significant surface shall be inclined approximately 6 degrees from vertical. Test areas within 1/16 inch (1.6 mm) of identification markings or of an edge, or at electrode contact marks, shall not be included for corrosion evaluation. The five test panels shall show not more than 15 scattered spots or pits, none larger than 1/32-inch (0.8-mm) diameter, on a total of 150 square inches (968 cm²) of test area. Individual test specimens shall show not more than five scattered spots or pits, none larger than 1/32-inch (0.8-mm) diameter, on any 30 square inches (194 cm²) of test area (see 2.4.1).

3.4 Quality

Coating on parts, as received by the purchaser, shall be substantially uniform in thickness except in small holes, unless a specific coating thickness is specified, and in fillets, radii, and deep recesses and shall be free from scratches, chips, and burned or powdery areas. Small irregularities at points of electrical contact are permissible. Differences in the anodic coating appearance on castings or wrought components due to welds, cast versus machined surface textures, or macro grain size and other inherent metallurgical artifacts shall not be cause for rejection of the anodic coating (see 8.5).

3.5 Tolerances

When a limited area to be hard coated is specified, and the tolerance is not provided, a tolerance of -0, +1/16 inch (+1.6 mm) shall be permitted on the extent of the hard-coated area, except when such area ends at a corner; in such cases, the area shall not extend beyond the corner by more than the projected thickness of the coating (see 8.2.8).

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for Inspection

The processor shall supply all samples for the processor's tests and shall be responsible for the performance of all required tests. Parts, when required for test, shall be supplied by the purchaser. 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

Thickness (see 3.3.1) or coating weight (see 3.3.2), unless otherwise specified, color (see 3.3.3), and quality (see 3.4) are acceptance tests and shall be performed on parts, or specimens representing parts when permitted herein, from each lot.

4.2.2 Periodic Tests

Coating weight (see 3.3.2), unless determined for acceptance testing, and abrasion resistance (see 3.3.4) are periodic tests and shall be performed at least monthly unless frequency of testing is specified by the cognizant engineering organization. Corrosion resistance, when sealing treatment is performed on parts (see 3.3.5), is a periodic test and shall be performed at least once each month that parts are sealed unless frequency of testing is specified by the cognizant engineering organization. Tests of cleaning and processing solutions are periodic tests and shall be performed at a frequency established by the processor unless frequency of testing is specified by the cognizant engineering organization (see 4.4.3 and 8.2.9).

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 property verification tests (see 3.3) 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.

4.3 Sampling for testing shall not be less than the following:

A lot shall be all coated parts of the same part number, processed to the same coating thickness, and presented for the processor's 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 sampled shall be as shown in Table 1.

Table 1 - Minimum sampling for acceptance tests

Number of Parts in Lot	Color and Quality	Thickness or Coating Weight
Up to 7	All	3 or all*
8 to 15	7	4
16 to 40	10	4
41 to 110	15	5
111 to 300	25	6
301 to 500	35	7
Over 500	50	8

* Whichever is less.

4.3.2 Periodic Tests

Sample quantities shall be two for abrasion resistance (see 3.3.4), five for corrosion resistance (see 3.3.5), and three for coating weight (see 3.3.2) unless otherwise specified by the cognizant engineering organization.

4.3.3 Test Specimens

4.3.3.1 Separate test specimens may be used under any one of the following circumstances: the coated parts are of such configuration or size as to be not readily adaptable to specified tests, nondestructive testing is not practical on actual parts, or it is not economically acceptable to perform destructive tests on actual parts. Except as specified below, acceptance test specimens shall be made of the same aluminum alloy group as the parts represented and periodic test specimens shall be fabricated from the predominant alloy anodized since the last periodic test. Whenever possible, specimens shall be anodized with an actual production lot.

4.3.3.2 If parts are of such size and shape that surface area cannot be determined readily, coating weight determinations shall be made on test panels approximately 0.025 to 0.063 inch (0.64 to 1.60 mm) in nominal thickness and not less than 3 inches (76 mm) square.

4.3.3.3 Specimens for abrasion resistance test (see 3.3.4) shall be either 4-inch (102-mm) nominal diameter round or 4-inch (102-mm) nominal square panel fabricated from AMS4037 (2024-T3), aluminum alloy sheet, or the predominant alloy (as defined above) anodized measuring not less than 0.063-inch (1.60-mm) thick with a center hole drilled in accordance with ASTM B1023 and shall not have been given a supplementary sealing treatment.

4.3.3.4 Corrosion resistance (see 3.3.5) shall be determined on test panels approximately 0.025 to 0.063 inch (0.64 to 1.6 mm) thick and not less than 3 x 10 inches (76 x 254 mm) fabricated from alloy AMS4037 (2024-T3) or the predominant alloy (as defined above) anodized.

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:

- 1) Masking materials and methods, when used
- 2) Surface preparation methods, including the compositions and temperatures of the baths used
- 3) Fixture and fixture contact location

- 4) Anodizing bath composition (including impurity limits), temperature, and agitation method
- 5) Method for determining coating thickness
- 6) Type and control of sealer, when used
- 7) Anodizing voltage limits, and voltage ramp rates where voltage is not constant
- 8) Touch-up method, if used
- 9) Stripping procedure, when approved
- 10) Purity of water used for anodizing, sealing, and rinsing (see 8.6)
- 11) Periodic test plan for cleaning and processing solutions (see 8.3)

4.5 Reports

The processor of coated parts shall furnish with each shipment a report stating that the parts have been processed and tested in accordance with the specified requirements and that the parts conform to the acceptance test requirements. This report shall include the purchase order number, lot number, AMS2469L, part number, and quantity.

4.6 Resampling and Retesting

- 4.6.1 If any acceptance test fails to meet specified requirements, the parts may be stripped, re-anodized, sealed (if specified), and retested. Alternatively, all parts in the lot may be inspected for the nonconforming attribute, and the nonconforming parts may be stripped, re-anodized, sealed (if specified), and retested.
 - 4.6.1.1 When stripping and rework is to be performed for a given lot (see 8.2.4), approval shall be granted by the cognizant engineering organization. The method of stripping shall not roughen, pit, or embrittle the basis metal or adversely affect part dimensions.
- 4.6.2 If any periodic test fails to meet the specified requirements, the process is nonconforming. No additional part shall be coated until the process is corrected and new specimens are coated and tested. Results of all tests shall be recorded and, when requested, reported. The cognizant engineering organization shall be notified of all parts since the last acceptable test.

5. PREPARATION OF DELIVERY

- 5.1 Coated parts shall be handled and packaged to ensure that the required physical characteristics and properties of the coating are preserved.
- 5.2 Packages of coated parts shall be prepared for shipment in accordance with commercial practice and in compliance with applicable rules and regulations pertaining to the handling, packaging, and transportation of the coated parts to ensure carrier acceptance and safe delivery.

6. ACKNOWLEDGMENT

The processor shall mention AMS2469L in all quotations and when acknowledging purchase orders.

7. REJECTIONS

Parts on which the coating does not conform to this specification, or to modifications authorized by the cognizant engineering organization, will be subject to rejection.