

MIL-C-23217B

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Superseding

MIL-C-23217A (ASG)

27 September 1963

## MILITARY SPECIFICATION

## COATING, ALUMINUM, VACUUM DEPOSITED

This specification is mandatory for use by all Departments and Agencies of the Department of Defense.

## 1. SCOPE

1.1 Scope. - This specification covers vacuum-deposited aluminum coatings.

1.2 Classification. - Aluminum coatings shall be of the following classes, as specified (see 6.2):

Class 1 - 0.0010 inch thick

Class 2 - 0.0005 inch thick

## 2. APPLICABLE DOCUMENTS

\* 2.1 The following documents, of the issue in effect on date of invitation for bids or request for proposal, form a part of this specification to the extent specified herein:

SPECIFICATIONSMilitary

MIL-S-5002	Surface Treatment and Metallic Coatings for Metal Surfaces of Weapons Systems
MIL-C-5410	Cleaning Compound, Aluminum Surface, Non-Flame Sustaining
MIL-C-22543	Cleaning Compound, Aircraft Surface (Alkaline-Organic-Water Base Emulsion)
MIL-C-25769	Cleaning Compound, Aircraft Surface, Alkaline Water Base

STANDARDSFederal

FED. TEST METHOD	
STD. NO. 151	Metals; Test Methods

FSC MFFP

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Military

MIL-STD-105

Sampling Procedures and Tables for Inspection  
by Attributes

(Copies of specifications, standards, drawings, and publications required by suppliers in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

\* 2.2 Other publications. - The following documents form a part of this specification to the extent specified herein. Unless otherwise indicated, the issue in effect on date of invitation for bids or request for proposal shall apply.

American Society for Testing and Materials

ASTM A-219	Test for Local Thickness of Electrodeposited Coatings
ASTM B-107	Specification for Magnesium Alloy Extruded Bars, Shapes, and Tubes
ASTM B-487	Measuring Metal and Oxide Coating Thickness by Microscopical Examination for a Cross Section

(Copies of the above publications may be obtained from the American Society for Testing and Materials, 1916 Race Street, Philadelphia, Pennsylvania 19103.)

## 3. REQUIREMENTS

3.1 Materials. - The materials used shall be such as to produce aluminum coatings which conform to this specification.

\* 3.2 Equipment and processes. - The equipment and processes employed to produce vacuum-deposited aluminum coatings shall be capable of providing a uniform coating in accordance with the detailed requirements of this specification.

\* 3.3 Cleaning. - All ferrous and nonferrous metals shall be subjected to appropriate cleaning and oxide removal procedures to ensure deposition of adherent deposits. All ferrous alloys having a hardness greater than Rockwell C-40, which have been subject to any cold working operations, such as grinding or bending, shall be stress relieved prior to cleaning and plating. Such stress relieving shall be at a temperature and for a time so as to achieve maximum stress relief.

\* 3.3.1 High-strength steel parts (180,000 psi). - Scale or oxide shall be removed by mechanical means, such as glass bead cleaning. Parts shall be degreased and cleaned by a suitable nonembrittling method. Soak pickling, cathodic cleaning or cathodic pickling shall not be used.

\* 3.3.2 High-strength aluminum alloy parts. - Parts shall be either chemically or mechanically cleaned. Materials, such as uninhibited sodium hydroxide solutions, and of abrasives containing iron, steel wool, iron oxide rouge, and steel wire, which may become embedded and accelerate corrosion of aluminum alloys shall not be used for cleaning. Materials conforming to MIL-C-5410, MIL-C-22543, or MIL-C-25769 shall be used for chemical cleaning. Other materials or methods shall be approved for use by the procuring activity. For this approval, data indicating freedom from damage due to etching, pitting and stress corrosion cracking shall be submitted to the procuring activity.

\* 3.3.3 Other metals. - Metals other than those listed in 3.3.1 and 3.3.2 shall be cleaned per MIL-S-5002 or equivalent.

3.4 Composition. - Unless otherwise specified, the composition of the coating shall be not less than 99 percent aluminum.

3.5 Application. - Unless otherwise specified, the coating shall be applied after all machining, brazing, welding, forming, and perforating of the article has been completed.

3.5.1 Areas of deposit. - The coatings shall completely cover all visible surfaces, including roots of threads, recesses, and sharp corners.

3.5.2 Deposit on basis metal. - Unless otherwise specified by the procuring activity, aluminum shall be vacuum deposited directly on the basis metal, without a preliminary coating of other metal.

3.6 Finish. - The coated parts shall have a matte finish.

3.7 Thickness of coating. - Unless otherwise specified, the thickness of vacuum-deposited aluminum shall be as specified in table I on all visible surfaces.

TABLE I. Coating thickness

Class	Thickness (inches)
1	0.0010 <sup>+</sup> 0.0005 -.0001
2	0.0005 <sup>+</sup> 0.0002 -.0002

\* 3.7.1 Thickness. - Unless otherwise specified, vacuum-deposited aluminum coatings supplied for aeronautical use shall have the thickness specified for class 1.

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\* 3.7.2 Bolts, studs, washers, and articles with portions externally threaded shall have class 2 thickness, except for aeronautical use.

\* 3.7.3 Exceptions to class 1 and class 2 thickness. - Holes, recesses, internal threads, and other areas where a controlled deposit cannot normally be obtained shall not be subject to a thickness requirement. In holes, recesses, internal threads, and other areas where a deposit of metal cannot be obtained, the uncoated areas shall be coated with suitable corrosion preventive compound such as MIL-C-16173 or "fill and drain" coated with epoxy primer MIL-P-23377.

\* 3.7.3.1 Parts whose dimensional tolerances will not permit a class 1 thickness shall be given a maximum thickness compatible with dimensional tolerances. In holes, recesses, internal threads, and other areas where a deposit of metal cannot be obtained, the uncoated areas shall be coated with suitable corrosion preventive compound such as MIL-C-16173 or "fill and drain" coated with epoxy primer MIL-P-23377.

\* 3.8 Stripping of aluminum coatings. - Parts to be recoated shall be stripped by mechanical means or in a suitable chemical solution. Cleaning in accordance with 3.3 is required after stripping.

\* 3.8.1 High-strength steel parts (180,000 psi). - Parts shall be stripped by mechanical means or with inhibited caustic solution. Parts stripped with caustic solution shall be baked after stripping to relieve any hydrogen embrittlement in the basis metal and shall be examined at approximately 10X magnification to insure freedom from attack.

\* 3.8.2 High-strength aluminum alloy parts. - Parts may be stripped by dry grit-blasting with aluminum oxide. Remove grit and dust from parts with clean compressed air. After grit-blasting, cleaning shall be in accordance with 3.3 or by approved solvent wiping. Abrasives containing iron shall not be used. Other materials or methods shall be approved by the procuring activity. For this approval, data indicating freedom from damage due to etching, pitting and stress corrosion cracking shall be submitted to the procuring activity.

\* 3.9 Corrosion resistance. - Plated parts or specimens shall show no evidence of corrosion of the basis metal when exposed for the periods of time shown in table II in accordance with the method specified in 4.5.4. The appearance of white corrosion products on the aluminum coating during the test period shall not be cause for rejection. This test is applicable to steel parts only and shall not be required when the basis metal is an aluminum alloy.

\* 3.10 Adhesion. - The adhesion of the coating shall be such that when examined at a magnification of approximately four diameters it does not show separation from the basis metal at the interface, when subjected to the test specified in 4.5.3. The interface between the aluminum and the basis metal is the surface of the basis metal before coating. The formation of cracks in the deposit caused by rupture of the basis metal which does not result in flaking, peeling, or blistering of the deposit shall not be considered an nonconformance to this requirement.

TABLE II. Salt spray test

Class	Test period (hours)
1	336
2	192

### 3.11 Workmanship. -

3.11.1 Basis metal. - The basis metal shall be substantially free from defects that will be detrimental to the appearance or the protective value of the coating. It shall be subjected to such deposits as hereinafter specified.

\* 3.11.2 Coating. - The vacuum-deposited aluminum coating shall be uniformly smooth, fine grained, and free from blisters, pits, nodules, burning, and other defects. The aluminum deposit shall show no indication of contamination. All visible surfaces shall be covered. All details of workmanship shall conform to the best practice for high quality coating.

## 4. QUALITY ASSURANCE PROVISIONS

\* 4.1 Responsibility for inspection. - Unless otherwise specified in the contract or purchase order, the supplier is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract or order, the supplier may use his own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the Government. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

4.2 Classification. - All the tests required herein for the testing of vacuum-deposited aluminum coatings are classified as quality conformance tests, for which necessary sampling techniques and the methods of testing are specified in this section.

\* 4.3 Separate specimens. - When the coated articles are of such form as to be not readily adaptable to a test specified herein, or for destructive tests, or for the sampling of small lot sizes, the tests shall be made by the use of separate specimens coated concurrently with the articles represented. The separate specimens shall be of a basis metal equivalent to that of the articles represented. "Equivalent" basis metal includes chemical composition and finish of surface prior to coating. For example, a cold-rolled steel surface should not be used to represent

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a hot-rolled steel surface. Due to the impracticality of forging or casting separate specimens, hot-rolled steel specimens may be used to represent forged and cast steel articles. Heat-treated histories should be nearly identical as possible. (See 6.2). Where the coated part is an aluminum alloy, specimens shall be fabricated from an aluminum alloy of the same chemical composition and heat-treat history as the coated article.

\* 4.3.1 The separate specimens shall be strips approximately 1 inch wide, 4 inches long, and 0.04 inch thick, for adhesion tests (4.5.3), but shall be at least 4 inches wide, 6 inches long, and approximately 0.04 inch thick for all other tests. These specimens shall be introduced into a lot at regular intervals prior to the cleaning operation preliminary to coating and shall not be separated therefrom until after completion of the processing. Conditions affecting the coating of the specimens, including the spacing and positioning with respect to vapor source and to other objects being coated, shall correspond as nearly as possible to those affecting the significant surfaces of the articles represented. Separate specimens shall not be used for thickness measurements unless the necessity for their use has been demonstrated. The use of separate specimens is always required when the basis metal of the coated article is an aluminum alloy.

#### 4.4 Sampling. -

\* 4.4.1 Lot. - A lot shall consist of coated articles of approximately the same size, shape, type, and class of coating.

4.4.2 Sampling for destructive tests of coating. - A random sample of four articles shall be taken from each inspection lot or four separately plated specimens shall be prepared in accordance with 4.3 to represent each inspection lot. If the number of articles in the inspection lot is four or less, the number of the articles in the sample shall be determined by the procuring activity.

4.4.3 Sampling for visual examination and nondestructive tests for plating thickness. - A random sample of plated articles shall be taken in accordance with MIL-STD-105 at inspection level II and acceptance quality level (AQL) of 1.5 percent defective to verify compliance with the provisions of this specification in regard to visual inspection and plating thickness (nondestructive tests). Any plated article in the sample having one or more defects shall be rejected and if the number of defective articles in any sample exceeds the acceptance number for the specified sampling plan of MIL-STD-105, the lot represented by the sample shall be rejected.

4.5 Test methods. - The tests of this specification shall be performed in accordance with the Federal Test Method Standard No. 151, and as specified herein.

\* 4.5.1 Composition. - Composition of the plating shall be determined as specified in Methods 111.2 and 112.2 of Federal Test Method Standard No. 151.

\* 4.5.2 Thickness. - Thickness determinations shall be made by the microscopic test, or magnetic test, ASTM Methods B487 and A219, respectively, except that for aluminum alloy substrates and for referee tests, the microscopic tests shall be used (see 6.3).

4.5.3 Adhesion. - Adhesion shall be determined by scraping the surface of the plated article to expose the basis metal and examining at four diameters magnification for evidence of nonadhesion. Alternatively, the article shall be clamped in a vise and the projecting portion bent back and forth until rupture occurs. If the edge of the ruptured plate can be peeled back or if separation between the plate and the basis metal can be seen at the point of rupture when examined at four diameters magnification, adhesion is not satisfactory.

\* 4.5.4 Corrosion-resistance. - The corrosion-resistance test shall be performed in accordance with the salt spray test conforming to ASTM B-107.

## 5. PREPARATION FOR DELIVERY

5.1 There are no packaging, packing, or marking requirements applicable to this specification.

## 6. NOTES

\* 6.1 Intended use. - Vacuum-deposited aluminum coating covered in this specification is intended for use as a protective coating on metal parts.

\* 6.1.1 The coating is used to provide corrosion resistance to ferrous parts free from hydrogen contamination and possible embrittlement. This coating does not protect from hydrogen embrittlement in use. The coating is porous and alternate wetting and drying can induce hydrogen into susceptible high-strength steel parts.

\* 6.1.2 The coating is used to provide resistance to stress corrosion cracking and pitting corrosion to high-strength aluminum alloys.

6.2 Ordering data. - Procurement documents should specify the following.

- (a) Title, number, and date of this specification.
- (b) Class of coating required (see 1.2).
- (c) Method of determining compliance with 4.3.

\* 6.2.1 Options. - Any desired options offered herein may be utilized in procurement documents.

6.3 Reagents for microscopic determination. - The following typical reagents are satisfactory for etching aluminum coatings for microscopic determination of coating thickness:

- (a) Coatings on steel: 10 percent weight NaOH
- (b) Coatings on aluminum alloys: Keller's etch

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6.4 Dimensional tolerance. - The dimensional tolerance of most threaded articles, such as nuts, bolts, and similar fasteners with complementary threads do not permit the application of a coating thickness much greater than class 2. If heavier coatings are required for satisfactory corrosion resistance, allowances must be made in the manufacture of the threaded fasteners for tolerance necessary for coating build-up.

\* 6.5 High temperature. - Vacuum-deposited aluminum coatings shall not be used on steel parts which, in service, reach a temperature higher than 925° F or come in direct contact with parts which reach this temperature.

6.6 Samples. - It is believed that this specification adequately describes the characteristics necessary to secure the desired material, and that normally, no samples will be necessary prior to award to determine compliance with this specification. If, for any particular purpose, samples with bids are necessary, they should be specifically asked for in the invitation for bids, and the particular purpose to be served by the bid sample should be definitely stated. The specification will apply in all other respects.

\* 6.7 Marginal indicia. - The margins of this specification have been marked to indicate where changes, deletions, or additions to the previous issue have been made. This has been done as a convenience only and the Government assumes no liability whatsoever for any inaccuracies in these documents. Bidders and contractors are cautioned to evaluate the requirements of this document based on the entire content as written, irrespective of the marginal notations and relationship to the last previous issue.

Custodians:

Army - MR

Navy - AS

Air Force - 11

Preparing activity:

Navy - AS

Project No. MFFP-0042

Reviewer activity:

Army - MR



## STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

(See Instructions – Reverse Side)

1 DOCUMENT NUMBER

2 DOCUMENT TITLE

3a NAME OF SUBMITTING ORGANIZATION

4 TYPE OF ORGANIZATION (Mark one)

☐ VENDOR☐ USER☐ MANUFACTURER☐ OTHER (Specify) \_\_\_\_\_

b ADDRESS (Street, City, State, ZIP Code)

## 5 PROBLEM AREAS

a. Paragraph Number and Wording

b Recommended Wording

c Reason/Rationale for Recommendation

## 6. REMARKS

7a. NAME OF SUBMITTER (Last, First, MI) – Optional

b WORK TELEPHONE NUMBER (Include Area Code) – Optional

c MAILING ADDRESS (Street, City, State, ZIP Code) – Optional

8 DATE OF SUBMISSION (YYMMDD)

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