NOT MEASUREMENT SENSITIVE
MIL-C-85614A
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SUPERSEDING
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MILITARY SPECIFICATION

COATING, FASTENER (TITANIUM AND CRES ALLOYS), ALUMINUM PIGMENTED, ORGANICALLY BONDED (FOR ALL THREADED AND UNTHREADED FASTENERS)

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

1. SCOPE

* 1.1 Scope. This specification covers the acceptance requirements for an aluminum pigmented, organically bonded coating applied at temperatures not greater than 450°F to all threaded and unthreaded fasteners made from titanium and corrosion resistant steel alloys.

2. APPLICABLE DOCUMENTS

2.1 Government documents.

2.1.1 Specifications and standards. The following specifications and standards form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those listed in the issue of the Department of Defense Index of Specifications and Standards (DODISS) and supplement thereto, cited in the solicitation (see 6.2).

SPECIFICATIONS

FEDERAL

QQ-A-225	Aluminum Alloy Bar, Rod and Wire
QQ-P-416	Plating, Cadmium (Electrodeposited)

MILITARY

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

Beneficial comments, (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to the Naval Air Engineering Center, Systems Engineering and Standardization Department (SESD) (Code 53), Lakehurst, NJ 08733-5100, by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

AMSC N/A FSC MFFP

SPECIFICATIONS (Continued)

MIL-S-5000	Steel, Chrome-Nickel-Molybdenum (E4340) Bars and Reforging Stock
MIL-S-8879	Screw Threads, Controlled Radius Root with Increased Minor Diameter, General Specification for
MIL-R-81294	Remover, Paint, Epoxy and Polyurethane Systems
MIL-H-83306	Hydraulic Fluid, Fire Resistant, Phosphate Ester Base, Aircraft
MIL-L-87132	Lubricant, Cetyl Alcohol, 1 Hexadeconal, Application to Fasteners
MIL-T-81533	Trichloroethane 1,1,1 (Methylchloroform) Inhibited Vapor Degreasing

STANDARDS

MILITARY

MIL-STD-6866	Inspection, Penetrant, Method of

(Unless otherwise indicated, copies of federal and military specifications, standards, and handbooks are available from the Naval Publications and Forms Center, (ATTN: NPODS), 5801 Tabor Avenue, Philadelphia, PA 19120-5099.)

* 2.2 Non-Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of the documents which are DoD adopted are those listed in the issue of the DoDISS cited in the solicitation. Unless otherwise specified, the issues of documents not listed in the DODISS are the issues of the documents cited in the solicitation (see 6.2).

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM B 287	Acetic Acid, Spray (FOG) Testing
ASTM D 740	Methyl Ethyl Ketone

(Application for copies should be addressed to the American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103-1187.)

2.3 Order of precedence. In the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

3.1 First article. When specified (see 6.2), a sample shall be subjected to first article inspection in accordance with 4.3.

3.2 Materials. The materials used shall be such as to produce organically bonded aluminum coatings which conform to this specification.

3.3 Equipment and processes. The equipment and processes shall be capable of providing a uniform coating in accordance with the requirements of this specification.

3.3.1 Cleaning. Before coating, fasteners shall have clean surfaces with no evidence of erosion, pitting or intergranular attack.

3.3.1.1 Coating process. The coating may be applied directly to the fastener surface, or the fastener may have a chemical conversion or mechanical pretreatment. Pretreatment shall not be deleterious to the fastener or its function. The cure temperature of the coating shall be not greater than 50°F below the minimum tempering temperature of the fastener, and shall not be greater than 425°F.

3.4 Appearance. The coating shall be smooth and of uniform thickness and color. It shall be free of pin holes, porosity, blisters, nodules, pits or other harmful imperfections.

3.5 Areas of deposit. As a minimum, the coating shall cover the shank, the thread surfaces, and under the head.

* 3.6 Thickness. The coating thickness shall be 0.0002 to 0.0005 inches (see 4.5.1). Coating is not required inside lightening holes in the head or point end, inside wrenching features, inside lockwire holes, or on breakaway devices (lock bolt pull stems, etc.).

3.7 Adhesion. After being subjected to the test specified in 4.5.2, the coating shall be continuously bonded to the fastener and shall not display loss of adhesion or separation from the fastener when examined at a magnification of 4X.

3.8 Fluid resistance. The coating shall be immersed in hydraulic fluid conforming to MIL-H-83306 for 30 days (720 hours). The coating shall show no evidence of blistering or loss of adhesion. Coating shall be not less than 4H pencil hardness prior to immersion and not less than 2H pencil hardness subsequent to immersion (see 4.5.3).

3.9 Paint remover resistance. The coated fasteners shall show no evidence of blistering or loss of adhesion when subjected to the paint remover test (see 4.5.4).

3.10 Embrittlement. Coated titanium fasteners shall display no evidence of cracking in the head-to-shank fillet or thread areas (see 4.5.5 and table II).

3.10.1 Embrittlement test block. The test block used for the embrittlement test (see 4.5.5) shall be a 7075-T6 aluminum alloy block (UNS A97075) in accordance with QQ-A-225/9. The block thickness shall be compatible with the grip lengths of the four coated fasteners used in the test.

3.11 Corrosion protective properties of coatings. The applied coating on the countersink areas and surface areas of the 2024 aluminum alloy (UNS

A92024) blocks surrounding the coated fasteners shall display no more corrosion than the corresponding areas with the cadmium plated fastener control blocks (see 4.5.6).

3.12 Heat resistance. The coating shall display no evidence of cracking or blistering when tested in accordance with 4.5.7. After heating, the coating shall be tested in accordance with 4.5.2 and shall meet the requirements specified in 3.7.

3.12.1 Adhesion test. After heating, the coating shall be tested in accordance with 4.5.2.1 and shall meet the requirements specified in 3.7.

3.13 Installation force. The installation forces for coated fasteners shall be not greater than the values listed in table I when tested in accordance with 4.5.8.

TABLE I. Installation force requirements.

Fastener Diameter Nominal	Interference Fit in Inches	Load Rate Pounds Per Minute	Installation Force	
			Mean Force	Maximum Force
0.25 inch	.003-.005	5,000	1,300	2,000
0.3125 inch	.003-.005	7,000	1,500	2,250
0.375 inch	.003-.005	11,000	1,500	2,300

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract or purchase order, the contractor is responsible for the performance of all inspection requirements (examinations and tests) as specified herein. Except as otherwise specified in the contract or purchase order, the contractor 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 this specification when such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

4.1.1 Responsibility for compliance. All items must meet all requirements of section 3. The inspection set forth in this specification shall become a part of the contractor's overall inspection system or quality program. The absence of any inspection requirements in the specification shall not relieve the contractor of the responsibility of ensuring that all products or supplies submitted to the Government for acceptance comply with all requirements of the contract. Sampling inspection, as part of manufacturing operations, is an acceptable practice to ascertain conformance to requirements, however, this does not authorize submission of known defective material, either indicated or actual, nor does it commit the Government to accept defective material.

4.2 Classification of inspections. The inspections specified herein are classified as follows:

a. First article inspection (see 4.3).
b. Quality conformance inspection (see 4.4).

4.3 First article inspection. First article inspections shall be as specified in Table II.

* 4.3.1 First article samples. The first article sample shall consist of 55 units. Of these 55 units, 41 shall be coated fasteners. The fastener size shall be 0.25 inch in diameter or larger, with 2D grip or longer. The other 14 units shall be test specimens: five (5) for use in the adhesion test, five (5) for the fluid resistance test, two (2) for the paint remover test, and two (2) for the heat resistance test. The specimens shall be coated on both sides and have the following dimensions: 2 inches wide, 3 inches long, and 0.04 inches thick. Both the specimens and the fasteners shall be of the fastener material for which approval is requested, and coated with the type of coating for which approval is requested.

4.3.2 Inspection routine. Sample units shall be subjected to the inspections specified in table II in the order shown.

TABLE II. First article inspection.

Inspection	Requirement Paragraph	Test Method	Quantity for Each Test	Number of Allowable Defects
Visual examination	3.4 & 3.5	4.4.2	5	0
Thickness	3.6	4.5.1	10	0
Adhesion	3.7	4.5.2	5	0
Fluid resistance	3.8	4.5.3	5	0
Paint remover resistance	3.9	4.5.4	2	0
Embrittlement (Titanium only)	3.10	4.5.5	4	0
Corrosion protective properties of coatings	3.11	4.5.6	12	0
Heat resistance	3.12	4.5.7	2	0
Installation force	3.13	4.5.8	10	0

4.3.3 Certified test report. The manufacturer shall furnish a certified test report showing that the manufacturer's product satisfactorily conforms to this specification. The test report shall include actual results of the first article tests specified herein. When this report is submitted, it shall be accompanied with data that completely describes the manufacturer's product. The drawing shall specify all dimensions and tolerances, composition

of materials selected, coatings or platings applied. The test data stated in this report shall not exempt a manufacturer from first article inspection.

4.4 Quality conformance inspection. Quality conformance inspection shall consist of the inspections and tests specified in table III.

4.4.1 Inspection lot. An inspection lot shall consist of fasteners coated at the same time, with coating material from the same batch. In the case of small production runs, an inspection lot may be made up from a group of small lots coated under similar conditions (see 6.4).

4.4.1.1 Sampling plan. The sampling plan shall be as specified in the contract or purchase order (see 6.2 and 6.5).

4.4.2 Visual inspection. The test specimens shall be visually examined to verify that the workmanship conforms to the appearance and the areas of deposit requirements.

TABLE III. Quality conformance inspection.

Inspection	Requirement Paragraph	Test Method Paragraph
Visual examination	3.4 & 3.5	4.4.2
Thickness	3.6	4.5.1
Adhesion test	3.7	4.5.2

4.5 Methods of inspection.

4.5.1 Thickness. Coating thickness shall be determined using instruments capable of producing measurements accurate to ± 0.0001 inch.

4.5.2. Adhesion test. The adhesion test shall be conducted with a 0.5 inch diameter pin (minimum length of 3 inches), the test specimens (see 4.3.1), and two strips of 3M Company No. 250 tape or equivalent. The age limit on this tape shall be not greater than six months after the date of manufacture. The test shall be conducted as follows:

a. Place the pin across the 2 inch side of the specimen. The pin shall be located in the middle of the specimen.

b. Bend the specimen around the pin until a 90 degree angle is formed.

c. Press one strip of tape across the inner bend of the specimen, and one strip across the outer bend of the specimen. The tape shall traverse the entire lengths of both sides of the bent surface.

d. Remove the tape in one abrupt motion.

e. Inspect both sides of the bent surface at 4X magnification for adhesion (3.7).

* 4.5.3 Fluid resistance. The fluid resistance test shall be conducted as follows:

a. Immerse five coated test specimens (4.3.1) in hydraulic fluid conforming to MIL-H-83306 for 30 days (720 hours).

b. Dry the samples in air.

c. Prepare pencils of varying hardness by squaring the tip of the lead before each trial.

d. Test for hardness by pushing pencils of increasing hardness across the surface at a 45 degree angle until one cuts or scratches the coating. The number of this pencil shall represent the coating hardness.

e. Test and inspect for adhesion according to 4.5.2.

* 4.5.4 Paint remover resistance. The paint remover resistance test shall be conducted as follows:

a. Immerse two coated test specimens (see 4.3.1) in paint remover conforming to MIL-R-81294, Type I, for not less than 24 hours at 70 ± 5 °F.

b. Rinse off the paint remover with tap water and allow to dry.

c. Test and inspect the test specimens for adhesion (4.5.2) and for fluid resistance (4.5.3).

d. Inspect both specimens for blistering (3.9).

4.5.5 Embrittlement test. The embrittlement test shall be conducted using four coated titanium fasteners and the embrittlement test block. The test shall be conducted as follows:

a. Into the embrittlement test block, drill four 0.25 inch diameter holes to provide a 0.003 to 0.005 inch interference fit between the hole and coated shank of the fastener. Surface roughness of the holes shall be not greater than Ra 125. The hole spacing shall allow at least 0.50 inch from all edges and other fastener heads.

b. Chamfer the bottom of the countersink hole to allow clearance of the fillet radius of the fastener.

c. Press (install) the fasteners into the holes.

d. Stress the fasteners in tension to 80 percent of the rated ultimate load as shown on the applicable fastener specification or standard. Use the bolt elongation formula (see 4.5.5.1) to determine the load.

e. Expose the fasteners (in the block) to 300°F ± 10 °F for 72 hours.

f. Remove the fasteners from the block.

g. Remove the coating from the fasteners.

h. Subject the fasteners to fluorescent penetrant inspection in accordance with MIL-STD-6866. If penetrant inspection reveals cracks, the fastener shall be sectioned, mounted, polished, and metallurgically inspected at 200X for cracks in the fillet-to-shank radius and thread areas. Inspect for embrittlement (3.10).

4.5.5.1 Elongation formula. The fastener elongation formula is calculated as follows:

$$d = \frac{K}{E} \left(A + 0.75z + \frac{YR^2}{S^2} - Y\right)$$

(All applicable dimensions are in inches ± 0.001 inch.)

Where: d = Elongation
K = Desired stress of bolt in KSI using section area at the maximum pitch diameter of threads
E = Modulus of elasticity (KSI) of bolt material at 70°F
A = Length of bushing assembly
Z = Maximum height of nut
Y = Nominal grip length of bolt
R = Maximum pitch diameter of bolt thread in accordance with MIL-S-8879
S = Nominal diameter of bolt shank

4.5.6 Corrosion test. Corrosion tests shall be conducted in accordance with 4.5.6.1, 4.5.6.2 and 4.5.6.3.

4.5.6.1 Block preparation. Two 0.500 ± 0.025 inch thick 7075-T6 aluminum alloy (UNS A97075) test blocks shall be anodized in accordance with MIL-A-8625 Type I. Six holes shall be drilled in each block to allow 0.003 to 0.005 inch interference fit between the coated fastener shank and the bare hole. Surface roughness of the holes shall be not greater than Ra 125. The bottom of the countersink hole shall be chamfered to allow clearance for the fastener fillet radius.

* 4.5.6.2 Fastener Installation. Twelve countersink head fasteners shall be used in this test. Six shall be aluminum coated and shall be installed in one of the test blocks, and six shall be cadmium-plated in accordance with QQ-P-416 Type II, class 2, and shall be installed in the other block. Each fastener shall be installed with the appropriate nut or collar system. The fastener heads shall be flush with the surface within ± 0.010 inch after installation. Fasteners shall be spaced such that the head of each is at least 0.50 inch from all edges and other fastener heads. After installation, grease and fingerprints shall be removed by solvent cleaning with methyl ethyl ketone (ASTM D 740), or trichloroethane (MIL-T-81533).

4.5.6.3 Accelerated exposure procedure. The assembled blocks shall be exposed for 14 days to the acetic acid salt spray test in accordance with ASTM B 287, except that specimens shall be subjected to four 6-hour cycles per day as follows:

a. Spray cycle for 45 minutes.

b. Direct air purge for 2 hours.

c. Subject blocks to 45-95 percent relative humidity at 95 ± 2°F for 3 hours and 15 minutes.

4.5.6.4 Examination. After exposure, remove all fasteners in such a manner as to prevent deformation of the fasteners or the hole. Remove loose corrosion and salt deposits by lightly brushing in tap water and dry. Compare countersink areas and areas on the surface around the fastener heads of the aluminum pigmented coated and cadmium plated fasteners (see 3.11).

* 4.5.7 Heat resistance. Two coated test specimens (4.3.1) shall be heated at 425 ± 25°F for 6 hours followed by cooling in air. After cooling, the specimens will be examined for conformance to the heat resistance requirements. The specimens shall then be tested in accordance with 4.5.2 for adhesion.

4.5.8 Installation test. The installation test should be conducted as follows:

a. Apply cetyl alcohol conforming to MIL-L-87132 to ten coated fasteners.

b. Into a 0.500 ± 0.025 inch thick 2024-T351 (UNS A92024) alloy plate conforming to QQ-A-225/6, drill holes to provide a 0.003 to 0.005 inch interference fit with the coated fasteners (see table I). The surface roughness of the holes shall be not greater than Ra 125. The hole spacing shall be 4D minimum, and the edge margin shall be not less than 2D.

c. Clean holes with trichloroethane 1,1,1 per MIL-T-81533 or equivalent solvent to remove cutting fluid.

d. Dry in air before installing fasteners.

e. Using a universal testing machine, press each fastener into a hole by applying a compressive load to the fastener head. The load shall be applied at the rate specified in table I until the lead-in radius of the fastener is pushed through the hole.

f. Installation forces shall be in accordance with table I.

5. PACKAGING

5.1 This section is not applicable to this specification.

6. NOTES

* (This section contains information of a general or explanatory nature that may be helpful, but is not mandatory.)

6.1 Intended use. The organically bonded aluminum pigmented coating covered by this specification is intended for use as a galvanic protective coating on both threaded and unthreaded titanium and corrosion resistant steel fasteners. Aluminum pigmented coatings conforming to the requirements specified herein may be used for either interference fit or clearance fit applications.

6.2 Ordering data. Acquisition documents should specify the following:

a. Title, number and date of this specification.

b. If first article testing is required (see 3.1 and 6.3)

c. Quality conformance sampling plan (see 4.4.1.1 and 6.5)

* 6.3 First article. When a first article inspection is required, the items should be a first article sample from the contractor's current inventory as specified in 4.3.1. The contracting officer should include specific instructions in acquisition documents regarding arrangements for examinations, approval of first article test results, and disposition of first articles. Invitations for bids should provide that the Government reserves the right to waive the requirement for samples for first article inspection to those bidders offering such products, who wish to rely on such production or test, must furnish evidence with the bid that prior Government approval is presently appropriate for the pending contract.

6.4 Inspection lot. An inspection lot shall mean a collection of aluminum pigmented coated fasteners from which samples shall be drawn and tested to determine conformance with this specification. This is different from a collection of coated fasteners designated as a lot for other purposes (e.g., production, shipment, etc.)

6.5 Sampling plan. Use of MIL-STD-105, inspection level II, with an AQL of 4.0 is recommended.

6.6 Subject term (keyword) listing.

Aluminum, pigmented
Clearance fit
Coating
Fastener
Galvanic, protective
Interference, fit
Organically, bonded

* 6.7 Changes from previous issue. The margins of this specification are marked with asterisks to indicate where changes (additions, modifications, corrections, deletions) from the previous issue were made. This was done as a convenience only and the Government assumes no liability whatsoever for any inaccuracies in these notations. Bidders and contractors are cautioned to evaluate the requirements of this document based on the entire content irrespective of the marginal notations and relationship to the last previous issue.

Custodians:
Air Force - 11
Army - AV

Review activities:
Army - MR
Air Force - 99
Navy - SH, OS

Preparing Activity:
Navy - AS
(Project No. MFFP-0394)

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

(See Instructions – Reverse Side)

1. DOCUMENT NUMBER	2. DOCUMENT TITLE
MIL-C-85614A	COATING, FASTENER (TITANIUM & CRES ALLOYS), ALUMINUM PIGMENTED, ORGANICALLY BONDED (FOR ALL THREADED & UN-THREADED FASTENERS)

3a. NAME OF SUBMITTING ORGANIZATION	4. TYPE OF ORGANIZATION *(Mark one)*
	☐ VENDOR
b. ADDRESS *(Street, City, State, ZIP Code)*	☐ USER
	☐ MANUFACTURER
	☐ OTHER *(Specify)*:

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)*

DD FORM 1426 PREVIOUS EDITION IS OBSOLETE.