METRIC

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SUPERSEDING
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DEPARTMENT OF DEFENSE
STANDARD PRACTICE

CADMIUM-TITANIUM PLATING, LOW EMBRITTLEMENT, ELECTRODEPOSITION

This document is inactive for new design.

AMSC: N/A

AREA: MFFP

F O R EW O R D

1. This Military Standard is approved for use by 309MXSG/MXRL, Department of the Air Force and is available for use by all departments and agencies of the Department of Defense.

2. This standard provides guidance for the Air Force repair process, acquisition, and manufacture of parts and/or spare parts on the landing gear of all military aircraft.

3. Beneficial comments, recommendations, additions, deletions, clarifications, etc. and any data that may improve this document should be sent to: 309MXSG/MXRL, Hill AFB, UT 84056-2609 or e-mailed to: 309MXSG/MXRL@hill.af.mil. Since contact information can change, verification of currency of this address information through ASSIST Online database at http://assist.daps.dla.mil.

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1. SCOPE

1.1 Scope. This standard covers the process and materials required for the electro-deposition of cadmium-titanium on high strength steel substrates. Subsequent heat treating techniques intended to minimize the effects of hydrogen embrittlement of the steel substrate are also described. This process is not authorized for use on steel heat treated above 1.65 X 10^9 Pa (240,000 pounds per square inch {psi}) without the approval of the applicable procuring activity.

1.2 Documentation. This standard meets the corrosion resistance requirements of SAE-AMS-QQ-P-416. It may be used whenever SAE-AMS-QQ-P-416 is specified provided any unique requirements in SAE-AMS-QQ-P-416 are complied with.

1.3 Classification.

1.3.1 Classes. The following classes of cadmium-titanium plating are covered by this standard:

a. Class 1 – 0.013 millimeters (mm) (0.0005 inch) thick minimum.

b. Class 2 – 0.008mm (0.0003 inch) thick minimum.

c. Class 3 – 0.005mm (0.0002 inch) thick minimum.

1.3.2 Types. The following types of cadmium-titanium plating covered by this standard:

a. Type I – Without supplementary chromate or phosphate treatment.

b. Type II – With supplementary chromate treatment.

c. Type III – With supplementary phosphate treatment.

2. REFERENCE DOCUMENTS

2.1 Government documents.

2.1.1 Specifications, standards, handbooks, and commercial items descriptions. The following specifications, standards, handbooks, and commercial items descriptions form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

COMMERCIAL ITEM DESCRIPTION

A-A-50800 Cadmium Oxide

A-A-51126 Anodes, Cadmium

DEPARTMENT OF DEFENSE SPECIFICATION

MIL-S-5002	Surfaces Treatments and Inorganic Coatings for Metal Surfaces of Weapons Systems

DEPARTMENT OF DEFENSE STANDARDS

MIL-STD-871 (Inactive)	Electro-Chemical Stripping of Inorganic Finishes
MIL-STD- 1504 (Inactive)	Abrasive Blasting

(Copies of these documents are available online http://assist.daps.dla.mil or from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)

2.2 Other Government Documents. The following other Government documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

CODE OF FEDERAL REGULATIONS (CFR)

29 CFR 1910	Toxic and Hazardous Substances

(Copies of this document are available online at www.access.gpo.gov/nara/cfr or from the Superintendent of Documents, U.S. Printing Office, North Capitol & “H” Streets, N.W., Washington D.C. 20402-0002.)

2.3 Non-Government Publications. The following documents compose a part of this standard to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

American Society for Testing and Materials (ASTM)

ASTM F519	Hydrogen Embrittlement Testing
ASTM B117	Salt Spray (Fog) Testing

(Application for copies of these documents should be addressed to ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959.)

Society of Automotive Engineers (SAE) International

SAE-AMS-QQ-P-416	Plating, Cadmium (Electrodeposited)

(Copies of these documents are available from www.sae.org or SAE World Headquarters, 400 Commonwealth Drive, Warrendale, PA 15096-001.)

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. DEFINITIONS

3.1 High Strength Steel. For the purpose of this standard, high strength steel is defined as steel heat treated to 1.24 X 10^9 Pa (180,000 psi) and above.

3.2 Material Batch. All items processed at one time through the plating bath.

4. GENERAL REQUIREMENTS

4.1 Materials and Equipment.

4.1.1 Materials. The use of reclaimed materials shall be encouraged to the maximum extent possible. Materials used in cadmium-titanium plating are as follows:

a. Cadmium Ball Anodes, A-A-51126

b. Cadmium Oxide, A-A-50800

c. Sodium Cyanide, Plating Grade, (96-98%NaCN)

d. Sodium Hydroxide, Flake or Granulated

e. Titanium Additive Compound

f. Hydrogen Peroxide - 35% Technical Grade

g. Filter Aid, Diatomaceous, Celite 501, John Manville or equivalent.

4.1.2 Equipment. Equipment used in cadmium-titanium plating.

a. Either generated or rectified D.C. current may be used. Ripple value shall not exceed 10 percent as measured by dividing the Root Mean Square of the A.C. voltage component by the D.C. voltage.

b. Tanks should be resistant to the operating temperature and chemical environment. The cadmium plating tank must be of 300 series stainless steel, carbon steel with a rigid polyvinylchloride lining, or other suitable non-metallic material, which has been determined to be compatible with cadmium titanium plating solutions.

c. Plating tanks to be operated at temperatures other than room temperature shall be equipped with an automatic temperature indicating and regulating devices.

d. An ammeter shall be placed in series with the cadmium-titanium tank cathode. The ammeter shall have sufficient shunts and switches to provide a full-scale reading equal to the maximum capacity of the power source, and an accuracy of ± 10 percent of the current being measured.

e. If conventional ball anodes are used, carriers may be made of either titanium or stainless steel. Cadmium bar anodes may be used if they are cast with no central steel spline and titanium or stainless steel hooks are used. Auxiliary or internal anodes must be of cadmium or 300 series stainless steel.

f. This process requires a continuously filtered bath. The filter must be of a type that permits introduction of the titanium paste mixture on the filter cloth. The filter must have a plate area of 0.98 to 2.45 square meters per kiloliter (40 to 100 square feet per 1,000 gallons) of plating solution. The filtration equipment must be 300 series stainless steel or have an approved type of lining such as rigid polyvinylchloride or other un-plasticized material. The filter cloth material should be of a high grade chemical resistant fabric. Cotton cannot be used in this system.

g. A blast cabinet shall be located near the plating line. The size of the cabinet shall be adequate to enclose the parts to be plated. Air lines shall be suitably trapped and filtered to prevent in-process contamination of the parts to be cleaned.

h. An oven capable of baking part at 190 ± 14˚C (375 ± 25˚F) shall be located near the plating line. The size of the oven shall be adequate to enclose parts to be plated. The oven shall be equipped with temperature indicating, recording and regulating devices.

4.2 Specification SAE-AMS-QQ-P-416. The requirements of SAE-AMS-QQ-P-416 shall be complied with on all parts, in conjunction with those specified in this standard. If there is a conflict between the two documents, the requirements of this standard shall govern.

4.3 Finish. The plated parts will have a finish that is smooth, continuous, homogeneous adherent and free from pits, blisters, nodules and any other indications of harmful defects. The appearance of a properly applied deposit may vary from a dull gray to a frosty white. A bright, shiny deposit indicates malfunction of the process, which may produce embrittled parts (see: MIL-S-5002)

4.4 Corrosion. The test panel shall show no corrosion on the base metal after 500 hours exposure to salt spray per ASTM B117. Corrosion at the edges of the panel shall not constitute failure.

4.5 Titanium Content of Plating. The titanium content of the plate shall be between 0.07 and 0.5 percent titanium.

4.6 Embrittlement. Qualification test specimens and process control test specimens shall be subjected to a sustained load test at 75 percent of the ultimate notched tensile strength. The specimens shall endure this sustained load for 200 hours minimum without failing or cracking. If hydrogen detection instrument testing is used for process control, the test must meet the requirements of the instrument manufacturer.

4.7 Reprocessing. Parts rejected for defective plating, requiring stripping and re-plating, shall include all of the pre-plating steps of this standard. Parts shall be stripped in accordance with MIL-STD-871.

5. DETAILED REQUIREMENTS

5.1 Prior to Plating. Prior to plating, all machining, forming, welding, and shot peening shall be completed.

5.1.1 Baking. Parts shall be baked for stress relief before plating for four hours minimum at 190 ± 14˚C (375 ± 25˚F). Shot peening when required shall be performed before plating and after stress relieving.

5.1.2 Storage of Parts. Storage of parts between stress relief and cleaning shall be controlled to prevent contact with water or other corrosive materials. Parts should be stored to permit free circulation of air around the parts.

5.1.3 Handling of Parts. After parts have been cleaned, they shall be handled in such a manner, white gloves, etc, that will assure a minimum of contamination.

5.1.4 Masking. Sections or areas of a part that are not to be plated shall be masked off. Plug and masking materials, which do not contaminate the plating bath shall be used. Masking should be performed at the most convenient step prior to plating.

5.1.5 Racking. Sufficient contact area and pressure shall be provided to carry the current without overheating. Racking should be performed at the most convenient step prior to plating.

5.1.6 Plating Sequence. If chromium and cadmium are used in combination, the chromium shall be deposited first. When chrome plating is to be followed by cadmium plating the 23 hour minimum bake period following chrome can be replaced by a four hour bake period at 190 ± 14˚C (375 ± 25˚F) provided the part is baked for 23 hours minimum after completion of the cadmium-titanium plating.

5.2 Plating Procedures. The cadmium-titanium plating procedure shall be performed as follows:

5.2.1 Step Number 1. Parts shall be degreased as necessary. No minimum elapsed time requirement shall apply between this operation and the cleaning operation of 5.2.2.

WARNING
PROVIDE ADEQUATE VENTILATION DURING DEGREASING OPERATIONS.
AVOID SKIN AND EYE CONTACT WITH SOLVENT SOLUTIONS.

5.2.2 Step Number 2. All parts shall be cleaned by dry blasting using 80 – 320 grit aluminum oxides (Al_2O_3), silicon dioxide (SiO_3), or garnet per MIL-STD-1504. Elapsed time between completion of cleaning and Step Number 3 shall not exceed 60 minutes.

5.2.3 Step Number 3. Rinse parts in cold water (Optional). A cyanide holding tank can be used to hold parts if the plating tank is full.

5.2.4 Step Number 4.(Optional). All parts can be dipped in a 2-4 percent by volume hydrochloric acid (HC1) solution, (60 seconds maximum at ambient temperature) followed by a cold water rinse.

5.2.5 Step Number 5. Cadmium plate in the solution listed below. Apply voltages so that the current will flow upon immersion of parts. Strike the parts at 4.3 to 5.4 amperes/sq decimeter (40 – 50 amps/sq ft {asf}) for 15 seconds, and then reduce the current to 1.6 to 3.2 amperes/sq decimeter (15 – 30 asf) until the required thickness of cadmium-titanium has been deposited.

a. Cadmium metal	18.5 – 33.5 g/l	(2.5 – 4.5 oz/gal)
b. Total cyanide	74 – 200 g/l	(10 – 27 oz/gal)
c. Sodium hydroxide	11.25 – 30 g/l	(1.5 – 4 oz/gal)
d. Titanium	40 – 100 mg/l	(40 – 100 ppm)
e. Sodium carbonate	0 – 60 g/l	(0 – 8 oz/gal)
f. Ratio NaCn/Cd	4/1 to 6/1	
g. Total permissible iron	300 mg/l	(300 ppm)
h. Temperature	15 - 30˚C	(60 - 85˚F)

WARNING
PROVIDE ADEQUATE VENILATION WHEN USING CADMIUM PLATING SOLUTIONS CONTAINING SODIUM HYDROXIDE AND SODIUM CYANIDE WEAR PROTECTIVE RUBBER GLOVES AND CHEMICAL GOGGLES TO PREVENT SKIN AND EYE EXPOSURE.

5.2.6 Step Number 6. Rinse parts in cold water.

5.2.7 Step Number 7. Rinse parts in hot water and blow dry with compressed air. Elapsed time between completion of plating and the start of baking, shall not exceed four (4) hours.

5.2.8 Step Number 8. Bake all parts heat-treated above 1.24 X 10^9 Pa (180,000 psi) for 12 hours minimum at 190 ± 14˚C (375 ± 25˚F).

NOTE: Refer to 5.3 if post plate treatment is required. If post plate treatment is not required, refer to 5.4.

5.3 Post Plate Treatment.

5.3.1 Types of Plating. Refer to applicable directives for type of plating. If the type of plating is not specified, the part shall be given the Type II treatment.

a. Type I – No post plate treatment required (see para 5.4)

b. Type II – (see para 5.3.1.1)

c. Type III – (see para 5.3.1.2)

WARNING
PROVIDE ADEQUATE VENTILATION WHEN USING IRIDITE AND/OR PHOSPHATING SOLUTIONS. AVOID SKIN AND EYE CONTACT.

5.3.1.1 Type II.

a. Immerse in Type II chromating solution (Iridite No. 8P or equivalent) for 15 to 30 seconds.

b. Rinse thoroughly in tap water. An additional rinse in warm water (60˚C maximum {140˚F}) may be used to facilitate drying.

c. See para 5.4.

5.3.1.2 Type III.

a. Immerse parts in Type III (SAE-AMS-QQ-P-416) phosphating solution for 15 to 30 seconds.

b. Rinse thoroughly in tap water. An additional rinse in warm water (60˚C maximum {140˚F}) may be used to facilitate drying.

c. See para 5.4.

5.4 Inspection. Inspection shall be in accordance with the production control inspection and test in SAE-AMS-QQ-P-416 and this standard.

5.5 Process Controls. Solutions and equipment used in the plating process shall be checked periodically and maintained in accordance with the requirements of this process standard.

5.6 Qualification Embrittlement Test. The processor shall demonstrate the ability to provide cadmium-titanium plating, which meets the requirements of paragraph 4.6 of this standard as follows:

a. Four round notched 4340 steel specimens per ASTM F519, Type 1a.1 or 1a.2 shall be prepared.

b. The specimens shall be prepared for plating and plated in accordance with all of the requirements of this specification. During plating the specimens shall be mounted symmetrically on a rack by themselves. All areas of the rack except the contact area shall be coated with a suitable maskant. An ammeter having a sensitivity of 0.5 amperes or better shall be connected in the plating circuit near the specimens being plated. The ammeter shall either be built into the rectifier being used or shall be inserted between the rectifier and the cathode. The specimens shall be plated at S1.6 A/dm^3 (15 amperes/ft^3) to a thickness of 0.020 mm {0.0008 inch). The specimens shall be baked for 12 hours at 190 ± 14˚C (375 ± 25˚F) within four (4) hours of removal from the bath.

c. The specimens will be subjected to 200 hours of static loading at 75 percent of the ultimate notched tensile strength. The test shall be considered passed if all four (4) specimens meet the requirements of para 4.6.

d. Upon successful completion of the static load test, one of the notched tensile specimens shall be sectioned across the notch parallel to the axis of the specimen. Photomicrographs shall be taken on the notched area and examined for complete coverage of the notch with plating (use 80 – 100 magnification).

5.7 Process Control Embrittlement Acceptance Test. The process embrittlement acceptance test shall be one of the following two methods:

5.7.1 Method I, Hydrogen Detection Instrument Testing.

a. Hydrogen detection instrument testing shall be performed within the processor's facility by a certified operator according to the instrument manufacturer's instructions.

b. Hydrogen detection instrument testing shall be conducted at least twice weekly.

5.7.2 Method II, Notched Tensile Test.

a. Two standard specimens of the type noted in para 5.6 shall be processed in conjunction with the plating of items in accordance with all of the requirements of this specification. The specimens shall be subjected to a sustained load test of 75 percent of the ultimate notched tensile strength of the material for 200 hours minimum and shall meet the requirements of para 4.6. Failure of any one of the specimens shall constitute failure of the test and production shall cease until the cause of failure is determined and the bath is re-qualified. Acceptance of items completed after the last successfully completed acceptance test shall be withheld until the extent and cause of failure have been determined.

b. The test for embrittlement shall be conducted as often as deemed necessary with a maximum interval of every 30 calendar days. If embrittlement tests have not been performed in the 30 days proceeding the processing of a material batch, the bath must be re-qualified in accordance with para 5.6.

5.8 Titanium Content of Plating. The titanium content of the plate shall be determined in accordance with the following steps:

a. Plate the cadmium-titanium deposit at normal current density onto passive stainless steel, nickel, or a chrome plated base, so as to produce a non-adherent deposit.

WARNING
PROVIDE ADEQUATE VENTILATION WHEN USING SULFURIC ACID.
WEAR PROTECTIVE RUBBER GLOVES AND CHEMICAL GOGGLES TO PREVENT SKIN AND EYE EXPOSURE.

b. Dissolve the weighed deposit in 50 milliliters (ml) of 15 – 20 percent sulfuric acid (H_3SO_4).

c. Analyze the sulfuric acid for titanium and compute the titanium content of the plating.

5.9 Safety and health. This document specifies the use of certain materials, which have been listed in 29 CFR 1910 (OSHA Standards) as “Toxic and Hazardous Substances.” Personnel exposure to these materials during this process must be limited to the values specified in the applicable portions of OSHA Standard 1910.1000.

5.10 Environmental Precaution. Because of the toxicity of cadmium vapors, adequate ventilation must be assured before cadmium plated items can be welded, soldered and heated.

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

6.1 Intended Use. This standard provides direction on the procedures and processes for cadmium-titanium plating, low embrittlement, electro-deposition for the repair of existing or procurement of new parts on the landing gear of all military aircraft.

6.2 Subject term (key word) listing.

Materials
Plating Sequence
Qualification
Type

6.3 Changes from previous issue. Marginal notations are not used in this revision to identify changes with respect to the previous issue due to the extent of the changes.

CONCLUDING MATERIALS

Custodian:
Air Force 70

Preparing Activity:
Air Force 70

Project: MFFP-0729-000

NOTE: The activities listed above were interested in this document as of the date of this document. Some organizations and responsibilities can change or verify of the currency of the information above by using the ASSIST Online database or http://assist.daps.dla.mil.