METRIC

MIL-STD-870C (USAF)
w/CHANGE 1
27 April 2009
SUPERSEDING
MIL-STD-870C
01 March 2007

DEPARTMENT OF DEFENSE
STANDARD PRACTICE

CADMIUM PLATING, LOW EMBRITTLEMENT, ELECTRODEPOSITION

This document is inactive for new design.

AMSC: N/A

AREA: MFFP

FOREWORD

1. This military standard is approved for use by 309MXSG/MXR, 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.

CONTENTS

CONTENTS

SUMMARY OF CHANGE 1 MODIFICATIONS

Delete the following reference document from paragraph 2.3, ASTM E 8, Metallic Materials, Tension Testing of. There is no longer a need for this test method; no superseding document will be identified.

The following detail requirement of MIL-STD-870C has been revised, paragraph 5.3.2, Step Number 2:

New Requirement: All parts shall be cleaned by dry blasting using 80 – 320 grit aluminum oxide (Al_2O_3), silicon dioxide (SiO_2) or garnet per MIL-STD-1504. Elapsed time between completion of cleaning and Step Number 3 shall not exceed four (4) hours.

Old Requirement: All parts shall be cleaned by dry blasting using 80 – 320 grit aluminum oxide (Al_2O_3), silicon dioxide (SiO_2) or garnet per MIL-STD-1504. Elapsed time between completion of cleaning and Step Number 3 shall not exceed 60 minutes.

Deleted “Embrittlement” from section 6.2 “Subject terms (key words) listing, no replacement added.

1. SCOPE

1.1 Scope. This standard covers the process and materials required for the electro-deposition of cadmium on high strength steel substrates. Subsequent heat treating techniques needed to insure low embrittlement of steel are also described. This process is not authorized for use on steel heat treated above 1.65 X 10^9 PASCAL's (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 compiled with.

1.3 Classification.

1.3.1 Classes. Cadmium plating covered by this standard identifies the following classes:

a. Class 1	0.013mm (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

2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 4 and 5 of this standard. This section does not include documents cited in other sections of this standard or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements or documents cited in sections 4 and 5 of this standard, whether or not they are listed.

2.2 Government documents.

2.2.1 Specifications, standards, handbooks, and commercial item descriptions. The following specifications, standards, handbooks, and commercial item 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.

DEPARTMENT OF DEFENSE SPECIFICATIONS

MIL-S-5002	Surface Treatments and Inorganic Coatings for Metal Surfaces of Weapon System

DEPARTMENT OF DEFENSE STANDARDS

MIL-STD-871 (Inactive)	Electro-chemical Stripping of Inorganic Finishes
MIL-STD-1504 (Inactive)	Abrasive Blasting of Aircraft Components

COMMERCIAL ITEM DESCRIPTIONS

A-A-50800	Cadmium Oxide
A-A-51126	Anodes, Cadmium

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

2.2.2 Other Government documents, drawings, and publications. The following other Government documents, drawings, and publications 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 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.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM F 519	Mechanical Hydrogen Embrittlement Evaluation of Plating Processes & Service Environments

(Copies of this document are available from www.astm.org or 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 this document are available from www.sae.org or SAE World Headquarters, 400 Commonwealth Drive, Warrendale, PA 15096-0001.)

2.4 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 law 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 10^9Pa (1.26 X 10^2kgf/mm) (1.8 X 10^5psi) and above.

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

4. GENERAL REQUIREMENTS

4.1 General. This section covers the materials and equipment required to accomplish the described process.

4.2 Materials and Equipment.

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

a. Sodium Hydroxide, flake or granulated.

b. Sodium Cyanide, plating grade (96 – 98%NaCN).

c. Cadmium Ball Anodes (A-A-51126)

d. Cadmium Oxide (A-A-50800).

4.2.2 Equipment. Equipment used in cadmium plating is as follows:

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 shall be resistant to the operating temperature and the chemical environment. Tanks, in which any electrolytic action is taking place, must be free of shorts.

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

d. An ammeter shall be placed in series with the cadmium 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. 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.

f. An oven capable of baking parts at 190.5 ± 13.9°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 indication, recording, and regulating devices.

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

4.4 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.

4.5 Finish. The plated part 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 plate may very from a dull grey to a frosty white. A bright, dense deposit indicates malfunction of the process, which may produce embrittled parts (See: MIL-S-5002).

4.6 Re-processing. 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 General. This section provides the detailed requirements required to accomplish the plating process identified in this standard.

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

5.2.1 Baking. Parts shall be baked for stress relief before plating for four (4) hours minimum at 190.5 ± 13.9°C (375 ± 25°F) provided the part is baked for 23 hours minimum after completion of the cadmium plating.

5.2.2 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 hours minimum bake period can be replaced by a four (4) hour bake period at 190.5 ± 13.9°C (375 ± 25°F) provided the part is baked for 23 hours minimum after completion of the cadmium plating.

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

5.2.4 Handling of parts. After the parts have been cleaned, they shall be handled in such a manner (white gloves, etc.) that will ensure a minimum of contamination.

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

5.2.6 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.

5.3 Plating procedures. The cadmium plating procedure shall be as described below:

5.3.1 Step Number 1. Parts shall be degreased as necessary. No minimum elapsed time requirement shall apply between this operation and the cleaning operation of Step Number 2.

5.3.2 Step Number 2. All parts shall be cleaned by dry blasting using 80 – 320 grit aluminum oxide (Al_2O_3), silicon dioxide (SiO_2) or garnet per MIL-STD-1504. Elapsed time between completion of cleaning and Step Number 3 shall not exceed four (4) hours.

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

5.3.4 Step Number 4. Cadmium plate at 5.4 to 7.5 amperes/sq decimeters (50 – 70 amperes/sq foot) in the following solution:

Cadmium metal	21 – 30 g/l (2.8 – 4.0 oz/gal)
Total cyanide	90 – 135 g/l (12 – 18 oz/gal)
Sodium hydroxide	11.2 – 30 g/l (1.5 – 4 oz/gal)
Sodium carbonate	0 – 60 g/l (0 – 8 oz/gal)
Ratio NaCN/Cd	4/1 to 6/1
Temperature	15.5 – 26.6°C (60 – 80°F)
Total permissible iron	700 parts/million

5.3.5 Step Number 5. Rinse parts in cold water.

5.3.6 Step Number 6. Rinse parts in hot water and blow dry with compressed air. Elapsed time between completion of plating and start of baking, Step Number 7, shall not exceed four (4) hours.

5.3.7 Step Number 7. Bake all parts heat treated above 1.24 X 10^9Pa (180,000 psi) for 23 hours minimum, at 190.5 ± 13.9°C (375 ± 25°F).

NOTE: Refer to paragraphs 5.4.1, 5.4.2, and 5.4.3 if post plating treatment is required. If post plating treatment is not required, refer paragraph 5.5.

5.4 Post plating treatment.

5.4.1 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.

Type I	No post plating treatment required (See: paragraph 5.5)
Type II	(See: paragraph 5.4.2)
Type III	(See paragraph 5.4.3)

5.4.2 Type II.

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

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

c. See paragraph 5.5

` 5.4.3 Type III.

a. Immerse parts in Type III (reference SAE-AMS-QQ-P-416) phosphate solution for 15 to 20 seconds.

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

c. See paragraph 5.5

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

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

5.7 Qualification embrittlement test. The processor shall demonstrate their ability to provide cadmium plate, which meets the requirements of paragraph 4.4 of this standard as follows:

a. Four round notched 4340 steel specimens per ASTM F 519, Type 1a.1 or 1a.2 shall be prepared.

b. The specimens shall be prepared for and plated in accordance with all of the requirements of this standard. 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 between the specimen rack and the cathode. The specimens shall be plated at 5.4 A/dm^2 (50 amps/ft^2) to a thickness of 0.020mm (0.0008 inch). The specimens shall be baked for 23 hours at 190.5 ± 13.9°C (375 ± 25°F) within four (4) hours of removal from the bath.

c. The specimens shall 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 paragraph 4.4.

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 of the notched area and examined for complete coverage of the notch with plating (Use 80 – 100 X magnifications).

e. A complete analysis report of the plating bath with the qualification test results shall be submitted, as required by, the procuring activity.

5.8 Re-qualification. Any significant change to the solution shall require re-qualification. Examples of significant changes are, if more than 20% of the solution is discarded and re-made, if the solution is dumped and a new solution made up, or if the solution is transferred out the processing tank. Re-qualification shall be accomplished by either of the following methods:

a. Re-qualify using the sustained notched tensile method in the above paragraphs 5.7.a through 5.7.d.

b. Re-qualify using the hydrogen detection instrument method in paragraph 5.9.1 and running the test in duplicate.

5.9 Process control embrittlement acceptance test. The process control embrittlement acceptance test shall be one of the following two methods:

5.9.1 Method 1, 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.

c. The lambda$_{pc}$ (λ_{pc}) as determined by the test procedure shall be less than or equal to 80. if the λ_{pc} is greater than 80 but less than or equal to 96, treat the solution and re-test. If the λ_{pc} is greater than 96 but less than or equal to 130, halt production investigate and correct the problem, and re-qualify the solution per paragraph 5.7. If λ_{pc} greater than 130 halt production reject all parts plated since the last acceptance test, correct the problem and re-qualify the solution per paragraph 5.7.

d. If the embrittlement test has not been performed in the 30 days preceding the processing of the material batch the bath must be re-qualified in accordance with paragraph 5.7.

5.9.2 Method 2, Notched tensile tests.

a. Two standard specimens of the type noted in paragraph 5.7 shall be processed in conjunction with the plating of items in accordance with all of the requirements of this standard. 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 paragraph 4.4. Failure of any one of the specimens shall constitute failure of the test and production shall cease until the cause of the 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 the failure has been determined.

b. The test for embrittlement shall be conducted as often as deemed necessary with the maximum interval of every 30 calendar days. If the embrittlement test has not been performed in the 30 days preceding the processing of the material batch the bath must be re-qualified in accordance with paragraph 5.7.

5.10 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 the process must be limited to the values specified in the applicable portions of the OSHA Standard 1910.1000.

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

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

6.2 Subject term (key word) listings:

Method
Procedure
Sequence
Type

6.3 Change notations. The margins of this standard are marked with vertical lines to indicate modifications generated by this change. This was done as a convenience only and the Government assumes no liability whatsoever for an 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.

CONCLUDING MATERIALS

Custodian:
Air Force – 70

Preparing Activity:
Air Force – 70

Project MFFP-2009-003

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