STANDARD OVERHAUL PRACTICES MANUAL

LOW HYDROGEN EMBRITTLEMENT CADMIUM - TITANIUM ALLOY PLATING

PART NUMBER NONE

PUBLISHED BY BOEING COMMERCIAL AIRPLANES GROUP, SEATTLE, WASHINGTON, USA
A DIVISION OF THE BOEING COMPANY
PAGE DATE: Jul 01/2009

BOEING®

STANDARD OVERHAUL PRACTICES MANUAL

Revision No. 18
Jul 01/2009

To: All holders of LOW HYDROGEN EMBRITTLEMENT CADMIUM - TITANIUM ALLOY PLATING 20-42-02.

Attached is the current revision to this STANDARD OVERHAUL PRACTICES MANUAL

The STANDARD OVERHAUL PRACTICES MANUAL is furnished either as a printed manual, on microfilm, or digital products, or any combination of the three. This revision replaces all previous microfilm cartridges or digital products. All microfilm and digital products are reissued with all obsolete data deleted and all updated pages added.

For printed manuals, changes are indicated on the List of Effective Pages (LEP). The pages which are revised will be identified on the LEP by an R (Revised), A (Added), O (Overflow, i.e. changes to the document structure and/or page layout), or D (Deleted). Each page in the LEP is identified by Chapter-Section-Subject number, page number and page date.

Pages replaced or made obsolete by this revision should be removed and destroyed.

ATTENTION

IF YOU RECEIVE PRINTED REVISIONS, PLEASE VERIFY THAT YOU HAVE RECEIVED AND FILED THE PREVIOUS REVISION. BOEING MUST BE NOTIFIED WITHIN 30 DAYS IF YOU HAVE NOT RECEIVED THE PREVIOUS REVISION. REQUESTS FOR REVISIONS OTHER THAN THE PREVIOUS REVISION WILL REQUIRE A COMPLETE MANUAL REPRINT SUBJECT TO REPRINT CHARGES SHOWN IN THE DATA AND SERVICES CATALOG.

Location of Change	Description of Change
20-42-02	
PGBLK 20-42-02-0	Changed "lead" to "load".

STANDARD OVERHAUL PRACTICES MANUAL

Subject/Page	Date	Subject/Page	Date	Subject/Page	Date
TITLE PAGE					
O 1	Jul 01/2009				
2	BLANK				
20-42-02 TRANSMITTAL LETTER					
O 1	Jul 01/2009				
2	BLANK				
20-42-02 HIGHLIGHTS					
O 1	Jul 01/2009				
2	BLANK				
20-42-02 EFFECTIVE PAGES					
1	Jul 01/2009				
2	BLANK				
20-42-02 CONTENTS					
1	Nov 01/2006				
2	BLANK				
20-42-02 REVISION RECORD					
1	Jul 01/2005				
2	Jul 01/2005				
20-42-02 RECORD OF TEMPORARY REVISIONS					
1	Jul 01/2005				
2	Jul 01/2005				
20-42-02 INTRODUCTION					
1	Jul 01/2005				
2	BLANK				
20-42-02 SUBJECT					
R 1	Jul 01/2009				
R 2	Jul 01/2009				
R 3	Jul 01/2009				
R 4	Jul 01/2009				
R 5	Jul 01/2009				
R 6	Jul 01/2009				
7	Nov 01/2007				
8	Nov 01/2006				

A = Added, R = Revised, D = Deleted, O = Overflow

TABLE OF CONTENTS

Paragraph Title	Page
LOW HYDROGEN EMBRITTLEMENT CADMIUM-TITANIUM ALLOY PLATING	1
INTRODUCTION	1
MATERIALS	1
TANK AND SOLUTION PREPARATION	2
ANODES	4
PREPLATE TREATMENT	4
PLATING PROCEDURE	5
POST-PLATE TREATMENT	6
QUALITY CONTROL	7

All revisions to this manual will be accompanied by transmittal sheet bearing the revision number. Enter the revision number in numerical order, together with the revision date, the date filed and the initials of the person filing.

Revision		Filed		Revision		Filed	
Number	Date	Date	Initials	Number	Date	Date	Initials

Revision		Filed	
Number	Date	Date	Initials

Revision		Filed	
Number	Date	Date	Initials

BOEING®

STANDARD OVERHAUL PRACTICES MANUAL

All temporary revisions to this manual will be accompanied by a cover sheet bearing the temporary revision number. Enter the temporary revision number in numerical order, together with the temporary revision date, the date the temporary revision is inserted and the initials of the person filing.
When the temporary revision is incorporated or cancelled, and the pages are removed, enter the date the pages are removed and the initials of the person who removed the temporary revision.

Temporary Revision		Inserted		Removed	
Number	Date	Date	Initials	Date	Initials

Temporary Revision		Inserted		Removed	
Date	Initials	Number	Date	Date	Initials

Temporary Revision		Inserted		Removed	
Number	Date	Date	Initials	Date	Initials

Temporary Revision		Inserted		Removed	
Date	Initials	Number	Date	Date	Initials

INTRODUCTION

1. General

A. The instructions in this manual tell how to do standard shop procedures during maintenance functions from simple checks and replacement to complete shop-type repair.

B. This manual is divided into separate sections:

(1) Title Page

(2) Transmittal Letter

(3) Highlights

(4) Effective Pages

(5) Contents

(6) Revision Record

(7) Record of Temporary Revisions

(8) Introduction

(9) Procedures

C. Refer to SOPM 20-00-00 for a definition of standard industry practices, vendor names and addresses, and an explanation of the True Position Dimensioning symbols used.

D. The data is general. It is not about all situations or specific installations. Use it as a guide to help you write minimum standards.

E. If the component overhaul instructions are different from the data in this subject, use the component overhaul instructions.

LOW HYDROGEN EMBRITTLEMENT CADMIUM-TITANIUM ALLOY PLATING

1. INTRODUCTION

NOTE: This low hydrogen embrittlement cadmium-titanium alloy plating is an optional and preferred procedure to the low hydrogen embrittlement cadmium plating procedure in SOPM 20-42-01. But if the overhaul instructions specify low hydrogen embrittlement cadmium-titanium plating and you cannot do it, you can always use low hydrogen embrittlement cadmium plating per SOPM 20-42-01 as an alternative. Stylus cadmium plating per SOPM 20-42-10 is optional for local areas not larger than 72 square inches on components with no load applied during the plating procedure.

A. The data in this subject comes from Boeing Process Specification BAC5804 for low hydrogen embrittlement cadmium-titanium alloy plating.

B. The data is general. It is not about all situations or specific installations. Use this data to help you write minimum standards.

C. This plating is usually used on low alloy, high-strength steels, such as those heat-treated above 220 ksi. The plating makes a corrosion resistant layer that lets hydrogen ions come through from the metal when the part is subsequently baked.

D. Refer to SOPM 20-00-00 for a list of all the vendor names and addresses.

2. MATERIALS

A. Sodium Cyanide, 97% NaCN minimum – Cyanogran M or Cyanobrick, V18873

B. Anodes, Cadmium – A-A-51126

C. Cadmium Oxide – A-A-50800

D. Sodium Hydroxide, Technical – O-S-598 or 48% solution

E. Sodium Dichromate Dihydrate, Technical – O-S-595

F. Sulfuric Acid, 66° Baume, Technical – O-S-809, Type 1

G. Wetting Agent – Nacconol 90G, V87570 (Replaces Nacconol 90F)

H. Titanium Paste – must be homogeneous and free of lumps, must contain a minimum of 1.9% titanium by weight, and contain no more than 10 ppm chloroform extractable materials.

(1) Olympic Titanium Paste, V0T9R1

(2) Ti-plate 504, V06186

(3) Titan Paste Type J, VS4143 or VS4404

I. Hydrogen Peroxide 35%, Technical Grade

J. Filter Aid, Celite 501, V9K562. Equivalent filter aids include those prepared from diatomaceous earths. Organic-based aids, such as those prepared from cellulose, are not acceptable.

K. Primer – BMS 10-11, Type 1

L. Hydrochloric Acid, 20° Baume, Technical – O-H-765

M. Chromic Acid, Technical – O-C-303

N. Fluoboric Acid, 48%, Technical

O. Carbonate Remover, ARP 210, V99442

P. Ultrachromate 300 Concentrate, V64709 or V0T9R1

Q. Nitric Acid, 40° or 42° Baume, Technical – O-N-350

3. TANK AND SOLUTION PREPARATION

A. General

(1) This process uses a continuously filtered bath. The filter must be of a type that puts soluble titanium into the plating bath.

(2) The filter must have sufficient free volume to contain all filter aid, titanium paste, and titanium in the bath, if all of these materials accidentally come out of solution.

(3) The filter rate must be a minimum of 2 tank volumes per hour. We recommend a maximum rate of 4 tank volumes per hour, and a filter cloth area of 6 square feet per 100 gallons of solution.

(4) The system can include a permanently installed carbon filter, if the flow rate is not more than 2% of tank volume per hour. The carbon filter can be used on a continuous or intermittent basis.

(5) All surfaces of the tank, filter, and related plumbing which continuously touch the plating solution must be made of, lined, or coated with one of the following materials. When the tank is not used, put a cover on it which is made of, or coated with, one of these materials.

(a) 300 series CRES

(b) Titanium or titanium alloy

(c) Epoxy primer

(d) Rigid polyvinyl chloride or polyvinyl dichloride

(e) Polytetrafluoroethylene

(f) Unfilled polyethylene or polypropylene

(g) Mylar

(h) Paraline AR, V70849

(i) Hypalon 70-H3, V06470

(j) Goodyear LS576 neoprene

(6) A lining or coating of a nonconducting material is recommended on the tank interior so the tank does not become bipolar.

B. Precondition Tank

CAUTION: DO NOT LET ORGANIC MATERIALS GET INTO THE TANK, PLUMBING, OR PLATING SOLUTION, BECAUSE ORGANIC MATERIALS WILL DECREASE OR REMOVE THE LOW HYDROGEN EMBRITTLEMENT PROPERTIES OF THE PLATED PARTS.

(1) Fill the tank with caustic cyanide holding solution (Table 1).

(2) Let this stand for one week. Operate the pump and filter system a minimum of 8 hours per day.

(3) Remove and discard this cyanide holding solution. Do not use this removed solution for the holding bath of Table 1.

(4) Rinse out the tank completely before you fill it with the plating solution.

C. Prepare Plating Solution

(1) Fill the tank approximately half full with water which has an electrical resistivity of not less than 50,000 ohm-cm. This is equivalent to approximately 10 ppm dissolved ionic solids.

WARNING: DO NOT BREATHE THESE SOLIDS OR LET THEM TOUCH THE SKIN.

(2) For each 100 gallons of final solution, add 100 pounds of sodium cyanide followed by 22 pounds of cadmium oxide.

(3) Mix thoroughly until all components are dissolved. Fill the tank with remaining water per Paragraph 3.C.(1).

(4) Stir to fully mix the solution. Then electrolyze the solution with some of the anodes used as cathodes, until you get a satisfactory quality of plating.

(5) After the new bath is correctly aged, add titanium to the bath as follows:

(a) Coat the filter cloth with filter aid.

(b) For each gallon of slurry, use one pound filter aid, three pounds titanium paste, 2.5 oz. sodium hydroxide, and water to make a gallon. Use one gallon of slurry for each 100 gallons of plating solution. These amounts can be adjusted for best results.

NOTE: Ti-plate 504 is a supplied as a slurry. If you use this product, add it to the system directly, without the sodium hydroxide or water.

(c) Add the slurry into the filter through a slurry tank or directly into the plating tank.

(d) Add 5 fluid ounces of 35% hydrogen peroxide directly to the tank for each 100 gallons of solution.

(e) After 30 minutes, analyze the plating solution for titanium content. Adjust the titanium to 55-97 parts per million (ppm) titanium. To increase titanium, add more hydrogen peroxide. The titanium content will automatically decrease as the peroxide complex breaks down with time.

D. Maintenance of Cadmium-Titanium Plating Bath

CAUTION: KEEP ORGANIC MATERIALS OUT OF THE PLATING BATH, BECAUSE THEY WILL DECREASE OR REMOVE THE LOW HYDROGEN EMBRITTLEMENT PROPERTIES.

(1) Control the plating solution within these limits and adjust it when necessary.

(a) Cadmium metal – 2.8-3.5 oz/gal (21-26 g/liter)

(b) Total cyanide (as NaCN) – 13-17 oz/gal (97-128 g/liter)

(c) Sodium hydroxide – 2.0-2.5 oz/gal (15-19 g/liter)

(d) Sodium carbonate – 8.0 oz/gal maximum (60 g/liter max.)

(e) Total iron contamination – 300 ppm maximum

(f) Titanium – 55-97 ppm

(g) Total cyanide to cadmium ratio (NaCN/Cd), 4:1-5:1

(h) Operation temperature – 60-85°F (15-30°C)

NOTE: Cool or heat as necessary. A heat exchanger in the filter return line is recommended.

(2) Analyze the bath for titanium content and adjust as necessary to control the concentration. Also, analyze the bath for titanium and adjust as necessary before you put the bath back in operation after a shutdown. To increase titanium content, add 35% hydrogen peroxide directly to the bath. We recommend approximately 4-6 fluid ounces of 35% hydrogen peroxide per 100 gallons of solution, added daily.

(3) When additions of hydrogen peroxide do not increase the titanium content, and there are no malfunctions in the filter system, add more titanium paste to the filter per Paragraph 3.C.(5) above. One pound of titanium paste will give the titanium to plate approximately 30 pounds of cadmium, or approximately 6500 amp-hours of plating time.

(4) Remove unwanted sodium carbonate, as necessary. Carbonate remover ARP 210, used correctly, will not decrease the hydrogen embrittlement properties of the bath. But you must do a test for hydrogen embrittlement after this treatment.

4. ANODES

NOTE: 300 series CRES anodes completely plated with cadmium, with no copper or nickel strike, are equivalent to cadmium anodes. Anodes must stay completely coated with cadmium after plating of parts.

A. Use solid cadmium anodes or cadmium ball anodes in titanium anode holders.

B. Do not let anode hooks, jigs, or racks touch plating solutions if they are made of materials not approved for the tank in Paragraph 3.

C. Use auxiliary (internal) anodes (300-series CRES or cadmium) to get the specified plating thickness where the ratio of hole depth of inside diameter is more than 1:1 for open holes, or more than 0.5:1 for blind holes. You can control current to the internal steel anodes independently from the current to the tank and the external anodes to be sure the current density is correct on the inside diameters.

5. PREPLATE TREATMENT

A. Complete all machining, forming, welding, or brazing before plating.

B. Before you start to plate them, stress relieve low alloy and corrosion resistant steel parts by the overhaul instructions. Where no stress relief details are given, stress relieve per SOPM 20-10-02.

C. Manual solvent clean as necessary, and then vapor degrease per SOPM 20-30-03. Make sure the parts are fully dry.

D. Mask the areas of parts not to be plated. This includes surfaces which have plasma flame spray coating.

E. Dry abrasive blast per SOPM 20-30-03. A rougher particle size, such as 80 grit aluminum oxide, will help the plating bond and the low hydrogen embrittlement property.

F. If you must stop, the parts must show no rust, dirt, or bad color change after you use one of these alternatives:

(1) You can keep parts for one hour maximum at ambient temperature with no special protection.

(2) You can keep parts for 6 hours maximum at ambient temperature if you keep them in a clean area and give them protection from dust and fumes.

(3) Within one hour, you can put the parts in a cyanide holding bath (Table 1). Keep the parts in this bath no longer than 4 hours.

Table 1: Cyanide Holding Bath

Material	Makeup per 100 gal.	Control
Sodium Cyanide	31 lb	4-5 oz/gal
Sodium Hydroxide	10 lb	1-2 oz/gal
Operating Temperature	———	60-95°F

G. Cold water rinse at 100°F max. for 0.5-5.0 minutes.

H. Activate the surfaces of the part to be plated by immersion in acid solution for 5-30 seconds. Remove the part immediately when gas occurs.

(1) Fluoboric acid solution (recommended): 2.5 volume parts fluoboric acid to 100 parts water. Control 1.25-2.50 oz/gal and 60-95°F.

(2) Hydrochloric acid solution (alternate): 3 volume parts hydrochloric acid to 100 parts water. Control at 0.82-1.64 oz/gal and 60-95°F.

I. Within 2 minutes, cold water rinse for minimum of 20 seconds and maximum of 6 minutes. Then start to plate within 2 minutes.

6. PLATING PROCEDURE

A. When the plating bath is first started, or after it was not used for a time, we recommend you plate samples and make adjustments before you plate parts.

B. Apply initial strike per Table 2.

Table 2: Initial Strike Current/Time

Strike Current Density (amps/sq ft)	Maximum Strike Time (seconds)
100	10
80	18
70	22
60	30
50	38
40	51
30	70

C. Decrease the current and plate to the specified thickness at 20-35 ASF per Table 3. Do not use a current density below 20 ASF, because low current density plating will decrease the low hydrogen embrittlement property of the deposit. You can temporarily stop the plating cycle to move parts in the racks to get 100% coverage.

Table 3: Time/Current Selection for Plating Thickness

Average Calculated Current Density (amps/sq ft)	Minimum Time to Plate 0.0005 Inches of Cd-Ti Alloy (minutes)
20	17.4
25	14
30	12
35	10

(1) For the first part plated with a given set up, you can stop plating and remove the part from the bath for thickness and coverage checks. When anode configuration, plating time and voltage adjustments are satisfactory, plate all parts of the same configuration as a continuous operation. Parts used to adjust plating conditions must be stripped and plated again.

(2) Do not mechanically remove material from, polish, or brush the plated areas.

D. Cold water rinse (100°F max) for approximately 1-10 minutes.

NOTE: Control the overflow rate on all immersion rinse tanks to keep the dissolved solids below 1000 ppm at the rinse water outlet, measured at the time parts are removed from the tank.

E. As an option, and to remove light powder films (but not on parts to get a BAC5810 phosphate treatment):

(1) Rinse parts in chromic acid-water solution for 0.5-2 minutes at ambient temperature. To prepare this solution, mix 34 pounds of chromic acid with 100 gallons of water. Control at 4.1-6.9 oz/gal.

(2) Cold water rinse (100°F max.) 0.5-5 minutes.

F. Dry within 5 minutes. A one-minute-maximum hot rinse (130°F maximum) can be used to help dry the parts, but do not use this as the regular rinse after plating.

G. Remove masking materials.

H. Low hydrogen embrittlement stylus cadmium plate per SOPM 20-42-10 all rack marks, contact areas, or surfaces which could not be plated by rack or anode design.

7. POST-PLATE TREATMENT

A. Hydrogen Embrittlement Relief Bake

(1) Bake steel parts within 8 hours of plating as specified in Table 4, unless specified by the overhaul instructions. The bake is not necessary for corrosion resistant steels A-286, and 300 series.

Table 4: Hydrogen Embrittlement Relief Bake Data

Material	Bake Time and Temp.
All except carburized and 440 steels	12 hrs minimum at 350-400°F
Carburized Steel, 440A, B, and C steels	5-8 hrs at 250-300°F

(2) If parts are to get phosphate treatment or dry film lubricant, the bakes of those procedures can be combined with this bake if you start the bake within 8 hours after plating, and bake per Paragraph 7.A.(1) above.

NOTE: If the overhaul instructions specify chromate treatment, and Ultrachromate 300 will be used, you can chromate treat before the hydrogen embrittlement bake as an option. But the resistance to corrosion will be better if you bake first, and then do the chromate treatment.

B. Magnetic particle examine (SOPM 20-20-01) if specified by the overhaul instructions. Then alkaline solvent or manually clean the parts per SOPM 20-30-03.

C. When the overhaul instructions specify chromate treatment:

(1) Put the parts in one of the chromate solutions (Table 5).

(a) Ultrachromate 300 (normal) for 15-30 seconds, or

(b) Ultrachromate 300 (dilute) for 30-90 seconds, or

(c) Cronak for 5-10 seconds, or

(d) Any other chromate solution per QQ-P-416, Type II.

(2) Rinse for 0.5-2 minutes. Hot water at 160°F maximum can be used to help the parts dry. Do not use this rinse water for the usual rinse after the plating.

(3) Within 5 minutes, dry at a temperature no hotter than 160°F.

Table 5: Chromate Treatment Solution

Solution Name	Material	Makeup/100 gal.	Control
Ultrachromate 300 (Normal)	Ultrachromate 300 Concentrate	20 gal	5.0-10.1 oz/gal as $Cr0_3$ *[1]
	pH	—	0.8 to 1.1 *[1]*[2]
	Operating temp	—	65-95°F
Ultrachromate 300 (Dilute)	Ultrachromate 300 Concentrate	9 gal	2.8-5.5 oz/gal as $Cr0_3$ *[1]
	pH	—	0.9-1.3 *[1]*[2]
	Operating temp	—	65-95°F
Cronak	Sodium dichromate	165 lb	24-30 oz/gal
	Sulfuric acid	1 gal	—
	Nacconol 90F or 90G	6 oz	—
	pH	—	0.65-1.0 *[2]

*[1] To increase $Cr0_3$ and decrease pH, add Ultrachrome 300 concentrate.

*[2] The pH can also be decreased with sulfuric acid or increased with sodium hydroxide.

D. When the overhaul instructions specify phosphate treatment, apply the phosphate and bake per BAC5810, Type III. This phosphate treatment can be done before or after the hydrogen embrittlement relief bake of Paragraph 7.A. above. But, if you phosphate treat after that bake, bake the parts again as specified in BAC5810, Type III.

8. QUALITY CONTROL

A. Appearance

(1) When examined without magnification, the deposit must be dull, continuous, smooth, fine grained, tightly bonded, and have no blisters, pits, nodules, flakes, or burns. A frosty property is acceptable and recommended.

(2) If applicable, the chromate treatment coatings must be tightly bonded and have no powder.

B. Plating Thickness

(1) Measure the thickness with a procedure that has a precision equal to or better than +/-10 percent of the thickness to be measured.

(2) Measure the thickness on the plating after the bakes and chromate or phosphate treatments are completed.

(3) When not specified by overhaul instructions, use a minimum thickness of 0.0005 inch and a maximum of 0.0008 inch. Thickness greater than 0.0008 inch is permitted in areas where the cathode current density is usually high, such as corners and edges.

(4) Unless specified by overhaul instructions, the thickness requirements apply only to visible surfaces that can be touched by a 0.75 inch diameter ball. But all visible surfaces must be completely covered by the plating.

C. Titanium Content

(1) If you add hydrogen peroxide manually, do tests of the bath for titanium a minimum of one time each 8 hours of operation.

(2) If you add hydrogen peroxide continuously and automatically, do tests of the bath for titanium a minimum of one time each day. You can use a longer interval if your experience with the procedure makes you sure the titanium content stays within the specified limits.

D. For hydrogen embrittlement control, do tests on the plating solution with a hydrogen detection instrument. Make these tests at least twice a week, on the day of plating if more than 3 days after the last hydrogen test, after each time the filter is recharged, and after each carbonate treatment. Refer to BAC5804 and BSS7321 for details.

E. Adhesion

(1) As a check on the procedure, do tests on specimens or parts per BAC5804 and BSS7235.

(2) As a check on parts you plated, do a tape test per BSS7225, Type 1, class 1 (dry test, no scribe). Visually examine all surfaces for blisters or flakes.

F. Corrosion Resistance – Do a salt spray test on plated parts or specimens. Refer to BAC5746 for details.

G. Do tests on samples at regular intervals to be sure of the plating quality. If the interval is not specified by this procedure or in BAC5804, use an interval that agrees with standard industry practices, your experience with the procedure, and to make sure you can find parts that could have bad plating. If BAC5804 gives a formula to calculate the interval, use it for your basic quality control plan.