STANDARD OVERHAUL PRACTICES MANUAL

ELECTROLESS NICKEL PLATING

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STANDARD OVERHAUL PRACTICES MANUAL

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To: All holders of ELECTROLESS NICKEL PLATING 20-42-08.

Attached is the current revision to this STANDARD OVERHAUL PRACTICES MANUAL

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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.

ELECTROLESS NICKEL PLATING

1. INTRODUCTION

A. The data in this subject comes from Boeing Process Specification BAC5728. The airline has a copy of the Boeing Process Specification Manual.

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

C. This nickel plating agrees with the requirements of MIL-C-26074 but, for parts 180 ksi and below, tests for hydrogen embrittlement are not necessary.

(1) Class 1 is the basic electroless nickel plating same as MIL-C-26074, Class 1, 3 and 4. Use this plating if the overhaul instructions do not include the class of electroless nickel plating.

(2) Class 2 is plating heat treated to make it hard, same as MIL-C-26074, Class 2.

(3) Class 3 is plating with increased corrosion protection.

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

2. MATERIALS

NOTE: Equivalent substitutes can be used.

A. Nickel sulfate, liquid, electroless nickel grade

B. Potassium carbonate, anhydrous, reagent grade

C. Sulfamic acid, technical, V36701 or V87664

D. Acetic acid, glacial, technical, O-A-76

E. Ammonium hydroxide, technical

F. Sulfuric acid, reagent grade

G. Elnic 100 System, Elnic, Inc.

(1) C-5 concentrate

(2) RP-1 nickel replenisher

(3) RP-2 catalyst replenisher

H. Duraposit 85 System, V21075

(1) Duraposit M catalyst concentrate

(2) Duraposit R nickel concentrate

(3) Duraposit S base/catalyst replenisher

I. Hydrochloric acid, 20 degree Baume', technical grade, O-H-765

J. Filter bags – Polypropylene, 1 or 5 micron, V15472

K. Abrasive – Pumice, Grade FF

L. Filter cartridges – 1 or 5 micron, V15472

M. Ammonium Hydroxide, reagent grade

N. Niklad 794 System, V99442

(1) Niklad 794A makeup concentrate

(2) Niklad 794B makeup additive

(3) Niklad 794HZ replenisher

O. Niposit 65 System, V21079

(1) Niposit 65M, makeup concentrate

(2) Niposit 65R, nickel replenisher

(3) Niposit 65S, base replenisher

P. Endox 214, V02258

Q. Disposable Tank Liner – Polyethylene or polypropylene up to 0.030 inch thick

R. Abrasive Paper – Wet- or dry silica carbide (only), 600 grit

S. Scotch-Brite – Silicon carbide Type S (grey), ultrafine or superfine, V76381

T. Stop Off Material

(1) Turco 544 Maskant, V61102

(2) Adcoat AC-828 or AC-850 Maskant, V1M391

(3) Adcoat AC-832 Topcoat, V1M391

(4) MIL-P-23377

U. Nitric acid, technical grade

3. EQUIPMENT

A. Use plating tanks with agitation devices such as filtered air, or mechanical stirring, rocker arm, or a recirculated solution sufficient to make the temperature the same within +/- 5°F at all points in the tank. The tank can be of stainless steel (which can be acid passivated) with a passivation voltage source, cathodes and rectifier. Other tank materials can be used if a disposable liner is used.

B. Use filters that will agree with the filtration requirements specified for the plating solutions.

C. Auxiliary equipment such as heaters, pumps, and tanks used for makeup must permit acid passivation of their surfaces, or if nonmetal must be resistant to the passivating acid used. Cooling equipment is optional. The tanks must have covers.

4. PREPARATION OF SOLUTIONS

A. General Makeup and Control Requirements

NOTE: Refer to Paragraph 4.B. thru Paragraph 4.E., as applicable, for details about the nickel plating bath to be used.

(1) Make up the solution in a clean tank.

(a) If a stainless steel tank is used before you make up the plating solution, passivate all stainless steel surfaces with concentrated nitric acid at a temperature of 70-90°F. Let the nitric acid flow for 1 hour minimum throughout the system to include all pipes, filter holders (empty), and pumps. Drain, collect, and keep the nitric acid in a stainless steel container at the end of this passivation procedure to let you use it to clean and passivating the system again if the solution contains no more than 2 oz/gal nickel and 5 ppm copper. Then fully rinse and flush the system with water to be sure of the removal of all nitric acid from all surfaces that will touch the electroless nickel plating solution. Hose down the tank walls. Then, send small amounts of water through the system. Do this until the pH is 6.5 minimum. A maximum of 1 gallon of ammonium hydroxide, technical grade, can be added for each 50 gallons of rinse water used here.

(b) When stainless steel tanks are used, apply and keep a 1.0-1.5 volt anodic potential on the tank.

(2) Add the specified chemicals in the sequence given by the plating procedure to be used.

(3) Use water with these properties:

(a) Water for plating solutions must have an electrical resistivity of not less than 50,000 ohm-cm.

(b) Rinse water must not contain more than 750 ppm total solids.

(4) When you move the plating solution from the holding tank to the plating tank, send it through a 5-micron filter. During plating, send at least 5 tank volumes per hour through a 5-micron filter. When you plate for long continuous times, 10 volumes per hour is the best rate. As an alternative, batch-filter at least 5 tank volumes through a 5-micron filter at least once each 24 hour period that the solution is used.

(5) Heat the solution to the operating temperature immediately before you start to plate.

(6) Cool the solution to below 150°F immediately after plating is complete.

(7) Adjust the solution to the specified control limits (laboratory analysis) before plating, and while the solution is below 150°F. Mix fully before you heat the solution to the plating temperature. Niposit 65 plating solution can be adjusted during the plating procedure by its procedure for a hot solution.

(8) Decomposition of the bath will cause bubbles of gas with a black precipitate of finely divided nickel. If this occurs, quickly cool the solution and discard it. Do not try to make it serviceable. Clean and passivate the tank again before you use it to make a new solution.

(9) Keep the cover on the tank at all times except when you add or remove parts for plating or during maintenance of solution. Particulate matter that falls into the solution will cause rough plating.

B. Niposit 65 Plating Solution

WARNING: NIPOSIT CONCENTRATES ARE HARMFUL IF SWALLOWED. DO NOT TAKE INTERNALLY. AVOID BREATHING OF VAPORS. AVOID CONTACT WITH SKIN, EYES, AND CLOTHING. WEAR PROTECTIVE CLOTHING, RUBBER GLOVES, AND SAFETY GLASSES. MANUAL: CMM MODEL: 747

(1) Clean the auxiliary tank and add these materials in the sequence given:

Item	Parts by Volume	Gallons to make 100 Gal. final solution
Water	12.0	75.00
Niposit 65R	1.0	6.25
Niposit 65M	3.0	18.75

(2) Control the plating solution temperature within +/- 5°F of a value in the range of 180-205°F (195-200°F is best).

(3) Control the metallic nickel in the plating solution at 5.7 - 7.8 g/liter (6.9 - 7.1 g/liter is best). Control the pH at 4.6-5.2.

(a) For each gallon of solution and each 1.0 gram/liter (3.8 gram/gal) of nickel required, add 37 ml of Niposit 65R followed by 74 ml of Niposit 65S.

1) Add the concentrates slowly to a cold solution as you stir it.

2) Add no more than one gallon at a time and add one replenisher, then the other and stir each until the necessary amount is added.

3) If a draw off is necessary, first adjust the solution up to or evaporate down to its original makeup volume and make an analysis. If this is not done, imbalance will occur of the proprietary additives which keep the plating rate stable.

(b) Increase the pH with ammonium hydroxide. Decrease the pH with a sulfuric acid solution (1 volume acid added to 9 volumes water).

(4) Metal contamination limits:

Metal	Maximum PPM
Cadmium	5
Chromium (as Cr +6)	8
Copper	12
Lead	6

(5) During the plating procedure, a hot solution can be adjusted when parts are in the bath with these precautions:

(a) At the same time, from opposite sides of the tank, slowly add two parts Niposit 65S and one part Niposit 65R. Add as you stir the solution. For maximum plate and solution life, add sufficient replenishment to keep the chemical concentration of nickel in the 6.9-7.1 g/liter range as plating continues. The rate of addition can be made to agree with the calculated decrease of nickel from the solution. Calculate this before the start of plating and make the adjustments in increments during the expected plating time.

(b) Adjustment of nickel to the correct value usually keeps the solution pH in the correct range. More adjustments can be made with reagent grade ammonium hydroxide or sulfuric acid. Dilute the concentrated sulfuric acid to 50% by volume before you add it to the plating bath. The Niposit replenishers 65R and 65S can also be used individually to make small pH adjustments.

(c) If there is a large decrease in solution volume, as by spills or unusual drag out, add more solution made by the above instructions.

C. Duraposit 85 Plating Solution

(1) Clean the auxiliary tank and add these materials in the sequence given:

Item	Parts by Volume
Water	80 (80.5 if liquid nickel sulfate is used)
Duraposit R, or	5
Liquid nickel sulfate	4.5
Duraposit M	15

NOTE: Liquid nickel sulfate contains approximately 133.8 grams/liter metallic nickel or 600 grams/liter as nickel sulfate hexahydrate.

(2) Control the nickel concentration at 80-100% (4.9-6.1 grams/liter as nickel).

(a) Add Duraposit R or liquid nickel sulfate as necessary but not more than 15% at one time.

(b) For each part of Duraposit R or liquid nickel sulfate added, subsequently and slowly add two parts of Duraposit S.

(3) Control the solution pH at 4.8-5.2. Increase the pH with liquid potassium carbonate (700 grams/liter of the anhydrous compound in deionized water). Decrease the pH with sulfuric acid approximately 20%.

(4) Control the solution temperature at 180-200°F (190°F is best).

(5) Control the load at 0.25-1.00 square feet per gallon (1.00 sq. ft./gal is best).

(6) Metal contamination limits:

Metal	Maximum PPM
Cadmium	2
Chromium (as Cr + 6)	40
Copper	2
Iron plus zinc	200
Lead	6

(7) Replace the solution after 3 operational cycles.

D. Elnic 100 Plating Solution

(1) Clean the auxiliary tank. Then add 4 volume parts water and 1 volume parts C-5 concentrate.

(2) Control the nickel concentration at 75-95% (5-7 grams/liter as nickel).

(a) We recommend adjustment when the nickel concentration decreases to 85%. Add replenishers RP-1 and RP-2 as necessary while parts are plating. For best results, add the replenishers in 5 or 10% increments. For a 10% increment adjustment, add 25 ml of RP-1 and 50 ml of RP-2 per gallon of plating solution.

(b) Add the RP-1 replenisher smoothly across the tank. Then add the RP-2 replenisher slowly to prevent foam. Do not add RP-2 around the heaters or above the parts.

(c) Make the analysis for nickel as frequently as necessary to be sure the nickel constration stays in the correct range.

(3) Control the solution pH at 4.6-4.8.

(a) Usually adjustment of the nickel to the correct value keeps the solution pH in the correct range. More adjustment can be made with ammonium hydroxide or sulfuric or acetic acid. The ammonium hydroxide and the sulfuric acid must be first diluted with an equal volume of deionized water.

(b) Checks of the pH are best made after the nickel adjustment is completed. Large changes in solution pH are usually a sign of contamination that comes in from the pretreatment line.

(4) Control the solution temperature at 185-195°F.

(5) Control the load at 0.25-1.00 square feet per gallon (0.4 sq ft/gal is best).

(6) Metal contamination limits:

Metal	Maximum PPM
Cadmium	2
Chromium (as Cr +6)	40

Metal	Maximum PPM
Copper	6
Iron plus zinc	200
Lead	2

(7) At the end of each cycle of operation (a 100% replenishment which is the same as 250 ml RP-1 and 500 ml of RP-2), add 10% C-5 concentration. Then adjust the nickel concentration per Paragraph 4.D.(2) above.

E. Niklad 794 Plating Solution

(1) Clean the auxiliary tank and add these materials in the sequence given:

Item	Parts by Volume	Gallons to make 100 Gal. final solution
Water	50	50.0
Niklad 794A	8	8.0
Niklad 794B	15	15.0
Water	27	27.0

(2) Control the pH at 4.5-5.5. Increase the pH with ammonium hydroxide. Decrease the pH with a sulfuric acid solution (1 volume acid added to 9 volumes water).

(3) Control the plating solution temperature at 185-205°F.

(4) Control the dissolved nickel in the solution at 0.4-0.9 oz/gal.

(a) For each 0.1 oz/gal of nickel deposited, add 2.0 fl oz/gal (1.5 gal/100 gal) each of Niklad 794A and Niklad 794B.

(b) When the plating thickness will be more than 0.003 inch, use 20 gal/100 gal Niklad 794B for make up. If not, use Niklad 794B only when there is a large decrease in solution volume, as because of spills or unusual heavy drag out.

(5) Metal contamination limits:

Metal	Maximum PPM
Cadmium	4
Chromium (as Cr +6)	12
Copper	12
Iron	150
Lead	3
Zinc	150

(6) Adjustment of nickel to the correct value usually keeps the solution pH in the correct operating range. If more adjustment of pH is necessary, refer to Paragraph 4.E.(2) above.

F. Uninhibited Hydrochloric Acid Solution (BAC5625, Solution 19)

(1) Add 14 gallons hydrochloric acid to 86 gallons water to make 100 gallons final solution.

(2) Maintain solution at a temperature of 60-140°F.

(3) Control solution at 5.5-8.0 oz/gal hydrochloric acid and 1.0 oz/gal (maximum) iron.

G. Sulfamic Acid Solution

(1) For each 100 gallons of solution, put 75 gallons water in a tank. Add and dissolve 90 pounds of sulfamic acid. Then add water as necessary.

(2) Control the solution at 13-15 oz/gal. Operate at room temperature.

5. PREPARATION OF PARTS

A. General

(1) The base metal must be free from defects that will be a problem for serviceability of the coating and part.

(2) Unless specified by the overhaul instructions, the surfaces of parts to be plated must be 125 microinch finish or smoother, and have no blemishes, pits, tool marks or other irregularities.

(3) Unless specified, apply this plating after all base-metal heat treatment and mechanical operations (machining, brazing, welding, forming, perforating, etc.).

B. Before plating, stress relieve all low alloy and corrosion resistant steel parts per the overhaul instructions. Where no stress relief details are given stress relief per SOPM 20-10-02.

C. Cleaning, Masking Racking

(1) If necessary, vapor degrease, emulsion clean, solvent clean, manual clean, or alkaline clean per SOPM 20-30-03.

(2) Remove scale from clean ferrous alloys, nickel alloys, cobalt alloys, and nickel plate and coil springs per SOPM 20-30-03.

(3) Surfaces must be water-break-free after they are put in any processing solution or rinse, except after vapor degreasing, solvent cleaning, or emulsion cleaning. A water-break-free surface is a surface which keeps a continuous water film for a period of at least 30 seconds after spray or soak in clean water at temperatures less than 100°F. Clean parts which do not have water-break-free surfaces.

(4) Put parts in racks to prevent caught gas during the plating. Do not let parts touch other parts or the tank. Turn parts to help them drain. Let the rack touch the parts in other than important areas if possible.

(5) Use electroless nickel stop-off on racks, fixtures, and as a maskant on parts.

D. Activation

NOTE: Unless specified, rinse water temperature must be less than 200°F.

(1) Heat-Treated Alloy Steels

(a) For steels above 180 ksi, dry abrasive blast per SOPM 20-30-03. For steels below 180 ksi, this is preferred option to the TSPG or Endox 214 activation procedures.

(b) TSPG Procedure

1) Periodic reverse clean in TSPG cleaner per SOPM 20-30-03 to remove heat scale, discoloration or rust. Usually 5-20 minutes is sufficient. As an option, abrasive blast with sand or water and pumice per SOPM 20-30-03.

2) Put the parts in sulfamic acid solution for 1-2 minutes to remove smut. Examine the surface for water breaks and, if necessary, clean again per Paragraph 5.C.(1), Paragraph 5.C.(2).

3) Periodic reverse clean in TSPG solution per SOPM 20-30-03 for 1-2 minutes. Stop on the cathodic cycle.

4) Rinse with water. If the parts have smut, put them in sulfamic acid solution for 30-60 seconds. Rinse again and put the parts in the plating solution. Do not let the parts dry.

(c) Endox 214 Procedure

1) Periodic reverse clean in Endox 214 solution per SOPM 20-30-03. Scotch-Brite or water-pumice-air blast can be used to help in scale removal.

2) Rinse with water. If the parts have smut or scale, hand scour thoroughly with silicon carbide Scotch-Brite (ultra-fine) or 600 grit silicon carbide wet/dry paper and clean water. Rinse thoroughly for at least 5 minutes. Examine the surface for water-breaks again. If water-breaks occur in less than 30 seconds, rescour, rinse, and examine again for water-breaks. Then, if water-breaks occur, go back to Paragraph 5.D.(1)(c)1) and do the procedure again.

3) When no water-breaks occur, activate with Endox 214 for 2-5 minutes at 3-7 volts with the periodic reverser set as in the cleaning procedure of Paragraph 5.D.(1)(c)1) above. End up anodically for 10-20 seconds before you turn off the rectifier.

4) Rinse with water for 10-15 minutes. If the parts have smut, put the parts in sulfamic acid solution for 1-2 minutes. Rinse again with water for 2-5 minutes.

5) Periodic reverse activate in Endox 214 for 1-2 minutes at 3.5-4.5 volts. Use the same periodic reverse cycle as in the cleaning procedure of Paragraph 5.D.(1)(c)1) above. Make the last cycle 15-20 seconds anodic.

6) Do not let the activated parts dry. Keep parts wet at all times. Rinse in air-agitated tap water or deionized water for at least 5 minutes. Continue to keep the parts wet until fully in the plating solution.

(2) Non-Heat-Treated Alloy Steel

(a) Put the parts in uninhibited hydrochloric acid solution for 1 minute maximum.

(b) Rinse and examine for smut. If the parts have no smut, rinse and continue with plating process. If the parts have smut, activate with the procedure for heat-treated alloy steel in Paragraph 5.D.(1) above.

(c) Nickel-Plate, Corrosion Resistant Steel, Nickel and Cobalt Base Alloys – Activate and nickel strike per SOPM 20-42-09 and continue with plating process.

(d) Aluminum Alloys – Prepare for plating per SOPM 20-41-04.

6. ELECTROLESS NICKEL PLATING PROCEDURE

A. Do not let the parts dry after activation. Immediately put them in the plating solution. If gassing does not start immediately, momentarily make the parts cathodic (negative) 1-3 volts or touch the parts with a nickel plated or soft iron wire. The tank passivation system can be used as the activation voltage source.

B. Constant agitation is necessary when the solutions are above 160°F. Air agitation is preferred, but mechanical agitation can be used if this moves the solution satisfactorily. Also, air agitation or filtered plating solution pointed at some areas of the part can be used to prevent gas pits or nodules because of contamination that comes down on surfaces, especially top surfaces. Mechanical movement of the part to prevent nodules or rough surfaces is recommended.

C. Include adhesion control coupons and, as applicable, corrosion and Class 2 and 3 control specimens with each tank load of parts. Plate these coupons along with the parts and do not remove them until the plating is completed.

D. The specimens used to monitor the plating thickness and calculate the plating rates can be removed at different times before completion of the plating. A correctly adjusted electroless nickel bath will plate at approximately 0.0005 inch per hour per surface.

E. Do not let parts touch each other or the tank.

F. Turn and move parts to prevent problems caused by caught gas bubbles.

G. Do not let the solution level decrease below 90% of the initial level. Add water to keep the level up. If a long plating cycle will decrease the nickel below the minimum permitted concentration, adjust the solution as necessary during the plating operation.

H. Plating thickness

(1) If the specified thickness is 0.004 inch or less, plate to get that thickness.

(2) If the specified thickness is more than 0.004 inch, remove the part from the plating bath at each 0.003-0.005 inch buildup. Rinse and make the surface rough with silicon carbide paper or Scotch-Brite. (This surface treatment is not necessary if there are no nodules or other buildups.) Activate and continue plating. Do not plate thicker than 0.015 inch.

(3) If the plating thicknes is not specified by the overhaul instructions, refer to Paragraph 7.B. for minimum thickness requirements by alloy type.

I. If the plating must be stopped, such as when bath decomposition occurs, immediately remove the parts and the test specimens from the plating bath. Rinse and dry them. Examine the plating for defects. If the plating is satisfactory, periodic reverse clean per SOPM 20-30-03 (optional) and then nickel strike per SOPM 20-42-09. Then continue plating.

J. Remove the parts from plating tank. Rinse, dry and visually examine the parts.

K. Remove maskant. Parts can be rinsed again and dried or alkaline cleaned per SOPM 20-30-03 to remove stains.

L. Post Plate Baking Requirements

(1) If not specified by overhaul manual instructions, bake parts per Table 1.

Table 1: Post-Plate Baking

BAC 5728 CLASS	BASE METAL	HEAT TREAT (KSI)	TIME (hr)	TEMP (°F)
1 *[1]	Alloy Steel	220 and up	23	350-400
		180-220	3	350-400
		Below 180	No bake	
		160-220 *[1]	3	350-400
		Carburized	8	250-300
	440A, B or C CRES	Hardened	8	250-300
2 *[2]	Steel *[3]	Below 220	3 then 0.5-1.5	350-400 625-675 *[4]

Table 1: Post-Plate Baking (Continued)

BAC 5728 CLASS	BASE METAL	HEAT TREAT (KSI)	TIME (hr)	TEMP (°F)
3	Steel	No bake unless specifically required		
MIL-C-26074, Class 3	Aluminum		1	350-400
Other Classes	Aluminum		1	240-260

*[1] Start this bake within 4 hours after plating.

*[2] Start this bake within 8 hours after plating.

*[3] Externally-threaded parts

*[4] Parts can be cooled between bakes.

7. QUALITY CONTROL

A. The nickel plating must be smooth, fine-grained, and have no blisters, pits, nodules, or porosity or separation when examined without magnification. Discoloration resulting from baking is acceptable.

B. On parts other than aluminum, the plating must not come off when tested per BSS 7235. As an alternative for parts plated per MIL-C-26074, the plating must not come off from the outside radius of a part or specimen that was bent 180° on a 1/2-inch diameter mandrel.

C. Unless specified by overhaul instruction, the minimum thickness must be:

(1) On ferrous alloys with less than 12% chromium, 0.0020 inch

(2) On aluminum and aluminum alloys, 0.015 inch

(3) On all other metals, 0.0005 inch

D. For tests of hardness, corrosion resistance and hydrogen embrittlement, refer to BAC5728.