STANDARD OVERHAUL PRACTICES MANUAL

ELECTRODEPOSITED NICKEL PLATING

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STANDARD OVERHAUL PRACTICES MANUAL

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To: All holders of ELECTRODEPOSITED NICKEL PLATING 20-42-09.

Attached is the current revision to this STANDARD OVERHAUL PRACTICES MANUAL

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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.

ELECTRODEPOSITED NICKEL PLATING

1. INTRODUCTION

A. The data in this subject comes from Boeing Process Specification BAC5746 for electrodeposited nickel plating. 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 to help you write minimum standards.

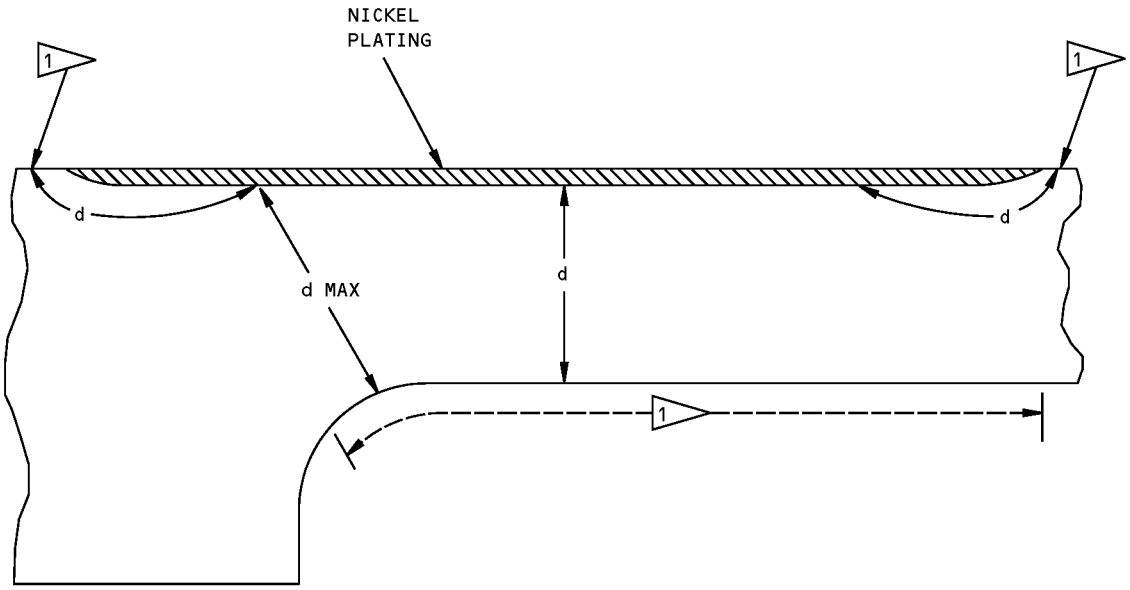
C. This procedure makes nickel electroplating that agrees with QQ-N-290.

D. This nickel plating is a relatively soft, low stressed, ductile coating for the protection of steels and other alloys and for the buildup of surfaces for repair purposes. Do not use this nickel plating on steels heat-treated above 220 ksi unless specified by the applicable overhaul instructions.

(1) The distance from the nickel plated surface through the base metal to the nearest unplated surface must be less than 2 inches (Figure 1). The unplated surface must have an area at least one-third that of the nickel plated surface to let hydrogen be baked out.

(2) The surface must be shot peened before you plate it.

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



d = HYDROGEN DIFFUSION PATH TO NEAREST UNPLATED SURFACE

d MAX = LONGEST HYDROGEN DIFFUSION PATH FOR PART. MUST BE LESS THAN 2.0 INCHES

NICKEL BUILD-UP OF GRIND-OUT

1 THESE SURFACES MUST BE WITHOUT FINISH AT THE TIME OF NICKEL PLATING

Hydrogen Diffusion Paths
Figure 1

2. MATERIALS

A. Sulfamate Nickel Plating Solution (Concentrate), Purified. This material must not contain brighteners or stress reducers but can contain bromides. Available from these vendors: V99442 (Type SN makeup, SNR replenisher and SNR-24 concentrated replenisher); V02621, V0309B, V27201 or V71361, V76323.

B. Sulfamic Acid, plating grade

C. Wetting Agent (Anti-pit)

(1) Duponel ME, V18873

(2) No. 7, No. 9, or No. Y-17, V27201 or V76383

(3) SNAP, SNAP-L (liquid), or SNAP-A/M, V99442

D. Boric Acid, Crystals, Technical

E. Nickel Anodes, 99% nickel rolled depolarized or carbon-nickel cast and rolled

F. Nickel Carbonate, plating grade

G. Activated Charcoal, plating grade

H. Bromide

(1) Additive No. B, V99442

(2) Nickel Bromide Concentrate, 18 percent, V0309B

(3) Nickel Bromide Crystals, plating grade, V0309B

(4) Sodium Bromide, pure or USP grade

I. Inhibitors

(1) Amchem Rodine 100 or 213, V84063

(2) Turco Acryl, V61102

J. Endox 214 cleaner solution (SOPM 20-30-03)

K. Trisodium Phosphate - Glutamate (TSPG) cleaner solution (SOPM 20-30-03)

L. Nickel Sulfate Hexahydrate, plating grade

M. Filter Aid, Diatomaceous earth

N. Hydrogen Peroxide, 35%, technical

O. Nickel Chloride Hexahydrate, plating grade

P. Hydrochloric Acid, 20-degree Baume', Technical, O-H-765

Q. Anode bags – unbleached muslin, dynel or napped polypropylene

R. Maskant, Turcoform 5696, V61102

S. Anode Basket and Hooks, Titanium (CP is recommended)

T. Nickel Chips, Sulfur Depolarized (SD)

U. Sodium Hydroxide, Flake or Granulated, Technical, O-S-598, or better

V. Sulfuric Acid, 66-degree Baume', Plating Grade, O-S-809, or better

W. Fluoboric Acid, 48 percent, technical

X. Hydrofluoric Acid, 70 percent, O-H-795

Y. Ammonium Bifluoride, technical

Z. Conductive Silver Composition, DuPont No. 8535, V18873

3. PREPARATION OF SOLUTIONS

WARNING: SOLUTIONS USED FOR NICKEL PLATING ARE CORROSIVE AND TOXIC. USE ADEQUATE PRECAUTIONARY MEASURES TO AVOID INJURY TO PERSONNEL AND DAMAGE TO EQUIPMENT.

A. Sulfamate Nickel Plating Solution

(1) Clean the tank thoroughly. Fill it to 1/2 level with nickel sulfamate concentrate, diluted with an equal volume of water.

(2) The bath can be made with bromides or chlorides, or you can do without them if you use sulfur depolarized anodes.

(a) Add bromide as necessary to get a bromine concentration of 0.2-1.5 oz/gal in the final solution.

(b) Or add nickel chloride hexahydrate to get a chlorine concentration of 0.45-0.65 oz/gal in the final solution.

(3) Add boric acid as necessary to get a boric acid concentration of 4.0 oz/gal minimum in the final solution. You can dissolve the boric acid crystals in deionized or distilled water and add this solution to the bath, or heat the bath to 150°F maximum and add the crystals directly. Add the crystals slowly and stir the solution.

(4) Add more nickel sulfamate concentrate as necessary to get a nickel concentration of 10-15 oz/gal in the final solution. Fill the tank to operating level with water.

(5) Adjust the pH of the solution, as required, as follows:

(a) Decrease the pH with a solution of sulfamic acid and water.

(b) Increase the pH with nickel carbonate, added through the filter.

(c) Add the chemicals carefully, and let the solution come back to equilibrium before you add more chemicals. If you added nickel carbonate, keep the solution at 120-140°F for at least 2 hours before you plate with it.

(6) Adjust the surface tension with wetting agent, if necessary. If powdered wetting agent is used, dissolve it 6 ounces per pint of warm water before you add it.

(7) Control the solution at these values: nickel sulfamate 43 oz/gal minimum, 0.2-1.5 oz/gal bromide or 0.45-0.65 oz/gal chloride, 28-40 dyne/cm surface tension, 10-15 oz/gal nickel (Types 1 and 3 plating) or 10 oz/gal minimum (Type 2 plating), and pH of 3.0-5.0. Control the boric acid as saturated with boric-acid-filled anode bags in the solution.

(8) Control the solution temperature at 120-140°F. During plating, control the temperature within +/- 5°F in that range.

(9) Use nickel anodes with anode bags. Use the bagged titanium anode basket with sulfur depolarized nickel chips.

(10) Remove metallic contamination per Paragraph 4. if above these values: 150 mg/liter iron, 37.5 mg/liter copper, 52.5 mg/liter zinc, 2.25 mg/liter lead, 7.50 mg/liter hexavalent chromium.

B. Watts Nickel Plating Solution (for plating parts below 220 ksi)

(1) Clean tank thoroughly and fill to 1/2 level with warm (120-140°F) deionized or distilled water.

(2) Add 40.0 ounces nickel sulfate for each gallon of final solution and stir until the chemical is dissolved.

(3) Add 6.0 ounces nickel chloride for each gallon of final solution and stir until the chemical is dissolved.

(4) Dissolve 5.0 ounces boric acid for each gallon of final solution in warm water, add to Watts solution, and stir to mix.

(5) Add water to fill the tank to the operating level.

(6) Adjust the pH of the solution as follows:

(a) Decrease the pH with a solution of sulfuric acid and water.

(b) Increase the pH with nickel carbonate, added through the filter.

(c) Add the chemicals carefully, and let the solution come back to equilibrium before you add more chemicals. If you added nickel carbonate, keep the solution at 120-140°F for at least 2 hours before you plate with it.

(7) Add wetting agent powder, 0.05 oz/gal, or liquid, 0.1 oz/gal.

(8) Control the solution at these values: 38.0-44.0 oz/gal nickel sulfate, 5.0-7.0 oz/gal nickel chloride, 4.0-5.0 oz/gal boric acid, 35.0-45.0 dyne/cm surface tension, 9.0-11.0 oz/gal nickel, and pH of 3.0-4.0.

(9) Control the solution at a temperature of 90-130°F. During plating, control the temperature within ±5°F in that range.

(10) Use nickel anodes with anode bags. Use the bagged titanium anode basket with sulfur depolarized nickel chips.

C. Nickel Strike Solution

(1) Clean tank thoroughly and fill to 1/2 level with water.

(2) Add 32 ounces nickel chloride powder (or 0.33 gallon of a nickel chloride liquid that has 6 pounds nickel chloride hexahydrate per gallon) for each gallon of final solution and stir until the chemical is dissolved.

(3) Add 10 fluid ounces hydrochloric acid for each gallon of final solution, or 44 fluid ounces per gallon for the optional high-chloride bath.

(4) Fill the tank to operating level with water.

(5) Control the solution at these values: 30.0-35.0 oz/gal nickel chloride, 3-5 oz/gal as hydrochloric acid for the standard bath, or 15-17 oz/gal hydrochloric acid for the optional high-chloride bath, and 1.0 oz/gal, maximum, iron.

(6) If the iron concentration gets to 1.0 oz/gal, make a new nickel strike solution, or remove the iron per Paragraph 4.B. Remove copper contamination per Paragraph 4.B. if you get dark deposits on the nickel plating or metallic copper immersion deposits on ferrous surfaces.

(7) Control the solution temperature at 60-100°F.

(8) Control anode to cathode ratio at 1 to 1 minimum.

(9) Use nickel anodes with anode bags. Use the bagged titanium anode basket with sulfur depolarized nickel chips.

D. Fluoboric Acid Activation Solution (for copper surfaces only)

(1) Fill the tank to 9/10 level with water.

(2) Add an amount of fluoboric acid equal to 2.5% of the final tank volume.

(3) Fill the tank to the operating level with water.

(4) Control the fluoboric acid at 1.25-2.50 oz/gal HBF4. Control the solution temperature at 60-90°F.

E. Sulfuric Acid Bath

(1) Make this with 13-15 ounces sulfamic acid per gallon (97-112 grams per liter) of final solution in water.

(2) Use the solution at room temperature.

F. Inhibited Hydrochloric Acid (BAC5625 Solution 1 or BAC5751 Solution 1)

(1) Clean tank completely. Put 10 gallons of water in the tank.

(2) Add 54 gallons hydrochloric acid for each 100 gallons of final solution.

(3) Add 5 pints of inhibitor. Do not mix different inhibitors.

(4) Fill the tank with water to the final level.

(5) Keep the solution at room temperature (60-100°F).

(6) Control the solution at 23-38 oz/gal HCl, 5 oz/gal maximum iron, and 0.5 oz/gal maximum copper. When you add hydrochloride acid to control the acid concentration, be sure to add 1 fluid ounce of inhibitor per gallon of acid (or 0.8 percent by volume).

G. Sulfuric - HF Solution

NOTE: The quantities of hydrofluoric acid in this recipe are for 70% HF. If you use a different concentration of hydrofluoric acid, be sure to adjust the quantities of this acid.

(1) Clean tank thoroughly and make up solution as follows:

(a) Fill tank to 1/2 level with cold water.

(b) While stirring, slowly add 25 gallons of sulfuric acid for each 100 gallons of final solution.

(c) Let the solution cool below 90°F, then add 4 gallons of hydrofluoric acid, or 25 pounds of ammonium bifluoride, for each 100 gallons of final solution.

(d) Fill the tank to operating level with cold water, stirring constantly.

(2) Control the solution temperature at 60-90°F.

(3) Control the solution at these values: 50-70 oz/gal sulfuric acid, 3-6 oz/gal fluoride, and 1.5 oz/gal maximum iron.

(4) Use acid resistant carbon electrodes or lead (Pb-7Sn) electrodes.

4. NICKEL PLATING SOLUTION PURIFICATION

A. Removal of Organic Contamination

(1) Move the dirty solution to a different tank to permit removal of the contamination.

(2) Adjust the pH to 2.0-2.5 with careful use of these chemicals:

(a) For sulfamate solution, add sulfamic acid.

(b) For Watts solution, add sulfuric acid.

(c) For the nickel strike solution, add hydrochloric acid.

(3) Add 1.0 pint hydrogen peroxide for each 100 gallons of solution. Agitate solution for 2 to 4 hours.

CAUTION: DO NOT HEAT THE SOLUTION ABOVE 150°F, BECAUSE THE CHEMICALS WILL DECOMPOSE AT APPROXIMATELY 155°F.

(4) Heat the solution to 140-150°F. Add 5-7 pounds activated charcoal per 100 gallons of solution and agitate 3-4 hours, or let the heated solution flow through an activated charcoal filter.

(5) Let the solution settle for at least 8 hours.

(6) Prepare a filter cake with 2 ounces of filter aid (as a 1 pound per gallon slurry) per square foot of filtering area. Let the solution flow through the filter until it comes out transparent.

(7) Rinse the filter with clean water.

(8) Increase the solution pH to 5.5-5.8 with a slurry of nickel carbonate.

(9) Clean the plating tank thoroughly. Heat solution to 120-140°F and send the solution through the filter, back to the plating tank.

(10) Keep the solution at 120-140°F for at least 2 hours before you use it.

(11) Adjust the temperature, pH and surface tension of the solution to the correct operating values per Paragraph 3.A., Paragraph 3.B., or Paragraph 3.C., as applicable.

B. Removal of Metal Impurities

(1) Electrolytic method (to remove copper, lead, iron, and zinc):

(a) Heat solution to operating temperature and agitate solution.

(b) With corrugated steel cathodes, fill the tank with as large a cathode area as possible.

(c) Plate something at 3.5-4.5 asf for 4-5 ampere hours per gallon of solution.

(2) High pH Precipitation Method (to remove iron and chromium):

NOTE: This procedure could remove some of the organic material.

(a) Move the solution to a different tank.

(b) Heat the solution to 120-140°F.

(c) Add 1.0 pint hydrogen peroxide per 100 gallons of solution.

(d) Increase the solution pH to 5.5-5.8 with a slurry of nickel carbonate.

(e) Add 4.0 pounds activated charcoal per 100 gallons of solution and agitate solution for 3 to 4 hours or let the heated solution flow through an activated charcoal filter.

(f) Let the solution stand at a temperature of 130-140°F for at least 8 hours.

(g) Prepare a filter cake with 2 ounces of filter aid (as a 1 pound per gallon slurry) per square foot of filtering area.

(h) Clean the plating tank thoroughly. Send the solution, through the filter, back to the plating tank.

(i) Adjust the temperature, pH and surface tension of the solution to the correct normal operating values per Paragraph 3.A., Paragraph 3.B., or Paragraph 3.C., as applicable.

5. PLATING PROCESSES

A. General

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

(2) The nickel plating solutions must be purified per Paragraph 4. when one or more of these conditions occur:

(a) The nickel plating you get is mirror-bright or rough, or has cracks, flakes or streaks or bad color after all solution controls are within correct limits.

(b) Organic contamination, such as solvent, lacquer, paint, oil, or grease, came into the solution. Cured masking materials on parts are not contamination if the plating results are satisfactory.

(c) Metallic contamination is more than the limits specified for the plating solution.

(d) The sulfamate nickel plating stress, when tested per BAC5746, is not within 0-9 ksi (tensile) for plating on parts 220 ksi and above, or -1 ksi (compressive) to 15 ksi (tensile) for plating on parts below 220 ksi.

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

(4) Unless the overhaul instructions are different, the part surface must not be rougher than 125 microinches.

B. Nickel plating on parts below 220 ksi (BAC5746, Type 1)

NOTE: In this procedure, you can use the sulfamate or the Watts plating baths.

(1) Stress relieve, if required.

(2) Vapor degrease, emulsion clean, or solvent clean, per SOPM 20-30-03, if required.

(3) Mask and rack as required.

(4) For low alloy steels below 220 ksi.

(a) If necessary, remove scale and oxide with one of these procedures:

1) Dry abrasive clean with glass beads or aluminum oxide abrasive. Then alkaline clean 10-12 minutes. Warm water rinse for 5 minutes minimum. Then start to nickel plate, per Paragraph 5.B.(7), within one minute.

2) Etch in inhibited hydrochloric acid solution 30 seconds - 5 minutes to remove light amounts of oxides, or 1-10 minutes to remove scale. Rinse immediately in cold water. If the oxides and scale are not removed, put the part back in the solution as necessary, but not more than 10 minutes (steels 180 ksi and above) or 25 minutes (steels below 180 ksi). Then fully rinse and continue with Paragraph 5.B.(7) within one minute.

3) For low alloy steels 180 ksi or below

a) Periodic reverse clean in TSPG solution 10-20 minutes at 120-140°F and 100-250 asf. Rinse with water and continue with Paragraph 5.B.(7) within one minute.

b) Periodic reverse clean in Endox 214 solution. Rinse with water and start to nickel plate, per Paragraph 5.B.(7), within one minute.

(b) Use one of these procedures to activate the part surface

1) TSPG (Preferred option for low alloy steels 180 ksi or below)

a) Periodic reverse electroactivate in TSPG solution. End on the anodic cycle.

b) Rinse 2-3 minutes.

c) Put the part in sulfamic acid solution for 30-90 seconds. Then start to nickel plate, per Paragraph 5.B.(7), within one minute.

2) Endox 214 Solution

a) Cathodic clean in Endox 214 solution at 50 asf for 1.5-2.0 minutes.

b) Rinse in warm water for 2-3 minutes.

c) Put the part in sulfamic acid solution for 30-60 seconds.

d) Rinse in warm water for 2-3 minutes.

e) Cathodic clean in Endox 214 solution again, at 50 asf for 1.5-2.0 minutes.

f) Rinse in warm water for 2-3 minutes. Then rinse in cold water for 30-60 seconds.

g) Put the part in sulfamic acid solution for 30-60 seconds.

h) Do not rinse. Within 30 seconds, put the part in the nickel plating solution and plate them, per Paragraph 5.B.(7).

3) Inhibited Hydrochloric Acid

a) Alkaline clean per SOPM 20-30-03. Then rinse in cold water.

b) Put the part in inhibited hydrochloric acid for 15 seconds maximum (parts cleaned with glass beads) or 10 seconds maximum (parts cleaned with aluminum oxide).

c) Rinse in cold water. Then start to nickel plate, per Paragraph 5.B.(7), within 30 seconds.

(5) For nickel surfaces, nickel, cobalt and chromium alloys, PH, 300 and 400 series CRES

(a) For PH steels, this procedure is preferred over the procedure of Paragraph 5.B.(5)(b):

1) Soak or spray alkaline clean, or dry or wet abrasive clean, per SOPM 20-30-03.

2) Rinse in cold water.

3) Put the part in inhibited hydrochloric acid for 30 seconds to one minute.

4) Rinse in cold water. As an option, parts can be held in an Endox 214 bath, a cyanide holding bath (BAC5625, Solution 11), or alkaline cleaner. After this option is used, rinse the parts in cold water.

5) Make electrical connections and put the parts in the nickel strike bath. Apply anodic current first for 3.0-3.5 minutes, then switch to cathodic for 4-5 minutes. Use 20-25 asf at 3-7 volts. If the anodic strike causes smut or bond problems on PH steels, use only the cathodic strike for 4-5 minutes.

6) Rinse fully for 30-90 seconds. Do not let the parts dry. Start to nickel plate, per Paragraph 5.B.(7), before the parts dry.

(b) For nickel, cobalt, chromium alloys, and 300 and 400-series CRES, and optionally for PH steels.

1) Electrolytic clean in Endox 214 or TSPG, or dry or wet abrasive clean, per SOPM 20-30-03.

2) Rinse in cold water for a minimum of 5 minutes.

3) Make electrical connections and put the parts in the nickel strike bath with the power energized. Use a current density of 25-35 as for the anodic and cathodic strikes. Apply anodic current for up to 3 minutes, then switch to cathodic for 4-5 minutes. If the anodic strike causes smut or bond problems, use only the cathodic strike, for 4-5 minutes. The anodic strike is also not necessary for 15-5PH which was abrasive cleaned with glass beads.

4) Rinse for 30-90 seconds. Do not let the parts dry. Start to nickel plate per Paragraph 5.B.(7).

(6) For copper alloys.

(a) Put the parts in the fluoboric acid bath for 2-6 minutes.

(b) Rinse in cold water for 30-45 seconds. Do not let the parts dry. Within one minute, put the parts in the nickel plating solution and plate them per Paragraph 5.B.(7).

(7) Nickel plate the parts.

(a) Attach the electrical connections to the parts before you put them in the plating tank.

(b) Set the voltage at 0.25-0.50 volt and apply power as the part goes into the solution.

(c) Keep the voltage in this range until the parts get to the temperature of the solution.

(d) When the parts are at the solution temperature, slowly increase the voltage until the current density is in the operating range. A current density of 70-100 asf is recommended. A higher density causes more edge buildup, and more risk of contamination such as by fingerprints. See Table 1 for approximate relations between current density, time, and plating thickness, but do not use that data as an alternative to measurements of the nickel plate you make.

(e) Plate to the thickness specified by the overhaul instructions. If not specified, the thickness must be 0.003 inch minimum on alloy steels, and 0.0015 inch minimum on other metals. If the nickel plate will be machined, plate a minimum of 0.003 inch oversize on each surface.

(f) If the current is stopped, activate the part surfaces again per Paragraph 5.B.(4)(b), Paragraph 5.B.(5) or Paragraph 5.B.(5)(b) as applicable.

(g) If the time to get the specified thickness will be more than 24 hours, stop the plating cycle and bake for hydrogen embrittlement relief as necessary. See Paragraph 5.D. below for details.

(8) Remove the parts from the tank. Rinse in cold water. A hot water rinse (above 130°F) can then be used to help dry the parts. Remove masks if applicable.

(9) Dry with clean, moisture-free compressed air.

(10) Bake for hydrogen embrittlement relief per Paragraph 5.D., if necessary. Do not bend springs or other plated parts before this bake.

Table 1: Nickel Plating Thickness Relations

Current Density, asf	Time to Deposit 0.001 inch plating, Minutes	Anode-to-Cathode Ratio, Minimum
20	50	1:1
30	40	
40	30	
50	20	
60	20	2:1
80	15	
100	12	
120	10	

C. Nickel plating on parts 220 ksi or above (BAC5746, Type 3) (Optional for low alloy steels below 220 ksi)

NOTE: In this procedure you can use only the sulfamate plating bath, not the Watts bath.

(1) Stress relieve, if required.

(2) Vapor degrease, emulsion clean, or solvent clean per SOPM 20-30-03, if required.

(3) Mask and rack as required.

(4) Dry abrasive blast clean per SOPM 20-30-03.

(5) Rinse in cold water.

(6) Soak in sulfuric-HF solution for 15-25 seconds. Then anodically etch for 60-90 seconds at 3-6 asi (432-864 asf). This will put a uniform dark gray to black layer of smut on the surface.

(7) Cold water rinse within 30 seconds after you stop the anodic current. Keep the surfaces wet and move the parts to the plating bath within 5 minutes.

(8) Clean the parts again, from Paragraph 5.C.(4), if one or more of these conditions occur.

(a) The sulfuric-HF etched surface does not have a layer of dark gray or black smut.

(b) The parts waited more than 5 minutes between the sulfuric-HF solution and the plating solution.

(c) The parts were not kept wet with water, but were permitted to dry.

(9) Nickel plate the parts

(a) Attach the electrical connections to the parts before you put them in the plating tank.

(b) Lower the parts into the solution.

(c) Within 3 minutes, strike-plate the parts at 60-100 asf for 1-3 minutes. Then reduce the current density to 20-30 asf until the parts get to the temperature of the solution.

(d) When the parts are at the solution temperature, increase the voltage until the current density is in the operating range. A current density of 70-100 asf is recommended. A higher density causes more edge buildup, and more risk of contamination such as by fingerprints. See Table 1 for approximate relations between current density, time, and plating thickness, but do not use that data as an alternative to measurements of the nickel plate you make.

(e) Plate to the thickness specified by the overhaul instructions. If not specified, the thickness must be 0.003 inch minimum on alloy steels, and 0.0015 inch minimum on other metals. If the nickel plate will be machined, plate a minimum of 0.003 inch oversize on each surface.

(f) If the current is stopped, activate the part surfaces again per Paragraph 5.C.(4) thru Paragraph 5.C.(8).

(g) If the time to get the specified thickness will be more than 24 hours, stop the plating cycle and bake for hydrogen embrittlement relief as necessary. See Paragraph 5.D. below for details.

D. Hydrogen Embrittlement Relief Bake

(1) Unless the overhaul instructions are different, start to bake the parts as necessary within 10 hours after plating or less than 24 hours after the current was first applied to the part. One bake can be used for long or multiple plating cycles if the bake starts within 24 hours after the current was first applied to the part. More than one bake is necessary for longer cycles. Reactivate parts before you start more plating cycles.

(2) Bake parts per Table 2 unless specified by the overhaul instructions. Set the control at the temperature specified. For parts 220 ksi or higher with a hydrogen diffusion path longer than 1.0 inch, increase the bake time 8 hours for each 0.5 inch (or fraction of 0.5 inch) that the diffusion path of the part is longer than 1.0 inch. The maximum hydrogen diffusion path length must not be longer than 2.0 inches.

(3) Unless specified, the bake is not necessary for these alloys:

(a) 300-Series CRES, A-286, nickel alloys 625 and 718

(b) PH steels below 180 ksi, unless they have external threads made after the part was age-hardened.

(c) 17-7PH in the CH-900 condition.

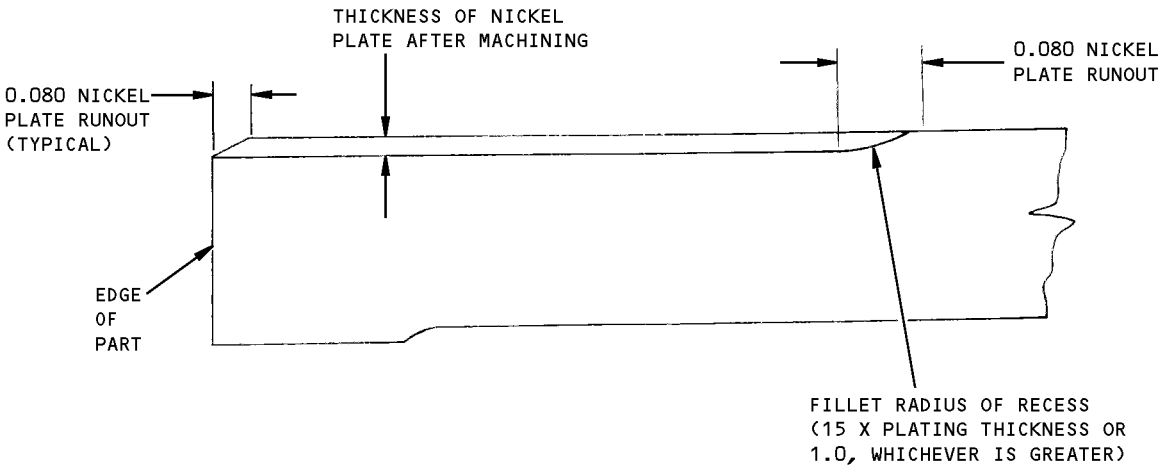
Table 2: Post-Plate Bake

BASE METAL	HEAT TREATMENT	TEMPERATURE (F)	TIME (HOURS)
Aluminum	Any Condition	200-225 or in boiling water	1-1.5
Ferrous	Carburized	250-300	5-8
440 A, B, C, or F Ferrous	Hardened or Tempered	250-300	5-8
Ferrous	Above 220 ksi	350-400	23 minimum
Threaded Ferrous	160 to 220 ksi	350-400	3 minimum
	Below 160 ksi	350-400	1-3
All other Ferrous	180 to 220 ksi	350-400	3 minimum
	Below 180 ksi	350-400	1-3
Copper, Nickel or Cobalt Alloy	Any Condition	350-400	1-3

6. NICKEL PLATE RUNOUT

A. The nickel plate runout area is that area of the nickel plated surfaces where the nickel plating thickness changes from the required thickness to zero. The specified runout is necessary to be sure the plotting area is correct and to give clearance for machining (where applicable) and masking materials.

B. Unless specified by the applicable overhaul instructions, make the nickel plating runout 0.080 inch wide at the edges of the plated area, as shown in Figure 2.



ALL DIMENSIONS ARE IN INCHES

Nickel Plate Runout Details
Figure 2

7. QUALITY CONTROL

A. The nickel plating must be smooth, fine grained, well bonded, and have no blisters, pits, nodules, porosity, burns or other defects. Slight color differences because of bakes are acceptable. The unplated surfaces must have no pits, burns, or etch marks when examined without magnification.

B. Plate Thickness

(1) When the nickel plate thickness is not specified by the overhaul instructions it must be 0.003 inch minimum on alloy steels and 0.0015 inch minimum on other metals.

(2) Unless specified by overhaul instructions, the thickness requirements apply only to surfaces that can be touched by a ball 0.75 inch in diameter. All other visible surfaces open to the plating current must be completely covered by the plating, except in recessed areas where the depth is more than twice the width or diameter.

(3) These thickness requirements apply to nickel plating after all necessary metal finishing operations. Do not include the thickness of other plating under the nickel when you measure the thickness of the nickel plating.

C. Do tests on the strength of the bond and the stress in the layer of nickel plating. Refer to BAC5746 for details.

D. 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 BAC5746, 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 BAC5746 gives a formula to calculate the interval, use it for your basic quality control plan.