DE HAVILLAND AIRCRAFT OF CANADA LIMITED

BOMBARDIER

Toronto Site

PPS 31.05 - SURFACE TREATMENT OF CORROSION RESISTANT STEEL (C9)

Issue 30
- This Production Process Standard (PPS) supersedes PPS 31.05, Issue 29.
- Vertical lines in the left hand margin indicate technical changes over the previous issue.
- Direct PPS related questions to christie.chung@dehavilland.com.
- This PPS is effective as of the distribution date.

THIS PPS IS CO-OWNED BY DE HAVILLAND AIRCRAFT OF CANADA LIMITED AND BOMBARDIER INC.

Prepared By:	(Christie Chung)	April 9, 2021
	De Havilland Canada PPS Group	
Approved By:	(Stephen Mabee)	April 9, 2021
	De Havilland Canada M&P Engineering	
	(Kenneth Quon)	April 19, 2021
	Bombardier Inc. M&P Engineering	

Signed original on file. Validation of paper prints is the responsibility of the user.

Issue 30 - Summary of Changes (over the previous issue)

The following summaries are not detailed and are intended only to assist in alerting PPS users to changes which may affect them; refer to the applicable sections of this PPS for detailed procedure and requirements.

- Specified this is a jointly owned PPS by both De Havilland Aircraft of Canada Limited and Bombardier Inc.
- Specified laboratories performing evaluation of DASH 8 parts must be approved according to DAGER-006.
- Specified use of BAPS 180-015 for passivation of parts must be at frozen Revision B.
- Clarified immersion tanks requirements.
- Revised Facilities Requirements section.
- Allow use of alternate equivalent clean protective gloves when handling cleaned parts.
- Defined initial and final rinse controls.
- Revised tap water control to meet the following: 550 μS/cm at 77 ± 10°F maximum; pH of 5.0 - 8.0; and 30 ppm maximum Chlorides (Cl^-).
- Added a note to every intermediate cleaning table specifying that to carry out "etching" before FPI only when specified by the engineering drawing or PPS 20.03. Only parts that have undergone metal smearing operations or operations that will smear metal or otherwise close that have undergone metal smearing operations or operations that will smear metal or otherwise close surface openings must be etched prior to FPI. See PPS 20.03 for a list of such operations. Ensure that the minimum part thickness is maintained in the etched area. Do not etch parts otherwise.
- Specified if FPI is required by the RNC, perform FPI according to PPS 20.03.
- Specified that all parts should be oven dried prior to FPI.
- Deleted Ridoline 153 as an option for alkaline cleaning.
- Renamed Ridoline 53 with Bonderite C-AK 53 Aero. Revised solution control as per manufacturer's technical data sheet (TDS).
- Renamed alkaline cleaner Turco Airlion 4090 to current product name, Bonderite C-AK 4090 Aero. Revised solution control as per manufacturer's TDS.
- Renamed alkaline cleaner Turco 4215 NC-LT to current product name, Bonderite C-AK 4215 NC-LT Aero. Revised solution control as per manufacturer's TDS.

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1 SCOPE

1.1 This Production Process Standard (PPS) specifies the procedure and requirements for the surface treatment of corrosion resistant steels at interim stages of fabrication and as a final treatment. If this PPS conflicts with other PPS's applicable to welding, brazing or finishing, the latter must take precedence. Surface treatment of corrosion resistant steel is identified by the protective treatment code C9.

1.1.1 As an alternative to the **passivation** procedure and requirements specified herein, it is acceptable to perform passivation of corrosion resistant steel according to BAPS 180-015, Rev. B. Perform surface treatments other than passivation (e.g., acid pickling, solvent cleaning, etc.) according to this PPS.

- Perform passivation of corrosion resistant steel according to the procedure and requirements of either BAPS 180-015, Rev. B or this PPS in their entirety; a piecemeal approach utilizing certain sections or portions of BAPS 180-015, Rev. B and this PPS is **not** acceptable.
- Subcontractor facilities which have been approved by Bombardier to perform passivation of corrosion resistant steel according to BAPS 180-015, Rev. B are considered approved to perform passivation of corrosion resistant steel according to this PPS without further approval needed.
- PPS Process Standard Deviations (PSD's) issued against this PPS are **not** applicable to BAPS 180-015, Rev. B. Likewise, requests for deviation (RFD's) allowed against BAPS 180-015, Rev. B are not applicable to this PPS.
- When processing parts according to BAPS 180-015, Rev. B as an alternative to processing parts according to PPS 31.05, deviations allowed by an approved RFD against BAPS 180-015, Rev. B may be used unless a specific limitation regarding program applicability is specified by the RFD.

1.1.2 This PPS complements the engineering drawings that specify its use as an authorized instruction. Except as noted in paragraph 1.1.1, the procedure specified in this PPS must be followed to ensure compliance with all applicable specifications and to fulfil the engineering design and reliability objectives. In general, if this PPS conflicts with the engineering drawing, follow the engineering drawing.

1.1.3 Refer to PPS 13.26 for the subcontractor provisions applicable to this PPS.

1.2 This PPS is co-owned by De Havilland Aircraft of Canada Limited (DHC) and Bombardier Inc. (BA) due to its applicability for both the DHC DASH 8 and BA Lear 45 programs. Frozen revisions of Bombardier documents (e.g., BAPS, BAERD GEN, BAMS, etc.) specified herein apply only to the DASH 8 program.

2 HAZARDOUS MATERIALS

2.1 Before receipt at DHC or BA, all materials must be approved and assigned Material Safety Data Sheet (MSDS) numbers by the DHC/BA Environment, Health and Safety Department. Refer to the manufacturer's MSDS for specific safety data on any of the materials specified in this PPS. If the MSDS is not available, contact DHC/BA Environment, Health and Safety Department.

3 REFERENCES

3.1 BAERD GEN-018 - Engineering Requirements for Laboratories.

3.2 DAGER-006 - Engineering Requirements for Laboratories.

3.3 BAPS 180-015, Rev. B - Passivation of Corrosion Resistant Steel.

3.4 DHC/BA Laboratory Drawing, LAB 068 - Etch Rate Hydrogen Absorption Test Panel.

3.5 DH4989 - Process Bath Analyses Form - *DHC/BA internal operating procedure*.

3.6 DHLPM Procedure No. 6013 (Intergranular Attack and End Grain Pitting Testing) - *DHC/BA internal operating procedure*.

3.7 EHS-OP-005 - Hazardous Materials Management, *DHC/BA internal operating procedure*.

3.8 PPS 13.13 - Personal Protective Respiratory Equipment.

3.9 PPS 13.26 - General Subcontractor Provisions.

3.10 PPS 13.39 - DASH 8 & Lear 45 Critical and Special Processes PPS Index.

3.11 PPS 17.02 - Abrasive Blasting.

3.12 PPS 20.03 - Fluorescent Penetrant Inspection.

3.13 PPS 30.06 - Heat Treatment of Precipitation Hardenable (PH) Stainless Steel.

3.14 PPS 30.08 - Heat Treatment of Martensitic Stainless Steel.

3.15 PPS 31.04 - Degreasing Processes.

3.16 PPS 31.11 - Vapour Blast Cleaning.

3.17 PPS 31.17 - Solvent Usage.

3.18 QDI-09-02 - Process Control - *DHC/BA internal Quality procedure*.

4 MATERIALS, EQUIPMENT AND FACILITIES

4.1 Materials

4.1.1 Alkaline cleaners as listed in Table I.

4.1.2 Copper sulphate, technical grade.

4.1.3 Hydrofluoric acid, 52%, MIL-A-24641.

4.1.4 Nitric acid, 42° Bé, A-A-59105.

4.1.5 Sodium dichromate, O-S-595.

4.1.6 Sulphuric acid, 66° Bé.

4.2 Equipment

4.2.1 Immersion tanks for re-circulating water rinse and chemical baths as listed in Table I. Immersion tanks must be resistant to the chemicals and to the operating temperatures used (e.g., mild steel with heating coil and agitation equipment for containing alkaline solutions; acid resistant containers for manual pickling and passivating; and stainless steel tank with agitation equipment for immersion pickling and passivating solutions). Tanks must be equipped with temperature indicating, regulating and recording devices capable of controlling the chemical solution temperatures within ± 5°F and equipped with mechanical or air agitation.

4.2.2 LAB 068-1 (titanium) and LAB 068-2 (CRES) test panels.

4.2.3 Wiping cloths (e.g., DSC 378-2).

4.2.4 Chemical resistant coat or apron and safety boots.

4.2.5 Neoprene gloves (e.g., DSC 422-5).

4.2.6 Protective gloves (e.g., DSC 422-1 lint-free cotton gloves).

4.3 Facilities

4.3.1 This PPS has been categorized as a Controlled Special Process according to PPS 13.39 and as such only facilities specifically approved according to PPS 13.39 are authorized to perform surface treatment of corrosion resistant steels at interim stages of fabrication and as a final treatment according to this PPS.

4.3.2 Subcontractors must direct requests for approval to DHC or BA Quality.

4.3.3 Facility approval must be based on a facility report, a facility survey and completion of a qualification test program, if required. The facility report must detail the materials and equipment to be used, the process sequence to be followed and the laboratory facilities used to show compliance with the requirements of this PPS. Any deviation from the procedure or requirements of this PPS must be detailed in the facility report. Based upon the facility report, DHC or BA Engineering may identify additional qualification and/or process control test requirements. During the facility survey, the facility requesting qualification must be prepared to demonstrate their capability. Once approved, no changes to subcontractor facilities may be made without prior written approval from DHC or BA Quality.

4.3.3.1 For approval of subcontractor facilities to perform surface treatment of corrosion resistant steels at interim stages of fabrication and as a final treatment according to this PPS, completion of a test program and submission of suitable test samples representative of production parts is required. Test samples must meet the requirements specified in section 6.

4.3.3.2 All testing and evaluation specified herein must only be performed by DHC/BA Toronto Materials Laboratory or by laboratories accredited according to DAGER-006 (DASH 8) or BAERD GEN-018 (Lear 45), as applicable.

5 PROCEDURE

5.1 General

5.1.1 When the engineering drawing calls for passivation of parts, refer to section 5.3 for the appropriate passivating method.

5.1.2 Wear clean protective gloves (e.g., DSC 422-1) when handling cleaned parts.

5.1.3 Do not acid passivate or acid pickle assembled corrosion resistant steel (CRES) parts listed in paragraph 5.3.3. Individual parts can be acid passivated before assembly if the conditions specified in Table III, Table IV or Table V are met.

5.1.4 Unless otherwise specified herein, removal of heat discolouration (i.e., after heat treatment, butt joint welding, etc.) may be delayed until the final cleaning operation.

5.1.5 Remove fluxes immediately after brazing or soldering to prevent the reaction of the flux with the substrate.

5.1.6 For the purposes of this PPS, the following water rinse types are defined as follows (refer to Table II for analysis requirements and control limits):

- Initial Rinse: An immersion tank filled with re-circulating water controlled to less stringent control limits. The initial rinse may or may not be followed by a final rinse, as specified herein.
- Final Rinse: An immersion tank filled with re-circulating water controlled to more stringent limits.

5.1.7 For the purpose of this PPS, the following terminologies are defined as follows:

a. Acid passivation consists of immersing CRES parts in a solution of nitric acid and oxidizing salts (sodium dichromate) to remove foreign particles, usually iron, which have become embedded during fabrication operations. The oxidizing salt raises the "passivating potential" of the bath which helps to generate a continuous invisible protective oxide film on the part's surface.

b. Acid pickling is the removal of surface oxides (scale) from CRES parts by immersion in a nitric/hydrofluoric acid solution.

c. A smut free surface is one which when wiped with a clean white tissue shows no visible deposits on the tissue.

d. A water-break-free surface is defined as a surface on which a water film will remain continuous for a period of at least 15 seconds without discontinuities or breaks.

e. Heat treatment process is any combination of heating and cooling operations that produce a change in the mechanical properties of a metal. Heat treatment processes include annealing, hardening (quenching and tempering) and aging.

f. Hydrogen embrittlement relief is a process that disperses or drives off the hydrogen thereby minimizing the propensity of the part to suffer hydrogen related damage.

g. Intermediate process operations are those operations performed before the final cleaning process. These operations are listed in Table III, Table IV and Table V for the respective CRES.

5.2 Preparation of Solutions

5.2.1 Prepare the solution baths as follows:

Step 1. Fill the tank half full with water (see Table I).

Step 2. Add the required amount of chemicals according to Table I slowly into the tank.

Step 3. Fill the tank up to the operating level with water.

5.3 Selection of Cleaning Processing Method

5.3.1 If decorative interior parts have been manufactured from protected, pre-finished stainless steel sheet (i.e., mill finish #4), and the surface finish remains protected and has not been marked or blemished, no cleaning operation is required regardless of whether the parts have been formed, sheared, etc.

5.3.2 Determine the cleaning processes for CRES before an intermediate process as follows:

Step 1. For the specified CRES type (Austenitic - 300 Series, Martensitic - 400 Series or Precipitation Hardenable - PH), refer to the appropriate table (Table III, Table IV or Table V respectively).

Step 2. For the specified intermediate process, choose the applicable cleaning process (i.e., acid passivating, acid pickling, alkaline, mechanical or solvent cleaning) specified in the respective table.

Step 3. If all the intermediate manufacturing processes for the part have not been completed, repeat from Step 2.

Step 4. If further cleaning process is not required for the part, the cleaning process for that part ends at this stage and no further cleaning is required.

5.3.2.1 If an approved dispositioned Report of Non-Conformance (RNC) specifies in-situ localized cleaning of specific areas on assemblies according to this PPS before fluorescent penetrant inspection, clean as follows. Take extreme care at all times to prevent ingress and/or seepage of cleaning solutions/rinse water, and to prevent contact with sealant and/or materials sensitive to cleaning solutions/rinse water.

Step 1. Suitably protect the surrounding structure (e.g., mask) around the area to be cleaned to prevent contamination with cleaning solutions (e.g., solvent, alkaline cleaners, acid cleaning solutions, etc.).

Step 2. Solvent clean the area to be cleaned according to PPS 31.17.

Step 3. Locally apply hydrofluoric/nitric acid solution and allow to dwell for the time required to remove 0.0002" - 0.0004" from the surface. During the dwell time, apply additional hydrofluoric/nitric acid solution as needed to prevent drying during the dwell time. Take care to prevent contamination (e.g., splashing) of the surrounding structure with hydrofluoric/nitric acid cleaning solution.

Step 4. Locally rinse the area to be cleaned using a brush, or swab, and water. Take care to ensure thorough rinsing to remove all trace of hydrofluoric/nitric acid solution without adversely affecting the surrounding structure.

Step 5. Remove materials used to protect the surrounding structure and allow the area to dry.

Step 6. Perform FPI according to PPS 20.03.

5.3.2.2 Where an approved dispositioned Report of Non-Conformance (RNC) specified rework/repair (including fluorescent penetrant inspection (FPI), as applicable) of localized specific areas on assemblies, after the rework/repair clean the area as follows. Take extreme care at all times to prevent ingress and/or seepage of cleaning solutions/rinse water, and to prevent contact with sealant and/or materials sensitive to cleaning solutions/rinse water.

Step 1. Suitably protect the surrounding structure (e.g., mask) around the area to be cleaned to prevent contamination with cleaning solutions (e.g., solvent, alkaline cleaners, acid cleaning solutions, etc.).

Step 2. Solvent clean the area to be cleaned according to PPS 31.17.

Step 3. Locally apply alkaline cleaning solution to the area to be cleaned using a brush or swab. Allow the alkaline cleaning solution to dwell for 5 to 20 minutes, applying additional alkaline cleaning solution as needed to prevent drying during the dwell time. Take care to prevent contamination (e.g., splashing) of the surrounding structure with alkaline cleaner.

Step 4. Locally rinse the area to be cleaned using a brush, or swab, and cold water. Take care to ensure thorough rinsing to remove all trace of alkaline cleaning solution without adversely affecting the surrounding structure.

Step 5. Check for a water break-free surface. If the area is not water break-free, repeat from Step 3 above.

Step 6. Locally apply acid passivating solution using a brush or swab and allow to dwell for 15 - 30 minutes. During the dwell time, apply additional acid passivating solution as needed to prevent drying during the dwell time. Take care to prevent contamination (e.g., splashing) of the surrounding structure with acid passivating solution.

Step 7. Locally rinse the area to be cleaned using a brush, or swab, and water. Take care to ensure thorough rinsing to remove all trace of acid passivating solution without adversely affecting the surrounding structure.

Step 8. Remove materials used to protect the surrounding structure and allow the area to dry.

5.3.3 After completing all manufacturing processes, acid passivate the part according to Flow Chart 5 as the final cleaning process. Do not acid passivate or acid pickle the following processed or CRES parts or assemblies but rather mechanically clean according to Flow Chart 2:

- PH steels, for the removal of heat treat scale.
- Parts heat treated to ultimate tensile strength levels 200 - 220 ksi and above.
- All alloys with brazed or soldered joints.
- Nitrided parts.
- Assemblies containing different alloys.
- Assemblies which may entrap fluids.
- Soldered assemblies.
- Welded assemblies except butt joint.

5.4 Hydrogen Embrittlement Relief (PH and 400 Series only)

5.4.1 PH and 400 series CRES are not normally pickled in the strength ranges where embrittlement relief would be required. However, for parts with a tensile strength range of 150 - 170 ksi or greater which have been specifically authorized to be pickled by an engineering order or if a subcontractor has been authorized by a DHC/BA PSD to chemically clean parts, embrittlement relieve the parts according to PPS 30.06 or PPS 30.08, within 4 hours of acid pickling or chemical cleaning.

5.4.2 If acid pickling or chemical cleaning forms a part of a plating operation and is delayed by a maximum of 4 hours followed by plating, embrittlement relief is not required between such operations except for parts such as springs which are stressed during plating.

6 REQUIREMENTS

6.1 All testing and evaluation specified herein must only be performed by DHC/BA Toronto Materials Laboratory or by laboratories accredited according to DAGER-006 (DASH 8) or BAERD GEN-018 (Lear 45), as applicable.

6.2 Ensure parts to be plated are chemically cleaned, smut free and water break-free.

6.3 Ensure all final processed parts and assemblies are free of all contaminants that would be detrimental to corrosion resistance.

6.4 Ensure complete removal of chemical processing solutions following any final rinsing of parts.

6.5 On a weekly basis, immerse a LAB 068-2 (CRES) test panel in the acid pickling solution for the amount of time required to remove a minimum 0.001" of material per side. Perform intergranular attack and end grain pitting testing on the test panel (e.g., according to the appropriate section of DHLPM Procedure No. 6013). End grain pitting in excess of 0.001" or intergranular attack in excess of 0.0002" is not acceptable. Refer suspect parts to DHC/BA Material Review Board (MRB) or DHC/BA delegated MRB for disposition.

6.6 Once a month, acid passivate one LAB 068-2 (CRES) test panel with the production batch it represents according to the procedures specified herein. It is acceptable to perform this test on a production part in place of a LAB 068-2 test panel. Evaluate the passivated surface according to Flow Chart 9 (Copper Test).

7 DHC/BA SAFETY PRECAUTIONS

7.1 The safety precautions specified herein are specific to DHC/BA to meet Canadian Federal and Provincial government environmental, health and safety regulations. It is strongly recommended that other facilities consider these safety precautions; however, suppliers, subcontractors and partners are responsible for ensuring that their own environmental, health and safety precautions satisfy the appropriate local government regulations.

7.2 Observe standard plant safety precautions when performing the procedure specified herein.

7.3 Do not keep, handle or eat food in the vicinity of cleaning baths.

7.4 Do not use baths, including water baths, for heating or cooling food or drinks.

7.5 Avoid ingestion of any of the materials specified herein. If ingestion occurs, obtain immediate medical attention.

7.6 Wash hands thoroughly after working with chemical baths.

7.7 Do not keep street clothes in the vicinity of cleaning baths.

7.8 Wear neoprene gloves, chemical resistant coat or apron and safety boots when operating chemical baths. Locate all safety showers and eyewash stations close to the chemical baths.

7.9 Avoid skin contact with cleaning solutions or copper sulphate test solution. If skin contact occurs, remove the contaminated clothing and wash the affected area with large quantities of water. In case of skin contact with hydrofluoric/nitric acid pickling solution, immediately flush affected area with large quantities of water followed by application of calcium gluconate gel to the skin and obtain immediate medical attention from the Health Centre.

7.10 Operators who have any broken skin or open wounds on hands or wrists must not work with cleaning baths.

7.11 Use faceshield with chemical goggles when there is a potential for splashes or misting to the face or eyes with chemical solutions. Use full facepiece respirator or powered air-purifying respirator with chemical goggles for handling concentrated acid and base materials. For full face piece respirator, combination cartridge for acid gas, vapour and HEPA filter must be used. If eye contact occurs, flush the eyes for a minimum of 15 minutes at the nearest eye-wash station and obtain immediate medical attention from the Health Centre.

7.12 Ensure that sufficient ventilation is provided when using the chemical solutions specified herein. Consult the Health and Safety Department for the threshold limit values.

7.13 Operators must wear protective respiratory equipment according to PPS 13.13 when operating chemical baths.

7.14 Refer to PPS 31.17 for the safety precautions for handling and using solvents.

8 PERSONNEL REQUIREMENTS

8.1 This PPS has been categorized as a Controlled Special Process according to PPS 13.39. Refer to PPS 13.39 for personnel requirements.

9 DISPOSAL OF CHEMICAL WASTES

9.1 Dispose of all chemical wastes according to national legislation and local regulations. At DHC/BA, dispose of chemical wastes according to EHS-OP-005.

10 MAINTENANCE OF EQUIPMENT AND SOLUTIONS

10.1 Maintenance of Equipment

10.1.1 Once a year, calibrate all instruments (i.e., gauges and regulators).

10.2 Maintenance of Solutions

10.2.1 A sample of the acid pickling, acid passivating, alkaline cleaning and water rinse baths must be tested according to Table II by an approved laboratory as specified in paragraph 4.3.3.2. Thoroughly mix the solutions before sampling.

10.2.2 Maintain operating temperatures according to Table I. Maintain the operating temperatures of the water rinses according to Table II.

10.2.3 If a water break-free surface on the part cannot be achieved following alkaline cleaning, suspend the alkaline cleaning process and take corrective action. If necessary, dispose of the alkaline solution (e.g., according to EHS-OP-005) and prepare a new solution according to Table I.

10.2.4 If the solutions fail to meet the requirements specified in Table II, suspend the applicable process (i.e., acid pickling or passivating) until the solution has been re-adjusted to meet these requirements. Re-analyze the solution within 24 hours of any adjustment.

10.2.5 At DHC/BA, if necessary, at least once a year or more frequently, remove solution from alkaline cleaning tanks, remove any particulate (sludge) and ensure that the agitation system is operating properly. Dispose of particulate (sludge) according to EHS-OP-005.

10.3 Nitric/Hydrofluoric Acid Pickling Solution Etch Rate

10.3.1 Control the nitric/hydrofluoric acid pickling solution to maintain an etch rate of 0.0025 - 0.0050 inch/surface/hour on a **LAB 068-1 (titanium)** test panel.

10.3.2 Once weekly, weigh and then immerse one **LAB 068-1 (titanium)** test panel in the pickling bath for at least 15 minutes. Then re-weigh the test panel and calculate the etch rate using the following formula:

$$\text{Etch Rate (mils/surface/hour)} = \frac{30\,(W_1 - W_2)\,T}{W_1\,t} \times 1000$$

W_1 = *weight before etching, grams*
W_2 = *weight after etching, grams*
T = *original thickness, inches*
t = *etch time, minutes*

10.4 Reports on Solution Testing

10.4.1 If additions of chemicals are required, indicate the amount to be added. Indicate on a Process Bath Analyses Form (e.g., DH4989), that the recommended adjustments have been made. Re-analyze the solution within 24 hours of the adjustment. Maintain records of the solution tests (e.g., according to QDI-09-02).

TABLE I - SOLUTION MAKE-UP (NOTE 1)

BATH TYPE (Note 2)	BATH MAKE-UP				OPERATING TEMPERATURE
	CHEMICALS	IMPERIAL	METRIC	U.S.	
ACID PICKLING - HYDROFLUORIC/NITRIC ACID SOLUTION					
HNO_3/HF (Note 3)	HNO_3 (42°Bé)	40 gal/100 gal	40 L/100 L	40 gal/100 gal	60 - 90°F
	HF (52%)	5.5 gal/100 gal	5.5 L/100 L	5.5 gal/100 gal	
INHIBITING NITRIC ACID PASSIVATING SOLUTION					
HNO_3/$Na_2Cr_2O_7$	HNO_3 (42°Bé)	25 gal/100 gal	25 L/100 L	25 gal/100 gal	60 - 90°F
	$Na_2Cr_2O_7$ (Note 4)	24 lbs/100gal	2.4 L/100 L	20 lbs/100 gal	
ALKALINE CLEANING SOLUTION					
Altrex 1097	Altrex 1097	50 lbs/100 gal	5 Kg/100 L	41 lbs/100 gal	150 - 200°F
Oakite 61B	Oakite 61B	41 lbs/100 gal	4.1 Kg/100 L	34 lbs/100 gal	160 - 190°F
Oakite 164	Oakite 164	50 lbs/100 gal	5.0 Kg/100 L	41 lbs/100 gal	160 - 180°F
Bonderite C-AK 53 Aero	Bonderite C-AK 53 Aero	14 lbs/100 gal	1.4 Kg/100 L	12 lbs/100 gal	140 - 160°F
Bonderite C-AK 4215 NC-LT Aero	Bonderite C-AK 4215 NC-LT Aero	52 lbs/100 gal	5.2 Kg/100 L	43 lbs/100 gal	120 - 140°F
Bonderite C-AK 4090 Aero	Bonderite C-AK 4090 Aero	41 lbs/100 gal	4.1 Kg/100 L	34 lbs/100 gal	110 - 160°F
RINSE WATER AND WATER USED FOR SOLUTION MAKE-UP (NOTE 5)					
According to Table II					

Note 1. It is acceptable for subcontractors to deviate from the specified make-up of solutions provided that the control requirements of Table II are met.

Note 2. See paragraph 4.2.1 for solution tank requirements.

Note 3. It is strongly recommended that 2 - 4% of the old solution be used in the make-up of a new solution to promote bath stability.

Note 4. Pre-mix with tap water before adding to solution.

Note 5. Use de-ionized water for the make up of the copper sulphate testing solution as specified in Flow Chart 9.

TABLE II - SOLUTION CONTROL

BATH TYPE	CHEMICALS	CONTROL LIMITS			TEST FREQUENCY (Note 1)	
		IMPERIAL	METRIC	U.S.	STANDARD	EXTENDED
ACID PICKLING - HYDROFLUORIC/NITRIC ACID SOLUTION						
HNO_3/HF	HNO_3	48 - 108 wt oz/gal	300 - 674 g/L	40 - 90 wt oz/gal	Weekly	Monthly
	HF	Maintain an Etch Rate of 0.0025 - 0.0050 in/hr for a **titanium** surface (Note 2)				
	Dissolved metal (Fe & Ti combined)	3.6 wt oz/gal (maximum)	22.5 g/L (maximum)	3.0 wt oz/gal (maximum)	Every 3 months	Every 3 months
INHIBITING NITRIC ACID PASSIVATING SOLUTION						
HNO_3/$Na_2Cr_2O_7$	HNO_3	24 - 42 wt oz/gal	150 - 262 g/L	20 - 35 wt oz/gal	Weekly	Every 2 Weeks
	$Na_2Cr_2O_7$	2.7 - 3.8 wt oz/gal	17 - 24 g/L	2.3 - 3.2 wt oz/gal		
	Dissolved Fe	0.8 wt oz/gal (maximum)	5 g/L (maximum)	0.7 wt oz/gal (maximum)	Every 3 months	Every 3 months
ALKALINE CLEANING SOLUTION						
Altrex 1097	Altrex 1097	7.2 - 9.6 wt oz/gal	45 - 60 g/L	6.0 - 8.0 wt oz/gal	Weekly	Monthly
Oakite 61B	Oakite 61B	3.6 - 9.6 wt oz/gal	22.5 - 60 g/L	3 - 8 wt oz/gal		
Oakite 164	Oakite 164	6.5 - 10 wt oz/gal	40.5 - 62.4 g/L	5 - 8 wt oz/gal		
Bonderite C-AK 53 Aero	Bonderite C-AK 53 Aero	1.2 - 3.6 wt oz/gal	7.5 - 22.5 g/L	1.0 - 3.0 wt oz/gal		
	Free Alkali	5.0 to 15.0 points (perform test according to the manufacuter's technical data sheet)				
Bonderite C-AK 4215 NC-LT Aero	Bonderite C-AK 4215 NC-LT Aero	7.2 - 9.6 wt oz/gal	45.0 - 60.0 g/L	6.0 - 8.0 wt oz/gal		
Bonderite C-AK 4090 Aero	Bonderite C-AK 4090 Aero	6.0 - 7.2 wt oz/gal	37.5 - 44.9 g/L	5.0 - 6.0 wt oz/gal		

Note 1. If, over a 12 month period, it can be demonstrated (through SPC charts, etc.) that the concentration of the applicable solution component is well within the requirements specified, then the analysis frequency may be reduced from "standard" to "extended". However, in the event that the solution component analysis fails the requirements specified, revert back to the "standard" analysis frequency until a controlled process can again be demonstrated.

Note 2. Determine the etch rate according to section 10.3 using a **LAB-068-1 (titanium)** test panel.

Note 3. In place of the hot de-ionized water rinse, it is acceptable to rinse parts in cold water (350 ppm TDS maximum (EC limit of 550 µS/cm at 77 ± 10°F); chloride ions of 30 ppm maximum; and pH of 5.0 to 8.0).

TABLE II - SOLUTION CONTROL

BATH TYPE	CHEMICALS	CONTROL LIMITS			TEST FREQUENCY (Note 1)	
		IMPERIAL	METRIC	U.S.	STANDARD	EXTENDED
RINSE WATER AND WATER USED FOR MAKE-UP						
Water used for Solution Make-Up	Water	TDS of 350ppm maximum (EC limit of 550 µS/cm at 77 ± 10°F); pH range of 5.0 - 8.0; and temperature of 120°F maximum			Less than 24 hours before solution make-up	
	Chloride ions	30 ppm maximum				
Hot de-ionized water rinse (Notes 3)	De-ionized water	TDS of 350ppm maximum (EC limit of 550 µS/cm at 77 ± 10°F); pH range of 5.0 - 7.0; and temperature of 140°F - 180°F maximum			Daily	Weekly
	Chloride ions	30 ppm maximum				
Initial rinse	Re-circulating water	TDS of 1000ppm maximum (EC limit of 1538 µS/cm at 77 ± 10°F); pH range of 5.0 - 8.0; and temperature of 120°F maximum				
Final rinse	Re-circulating water	TDS of 350ppm (EC limit of 550 µS/cm at 77 ± 10°F); pH range of 5.0 - 8.0; and temperature of 180°F maximum				

Note 1. If, over a 12 month period, it can be demonstrated (through SPC charts, etc.) that the concentration of the applicable solution component is well within the requirements specified, then the analysis frequency may be reduced from "standard" to "extended". However, in the event that the solution component analysis fails the requirements specified, revert back to the "standard" analysis frequency until a controlled process can again be demonstrated.

Note 2. Determine the etch rate according to section 10.3 using a **LAB-068-1 (titanium)** test panel.

Note 3. In place of the hot de-ionized water rinse, it is acceptable to rinse parts in cold water (350 ppm TDS maximum (EC limit of 550 µS/cm at 77 ± 10°F); chloride ions of 30 ppm maximum; and pH of 5.0 to 8.0).

TABLE III - 300 SERIES (AUSTENITIC) CRES: CLEANING PROCESSES FOR A GIVEN INTERMEDIATE PROCESS OPERATION

INTERMEDIATE PROCESS OPERATION	CLEANING PROCESS (NOTE 1)
Brazing	Before brazing, acid pickle according to Flow Chart 6. After brazing, remove flux according to Flow Chart 7.
Buffing	Before and after buffing, solvent clean according to Flow Chart 1.
Electrical Discharge Machining (EDM)	Before electrical discharge machining (EDM), acid pickle according to Flow Chart 6.
Electropolishing	Before electropolishing, solvent clean according to Flow Chart 1 and then alkaline clean according to Flow Chart 3.
Fluorescent Penetrant Inspection (Note 2)	Unless etching is specified by the engineering drawing or PPS 20.03, before fluorescent penetrant inspection, alkaline clean according to Flow Chart 3. Only If etching is specified by the engineering drawing or PPS 20.03, etch according to Flow Chart 4 before fluorescent penetrant inspection. After fluorescent penetrant inspection, clean according to Flow Chart 8.
Forming	Solvent clean according to Flow Chart 1 before forming.
Heat Treatment	For annealing purposes only, acid pickle according to Flow Chart 6 before heat treatment (Note 3).
Machining	Solvent clean according to Flow Chart 1 before machining.
Painting	Before painting, acid passivate according to Flow Chart 5 or mechanically clean according to Flow Chart 2.
Plating	Before plating, acid pickle according to Flow Chart 6 or mechanically clean according to Flow Chart 2.
Removal of Heat Treatment Discolouration	To remove heat treatment discolouration, abrasive blast using glass beads or aluminum oxide according to PPS 17.02 or acid pickle according to Flow Chart 6.
Removal of Scale Inhibiting Agent after Heat Treatment	Mechanically clean according to Flow Chart 2.
Shot Peening	Solvent clean according to Flow Chart 1 before shot peening.
Soldering	Before soldering, acid pickle according to Flow Chart 6. After soldering, remove flux according to Flow Chart 7.

Note 1. After completing all manufacturing processes, final clean according to paragraph 5.3.3.

Note 2. Carry out “etching” before FPI only when specified by the engineering drawing or PPS 20.03. Only parts that have undergone metal smearing operations or operations that will smear metal or otherwise close that have undergone metal smearing operations or operations that will smear metal or otherwise close surface openings must be etched prior to FPI. See PPS 20.03 for a list of such operations. Ensure that the minimum part thickness is maintained in the etched area. Do not etch parts otherwise.

Note 3. 300 Series (Austenitic) CRES is not heat hardenable. This process is for possible annealing treatment only.

TABLE III - 300 SERIES (AUSTENITIC) CRES: CLEANING PROCESSES FOR A GIVEN INTERMEDIATE PROCESS OPERATION

INTERMEDIATE PROCESS OPERATION	CLEANING PROCESS (NOTE 1)
Spinning	Solvent clean according to Flow Chart 1 before spinning.
Vapour Blasting	Solvent clean according to Flow Chart 1 before vapour blasting.
Vibratory Tumble Deburring	Before vibratory tumble deburring, solvent clean according to Flow Chart 1 or alkaline clean according to Flow Chart 3.
Welding (Fusion or Resistance)	Before fusion or resistance welding, acid pickle according to Flow Chart 6.

Note 1. After completing all manufacturing processes, final clean according to paragraph 5.3.3.

Note 2. Carry out “etching” before FPI only when specified by the engineering drawing or PPS 20.03. Only parts that have undergone metal smearing operations or operations that will smear metal or otherwise close that have undergone metal smearing operations or operations that will smear metal or otherwise close surface openings must be etched prior to FPI. See PPS 20.03 for a list of such operations. Ensure that the minimum part thickness is maintained in the etched area. Do not etch parts otherwise.

Note 3. 300 Series (Austenitic) CRES is not heat hardenable. This process is for possible annealing treatment only.

TABLE IV - 400 SERIES (MARTENSITIC) CRES: CLEANING PROCESSES FOR A GIVEN INTERMEDIATE PROCESS OPERATION.

INTERMEDIATE PROCESS OPERATION	CLEANING PROCESS (NOTE 1)
Brazing	Before brazing, acid pickle according to Flow Chart 6 or mechanical clean according to Flow Chart 2. After brazing, remove flux according to Flow Chart 7.
Buffing	Before and after buffing, solvent clean according to Flow Chart 1.
Electrical Discharge Machining (EDM)	Before electrical discharge machining (EDM), acid pickle according to Flow Chart 6.
Electropolishing	Before electropolishing, solvent clean according to Flow Chart 1 and then alkaline clean according to Flow Chart 3.
Fluorescent Penetrant Inspection (Note 2)	Unless etching is specified by the engineering drawing or PPS 20.03, before fluorescent penetrant inspection alkaline clean according to Flow Chart 3. Only If etching is specified by the engineering drawing or PPS 20.03, etch according to Flow Chart 4 before fluorescent penetrant inspection. After fluorescent penetrant inspection, clean according to Flow Chart 8.

Note 1. After completing all manufacturing processes, final clean according to paragraph 5.3.3.

Note 2. Carry out “etching” before FPI only when specified by the engineering drawing or PPS 20.03. Only parts that have undergone metal smearing operations or operations that will smear metal or otherwise close that have undergone metal smearing operations or operations that will smear metal or otherwise close surface openings must be etched prior to FPI. See PPS 20.03 for a list of such operations. Ensure that the minimum part thickness is maintained in the etched area. Do not etch parts otherwise.

TABLE IV - 400 SERIES (MARTENSITIC) CRES: CLEANING PROCESSES FOR A GIVEN INTERMEDIATE PROCESS OPERATION.

INTERMEDIATE PROCESS OPERATION	CLEANING PROCESS (NOTE 1)
Forming	Solvent clean according to Flow Chart 1 before forming.
Heat Treatment	Before heat treatment, abrasive clean according to Flow Chart 2 or acid pickle according to Flow Chart 6.
Machining	Solvent clean according to Flow Chart 1 before machining.
Magnetic Particle Inspection	Before and after magnetic particle inspection, alkaline clean according to Flow Chart 3.
Painting	Before painting, acid passivate according to Flow Chart 5 or mechanically clean according to Flow Chart 2.
Plating	Before plating parts that have been heat treated to a tensile strength of less than 150 - 170 ksi, acid pickle according to Flow Chart 6 or mechanically clean according to Flow Chart 2. For parts heat treated to150 - 170 ksi or greater, mechanically clean according to Flow Chart 2 before plating.
Removal of Heat Treatment Discolouration	To remove heat treatment discolouration, abrasive clean according to PPS 17.02 or acid pickle according to Flow Chart 6.
Removal of Scale Inhibiting Agent after Heat Treatment	Mechanically clean according to Flow Chart 2.
Shot Peening	Solvent clean according to Flow Chart 1 before peening.
Soldering	Before soldering, acid pickle according to Flow Chart 6 or mechanical clean according to Flow Chart 2. After soldering, remove flux according to Flow Chart 7.
Spinning	Solvent clean according to Flow Chart 1 before spinning.
Vapour Blasting	Solvent clean according to Flow Chart 1 before vapour blasting.
Vibratory Tumble Deburring	Before vibratory tumble deburring, solvent clean according to Flow Chart 1 or alkaline clean according to Flow Chart 3.
Welding, Fusion or Resistance	Before fusion or resistance welding, acid pickle according to Flow Chart 6 or mechanical clean according to Flow Chart 2.

Note 1. After completing all manufacturing processes, final clean according to paragraph 5.3.3.

Note 2. Carry out “etching” before FPI only when specified by the engineering drawing or PPS 20.03. Only parts that have undergone metal smearing operations or operations that will smear metal or otherwise close that have undergone metal smearing operations or operations that will smear metal or otherwise close surface openings must be etched prior to FPI. See PPS 20.03 for a list of such operations. Ensure that the minimum part thickness is maintained in the etched area. Do not etch parts otherwise.

TABLE V - PH (PRECIPITATION HARDENABLE) CRES: CLEANING PROCESSES FOR A GIVEN INTERMEDIATE PROCESS OPERATION.

INTERMEDIATE PROCESS OPERATION	CLEANING PROCESS (NOTE 1)
Brazing	Before brazing, acid pickle according to Flow Chart 6 or mechanical clean according to Flow Chart 2. After brazing, remove flux according to Flow Chart 7.
Buffing	Before and after buffing, solvent clean according to Flow Chart 1.
Electrical Discharge Machining (EDM)	Before electrical discharge machining (EDM), acid pickle according to Flow Chart 6.
Fluorescent Penetrant Inspection (Note 2)	Unless etching is specified by the engineering drawing or PPS 20.03, before fluorescent penetrant inspection alkaline clean according to Flow Chart 3. Only If etching is specified by the engineering drawing or PPS 20.03, etch according to Flow Chart 4 before fluorescent penetrant inspection. After fluorescent penetrant inspection, clean according to Flow Chart 8.
Forming	Before forming, solvent clean according to Flow Chart 1.
Heat Treatment	Before heat treatment, acid pickle according to Flow Chart 6 or abrasive blast according to Flow Chart 2.
Machining	Solvent clean according to Flow Chart 1 before machining.
Magnetic Particle Inspection	Before and after magnetic particle inspection, alkaline clean according to Flow Chart 3.
Painting	Before painting, acid passivate according to Flow Chart 5 or mechanically clean according to Flow Chart 2.
Plating	Before plating parts that have been heat treated to a tensile strength of less than 150 - 170 ksi, acid pickle according to Flow Chart 6 or mechanically clean according to Flow Chart 2. For parts heat treated to150 - 170 ksi or greater, mechanically clean according to Flow Chart 2 before plating.
Removal of Heat Treatment Discolouration	To remove heat treatment discolouration, abrasive blast using glass beads or aluminum oxide according to PPS 17.02.
Removal of Scale Inhibiting Agent after Heat Treatment	Mechanically clean according to Flow Chart 2.
Shot Peening	Before shot peening, solvent clean according to Flow Chart 1.
Soldering	Before soldering, acid pickle according to Flow Chart 6 or mechanical clean according to Flow Chart 2. After soldering, remove flux according to Flow Chart 7.

Note 1. After completing all manufacturing processes, final clean according to paragraph 5.3.3.

Note 2. Carry out “etching” before FPI only when specified by the engineering drawing or PPS 20.03. Only parts that have undergone metal smearing operations or operations that will smear metal or otherwise close that have undergone metal smearing operations or operations that will smear metal or otherwise close surface openings must be etched prior to FPI. See PPS 20.03 for a list of such operations. Ensure that the minimum part thickness is maintained in the etched area. Do not etch parts otherwise.

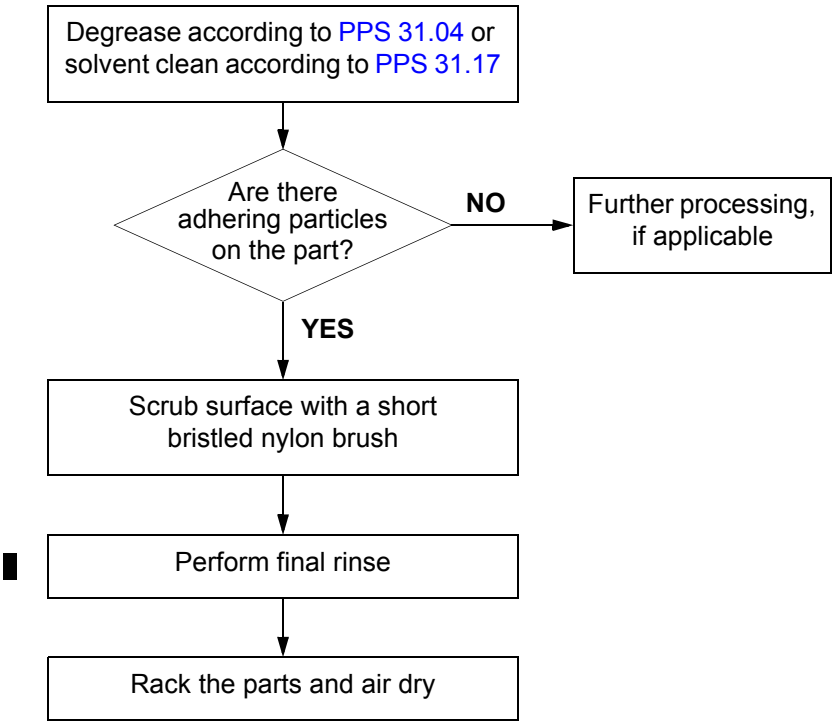
TABLE V - PH (PRECIPITATION HARDENABLE) CRES: CLEANING PROCESSES FOR A GIVEN INTERMEDIATE PROCESS OPERATION.

INTERMEDIATE PROCESS OPERATION	CLEANING PROCESS (NOTE 1)
Spinning	Before spinning, solvent clean according to Flow Chart 1.
Vapour Blasting	Before vapour blasting, solvent clean according to Flow Chart 1.
Vibratory Tumble Deburring	Before vibratory tumble deburring, solvent clean according to Flow Chart 1 or alkaline clean according to Flow Chart 3.
Welding (Fusion or Resistance)	Before fusion or resistance welding, acid pickle according to Flow Chart 6 or mechanical clean according to Flow Chart 2.

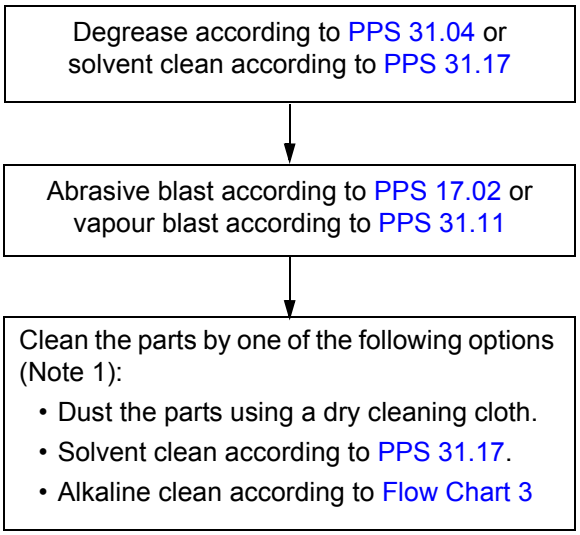
Note 1. After completing all manufacturing processes, final clean according to paragraph 5.3.3.

Note 2. Carry out “etching” before FPI only when specified by the engineering drawing or PPS 20.03. Only parts that have undergone metal smearing operations or operations that will smear metal or otherwise close that have undergone metal smearing operations or operations that will smear metal or otherwise close surface openings must be etched prior to FPI. See PPS 20.03 for a list of such operations. Ensure that the minimum part thickness is maintained in the etched area. Do not etch parts otherwise.

FLOW CHART 1 - DEGREASING

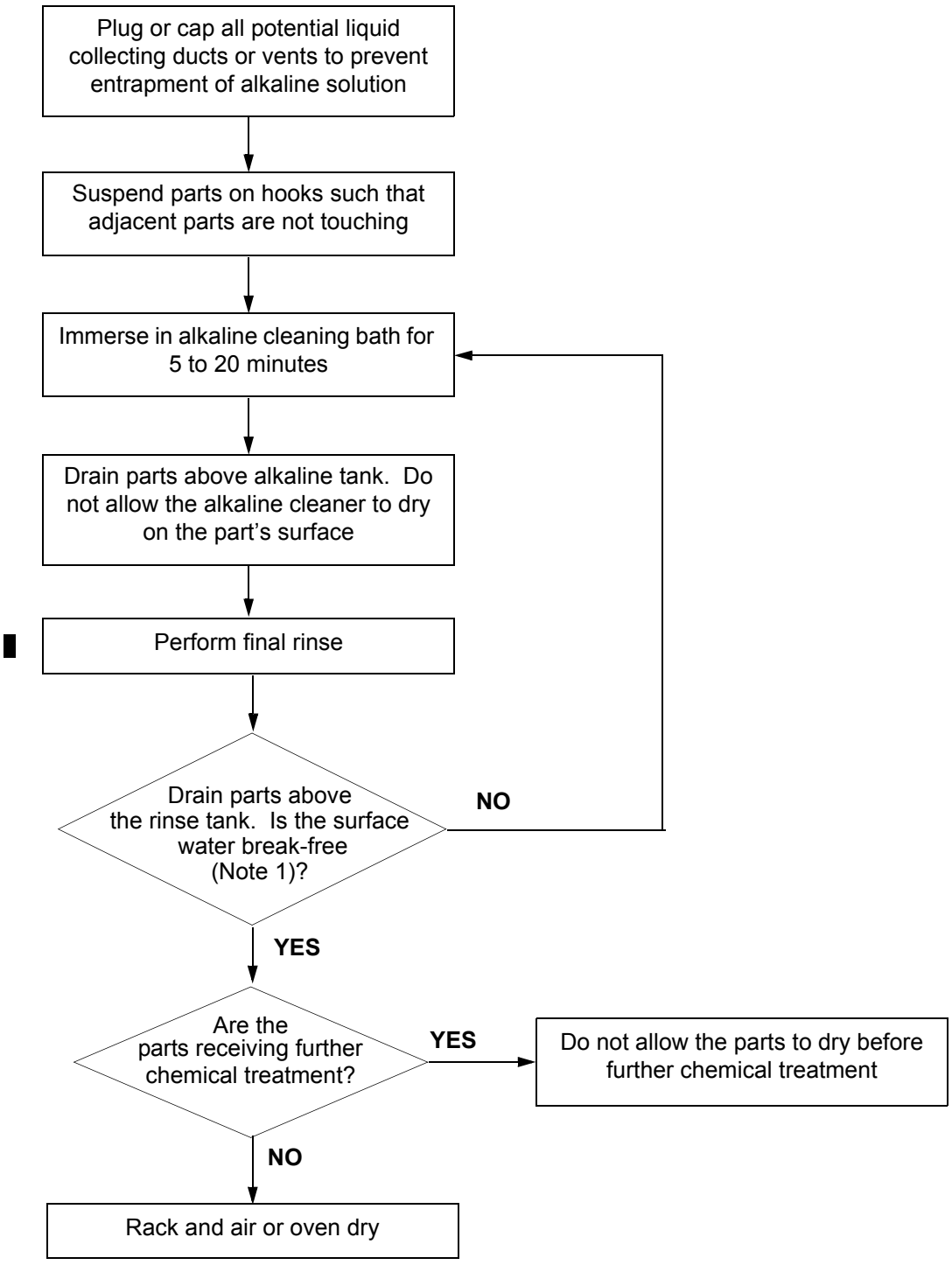


FLOW CHART 2 - MECHANICAL CLEANING



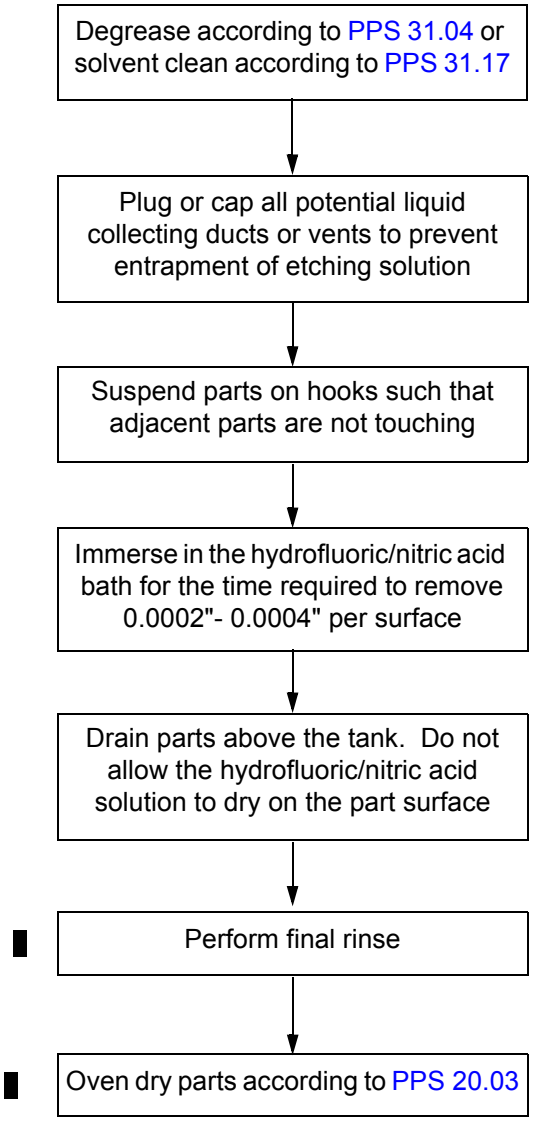
Note 1. For removal of scale inhibiting agent after heat treatment, alkaline clean according to Flow Chart 3 (the other options are not acceptable in this instance.

FLOW CHART 3 - ALKALINE CLEANING

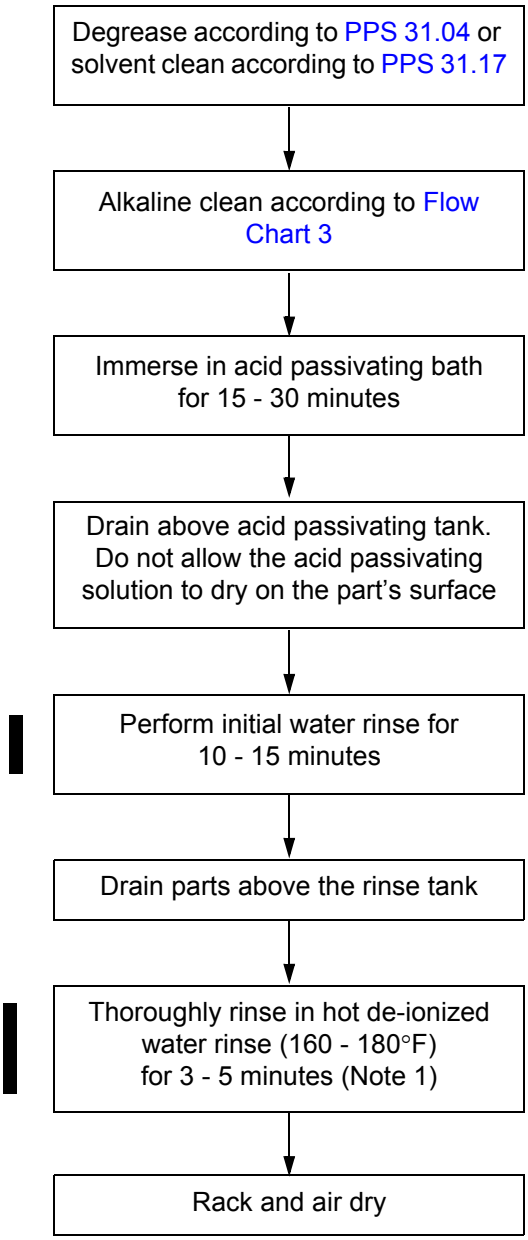


Note 1. A water break-free surface is defined as a surface on which a water film will remain continuous for a period of at least 15 seconds without discontinuities or breaks.

FLOW CHART 4 - ETCHING BEFORE FLUORESCENT PENETRANT INSPECTION

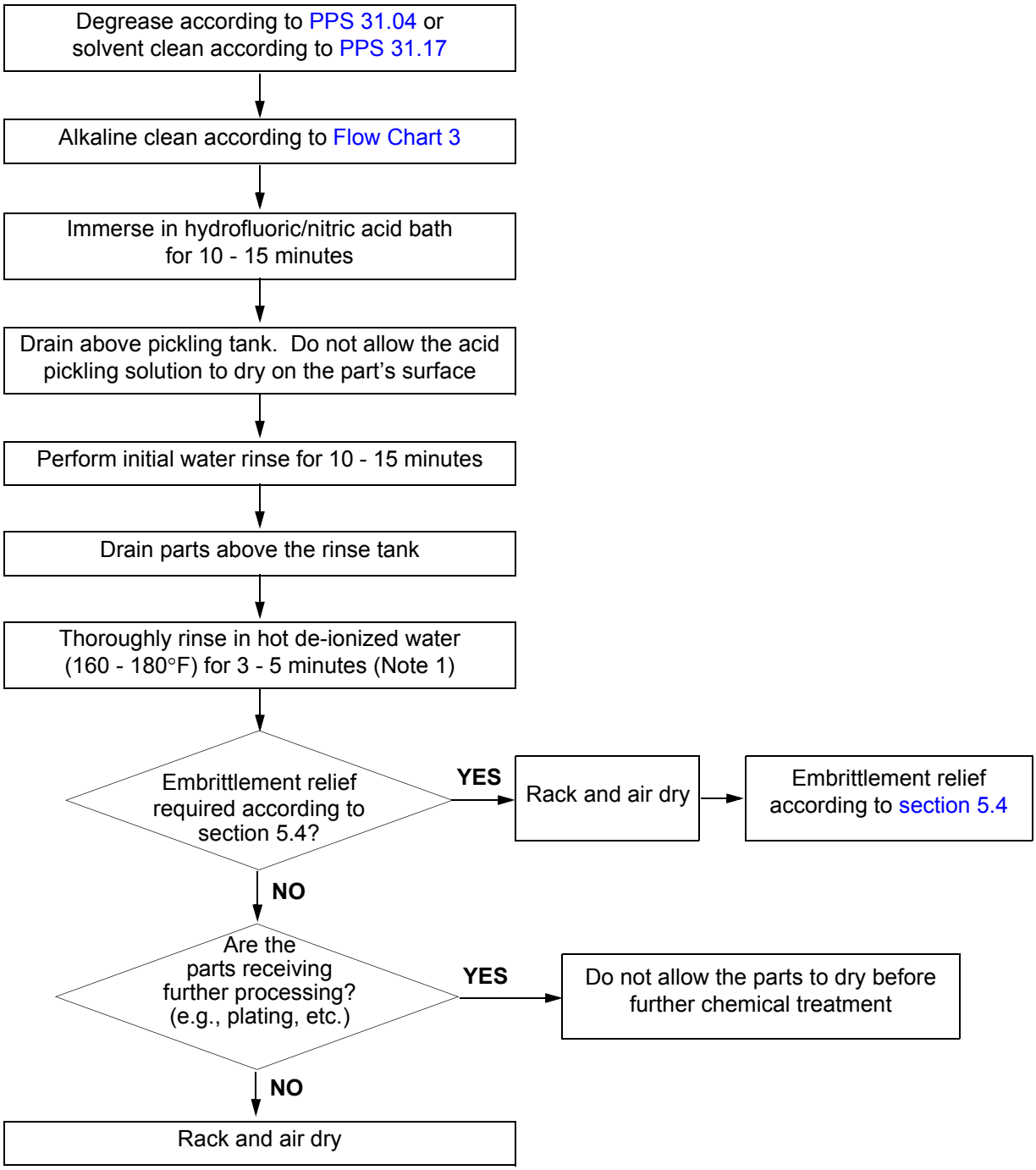


FLOW CHART 5 - INHIBITED NITRIC ACID PASSIVATION



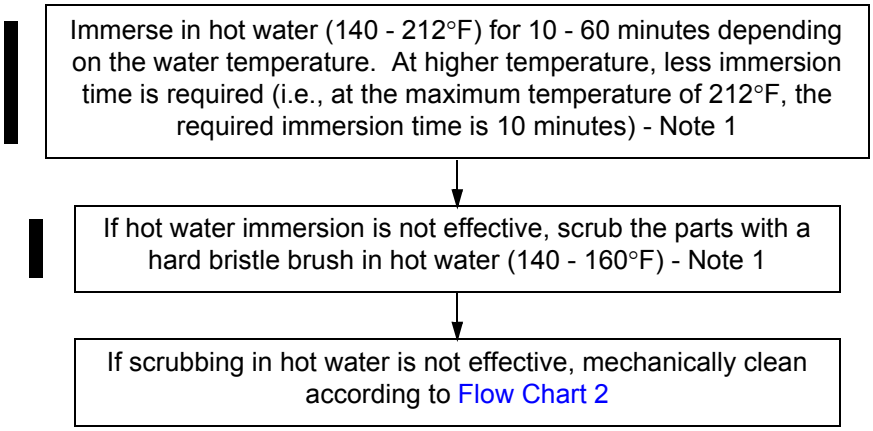
Note 1. In place of the hot de-ionized water rinse, it is acceptable to rinse parts in the final water rinse as controlled according to Table II.

FLOW CHART 6 - HYDROFLUORIC/NITRIC ACID PICKLING



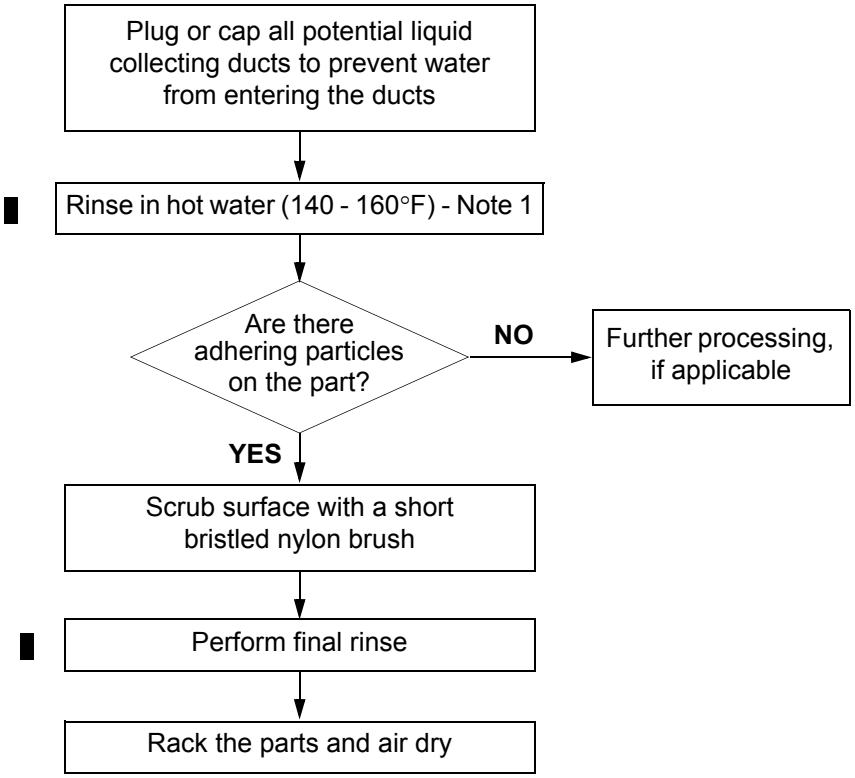
Note 1. In place of the hot de-ionized water rinse, it is acceptable to rinse parts in the final water rinse as controlled according to Table II.

FLOW CHART 7 - FLUX REMOVAL



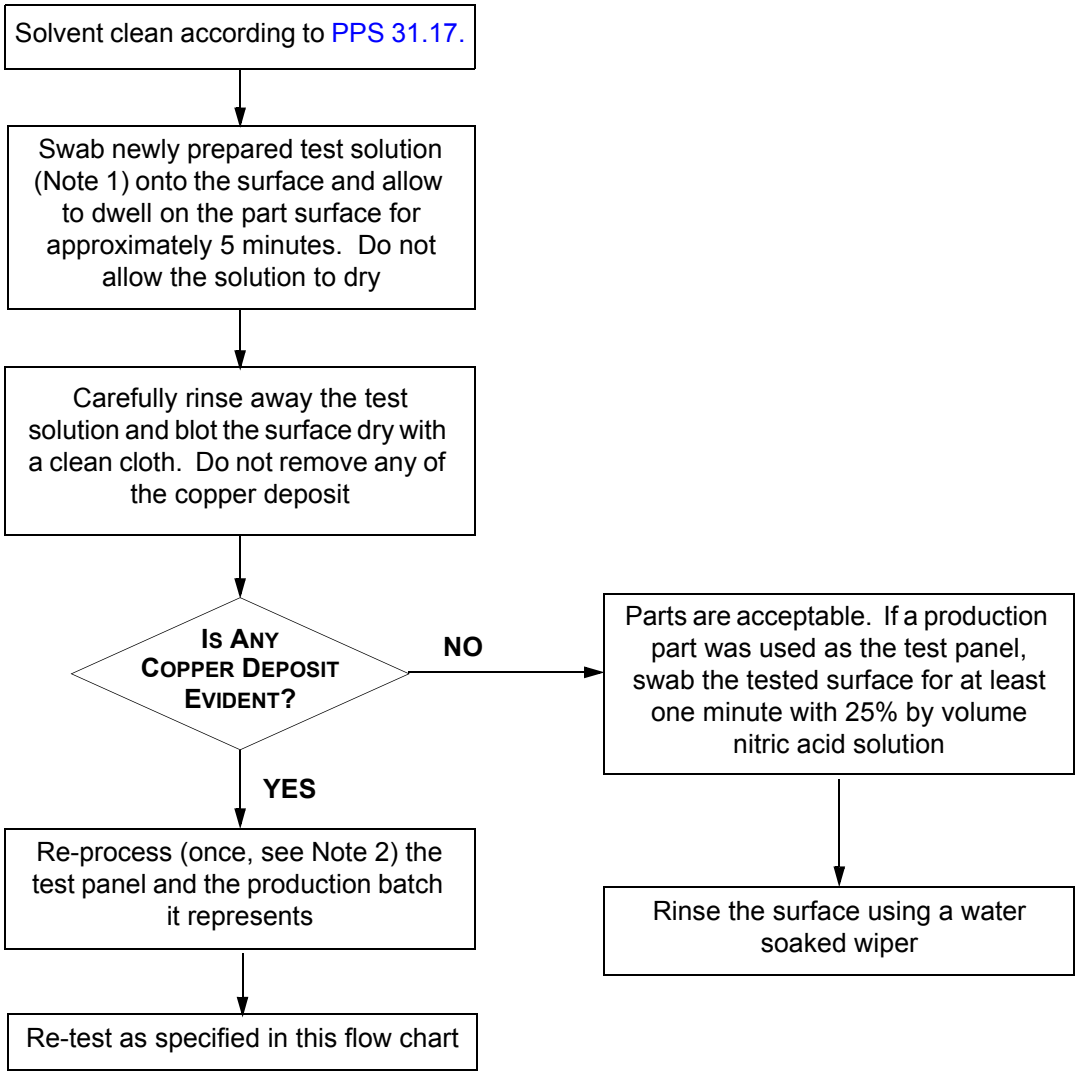
Note 1. Water TDS/EC and pH shall meet that of the final rinse as specified in Table II.

FLOW CHART 8 - CLEANING AFTER FLUORESCENT PENETRANT INSPECTION



Note 1. Water TDS/EC and pH shall meet that of the final rinse as specified in Table II.

FLOW CHART 9 - COPPER DEPOSIT MONTHLY TESTING



Note 1. Prepare test solution by mixing 16 grams of copper sulphate and 5 mL sulphuric acid, 66°Bé, per litre of de-ionized water. Prepare the amount of test solution necessary for the testing on hand (e.g., if half a litre of solution is required, mix 8 grams of copper sulphate and 2.5 mL sulphuric acid, 66°Bé, in half a litre of de-ionized water).

Note 2. If, after a second copper sulphate test as specified in this flow chart, the test panel is determined to be unacceptable, suspend the passivation process until the cause of the failure has been established and corrective action taken.