BOMBARDIER

Toronto Site

PROPRIETARY INFORMATION

PPS 31.13

PRODUCTION PROCESS STANDARD

Cleaning Aluminum Alloys For High Strength Adhesive Bonding

Issue 11
- This standard supersedes PPS 31.13, Issue 10.
- Vertical lines in the left hand margin indicate technical changes over the previous issue.
- Direct PPS related questions to christie.chung@aero.bombardier.com or (416) 375-7641.
- This PPS is effective as of the distribution date.

- **THIS STANDARD SPECIFIES MANUFACTURING PROCESSES WHICH ARE CRITICAL TO THE STRUCTURAL INTEGRITY AND TRANSPORT CANADA CERTIFICATION OF BOMBARDIER AEROSPACE TORONTO AIRCRAFT.**
- **IT IS IMPERATIVE THAT THE PROCEDURE SPECIFIED HEREIN BE STRICTLY ADHERED TO.**
- **THE CURRENT ISSUE OF THIS PPS AND ANY SUBSEQUENT REVISIONS TO THE PROCEDURE AND REQUIREMENTS SPECIFIED HEREIN SHALL BE AUTHORIZED BY AN UNDERSIGNED TRANSPORT CANADA DESIGN APPROVAL DESIGNEE (DAD).**

(Ed Giovannetti, DAD 259) June 23, 2017

Prepared By: (Christie Chung) April 27, 2017

PPS Group

Approved By: (Bruce Campbell) June 23, 2017

Materials Technology

(Stephen Pitt) June 30, 2017

Quality

TABLE OF CONTENTS

Sections **Page**

Tables

Figures

Flow Charts

1 SCOPE

1.1 This Production Process Standard (PPS) specifies the procedure and requirements for cleaning and etching aluminum alloys and metal honeycomb before adhesive bonding according to PPS 36.07.

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

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

1.1.3 Procedure or requirements specified in a Bombardier BAPS, MPS, LES or P. Spec. do not supersede the procedure or requirements specified in this PPS. Similarly, the procedure and requirements specified in this PPS are not applicable when use of a BAPS, MPS, LES or P. Spec. is specified.

2 HAZARDOUS MATERIALS

2.1 Before receipt at Bombardier Toronto, all materials shall be approved and assigned Material Safety Data Sheet (MSDS) numbers by the Bombardier Toronto 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 the Bombardier Toronto Environment, Health and Safety Department.

3 REFERENCES

3.1 BAERD GEN-018 - Engineering Requirements for Laboratories.

3.2 BAERD GEN-023 - Contamination Control for Compressed Air.

3.3 PPS 10.52 - Certification of Platen Press.

3.4 PPS 13.26 - General Subcontractor Provisions.

3.5 PPS 13.39 - Bombardier Toronto Engineering Process Manual.

3.6 PPS 27.02 - Edge Finishing Aluminum Alloy Parts.

3.7 PPS 31.04 - Degreasing Processes.

3.8 PPS 32.11 - Chromic Acid Anodizing for High Strength Adhesive Bonding.

3.9 PPS 36.07 - Metal to Metal and Metal to Metal Honeycomb High Strength Bonding Using DHMS A6.03 Adhesive Film and Primer.

3.10 PPS 36.21 - Environment Control Requirements for High Strength Bonding Rooms.

4 MATERIALS, EQUIPMENT AND FACILITIES

4.1 Materials

4.1.1 Alkaline cleaners:

- Bonderite C-AK 53 AERO and Ridosol 501 Additive (Henkel)
- Bonderite C-AK 4215 NC-LT AERO and Bonderite C-AD 4215 AERO (Henkel)

4.1.2 Deoxidizers as listed in Table I.

4.1.3 Sulphuric acid, commercially pure.

4.1.4 Sodium dichromate.

4.1.5 Protective wrapping, Kraft paper.

4.1.6 Cotton gloves (e.g., DSC 422-1).

4.1.7 Alclad aluminum alloy sheet, 2024-T3 (QQ-A-250/5), 6" X 6" X 0.125" thickness.

4.1.8 DHMS A6.03-1 adhesive primer.

4.1.9 DHMS A6.03 adhesive film.

4.2 Equipment

4.2.1 All air used for spraying and drying of parts in any location or for the operation of air motors within the Controlled Contamination Area (CCA) shall be filtered for airborne dust and meet the requirements of PPS 36.21 at the using area. Air used for processing solution agitation shall be supplied free of oil.

4.2.1.1 Compressed air shall meet the requirements of BAERD GEN-023.

4.2.2 Liquid handling facilities shall preclude contamination by grease, oil, suspended or dissolved solids, or other substances detrimental to adhesion.

4.2.3 Design and control lubricated equipment so as to prevent any contamination of adhesives or cleaned details by the lubricant.

4.2.4 Immersion tanks for water rinse (re-circulating and de-ionized) and chemical baths as listed in Table I. Immersion tanks shall 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; and stainless steel tanks with agitation equipment for immersion deoxidizers). Tanks shall 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.

4.2.5 Platen press certified to PPS 10.52.

4.2.6 Humidity cabinet capable of maintaining a relative humidity of 95 to 100 percent at a temperature of 125 ± 5°F.

4.3 Facilities

4.3.1 This PPS has been categorized as a Controlled Critical Process according to PPS 13.39 and as such only facilities specifically approved according to PPS 13.39 are authorized to perform cleaning and etching aluminum alloys and metal honeycomb before adhesive bonding according to this PPS.

4.3.2 Bombardier subcontractors shall direct requests for approval to Bombardier Aerospace Supplier Quality Management. Bombardier Aerospace facilities shall direct requests for approval to the appropriate internal Quality Manager.

4.3.3 Facility approval shall be based on a facility report, a facility survey and completion of a qualification test program, if required. The facility report shall 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 shall be detailed in the facility report. Based upon the facility report, Bombardier Toronto Materials Technology may identify additional qualification and/or process control test requirements. During the facility survey, the facility requesting qualification shall be prepared to demonstrate their capability. Once approved, no changes to subcontractor facilities may be made without prior written approval from Bombardier Toronto Materials Technology.

4.3.3.1 For approval of subcontractor facilities to perform cleaning and etching aluminum alloys and metal honeycomb before adhesive bonding according to this PPS, completion of a test program and submission of suitable test samples representative of production parts is required. Test samples shall meet the requirements as defined by Bombardier Toronto Materials Technology.

4.3.4 All testing and evaluation specified herein shall only be performed by Bombardier Toronto Materials Laboratory or by laboratories accredited according to BAERD GEN-018.

5 PROCEDURE

5.1 General

5.1.1 Agitate all cleaning solutions after prolonged standing (48 hours or more) or after the addition of chemicals, water or aluminum, to ensure uniformity of concentration and temperature.

5.1.2 Deoxidizers and associated rinse tanks shall not be used for purposes other than metal bond and subsequent finishing.

5.1.3 For the purposes of this PPS, the term “MRB” (Material Review Board) shall be considered to include Bombardier Aerospace Toronto MRB and Bombardier Aerospace Toronto delegated MRB.

5.2 Preparation of Solutions

5.2.1 General

5.2.1.1 Refer to Table II for the requirements for the water used for solutions make-up.

5.2.2 Alkaline Cleaner

5.2.2.1 Make up alkaline cleaners according to manufacturer's instructions.

5.2.3 Deoxidizer

5.2.3.1 Make up the deoxidizing solutions as follows:

Step 1. Fill the tank to approximately 2/3 operating capacity with water.

Step 2. Air agitate the bath while slowly and cautiously adding the required amount of sulphuric acid as specified in Table I.

Step 3. With constant agitation, add the required amount of sodium dichromate as specified in Table I. Allow the sodium dichromate to completely dissolve before bringing the tank to operating level by the addition of water.

5.3 Conditioning of Acid Etch Solution

5.3.1 Seed new acid etch solutions by dissolving 0.25 weight ounce (1.5 g) of 2024 aluminum in each gallon of the new solution and add sufficient copper sulphate ($CuSO_4 \bullet 5H_2O$) to obtain a copper content of approximately 250 to 550 ppm.

5.3.2 Do not use any of the old solution for make up of the new solution.

TABLE I - MAKE-UP OF SOLUTIONS

BATH TYPE (NOTE 2)	BATH MAKE-UP (NOTES 1 AND 3)				OPERATING TEMPERATURE
	CHEMICALS	IMPERIAL UNIT	METRIC UNIT	U.S. UNIT	
ALKALINE CLEANING SOLUTIONS					
Bonderite C-AK 4215 NC-LT AERO	Bonderite C-AK 4215 NC-LT AERO	31 lbs/100 gal	3.1 kg/100 L	26 lbs/100 gal	130 ± 10°F
	Bonderite C-AD 4215 AERO	1 qt/100 gal	0.25 L/100 L	1 qt/100 gal	
Bonderite C-AK 53 AERO (Note 4)	Bonderite C-AK 53 AERO (Note 4)	12 lbs/100 gal	1.2 kg/100 L	10 lbs/100 gal	150 ± 10°F
	Ridosol 501 Additive	1 gal/100 gal	1 L/100 L	1 gal/100 gal	
DEOXIDIZING SOLUTIONS					
Acid Etch	Sulphuric acid	15 gal/100 gal	15 L/100 L	15 gal/100 gal	155 ± 5°F
	Sodium dichromate	90 lbs/100 gal	9.0 Kg/100 L	75 lbs/100 gal	

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. Refer to paragraph 4.2.4 for tank requirements.
Note 3. Use water meeting the requirements specified in Table II to make up all solutions.
Note 4. Dissolve Bonderite C-AK 53 AERO in a separate container of water and add it to the bath.

5.4 Racking of Parts

5.4.1 Rack parts so as the following are met:

- Adjacent parts do not touch.
- The cleaning solution and rinse water can circulate freely between parts.
- The parts are in a position that promotes solution drainage without solution entrapment in recesses or creation of air pockets.
- Space parts so that they are visually inspectable to the water break-free requirements specified in paragraph 6.1.2.3.

5.5 Cleaning and Etching

5.5.1 Clean and deoxidize sheet metal and machined parts according to Flow Chart 1.

5.5.2 Transfer Operation

5.5.2.1 During the transfer of parts from the deoxidizer to the rinse tank, cold water spray rinse parts (90°F maximum) to preclude unwanted chemical changes in the oxide coating.

5.5.2.1.1 Accomplish this with spray rinse nozzles located on the overhead transfer rack and on the periphery of the deoxidizing solution tank. Position and activate these spray nozzles so that each detail part is exposed to water spray immediately as the parts commence to break the surface of the deoxidizing solution and continue until the parts are fully immersed in the subsequent rinse tank.

5.5.2.1.2 During the transfer operation, all parts shall remain cool and wet, precluding any drying of the surfaces.

5.5.2.1.3 Transfer the parts as quickly as possible. The time from the first part breaking the surface of the deoxidizing solution until the last part is immersed in the rinse tank shall not exceed 90 seconds.

5.5.3 Rinsing Operation

5.5.3.1 The feed water to all rinse operations shall meet the requirements specified in Table II.

5.5.3.2 Agitate immersion rinses to prevent stratification of solids in the rinse water.

5.5.3.3 During the rinse operation, the combination of cold water rinsing (90°F maximum) and part racking shall accomplish the requirement that all surfaces of each production part, including top, bottom and all sides, are exposed to sufficient rinsing to remove all acid from these surfaces. Accomplish this by one of the following methods:

- A single immersion rinse according to paragraph 5.5.3.3.1.
- A double immersion rinse combination according to paragraph 5.5.3.3.2.
- A spray rinse followed by a single immersion rinse according to paragraph 5.5.3.3.3.
- A single spray rinse according to paragraph 5.5.3.3.4.

5.5.3.3.1 If a **SINGLE IMMERSION** rinse is used, the rinse water shall not contain more than 1000 ppm total dissolved solids and shall be 5 to 10 minutes in duration.

5.5.3.3.2 If a **DOUBLE IMMERSION** rinse is used, the first rinse water shall not contain more than 5000 ppm total dissolved solids and the second rinse water shall not contain more than 1000 ppm total dissolved solids. During the transfer operation between rinses, the parts shall remain cool and wet. The time from the start of the first immersion rinse to complete immersion in the final immersion rinse shall not exceed 3 minutes. The final immersion rinse shall be 5 to 10 minutes in duration.

5.5.3.3.3 If a **SPRAY RINSE FOLLOWED BY A SINGLE IMMERSION** rinse is used, the final immersion rinse water shall not contain more than 1000 ppm total dissolved solids. During the transfer operation between rinses, the parts shall remain cool and wet. The time from the start of the spray rinse to the complete immersion in the final immersion rinse shall not exceed 3 minutes. The final immersion rinse shall be 5 to 10 minutes in duration.

5.5.3.3.4 If a **SINGLE SPRAY** rinse is used, the following conditions apply:

- The spray rinse shall be 5 to 15 minutes in duration.
- The rinsing operation shall consist of a horizontal spray and an overhead spray. Both spraying mechanisms shall be functioning for the entire duration of the rinsing operation.
- The parts shall be located centrally in the rinse tank, in the direct spray area of the nozzles, to ensure the optimum rinsing water pressure.

5.5.3.4 After completion of the rinsing operation, check parts for a water break-free surface according to paragraph 6.1.2.3. If a water break-free surface is not evident, re-clean according to section 5.5 and re-inspect. Parts may be re-cleaned once, in addition to the initial cleaning operation, without MRB approval. Parts may be cleaned a maximum of 3 times but MRB approval is required before the third cleaning.

5.5.4 Aluminum Honeycomb Core

5.5.4.1 Clean honeycomb cores, other than cores which have been polyethylene glycol filled, before bonding as follows (see Flow Chart 2):

Step 1. Degrease according to PPS 31.04. Position cores so that the cells are vertical. Except for pre-crushed cores or filled cores, a maximum of 4 pieces may be stacked to a maximum height of 12" provided that the faces are not damaged. Do not stack pre-crushed cores.

Step 2. If all soluble contaminants have not been removed, repeat degreasing. If insoluble soils are present after the second degreasing cycle, immerse the core in the alkaline cleaner specified in Table I for 5 minutes and immediately rinse, first with cold water and then with hot de-ionized water (160 - 200°F) and re-inspect for insoluble contaminants. If insoluble contaminants are still evident, reject the core.

Step 3. Except as specified, dry cores for a minimum of 15 minutes at 130 - 250°F. Dry spliced cores containing cured adhesive or filled cores containing cured filler for a minimum of 45 minutes at 225 - 250°F.

5.5.4.2 Clean cores which have been filled with polyethylene glycol to aid in machining as follows (see Flow Chart 3):

Step 1. Immerse the core in a hot water bath (200°F minimum) for 10 minutes to melt out the bulk polyethylene glycol. Do not stack pre-crushed cores or filled cores.

Step 2. Allow to drain.

Step 3. Immerse the core in water (170 ± 10°F) for 5 minutes.

Step 4. Allow to drain and dry.

Step 5. Degrease according to PPS 31.04.

Step 6. Immerse in alkaline cleaner for 5 minutes, remove and cold water rinse within 30 seconds.

Step 7. Repeat the alkaline cleaner immersion and cold water rinse.

Step 8. Rinse the core with de-ionized water (160 - 200°F) and inspect under a black light source while the core is still wet. Check for evidence of residual polyethylene glycol which will show as a fluorescent glow.

Step 9. If there is evidence of fluorescence, alkaline clean according to Step 6 and check cores according to Step 8.

Step 10. Dry cores with no evidence of fluorescence for a minimum of 15 minutes at 130 - 250°F. Dry spliced cores containing cured adhesive or filled cores containing cured filler for a minimum of 45 minutes at 225 - 250°F.

Step 11. Wrap cleaned cores in clean, neutral Kraft paper and transport and store on suitable boards to prevent distortion and damage to the cores.

5.6 Handling and Protection of Cleaned Parts

5.6.1 Wear clean, cotton gloves when handling cleaned parts. Only handle parts on the outer edges.

5.6.2 If possible, transport parts to a Controlled Contamination Area (CCA) meeting the requirements of PPS 36.21 within 30 minutes of completion of cleaning. If the delay exceeds 30 minutes, protect the parts by sealing in a heat sealable MIL-B-131 bag. The bag shall contain sufficient desiccant to ensure that all moisture is absorbed during this extended storage period. Place the applicable tensile shear and wedge crack extension test pieces in the same bag.

5.6.3 For cleaned aluminum honeycomb cores, after the core is completely dry, wrap in clean, neutral Kraft paper and transport to a CCA within 30 minutes of completion of cleaning. Transport and store cores on suitable boards to prevent distortion and damage. If honeycomb cores are to be stored outside of the CCA for more than 30 minutes, then bag cores according to paragraph 5.6.2.

5.6.4 Prime parts within the time limit specified in the applicable bonding PPS.

5.6.5 The oxide layer produced by the acid etch is extremely fragile. Take care in order not to damage this layer (i.e., only handle parts by the edges).

6 REQUIREMENTS

6.1 General

6.1.1 Parts shall be completely free of water before placing in the degreaser.

6.1.2 Cleaned parts to be bonded shall be free of smut and water break-free.

6.1.2.1 A surface free of smut is one which appears clean, bright, and free of any powdery deposits.

6.1.2.2 A cleaned surface shall not contain material detrimental to the process which is to be subsequently applied.

6.1.2.3 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.

6.1.3 If re-cleaning according to paragraph 5.5.3.4 or paragraph 6.2.1.2, parts may be re-cleaned once, in addition to the initial cleaning operation, without MRB approval. Parts may be cleaned a maximum of 3 times but MRB approval is required before the third cleaning.

6.2 Clean Line Process Control Test (Crack Extension Test)

6.2.1 Conduct a Clean Line Process Control Test for every load of Bombardier Aerospace parts processed through the clean line (sodium dichromate/sulphuric acid etch).

6.2.1.1 Each Clean Line Process Control Test shall consist of one crack extension test panel (5 test pieces per panel), prepared and tested according to section 6.2.2 and section 6.2.3.

6.2.1.1.1 If the load of parts is to be chromic acid anodized according to PPS 32.11, do not perform the Clean Line Process Control Test after removal from the clean line, but anodize the test panels with the load and then perform an Anodize Process Control Test according to PPS 32.11.

6.2.1.2 If the crack extension test fails the requirement specified in paragraph 6.2.3.3, take the following action:

- Production parts which have not been primed may be re-cleaned, provided that the requirements specified in paragraph 6.1.3 are met.
- Production parts which have been primed, but not cured, may be stripped of any primer by an appropriate method and re-cleaned as specified herein, provided that the requirements specified in paragraph 6.1.3 are met.
- Quarantine production parts which have been primed and cured and refer such parts to MRB for disposition.
- The failed test specimens shall be retained until the disposition of all affected production parts has been resolved.

6.2.2 Preparation of Crack Extension Test Panels

6.2.2.1 Each test panel shall consist of two test plates conforming to the dimensions in Figure 1. Blank or shear each test plate from 2024-T3 alclad aluminum alloy to QQ-A-250/5. Deburr each plate according to PPS 27.02 before surface treatment.

6.2.2.2 Prepare a record sheet to accompany the test panels through all processing operations. Record information, as specified in section 6.2.4, on the record sheet.

6.2.2.3 Clean and dry the test panel along with a production clean load. Locate the individual test plates centrally in the load, with the production details distributed evenly around them, and in such a manner that they represent the upper and lower solution levels to which the production details are exposed.

6.2.2.4 Prime the test plates using qualified DHMS A6.03-1 primer and bond them together using receipt tested DHMS A6.03 adhesive film (0.045 lbs/ft^2) as follows:

Step 1. Apply 6" x 6" square adhesive film to the surface of one of the test plates and lightly roll to obtain uniformity.

Step 2. Place a piece of separator film over the adhesive at one end and place the second test plate over the first (see Figure 1).

Step 3. Cure the test panel according to PPS 36.07.

Step 4. Cut the test panel to produce 5 test pieces as shown in Figure 1. Cut using a band saw, keeping frictional heating of the bond to a minimum.

6.2.3 Crack Extension Test Procedure

6.2.3.1 Perform wedge crack extension testing of each test piece as follows:

Step 1. Securely clamp the end of the test piece opposite the separator film within 1.5" of the end. Only place one test piece in the clamp for testing at one time.

Step 2. Insert a wedge, with dimensions as shown in Figure 1, into the bond line of the test piece at the end containing the separator film.

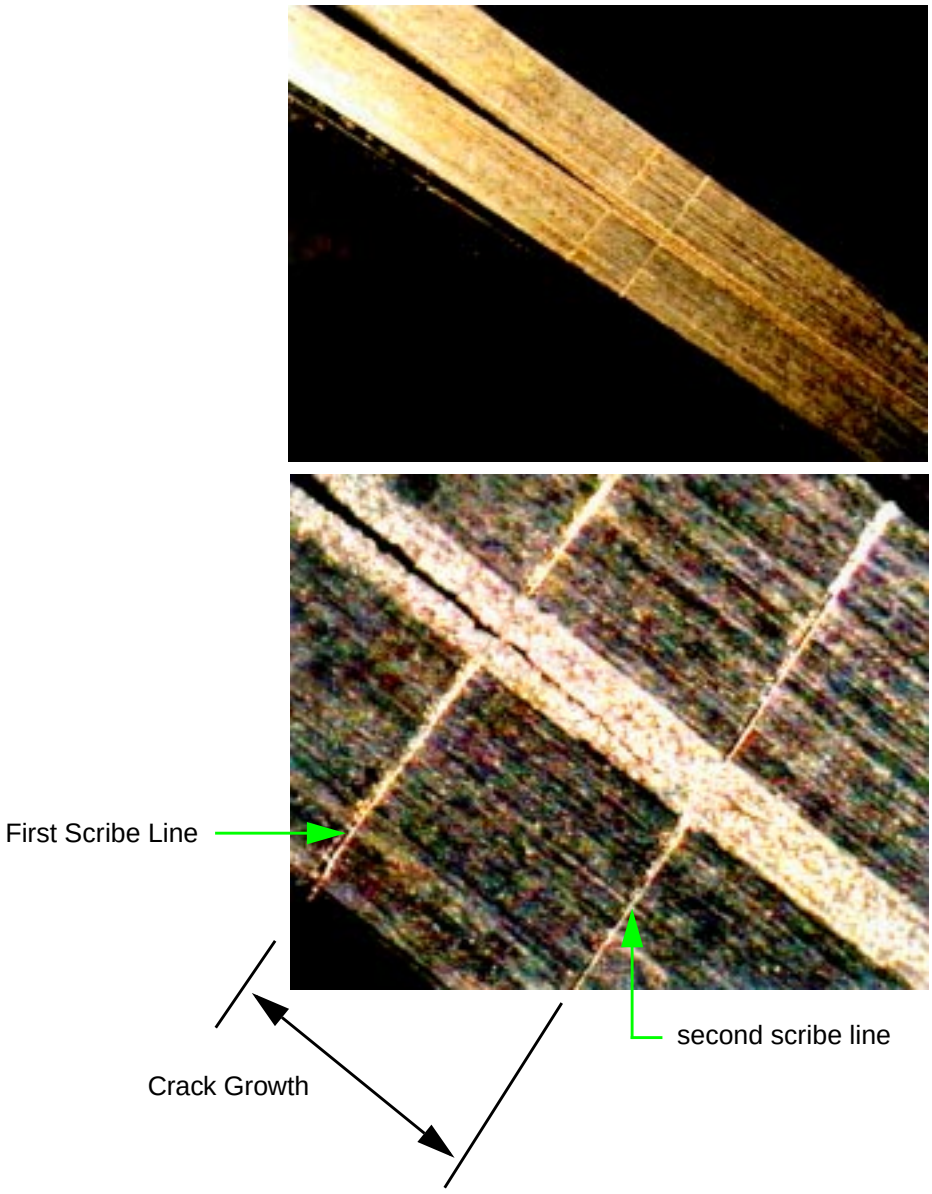
Step 3. Push in the wedge until the end of the wedge is flush with the end of the test piece, keeping the sides of the wedge approximately flush with the sides of the test piece (see Figure 1).

Step 4. Locate the tip of the initial crack and mark it on both sides of the test piece using a fine line (First Scribe Line).

Step 5. Expose the wedged open specimen to 95 to 100 percent relative humidity, for 60 to 75 minutes in a chamber maintained at 120 ± 5°F.

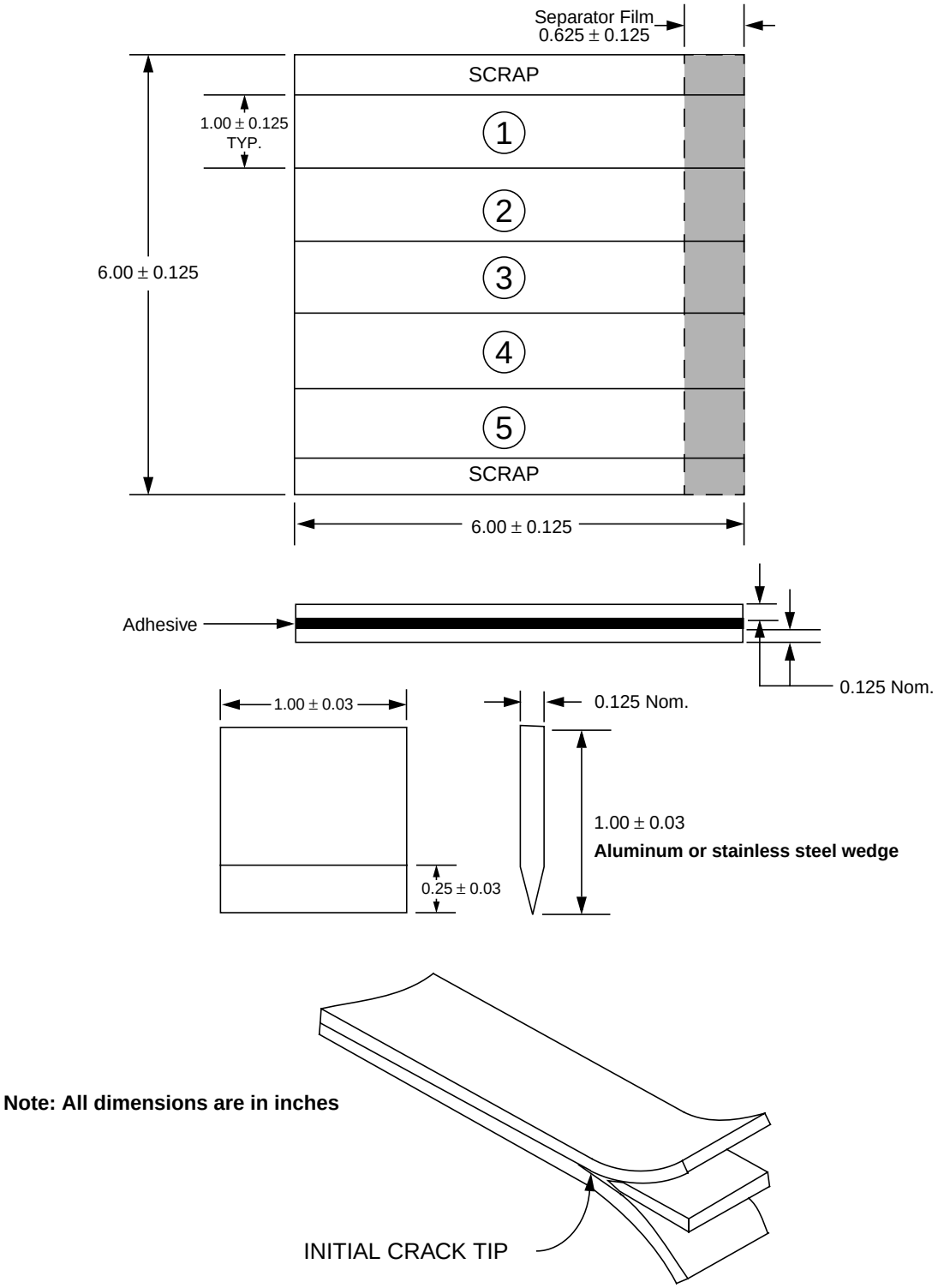
Step 6. Locate the tip of the crack and mark it on both sides of the test piece using a fine line (Second Scribe Line).

Step 7. Measure the increase in crack length, on both sides of the test piece, resulting from the humidity exposure within 2 hours after removal using 5 to 30 power magnification to locate the crack tip. Record the mode of failure (i.e., adhesive, cohesive or contact). Refer to the following pictures on how to determine where the crack begins (i.e., not where resins lightens in colour but at the actual crack).



6.2.3.2 The test results (i.e., PASS/FAIL) as well as the actual amount of crack extension shall be recorded on the Test Record Sheet according to section 6.2.4.

6.2.3.3 The crack extension shall not be more than 0.3" on any one individual test piece.



Note: All dimensions are in inches

FIGURE 1 - CRACK EXTENSION SPECIMEN CONFIGURATION FOR ALUMINUM CLEAN LINE PROCESS CONTROL

6.2.4 Clean Line Process Control Test Record Sheet

6.2.4.1 The Clean Line Process Control Test Record Sheet shall be maintained on file by the subcontractor.

6.2.4.1.1 The Record Sheet shall accompany the test panels and have the following processing information recorded on it:

- Clean Line load number
- Date
- Bath temperature
- Immersion times
- Adhesive, primer and film batch number and unit (film) or lot (primer) number
- Record of priming and bonding area temperature and humidity during processing of test panels
- Autoclave or platen press load number for traceability of processing information (i.e. heat-up time, cure time, temperature and pressure)
- Test results according to paragraph 6.2.3.2

7 SAFETY PRECAUTIONS

7.1 The subcontractor performing the work for Bombardier Aerospace Toronto shall define the safety precautions applicable to the procedures specified in this PPS.

8 PERSONNEL REQUIREMENTS

8.1 This PPS has been categorized as a Controlled Critical Process according to PPS 13.39. Refer to PPS 13.39 for additional personnel requirements. Certified and/or qualified personnel shall have a good working knowledge of the following, as applicable:

- how to operate the clean line equipment
- importance of logging the required processing information
- importance of the rinsing operations
- time allowance between each cleaning operation
- importance of cleaned parts handling
- how to process wedge crack extension test panels

9 MAINTENANCE OF SOLUTIONS

9.1 Analysis of Solutions

9.1.1 All solution analysis shall be performed by a laboratory as specified in paragraph 4.3.4.

9.1.2 For initial qualification and at the intervals indicated in Table II, analyze a sample of the cleaning and deoxidizing solutions to ensure conformance to the requirements of this standard.

9.1.3 Maintain a record of solution analysis.

9.1.4 Keep a record of all changes made to the solutions and the date on which the changes were made. Re-analyze the solution within 24 hours of any adjustment. Maintain records of the solution tests.

9.2 Metal Removal Rate - Sodium Dichromate/Sulphuric Acid Etch

9.2.1 Once every two working days, determine the metal removal rate as follows:

Step 1. Degrease according to PPS 31.04 and alkaline clean as specified herein one test specimen, 3" x 3" x 0.040" of alclad 2024-T3 aluminum alloy conforming to QQ-A-250/5.

Step 2. Measure the specimen thickness to the nearest 0.001".

Step 3. Weigh the specimens to the nearest 0.0001 gram before and after a timed immersion period (e.g., 15 minutes) in the deoxidizing solution. Agitate the deoxidizing solution for a minimum of 15 minutes before immersion of the specimens. The metal removal rate shall be determined with the solution in a static (unagitated) condition.

Step 4. Measure and record the temperature of the deoxidizing solution during the immersion time.

Step 5. Calculate the removal rate as follows:

$$\text{Metal Removal Rate (inch/surface/hour)} = \frac{\text{Weight Loss}}{\text{Original Weight}} \times \text{Original Thickness (inch)} \times \frac{30}{\text{Minutes Immersed}}$$

9.2.1.1 The metal removal rate shall be 0.00022 to 0.00034 inch/surface/hour.

9.2.1.2 When chemical replenishment does not maintain the required removal rate, adjust the temperature within the specified limits of Table I. A temperature increase of 7°F will increase the metal removal rate approximately 0.0001 inch/surface/hour.

TABLE II - SOLUTION CONTROL

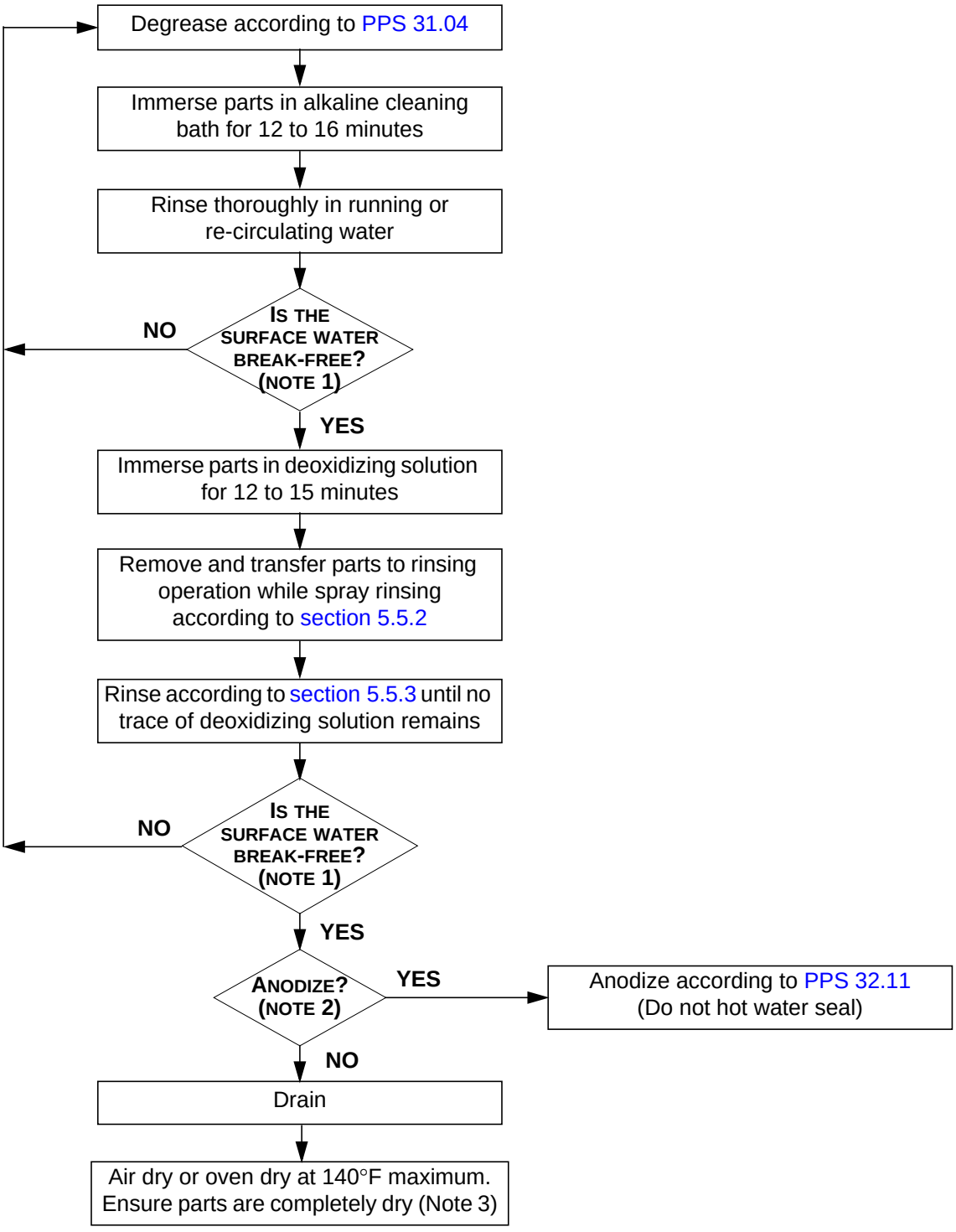
BATH TYPE	CHEMICAL	CONCENTRATION			ANALYSIS FREQUENCY (NOTE 1)	
		IMPERIAL UNITS	METRIC UNITS	U.S. UNITS	STANDARD	EXTENDED
ALKALINE CLEANERS						
Bonderite C-AK 4215 NC-LT AERO	Bonderite C-AK 4215 NC-LT AERO	4 - 6 oz/gal	25 - 37.5 g/L	3 - 5 oz/gal	Weekly	Monthly
	Bonderite C-AD 4215 AERO	See Note 2				
Bonderite C-AK 53 AERO	Bonderite C-AK 53 AERO	1 - 2 oz/gal	6.2 - 12.5 g/L	0.8 - 1.7 oz/gal	Weekly	Monthly
DEOXIDIZERS						
Acid Etch	Sulphuric acid	21 - 25% by wt	131 - 160 mL/L	21 - 25% by wt	Weekly	Monthly
	Sodium dichromate	13 - 15 oz/gal	81 - 93 g/L	11 - 13 oz/gal		
	Copper (Cu)	250 - 550 ppm maximum			Every 3 Months	
WATER FOR RINSE AND SOLUTION MAKE-UP						
De-ionized water rinse supplied for spray rinsing honeycomb cores	De-ionized Water	De-ionized water shall meet a conductivity limit of 220 µmhos and pH range of 5.0 to 7.0.			Weekly	Monthly
Feed water used for rinsing and make-up of solutions (Note 3)	Total dissolved solids	500 ppm maximum			Weekly	Monthly
	Chlorides	25 ppm maximum				
	Fluorides	17 ppm 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. When the alkaline cleaner fails to remove all traces of mill markings, add Turco 4215 Additive to the bath, up to a maximum of one quart/100 gallons (2.5 mL/L) of final solution.

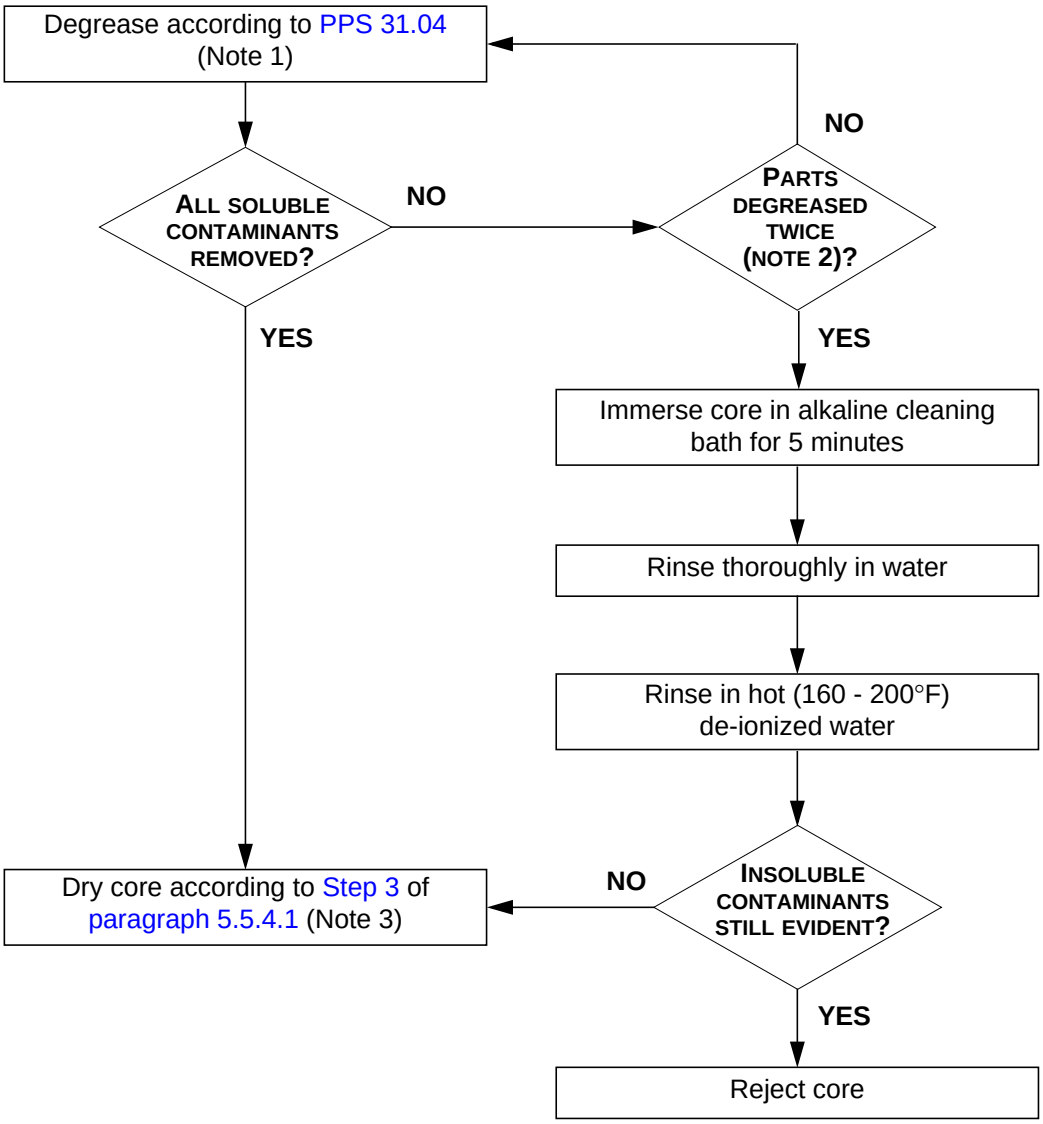
Note 3. The pH shall be within the range of 5.0 to 8.0.

FLOW CHART 1 - CLEANING AND ETCHING OF SHEET METAL AND MACHINED PARTS



Note 1. See paragraph 5.5.3.4.
Note 2. Anodize according to PPS 32.11 only if specified on the engineering drawing. Do not hot water seal.
Note 3. See paragraph 5.6.2.

FLOW CHART 2 - CLEANING HONEYCOMB CORE (NOT POLYETHYLENE GLYCOL FILLED)

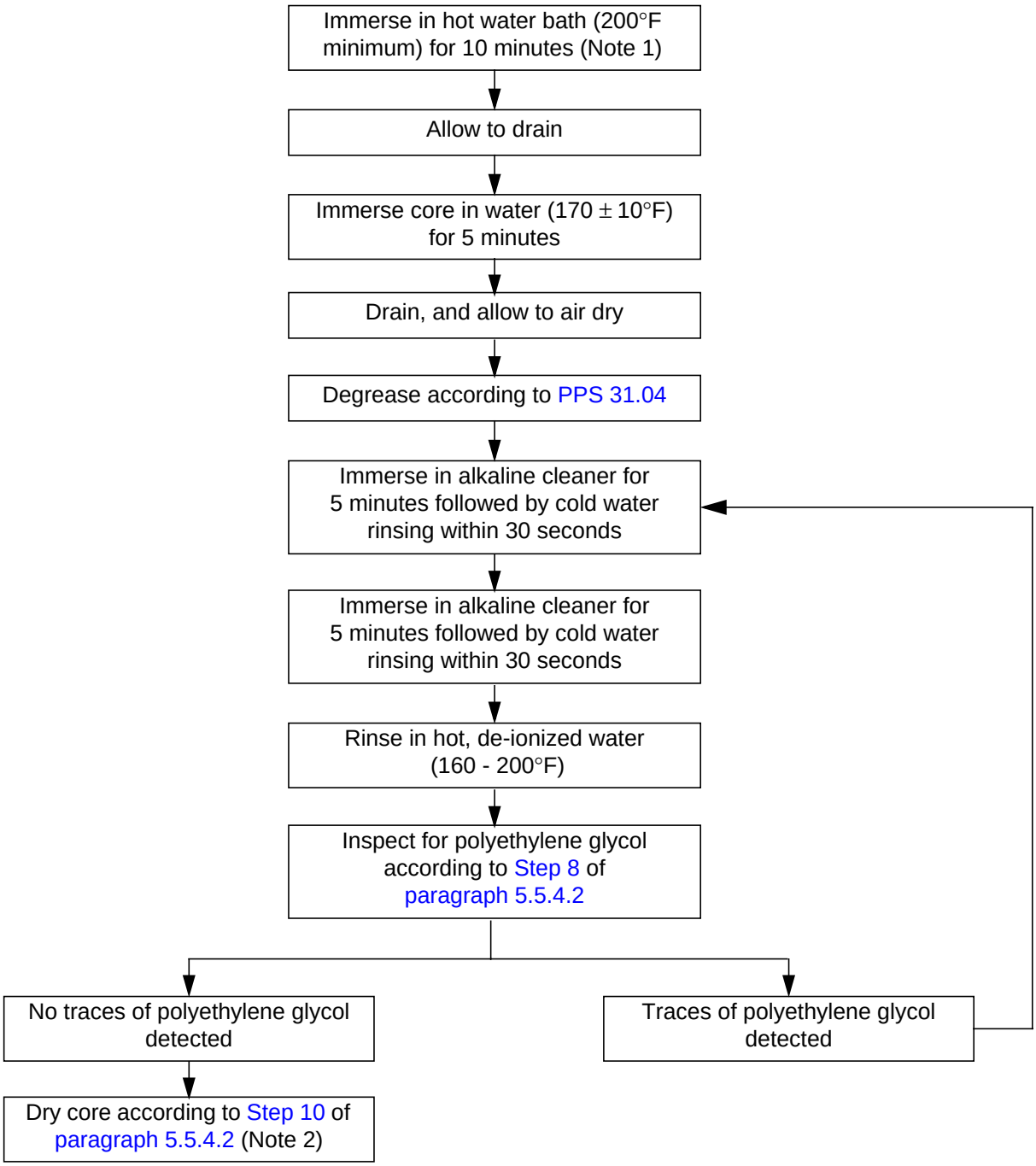


Note 1. Position cores so that the cells are vertical. Except for pre-crushed cores, a maximum of 4 pieces may be stacked to a maximum height of 12" provided that the faces are not damaged. Do not stack pre-crushed cores.

Note 2. If insoluble soils are present after the second degreasing cycle, immerse the core in the alkaline cleaner specified in Table II.

Note 3. See paragraph 5.6.3.

FLOW CHART 3 - CLEANING HONEYCOMB CORE (POLYETHYLENE GLYCOL FILLED)



Note 1. Do not stack pre-crushed cores or filled cores.
Note 2. See paragraph 5.6.3.