BOMBARDIER
Toronto Site
PROPRIETARY INFORMATION

PPS 32.11

PRODUCTION PROCESS STANDARD

CHROMIC ACID ANODIZING FOR HIGH STRENGTH ADHESIVE BONDING

Issue 5
- This standard supersedes PPS 32.11, Issue 4.
- 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 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) May 19, 2017

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1 SCOPE

1.1 This Production Process Standard (PPS) specifies the procedure and requirements for the chromic acid anodizing of aluminum alloys before high strength adhesive bonding according to PPS 36.07, as applicable.

1.1.1 Refer to PPS 32.03 for the procedure and requirements for the chromic acid anodizing of aluminum alloys not bonded according to the above standards.

1.1.2 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.

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

1.1.4 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 PPS 13.26 - General Subcontractor Provisions.

3.2 PPS 21.03 - Priming, Sealing & Repair of Integral Fuel Tanks.

3.3 PPS 27.02 - Edge Finishing Aluminum Alloy Parts.

3.4 PPS 31.13 - Cleaning Aluminum Alloys for High Strength Adhesive Bonding.

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

3.6 PPS 36.21 - Environmental Control Requirements for High Strength Bonding Rooms.

3.7 ASTM-B117 - Standard Practice for Operating Salt Spray (Fog) Apparatus.

3.8 ASTM-B137 - Standard Test Method for Measurement of Coating Mass Per Unit Area on Anodically Coated Aluminum.

3.9 ASTM-D2794 - Standard Test Method for Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact).

3.10 DHLPM Procedure No. 3111 - Coating Weight of Anodic Coatings - *Bombardier Toronto internal operating procedure*.

3.11 DHLPM Procedure No. 4055 - Determination of Free Chromic Acid in Chromic Acid Anodizing Solution - *Bombardier Toronto internal operating procedure*.

3.12 DHLPM Procedure No. 6011 - Description of Operation and Conditions Required For Salt Spray (Fog) Testing For Specification Purposes - *Bombardier Toronto internal operating procedure*.

3.13 Bombardier Toronto Laboratory Drawings - LAB 064, LAB 065, and LAB 066.

4 MATERIALS, EQUIPMENT AND FACILITIES

4.1 Materials

4.1.1 Aluminum Alloy Wire - 1/16" and 3/32" diameter gauge.

4.1.2 Protective wrapping, neutral Kraft Paper or polyethylene plastic bags.

4.1.3 MIL-B-131 heat sealable bag.

4.1.4 Desiccant.

4.1.5 Chromic acid flakes, technical grade, A-A-55827.

4.1.6 DHMS A6.03 adhesive film.

4.1.7 DHMS A6.03-1 adhesive primer.

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.

4.2.2 Anodizing Racks.

4.2.3 Spline Racks.

4.2.4 Immersion tanks for water rinse (re-circulating and de-ionized) and anodizing bath as listed in Table I. Immersion tanks shall be resistant to the chemicals and to the operating temperatures used (e.g., stainless steel or polyethylene lined for containing anodizing solutions). Tanks shall be equipped with temperature indicating, regulating and recording devices capable of controlling the chemical solution temperatures within ± 5°F.

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

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

4.3 Facilities Requirements

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 the chromic acid anodizing of aluminum alloys before high strength 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 the chromic acid anodizing of aluminum alloys before high strength 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 defined by 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 Chromic acid anodizing consists of forming a thin, impervious, oxide layer on the surface of aluminum alloys by electro-chemical means to provide increased corrosion resistance, improved paint adhesion and a suitable substrate for high strength adhesive bonding.

5.1.2 Whenever possible, complete all fabricating operations (i.e., heat treatment, machining, welding, filing, etc.) before anodizing.

5.1.3 Refer to Flow Chart 1 for processing sequences and operations.

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

5.2 Preparation of Solutions

5.2.1 Prepare and operate anodizing solutions according to Table I. Prepare the chemical solutions as follows:

Step 1. Half fill the tank with de-ionized water.

Step 2. Add the required amount of chemicals.

Step 3. Fill the tank to operating level with de-ionized water.

5.2.2 Equip sealing and rinse tanks with inlets and outlets to allow the addition of fresh de-ionized water, as required, to maintain the baths within the limits specified in Table IV.

5.2.3 Only use the de-ionized water sealing bath to seal anodized unprimed surfaces after high strength adhesive bonding according to PPS 36.07, as applicable.

TABLE I - MAKE-UP OF SOLUTIONS

BATH TYPE (NOTE 2)	BATH MAKE-UP (NOTE 1)					OPERATING TEMPERATURE (°F)
	CHEMICALS	IMPERIAL UNITS	METRIC UNITS	U.S. UNITS	WATER	
Anodizing Bath	Chromic Acid	25 lbs/100 gal_{Imp}	2.5 Kg/100 L	20.8 lbs/100 gal_{US}	De-ionized	90 to 95
Hot De-ionized Water Sealing Bath (Note 3)	—				De-ionized	190 to 210
De-Ionized Water Rinse	—				De-ionized	60 to 90

Note 1. It is acceptable for subcontractors to deviate from the specified make-up of solutions provided that the control requirements of Table IV are met.
Note 2. Refer to paragraph 4.2.4 for tank requirements.
Note 3. Only use the de-ionized water sealing bath to seal anodized unprimed surfaces after high strength adhesive bonding according to PPS 36.07, as applicable.

5.3 Preparation of Parts

5.3.1 Racking of Parts

5.3.1.1 Assemble parts on splines or wire them directly to the anode rack to:

- permit free circulation of the anodizing solution to all work surfaces.
- permit good drainage.
- prevent contact with the wall of the tank or adjacent parts.
- prevent air entrapment.
- minimize the number of contact points on the part.

5.3.1.2 If the parts are too large to be clipped to the splines, wire them directly to the anode rack ensuring that the following are met. Suspend smaller parts using 1/16 inch wire. Suspend large parts using 3/32 inch wire.

- There are no contact points between adjacent parts.
- The racking wires are used only once unless the oxide layer on the wire formed during anodizing is stripped before re-use.
- The cross-sectional area of the suspending wire from the parts to the rack is kept uniform.
- The wire is wound tightly around the parts to ensure good electrical contact.

5.3.2 Cleaning of Parts

5.3.2.1 Clean all parts, while racked, according to PPS 31.13 immediately before anodizing. Clean and anodize parts in an uninterrupted sequence. Include a crack extension test panel, prepared and tested according to section 6.4, with each load of parts.

5.4 Anodizing

5.4.1 Except as specified in paragraph 5.4.1.1, anodize all production parts at 40 ± 2 volts.

5.4.1.1 For the following parts only, anodize as follows:

- Anodize 7050, 7075 and 7175 bare and clad aluminum alloy parts and 2014 bare aluminum parts at 22 ± 2 volts.
- For N/C machined 7050 and 7075 aluminum alloy production parts, as a special check for soft spots, anodize first at 40 ± 2 volts and then, if the parts are found to be acceptable, re-anodize at 22 ± 2 volts.

5.4.2 Anodize parts at 40 ± 2 volts as follows:

Step 1. Immerse the parts completely in the anodizing bath.

Step 2. Apply the current within 2 minutes of immersion by starting at zero volts and increasing at 4 volts/minute (ramp-up rate) for 10 minutes until 40 ± 2 volts is reached.

Step 3. Anodize at 40 ± 2 volts for 30 ± 2 minutes.

Step 4. Shut-off the current.

Step 5. Remove the parts from the bath within 2 minutes of the current being shut-off.

Step 6. Drain parts over the anodizing bath for approximately 1 minute.

Step 7. Rinse parts thoroughly in cold de-ionized water (maximum 95°F) for 2 to 5 minutes.

Step 8. Inspect for soft spots, which may or may not be readily visible, by comparing suspect indications to pictures or samples showing soft spots. Soft spots are indicated by a colour contrast with the surrounding anodic film (see Figure 1). Refer parts with soft spots to MRB for disposition.

Step 9. For N/C machined 7050 and 7075 aluminum alloy production parts, before the parts dry, re-anodize at 22 ± 2 volts.

5.4.3 Anodize parts at 22 ± 2 volts as follows:

Step 1. Immerse the parts completely in the anodizing bath.

Step 2. Apply the current within 2 minutes of immersion by starting at zero volts and increasing at no more than 7 volts/minute (ramp-up rate) until 22 ± 2 volts is reached.

Step 3. Anodize at 22 ± 2 volts for 30 ± 2 minutes.

Step 4. Shut-off the current.

Step 5. Remove the parts from the bath within 2 minutes of the current being shut-off.

Step 6. Drain parts over the anodizing bath for approximately 1 minute.

Step 7. Rinse parts thoroughly in cold de-ionized water (maximum 95°F) for 2 to 5 minutes.

Step 8. Inspect for soft spots, which may or may not be readily visible, by comparing suspect indications to pictures or samples showing soft spots. Soft spots are indicated by a colour contrast with the surrounding anodic film (see Figure 1). Refer parts with soft spots to MRB for disposition.

5.4.4 When rinsing, if a spray rinse is used, use a fine spray which produces misty streams of water falling on the part. Course and heavy spray jets producing concentrated streams over long distances are not acceptable. Parts shall be water break-free following rinsing after anodizing. 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.

5.4.5 Take care to avoid contaminating the anodic surface during inter-stage inspection (i.e., do not touch surfaces).

5.4.6 Do not remove or displace electrical contact wires between anodizing cycles. If removed, strip parts according to section 5.7 before re-anodizing.

5.4.7 Dry parts after anodizing at a maximum temperature of 140°F. Drying at room temperature may be hastened by directing clean, dry, oil-free air over the anodized parts.

5.4.8 Handle all anodized parts with clean cotton gloves.

5.4.9 If possible, transport parts to a Controlled Contamination Area (CCA) meeting the requirements of PPS 36.21 within 30 minutes of completion of anodizing. 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. For anodized parts transported to a CCA within 30 minutes of completion of anodizing, if not primed within 16 hours of completion of anodizing the parts shall be wrapped and sealed in clean neutral Kraft paper if not already bagged. Anodized parts shall be primed within 30 days of anodizing.

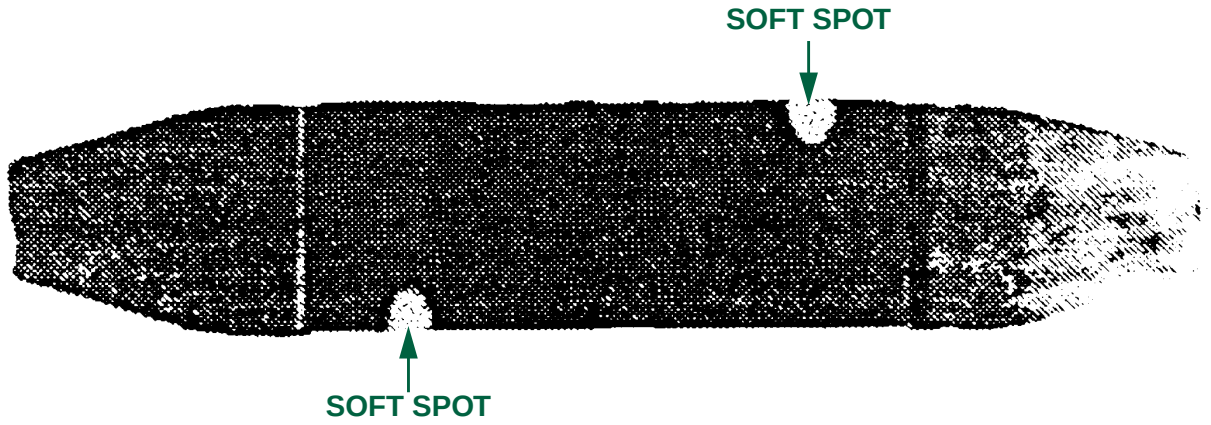


FIGURE 1 - 7075-T6 ALUMINUM ATTACHMENT TEE WITH SOFT SPOT AREAS

5.5 Bonding

5.5.1 Perform bonding according to PPS 36.07, as applicable, before sealing the anodic coating according to section 5.6.

5.6 Post Bonding Treatment

5.6.1 After bonding, process parts as follows:

Step 1. Immerse unprimed anodized surfaces of bonded assemblies in the hot de-ionized water sealing bath for 20 to 30 minutes within 72 hours of high strength adhesive bonding according to PPS 36.07, as applicable. Do not hot water seal parts until after high strength adhesive bonding.

Step 2. Dry parts at a maximum temperature of 140°F. Drying at room temperature may be hastened by directing clean, dry, oil-free air over the sealed parts.

5.7 Rework of Damaged Anodic Coating

5.7.1 Reprocess parts with damaged or removed anodic coatings according to PPS 31.13, provided the requirements specified in paragraph 6.1.2 are met, and re-anodize according to the procedure specified herein.

5.8 Special Planning Instructions

5.8.1 If parts were anodized at 22 ± 2 volts according to paragraph 5.4.3, record this against the chromic acid anodizing operation.

6 REQUIREMENTS

6.1 Cleaning/Anodizing Line Processing Record

6.1.1 Maintain a record of cleaning/anodizing line processing information for each load of parts. Include the following information on the record:

- Clean/anodize load number
- Date
- Cleaning and anodizing bath temperatures
- Immersion times in baths

6.1.2 If reprocessing is necessary, it is acceptable to re-clean the parts once according to PPS 31.13, 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 Process Qualification

6.2.1 For process qualification, process test panels through the anodizing cycle and submit for coating weight determination, corrosion resistance testing and paint adhesion testing as specified herein.

6.2.2 Process qualification test panels shall be submitted to a laboratory as specified in paragraph 4.3.4. Additional tests may be requested at any time at the discretion of Bombardier.

6.3 Production Parts

6.3.1 General

6.3.1.1 Every month during which there has been production of Bombardier Toronto parts, test panels shall be processed through the anodizing cycle and submitted for coating weight determination, corrosion resistance testing and paint adhesion testing as specified herein.

- Once each quarter, subcontractors shall forward the results of monthly test panels to Bombardier Toronto.
- Every 6 months subcontractors shall submit monthly test panels to a laboratory as specified in paragraph 4.3.4 for analyses. If the panels were submitted to a Bombardier Laboratory other than the Bombardier Toronto Materials Laboratory, forward the results to Bombardier Materials Technology.
- At the discretion of Bombardier, it may be necessary that monthly test panels be likewise submitted for verification of test results.
- In order to maintain qualified status, all facilities processing parts for Bombardier Toronto according to this PPS shall maintain records of monthly testing. If these records cannot be produced, then the facility may be required to re-qualify.

6.3.1.2 If there has been no production of Bombardier Toronto parts for 1 to 6 months but there has been production on non-Bombardier Toronto parts, forward monthly test results for corrosion resistance and coating weight distribution testing performed according to MIL-A-8625 for the period during which when no Bombardier Toronto parts were being processed to Bombardier Toronto for review and approval before resuming processing of parts for Bombardier Toronto. If such test results are not available, process test panels for coating weight determination, corrosion resistance testing and paint adhesion testing as specified herein and forward the test results to Bombardier Toronto for review and approval before resuming processing of parts for Bombardier Toronto.

6.3.1.3 If the chromic acid anodizing line has not been processing any parts for more than 1 month or if there has been no production of Bombardier Toronto parts for over 6 months, process test panels for coating weight determination, corrosion resistance testing and paint adhesion testing as specified herein and forward the test results to Bombardier Toronto for review and approval before resuming processing of parts for Bombardier Toronto.

6.3.2 Process Checks

6.3.2.1 Once per shift, check the following to verify that anodizing is being conducted according to this PPS. Take corrective actions, as necessary.

- operating voltage
- the anodizing bath temperature
- details of the sealing procedure (e.g., sealing bath temperature and immersion time)

6.3.3 Testing Requirements

6.3.3.1 Refer to Table II for a summary of test panel requirements.

TABLE II - SUMMARY OF TESTING REQUIREMENTS

TEST	TESTING FREQUENCY	NUMBER OF PANELS	TEST SPECIMENS	TESTING PROCEDURE (NOTE 1)
Visual Inspection	According to Table III and paragraph 6.3.5.2	According to Table III	Production parts	According to section 6.3.5
Wedge Crack Extension	Every production load (see section 6.4)	1 (5 test pieces per panel)	According to section 6.4.3	According to section 6.4.4
Coating Weight	Monthly (see section 6.3.4)	4	LAB-065-1 or QQ-A-250/4 to MIL-A-8625 (0.032" min)	DHLPM Procedure No. 3111 or ASTM B137
Corrosion Resistance	Monthly (see section 6.3.4)	5	LAB 064-1 or MIL-C-5541 (0.032" min)	DHLPM Procedure No. 6011 or ASTM B117
Paint Adhesion	Monthly (see section 6.3.4)	4	LAB 066-3	According to section 6.3.8

Note 1. Refer to the appropriate sections for details regarding test requirements.

6.3.3.2 For visual inspection according to section 6.3.5, select a sample from each production lot, including any parts that appear unusual in colour or evenness of colouration, by taking at random from the lot, not less than the number of items indicated in Table III.

6.3.3.2.1 If the number of non-conforming items in any sample exceeds the acceptance number specified in Table III, reject the represented lot, and disposition them according to section 6.4.6.

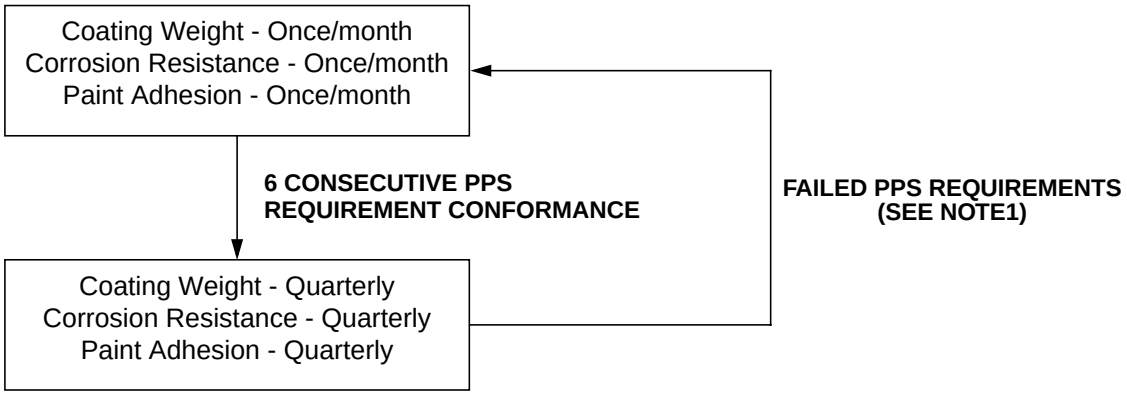
TABLE III - VISUAL SAMPLING SCHEDULE

NUMBER OF ITEMS IN INSPECTION LOT	NUMBER OF ITEMS IN SAMPLE (SELECTED AT RANDOM)	ACCEPTANCE NUMBER (NOTE 1)	REJECTION NUMBER
1 to 5	All	0	1
6 to 25	5	0	1
26 to 50	8	0	1
51 to 90	13	0	1
91 to 150	20	1	2
151 to 280	32	1	2
281 to 500	50	2	3
501 to 1200	80	3	4

Note 1. Any defective items within the permitted number of defectives shall not be accepted with the lot but be rejected.

6.3.4 Testing Frequency

6.3.4.1 Process control requirements for coating weight, corrosion resistance and paint adhesion shall be tested on a periodic basis. The testing frequency shall be as follows:



Note 1. Refer to MRB for disposition of parts processed since the last successful testing.

6.3.4.2 In the event that process control panels fail to meet the requirements specified herein, production shall be suspended until corrective action is implemented and verified by re-testing. Parts fabricated during the loss of control time period shall be rejected and referred to MRB for disposition.

6.3.5 Visual Inspection

6.3.5.1 The anodic coating shall be continuous, smooth and uniform in appearance and free from powder areas, breaks, scratches or other damage. Ensure that the number of contact points is minimal, consistent with good practice.

6.3.5.2 Visually examine **all** N/C machined 7000 series aluminum alloy parts for evidence of soft spots as indicated by a colour contrast with the surrounding anodic coating (see Figure 1). Refer parts with soft spots to the MRB for disposition.

6.3.6 Coating Weight

6.3.6.1 For coating weight determination, prepare and test 4 anodized LAB 065-1 test panels or QQ-A-250/4 test panels meeting the requirements of MIL-A-8625 (0.032" thick minimum) according to DHLPM Procedure No. 3111 or ASTM-B137. The optimum coating weight range is 200 - 450 mg/ft^2. If the coating weight of any of the panels is determined to be below 200 mg/ft^2, suspend the anodizing process until the cause of failure has been established and corrective action taken. If the coating weight of any of the panels is determined to be between 450 - 700 mg/ft^2, monitor the process and rectify the anomaly before coating weight exceeds 700 mg/ft^2. If the coating weight of any of the panels is greater than 700 mg/ft^2, determine the reasons for the increase and rectify the problem.

6.3.7 Corrosion Resistance

6.3.7.1 For corrosion resistance testing, expose 5 anodized LAB 064-1 test panels or test panels meeting the requirements of MIL-C-5541 (0.032" thick minimum) to a 5% salt spray according to ASTM-B117 or DHLPM Procedure No. 6011, except the test surface shall be inclined 6° from the vertical. Expose the panels for 336 hours and examine them for corrosive attack. If there is evidence of corrosive attack in excess of the following limits suspend the anodizing process until the cause of the failure has been established and corrective action taken:

- There shall be no spots or pits larger than 0.031" in diameter and no more than 15 isolated spots or pits in total on the 150 in^2 of test area (do not count spots or pits less than 0.010" in diameter or within 0.25" of identification markings, holding points or panel edges).
- There shall be no more than 5 isolated spots or pits on any single panel (do not count spots or pits less than 0.010" in diameter or within 0.25" of identification markings, holding points or panel edges).

6.3.8 Paint Adhesion

6.3.8.1 Perform paint adhesion testing on 4 anodized LAB 066-3 test panels as follows:

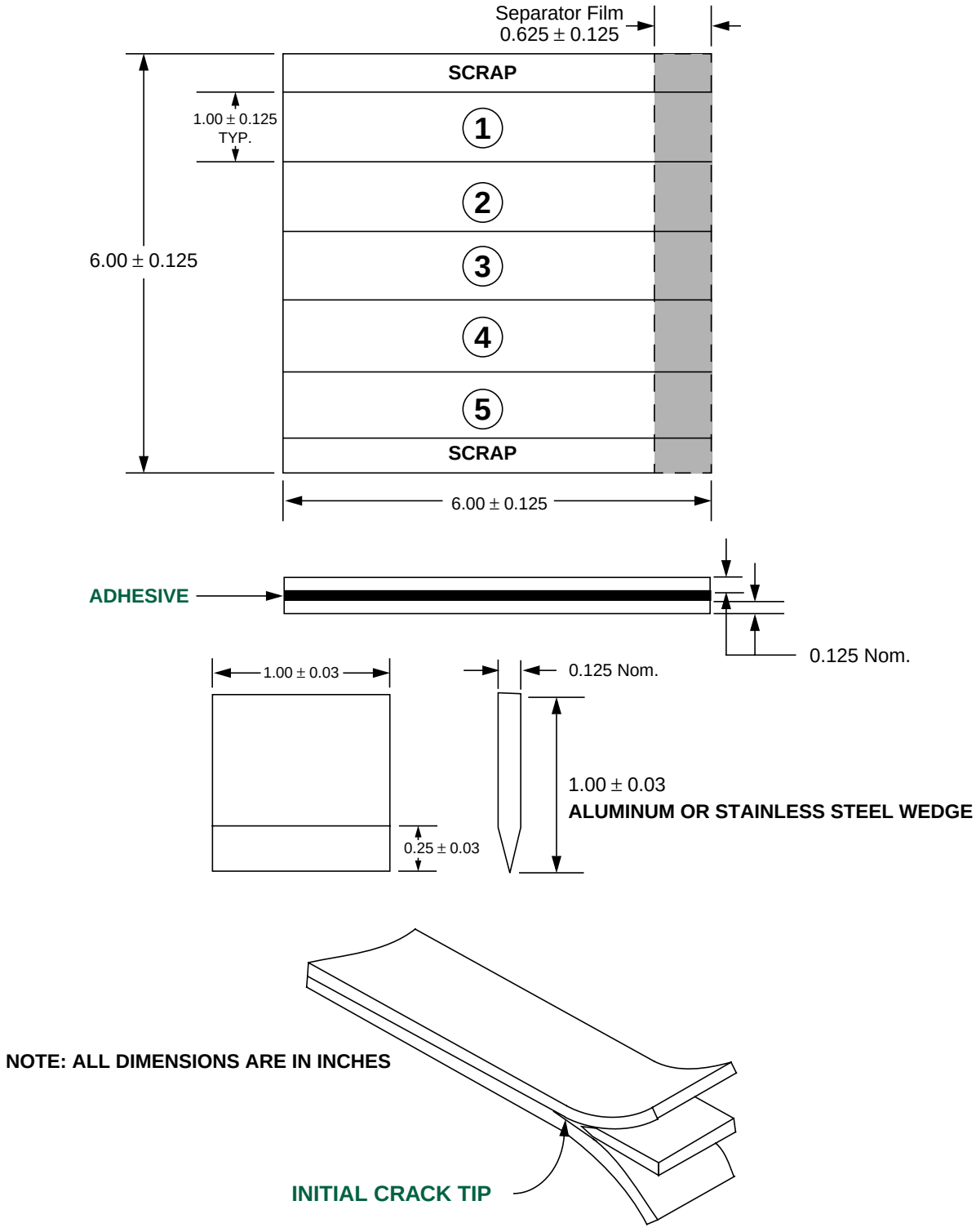
Step 1. Finish one side of each of the test panels with one coat of F21 according to PPS 21.03 and allow to cure for a minimum of 72 hours at room temperature before impact testing.

Step 2. Subject all the test panels to a forward and reverse impact of 35 inch-pounds according to ASTM-D2794. Adhesion is considered satisfactory if the primer does not crack, flake or peel. If one or more of the test panels shows evidence of cracking, flaking or peeling, suspend the anodizing process until the cause of failure has been established and corrective action taken.

6.4 Anodize Process Control Test (Crack Extension Test)

6.4.1 Conduct an anodize process control test for every load of parts processed through the cleaning/anodizing line.

6.4.2 Each process control test consists of one crack extension test panel (5 test pieces per panel), prepared according to section 6.4.3 and tested according to section 6.4.4.



NOTE: ALL DIMENSIONS ARE IN INCHES

FIGURE 2 - CRACK EXTENSION SPECIMEN CONFIGURATION FOR ALUMINUM CLEAN LINE PROCESS CONTROL

6.4.3 Preparation of Crack Extension Test Panels

6.4.3.1 Each test panel shall consist of two test plates conforming to the dimensions in Figure 2. Blank or shear each test plate from 2024-T3 bare aluminum alloy to QQ-A-250/4. Debur each plate according to PPS 27.02 before surface treatment.

6.4.3.2 Prepare a record sheet to accompany the test panels through all processing operations. Record the information, as specified in section 6.4.5, on the record sheet.

6.4.3.3 Locate the individual test plates centrally in the cleaning/anodizing 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.

6.4.3.4 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 lb/sq. ft.) 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 2).

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 2. Cut using a band saw, keeping frictional heating of the bond to a minimum.

6.4.4 Crack Extension Test Procedure

6.4.4.1 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 2, into the bond line of the test piece at the end containing the separator film.

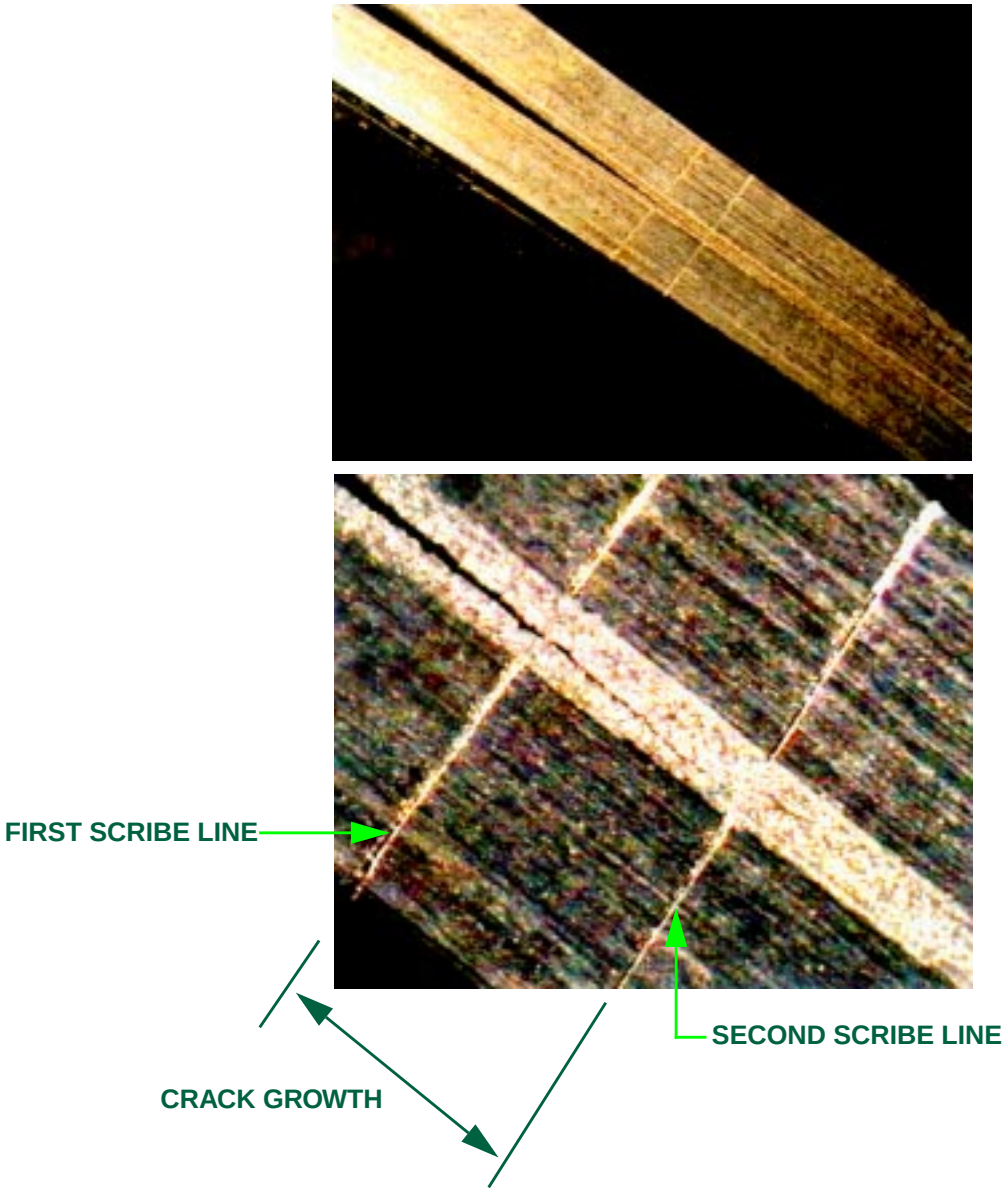
Step 3. Push in the wedge until the end of the wedge is flush with the end of the test piece, keeping the sides of the wedge approximately flush with the sides of the test piece (see Figure 2).

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).



6.4.4.2 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 6.4.5.

6.4.4.3 The crack extension shall not be more than 0.3" on any one individual test piece. If the crack extension test fails this requirement specified, take the following action:

- Production parts which have not been primed may be re-processed according to PPS 31.13, provided that the requirements specified in paragraph 6.1.2 are met, re-anodized and re-inspected as specified herein.
- The failed test specimens shall be retained until the disposition of all affected production parts has been resolved.

6.4.5 Test Record Sheet

6.4.5.1 Use an Anodize Process Control Test Record Sheet to record the following information during processing:

- Anodize load number.
- Adhesive primer and film batch number and unit (film) or lot (primer) number.
- Priming and bonding area temperature and humidity readings 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).
- Crack extension values for individual test pieces.

6.4.5.2 Maintain the Test Record Sheets on file for a minimum of 3 years.

6.4.6 Disposition

6.4.6.1 Any rejected lots shall be 100% inspected. Accept all parts that meet the above requirements. For parts that do not meet the requirements, re-process parts according to PPS 31.13, provided that the requirements specified in paragraph 6.1.2 are met, re-anodize and re-inspect as specified herein.

7 SAFETY PRECAUTIONS

7.1 Safety precautions applicable to the materials and procedures specified herein shall be defined by the subcontractor performing the work for Bombardier Toronto.

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:

- understand the function of chromic acid anodizing.
- understand the importance of proper solution preparation and control.
- understand the requirements of surface cleaning, pre-treatment and the effects of improperly cleaned part surfaces on the performance of the coating.
- be familiar with the method of obtaining chromic acid anodic coating.
- understand fully the restrictions on various alloys with reference to this process.
- be familiar with the theory behind the anodizing procedure.
- know the importance of proper sealing of the anodic coating.
- know material and part handling requirements.
- be familiar with the sequence of operations in the process line.
- know proper part racking procedures and crane operation.
- be familiar with the function and operation of the process tanks.
- understand the importance and application of the hot water sealing bath.
- know what parts cannot be hot water sealed.
- know how to use all processing parameter controls to produce acceptable production parts.
- be familiar with the relevant safety equipment and precautions.
- be able to identify soft spots as illustrated in Figure 1.
- be familiar with requirements for wedge crack extension testing, coating appearance, coating weight, paint adhesion and corrosion resistance and how they are evaluated or measured.
- be familiar with engineering drawing notations regarding chromic acid anodizing.
- know the procedure and requirements for preparation of aluminum surfaces for chromic acid anodizing.
- know how to process production parts.
- know how to identify and process required test specimens.
- know how to identify processed test specimens.
- understand the importance of recording required data as specified herein (e.g., section 6.1 and section 6.4.5).

9 MAINTENANCE OF EQUIPMENT

9.1 Tighten and replace all loose clips attached to the racks.

9.2 Keep the contact surfaces of the rack hook and anode rack clean and free from chromic acid stains.

9.3 Examine contact pads weekly and clean contact areas with aluminum wool or a brass wire brush.

9.4 Wipe electrical equipment weekly with a cloth to remove dust and grime.

9.5 Once every 6 months, the anodizing control unit (i.e., voltage ramp, anodizing voltage and cycle time control units) shall be calibrated.

10 MAINTENANCE OF SOLUTIONS

10.1 Solutions Control

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

10.1.2 Take samples of the anodizing bath, de-ionized rinse water and sealing bath solutions for chemical analysis according to the analysis frequency specified in Table IV. Ensure that the solutions are thoroughly mixed immediately before taking samples. Verify that the solutions meet the requirements specified in Table IV.

10.1.3 Maintain a record of solution analysis.

10.1.4 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.

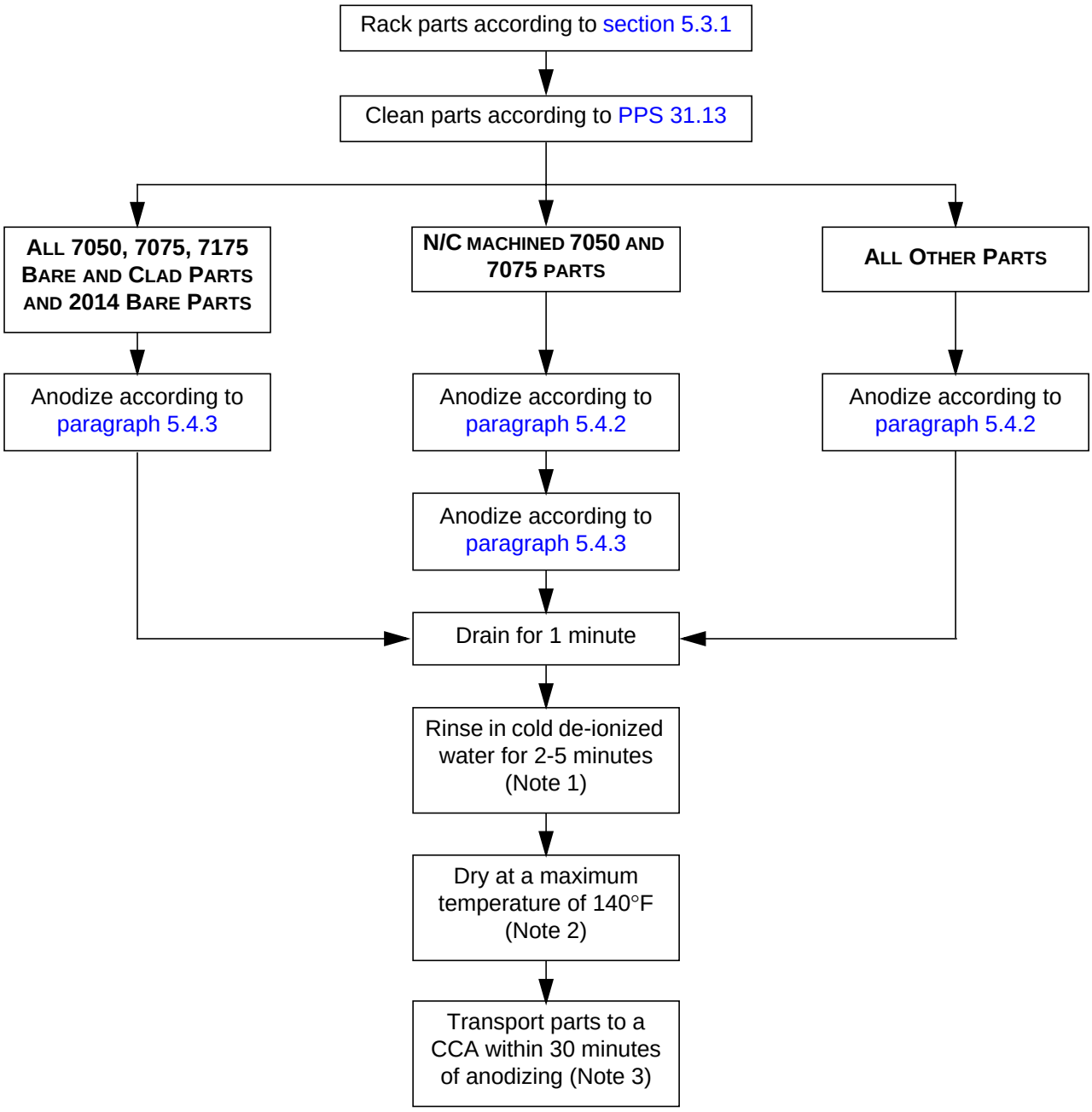
TABLE IV - CONTROL OF SOLUTIONS

TYPE OF BATH	SOLUTION COMPONENT	TEST METHOD	CONCENTRATION	PH	ANALYSIS FREQUENCY (NOTE 1)	
					STANDARD	EXTENDED
Anodizing Bath	Free chromic acid	DHLPM Procedure #4055	1.5 to 2.5% by weight	—	Weekly	Monthly
	Total chromic acid	DHLPM Procedure #4055	10% by weight maximum			
Hot De-ionized Water Sealing Bath (Note 2)	De-ionized water	—	100 ppm maximum total dissolved solids	5.0 - 8.0	Weekly	Monthly
Rinse	De-ionized water	—	350 ppm maximum total dissolved solids	3.0 - 8.0	Weekly	Monthly

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. Only use the de-ionized water sealing bath to seal anodized unprimed surfaces after high strength adhesive bonding according to PPS 36.07, as applicable.

FLOW CHART 1 - CHROMIC ACID ANODIZING BEFORE HIGH STRENGTH ADHESIVE BONDING



Note 1. See paragraph 5.4.4.
Note 2. Drying at room temperature may be hastened by directing clean, dry, oil-free air over the anodized parts.
Note 3. If possible, transport parts to a Controlled Contamination Area (CCA) meeting the requirements of PPS 36.21 within 30 minutes of completion of anodizing. If the delay exceeds 30 minutes, protect the parts according to paragraph 5.4.9.