BOMBARDIER

Toronto Site

PROPRIETARY INFORMATION

PPS 33.11

PRODUCTION PROCESS STANDARD

CADMIUM-TITANIUM PLATING (E8)

Issue 4
- This standard supersedes PPS 33.11, Issue 3.
- 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.

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1 SCOPE

1.1 This Production Process Standard (PPS) specifies the procedure and requirements for the electrodeposition of cadmium-titanium alloy onto corrosion resistant steels, low alloy steels heat treated to ultimate tensile strength levels of 180 ksi and up, and for threaded parts heat treated to ultimate tensile strength levels of 160 ksi and up.

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 fulfill 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.

1.2 Cadmium-titanium plating is identified by protective treatment code E8.

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 SAE-AMS 6345 - Steel, Sheet, Strip, and Plate 0.95Cr - 0.20M0 (0.28-0.33C) (SAE 4130) Normalized or Otherwise Heat Treated.

3.2 SAE-AMS 6414 - Steel Bars, Forgings, and Tubing 0.80 Cr - 1.8 Ni - 0.25 Mo (0.38-0.43 C) (SAE 4340) Vacuum Consumable Electrode Remelted.

3.3 ASTM F519 - Standard Test Method for Mechanical Hydrogen Embrittlement Testing of Plating Processes and Aircraft Maintenance Chemicals.

3.4 ASTM B117 - Salt Spray (Fog) Testing.

3.5 BAERD GEN-018 - Engineering Requirements for Laboratories.

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

3.7 MIL-S-18729 - Steel Plate, Sheet, and Strip, Alloy 4130 Aircraft Quality.

3.8 PPS 13.26 - General Subcontractor Provisions.

3.9 PPS 13.39 - Bombardier Toronto Engineering Process Manual.

3.10 PPS 17.02 - Abrasive Blasting.

3.11 PPS 30.04 - Steel Heat Treatment - Carbon and Low Alloy Steels.

3.12 PPS 30.06 - Heat Treatment of Precipitation Hardenable (PH) Stainless Steels.

3.13 PPS 31.04 - Degreasing Processes.

3.14 PPS 31.05 - Surface Treatment of Corrosion Resistant Steels (C9).

3.15 PPS 31.17 - Solvent Usage.

4 MATERIALS, EQUIPMENT AND FACILITIES

4.1 Materials

4.1.1 Ammonium nitrate, technical grade.

4.1.2 Cadmium ball anodes, QQ-A-671.

4.1.3 Cadmium oxide, MIL-C-6151.

4.1.4 Chromic acid, technical grade.

4.1.5 Fluoboric acid, 48%, technical grade.

4.1.6 Nitric acid, 40 or 42° Bé, technical grade.

4.1.7 Hydrochloric acid, 20° Bé, technical grade.

4.1.8 Hydrogen peroxide, 35%, technical grade.

4.1.9 Iridite No. 8P, Witco Corporation.

4.1.10 Sodium hydroxide, technical grade, O-S-598.

4.1.11 Sodium cyanide, plating grade, 96 to 98% NaCN, E.I. Dupont Co.

4.1.12 Sodium hydroxide, flake or granulated, O-S-598.

4.1.13 Sulphuric acid, 66° Bé, technical grade.

4.1.14 Titanium paste shall be homogeneous, free of lumps and shall contain a minimum of 1.9 percent by weight soluble titanium and shall contain no more than 10 ppm chloroform extractable materials. It is recommended that titanium paste be used within 8 months of the production date as soluble titanium in the titanium paste is usually reduced after 8 months storage. The approved sources are Titan Paste Type J supplied by Tokada Laboratories (Nagoya, Japan), Ti-Plate 504 supplied by DriLube Company, and Olympic Titanium-Paste supplied by Olympic Scientific Inc.

4.1.15 Filter aid (e.g., Johns-Manville Company Celite 501). Acceptable filter aids include those prepared from diatomaceous earths. Organic-based aids such as those prepared from cellulose are not acceptable.

4.1.16 Maskant (e.g., 3M electroplating tape No. 470, Adcoat AC-850 supplied by Adcoat Inc., Mascoat B100, and Microshield (spray or lacquer) supplied by Tolber).

4.2 Equipment

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

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

4.2.3 Protective rubber gloves (e.g., DSC 422-5).

4.2.4 Protective splash goggles.

4.2.5 Abrasive pads (e.g., Scotch-Brite pads, medium, 3M Canada Limited)

4.2.6 Protective wrapping materials (e.g., Kimpac, plastic bubble film or poly foam)

4.2.7 Either generated or rectified D.C. current may be used. Ripple value shall not exceed 3 percent as measured by dividing the root mean square of the A.C. voltage component by the D.C. voltage.

4.2.8 This process requires a continuously filtered bath. The filter shall be of a type that permits introduction of the titanium paste mixture on the filter cloth. The filter shall have a plate area of 1 to 2.5 square meters per kiloliter (60 to 100 square feet per 1, 000 gallons) of plating solution. The filter cloth material shall be of a high grade chemical resistant fabric. Cotton cannot be used in this system. The filter system shall be capable of recycling the bath solution 2 to 4 times per hour.

4.2.9 All surfaces of the plating tank, filter, and associated plumbing which are in continuous contact with the plating solution shall be made of, or lined or coated with, and covered with (when idle), a material which will not affect the low hydrogen embrittlement quality of the plated parts and shall be resistant to the operating temperature and the chemical environment. The tank shall be lined with a rigid polyvinyl chloride lining, or other suitable non-metallic material which has been determined to be compatible with cadmium-titanium plating solutions.

4.2.10 Plating and stripping tanks to be operated at temperature other than room temperature shall be equipped with automatic temperature indicating and regulating devices.

4.2.11 An ammeter shall be placed in series with the cadmium-titanium tank cathode. The ammeter shall have sufficient switches to provide a full-scale reading equal to the maximum capacity of the power source, and an accuracy of ± 5 percent of the current being measured. Protect meters from chemical splashing and/or the ingress of such chemicals.

4.2.12 Use conventional cadmium anodes in carriers made of either titanium or stainless steel. Cadmium bar anodes may be used if they are cast with no central steel spline and titanium or stainless steel hooks are used. Auxiliary or internal anodes shall be of cadmium or 300 series stainless steel.

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 the electrodeposition of cadmium-titanium alloy onto corrosion resistant steels, low alloy steels heat treated to ultimate tensile strength levels of 180 ksi and up, and for threaded parts heat treated to ultimate tensile strength levels of 160 ksi and up 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 Engineering 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 Aerospace Supplier Quality Management.

4.3.3.1 For approval of subcontractor facilities to perform the electrodeposition of cadmium-titanium alloy onto corrosion resistant steels, low alloy steels heat treated to ultimate tensile strength levels of 180 ksi and up, and for threaded parts heat treated to ultimate tensile strength levels of 160 ksi and up 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 specified in section 6.

4.3.3.2 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 Always wear clean cotton gloves when handling cleaned parts.

5.1.2 Compressed air used for drying shall meet the requirements of BAERD GEN-023.

5.1.3 Unless otherwise specified, apply cadmium-titanium plating after all substrate metal heat treatments and mechanical operations, such as machining, brazing, welding, forming and shot peening, have been completed.

5.1.4 Surfaces shall be water-break-free following immersion in any processing solution or rinse, except following degreasing according to PPS 31.04. Re-clean parts which develop water breaks. 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 discontinuity or breaks.

5.1.5 Agitate the solutions as required to minimize all temperature and concentration gradients.

5.1.6 Place all electrode connections in a non-functional area in which the presence of a plating imperfection will not affect the fit, form or function of the part.

5.1.7 The plater shall verify that parts have been stress relieved according to the applicable PPS before cadmium-titanium plating.

5.1.8 The total dissolved solids of the incoming water shall not be greater than 12 ppm for the make-up of the plating solution.

5.2 Preparation of Solutions

5.2.1 Make up and control the solutions according to Table I.

TABLE I - CONTROL OF SOLUTIONS

SOLUTION	SOLUTION COMPONENT	CONTROL REQUIREMENTS			ANALYSIS FREQUENCY
		CONCENTRATION	OPERATING TEMPERATURE	pH	
Cyanide Holding Solution (Note 1)	Sodium Cyanide	30 to 38 g/L (4 to 5 oz/gal)	61 to 90°F	—	Weekly
	Sodium Hydroxide	7 to 15 g/L (1 to 2 oz/gal)			
Acid Activating Solution (Note 1)	Hydrochloric Acid	6.2 to 12.3 g/L (0.82 to 1.64 oz/gal)	61 to 90°F	—	Weekly
Acid Activating Solution (Note 1)	Fluoboric Acid	9.4 to 18.9 g/L (1.25 to 2.50 oz/gal)	61 to 90°F	—	Weekly
Plating Solution Control	Cadmium Metal	21 to 26 g/L (2.8 to 3.5 oz/gal)	60 to 85°F	—	Weekly
	Total Cyanide (as NaCN)	97 to 128 g/L (13 to 17 oz/gal)			
	Sodium Hydroxide	15 to 19 g/L (2.0 to 2.5 oz/gal)			
	Titanium (Note 2)	55 to 100 mg/L (55 to 100 ppm)			
	Ratio NaCN/Cd	4/1 to 5/1			
	Sodium Carbonate	0 to 60 g/L (0 to 8 oz/gal)			Monthly
	Total Permissible Iron	300 mg/L (300 ppm)			
Neutralizing Rinse	Chromic Acid	30 to 50 g/L	61 to 90°F	—	Weekly
Chromate Conversion	Iridite No 8P (Note 3)	1.9 to 3.8 g/L (as Cr^{6+})	61 to 90°F	0.8 to 1.5	Weekly
Stripping Solution	Ammonium Nitrate	105 to 155 g/L	61 to 90°F	—	Weekly
	Dissolved Metal	30 g/L maximum			
Rinse Water	Tap Water	Tap water rinse shall not exceed a solid accumulation requirement of 950 ppm.		5.0 to 8.0	Weekly
	De-ionized Water	De-ionized water rinse shall not exceed a solid accumulation requirement of 250 ppm.		5.0 to 7.0	

Note 1. Agitate solutions to prevent temperature stratification and to ensure complete mixing.
Note 2. Titanium content may be increased by the addition of H_2O_2 to the solution. It is recommended that continuous metered addition of H_2O_2 (approximately 4 to 6 fluid ounces of 35 percent H_2O_2 for each 100 gallons of solution) be used to make the daily additions with a minimum fluctuation in solutions composition.
Note 3. Nitric acid can be added to adjust the pH to meet the control requirements.

5.3 Preparation of Parts

5.3.1 Before plating, ensure that the parts are free from flaws or defects that would be detrimental to the appearance or protective value of the plating.

5.3.2 Stress relieve according to PPS 30.04 or PPS 30.06, as applicable, before cadmium-titanium plating. Storage of parts between stress relief and cleaning shall be controlled to prevent contact with water or other corrosive materials. Store parts to permit free circulation of air around the parts.

5.3.3 Avoid delays between cleaning and cadmium-titanium plating.

5.3.4 Mask off all areas of parts and immersed portion of racks not to be plated using a suitable maskant (see paragraph 4.1.16). Before masking, degrease the parts according to PPS 31.04 or solvent clean according to PPS 31.17.

5.3.5 Rack parts to prevent entrapment of gases and solution drag-out. Make electrical connections to prevent arcing and to provide sufficient contact to carry the required current. Rack coil springs without extending or compressing. Close wound springs may be extended provided that embrittlement relief is done while they are still flexed and that there is no additional flexure.

5.3.6 Before further processing, parts shall show no rust, soiling or discolouration.

5.3.7 Prepare parts for cadmium-titanium plating according to Flow Chart 1.

5.4 Cadmium-Titanium Plating

5.4.1 Once cadmium-titanium plating has started, continue the plating process until the desired plating thickness is achieved. Ensure plating is uniform throughout the part (i.e., there are no unplated areas). It is acceptable to remove the parts from the bath during the cycle to check the plating thickness and uniformity.

5.4.2 Perform cadmium-titanium plating according to Flow Chart 2.

5.4.3 Embrittlement relief according to PPS 30.04 or PPS 30.06, as applicable, within 4 hours of plating.

5.5 Post Plate Treatment

5.5.1 Perform post plate treatment as follows:

Step 1. Degrease according to PPS 31.04 or solvent clean according to PPS 31.17.

Step 2. Alkaline clean according to PPS 31.05.

Step 3. Immerse in the chromate conversion solution made-up and controlled as specified by Table I for 15 to 30 seconds.

Step 4. Rinse thoroughly in tap water and allow to dry. An additional rinse in warm water (140°F maximum) may be used to facilitate drying.

Step 5. Wrap parts in protective wrapping (see paragraph 4.2.6) before transporting for further processing.

5.6 Removal of Plating

5.6.1 If plating is determined to be unacceptable before the hydrogen embrittlement relief bake as specified in Flow Chart 2, parts shall be embrittlement relief baked according to PPS 30.04 or PPS 30.06, as applicable, before stripping as follows. If parts are determined to be unacceptable after the hydrogen embrittlement relief bake as specified in Flow Chart 2, strip as follows:

Step 1. Degrease according to PPS 31.04 or solvent clean according to PPS 31.17.

Step 2. Alkaline clean according to PPS 31.05.

Step 3. Mask and rack parts as necessary. Mask off all areas of parts and immersed portion of racks not to be stripped using a suitable maskant (see paragraph 4.1.16).

Step 4. Immerse in the stripping solution specified in Table I until the cadmium-titanium deposit is completely removed (30 minutes maximum).

Step 5. Immediately after stripping, cold water rinse (85°F maximum).

Step 6. Hot water rinse (130 to 150°F) to facilitate drying.

Step 7. Bake at 375 ± 25°F within 4 hours after stripping for a minimum of 3 hours.

Step 8. Wrap parts in protective wrapping (see paragraph 4.2.6) before transporting for further processing.

6 REQUIREMENTS

6.1 Sampling

6.1.1 For visual examination according to section 6.2 and non-destructive plating thickness tests according to section 6.3, select a sample from each lot by taking at random from the lot, not less then the number of items indicated in Table II. If the number of non-conforming items in any sample exceeds the acceptance number specified in Table II, disposition the parts of the represented lot according to section 6.10.

TABLE II - VISUAL AND PLATING THICKNESS SAMPLING SCHEDULE

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

Note 1. Any defective items within the permitted number of defectives shall not be accepted with the lot but shall be stripped, re-plated and re-inspected as specified herein.

6.2 Visual Appearance

6.2.1 The plating shall be dull, smooth, continuous, homogeneously adherent, and free from blisters, pits, nodules, burnt edges or any other indications of harmful defects. The appearance of a properly applied plate may vary from a dull grey to a frosty white. A bright, shiny deposit indicates malfunction of the process which may produce embrittled parts.

6.3 Plating Thickness

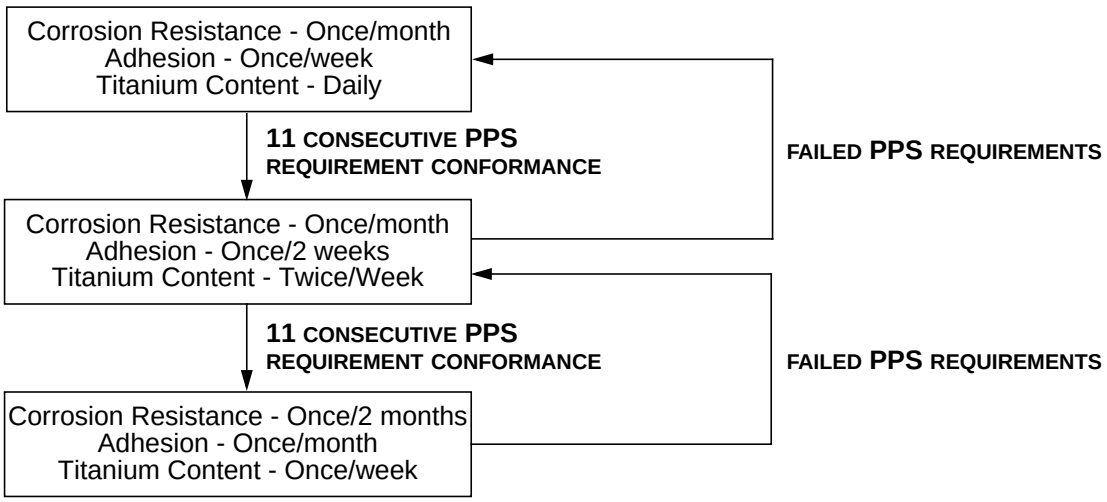
6.3.1 After plating, baking and all supplemental treatments, measure plating thickness using a method having a precision of ± 10% of the thickness being measured. Calculate the plating thickness by taking measurements before and after plating and at several locations.

6.3.2 Unless otherwise specified on the engineering drawing, the plating thickness shall be 0.0003" minimum (except for rack marks or contacts) and 0.0005" maximum (except in normally high cathode current density areas, such as corners and edges).

6.3.3 Unless otherwise specified on the engineering drawing, thickness measurements shall apply only to visible surfaces that can be touched by a ball 0.75" in diameter. The part shall be completely covered with cadmium-titanium plate on all visible areas exposed to the plating current.

6.4 Testing Frequency

6.4.1 Process control requirements for adhesion, corrosion resistance and Titanium content shall be tested on a periodic basis. The testing frequency is as follows:



6.4.2 Refer to section 6.5 for hydrogen embrittlement testing frequency requirements.

6.4.3 Calibrate all devices used for process control every 6 months.

6.5 Hydrogen Embrittlement Testing

6.5.1 It is acceptable to perform hydrogen embrittlement testing according to either section 6.5.2 or section 6.5.3.

6.5.2 Hydrogen Detection Instrument Method

6.5.2.1 Hydrogen Detection Instrument (HDI) testing shall be performed within the processor's facility by a certified operator. Each subcontractor's HDI testing procedure shall be Bombardier Toronto approved. HDI testing shall be performed:

- At least twice every 7 calendar days, on 1st and 4th working days of the week (e.g., on Monday and Thursday).
- On the same day of plating if more than 3 days have elapsed since the last HDI test.
- Every time a new plating bath is made up.
- Every time alterations are made to the plating bath.

6.5.2.2 Action based on HDI testing shall be according to Table III.

6.5.2.2.1 Applicable definitions for Table III are as follows:

- I_H - probe emission current, observed electrical current from the internal probe plate during a run (one unit = 0.0001 mA).
- Hydrogen peak - maximum current I_H obtained after probe is inserted in the oven following cathodic charging or plating.
- Lambda - time in seconds for I_H to drop from the zero slope hydrogen peak value to one half the hydrogen peak value.
- λ - the Lambda obtained from a calibration run.
- λ_p - the Lambda obtained from a plating run.
- λ_{pc} - normalized test Lambda, obtained from λ_p by the following equation:

$$\lambda_{pc} = \lambda_p (40/\lambda)$$

TABLE III - HYDROGEN EMBRITTLEMENT CONTROL LIMITS

λ_{pc}	ACTION NECESSARY
Less than 100	None - Previously plated production parts are acceptable and plating process is acceptable.
100 - 139	Stop production plating on Bombardier Toronto parts. Previously plated production parts are acceptable. However, the plating process is unacceptable and shall be corrected as follows: The cause of unacceptably high λ_{pc} values shall be determined and corrected. The λ_{pc}, obtained from the corrected process, shall be less than 90, before initiating production plating.
Greater than 139	Same as above (λ_{pc} is between 100 and 139), except all production parts plated since the most recent acceptable HDI test are not considered acceptable.

6.5.2.3 If the HDI becomes inoperative, accomplish testing for hydrogen embrittlement using notched tensile specimens, material and dimensions as specified by Table IV, according to section 6.5.3. Process two notched tensile specimens within every 7th calendar day until regular testing with the HDI is resumed.

6.5.2.4 If plating production is not continuous, HDI testing or notched tensile testing shall be run at the end of production before parts acceptance.

6.5.3 Notched Tensile Test Specimens Method

6.5.3.1 Perform testing according to paragraph 6.5.3.2 within every 7th calender day.

6.5.3.2 Subject 2 test specimens, material and dimensions as specified by Table IV, to a sustained load test at 75 percent of the ultimate tensile strength. The specimens shall endure this sustained load for 200 hours minimum without failing or cracking.

6.6 Titanium Content

6.6.1 The titanium content of the plating shall be in the range of 0.1 to 0.5 percent titanium when tested as follows:

Step 1. Plate the cadmium-titanium deposit at normal current density onto copper foil so as to produce a non-adherent deposit.

Step 2. Dissolve the weighted deposit in 50 milliliters (mL) of 15 to 20 percent sulphuric acid (H_2SO_4).

Step 3. Analyze the sulphuric acid and determine the titanium content of the plate.

6.7 Corrosion Resistance Testing

6.7.1 Expose 5 plated test panels for corrosion resistance, material and dimensions as specified by Table IV, to a 5% salt spray according to DHLPM Procedure No. 6011 or ASTM B117, except the test surface shall be inclined 6° from the vertical. Expose the panels for 500 hours and examine them for corrosive attack.

6.7.1.1 If there are visible white corrosion products of cadmium-titanium plate within 96 hours of exposure, discontinue the corrosion resistance testing and disposition according to section 6.10. If there are visible red rust on the base metal within 500 hours of exposure, suspend the cadmium-titanium plating process until the cause of the failure has been established and corrective action taken.

6.8 Adhesion Test

6.8.1 Plate 2 test panels, material and dimensions as specified by Table IV at the testing frequency according to section 6.4, and submit the test specimens to an approved laboratory for plating testing according to DHLPM Procedure No. 3058 or as follows:

Step 1. Bend each test specimen repeatedly through 180° on a mandrel a diameter equal to twice the thickness of the specimen until the base metal fractures.

Step 2. Using a sharp instrument, attempt to remove the plating from the substrate at the fracture surface. The specimen fails if any plating is removed from the substrate.

6.8.2 At least one of the specimens shall be metallographically or electro-magnetically examined to ensure that the plating meets the thickness requirements specified in section 6.3.

6.9 Test Specimens

6.9.1 Process the test specimens meeting the requirements of Table IV with the production parts they represent.

TABLE IV - TEST SPECIMENS MATERIALS AND DIMENSIONS

TEST	SPECIMEN MATERIAL	CONFIGURATION	DIMENSIONS
Adhesion	4130 Condition N SAE-AMS 6345 (MIL-S-18729)	sheet	4" x 1" x 0.040"
Corrosion resistance and thickness		sheet	4" x 6" x 0.040"
Hydrogen embrittlement	SAE 4340 (260-280 ksi) SAE-AMS 6414	round notched tensiles	according to ASTM F519-96 Type 1a
Titanium content of deposit	copper	foil	2" x 2" x 0.003"

6.10 Disposition

6.10.1 All parts of any unaccepted lots shall be 100% inspected. Accept all parts that meet the above requirements. For parts that do not meet the requirements, strip, bake, re-plate and re-inspect.

6.10.2 If test specimens fail to meet the requirements of section 6.5, section 6.6, section 6.7 or section 6.8, suspend the cadmium-titanium plating process, establish the cause of the failure and take corrective action.

6.11 Qualification Testing

6.11.1 To qualify to this PPS, subcontractors shall process two sets of 2 plating thickness, 2 adhesion, 4 corrosion resistant, 2 titanium content and 4 hydrogen embrittlement test specimens. If HDI method is used, then subcontractors shall also submit HDI test results according to section 6.5.2. The subcontractor shall submit to the Bombardier Toronto Materials Technology one set of test samples and test results determined by the subcontractors laboratory (or an approved alternate laboratory) and a second set of test samples to be tested at the discretion of the Bombardier Toronto Materials Laboratory. The subcontractor shall also submit to Bombardier Toronto a copy of their HDI testing procedure for review and approval. Upon review of these documents and test samples, Bombardier Toronto will provide the supplier with product qualification or reasons for disqualification.

6.11.2 Subcontractors shall be re-qualified according to paragraph 6.11.1 every 12 months.

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

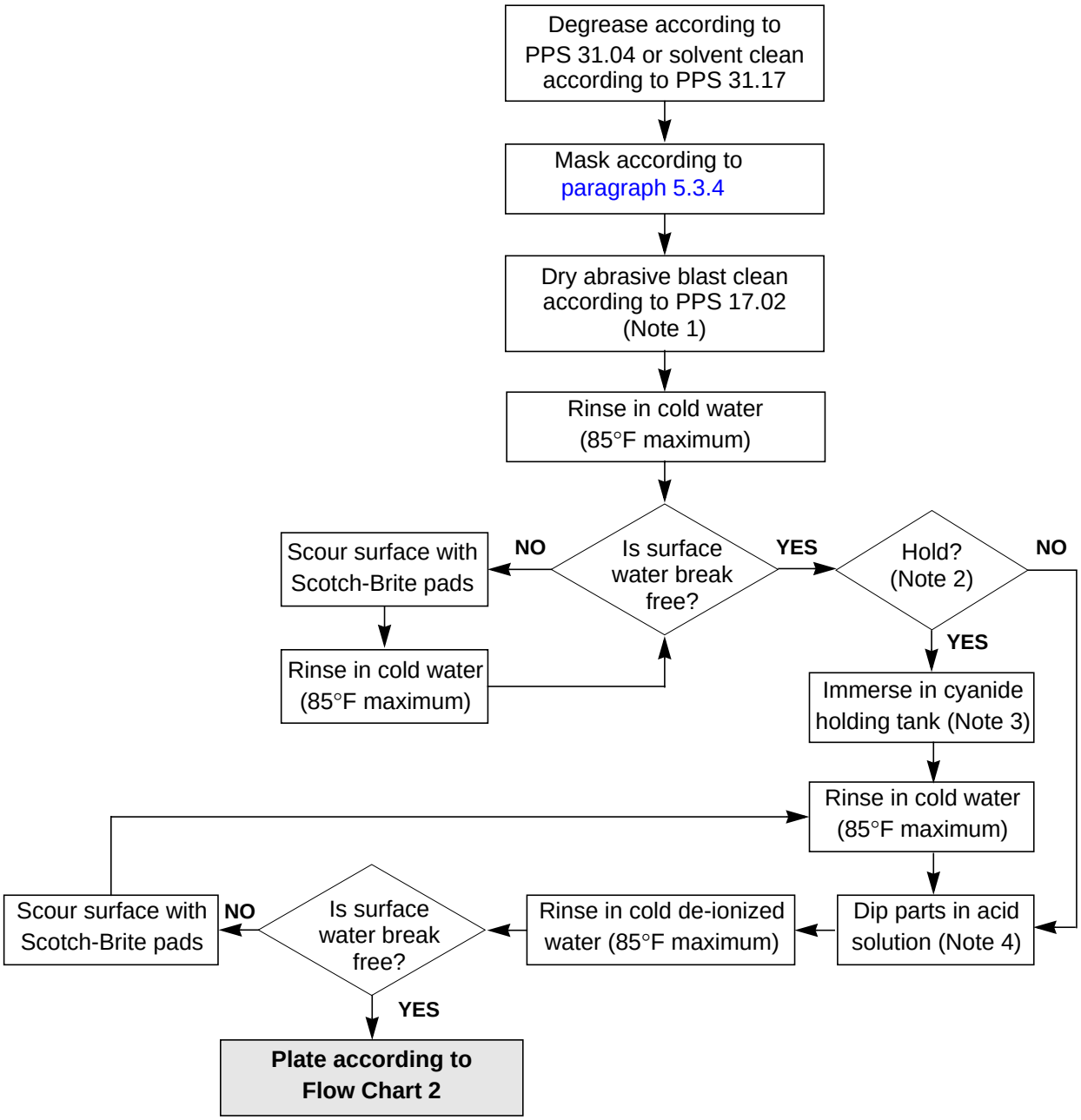
8.1 This PPS has been categorized as a Controlled Critical Process according to PPS 13.39. Refer to PPS 13.39 for additional personnel requirements. Certified and/or qualified personnel shall have a good working knowledge of the following, as applicable:

- function of the cadmium-titanium plating on various substrates
- the various substrates which may be effectively cadmium-titanium plated
- requirements for surface cleaning and pre-treatment
- theory of cadmium-titanium plating
- relationship between part surface area or section thickness and coating parameters
- material and part handling requirements
- part racking and loading procedures
- how to use all processing parameter controls to produce acceptable production parts
- safety precautions
- requirements for cadmium-titanium plating appearance, thickness, titanium content, adhesion and corrosion resistance and how they are evaluated or measured
- engineering drawing notations regarding cadmium-titanium plating
- how to use processing cards to produce acceptable parts
- specification requirements for process materials
- how to process production parts
- how to identify and process required test specimens

9 MAINTENANCE OF SOLUTIONS

9.1 Maintain the chemical concentration of plating solutions to ensure consistent plating adhesion and thickness.

FLOW CHART 1 - PREPARATION OF PARTS FOR CADMIUM-TITANIUM PLATING



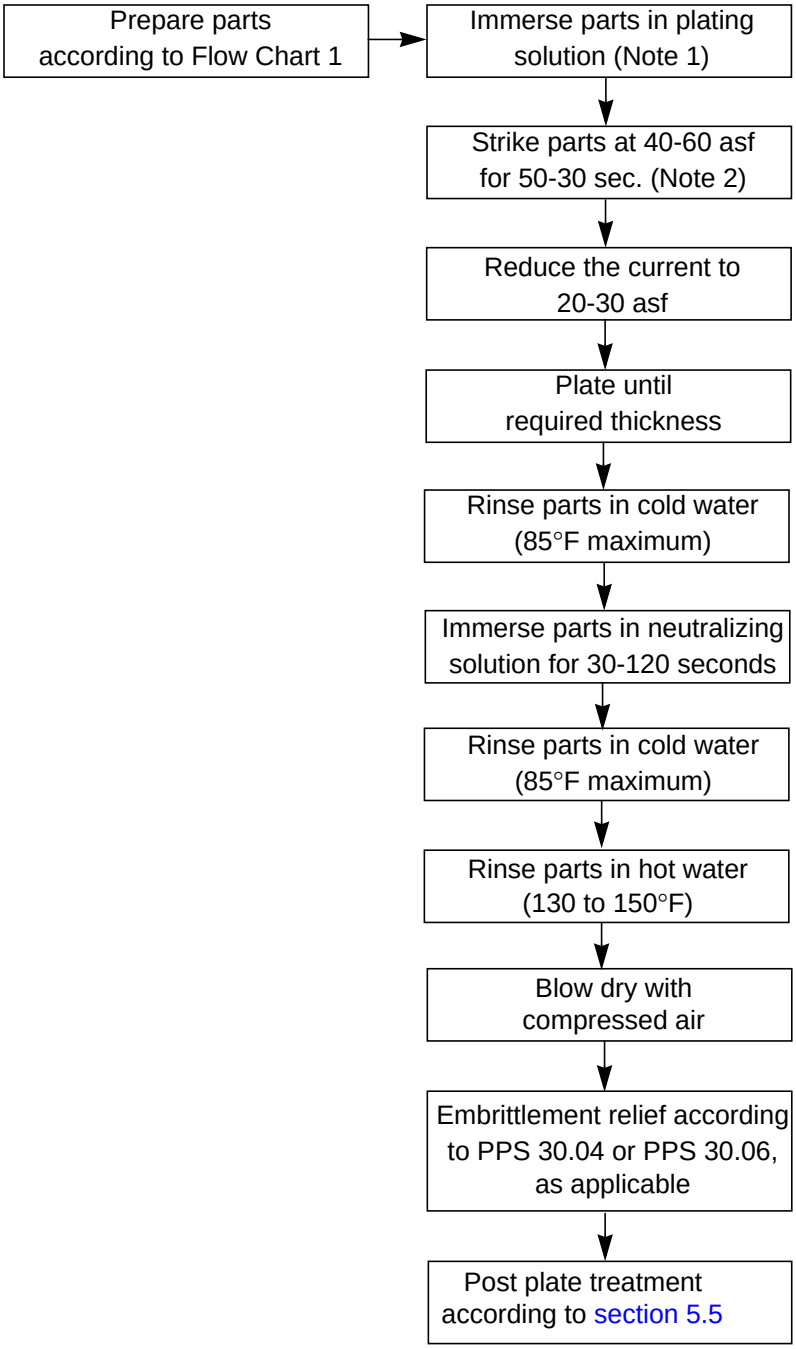
Note 1. Use 180 grit aluminum oxide. Elapsed time between completion of cleaning and rinsing shall not exceed 60 minutes.

Note 2. A cyanide holding tank can be used to hold parts if the plating tank is full.

Note 3. Within 1 hour, immerse in the cyanide holding bath solution made-up and controlled according to Table I until the parts are ready to be placed into the plating bath. The maximum holding time is 4 hours.

Note 4. Immerse for a maximum of 30 seconds at a temperature of 61 to 90°F in the hydrochloric acid solution specified in Table I. For copper foil test specimens, immerse in the fluoboric acid solution specified in Table I for a maximum of 30 seconds.

FLOW CHART 2 - CADMIUM-TITANIUM PLATING



Note 1. Apply voltages so that the current will flow upon immersion of parts.

Note 2. If striking parts at 40 asf (amps/sq ft), the duration should be for 50 seconds. If striking parts at 60 asf, the duration should be for 30 seconds.

Note 3. Elapsed time between completion of plating and start of embrittlement relieve shall not exceed 4 hours.