BOMBARDIER
Toronto Site
PROPRIETARY INFORMATION

PPS 33.01

PRODUCTION PROCESS STANDARD

CADMIUM PLATING (E1)

Issue 19
- This standard supersedes PPS 33.01, Issue 18.
- 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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TABLE OF CONTENTS

Section & Title **Page**

Tables

Flow Charts

1 SCOPE

1.1 This Production Process Standard (PPS) specifies the procedure and requirements for subcontractors performing cadmium plating of ferrous and non-ferrous metals for Bombardier Toronto.

1.1.1 Except for springs having a tensile strength of 180 - 200 ksi or greater, the procedures stated in this PPS cannot be used to plate parts having a tensile strength of 200 - 220 ksi or greater. Such parts shall be IVD coated (M2) according to PPS 24.02.

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.

1.2 Cadmium plating is identified by protective treatment code E1.

1.3 In place of cadmium plating as specified herein, it is acceptable to apply a Class 3 ion vapour deposited (IVD) aluminum coating according to PPS 24.02 (i.e., if the engineering drawing specifies cadmium plating according to PPS 33.01 or an E1 protective treatment, it is acceptable to instead apply a Class 3 IVD (M2) coating according to PPS 24.02).

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 ASTM B117 - Standard Test Method of Salt Spray (Fog) Testing.

3.2 BAERD GEN-018 - Engineering Requirements for Laboratories.

3.3 DHLPM Procedure No. 3058 - Adhesion of Plated Coatings - *Bombardier Toronto internal operating procedure*.

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

3.5 PPS 1.08 - Magnetic Pulse Forming of End Fittings.

3.6 PPS 13.26 - General Subcontractor Provisions.

3.7 PPS 13.39 - Bombardier Toronto Engineering Process Manual.

3.8 PPS 16.01 - Application of Hard and Soft Film (F13) Corrosion Preventive Compound.

3.9 PPS 16.20 - Temporary Corrosion Protection of Carbon and Low Alloy Steel Parts.

3.10 PPS 17.02 - Abrasive Blasting.

3.11 PPS 24.02 - Ion Vapour Deposited Aluminum Coatings (M2).

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

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

3.14 PPS 30.08 - Heat Treatment of Martensitic Stainless Steels.

3.15 PPS 31.03 - Cleaning of Carbon and Low Alloy Steels.

3.16 PPS 31.05 - Surface Treatment of Corrosion Resistant Steel.

3.17 PPS 31.06 - Cleaning of Copper and Copper Alloys.

3.18 PPS 32.08 - Application of Zinc Phosphate Coatings to Plated Parts.

3.19 PPS 33.02 - Removal of Metallic Coatings.

3.20 PPS 33.03 - Electro-Deposited Nickel Plating (E3).

3.21 Bombardier Toronto Laboratory Drawings - LAB 051 and LAB 064.

4 MATERIALS, EQUIPMENT AND FACILITIES

4.1 Materials

4.1.1 Bright Dip bath chemicals, as specified in Table I.

4.1.2 Hydrochloric acid, technical grade.

4.1.3 Protective wrapping materials - Kimpac, plastic bubble film, poly foam.

4.1.4 Suitable maskant (e.g., adhesive backed aluminum tape, stop-off lacquer, etc.).

4.1.5 Test Specimens - LAB 064-3; LAB 051-3.

4.2 Equipment

4.2.1 Tank for Bright Dip bath, earthenware, hard rubber or polypropylene.

4.2.2 Thickness gauge, capable of measurement of ± 0.05 mil (± 0.00005 inch). Use the following type of thickness gauge:

- F-sensors work on the magnetic-induction principle and are suitable for ferrous base material (e.g., MINITEST 2100).
- N-sensors work on an eddy current principle and shall be used for non-ferrous base material.

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 cadmium plating of ferrous and non-ferrous metals 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 cadmium plating of ferrous and non-ferrous metals 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 On all close tolerance surfaces, where the plating thickness could affect the fit of finished mating parts, ensure a plating allowance of 0.0003" to 0.0005" per surface during the machining operation.

5.2 Preparation of Parts for Plating

5.2.1 Before plating, ensure that the parts are free from flaws or defects (including rust in blind holes) that would be detrimental to the appearance or protective value of the plating.

5.2.2 Prepare parts for cadmium plating according to Flow Chart 1 or Flow Chart 2, as applicable.

5.2.3 Avoid delays between cleaning and cadmium plating to avoid rust formation and contamination on part surfaces.

5.2.4 Mask off all areas not to be plated using a suitable maskant (e.g., adhesive backed aluminum tape, stop-off lacquer, etc.). Mask either before or after abrasive blast cleaning depending on surface finish requirements.

5.3 Plating Procedure

5.3.1 Perform cadmium plating of carbon and low alloy steel and non-ferrous parts according to Flow Chart 3.

5.3.2 Perform cadmium plating of corrosion resistant steel parts according to Flow Chart 4.

5.3.3 Once started, continue the plating process until the desired plating thickness is achieved. It is acceptable to remove the parts from the bath during the cycle to check the plating thickness.

5.4 Preparation of Bright Dip Bath

5.4.1 Prepare and control the Bright Dip bath according to Table I in a tank as specified in paragraph 4.2.1.

TABLE I - CONTROL OF BRIGHT DIP BATH

SOLUTION	CHEMICALS	METRIC UNITS	OPERATING TEMPERATURE (˚F)	CONCENTRATION ANALYSIS FREQUENCY (NOTE 1)	
				STANDARD	EXTENDED
Bright Dip (Note 2)	Chromic Acid (A-A-55827)	68 - 81 g/L	60 to 90	Monthly	Every 3 months
	Sulphuric Acid (66˚ Bé)	1.0 - 2.5 g/L			

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. Make up the Bright Dip bath solution with tap water. The tap water total accumulated solids concentration shall not exceed 350 ppm.

5.5 Embrittlement Relief

5.5.1 Embrittlement relieve the following parts according to PPS 30.04, PPS 30.06 or PPS 30.08, as applicable, within 4 hours of plating:

- Parts with a tensile strength range of 150 - 170 ksi or greater.
- Springs with a tensile strength of 180 - 200 ksi or greater.

5.5.2 If more than one type of plating is required on a part, it is not necessary to embrittlement relieve between plating processes provided that the part is embrittlement relieved after the final plating cycle within 4 hours of the completion of the first plating process.

5.5.3 For parts that require both embrittlement relief and phosphate treatment according to PPS 32.08 after plating, perform embrittlement relief before phosphate treatment. For parts heat treated to 180 - 200 ksi or less, it is permissible to phosphate treat and plate before embrittlement relief provided that embrittlement relief is performed within 4 hours of the completion of the first plating process.

5.6 Post Plating Protection Requirements

5.6.1 Perform the following post plating protection treatment before shipping or placing parts into storage within 30 minutes of the final operation (i.e., plating, embrittlement relief or phosphate treatment):

- Oil dip coat unplated areas of low alloy steel parts and plated low alloy steel tubes that are not hermetically sealed according to PPS 16.20.
- Treat unplated areas of corrosion resistant steel parts and the inside diameter of corrosion resistant steel tubes that are not hermetically sealed according to PPS 16.01.

5.6.2 Wrap all parts in protective wrapping (see paragraph 4.1.3) before transporting for further processing.

6 REQUIREMENTS

6.1 General

6.1.1 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.

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

6.2 Process Qualification

6.2.1 For process qualification, process panels as specified in Table II through the complete plating process as specified herein. All panels shall meet the requirements specified prior to commencing processing of parts for Bombardier Toronto.

6.2.2 Process qualification test panels shall be submitted to a laboratory as specified in paragraph 6.1.2. 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 If monthly and/or quarterly corrosion resistance panels were tested by a Bombardier approved laboratory and not the Bombardier Toronto Materials Laboratory, once a year, subcontractors shall submit monthly and/or quarterly results along with test panels to Bombardier Toronto for verification of test results. Additional tests may be requested at any time at the discretion of Bombardier.

6.3.1.2 In order to maintain qualified status, all facilities processing parts for Bombardier Toronto according to this PPS shall maintain records of all testing. If these records cannot be produced, then the facility may be required to re-qualify according to section 4.3.

6.3.2 Test Requirements

6.3.2.1 Refer to Table II for a summary of test 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	According to Table III	Production parts	Visual (according to section 6.3.4)
Corrosion Resistance	According to section 6.3.3	5	LAB 064-3	DHLPM Procedure No. 6011 or ASTM B117
Adhesion	According to section 6.3.3	4	LAB 051-3	DHLPM Procedure No. 3058 and according to section 6.3.6
Plating Thickness	According to Table III and section 6.3.3	According to Table III	Production parts	According to section 6.3.7

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

6.3.2.2 For visual examination according to section 6.3.4 and plating thickness tests according to section 6.3.7, select a sample from each lot by taking at random from the lot, not less than the number of items indicated in Table III. If the number of non-conforming items in any sample exceeds the acceptance number specified in Table III, reject the represented lot and disposition according to section 6.3.8.

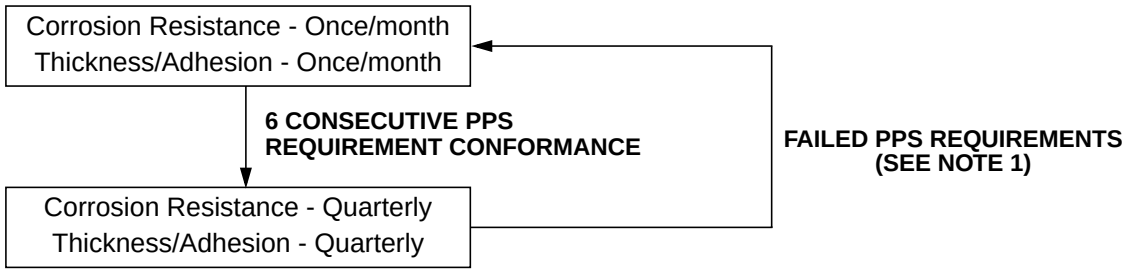
TABLE III - VISUAL AND PLATING THICKNESS SAMPLING SCHEDULE

NUMBER OF ITEMS IN LOT	NUMBER OF ITEMS IN SAMPLE (SELECTED AT RANDOM)	ACCEPTANCE NUMBER (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 such parts shall be disposition according to section 6.3.8.

6.3.3 Test Frequency

6.3.3.1 Process control requirements for adhesion, thickness and corrosion resistance 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 Visual Inspection

6.3.4.1 Inspect parts for visual appearance as follows:

- Ensure that the cadmium plating is smooth, fine grain, adherent and uniform in appearance.
- Ensure that the coating is free from staining, pits, nodules, burns and porosity.
- Ensure that the coating is continuous over the entire surface of the part including holes and recesses to a depth at least equal to the diameter of the hole or recess.

6.3.5 Corrosion Resistance

6.3.5.1 Process five (5) LAB 064-3 test specimens, together with the representative production load and perform corrosion resistance testing according to paragraph 6.3.5.2.

6.3.5.2 Check corrosion resistance by exposing the five (5) plated LAB 064-3 test specimens to a 5% salt spray according to ASTM B117 or DHLPM Procedure No. 6011, except the test surface shall be inclined 15 to 30° from the vertical. Expose the panels to salt spray for 96 hours and examine them for corrosive attack.

6.3.5.3 If there is evidence of corrosive attack in excess of the following specified limits, suspend the cadmium plating process and take corrective action according to section 6.3.8:

- The specimen shall not show white corrosion products of cadmium, pitting, or basis metal corrosion products visible to the unaided eye at normal reading distance. White corrosion productions within 0.25 inch of identification markings, holding points or specimen edges shall not be cause for rejection.

6.3.6 Adhesion Test

6.3.6.1 Process four (4) LAB 051-3 test specimens with each lot of production parts through the entire cleaning and plating procedure and perform plating adhesion testing according to DHLPM Procedure No. 3058 or as follows:

Step 1. Clamp the test specimen in a vise and bend each test specimen repeatedly through 180° on a mandrel with a diameter equal to 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.

6.3.6.2 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 6.3.7.

6.3.6.3 If one or more of the test specimens fail the adhesion requirements, disposition the entire production lot according to section 6.3.8.

6.3.7 Plating Thickness

6.3.7.1 Except for the inside walls of tubing, long bores and blind holes, the plating thickness shall be between 0.0003" and 0.0005" for all surfaces. The inside walls of tubing, long bores and blind holes do not have a thickness requirement because a controlled deposit on these surfaces is generally not possible.

6.3.7.2 If the engineering drawing specifies cadmium plating on surfaces where a controlled deposit is not possible, use internal anodes to achieve the required thickness.

6.3.7.3 If possible, determine the coating thickness by direct measurement at five (5) locations on the part using a calibrated thickness gauge (see paragraph 4.2.2). If the average value on any part does not meet the required coating thickness specified, reject the part and disposition according to section 6.3.8.

6.3.7.4 If coating thickness cannot be determined using production parts, verify the coating thickness utilizing the four (4) Lab 051-3 adhesion test specimens prepared according to paragraph 6.3.6.1. Measure five (5) locations on each test specimen using a calibrated thickness gauge (see paragraph 4.2.2) and determine the average coating thickness. If one or more of the test specimens fail to meet the coating thickness requirements specified, reject the represented lot and disposition according to section 6.3.8.

6.3.8 Disposition

6.3.8.1 Any rejected lots shall be 100% inspected. Accept all parts that meet the above requirements. For every part that does not meet the requirements, strip the plating according to PPS 33.02, re-plate and re-inspect the parts as specified herein. If the plated part fails to meet the requirements a second time after having already been stripped and re-processed once, refer the part to MRB for disposition. Determine the cause of failure and take corrective action prior to commencing processing production parts. As part of the corrective action plan, satisfactory test results of applicable test specimens re-submitted by the subcontractor is required.

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

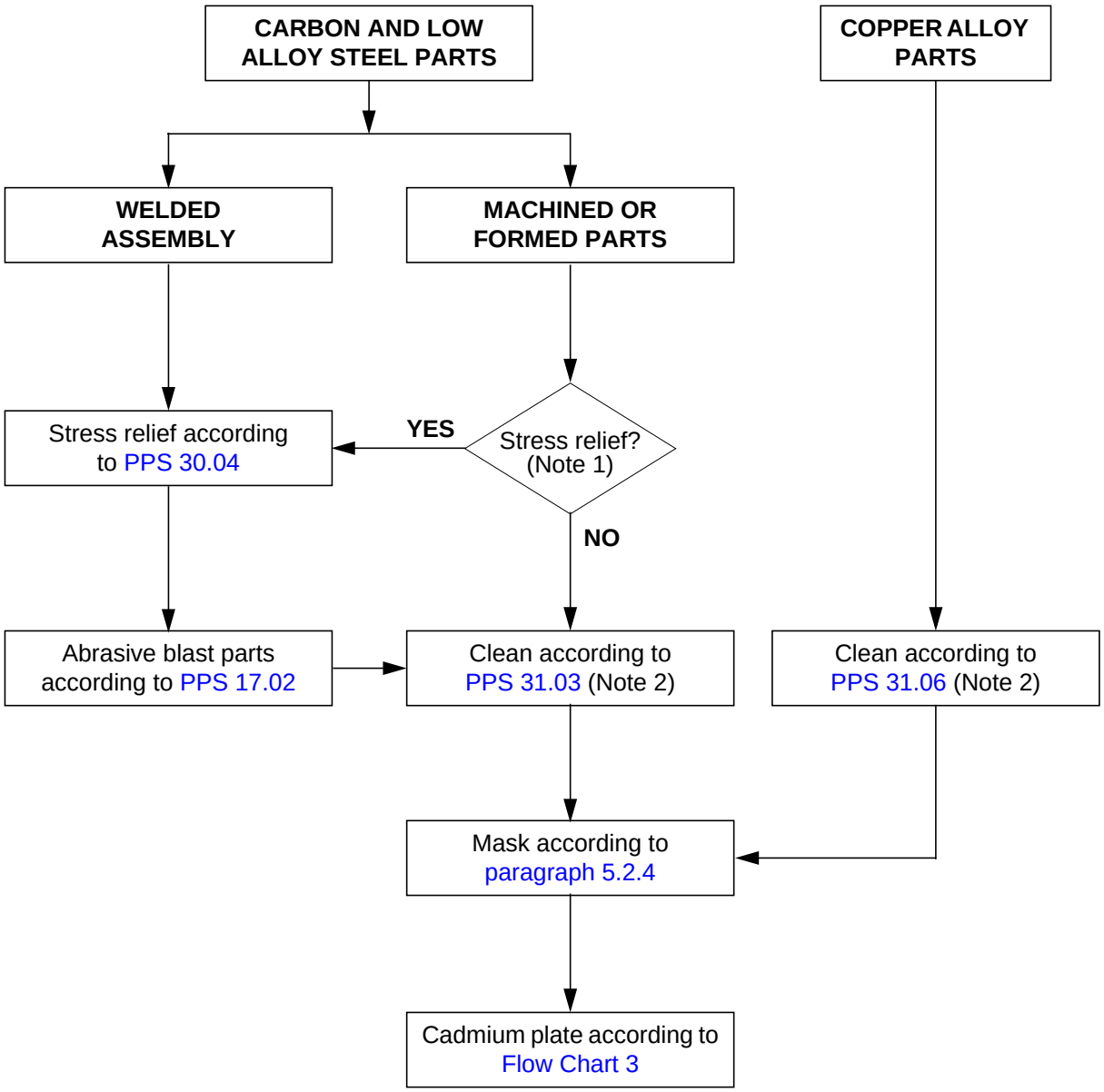
8.1 This PPS has been categorized as a Controlled Critical Process according to PPS 13.39. Refer to PPS 13.39 for personnel requirements.

9 MAINTENANCE OF SOLUTIONS

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

9.2 Maintain the Bright Dip bath according to Table I.

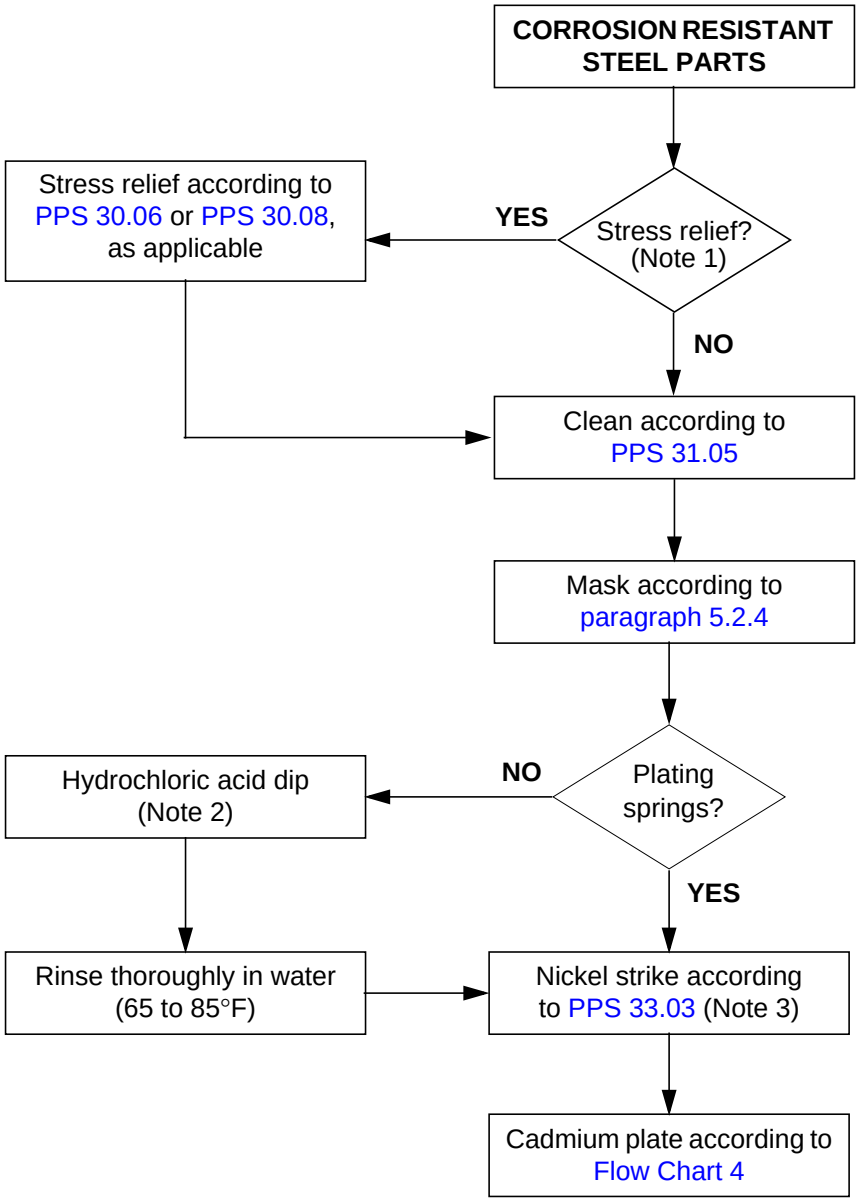
FLOW CHART 1 - PREPARATION OF CARBON AND LOW ALLOY STEEL OR COPPER ALLOY PARTS FOR CADMIUM PLATING



Note 1. Stress relieve parts that have a tensile strength of 180 - 200 ksi or greater that have been machined, cold formed, cold straightened or ground.

Note 2. For tubing that will be magneformed according to PPS 1.08 after cadmium plating, do not abrasive clean before cadmium plating.

FLOW CHART 2 - PREPARATION OF CORROSION RESISTANT STEEL PARTS FOR CADMIUM PLATING

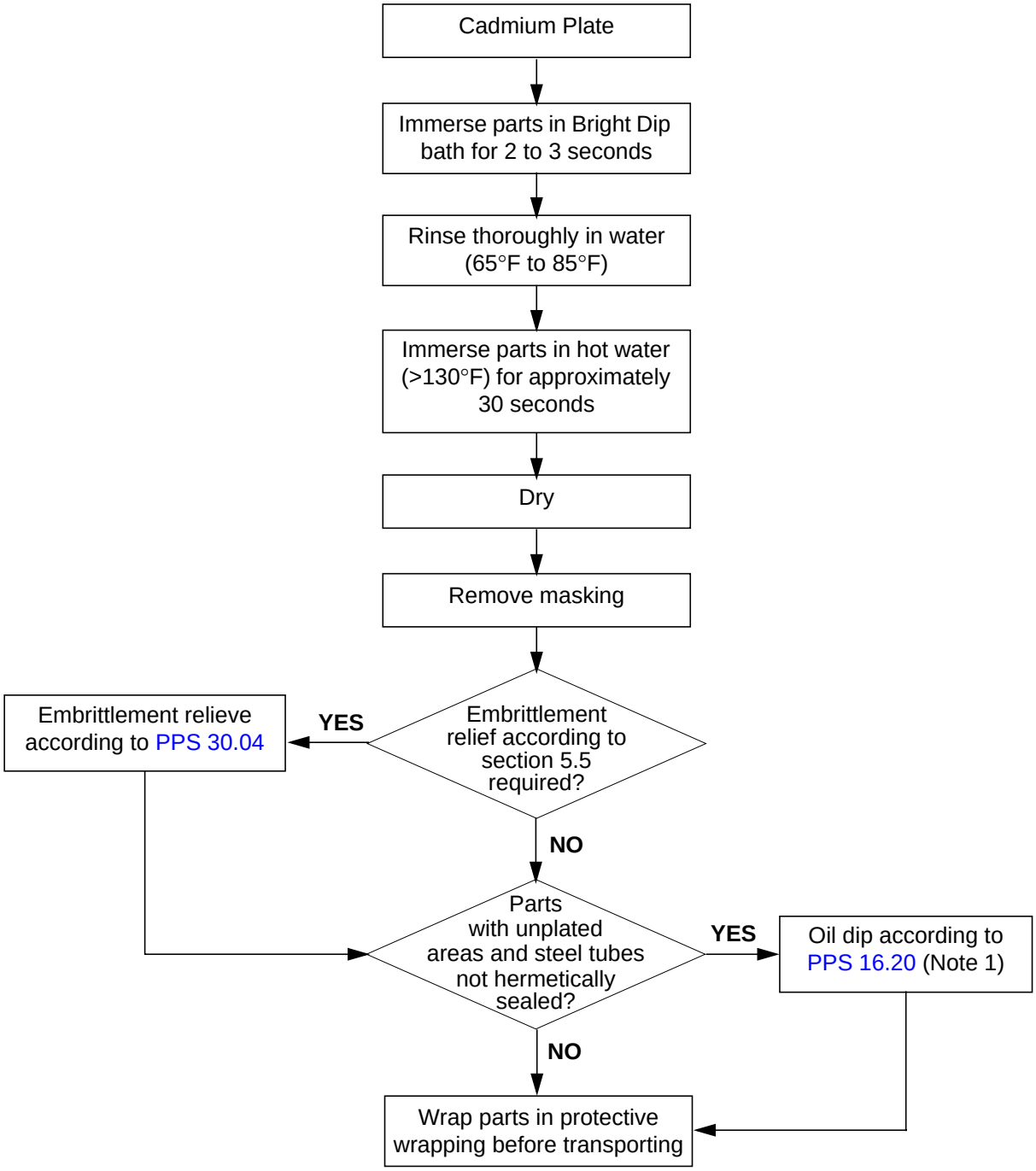


Note 1. Stress relieve parts that have a tensile strength of 180 ksi or greater that have been machined, cold formed, cold straightened or ground.

Note 2. Etch stainless steel parts, except for springs, by immersing in an agitated hydrochloric acid bath (40 fluid ounces per Imperial gallon of water) for 9 to 11 seconds before plating.

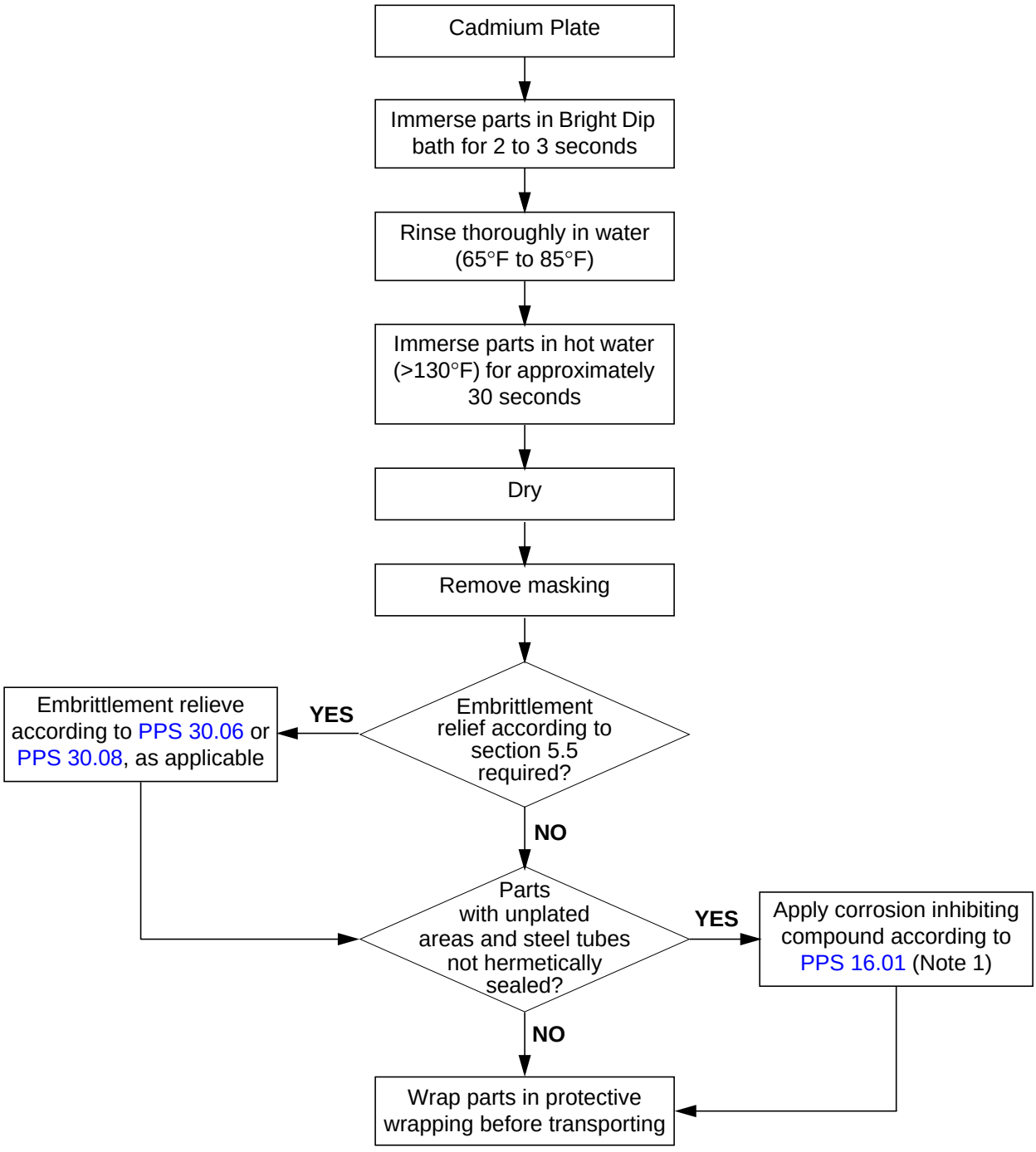
Note 3. This prevents blistering of the cadmium during the plating process.

FLOW CHART 3 - CADMIUM PLATING CARBON AND LOW ALLOY STEEL OR NON-FERROUS PARTS



Note 1. Perform oil dip operation within 30 minutes of the final operation (i.e., plating, embrittlement relief or phosphate treatment).

FLOW CHART 4 - CADMIUM PLATING CORROSION RESISTANT STEELS



Note 1. Treat unplated areas of corrosion resistant steel parts and the inside diameter of tubes within 30 minutes of the final operation (i.e., plating, embrittlement relief or phosphate treatment).