BOMBARDIER
Toronto Site
PROPRIETARY INFORMATION

PPS 33.04

PRODUCTION PROCESS STANDARD

HARD CHROMIUM PLATING (E2 AND E9)

Issue 12
- This standard supersedes PPS 33.04, Issue 11.
- 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.

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

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1 SCOPE

1.1 This Production Process Standard (PPS) specifies the procedure and requirements for hard chromium plating of ferrous metals. Hard chromium plating metals in the strength range of 200 - 220 ksi and less is identified by protective treatment code E2, according to PPS 23.02, and E9 for hard chromium plating high strength steel with ultimate tensile strength range of 220 - 240 ksi and greater.

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.

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 PPS 13.26 - General Subcontractor Provisions.

3.3 PPS 13.39 - Bombardier Toronto Engineering Process Manual.

3.4 PPS 16.20 - Temporary Corrosion Protection of Carbon and Low Alloy Steels.

3.5 PPS 17.03 - Saturation Shot Peening.

3.6 PPS 23.02 - Protective Treatment and Decorative Surface Finish Code System.

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

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

3.9 PPS 30.08 - Steel Heat Treatment of Martensitic Stainless Steels.

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

3.11 PPS 31.05 - Surface Treatment of Corrosion Resistant Steels.

3.12 PPS 33.02 - Removal of Metallic Coatings.

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

3.14 PPS 33.05 - Copper Plating (E7).

4 MATERIALS, EQUIPMENT AND FACILITIES

4.1 Materials and Equipment

4.1.1 All materials and equipment used in this process shall be defined by the subcontractor performing plating operations provided that the final plated parts meet the requirements specified herein.

4.2 Facilities

4.2.1 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 hard chromium plating of ferrous metals according to this PPS.

4.2.2 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.

4.2.3 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.

4.2.3.1 For approval of subcontractor facilities to perform hard chromium plating of 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.

4.2.3.2 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 Carry out hard chromium plating after all welding, brazing, soldering, machining and heat treatment (except embrittlement relief).

5.1.2 Design applications for hard chromium plating of parts consists of two distinct methods as described below.

- The standard (preferred) method is to PLATE TO SIZE, whereby parts are machined undersize and are plated directly so the finish drawing dimensions without subsequent machining.
- The alternate method of GRIND TO SIZE, consists of machining parts undersize, plating oversize and then grinding to the finish drawing dimensions. This method shall only be used where the engineering drawing specifies GRIND TO SIZE AFTER PLATING and where the part is capable of being machined (before plating) and ground (after plating) on centres.

5.2 Preparation of Parts

5.2.1 Prepare parts for plating as follows:

Step 1. Ensure all surfaces to be hard chromium plated shall have been machined undersize by the machining allowance specified in PPS 23.02, for the particular thickness of plating specified on the engineering drawing. If the engineering drawing also specifies a copper flash (E7) or nickel plate (E3) undercoating, additional machining allowances as per PPS 23.02 shall be provided for the undercoating.

Step 2. Stress relieve parts according to PPS 30.04, PPS 30.06 or PPS 30.08, as applicable.

Step 3. If shot peening is specified on the engineering drawing, shot peen parts according to PPS 17.03.

Step 4. Immediately before plating, thoroughly clean parts according to PPS 31.03 or PPS 31.05, as applicable.

Step 5. Protect part areas that are not to be plated (including part centres of GRIND TO SIZE AFTER PLATING parts) with a suitable masking agent.

Step 6. Rack parts so as to obtain a uniform plating thickness over the entire plated surface without edge burning or excessive deposition of chromium. Current robbing facilities (guards, thieves, or bleeders) may be used as necessary to accomplish uniform plating.

5.3 Plating Procedure

5.3.1 Unless the engineering drawing specifies a copper flash (E7) and nickel plate (E3), deposit chromium plating directly onto the base metal without any preliminary coating. If the engineering drawing specifies a copper flash (E7) and nickel plate (E3), process parts according to PPS 33.05 and PPS 33.03, respectively, before chrome plating.

5.3.2 Maintain the required current density and solution temperature from the beginning of the plating cycle and hold constant throughout the procedure.

5.3.3 Carry out plating of parts for the time required to plate to the plating thickness specified in Table II.

5.3.4 Use anodes and robbers as necessary to ensure the parts receive the desired plating thickness. Contoured anodes may be used to maintain plate uniformity.

5.3.5 Plate grind relief areas only if specifically called for on the engineering drawing.

5.3.6 After plating, remove all masking material.

5.4 Embrittlement Relief

5.4.1 Embrittlement relieve parts with a tensile strength range of 150-170 ksi or greater according to PPS 30.04, PPS 30.06 or PPS 30.08, as applicable, within 4 hours of plating.

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

5.5 Finishing of Plated Surfaces

5.5.1 Parts which are PLATED TO SIZE do not require grinding or machining of plated surfaces after the plating operation. Remove edge build up of chrome plate by carefully hand working with a fine stone.

5.5.2 Grind parts which are plated as GRIND TO SIZE to the finish part dimensions after plating. The maximum rate of grinding (metal removed) per pass shall be 0.0002", using a maximum grinding wheel speed of 6500 SFM with flood cooling during all grinding operations.

5.6 Protection of Parts for Shipping

5.6.1 For shipping, wrap and package parts to prevent damage to the parts.

5.6.2 Before shipment for plating, oil-coat all carbon and low alloy steel parts according to PPS 16.20. After plating, re-oil all unplated part surfaces according to PPS 16.20 before shipping.

6 REQUIREMENTS

6.1 Production Parts

6.1.1 Select at random from each lot at least the number of parts specified in Table I for visual inspection as specified in section 6.2 and plating thickness measurement as specified in section 6.3. Those items of a sample lot which do not meet the requirements shall be considered as non-conforming and if the number of non-conforming parts exceeds the acceptance number for that sample, inspect every part in the lot represented by the sample. Strip unacceptable parts according to PPS 33.02, re-plate and re-inspect all unacceptable parts as specified herein.

TABLE I - SAMPLING SCHEDULE

NUMBER OF ITEMS IN 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 rejected.

6.2 Visual Appearance

6.2.1 Ensure that chromium deposits are homogeneous, smooth, uniform in appearance, free from frosty areas, pin holes, pits, nodules and other defects. When only a portion of the surface is plated and the surface plated is not bounded by grind relief areas, ensure that the deposit has been finished in such a manner that it will blend smoothly with the adjacent unplated areas.

6.3 Plating Thickness

6.3.1 Ensure that the thickness of the chromium plate meets the requirements specified in Table II for the particular plating method and application as specified on the engineering drawing or manufacturing documentation (e.g., Process Sheet). Calculate the minimum plating thickness from measurements taken before and after plating at several locations in areas where the plating thickness would be expected to be at a minimum. The length of edge bleed-out shall not exceed 1/16". Bleed-out may extend over a corner radius, but chromium plating is not acceptable in a fillet radius, unless specifically called on the engineering drawing. No edge build-up is permitted on parts “plated to size”. Strip unacceptable parts according to PPS 33.02 and re-plate as specified herein.

TABLE II - PLATE THICKNESS

PLATING METHOD	APPLICATION	PLATE THICKNESS
PLATE TO SIZE	Standard Use (Note 1)	0.0002" - 0.0004"
	Heavy Duty	0.0005" - 0.0007"
GRIND TO SIZE (Note 2)	Special Use	Before grinding: 0.002" - 0.003"
		After grinding: 0.0005" - 0.0015"

Notes: 1. This is the standard plating to be used in all cases where the engineering drawing does not otherwise specify a plate thickness.
2. This plating method shall only be used where the engineering drawing specifies GRIND TO SIZE AFTER PLATING and where the part is capable of being machined (before plating) and ground (after plating) on centres.

6.4 Every 3 months, plate four test specimens, 1" x 4" x 0.040" of 4130 (MIL-S-18729) condition N material quarterly according to the procedure specified herein. Submit the test specimens to a laboratory as specified in paragraph 4.2.3.2 for plate adhesion testing as follows:

Step 1. Bend each test specimen repeatedly through an angle of 180°,on a diameter of 0.04" until fracture of the basis metal occurs.

Step 2. Using a sharp instrument, attempt to detach an appreciable area of the plating from the substrate metal at the fracture. If it is possible to detach an appreciable area of the plating from the substrate metal at the fracture, suspend plating operations until the cause of the failure is determined and another 4 test specimens have been prepared for adhesion re-testing.

7 SAFETY PRECAUTIONS

7.1 The safety precautions applicable to the materials and procedures specified herein shall be as defined by the subcontractor performing such 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.