BOMBARDIER
Toronto Site
PROPRIETARY INFORMATION

PPS 33.09

PRODUCTION PROCESS STANDARD

ELECTROLESS NICKEL BORON PLATING

Issue 5
- This standard supersedes PPS 33.09, 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.

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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 electroless nickel boron plating, with or without lubricant, of low alloy steel, heat treated to a strength range of 200 - 220 ksi or greater, and nickel alloys.

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

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

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

2 HAZARDOUS MATERIALS

2.1 Before receipt at Bombardier Toronto, all materials shall be approved and assigned Material Safety Data Sheet (MSDS) numbers by the Bombardier Toronto Environment, Health and Safety Department. Refer to the manufacturer's MSDS for specific safety data on any of the materials specified in this PPS. If the MSDS is not available, contact the Bombardier Toronto Environment, Health and Safety Department.

3 REFERENCES

3.1 BAERD GEN-018 - Engineering Requirements for Laboratories.

3.2 DHMS C4.15 - Electroless Nickel-Boron Plating.

3.3 PPS 13.26 - General Subcontractor Provisions.

3.4 PPS 13.39 - Bombardier Toronto Engineering Process Manual.

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

3.6 PPS 17.02 - Abrasive Blasting.

3.7 PPS 17.03 - Saturation Shot Peening.

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

3.9 PPS 30.13 - Heat Treatment of Nickel and Nickel Alloys.

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

3.11 PPS 31.11 - Vapour Blast Cleaning.

3.12 PPS 31.12 - Cleaning Nickel and Nickel Alloys.

3.13 PPS 32.09 - Application of Dry Film Lubricants (C3, C7 and C8).

3.14 PPS 33.02 - Removal of Metallic Coatings.

4 MATERIALS, EQUIPMENT AND FACILITIES

4.1 Materials

4.1.1 Nickel Boron Plating - Electroless, to DHMS C4.15, Classes 1 to 5.

4.1.2 All material 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 Equipment

4.2.1 All 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.

4.3 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 electroless nickel boron plating, with or without lubricant, of low alloy steel, heat treated to a strength range of 200 - 220 ksi or greater, and nickel alloys 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 electroless nickel boron plating, with or without lubricant, of low alloy steel, heat treated to a strength range of 200 - 220 ksi or greater, and nickel alloys 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 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.

5.1.2 Electroless nickel boron plating, with or without lubricant, is used to provide a hard, wear resistant, low friction, corrosion resistant coating on high strength steel and nickel alloy parts.

5.1.3 DHMS C4.15 specifies five classifications of coatings, as listed below. However, this PPS covers only Classes 1 and 4.

Class 1 - Electroless Nickel-Boron (NiBRON)

Class 2 - Electroless Nickel-Boron with Fluorotelemar Lubricant added (Nibrolube 1)

Class 3 - Electroless Nickel-Boron with Molydisulphide Lubricant added (Nibrolube 2)

Class 4 - Electroless Nickel-Boron with Molydisulphide Lubricant impinged (Nibrolube 3)

Class 5 - Electroless Nickel-Boron with low stress nickel phosphorous pre-coat and seal coat (NiBROCLAD)

5.2 Preparation of Parts for Plating

5.2.1 Stress Relief

5.2.1.1 Stress relief all steel parts that have been machined, cold formed, cold straightened or ground in the final heat treat temper, as specified on the engineering drawing, according to PPS 30.04.

5.2.1.2 Stress relief Inconel 600 and Inconel 625 parts that have been welded according to PPS 30.13.

5.2.2 Shot Peening

5.2.2.1 If specified on the engineering drawing, shot peen parts, to the class specified, according to PPS 17.03.

5.2.3 Masking

5.2.3.1 If specified on the engineering drawing, protect areas of the part not to be plated with a suitable masking agent.

5.2.3.2 In addition, if specified on the manufacturing document (e.g., Process Sheet or Shop Order), mask close tolerance fastener holes drilled to final size.

5.2.4 Cleaning

5.2.4.1 Immediately before plating, abrasive blast clean parts according to PPS 17.02, vapour blast clean according to PPS 31.11 or clean according to PPS 31.03 or PPS 31.12, as applicable, to provide an active surface for plating.

5.2.4.2 Apply pre-strike coatings if required by the alloy being plated.

5.3 Plating Procedure

5.3.1 Immerse parts in the plating solution so the blind holes are completely filled with solution and, if possible, with the hole facing up.

5.3.2 Gently agitate complex parts with numerous holes, angles, etc. during the plating cycle.

5.3.3 The plating process shall be continuous without interruption.

5.3.4 Carry out plating of parts for the time required to provide the plate thickness specified on the engineering drawing.

5.3.5 On completion of plating, neutralize parts, rinse in clean water, and dry.

5.4 Post Plate Heat Treatment

5.4.1 If applicable, remove masking material.

5.4.2 Heat treat parts for the time and at the temperature specified on the engineering drawing.

5.5 Lubricant Treatment - Class 4

5.5.1 If the engineering drawing specifies areas of the part not to be coated, protect such areas using a suitable masking agent.

5.5.2 If the engineering drawing specifies Class 4 coating, coat the applicable area with molybdenum disulphide by impingement to achieve the dry film thickness specified on the engineering drawing.

5.5.3 Where applicable, remove the masking material.

5.5.4 Oven cure the molybdenum disulphide coating for 1 hour at 400 ± 25°F.

5.6 Re-work

5.6.1 Parts requiring re-work shall have the coatings stripped as specified below and re-coated as specified herein:

- Strip molybdenum disulphide according to PPS 32.09.
- Strip nickel boron plating according to PPS 33.02.

5.7 Protection of Parts for Shipping

5.7.1 Before shipping, suitably wrap and package parts to prevent them from being damaged.

5.7.2 Before shipping to a subcontractor for plating, oil-coat all carbon and low alloy steel parts according to PPS 16.20.

5.7.3 Subcontractors shall re-oil all unplated carbon and low alloy steel part surfaces before shipping to Bombardier Toronto or transhipping to another subcontractor.

6 REQUIREMENTS

6.1 General

6.1.1 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 Production Parts

6.2.1 For inspection of the nickel boron coating according to section 6.2.2 and the molybdenum disulphide coating according to section 6.2.3, select a sample from each inspection lot by taking, at random from the lot, not less than the number of items indicated in Table I.

6.2.1.1 If the number of non-conforming items in any sample exceeds the acceptance number specified in Table I, reject the represented lot, and disposition them according to paragraph 6.4.1.

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.

6.2.2 Nickel Boron Plating

6.2.2.1 Visual Appearance

6.2.2.1.1 Inspect the plating under 5X magnification. The plating shall be smooth, adherent, and shall be free from porosity, roughness, cracks or other imperfections detrimental to the part. A nodular surface appearance is acceptable.

6.2.2.1.2 Discolouration from heat treatment is acceptable.

6.2.2.2 Plating Thickness

6.2.2.2.1 The plating thickness shall be as specified on the engineering drawing.

6.2.2.2.2 The thickness shall be calculated from measurements taken before and after plating at several locations on the part.

6.2.3 Molybdenum Disulphide Coating

6.2.3.1 Visual Appearance

6.2.3.1.1 The coating shall have a smooth, even finish. Slight variations in colour are acceptable. A pebbly, rough surface is not acceptable.

6.2.3.2 Coating Thickness

6.2.3.2.1 The coating thickness shall be as specified on the engineering drawing.

6.2.3.2.2 The thickness shall be calculated from measurements taken before and after coating or by direct measurement using a suitable electronic thickness gauge. Measurements shall be taken at several locations on the part.

6.3 Test Specimens

6.3.1 Process 4 LAB 051 test specimens (see Table II) through cleaning, plating and heat treatment with each lot of production parts. Do not molybdenum disulphide coat the test specimens.

6.3.1.1 Plate 3 test specimens to the same thickness as the production parts and use 1 for adhesion testing and 2 for plating thickness testing according to section 6.3.3.

6.3.1.2 One test specimen shall be given an additional plating thickness to allow micro-hardness testing according to section 6.3.4. Plating thickness shall be 0.0015 to 0.0030 inches and identify the specimen as shown in Figure 1.

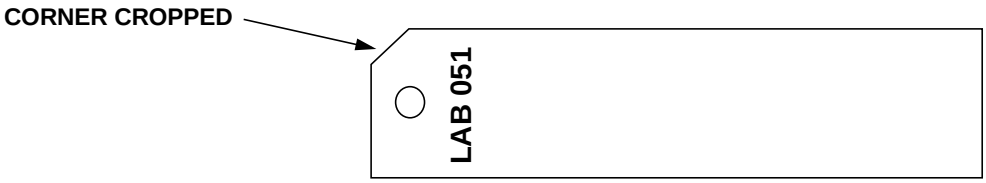

FIGURE 1 - PLATE HARDNESS TEST SPECIMEN

6.3.2 Submit the processed test specimens to a laboratory as specified in paragraph 4.3.3.2, at the discretion of Bombardier Quality, for plate adhesion and hardness testing.

6.3.2.1 It shall be the responsibility of the facility processing work according to this standard to include the test piece in the production batch. Test pieces are available in bulk from Bombardier Toronto.

TABLE II - TEST SPECIMENS

TEST SPECIMEN	REPRESENTED MATERIAL
LAB 051-3 (4130)	300M
LAB 051-10 (INCONEL 625)	INCONEL 625

6.3.3 Adhesion and Plating Thickness Tests

6.3.3.1 For adhesion testing, bend one test specimen (see paragraph 6.3.1.1) once at room temperature (60 - 90°F) through an angle of 180°, around a 1/4 inch diameter mandrel.

6.3.3.1.1 There shall be no evidence of breakaway particles on the outside radius, except for an area extending inward from the edge of the test specimen where the metal has been distorted by the bend.

6.3.3.2 To verify plating thickness, examine two test specimens (see paragraph 6.3.1.1) metallographically. Determine coating coverage of the sample by visual means using a stereo microscope at 10X to 45X magnification. There shall be no bare areas, pores or discontinuities anywhere on the two specimens.

6.3.3.2.1 Select four areas in each specimen where the coating appears thinnest. The average coating thickness at each area (determined by drawing a straight line through the crests and troughs of the coating and then computing an arithmetic mean) shall be within the plating thickness specified on the engineering drawing.

6.3.3.3 Failure of the test specimens to meet adhesion and plating thickness requirements shall be cause to reject and action the represented lot according to paragraph 6.4.2.

6.3.4 Plate Hardness

6.3.4.1 Test the second test specimen (see paragraph 6.3.1.2) for plate hardness using a Knoop microhardness tester. Conduct hardness tests on a prepared metallographic specimen of the cross section.

6.3.4.2 The minimum plate hardness shall be Knoop 980/50 g.

6.3.4.3 Failure of the test specimen shall be cause for rejection of the lot represented. Action the reject lot according to paragraph 6.4.3.

6.4 Disposition

6.4.1 Lots rejected for non-conformance of the nickel boron plating (according to section 6.2.2) or the molybdenum disulphide coating (according to section 6.2.3) shall be 100% inspected and parts meeting the requirements shall be accepted. Parts not meeting the requirements shall be stripped, re-coated (together with another test specimen if re-plating with nickel boron) and re-inspected.

6.4.2 Lots rejected for plate adhesion (according to section 6.3.3) shall be stripped, replated (together with another test specimen) and re-inspected.

6.4.3 Refer lots rejected for plate hardness (according to section 6.3.4) to MRB for disposition.

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.

FLOW CHART 1 - NICKEL BORON PLATING AND MOLYBDENUM DISULPHIDE COATING