BOMBARDIER
Toronto Site
PROPRIETARY INFORMATION

PPS 30.17

PRODUCTION PROCESS STANDARD

STEEL CASE HARDENING - ION NITRIDING

Issue 7
- This standard supersedes PPS 30.17, Issue 6.
- Vertical lines in the left hand margin indicate 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 case hardening carbon and low alloy steels, martensitic and precipitation hardenable corrosion resistant steels by ion nitriding.

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 Form DH3772 - Steel Heat Treatment Record - *Bombardier Toronto internal operating procedure*.

3.3 PPS 13.26 - General Subcontractor Provisions.

3.4 PPS 13.39 - Bombardier Toronto Engineering Process Manual.

3.5 PPS 17.02 - Abrasive Blasting.

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

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

3.8 PPS 30.08 - Heat Treatment of Martensitic Stainless Steels.

3.9 PPS 31.05 - Surface Treatment of Corrosion Resistant Steel (C9).

4 MATERIALS, EQUIPMENT AND FACILITIES

4.1 Materials

4.1.1 Masking material as specified on the applicable qualified Processing Card.

4.2 Equipment

4.2.1 Suitable ion nitriding equipment consisting of a vacuum furnace, a vacuum pump, a nitriding gas supply, a temperature regulating device and an electric power supply. Furnace temperature variation from the set point shall be no more than ± 15°F during the nitriding cycle. Controls shall be of the automatic controlling and recording type. The equipment shall be capable of measuring, controlling and recording the vacuum (pressure) levels in the vessel during the processing cycle. The equipment shall also be capable of measuring and controlling the ratio of each gas mixture component within ± 1% of the selected value.

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 case hardening carbon and low alloy steels, martensitic and precipitation hardenable corrosion resistant steels by ion nitriding 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 case hardening carbon and low alloy steels, martensitic and precipitation hardenable corrosion resistant steels by ion nitriding 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 as specified by Bombardier Toronto Engineering.

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 Ion nitriding is a vacuum process for producing a nitrided case on ferrous materials using glow discharge. The process is also called glow discharge nitriding or plasma/ion nitriding. The advantages of ion nitriding over other nitriding processes (i.e., gas or liquid salt bath nitriding) include better control of the thickness and hardness of the case structure, greater dimensional stability of the part, less distortion and less surface roughening.

5.1.2 All facilities processing work according to this PPS shall complete a steel heat treatment record (e.g., Form DH3772) for all heat treat operations. Each form shall be appropriately stamped by the responsible personnel and kept with the heat treat records.

5.1.3 Process each part number according to a an approved PCD qualified according to section 5.2. The processing card shall include the following information:

- part number
- procedure for masking
- minimum or maximum number of parts that can be run in one load
- loading diagram showing location and spacing of each part
- location of work thermocouple
- location of LAB 045 test sample
- location of auxiliary anodes and cathodes, when required
- program for pressure, temperature and gas mix throughout the nitriding cycle. Ensure that the maximum nitriding temperature is at least 100°F less than the precipitation hardening or tempering temperature specified in PPS 30.04, PPS 30.06 or PPS 30.08, as applicable.

5.1.4 Examination and testing of test pieces or test parts shall be performed by the Bombardier Toronto Materials Laboratory or a Bombardier approved laboratory.

5.1.5 For the purposes of this PPS, a production batch consists of all the parts of one part number processed in one furnace load.

5.1.6 LAB 045 test pieces used for qualification of processing cards or batch acceptance testing shall of the same material type and condition as the parts represented.

5.2 Qualification of Processing Cards/Batch Acceptance Testing

5.2.1 Before use on production parts, all Processing Cards shall be qualified. Unless Bombardier specifies qualification using a test production part, qualify the Processing Cards using two LAB 045 test pieces processed through the ion nitriding cycle in different areas of the furnace.

5.2.2 When specified (i.e., for Processing Card qualification or batch acceptance testing, as applicable) process test pieces or test parts as follows:

Step 1. For test parts, ensure that any masked areas show no evidence of nitriding.

Step 2. Section each LAB 045 test piece through its diameter or section the test part at the locations specified by Bombardier, as applicable.

Step 3. If using LAB 045 test pieces, mount, polish and etch one half of the section(s). If using a test part, mount, polish and etch one half of each section.

Step 4. Perform microhardness traverse and microscopic examination at 500X on the mounted, polished and etched section(s).

- **Case Hardness**: Measure the case hardness on the sectioned test piece using a microhardness tester. Minimum case hardness shall be 65 Rc (780 Knoop/200 g min).
- **Case Depth**: Determine the effective case depth by a hardness survey conducted on a metallographic specimen. The minimum acceptable case depth is 0.001". Refer to the engineering drawing for the maximum acceptable case depth. If the engineering drawing does not specify the maximum acceptable case depth, refer to Liaison Engineering.
- **Core Hardness**: The core hardness, as measured approximately in the centre of the test piece, shall be the same as the material hardness in the precipitation hardened condition specified in PPS 30.04, PPS 30.06 or PPS 30.08, as applicable.

5.3 Preparation of Parts

5.3.1 Prepare parts for nitriding as follows:

Step 1. Heat treat parts according to PPS 30.04, PPS 30.06 or PPS 30.08, as applicable, to the temper specified on the engineering drawing.

Step 2. Unless the engineering drawing specifies machining after nitriding, machine parts to the finish dimensions. If a machining allowance is specified, allow for dimensional growth (consider a growth of 0.0001 inch per 0.005 inch diffusion depth as typical).

Step 3. Stress relieve ground or straightened parts according to PPS 30.04 PPS 30.06 or PPS 30.08, as applicable.

Step 4. Abrasive blast clean parts according to PPS 17.02.

Step 5. If the engineering drawing specifies areas of parts not to be nitrided, mask such surfaces by copper plating or by other suitable mechanical masking covers that effectively act as barriers between the glow discharge and the part surfaces. Record the masking method used on the processing card and do not use other masking methods on that part.

5.4 Ion Nitriding Procedure

5.4.1 Before processing each batch of production parts, measure the furnace leak rate as follows to ensure it does not exceed 10 microns per hour:

Step 1. Evacuate the vessel to 75 microns (9.98 Pa) or less and record this initial pressure.

Step 2. Take a second reading at least 15 minutes after the first reading and use the pressure differential and elapsed time to determine the leak rate.

5.4.2 Perform ion nitriding as follows:

Step 1. Place and support parts in the nitriding furnace in a way to minimize distortion at the nitriding temperature and ensure complete exposure of all unmasked surfaces.

Step 2. Include the applicable LAB 045 test piece with the batch of parts being nitrided. Ensure test pieces remain with their respective batches during ion nitriding.

Step 3. Heat the load in the furnace containing the process gas mixture, at the temperature and pressure indicated on the processing card, for the time required to produce the specified case depth.

Step 4. After completion of the nitriding cycle, allow parts to cool to 300°F or less in the nitriding atmosphere before removing the parts from the furnace.

5.5 Post Nitriding Procedure

5.5.1 If specified on the engineering drawing, grind the parts to finish dimensions. After grinding stress relieve according to PPS 30.04, PPS 30.06 or PPS 30.08, as applicable.

5.5.2 If ion nitriding is the final operation and no further working (e.g., grinding) or heat treatment is necessary, use a Scotch-Brite pad to remove any black deposits. Dust off loose particles with a clean cloth.

6 REQUIREMENTS

6.1 Masked surfaces shall show no evidence of nitriding.

6.2 If requested by Bombardier, submit the LAB 045 processed with the batch or a production part from the batch, as specified, for batch acceptance testing as specified in section 5.2. If the test piece or part fails to meet the test requirements, refer the represented batch to Bombardier Toronto Material Review Board (MRB) or Bombardier Toronto delegated MRB for disposition. If Bombardier Toronto MRB or Bombardier Toronto delegated MRB specifies re-nitriding the batch, process the remaining half of the original test piece plus a new LAB 045 test piece with the parts.

6.3 For each production load processed, maintain the following records on file:

- processing card
- recorder charts for furnace temperature
- recorder charts for furnace vacuum (pressure)
- recorder charts for leak rate
- recorder charts for gas mixture

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 SPECIAL POINTS TO NOTE

9.1 Before shipping parts to a subcontractor for ion nitriding, suitably wrap and package parts to prevent handling damage. Include one LAB 045 test piece, of the same material type and condition as the production batch, with each batch of parts shipped to a subcontractor for processing.