BOMBARDIER
Toronto Site
PROPRIETARY INFORMATION

PPS 30.16

PRODUCTION PROCESS STANDARD

STEEL CASE HARDENING - LIQUID NITRIDING

Issue 11
- This standard supersedes PPS 30.16, Issue 10.
- 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 case hardening of steel by liquid salt bath 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 AMS 2753 - Liquid Salt Bath Nitriding (Non-Cyanide Bath).

3.2 AMS 2755 - Liquid Salt Bath Nitriding.

3.3 BAERD GEN-018 - Engineering Requirements for Laboratories.

3.4 DHLPM Procedure No. 3012 - Leitz Durimet Microhardness Tester - *Bombardier Toronto internal operating procedure.*

3.5 Bombardier Toronto form DH #3772A/3772B - Steel Heat Treatment Quality Control and Inspection Record.

3.6 MIL-T-10727 - Tin Plating; Electrodeposited or Hot Dipped for Ferrous and Non-Ferrous Metals.

3.7 PPS 13.26 - General Subcontractor Provisions.

3.8 PPS 13.39 - Bombardier Toronto Engineering Process Manual.

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

3.10 PPS 20.08 - Hardness Testing of Metals.

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 30.08 - Heat Treatment of Martensitic Stainless Steels.

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

3.15 PPS 31.04 - Degreasing Processes.

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

4 MATERIALS, EQUIPMENT AND FACILITIES

4.1 Materials

4.1.1 Acid solution as specified in PPS 31.03.

4.2 Equipment

4.2.1 Protective gloves (e.g., DSC 422-3).

4.2.2 Aluminized fire-proof jacket and hood.

4.2.3 All equipment and facilities employed in carrying out the procedure specified herein shall be approved by Bombardier as meeting the requirements of this PPS and applicable facility Quality Instructions.

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 case hardening of steel by liquid salt bath 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 the case hardening of steel by liquid salt bath 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 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 standard, the term NITRIDING includes TUFFTRIDING, MALCOMIZING, MELONIZING and other proprietary liquid salt bath nitriding processes that meet the requirements of this PPS and AMS 2753 or AMS 2755.

5.1.2 Melonizing (AMS 2753) may be used in all cases where Tufftriding (AMS 2755) is specified on the engineering drawing.

5.2 Machining

5.2.1 Unless otherwise specified on the engineering drawing, finish machine parts before hardening and tempering. If the engineering drawing specifies finish machining after hardening and tempering, rough machine parts to a size of 0.002" - 0.003" over the finish part dimensions and finish machine after hardening and tempering.

5.3 Cleaning

5.3.1 Before and after hardening and tempering, thoroughly clean the parts according to the applicable cleaning PPS, as specified in Table I.

TABLE I - APPLICABILITY OF STANDARDS

MATERIAL	CONDITION	CLEANING PPS	HEAT TREATMENT PPS	NITRIDING METHOD
4130 Low alloy steel	Wrought (125 - 145 ksi)	PPS 31.03	PPS 30.04	AMS 2753 (Preferred) AMS 2755 (Alternate)
4340 Low alloy steel	Wrought (150 - 170 ksi & 125 - 145 ksi)			
17-4 PH Precipitation hardenable steel	Wrought H1150 (135 - 155 ksi) Cast H1100 (130 - 150 ksi)	PPS 31.05	PPS 30.06	
431 Martensitic stainless steel	Wrought (125 - 145 ksi)		PPS 30.08	
17-7 PH Precipitation hardenable steel	Wrought TH1050 (180 - 200 ksi)		PPS 30.06	AMS 2753
Custom 455 Precipitation hardenable steel	Wrought H1050 (180 - 200 ksi)			
410 Martensitic stainless steel	Cast (125 - 160 ksi)		PPS 30.08	

5.4 Hardening and Tempering

5.4.1 Before nitriding, heat treat the parts to the tensile strength range specified on the engineering drawing, according to the applicable heat treat PPS as specified in Table I. If necessary, straighten the parts after tempering.

5.5 Stress Relieving

5.5.1 Stress relieve 17-7 PH wrought (180 - 200 ksi or greater) and Custom 455 wrought (180 - 200 ksi or greater) parts that have been machined, cold formed, cold straightened or ground, according to PPS 30.06.

5.6 Protection of Parts for Shipping

5.6.1 Before shipping, suitably wrap and package the parts to prevent damage. Before shipping to a subcontractor for nitriding, oil coat parts of 4130 and 4340 low alloy steel according to PPS 16.20. Subcontractors shall re-oil all nitrided parts before shipping to Bombardier or to another subcontractor.

5.6.2 Include one test piece, as specified in Table II, with each batch of parts being shipped to subcontractors for processing.

5.7 Stopping-Off

5.7.1 If the engineering drawing specifies that certain areas of parts are not to be case hardened, mask these areas with electrodeposited tin plate according to MIL-T-10727, 0.0002" - 0.0006" thick.

5.8 Nitriding

5.8.1 Before nitriding parts of 4130 and 4340 low alloy steel that have been protected from corrosion according to paragraph 5.6.1, solvent clean or degrease according to PPS 31.04.

5.8.2 Nitride parts to meet the requirements of this PPS and AMS 2753 or AMS 2755 as specified in Table I.

5.8.3 Include one test piece, as specified in Table II, in each batch of parts being nitrided. It is the responsibility of the facility processing work according to this standard to include the test piece with the production batch.

5.9 Stripping of Tin Plate

5.9.1 After nitriding, strip the tin plate from parts that have been stopped-off according to section 5.7 by immersing them in an acid solution specified in PPS 31.03, until the tin plate is completely removed.

5.9.1.1 Immediately after the tin plate has been stripped, remove the parts from the acid solution, rinse thoroughly in cold water and allow to dry.

5.10 Embrittlement Relief

5.10.1 After removing the tin plate from parts of 4340 (150 - 170 ksi), 17-7 PH wrought TH1050 (180 - 200 ksi) and Custom 455 wrought H1050 (180 - 200 ksi) embrittlement relieve according to PPS 30.04 and PPS 30.06, as applicable.

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.

6.1.2 One test piece, as specified in Table II, shall be included in each batch of parts being nitrided. After processing according to this PPS, the test piece shall be submitted to the Bombardier Toronto Materials Laboratory for examination according to paragraph 6.1.3.

6.1.3 The test piece shall be sectioned through the diameter and one half shall be mounted, polished and etched for microhardness traverse and microscopic examination at 500X. Perform the microhardness test according to DHLPM Procedure No. 3012. Perform the Rockwell hardness test according to PPS 20.08. Reject the represented batch of parts for any sample not meeting the requirements specified in Table II.

6.2 Heat Treatment Records

6.2.1 Enter all records of heat treatment data on form DH #3772A/3772B or equivalent (see Figure 1 and Figure 2).

6.2.2 Records shall be stamped by the inspector responsible.

TABLE II - INSPECTION REQUIREMENTS

REPRESENTED PART MATERIAL	LAB 045 TEST PIECE							
	TEST PIECE NUMBER	TEST PIECE MATERIAL	MINIMUM CASE HARDNESS		CASE DEPTH (INCHES)		CORE HARDNESS (NOTE 1)	
			KNOOP SCALE (NOTE 3)	ROCKWELL C SCALE (NOTE 4)	MIN	MAX	VICKERS	ROCKWELL C SCALE
4130 (125 - 145 ksi)	LAB 045-3	4130 (125 - 145 ksi)	450	44			279 - 322	27.0 - 32.5
4340 (150 - 170 ksi & 125 - 145 ksi)	LAB 045-3	4340 (150 - 170 ksi)	450	44			330 - 372	33.5 - 38.0
17-4 PH Wrought H1150 (135 - 155 ksi)	See Note 2		900	67	0.0002	0.001	See Note 2	
17-4 PH Cast H1100 (130 - 150 ksi)								
17-7 PH Wrought TH1050 (180 - 200 ksi)								
Custom 455 Wrought H1050 (180 - 200 ksi)								
410 Cast (125 - 160 ksi)	LAB 045-7	431 (125 - 145 ksi)	900	67			279 - 318	27.0 - 32.0
431 Wrought (125 - 145 ksi)								

Notes
1. Core hardness is representative of test pieces only and does not necessarily reflect actual core hardness of the represented parts.
2. Contact Bombardier Methods if these materials are to be liquid nitrided.
3. Values are based on loads of 500 grams or more.
4. Values are for reference or comparison only.

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.

BOMBARDIER Inc.
de Havilland

STEEL HEAT TREATMENT QUALITY CONTROL AND INSPECTION RECORD

PART NO: _____
ISSUE: _____
NAME: _____
CONTRACT: _____

MATERIAL SPEC: _____ H.T. SPEC.
APPLICABLE SWG/DESIGN REQUIREMENTS
TENSILE: T.S. Y.S. E.
METALLOGRAPHIC: CARB. DECARB. OXID.
HARDNESS:
MISC.:

	RECORDING DATE	HEAT TREAT NO.	MATERIAL SOURCE REF.	WORK ORDER/JOB CARD NO.	QUANTITY MATERIAL OR PARTS	THICKNESS OR RULING SECTION	HEAT TREATMENT TEST RESULTS	INSPECTION REPORT	INSPECTION STAMP
1					A N S/R H/T		T.S. HARDNESS - Y.S. METALLO - E MISC. - REPORT #	DATE - ACCEPTED - REJECTED - RE H.T.'D -	
2					A N S/R H/T		T.S. HARDNESS - Y.S. METALLO - E MISC. - REPORT #	DATE - ACCEPTED - REJECTED - RE H.T.'D -	
3					A N S/R H/T		T.S. HARDNESS - Y.S. METALLO - E MISC. - REPORT #	DATE - ACCEPTED - REJECTED - RE H.T.'D -	
4					A N S/R H/T		T.S. HARDNESS - Y.S. METALLO - E MISC. - REPORT #	DATE - ACCEPTED - REJECTED - RE H.T.'D -	
5					A N S/R H/T		T.S. HARDNESS - Y.S. METALLO - E MISC. - REPORT #	DATE - ACCEPTED - REJECTED - RE H.T.'D -	
6					A N S/R H/T		T.S. HARDNESS - Y.S. METALLO - E MISC. - REPORT #	DATE - ACCEPTED - REJECTED - RE H.T.'D -	
7					A N S/R H/T		T.S. HARDNESS - Y.S. METALLO - E MISC. - REPORT #	DATE - ACCEPTED - REJECTED - RE H.T.'D -	

NOTE: 1. MAKE ENTRIES IN INK.
2. RETAIN RECORD FOR 3 YEARS (MIN).
3. DO NOT DEFACE OR DESTROY
4. DO NOT REMOVE FROM H.T. AREA

DH3772A

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FIGURE 1 - FORM 3772A SAMPLE

BOMBARDIER INC.
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STEEL HEAT TREATMENT RECORD

PART NO. _____ NAME: _____ SHEET NO._____

	HEAT TREAT REF. NO.	NORMALIZE F	STRESS RELIEVE F	AUSTENIZE F	DEW POINT	QUENCH MEDIUM	TEMPER F	MISCELLANEOUS (ANNEAL ETC.)
1		TEMP -	TEMP -	TEMP -	1-	OIL	TEMP -	HEAT TREATER # -
		SOAK -	SOAK -	SOAK -	2-	WATER	SOAK -	
		FURNACE # -	FURNACE # -	FURNACE # -	3-	SALT	FURNACE # -	
		CHART -	CHART -	CHART -	4-	F	CHART -	
		DATE -	DATE -	DATE -	5-		DATE -	
2		TEMP -	TEMP -	TEMP -	1-	OIL	TEMP -	HEAT TREATER # -
		SOAK -	SOAK -	SOAK -	2-	WATER	SOAK -	
		FURNACE # -	FURNACE # -	FURNACE # -	3-	SALT	FURNACE # -	
		CHART -	CHART -	CHART -	4-	F	CHART -	
		DATE -	DATE -	DATE -	5-		DATE -	
3		TEMP -	TEMP -	TEMP -	1-	OIL	TEMP -	HEAT TREATER # -
		SOAK -	SOAK -	SOAK -	2-	WATER	SOAK -	
		FURNACE # -	FURNACE # -	FURNACE # -	3-	SALT	FURNACE # -	
		CHART -	CHART -	CHART -	4-	F	CHART -	
		DATE -	DATE -	DATE -	5-		DATE -	
4		TEMP -	TEMP -	TEMP -	1-	OIL	TEMP -	HEAT TREATER # -
		SOAK -	SOAK -	SOAK -	2-	WATER	SOAK -	
		FURNACE # -	FURNACE # -	FURNACE # -	3-	SALT	FURNACE # -	
		CHART -	CHART -	CHART -	4-	F	CHART -	
		DATE -	DATE -	DATE -	5-		DATE -	
5		TEMP -	TEMP -	TEMP -	1-	OIL	TEMP -	HEAT TREATER # -
		SOAK -	SOAK -	SOAK -	2-	WATER	SOAK -	
		FURNACE # -	FURNACE # -	FURNACE # -	3-	SALT	FURNACE # -	
		CHART -	CHART -	CHART -	4-	F	CHART -	
		DATE -	DATE -	DATE -	5-		DATE -	
6		TEMP -	TEMP -	TEMP -	1-	OIL	TEMP -	HEAT TREATER # -
		SOAK -	SOAK -	SOAK -	2-	WATER	SOAK -	
		FURNACE # -	FURNACE # -	FURNACE # -	3-	SALT	FURNACE # -	
		CHART -	CHART -	CHART -	4-	F	CHART -	
		DATE -	DATE -	DATE -	5-		DATE -	

FIGURE 2 - FORM 3772B SAMPLE

FLOW CHART 1 - NITRIDING