BOMBARDIER
Toronto Site
PROPRIETARY INFORMATION

PPS 30.06

PRODUCTION PROCESS STANDARD

HEAT TREATMENT OF PRECIPITATION HARDENABLE (PH) STAINLESS STEELS

Issue 24
- This standard supersedes PPS 30.06, Issue 23.
- 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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	Materials Technology	
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	Quality	

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1 SCOPE

1.1 This Production Process Standard (PPS) specifies the procedure and requirements for heat treatment (including solution heat treatment, austenite conditioning, homogenizing, precipitation hardening, stress relief and embrittlement relief) of precipitation hardenable (PH) stainless steels.

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 ASTM E8 - Standard Test Methods for Tension Testing of Metallic Materials.

3.2 BAERD GEN-007 - Quality Control of Heat Treating Equipment and Hot Forming Equipment.

3.3 BAERD GEN-018 - Engineering Requirements for Laboratories.

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

3.5 PPS 13.26 - General Subcontractor Provisions.

3.6 PPS 13.39 - Bombardier Toronto Engineering Process Manual.

3.7 PPS 15.01 - Part Marking.

3.8 PPS 20.01 - Magnetic Particle Inspection.

3.9 PPS 20.03 - Fluorescent Penetrant Inspection.

3.10 PPS 20.08 - Hardness Testing of Metals.

3.11 PPS 30.02 - Sub-Zero Treatment of Steel Parts.

3.12 PPS 31.04 - Degreasing Processes.

3.13 PPS 31.05 - Surface Treatment of Corrosion Resistant Steel.

3.14 PPS 31.17 - Solvent Usage.

3.15 PPS 35.07 - Requirements for Investment and Sand Castings.

4 MATERIALS, EQUIPMENT AND FACILITIES

4.1 Materials

4.1.1 Scale inhibiting agent (e.g., Turco Pretreat, Henkel product code IDH 596970).

4.2 Equipment

4.2.1 General

4.2.1.1 Furnaces used for heat treatment shall be equipped with pyrometric control, and chart recorder controlled according to BAERD GEN-007.

4.2.1.2 Instrumentation and equipment shall be qualified according to BAERD GEN-007.

4.2.1.3 Spraying equipment (e.g., Binks Model #7 spray gun with #36 SD tip).

4.2.1.4 No. 1 Zahn cup.

4.2.2 Heating Equipment

4.2.2.1 Except for close tolerance finish machined parts, perform heat treatment of precipitation hardenable stainless steels using air, inert gas or vacuum furnaces. Close tolerance finish machined parts that have been pre-treated with scale inhibiting Turco Pretreat or equivalent may be heat treated in air furnaces; otherwise, use only inert gas or vacuum furnaces for these parts.

4.2.2.2 Do not use dissociated ammonia or bright annealing gas atmospheres when heat treating PH steels.

4.2.2.3 The processing temperature within the heating equipment shall not vary by more than the tolerance specified in Table I at any point in the working zone.

4.2.2.4 Use automatic controlling and recording temperature measuring instruments, preferably of the potentiometric type. Adequately protect thermocouples located in the working zone.

4.2.2.5 Use an electric furnace or gas-fired radiant tube furnace utilizing a circulating atmosphere type atmosphere for heat treating PH steels.

4.2.2.6 Except as noted below, when precipitation hardening parts, use an air atmosphere.

- Use an inert gas atmosphere when discolouration and/or scale shall be prevented to meet part tolerances.
- When processing parts above 1700°F, use an inert gas atmosphere or vacuum to obtain scale-free surfaces.

4.2.2.7 The dew point of inert atmospheres (such as, hydrogen, argon, helium) shall be maintained below -65°F.

4.2.3 Quenching Equipment

4.2.3.1 Within the quenching tanks, provide adequate circulation of the quenching media and means for cooling or heating, as applicable. Do not use compressed air for agitation. Ensure the tanks are large enough for the work load involved and equip the tanks with temperature gauges.

4.2.3.2 Locate quenching and handling equipment to obtain the required speed of quench.

4.2.3.3 At the beginning of the quenching operation, the temperature of the quenching medium shall not exceed 80°F. At the end of the quenching operation, the temperature of the quenching medium shall not exceed 200°F.

4.2.3.4 Vacuum furnaces shall be equipped for drop bottom quenching.

4.2.4 Approval of Equipment

4.2.4.1 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 heat treatment (including solution heat treatment, austenite conditioning, homogenizing, precipitation hardening, stress relief and embrittlement relief) of precipitation hardenable (PH) stainless steels 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 heat treatment (including solution heat treatment, austenite conditioning, homogenizing, precipitation hardening, stress relief and embrittlement relief) of precipitation hardenable (PH) stainless steels 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 Preparation of Material

5.1.1 General

5.1.1.1 Before heat treatment, ensure that all parts are identified according to PPS 15.01.

5.1.1.2 Before heat treatment, clean all parts according to PPS 31.05. Solvent clean parts according to PPS 31.17 between solution heat treatment and precipitation hardening, if necessary.

5.1.1.3 Before heat treating parts 1000°F and above in an air atmosphere, process parts as follows:

Step 1. Clean parts according to PPS 31.05 ensuring that part surfaces are water break-free and free from any contaminants including fingerprints, shop soil, etc.

Step 2. Within 4 hours of cleaning, apply scale inhibiting protective coating according to section 5.1.2. If the parts are stored longer than 4 hours, solvent clean the surfaces according to PPS 31.17 immediately before applying the protective coating. Application of the coating is not required if, after heat treatment, parts will be machined all over by 0.010" minimum.

Step 3. Verify that the protective coating is free of blisters, continuous, adherent and meets the minimum thickness specified. If necessary, remove the protective coating by alkaline cleaning according to PPS 31.05 and re-apply.

5.1.2 Application of Scale Inhibiting Protective Coating

5.1.2.1 For application of scale inhibiting protective coating, apply Turco Pretreat or an alternative product which will serve the same function. Apply Turco Pretreat scale inhibiting protective coating by spray according to paragraph 5.1.2.2. Apply alternative scale inhibiting protective coating according to the manufacturer's instructions.

5.1.2.2 Spray apply Turco Pretreat as follows:

Step 1. Thoroughly mix Turco Pretreat before use.

Step 2. Dilute Turco Pretreat with the solvent specified in PPS 31.17 to the desired viscosity (approximately 30 to 40 seconds measured with a No. 1 Zahn cup).

Step 3. For parts to be heat treated below 1450°F, spray apply to achieve a dry film thickness of 0.0002" to 0.0005". For parts to be heat treated at 1450°F and above, spray apply in two cross coats to achieve a total dry film thickness of 0.0005" to 0.001".

Step 4. Allow the parts to air dry for a minimum of 10 minutes before handling and for at least 24 hours before exposure to heat treat conditions.

Step 5. If required, wrap with protective paper or plastic.

5.1.2.3 The coating need not be removed and re-applied between each stage of a multiple stage heat treatment process. However, inspect the coating and repair if damaged before each stage of the heat treatment process to ensure the integrity of the coating.

5.2 Heat Treatment Handling

5.2.1 Examine and clean heat treatment fixtures before processing parts. Ensure that any areas of the fixtures that come into contact with the parts are free of loose scale, dirt, oil, water, or any materials that are volatile or that may spall at the heat treatment temperature.

5.2.2 Place or hang parts in suitable racks or supports in a manner that allows free circulation of the heating and quenching media and minimizes distortion and warpage during heating and quenching.

5.2.3 Except when using a vacuum furnace, load parts by opening the furnace door, inserting the parts and closing the furnace door as rapidly as possible. When loading and unloading parts, avoid causing nicks or other damage to the surface of finished parts. When loading parts having a heat treatment protective coating, take care to avoid damaging the coating.

5.2.4 Except for vacuum furnaces, before loading, ensure the furnace is operating at the middle of the specified temperature range before loading it. If using a vacuum furnace, loading parts at room temperature is acceptable. Set temperature control instruments at the correct operating temperature.

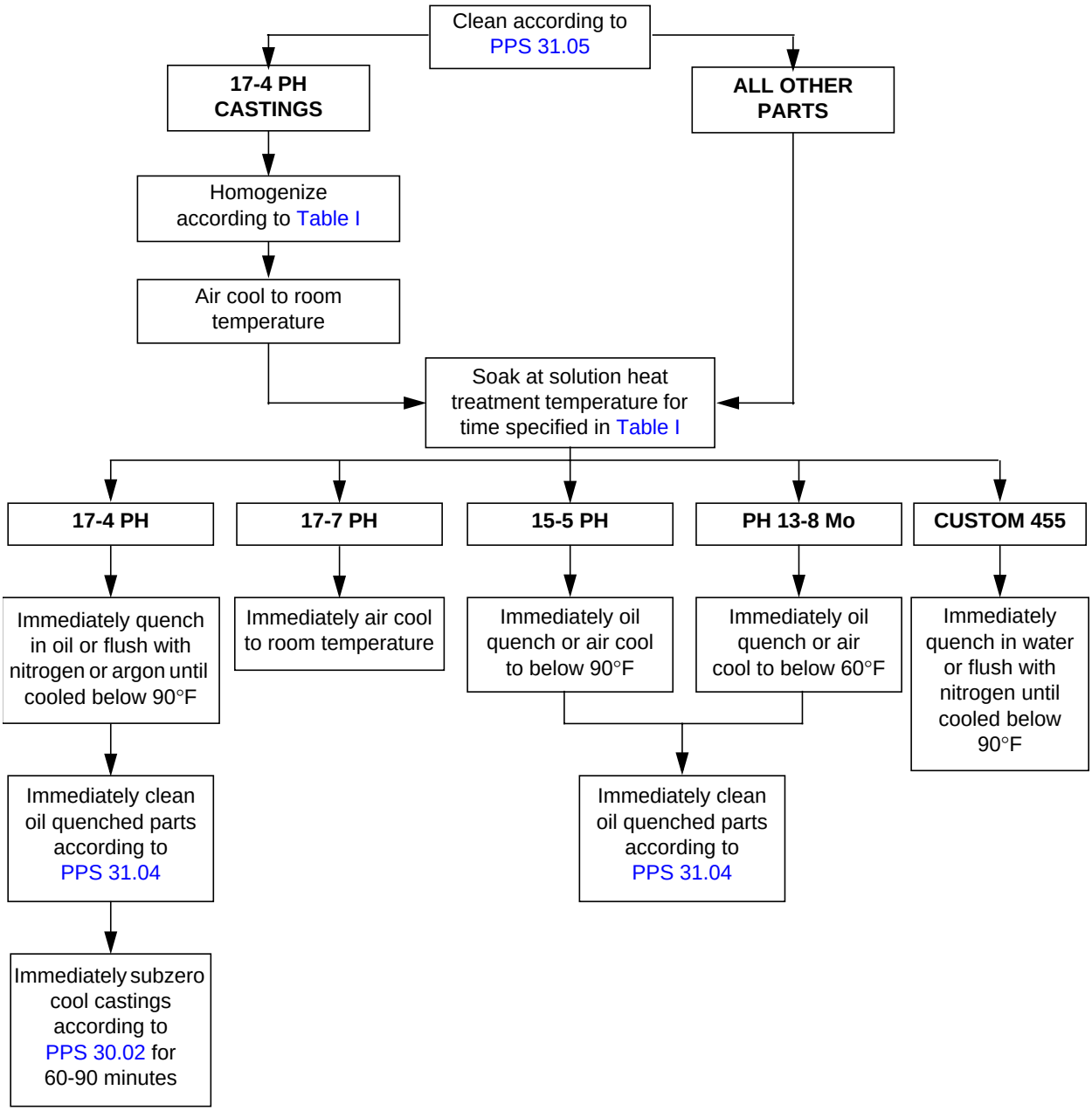
5.3 Heating and Soaking

5.3.1 Soak parts at the required temperature for not less than the specified time. The soaking time commences when, after loading the furnace, the temperature has returned to the middle of the specified range.

5.4 Solution Heat Treatment

5.4.1 If specified on the engineering drawing, perform solution heat treatment according to Flow Chart 1 on any parts not already in the solution heat treated condition and before precipitation hardening.

FLOW CHART 1 - SOLUTION HEAT TREATMENT



5.5 Precipitation Hardening and Austenite Conditioning

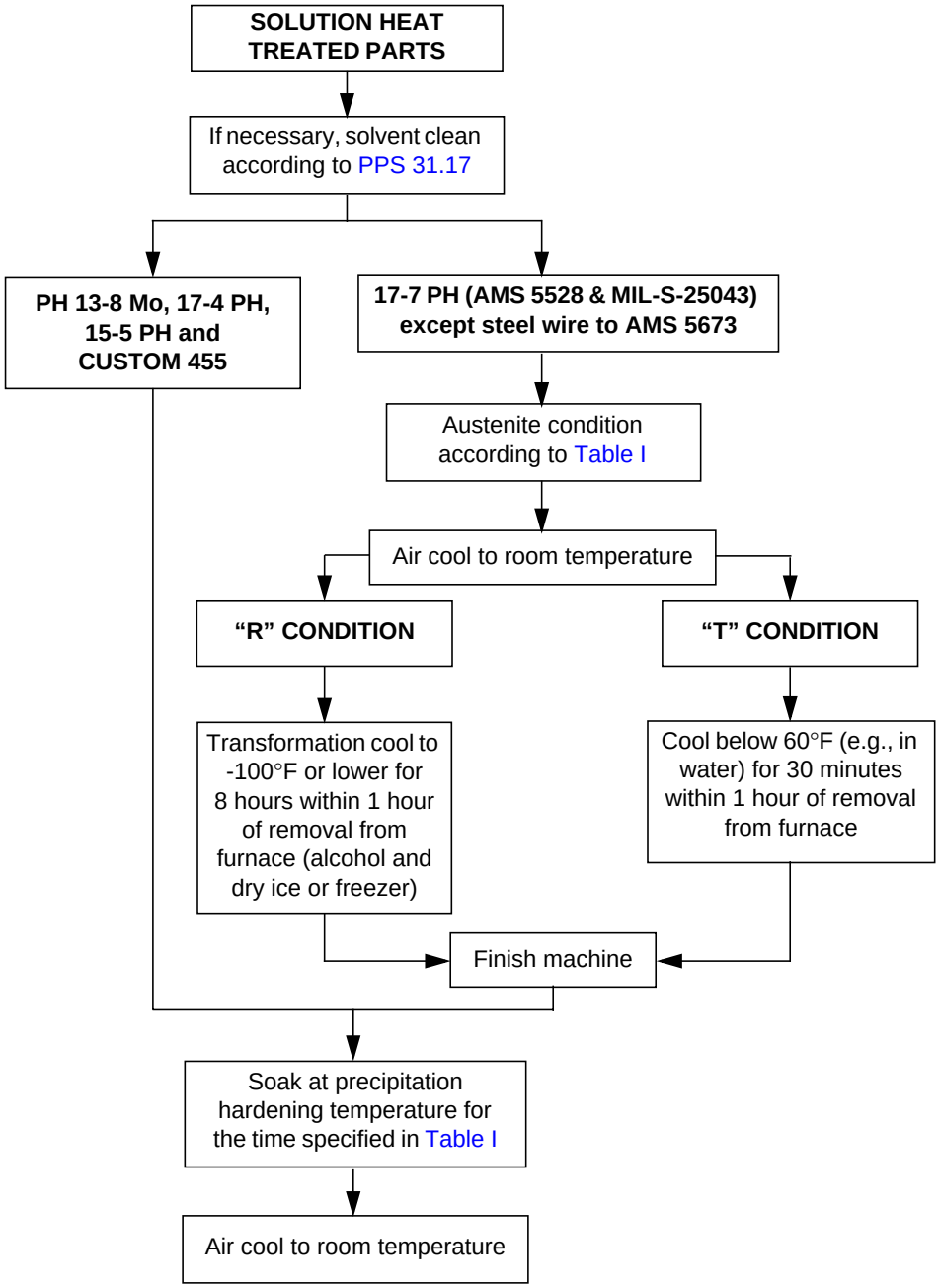
5.5.1 Perform precipitation hardening and austenite conditioning according to Flow Chart 2 for the particular materials and final heat treat temper specified on the engineering drawing.

5.5.2 Parts exceeding the hardness specified in Table II may undergo an additional aging treatment of up to 4 hours at a maximum temperature of 100°F above the aging temperature specified in Table I.

5.5.3 Parts exhibiting hardness less than specified minimums are not acceptable and shall be re-solution heat treated and aged.

5.5.4 If a difference exists between tensile test and hardness test values, use the tensile test values.

FLOW CHART 2 - PRECIPITATION HARDENING



5.6 Stress Relieving

5.6.1 Stress relieve the following parts at 100°F below the precipitation hardening temperature for 2 hours minimum:

- All parts having a final heat treat temper of 180-200 ksi or greater and threaded parts of 160-180 ksi or greater that have been machined, ground or rolled in the final temper condition and that will undergo pickling, plating or passivation. Air cool to room temperature as soon as possible after stress relief.
- Any castings that require stress relief after straightening, as specified in PPS 35.07. Air cool to room temperature after stress relief.

5.6.2 Do not stress relieve parts that have been shot peened or otherwise cold worked for improvement of fatigue resistance.

5.7 Embrittlement Relief

5.7.1 Embrittlement relieve within 4 hours of chemical cleaning, pickling or plating.

5.7.1.1 If parts are to be plated and the post plating embrittlement relief will be completed within 4 hours of pickling, the post pickling embrittlement relief is optional.

5.7.2 Except as noted in paragraph 5.7.2.1, embrittlement relieve at 375 ± 25°F for 3 to 24 hours as required by the cleaning or plating PPS.

5.7.2.1 For parts having tensile strengths over 180 ksi or threaded fasteners having tensile strengths over 160 ksi, embrittlement relieve at 375 ± 25°F for 23 hours minimum.

5.8 Post Heat Treatment

5.8.1 Remove any heat treatment protective coating applied according to section 5.1.2 by cleaning according to PPS 31.05.

5.8.2 Remove heat treat scale and/or discolouration from part surfaces by abrasive blasting according to PPS 17.02. Alternatively, parts may be pickled according to PPS 31.05 provided that the tensile strength does not exceed 180 - 200 ksi.

TABLE I - HEAT TREATMENT OF PH STEELS (NOTE 1)

ALLOY	MATERIAL SPECIFICATION	FORM	HOMOGENIZING (Note 5)	SOLUTION HEAT TREAT	AUSTENITE CONDITIONING	PRECIPITATION HARDENING
PH 13-8 Mo	AMS 5629	BAR, FORGINGS AND EXTRUSIONS	—	1700 ± 25°F (Note 2 & 4)	—	H1000 (205-225 ksi) 1000 ± 10°F for 4-4.5 hours
						H1025 (185-205 ksi) 1025 ± 10°F for 4-4.5 hours
						H1050 (175-195 ksi) 1050 ± 10°F for 4-4.5 hours
						H1100 (150-170 ksi) 1100 ± 10°F for 4-4.5 hours
						H1150 (135-155 ksi) 1150 ± 10°F for 4-4.5 hours
15-5 PH	AMS 5659 AMS 5862	BAR, FORGINGS AND PLATE	—	1900 ± 25°F (Note 2 & 4)	—	H900 (190-210 ksi) 900 ± 10°F for 1-1.25 hour
						H925 (180-200 ksi) 925 ± 10°F for 4-4.5 hours
						H1025 (155-175 ksi) 1025 ± 10°F for 4-4.5 hours
						H1075 (145-165 ksi) 1075 ± 10°F for 4-4.5 hours
						H1100 (140-160 ksi) 1100 ± 10°F for 4-4.5 hours
						H1150 (135-155 ksi) 1150 ± 10°F for 4-4.5 hours
17-4 PH	AMS 5643	BAR	—	1900 ± 25°F (Note 2 & 4)	—	H1025 (155-175 ksi) 1025 ± 10°F for 4-4.5 hours
						H1150 (135-155 ksi) 1150 ± 10°F for 4-4.5 hours
	AMS 5342	INVESTMENT CASTINGS	2100 ± 25°F for 90 minutes			H1100 (130-160 ksi) 1100 ± 10°F for 1.5-2 hours
	AMS 5343					H1000 (150-180 ksi) 1000 ± 10°F for 1.5-2 hours
17-7 PH	AMS 5528 MIL-S-25043	SHEET, STRIP AND PLATE	—	1950 ± 25°F (Note 3 & 4)	"T" 1400 ± 25°F for 1.5 hours	TH1050 (180-200 ksi) 1050 ± 10°F for 1.5-2 hours
					"R" 1750 ± 25°F for 10 minutes (note 6)	RH950 (200-240 ksi) 950 ± 10°F for 1-1.25 hour
	AMS 5678	WIRE		—	—	CH900 (220-240 ksi) 900 ± 10°F for 1-1.25 hour
Custom 455	AMS 5617	BAR	—	1525 ± 25°F for 30 minutes	—	H950 (225-245 ksi) 950 ± 10°F for 4-4.5 hours
						H1000 (200-220 ksi) 1000 ± 10°F for 4-4.5 hours
						H1050 (180-200 ksi) 1050 ± 10°F for 4-4.5 hours

Note 1. Refer to section 5.6 for stress relief data, section 5.7 for embrittlement relief data and Flow Chart 1 and Flow Chart 2 for quenching/cooling data.
Note 2. Soak for 30 minutes per 1/2" of thickness or fraction thereof.
Note 3. Soak for 15 minutes per 1/8" of thickness or fraction thereof.
Note 4. Thickness is the minimum dimension of the heaviest section of the part or the minimum dimension of a multi-layer load, whichever is greater.
Note 5. Homogenizing is a thermal process used to promote uniformity of chemical composition and microstructure in castings.
Note 6. Soak for a minimum of 10 minutes plus one minute for each 0.010 inch of thickness or fraction thereof. The tolerance for the soak time shall be: +10, -0 minutes (e.g., for a 0.100 inch thick part, the soak time shall be 20 - 30 minutes).

TABLE II - MECHANICAL PROPERTIES & HARDNESS REQUIREMENTS

ALLOY (Note 1)	MATERIAL SPEC.	FORM	CONDITION	MAXIMUM UTS (ksi)	MINIMUM 0.2% YIELD STRENGTH (ksi)	MINIMUM % ELONGATION (Note 2)	MINIMUM % REDUCTION IN AREA	ROCKWELL HARDNESS (Note 1)
PH 13-8 Mo	AMS 5629	BAR, FORGINGS AND EXTRUSIONS	Solution heat treated	—				C-39 maximum
			H1000	205-225	190	10.0	50	C-43 - C-48
			H1025	185-205	175	11.0	50	C-41 - C-46
			H1050	175-195	165	12.0	50	C-40 - C-46
			H1100	150-170	135	14.0	50	C-34 - C-42
			H1150	135-155	90	14.0	50	C-30 - C-38
15-5 PH	AMS 5659 AMS 5862	BAR, FORGINGS AND PLATE	Solution heat treated	—				C-38 maximum
			H900	190-210	170	10.0	35	C-40 - C-47
			H925	180-200	155	10.0	38	C-38 - C-45
			H1025	155-175	145	12.0	45	C-34 - C-42
			H1075	145-165	125	13.0	45	C-31 - C-38
			H1100	140-160	115	14.0	45	C-30 - C-37
			H1150	135-155	105	16.0	50	C-28 - C-37
17-4 PH	AMS 5643	BAR	Solution heat treated	—				C-39 maximum
			H1025	155-175	145	12.0	—	C-34 - C-42
			H1150	135-155	105	16.0	—	C-28 - C-37
	AMS 5342	INVESTMENT CASTINGS	H1100	See PPS 35.07				C-30 - C-37
	AMS 5343		H1000					C-36 - C-43
	AMS 5344		H900					C-40 - C-47
17-7 PH	AMS 5528 MIL-S-25043	SHEET, STRIP AND PLATE	Solution heat treated	—				B-92 maximum
			TH1050	180-200	150	6.0	—	C-38 - C-44
			RH950	220-240 (0.0015 - 0.1874" thick)	180	1.0	—	C-42 - C-49
				200-240 (0.1875 - 0.6250" thick)	180	6.0	—	C-42 - C-49
	AMS 5678	WIRE	CH900	220-240	180	1.0	—	C-46 minimum
Custom 455	AMS 5617	BAR	Solution heat treated	—				C-36 maximum
			H950	225-245	205	10.0	40	C-46 - C-49
			H1000	200-220	180	12.0	40	C-44 - C-48
			H1050	180-200	165	14.0	45	C-40 - C-43

Note 1. If an alloy or temper is not listed, refer to PPS 20.08.
Note 2. % elongation in 2 inches, 4D or 4.5A, as applicable.

6 REQUIREMENTS

6.1 Magnetic Particle Inspection

6.1.1 If specified on the engineering drawing, inspect parts and materials according to PPS 20.01.

6.2 Fluorescent Penetrant Inspection

6.2.1 If specified on the engineering drawing, fluorescent penetrant inspect parts and material according to PPS 20.03.

6.3 Hardness Testing

6.3.1 Before machining wrought alloy parts after heat treatment, test the hardness of one or more parts (as necessary) from each solution heat treated or precipitation hardened batch according to section 6.4. If parts are not to be machined after heat treatment, test the hardness of all parts from each solution heat treated or precipitation hardened batch according to section 6.4.

6.3.2 After final heat treatment, test the hardness of one casting from each lot according to section 6.4.

6.4 Hardness Test Procedure

6.4.1 Perform hardness testing according to PPS 20.08. If hardness testing according to PPS 20.08 is not practical due to the size or configuration of the part, samples may be selected for destructive tests based on statistical sampling methods when authorized by a Bombardier Toronto Process Standard Deviation (PSD).

6.4.2 For precipitation hardened bar and rod stock material, cut a test piece, with a length equal to the diameter or minimum thickness of the largest section, from one bar from each furnace load. Test the hardness of the test piece according to PPS 20.08 at the approximate centre of the cut surface.

6.4.3 For precipitation hardened castings, test the hardness on a surface after removing a minimum of 0.010" of material or test the hardness on a sectioned surface of a scrap casting from the same lot and heat treat batch.

6.4.4 Take at least 3 hardness readings on each part being tested.

6.4.5 Minimum and maximum hardness values obtained on any one part shall not differ by more than 4 Rc points, or equivalent, and shall be as specified on the engineering drawing or in Table II.

6.4.6 Refer to Table II for the acceptable Rockwell hardness range for each alloy and condition. If Table II does not list an alloy or temper, refer to PPS 20.08 for the acceptable hardness range.

6.5 Tensile Testing

6.5.1 If the engineering drawing specifies “TENSILE TEST”, test the tensile strength of wrought alloy parts after heat treatment as follows:

Step 1. From each furnace load of parts, inspect two tensile test specimens minimum, cut from the same material batch as the production parts. Test specimen dimensions shall conform to ASTM E8 or the Laboratory Drawings listed in Table III.

TABLE III - TEST SPECIMEN RAW MATERIAL DIMENSIONS

LAB DRAWING	BAR AND PLATE		SHEET AND STRIP	
	Diameter	Length (Note 1)	Width	Length
None (Note 2)	less than 1/4"	2"	—	—
LAB 027-1	1/4"	2"		
LAB 011-7	1/2"	5"		
LAB 011-5	5/8"	5"		
LAB 011-3	3/4"	5-1/2"		
LAB 011-2	7/8"	5-1/2"		
LAB 009-1	1"	7"		
LAB 025-2	—	—	1"	10"

Note 1. Dimensions given are finished part dimensions. Therefore, it will be necessary to increase the length to accommodate chucking.
Note 2. To Laboratory instructions.

Step 2. Submit the inspected test specimens to a Bombardier approved laboratory for testing. The tensile strength specimens shall meet the tensile strength requirements specified in Table II or on the engineering drawing. If only the minimum or maximum UTS value is specified, consider the acceptable range to be 20 ksi above the minimum or below the maximum.

Step 3. Reject the represented parts if the tensile test specimen fails to meet the specified requirements.

6.5.2 Test the tensile strength of castings according to PPS 35.07.

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 additional personnel requirements. Certified and/or qualified personnel shall have a good working knowledge of the following, as applicable:

- be familiar with the engineering drawings, work order instructions and PPS sections regarding the heat treatment of precipitation hardenable stainless steels
- know how to set up and operate steel heat treat furnaces, thermocouples, dew point analyser, quenching equipment, rinsing equipment and hardness testing machines
- know the physical and mechanical properties of corrosion resistant steels
- know the definitions, significance and application of alloying elements, transformation temperature and range, solution heat treatment, precipitation hardening, annealing, homogenizing, normalizing, cold working, stress relieving, austenite conditioning, sub-zero treating, embrittlement relief, cooling and quenching
- know the breakdown and relevance of the AISI designation system and temper codes

9 SPECIAL POINTS TO NOTE

9.1 Dimensional Changes during Heat Treatment

9.1.1 17-7 PH steel shows a net dimensional expansion of approximately 0.004" per inch when heat treated from the solution heat treated condition to the TH1050 or RH900 condition.

9.1.2 Table IV shows the approximate amount of dimensional contraction exhibited by various alloys when heat treated from one temper to various other tempers.

9.2 Heat Treatment Records

9.2.1 Keep records of all heat treat operations, including information regarding Job Card number, part number, material type, furnace or bath, quantity of parts, heating time, soaking time and temperature, cooling time (if furnace cooled) and average Rockwell hardness.

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

9.2.3 Records shall be stamped by the inspector responsible.

TABLE IV - DIMENSIONAL CONTRACTION DURING HEAT TREATMENT

ALLOY	INITIAL TEMPER	TEMPER AFTER HEAT TREATMENT	APPROXIMATE DIMENSIONAL CONTRACTION
PH 13-8 Mo	Solution heat treated	H1000	0.0006"/inch
		H1050	0.00065"/inch
		H1100	0.001"/inch
		H1150	0.003"/inch
15-5 PH		H1025	0.0005"/inch
		H1150	0.0009"/inch
17-4 PH		H1025	0.0005"/inch
		H1150	0.001"/inch
17-7 PH (Note 1)	T (austenite conditioned)	TH1050	0.0005"/inch
	R (austenite conditioned)	RH950	
Custom 455	Solution heat treated	H950	0.0009"/inch
		H1000	0.0012"/inch
		H1050	0.0015"/inch
	Any precipitation hardened condition	Re-solution heat treated	0.0025"/inch

Note 1. It is recommended that finish machining be done in the T or R condition with allowances made for dimensional contraction during final heat treatment.

PART NO: ____________
ISSUE: ____________
NAME: ____________
CONTRACT: ____________

BOMBARDIER Inc.
de Havilland

STEEL HEAT TREATMENT QUALITY CONTROL AND INSPECTION RECORD

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. Y.S. E REPORT #	HARDNESS - METALLO - MISC. -	DATE - ACCEPTED - REJECTED - RE H.T.'D -	
2					A N S/R H/T		T.S. Y.S. E REPORT #	HARDNESS - METALLO - MISC. -	DATE - ACCEPTED - REJECTED - RE H.T.'D -	
3					A N S/R H/T		T.S. Y.S. E REPORT #	HARDNESS - METALLO - MISC. -	DATE - ACCEPTED - REJECTED - RE H.T.'D -	
4					A N S/R H/T		T.S. Y.S. E REPORT #	HARDNESS - METALLO - MISC. -	DATE - ACCEPTED - REJECTED - RE H.T.'D -	
5					A N S/R H/T		T.S. Y.S. E REPORT #	HARDNESS - METALLO - MISC. -	DATE - ACCEPTED - REJECTED - RE H.T.'D -	
6					A N S/R H/T		T.S. Y.S. E REPORT #	HARDNESS - METALLO - MISC. -	DATE - ACCEPTED - REJECTED - RE H.T.'D -	
7					A N S/R H/T		T.S. Y.S. E REPORT #	HARDNESS - METALLO - MISC. -	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

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FIGURE 1 - FORM 3772A SAMPLE

BOMBARDIER INC.
de Havilland
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