BOMBARDIER
Toronto Site
PROPRIETARY INFORMATION

PPS 30.07

PRODUCTION PROCESS STANDARD

HEAT TREATMENT OF BERYLLIUM COPPER ALLOYS

Issue 12
- This standard supersedes PPS 30.07, Issue 11.
- 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 the heat treatment of beryllium copper 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-007 - Quality Control of Heat Treating Equipment and Hot Forming Equipment.

3.2 BAERD GEN-018 - Engineering Requirements for Laboratories.

3.3 PPS 13.26 - General Subcontractor Provisions.

3.4 PPS 13.39 - Bombardier Toronto Engineering Process Manual.

3.5 PPS 15.01 - Part Marking of Aircraft Parts and Assemblies.

3.6 PPS 20.08 - Hardness Testing of Metals.

3.7 PPS 31.06 - Cleaning of Copper and Copper Alloys.

4 EQUIPMENT AND FACILITIES

4.1 Equipment

4.1.1 General

4.1.1.1 Air furnaces and salt baths used for heat treatment shall be equipped with pyrometric control, and chart recorder controlled according to BAERD GEN-007.

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

4.1.2 Heating Equipment

4.1.2.1 Heat treatment shall be carried out in air furnaces or controlled atmosphere furnaces. Air furnaces used for precipitation age hardening shall be of the circulating air type.

4.1.2.2 The design and construction of the heating equipment shall be such that the temperature at any point in the working zone, with any heat treat charge, shall not vary more than ± 25°F from the specified solution heat treating temperature, or not more than ± 10°F from the specified precipitation aging temperature, subsequent to bringing the charge up to temperature.

4.1.2.3 Automatic controlling and recording temperature measuring instruments, preferably of the potentiometric type, shall be used. Thermocouples located in the working zone shall be adequately protected.

4.1.3 Quenching Equipment

4.1.3.1 Quench baths shall be provided and located to facilitate rapid transfer of the material from the furnace to the quench bath.

4.1.3.2 Quenching tanks shall provide adequate circulation of the water which shall not exceed 100°F at any time during use. Tanks shall be of adequate size for the workload involved and shall be equipped with temperature gauges.

4.1.4 Approval of Equipment

4.1.4.1 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.

4.2 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 the heat treatment of beryllium copper alloys 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 the heat treatment of beryllium copper 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.

4.2.3.2 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 Unless otherwise specified, beryllium copper shall be purchased in the solution heat treated condition or the solution heat treated and cold worked condition and subsequently age hardened.

5.1.2 Age harden beryllium copper alloy No. 172 bar and rod (QQ-C-530) parts in the A or H condition which are to be age hardened to the AT or HT condition, before machining.

5.1.3 Identify all parts according to PPS 15.01 before heat treatment.

5.1.4 Clean parts according to PPS 31.06 before heat treatment.

5.2 Heat Treatment Handling

5.2.1 Place or hang parts in suitable supports or racks in such a manner as to allow free circulation of the heating and quenching media and to minimize distortion or warpage during heating and quenching.

5.2.2 Take care during loading and unloading to avoid nicks or other damage to the surfaces of finished parts.

5.2.3 Operate furnaces at the middle of the temperature range before being loaded. Set temperature control instruments at the correct operating temperature.

5.3 Heating and Soaking

5.3.1 Soak parts at the applicable temperature for not less than the specified minimum 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 Treating

5.4.1 Carry out solution heat treatment if specified on the engineering drawing or before precipitation age hardening of any parts which are not in the solution heat treated condition.

5.4.2 Accomplish solution heat treatment by heating the parts according to Table I, followed by rapid quenching in cold water. Transfer parts from the furnace to the quench bath as rapid as possible; the maximum acceptable quench delay is 5 seconds. Ensure that the initial temperature of the quench bath does not exceed 70°F and that parts are agitated during quenching to ensure the maximum rate of cooling.

TABLE I - SOLUTION HEAT TREATMENT

MATERIAL		TEMPER BEFORE SOLUTION HEAT TREATMENT	MATERIAL GAUGE (INCHES)	SOAKING		TEMPER AFTER QUENCHING
FORM	SPECIFICATION			TIME	TEMPERATURE	
Bar & Rod	QQ-C-530 Alloy No. 172	1/4H, 1/2H, H, 1/4HT, 1/2HT, HT, AT	Up to 0.030"	15 minutes minimum	1425°F - 1475°F	A
			0.030" - 0.125"	30 minutes minimum		
Strip	QQ-C-533 Alloy No. 172		Over 0.125"	30 minutes per 1/8" of ruling section minimum (3 hours maximum)		

5.5 Precipitation Age Hardening

5.5.1 Material shall be in the solution heat treated condition (i.e. A, H, 1/4H or 1/2H tempers) before age hardening.

5.5.2 Accomplish precipitation age hardening by heating the parts according to Table II followed by cooling to room temperature in still air.

TABLE II - PRECIPITATION AGE HARDENING

MATERIAL		TEMPER BEFORE AGING	DIAMETER OR THICKNESS	AGING		TEMPER AFTER AGING
FORM	SPECIFICATION			TIME	TEMPERATURE	
Bar & Rod	QQ-C-530 Alloy No. 172	A	All	3 hours minimum	600°F - 625°F	AT
		H	Up to 0.75"	2 hours minimum		HT
			Over 0.75"	3 hours minimum		
Strip	QQ-C-533 Alloy No. 172	A	All	3 hours minimum		AT
		1/4H		2 hours minimum		1/4HT
		1/2H		2 hours minimum		1/2HT
		H		2 hours minimum		HT

5.6 Post Heat Treatment Cleaning

5.6.1 If necessary, remove oxide film formed during solution heat treatment by treating the parts with Bright Dip according to PPS 31.06. Take care not to leave the parts in the Bright Dip solution longer than necessary to clean the surface, as severe corrosion and pitting may result.

6 REQUIREMENTS

6.1 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.

6.2 All testing and evaluation specified herein shall only be performed by Bombardier Toronto Materials Laboratory or by laboratories accredited according to BAERD GEN-018.

6.3 After age hardening, select a random sample of parts from each furnace load according to Table III for hardness testing as follows.

6.3.1 Carry out hardness testing according to PPS 20.08.

6.3.2 Take a minimum of 3 hardness readings on each part to be tested.

6.3.3 The minimum and maximum hardness values obtained on any one part shall not differ more than 3 Rockwell C points, or equivalent. All hardness values shall be within the range specified in Table IV for the particular alloy, heat treat condition and tensile strength range specified on the engineering drawing. If an alloy or temper is not specified in Table IV, refer to PPS 20.08 for the required hardness value.

6.3.4 Consider parts which fail to meet the specified hardness requirements, at one or more points of measurement, as non-conforming. When the number of non-conforming parts exceeds the acceptance number for that sample, as specified in Table III, refer the lot represented by the sample to MRB for disposition.

6.3.5 Except for parts in the 1/4 HT, 1/2 HT or HT condition, re-solution heat treat non-conforming parts before repeating precipitation age hardening. Do not re-solution heat treat non-conforming parts in the 1/4 HT, 1/2 HT or HT conditions without Bombardier engineering approval.

TABLE III - SAMPLING SCHEDULE

NUMBER OF ITEMS IN INSPECTION LOT	**NUMBER OF ITEMS IN SAMPLE** (selected at random)	**ACCEPTANCE NUMBER (NOTE 1)**
1 - 5	All	0
6 - 25	5	0
26 - 50	8	0
51 - 90	13	0
91 - 150	20	1
151 - 280	32	1
281 - 500	50	2
501 - 1200	80	3

Note 1. Any non-conforming parts within the permitted number of defectives shall not be accepted with the lot but shall be referred to MRB for disposition.

TABLE IV - HARDNESS TEST REQUIREMENTS

MATERIAL		**FINISH TEMPER**	**MATERIAL GAUGE**	**TENSILE STRENGTH (KSI)** (Note 1)	**ROCKWELL HARDNESS**		**VICKERS HARDNESS (10 KG)**
FORM	**SPECIFICATION**				**C SCALE**	**30N SCALE**	
Bar & rod	QQ-C-530 Alloy No. 172	AT	All	165 - 190	36 - 40	--	350 - 412
		HT	0.020" - 0.375"	185 - 215	39 - 45	--	380 - 435
			0.376" - 1.000"	180 - 210	38 - 44	--	375 - 430
			Over 1.000"	175 - 205	37 - 43	--	365 - 427
Strip	QQ-C-533 Alloy No. 172	AT	All	165 - 190	36 minimum	56 minimum	350 minimum
		1/4T		175 - 200	38 minimum	58 minimum	365 minimum
		1/2T		185 - 210	39 minimum	59 minimum	380 minimum
		HT		190 - 215	40 minimum	60 minimum	385 minimum

Note 1. As specified on the engineering drawing.

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 HEAT TREATMENT RECORDS

9.1 Records shall be maintained of all heat treat operations, including information such as Job Card number, part number, material specification, furnace or bath, quantity of parts, heating time, soaking time and temperature and average Rockwell hardness.

10 SPECIAL POINTS TO NOTE

10.1 Parts to be silver brazed shall be in the solution heat treated condition (A or H) before brazing. Brazed parts shall be age hardened when specified on the engineering drawing, but shall not be subjected to further solution heat treatment.