BOMBARDIER
Toronto (de Havilland)
PROPRIETARY INFORMATION

PPS 1.38

PRODUCTION PROCESS STANDARD

Hot Straightening of Aluminum Alloy

Issue 7
- This standard supersedes PPS 1.38, Issue 6.
- Vertical lines in the left hand margin indicate technical changes over the previous issue.
- Direct PPS related questions to PPS.Group@aero.bombardier.com or (416) 375-4365.
- 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 hot straightening of aluminum alloys. This procedure may only be used when authorized by Bombardier Toronto (de Havilland) approved MRB.

1.1.1 This PPS complements the engineering drawings that specify its use as an authorized instruction. The procedure specified in this PPS must 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.

2 Hazardous Materials

2.1 Before receipt at Bombardier Toronto (de Havilland), all materials must be approved and assigned Material Safety Data Sheet (MSDS) numbers by the Bombardier Toronto (de Havilland) 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 (de Havilland) Environment, Health and Safety Department.

3 References

3.1 PPS 13.26 - General Subcontractor Provisions.

3.2 PPS 20.03 - Fluorescent Penetrant Inspection.

3.3 PPS 20.07 - Electrical Conductivity Testing of Aluminum Alloys.

3.4 PPS 20.08 - Hardness Testing of Metals.

3.5 PPS 31.04 - Degreasing Processes.

3.6 PPS 31.17 - Solvent Usage.

4 Materials and Equipment

4.1 Materials

4.1.1 No special materials required.

4.2 Equipment

4.2.1 Tempilstiks or Tempilaq (assorted temperatures from 200°F to 325°F (93°C to 163°C), as required).

4.2.2 Surface pyrometer capable of continuously monitoring part temperatures during heating and hot straightening operations.

4.2.3 Suitable heating ovens, heated oil bath, heating dies or heating blanket capable of maintaining the required straightening temperature as specified in Table 1.

5 Procedure

5.1 If authorized by Bombardier Toronto (de Havilland), aluminum alloy parts which have become distorted during machining, heat treatment or handling may be re-worked by hot straightening according to this PPS.

5.2 Before production parts are straightened, process a test sample of the same material having the same section size and condition as the production parts at the maximum temperature and time specified in Table 1 according to the procedure specified in paragraph 5.3. Before and after processing, subject the test sample to electrical conductivity testing according to PPS 20.07 and hardness testing according to PPS 20.08. If the test sample passes both electrical conductivity and hardness testing, it is acceptable to process production parts. If the test sample does not pass both electrical conductivity and hardness testing, refer to Liaison Engineering for disposition.

5.3 Hot straighten parts as follows:

Step 1. If the part is contaminated with oil or grease, degrease according to PPS 31.04 or solvent clean according to PPS 31.17.

Step 2. Using a heating oven, oil bath, heating dies or heating blankets, heat the part to the hot straightening temperature specified in Table 1. During the heating and hot straightening operations, maintain a continuous check on the part temperature using Tempilstiks, Tempilaq or a surface pyrometer. Forming parts below the minimum temperature will result in reduced ductility at the bend area, promote strain hardening and possible cracking and is not acceptable. Heating parts above the maximum temperature specified in Table 1 or holding at temperature longer than the maximum time allowed will decrease the tensile strength of the material and is not acceptable.

Step 3. Allow the part to soak at the hot straightening temperature long enough to ensure temperature uniformity throughout the area to be straightened. Ensure that the maximum temperature and soak time are not exceeded. The total time at the hot straightening temperature includes all time at which the part is above the minimum hot straightening temperature and applies to the time of one continuous heating operation or the cumulative time of several heating operations.

Step 4. Apply stress to the area to be straightened in a manner that distributes the force evenly over the entire area. Stop straightening immediately if the part temperature drops below the minimum hot straightening temperature.

Step 5. If necessary, provided that the maximum time at the hot straightening temperature has not been exceeded, it is acceptable to repeat Step 2 through Step 4, until the part has been successfully straightened.

Step 6. Degrease parts heated in an oil bath according to PPS 31.04 or solvent clean according to PPS 31.17.

Step 7. Subject all parts to electrical conductivity testing according to PPS 20.07.

Step 8. Subject machined parts to fluorescent penetrant inspection according to PPS 20.03.

Table 1 - Temperature and Dwell Time Limits

MATERIAL	CONDITION (Note 3)	MAXIMUM CUMULATIVE TIME ABOVE 200°F (93°C)	HOT STRAIGHTENING TEMPERATURE	MAXIMUM CUMULATIVE TIME AT HOT STRAIGHTENING TEMPERATURE
2024	-T3 (Note 1)	n/a	275°F - 325°F (135°C - 163°C)	60 minutes
	-T4 (Note 1)	n/a	275°F - 325°F (135°C - 163°C)	60 minutes
7050	-T7	8 hours	275°F - 325°F (135°C - 163°C)	60 minutes
7075	-T6	8 hours	250°F - 300°F (121°C - 149°C)	60 minutes
	-T7	8 hours	275°F - 325°F (135°C - 163°C)	60 minutes
7150	-T7	8 hours	250°F - 300°F (121°C - 149°C)	See Note 2
7475	-T7	8 hours	275°F - 325°F (135°C - 163°C)	60 minutes

Note 1. 2024 alloy may be hot straightened in the -T3 or -T4 temper provided that the final temper required is -T8 or -T6, respectively, and artificial aging follows hot straightening.

Note 2. For 7150 alloy, the cumulative time between 250°F (121°C) and 300°F (149°C) must not exceed 60 minutes **and** the cumulative time above 275°F (135°C) must not exceed 5 minutes.

Note 3. For aluminum alloys having temper designations with two, three, four or five digits not shown in this table, the same conditions apply as for the basic temper with the same first digit.

6 Requirements

6.1 Before hot straightening of production parts, a test sample of the same material having the same section size and condition as the production parts must be processed at the maximum temperature and time specified in Table 1 according to the procedure specified in paragraph 5.3. Before and after processing, the test sample must meet the electrical conductivity requirements specified in PPS 20.07 and hardness requirements specified in PPS 20.08.

6.2 After final hot straightening, only those production parts which meet the straightness requirements specified on the engineering drawing and the electrical conductivity requirements specified in PPS 20.07 are acceptable. In addition, machined parts must also be fluorescent penetrant inspected according to PPS 20.03 for evidence of cracks.

7 Safety Precautions

7.1 Observe general shop safety precautions when performing the procedure specified herein.

8 Personnel Requirements

8.1 Personnel must have a good working knowledge of the applicable procedure and requirements as specified herein and must have exhibited their competency to their supervisor.