BOMBARDIER
Toronto (de Havilland)
PROPRIETARY INFORMATION

PPS 6.24

PRODUCTION PROCESS STANDARD

Autofrettage

Issue 5
- This standard supersedes PPS 6.24, Issue 4.
- 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 autofrettage, a single pressurization cycle used to reduce tube bend flatness and improve fatigue life on titanium (Ti-3Al-2.5V CWSR) and CRES (304 1/8 hard) hydraulic tubes when specified by the engineering drawing or authorized by Liaison engineering.

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 6.01 - Fabrication of Rigid Fluid Lines.

3.2 PPS 6.05 - Closure of Fluid Lines and Fluid System Components.

3.3 PPS 6.10 - Cleaning of Fluid System Components.

3.4 PPS 13.26 - General Subcontractor Provisions.

3.5 PPS 31.04 - Degreasing Processes.

4 Materials and Equipment

4.1 Materials

4.1.1 De-ionized water, as a pressurization medium.

4.2 Equipment

4.2.1 Pressurization rig and auxiliary equipment, utilizing de-ionized water, capable of achieving and maintaining a pressure of 12,000 psi.

5 Procedure

5.1 General

5.1.1 For the purposes of this PPS, autofrettage consists of a **single** high pressurization cycle used to reduce tube bend flatness and improve fatigue life. Autofrettage may only be performed on any particular tube **once**.

5.2 Preparation of Parts

5.2.1 Ensure that the interiors of all parts to be subjected to autofrettage are free from contamination and foreign matter. If necessary, degrease parts according to PPS 31.04 before autofrettage. Take care to ensure that hydraulic fluid lines and hydraulic system components used with MIL-H-5606 hydraulic fluid do not come into contact with solvent blends containing isopropyl alcohol, also known as isopropanol and 2-propanol. Hydraulic fluid lines and hydraulic system components used with MIL-H-5606 hydraulic fluid which have been contaminated with solvent blends containing isopropyl alcohol must be cleaned according to PPS 6.10

5.3 .Autofrettage

5.3.1 Perform autofrettage as follows:

Step 1. Attach the tube end to a pressure source and cap the other end. If the tube has flared connectors or dynamic-beam fittings attached by internal swaging, leave the connectors attached. If the connectors are externally swaged, autofrettage must be performed before installation of the connectors.

Step 2. Apply pressure at a rate of approximately 20,000 psi/minute until the autofrettage pressure specified in Table 1 is reached.

Step 3. Maintain the autofrettage pressure for 30 to 60 seconds.

Step 4. Release the pressure and remove the tube.

Step 5. Inspect tubes for flatness according to PPS 6.01 and for contour according to the engineering drawing.

Table 1 - Autofrettage Pressures

TUBE MATERIAL	NOMINAL TUBE DIAMETER	NOMINAL TUBE WALL THICKNESS	AUTOFRETTAGE PRESSURE
CRES 304 1/8 hard (MIL-T-6845)	3/16"	0.020"	12,000 psi
	1/4"		
	5/16"		
	3/8"	0.022"	
	1/2"	0.028"	
	5/16"	0.035"	
	3/4"	0.042"	
	1"	0.058"	
Ti-3Al-2.5V CWSR (AMS 4945)	1/4"	0.016"	
	3/8"	0.019"	
	1/2"	0.026"	
	5/16"	0.032"	
	3/4"	0.039"	
	1"	0.051"	
	1 1/4"	0.065"	

5.4 Post Autofrettage Procedure

5.4.1 After performing autofrettage, process tubes as follows:

Step 1. Thoroughly drain the tube.

Step 2. Blow through with clean, dry oil-free air.

Step 3. Dry tubes thoroughly.

Step 4. Cap tubes according to PPS 6.05.

Step 5. Handle and store the tubes carefully to preserve their shape (i.e., to prevent additional bending).

6 Requirements

6.1 The rate of pressure rise for autofrettage of tubes must not exceed 20,000 psi/minute.

6.2 On completion of post autofrettage draining, all tubes shall be capped according to PPS 6.05.

6.3 Autofrettage shall not be performed more than once on the same tube.

6.4 Refer to PPS 6.01 for the tube bend flatness limits.

7 Safety Precautions

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

8 Personnel Requirements

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

9 Maintenance of Equipment

9.1 When pressurization rigs are not in use, cap or plug open ports and lines according to PPS 6.05.