BOMBARDIER
Toronto Site
PROPRIETARY INFORMATION

PPS 6.12

PRODUCTION PROCESS STANDARD

PRESSURE TESTING HYDRAULIC COMPONENTS FUEL AND BLEED AIR LINES

Issue 17
- This standard supersedes PPS 6.12, Issue 16.
- Vertical lines in the left hand margin indicate technical changes over the previous issue.
- Direct PPS 6.12 related questions to michael.wright@aero.bombardier.com.
- 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 pressure testing hydraulic fluid line assemblies and components, high and low pressure fuel and bleed air lines as well as Permaswage tooling certification test assemblies.

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.

1.2 Refer to PPS 6.24 for the procedure and requirements for autofrettage of tubing.

2 Hazardous Materials

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

3 References

3.1 General

3.1.1 Unless a specific issue is indicated, the issue of the reference documents specified in this section in effect at the time of manufacture shall form a part of this specification to the extent indicated herein.

3.2 Bombardier (Toronto Site) Specifications

3.2.1 PPS 2.27 - Installation of Lee Plugs and Jets.

3.2.2 PPS 6.03 - Installation of Fluid Lines and Fittings.

3.2.3 PPS 6.04 - Identification of Fluid System Lines.

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

3.2.5 PPS 6.10 - Cleaning of Fluid System Components.

3.2.6 PPS 6.18 - Certification of Permaswage Tooling.

3.2.7 PPS 6.24 - Autofrettage.

3.2.8 PPS 13.26 - General Subcontractor Provisions.

3.2.9 PPS 15.01 - Part Marking.

3.2.10 PPS 15.06 - Electrochemical Etch Marking of Aircraft Parts and Assemblies.

3.2.11 PPS 31.04 - Degreasing Processes.

3.2.12 PPS 31.17 - Solvent Usage.

3.3 Boeing Material Specifications

3.3.1 BMS 3-11 – Hydraulic Fluid, Fire Resistant.

3.4 Government Specifications

3.4.1 MIL-H-5606 - Hydraulic Fluid, Petroleum Base; Aircraft, Missile, and Ordnance.

4 Materials and Equipment

4.1 Materials

4.1.1 Unless otherwise specified in this section, use only the materials specified; use of superseding or alternative materials is not allowed.

4.1.2 Pressure test media:

- Distilled or de-ionized water (5 - 7 pH and maximum 12 ppm or 20 µS/cm contamination)
- Synthetic phosphate ester base hydraulic fluid to BMS 3-11 Type IV, Class 1, Grade A
- Petroleum base hydraulic fluid to MIL-H-5606.

4.1.2.1 Refer to Table 1 for pressure test media to use for the particular type of part to be pressure tested.

4.1.3 Thread and gasket lubricant, phosphate ester compatible (e.g., MCS352 or Hi-Lo MS #1).

4.1.4 Polyethylene bags or sheet and suitable tape.

4.1.5 Protective rubber gloves (e.g., DSC 422-2).

4.2 Equipment

4.2.1 Hydraulic pressure test bench and auxiliary equipment using phosphate ester base hydraulic fluid. Test rigs using phosphate ester hydraulic fluid must be identified with a broad purple band painted on basic (impervious finish) white.

4.2.2 Hydraulic pressure test bench and auxiliary equipment using petroleum base hydraulic fluid.

4.2.3 Pressure test bench and auxiliary equipment using water, capable of achieving and maintaining a minimum pressure of 6,500 psi. Note that this requirement is for equipment capability only; carry out pressure testing according to section 5.2 at the pressure specified in Table 1.

5 Procedure

5.1 General

5.1.1 In order to prevent contamination of the aircraft hydraulic system with an incompatible type of fluid, it is essential that all fluid lines and fittings are thoroughly cleaned and flushed as specified herein after pressure testing.

5.1.2 Pressure testing of components, fluid lines and fittings according to this PPS consists of proof pressure testing individual parts or assemblies to ensure that the maximum design service pressure of each system is met or exceeded without leakage or failure.

5.1.3 The proof pressure to be applied to individual lines, components or fittings is specified by the engineering drawing, Acceptance Test Procedure (ATP) or PPS.

5.1.4 Ensure that the interiors of all parts to be pressure tested are free from contamination and foreign matter. If necessary, degrease parts according to PPS 31.04 before pressure testing.

5.2 Pressure Testing

5.2.1 If specifically allowed by notation on the engineering drawing, bleed air lines may be partially filled with water before pressure testing (some bleed air line assemblies contain lap joints or have the potential for trapping water).

5.2.2 Connect tubes to the pressure test rig by **tightening** the coupling nuts or fittings. Utilize the appropriate pressure test rig as specified in section 4.2 for the test media being used (e.g., when using water as the pressure testing media, utilize a pressure test rig as specified in para. 4.2.3).

5.2.3 Except as noted below, the rate of pressure rise for testing fluid line assemblies and components must not exceed 60,000 psi/minute (1,000 psi/second). Unless shop fittings are used for testing purposes in place of the fluid line fittings specified by the engineering drawing, when pressure testing Learjet Model 45 bleed air lines the rate of pressure rise must not exceed 300 psi/minute (5 psi/second).

5.2.4 Pressure test components and assemblies to the pressure specified on the engineering drawing, ATP or PPS. Refer to Table 1 for pressure test details for the particular type of part to be pressure tested.

Table 1. Pressure Test Details

Part or Assembly Description	Test Pressure	Maintain Pressure	Test Media
Hydraulic Components (Note 1)	As specified by the Engineering Drawing	5 minutes minimum	Phosphate ester based hydraulic fluid
Hydraulic Fluid Lines (rigid and flexible)	As specified by the Engineering Drawing	1 minute minimum	Water or petroleum based hydraulic fluid
Learjet Model 45 Welded Titanium Hydraulic Lines	6,000 psi	1 - 2 minutes	Water or petroleum based hydraulic fluid
Learjet Model 45 Bleed Air Lines	As specified by the Engineering Drawing	1 minute minimum	Air or water/air (Note 2)
High Pressure Fuel Lines	As specified by the Engineering Drawing	1 minute minimum	Water or petroleum based hydraulic fluid
Low Pressure Fuel Lines	As specified by the Engineering Drawing	1 minute minimum	Air
Fluid Line Fittings with Lee Jet Inserts (Note 3)	3,000 psi	2 minutes minimum	Water or petroleum based hydraulic fluid (Note 4)
Fuel Line Shrouds	35 psi	1 minute minimum	Air
Permaswage Tooling Certification Test Assemblies	As specified in Table 2	1 minute minimum	Water or petroleum based hydraulic fluid

Note 1. Hydraulic components include multi-part assemblies such as actuators as opposed to fluid line assemblies consisting of flared tubes and coupling nuts.

Note 2. To reduce test volumes, if specifically allowed by the engineering drawing it may be acceptable to partially fill bleed air ducts with water before testing.

Note 3. Apply flow pressure to the fitting from the opposite end to which the insert was installed (i.e. so that the pressure tends to push the insert out of the fitting), see Figure 1.

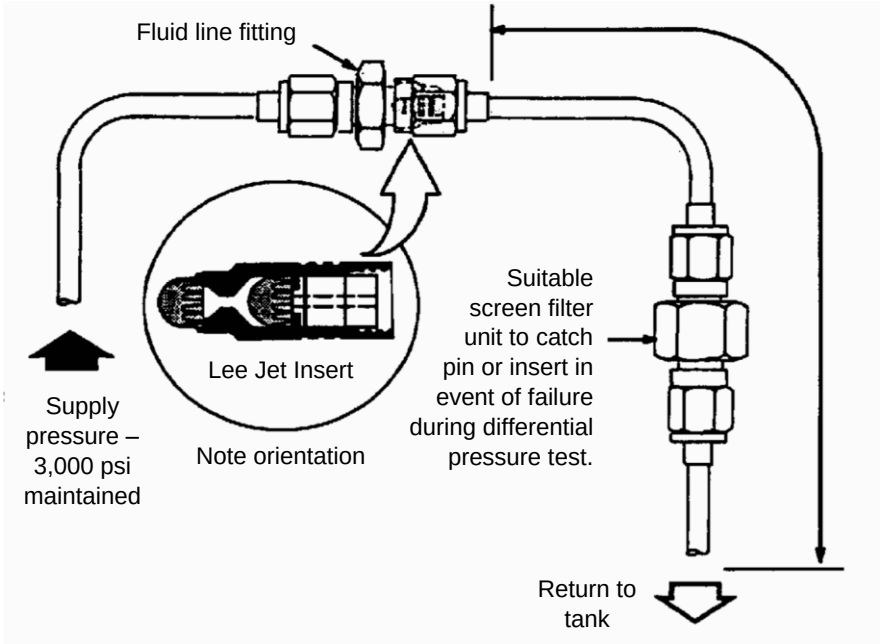

Figure 1. Pressure Testing Lee Jet Inserts in Fluid Line Fittings

5.2.5 Pressure test Permaswage tooling certification test assemblies as follows.

Step 1. Pressure test according to Table 1 to the initial pressure specified in Table 2. During the pressure test, carefully visually check the Permaswage fitting for leakage from behind a safety cover.

Step 2. Reduce the line pressure to zero and visually check the Permaswage fitting for evidence of leaks. Visually ensure that the Permaswage fitting and tubing are free of deformation caused by pressure testing.

Step 3. Proof pressure test according to Table 1 to the proof pressure specified in Table 2. Permaswage fitting leaks during the proof pressure test are not considered failure.

Step 4. Visually ensure that the Permaswage fitting and tubing are free of deformation caused by pressure testing.

5.2.6 If the fittings or coupling nuts leak during pressure testing, **torque** according to PPS 6.03 (including leak proof torquing, if necessary) and re-pressure test according to Table 1. For AN818 and NAS593 tube coupling nuts, torque to the value specified by the engineering drawing. If the engineering drawing does not specify a torque value, torque to the value specified in Table 3.

Table 2. Permaswage Tooling Certification Pressure Test Data

Tube			Pressure Test	
Material	**Size**	**Wall Thickness**	**Initial**	**Proof**
Aluminum 6061	-06 (3/8")	0.028"	1300 psi	1950 psi
	-08 (1/2")	0.035"	1300 psi	1950 psi
	-10 (5/8")	0.028"	50 psi	75 psi
	-12 (3/4")	0.028"	100 psi	150 psi
	-16 (1")	0.028"	10 psi	15 psi
21-6-9 CRES	-03 (3/16")	0.030"	1800 psi	2700 psi
	-04 (1/4")	0.032"		
304 1/8 HD CRES	-04 (1/4")	0.020"	3000 psi	4500 psi
	-06 (3/8")	0.020"		
		0.028"		
	-08 (1/2")	0.035"		
Titanium Ti-3Al-2.5V	-04 (1/4")	0.016"	4500 psi	6000 psi
	-06 (3/8")	0.019"		
	-08 (1/2")	0.026"		
	-10 (5/8")	0.032"		
	-12 (3/4")	0.039"		
	-16 (1")	0.051"		

Note 1. For tube material/size/wall thickness combinations other than those specified herein, refer to Liaison Engineering for the initial and proof pressure test values.

Table 3. Torquing Flared Nuts and Hose Assemblies

Tube Size	Torque Value (In-Lbs)	
	Aluminum Alloy Tube (Notes 1 & 2)	**Steel Alloy, Cres Or Titanium Tube** (Note 1)
1/8"	20 - 30	75 - 85
3/16"	25 - 35 (15 - 35)	95 - 105
1/4"	50 - 65 (20 - 65)	135 - 150
5/16"	70 - 90 (30 - 90)	170 - 200
3/8"	110 - 130 (35 - 130)	270 - 300
1/2"	230 - 260	450 - 500
5/8"	330 - 360	650 - 700
3/4"	460 - 500	900 - 1000
1"	500 - 700	1200 - 1400
1 1/4"	800 - 900	1520 - 1680
1 1/2"	800 - 900	1900 - 2100
2"	1800 - 2000	2660 - 2940

Note 1. If the hose fitting material and the tube material are different, use the torque limits for aluminum alloy tubes.

Note 2. Torque values in brackets apply to 5052-O aluminum tubing with a wall thickness of 0.022".

5.3 Post Pressure Test Processing

5.3.1 After pressure testing, process **components** as follows. Process fluid lines and fittings according to paragraph 5.3.2.

Step 1. Thoroughly drain the component.

Step 2. Solvent clean the component according to PPS 31.17. If specified on the engineering drawing or ATP, flush components with the solvent specified in PPS 31.17. 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 (IPA), 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.

Step 3. If specified on the engineering drawing or ATP, apply phosphate ester compatible lubricant to male threads of fluid line fittings and internal areas of components which are outside the fluid zone.

Step 4. Unless installation is to follow immediately in the same work area, cap all components according to PPS 6.05.

Step 5. Identify the components according to section 5.4.

Step 6. If components are to be returned to Stores, protect by wrapping or bagging in polyethylene closed with suitable tape.

5.3.2 After pressure testing, process **fluid lines** and **fittings** as follows. Process components according to paragraph 5.3.1.

Step 1. Clean fluid lines and fittings according to PPS 6.10.

Step 2. Cap fluid lines and fittings according to PPS 6.05. Do not handle fluid lines by their fittings. Ensure that the protective caps are not loosened or removed until that particular end is being fitted to an assembly.

Step 3. Identify and part mark fluid lines according to section 5.4.

Step 4. Handle and store fluid line tubes carefully to preserve their shape (i.e., to prevent bending). Store similarly shaped lines together.

5.4 Identification and Part Marking

5.4.1 On completion of successful pressure testing, ink stamp “PRESSURE TESTED” on each line or component or, if the line or fitting is too small, on the tag bearing the part number.

5.4.2 Part mark fluid system lines according to PPS 15.01.

5.4.3 Except for Learjet Model 45 bleed air piccolo tubes, part mark welded titanium lines and titanium bleed air lines according to PPS 15.06. Identify Learjet Model 45 bleed air piccolo tubes with an intermediate part mark ink stamped according to PPS 15.01.

5.4.4 Identify fluid system lines with function, direction of flow and high pressure warnings according to PPS 6.04.

6 Requirements

6.1 Fluid lines, components or fittings to be pressure tested according to this standard shall be tested to the pressures specified on the engineering drawing, ATP or PPS.

6.2 Except for Learjet Model 45 bleed air lines, the rate of pressure rise for testing fluid line assemblies and components must not exceed 60,000 psi/minute (1,000 psi/second). For Learjet Model 45 bleed air lines the rate of pressure rise must not exceed 300 psi/minute (5 psi/second) unless shop fittings are used for testing purposes in place of the fluid line fittings specified by the engineering drawing.

6.3 Fluid lines, components or **leak-proof torqued** fittings/coupling nuts which leak or deform during testing are not acceptable.

6.4 After pressure testing, visually check fluid line fittings incorporating Lee Jet restrictors as specified in PPS 2.27 to verify that the jet and locking pin have remained seated during the pressure differential flow test.

6.5 After pressure testing, all successfully tested assemblies shall be identified according to section 5.4.

6.6 On completion of post-test draining and cleaning, all lines and components shall be capped according to PPS 6.05.

6.7 For Permaswage tooling certification test assemblies which show evidence of leaks during or immediately after initial pressure testing or which show evidence of deformation of the tubing or fitting after either initial or proof pressure testing, the associated Permaswage tooling will be considered to have failed certification testing.

7 Safety Precautions

7.1 **The safety precautions specified herein are specific to Bombardier (Toronto Site) to meet Canadian Federal and Provincial government environmental, health and safety regulations. It is recommended that other facilities consider these safety precautions; however, suppliers, subcontractors and partners are responsible for ensuring that their own environmental, health and safety precautions satisfy the appropriate local government regulations.**

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

7.3 **Do not smoke in any areas where hydraulic fluid pressure testing is being carried out.**

7.4 **When working with hydraulic fluid, wear protective rubber gloves. If skin irritation occurs, wash the affected areas thoroughly with soap and water. If irritation persists, report to the Health Centre.**

7.5 **Bombardier Toronto (de Havilland) approved safety glasses shall be worn at all times when working with hydraulic fluid. Eye contact with hydraulic fluid will cause severe irritation. If eye contact has occurred, flush eyes thoroughly with large amounts of water at an eye wash station (15 minutes minimum) and report to the Health Centre immediately.**

7.6 **Wash hands thoroughly with soap and water before eating or smoking. If ingestion of hydraulic fluid has occurred, do not induce vomiting. Contact the Health Centre immediately.**

7.7 **Use clear 3/8" minimum thickness Plexiglas safety shields when pressure testing assemblies.**

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.

9 Maintenance of Equipment

9.1 Ensure that all test rigs involved in the pressure testing of aircraft hydraulic parts and assemblies are regularly serviced and maintained as recommended by the manufacturer.

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