**BOMBARDIER**
Toronto (de Havilland)
PROPRIETARY INFORMATION

# PPS 12.04

## PRODUCTION PROCESS STANDARD

# Installation of Interference Fit Bearings and Bushings using Liquid Nitrogen

Issue 12
- This standard supersedes PPS 12.04, Issue 11.
- Vertical lines in the left hand margin indicate technical changes over the previous issue.
- This PPS is effective as of the distribution date.
- Validation of issue status is the responsibility of the user.

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**Issue 12 - Summary of Changes** (over the previous issue)

The following summaries are not detailed and are intended only to assist in alerting PPS users to changes which may affect them; refer to the applicable section(s) of this PPS for detailed procedure and requirements.

- Revised/clarified para. 5.4.4 with regard to the procedure to be followed if the bore of a bushing is found to be undersized after installation.

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**Scope**

1.1 This Production Process Standard (PPS) specifies the procedure and requirements for installation of interference fit bearings and bushings using liquid nitrogen.

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 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 (de Havilland) Process Specifications

3.2.1 PPS 1.16 - Roller Burnishing.

3.2.2 PPS 13.26 - General Subcontractor Provisions.

3.2.3 PPS 13.39 - Bombardier Toronto Engineering Process Manual.

3.2.4 PPS 31.17 - Solvent Usage.

3.2.5 PPS 34.08 - Application of Epoxy-Polyamide Primer (F19 & F45).

## 4 Materials, Equipment and Facilities

### 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 Liquid nitrogen, commercial grade.

4.1.3 Primer, fluid resistant epoxy, F19 Type 2 (green), as specified by PPS 34.08.

### 4.2 Equipment

4.2.1 Liquid nitrogen storage tank, with phase separator nozzle (e.g., #LC3).

4.2.2 Insulated transport boxes (e.g., SD8878).

4.2.3 Neoprene rubber gloves (e.g., DSC 422-5).

4.2.4 Handling tools, tongs (e.g., CanLab #T5011).

### 4.3 Facilities

4.3.1 This PPS has been categorized as a “Controlled Special Process” according to PPS 13.39 and as such only facilities specifically approved according to PPS 13.39 are authorized to perform installation of interference fit bearings and bushings using liquid nitrogen according to this PPS.

4.3.2 Bombardier subcontractors must direct requests for approval to Bombardier Aerospace Supplier Quality Management. Bombardier Aerospace facilities must 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 must 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 must be detailed in the facility report. Based upon the facility report, Bombardier Toronto (de Havilland) Materials Technology may identify additional qualification and/or process control test requirements. During the facility survey, the facility requesting qualification must 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 Unless otherwise specified by Bombardier Aerospace Supplier Quality Management, approval of subcontractors to perform installation of interference fit bearings and bushings using liquid nitrogen according to this PPS does not require completion of a test program or submission of test samples.

## 5 Procedure

### 5.1 General

5.1.1 Cooling of an interference fit bushing or bearing with liquid nitrogen will contract the diameter sufficiently to allow the assembly of the bearing or bushing into the applicable bore.

5.1.2 Time is an important factor in the installation since warming of the chilled part will cause expansion and seizing, making completion of the installation impossible. Once installed, they are very difficult to remove.

### 5.2 Preparation

5.2.1 Before installing bearings or bushings, ensure that the bore of the part meets all the requirements of the engineering drawing, including size and the application of any protective treatments (e.g., anodized, alodined, primed, etc.). If a bearing is installed in a bore which is slightly under-sized, it will not rotate freely.

5.2.2 Lay out the parts, bearings or bushings in such a manner as will allow rapid installation.

5.2.3 Before soaking the bearings or bushings in liquid nitrogen, solvent clean the bore of the part and the bearing/bushing according to PPS 31.17.

5.2.4 If the engineering drawing specifies wet installation, coat the bore with F19, Type II (green) primer and install the bushings or bearings within one minute of primer application. Do not install bushings or bearings after the F19 primer has dried.

### 5.3 Filling Liquid Nitrogen

5.3.1 Except as noted in para. 5.3.2, discharge the liquid nitrogen through the phase separator nozzle into an insulated metal tray until the amount of liquid nitrogen collected will completely cover the parts to be installed.

5.3.2 When transporting liquid nitrogen:

- Fill the insulated transport container with liquid nitrogen to approximately half of its volume.
- Identify the contents and the proper upright position on the insulated transport container.
- Ensure that the container is securely latched for transport.
- Transport the transport container in an upright position to prevent spillage of the liquid nitrogen.
- Transport the liquid nitrogen quickly to minimize loss due to evaporation.

5.4 **Installation of Bearings and Bushings**

5.4.1 Install bearings and bushings as follows:

Step 1. Leave the bearings and bushings to be installed soaking in the liquid nitrogen until immediately before installation and boiling ceases.

Step 2. Use tongs to remove the bearing or bushing from the liquid nitrogen.

Step 3. Without delay, ensure that the bearing or bushing is aligned square with the bore and that it is correctly located according to the engineering drawing before inserting the bearing or bushing into the bore and manually pushing it into place. Install the bearing / bushing as quickly as possible to prevent expansion and seizing of parts in the bore (which would make it impossible to complete the installation); the maximum time for installation is 1 minute (less for small bushings).

5.4.2 If the fit of the bearing / bushing is too tight to allow manual installation:

Step 1. Immediately remove the bearing / bushing from the edge of the bore.

Step 2. Ensure that the bearing / bushing and the bore are within the dimensional tolerances of the engineering drawing.

Step 3. If F19 has been applied and has dried inside the bore, solvent clean the bore according to PPS 31.17.

Step 4. Ensure that the bushing is clean and re-cool in liquid nitrogen.

Step 5. If applicable, re-apply F19 to the bore (remember to install the bearing or bushing while the F19 primer is still wet).

Step 6. Press the bushing into the bore using a suitable press.

5.4.3 Due to the rapid evaporation rate of liquid nitrogen, more liquid nitrogen may be added if further shrink fit installation operations are required.

5.4.4 If the bore diameter of a bushing is found to be undersized after installation, a microroll burnishing operation according to PPS 1.16 may be used to remove up to 0.0002" maximum from a previously honed surface.

5.4.5 After shrink fit installation, if the engineering drawing specifies that the edge of an installed bushing be “pressed over” on assembly, use a suitable driver or tool on a hydraulic press to deform the lip of the bushing into the bore countersink. A suitable driver or tool will have the same outside diameter as the inside diameter of the bushing with an angled step the same angle as the bore countersink.

### 5.5 Removal of Installed Bearings and Bushings

5.5.1 If it is necessary to remove bearings or bushings installed according to the procedure specified herein, refer to Liaison Engineering for disposition.

## 6 Requirements

6.1 Before installation, parts shall be solvent cleaned according to PPS 31.17.

6.2 Ensure installed bearings and bushings meet the engineering drawing requirements.

6.3 Ensure self-aligning bearings installed by the shrink fit method move freely after installation. If the bearings do not move freely, apply torque up to the maximum specified in Table 1; if the maximum torque listed in Table 1 is insufficient to free the bearing, the installation is not acceptable and the cause of failure must be determined and rectified.

6.4 If the engineering drawing calls out “wet install with F19 primer”, bushings must be installed within one minute of the application of F19, Type 2 (green) primer to the bore surface. Under no circumstances install bushings after the F19 primer has dried inside the bore.

**Table 1. Maximum Torque for Freeing Self-Aligning Bearings**

| Bearing Bore Diameter | Maximum Force |
|---|---|
| 0.1875" | 10 in-lbs |
| 0.2500" | |
| 0.3125" | |
| 0.3750" | 15 in-lbs |
| 0.4375" | |
| 0.5000" | 20 in-lbs |
| 0.5625" | |
| 0.6250" | |
| 0.7500" | |

## 7 Safety Precautions

7.1 **The safety precautions specified herein are specific to Bombardier Toronto (de Havilland) 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 **Take care when handling liquid nitrogen to avoid contact with any part of the body or clothing. Contact with the liquid nitrogen can cause low- temperature freeze burns. If contact occurs, wash thoroughly with soap and water.**

7.4 **Always wear splash goggles and neoprene rubber gloves while handling the discharge nozzle and during the installation process.**

7.5 **Do not ingest liquid nitrogen. If liquid nitrogen is ingested, obtain medical attention immediately.**

7.6 **Liquid nitrogen will displace oxygen in confined spaces. Its volume expansion from liquid to gas at standard conditions is 1 to 696 (i.e., as a gas the nitrogen will expand to fill a volume 696 times as great as it occupied as a liquid). Evaporation of large amounts of liquid nitrogen in un-ventilated or confined spaces could cause suffocation. Therefore, working areas (e.g., storage, transfer, filling, installation, etc.) must be provided with adequate ventilation.**

7.7 **Liquid nitrogen, at -320°F (-196°C), can cause frostbite or "burn" if it comes into contact with human skin or tissue for more than a few seconds. Brief contact with the liquid due to accidental splashing will not cause harm, however, care must be taken to avoid trapping spilled liquid against the skin. Wear loose fitting clothing and ensure that pants are long enough to overlap shoes.**

7.8 **Always wear neoprene rubber gloves when handling tooling, bearings or bushings cooled by liquid nitrogen.**

7.9 **Pour liquid nitrogen in small quantities to avoid splashing, thermal shock and rapid build-up of pressure.**

7.10 **In the case of a large spill of liquid nitrogen:**

- **Stay clear of the liquid nitrogen and allow it to evaporate with adequate ventilation.**
- **Immediately remove any clothing or shoes which may have been saturated with liquid nitrogen. Flush skin with cold tap water if "burned".**

7.11 **If any prolonged contact of liquid nitrogen with skin or eyes occurs, immediately flush with water and obtain medical attention.**

7.12 **Always use tongs to remove bearings or bushings from liquid nitrogen. Never reach in with a gloved hand.**

## 8 Personnel Requirements

8.1 This PPS has been categorized as a "Controlled Special Process" by PPS 13.39. Refer to PPS 13.39 for personnel requirements.