BOMBARDIER
Toronto (de Havilland)
PROPRIETARY INFORMATION

PPS 41.03

PRODUCTION PROCESS STANDARD

Handling and Installation of Flexible Drive Shafts

Issue 4
- This standard supersedes PPS 41.03, Issue 3.
- Vertical lines in the left hand margin indicate 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 PPS (Production Process Standard) specifies the procedure and requirements for handling and installation of the flexible drive shafts.

1.1.1 This PPS complements the engineering drawings that specify its use as an authorized instruction and the procedure specified 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. 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 (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 19.01 - Safetying Devices.

4 Materials and Equipment

4.1 Materials

4.1.1 Flexible drive shaft assemblies as specified on the engineering drawing.

4.1.2 Mounting clamps and hardware as specified on the engineering drawing.

4.1.3 MS 3367-1-9 plastic cable clamps.

4.2 Equipment

4.2.1 MS 90387-1 plastic cable clamp installation tool.

5 Procedure

5.1 General

5.1.1 The flex shafts are similar in design to an automobile speedometer cable and consist of a wire wrapped inner drive shaft with square drive fittings swaged onto each end and the outer protective casing with attachment ferrules on each end.

5.2 Handling of Flex Shafts

5.2.1 In order to ensure satisfactory performance and service life of the flex shafts, it is important that the shafts are not kinked or subjected to sharp bends at any time. Never bend the flex shaft tighter than specified in the following table when handling it:

FLEX SHAFT MANUFACTURER	MINIMUM BEND DIAMETER
Sundstrand	48"
Microtecnica	36"

5.2.2 Take care at all times to ensure that the flex shaft squared end core fittings are not accidentally bent.

5.3 Storage of Flex Shafts

5.3.1 Store flex shafts coiled in the shipping box they are received in until just before they are installed in the A/C.

5.3.2 Never bend the flex shaft tighter than specified in the following table when storing it:

FLEX SHAFT MANUFACTURER	MINIMUM BEND DIAMETER
Sundstrand	48"
Microtecnica	36"

5.3.3 Store the shipping box flat and leave the flex shafts coiled to the maximum diameter permitted by the box.

5.4 Re-Stretching of Flex Shafts to Design Length

5.4.1 The overall length of the flex shaft outer casing will shorten in the process of coiling, shipping and storage. Re-establish the design length of the outer casing as follows:

Step 1. Remove the flex shaft from the shipping box and carefully uncoil the assembly onto a clean flat work bench.

Step 2. Temporarily remove the plastic caps on the casing end ferrules.

Step 3. Mark off the design length of the outer casing on the work bench.

Step 4. For Sundstrand flex drive shafts, bring the casing back to the required length by pulling sharply on the casing end ferrules. The lengthening procedure should be performed by 2 operators using one or two sharp tugs to “seat” the casing. Do not use a long hard pull as this could stretch the braid and cause the casing to become too long.

For Microtecnica flex drive shafts, bring the casing back to the required length by securing one casing end ferrule and applying a 30 - 40 lb pull on the free end.

Step 5. Remove any remaining curves or non-straight lengths in the casing by rolling the flex shaft on a flat surface using the palms of your hands. Re-check length against bench marks.

Step 6. Replace the plastic caps on the casing end ferrules.

5.5 Installation of Flex Shafts

5.5.1 Avoid bending the flex shaft more than the minimum necessary to facilitate installation. Never bend the flex shaft tighter than specified in the following table when installing it:

FLEX SHAFT MANUFACTURER	MINIMUM BEND DIAMETER
Sundstrand	48"
Microtecnica	24"

5.5.2 Leave the protective plastic caps on the drive shaft ends in place until just before connecting the flex shaft to the coupling or interconnecting unit.

5.5.3 To prevent sharp bends or kinks, it is necessary for 2 operators to work together to install long flex shaft assemblies.

5.5.4 Ensure that the flap position transducers (for DASH 8 on LH and RH transfer gearboxes; for Learjet 45 on outboard actuators) have been rigged and adjusted according to the applicable Engineering Order before connecting the flex shafts.

5.5.5 Adjust the position of long flex shafts between couplings and interconnecting units to provide large radius uniform bends at both ends.

5.5.6 For DASH 8 installation, use an MS 90387-1 installation tool (set to a tension setting of 7) to install MS 3367-1-9 plastic cable clamps on the half round type flex shaft clamps.

5.5.7 For DASH 8 installation, ensure that the torque sensor unit has been rigged and adjusted according to the applicable Engineering Order before connecting flex shafts to the inboard side of torque sensor. The input drive shaft on the torque sensor may be rotated a maximum of 45° clockwise or counter clockwise to facilitate alignment of the square drive with the drive shaft.

5.5.8 For DASH 8 installation, adjust the position of short flex shafts between the torque sensor and the coupling to provide large radius uniform bends at both ends.

5.5.9 For DASH 8 installation, wire lock all flex shaft connections at couplings and interconnect units according to PPS 19.01.

5.6 Removal of Flex Shafts

5.6.1 Avoid bending the flex shaft more than the minimum necessary to facilitate removal. Never bend the flex shaft tighter than specified in the following table when removing it:

FLEX SHAFT MANUFACTURER	MINIMUM BEND DIAMETER
Sundstrand	48"
Microtecnica	24"

5.6.2 Right after removing the flex shaft, cap the casing end fittings with plastic caps or with masking tape to prevent contamination of the drive shaft cable with shop swarf or dirt.

5.6.3 Wherever possible, store the removed flex shaft flat and straight on a clean work bench. If necessary, the flex shaft may be coiled to a minimum diameter of 48" and stored flat on a bench or shelf.

5.7 Re-Installation of Flex Shafts

5.7.1 Before re-installing flex shafts which have been coiled after being removed from the A/C, re-stretch the flex shaft to its design length according to section 5.4.

6 Requirements

6.1 Flexible drive shafts shall not be removed from their shipping boxes until just before they are installed.

6.2 Before installation, flex shafts shall be stretched according to section 5.4 to re-establish the design length of the flex shaft assembly.

6.3 Long flex shaft assemblies shall be handled and installed by 2 operators to prevent sharp bends or kinks in the shaft.

6.4 Flex shaft assemblies shall never be bent or coiled tighter than specified in the following table:

FLEX SHAFT MANUFACTURER	MINIMUM BEND DIAMETER FOR STORAGE	MINIMUM BEND DIAMETER FOR INSTALLATION OR REMOVAL
Sundstrand	48"	48"
Microtecnica	36"	24"

6.5 Flex shaft assemblies shall be routed and positioned so as to provide large radius uniform bends at each end.

6.6 For DASH 8 assemblies, flex shaft connections at couplings and interconnect units shall be safety wired according to PPS 19.01.

7 Safety Precautions

7.1 The procedures specified herein present no specific safety hazards when carried out according to accepted plant safety regulations.

8 Personnel Requirements

8.1 Personnel responsible for handling and installation of the flexible drive shafts must have a good working knowledge of the procedure and requirements as specified herein and must have exhibited their familiarity to their supervisor.

9 Additional Information

9.1 The DASH 8 secondary flap drive system acts as a back-up system to prevent asymmetric (uneven) deployment of the wing flaps in the event of failure of the primary (Torque Tube) flap drive system. The system consists of 5 flexible drive shafts (flex shafts) coupled together to interconnect the LH and RH primary drive through a transfer gearbox in each outer wing and through a torque sensor unit located on the rear spar on the left side of the centre wing section. In the event of failure of the primary flap drive on one side of the A/C, the resultant torque load in the secondary drive system causes the torque sensor to transmit the drive from the operating side to the non-operating side to drive the flaps to their selected position.

9.2 On the Learjet 45, four flex drive shafts transmit rotary power from the flap power unit to four ball screw flap actuators. The outboard shafts between the flap actuators are identical on the left and right wing.