BOMBARDIER
Toronto (de Havilland)
PROPRIETARY INFORMATION

PPS 37.13

PRODUCTION PROCESS STANDARD

Induction Brazing

Issue 10
- This standard supersedes PPS 37.13, Issue 9.
- Vertical lines in the left hand margin indicate technical changes over the previous issue.
- Direct PPS 37.13 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 induction brazing of carbon and low alloy steels and corrosion resistant steels. Refer to PPS 3.10 for the procedure and requirements for the induction brazing of terminals to steel cables.

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 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 (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) Specifications

3.2.1 PPS 3.10 - Induction Brazing of Terminals to Steel Cables.

3.2.2 PPS 13.26 - General Subcontractor Provisions.

3.2.3 PPS 13.39 - Bombardier Toronto Engineering Process Manual.

3.2.4 PPS 16.01 - Application of Hard and Soft Film Corrosion Preventive Compound.

3.2.5 PPS 17.02 - Abrasive Blast Cleaning.

3.2.6 PPS 20.10 – Radiographic inspection.

3.2.7 PPS 31.03 - Cleaning of Carbon and Low Alloy Steels.

3.2.8 PPS 31.04 - Degreasing Processes.

3.2.9 PPS 31.05 - Surface Treatment of Corrosion Resistant Steel.

3.2.10 PPS 31.17 - Solvent Usage.

3.3 Bombardier Aerospace Engineering Requirement Documents

3.3.1 BAERD GEN-018 – Engineering Requirements for Laboratories.

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 Silver brazing alloy to MIL-B-15395 Group VII, wire or strip, 1170°F (632°C) melting point (e.g., Silver Alloy 45).

4.1.3 Brazing alloy to ASTM-B-260-56-T-CB.

4.1.4 Silver brazing flux to AMS 3410, active from 900°F - 1400°F (482°C - 760°C).

4.1.5 High temperature brazing flux to AMS 3411, active from 1100°F - 1700°F (593°C - 927°C), (e.g., Handy & Harman of Canada Ltd. Handy Flux Type B-1).

4.2 Equipment

4.2.1 Radio frequency induction heating unit.

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 induction brazing 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, for approval of subcontractor facilities to perform induction brazing according to this PPS, completion of a test program and submission of suitable test samples representative of production parts is required. Test samples must meet the requirements specified in section 5.2.

5 Procedure

5.1 General

5.1.1 The brazing process is dependent upon capillary attraction to draw the filler metal into the joint and, as a result, only joint faces having clearances within the specified range will fill and hold silver braze metal.

5.1.2 Metallographic examination may only be performed at the Bombardier Toronto (de Havilland) Materials Laboratory or at a laboratory listed as approved to BAERD GEN-018 according to the Bombardier Approved Supplier Listing (BASL).

5.1.3 Refer to Figure 1 for an example of an engineering drawing call-out for induction brazing with silver and copper braze alloys.

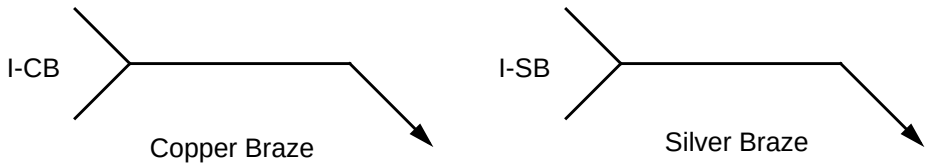

Figure 1. Induction Brazing Symbols

5.2 Preparation for Brazing

5.2.1 Prepare parts for brazing (or re-brazing of defective joints) as follows:

Step 1. Pre-fit all braze joints and ensure the clearance between joint faces is within the range of 0.001" - 0.003".

Step 2. Thoroughly abrade the joint faces and adjacent areas to the bare metal using a stainless steel wire brush. Remove all foreign matter, scale, oxides, etc. If necessary, clean chemically according to PPS 31.03 or PPS 31.05, as applicable. Alternatively, light grit blasting according to PPS 17.02 is also permitted provided it does not alter part dimensions. Clean immediately before fluxing and brazing.

Step 3. Degrease parts according to PPS 31.04 or solvent clean joint faces and adjacent areas according to PPS 31.17.

5.2.2 Prepare brazing metal strip or wire as follows:

Step 1. Cut brazing filler metal strip or wire to the length or shape of the braze joint. On flat face to face joints, the filler metal must cover the minor face and may protrude up to 0.010" beyond the minor face edge.

Step 2. On tubular or cylindrical joints, coil the brazing wire to the outside diameter of the internal member of the joint. Refer to the Induction Brazing Schedule for the brazing wire diameter and length.

5.2.3 Maintain flux according to the manufacturer's instructions shown on the container.

5.3 Certification of Machine Settings

5.3.1 Establish an Induction Brazing Schedule for each material gauge, alloy type and joint configuration before production brazing. For joints that are closely similar in nature but have different part numbers, it is acceptable to use the same brazing schedule.

5.3.2 Certify the Induction Brazing Schedule for each family of joints by preparing 2 representative samples for testing using the parameters specified on the brazing schedule and the brazing procedure specified herein.

- For tubes with brazed fittings, cut the samples in half longitudinally and examine radiographically according to PPS 20.10. After radiographic examination, metallographically examine the 2 halves with the smallest total void areas. Peel apart and visually examine the other 2 halves.
- Examine brazed samples other than tubes with fittings radiographically according to PPS 20.10, metallographically or, by another suitable means that will clearly indicate any defects.

Samples must meet the metallographic and/or radiographic limits specified in Table 1 and the visual examination requirements specified in section 6. If there is a failure in any sample, amend the brazing schedule parameters and re-test. Consider machine settings certified only when both representative samples meet the requirements.

Table 1. Void Limitations

Overlap Distance (Note 1)	**Maximum Acceptable Voids**	
	Total Area (Note 2)	**Maximum Length Of Any Single Defect** (Note 3)
4	15%	15%
5	20%	20%
6 and over	50%	25%

Note 1. Ratio of length of the joint to thickness of the thinnest member.

Note 2. Percent of total faying surface area.

Note 3. Percent of joint length.

5.4 Brazing Procedure

5.4.1 If an assembly is to be heat treated after brazing, use brazing alloy to ASTM-B-260-56-T and high temperature brazing flux to AMS 3411 (e.g., Handy Flux Type B-1).

5.4.2 Perform induction brazing as follows:

Step 1. Apply an even coating of flux to the joint surfaces and adjacent areas.

Step 2. Fit fluxed details as quickly as possible, at the same time as placing the filler metal into position. Set up only the number of details that can be brazed during one shift.

Step 3. Locate each assembly on a brazing fixture, if available, or securely support and align the assembly on the brazing table.

Step 4. Install the correct brazing coil and set the variable machine parameters as specified on the certified Induction Brazing Schedule.

Step 5. Energize the brazing coil according to the machine manufacturer's instructions and perform the brazing operation. Avoid overheating the joint during brazing.

Step 6. Before further handling, allow the brazed assembly to cool until the filler metal solidifies.

Step 7. Unload the assembly from the fixture or table and allow to cool to room temperature. Cool corrosion resistant steel parts by quenching in cold water.

Step 8. Remove all residual flux by scrubbing with a stainless steel wire brush or by washing the assembly in boiling water and air drying.

Step 9. Protect carbon and low alloy steel joints against corrosion according to PPS 16.01.

6 Requirements

6.1 Voids or cracks at any joint edge are unacceptable.

6.2 Ensure that clearance between joint members is within the range of 0.001" - 0.003".

6.3 Joint faces with a highly polished appearance are not acceptable.

6.4 Filler metal at joint edges shall be a continuous unbroken line or ring without voids or cracks.

6.5 Excessive filler metal deposited beside the joint is unacceptable.

6.6 Part distortion due to the brazing operation is unacceptable.

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 **Do not handle an energized brazing coil nor wear rings or watches near the energized coil as high frequency burns could result.**

7.4 **If it is necessary to adjust the position of the assembly with the coil energized, use a wooden or fibre dowel.**

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.

9 Additional Information

9.1 After silver brazing, do not heat corrosion resistant steel joints above 600°F (316°C).

9.2 Except when reworking a defective joint, do not re-heat the assembly to a temperature above 100°F (56°C) less than the filler metal melting point.

9.3 Ensure brazed joints are not exposed to temperatures greater than 1700°F (927°C) after brazing.

9.4 Do not passivate or acid pickle silver brazed parts.

9.5 Do not weld within 2" of a brazed joint.