BOMBARDIER
Toronto (de Havilland)
PROPRIETARY INFORMATION

PPS 1.18

PRODUCTION PROCESS STANDARD

Electrical Discharge Machining

Issue 4
- This standard supersedes PPS 1.18, 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 Production Process Standard (PPS) specifies the procedure and requirements for electrical discharge machining (EDM).

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. 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 1.35 - Machining of Titanium Alloys.

3.2 PPS 20.01 - Magnetic Particle Inspection.

3.3 PPS 20.03 - Fluorescent Penetrant Inspection.

3.4 PPS 30.04 - Steel Heat Treatment - Carbon and Low Alloy Steels.

3.5 PPS 31.02 - Cleaning Processes for Aluminum and Aluminum Alloys.

3.6 PPS 31.03 - Cleaning of Carbon and Low Alloy Steel.

3.7 PPS 31.05 - Surface Treatment of Corrosion Resistant Steels.

3.8 PPS 31.06 - Cleaning of Copper and Copper Alloys.

3.9 PPS 31.07 - Cleaning and Stripping of Painted Surfaces.

3.10 PPS 31.09 - Cleaning of Titanium and Titanium Alloys.

3.11 PPS 31.12 - Cleaning of Nickel and Nickel Alloys.

3.12 PPS 31.17 - Solvent Usage.

3.13 PPS 42.01 - Chemical Milling of Aluminum and Aluminum Alloys.

4 Materials and Equipment

4.1 Materials

4.1.1 Non-corrosive dielectric fluid. Dielectric fluids shall not include any material which is corrosive or damaging to the part. Dielectric fluids used in EDM of titanium or titanium alloys shall not contain chlorine in any form.

4.2 Equipment

4.2.1 Electrical discharge machining equipment must meet the following requirements:

- The control mechanism must include provision for automatic control of the distance between the part and the tool.
- Instrumentation must be provided to measure the current between the tool and the part and to indicate the input voltage.
- Instrumentation must be provided to indicate when shorting occurs between the tool and the part.
- Filtration must be provided for the dielectric fluid.
- Electrode material must be one of the following: brass, copper, copper graphite, copper plate, copper tungsten, graphite, silver tungsten, tungsten, tungsten carbide, zinc alloy.

5 Procedure

5.1 General

5.1.1 Electrical discharge machining (EDM) is a process in which material is removed from a conductive part by the erosive action of repeated electrical discharges on its surface. Type I EDM requires removal of the heat affected zone after EDM. Type II EDM allows EDM to the final dimensions specified on the engineering drawing. Type III EDM allows EDM to the final dimensions specified on the engineering drawing and need not be performed according to an approved EDM schedule. If no type is specified on the engineering drawing Type I EDM requirements apply.

5.1.2 For the purposes of this PPS, areas exhibiting changes in structure or hardness from those typical of the base material before EDM are considered **heat affected zones** (HAZ).

5.1.3 For the purposes of this PPS, **dielectric fluid** is the liquid used to conduct current between the EDM equipment electrode and the part, carry away residue from the spark gap and cool the part. Dielectric fluid must be applied to fill the space between the electrode and the part in the immediate machining and surrounding area to ensure a uniformly machined surface.

5.1.4 For the purposes of this PPS, the **power supply** is the apparatus which supplies discharges between the tool and the part in the EDM process (including output capacitors).

5.1.5 For the purposes of this PPS, the **control mechanism** is the apparatus which senses deviations from proper EDM conditions and applies correction signals (including the mechanical means for automatically positioning the tool).

5.1.6 For the purposes of this PPS, **residue** includes all particles formed by the removal of material from the tool and/or part during machining.

5.2 Preparation of Parts

5.2.1 Before EDM, remove foreign substances which could interfere with the EDM process as follows:

Step 1. Strip primer or paint, if any, according to PPS 31.07.

Step 2. Clean the entire part surface according to PPS 31.02, PPS 31.03, PPS 31.05, PPS 31.06, PPS 31.09 or PPS 31.12, as applicable.

5.3 Preparation of EDM Equipment

5.3.1 Prepare EDM equipment as follows:

Step 1. If the EDM equipment had previously been used to machine another material of different chemical composition, remove all contamination from the previous EDM.

Step 2. Replace the dielectric fluid if it is contaminated with solvent or other soluble foreign material which is harmful to the part or degrades the electrical properties of the dielectric fluid.

Step 3. Except for Type III EDM, set up the EDM equipment according to the proven EDM schedule. For Type III EDM, set up the EDM equipment to remove the required material. If the EDM equipment or material to be machined is changed to one of a different chemical composition, do not begin EDM until the dielectric fluid is completely clear.

5.4 Electrical Discharge Machining (EDM)

5.4.1 Perform EDM as follows:

Step 1. Ensure that the part is free of contamination and foreign matter according to section 5.2.

Step 2. Ensure that the EDM equipment has been set up properly according to section 5.3.

Step 3. Begin machining, taking care to ensure that neither arcing nor shorting consistently occurs between the electrode and the part. If necessary to maintain stability, it is acceptable to alter the control mechanism rate of response.

During machining, monitor the current and voltage. Terminate the EDM process if either the current or voltage becomes abnormal.

Do not allow residue to accumulate between the electrode and the part.

Ensure that, as a minimum, the dielectric fluid covers the electrode and entire immediate machining and surrounding area.

5.5 Post EDM Procedure

5.5.1 For all Type I EDM parts, use conventional machining methods to remove a thickness equal to 1.5 times the maximum depth of the HAZ (as specified on the EDM schedule) from all electrical discharge machined surfaces. For aluminum alloy parts it is acceptable to chemical mill according to PPS 42.01 in place of conventional machining.

5.5.2 Stress relieve 4130, 4140, 4330V, 4340, 300M or similar alloy steels which have been Type II or Type III EDM. Stress relieve according to PPS 30.04. If these parts are to also be shot peened, stress relief must be performed before shot peening.

6 Requirements

6.1 Non-Destructive Testing of Production and Sample Parts

6.1.1 After EDM (and machining to remove HAZ on Type I EDM parts) ferromagnetic parts must be magnetic particle inspected according to PPS 20.01 and non-ferromagnetic parts must be fluorescent penetrant inspected according to PPS 20.03. There shall be no evidence of cracking outside the heat affected zone.

6.2 Maintenance and Calibration of Equipment

6.2.1 Perform tests to determine the average current, voltage, frequency and wave shape and the effectiveness of the control system in holding these values constant. These tests shall be made under conditions simulating those used in the EDM of parts according to this PPS. Record results of the tests into the machine records. If there is any evidence of malfunction, repair the EDM power supply or control mechanism to restore normal performance.

6.2.2 Every 6 months for analog instruments and yearly for digital instrumentation, the meters and other equipment used to monitor discharge current and to set voltage must be calibrated to the manufacturer's stated accuracy.

6.3 EDM Schedules

6.3.1 Except for Type III EDM, before production a proven EDM schedule must be prepared for each part number particular to each EDM machine together with its specific filtration and power supply system. The EDM schedule must include the following information:

- Machine and power supply identification (i.e. make, model & serial number)
- Part number to be machined
- Part alloy identification number (i.e., material specification, alloy and temper)
- Dielectric fluid (i.e. material & specification), pressure, flushing method and flow rate
- Power supply control settings (i.e., capacitance, polarity, average voltage, average current, etc.)
- Control mechanism settings (e.g., surface finishing setting)
- Tool (electrode) material and usage
- Elapsed machine time or material removal depths at which changes are made in any of the above (including re-shaping of the tool)
- For Type I EDM - Maximum depth of HAZ (determined during schedule proving as per paragraph 6.3.2).

6.3.2 EDM schedules must be proven as follows:

Step 1. Machine a sample part of the same material as the represented part to the required configuration according to the EDM schedule.

Step 2. Non-destructively test for evidence of cracks according to section 6.1.

Step 3. Metallographically determine the extent and depth of the HAZ by examination of changes in the metallurgical structure and micro hardness on a cross-section of the sample part using a Knoop indenter. For Type II parts the maximum depth of HAZ must be no more than 0.012". When establishing the maximum depth of HAZ ensure to examine the following critical areas:

- The smallest radius
- Any “V” shaped cuts
- Any cuts close together

Step 4. Check for indication of intergranular attack at 100X or greater magnification. There shall be no evidence of intergranular attack.

Step 5. If the sample part is unacceptable for any reason, correct the EDM schedule and repeat the schedule proving process as specified herein.

6.3.3 A new EDM schedule must be prepared and proven if the source or nominal composition of the tool or dielectric fluid is altered.

7 Safety Precautions

7.1 Safety precautions applicable to the materials and procedure specified herein shall be defined by the subcontractor performing such work for Bombardier Toronto (de Havilland).

8 Personnel Requirements

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