BOMBARDIER
Toronto (de Havilland)
PROPRIETARY INFORMATION

PPS 20.05

PRODUCTION PROCESS STANDARD

Macro-Etch Examination of Machined or Ground, High Strength Low Alloy Steels

Issue 8
- This standard supersedes PPS 20.05, Issue 7.
- Vertical lines in the left hand margin indicate technical changes over the previous issue.
- Direct PPS 20.05 related questions to michael.wright@aero.bombardier.com.
- This PPS is effective as of the distribution date.

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	Production Process Standards (PPS)		
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Signed original on file. Validation of paper prints is the responsibility of the user.

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1 Scope

1.1 This Production Process Standard (PPS) specifies the procedure and requirements for etch examination of bare high strength, low alloy steels (tensile strengths ≥ 180,000 psi) to detect burns caused by abusive machining or grinding in the heat treated condition.

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) Specifications

3.2.1 PPS 13.26 - General Subcontractor Provisions.

3.2.2 PPS 13.39 - Bombardier Toronto Engineering Process Manual.

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

3.2.4 PPS 17.02 - Abrasive Blast Cleaning.

3.2.5 PPS 20.01 - Magnetic Particle Inspection.

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

3.2.7 PPS 31.04 - Degreasing Processes.

3.2.8 PPS 31.17 - Manual Solvent Cleaning.

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 Ammonium persulfate, commercial grade.

4.1.3 Hydrochloric acid to ASTM E1146 or O-H-765.

4.1.4 Nitric acid to A-A-59105 or O-N-350.

4.1.5 Sodium hydroxide to ASTM D456 or A-A-895.

4.1.6 Sodium phosphate to O-S-642.

4.1.7 Vinyl masking tape, acid/alkaline resistant.

4.2 Equipment

4.2.1 Containers for solutions as specified in Table 1, capable of agitating the solution. Acid and alkali resistant tanks (preferably polyethylene or polyvinyl chloride material) with agitation equipment.

4.2.2 Water rinse tanks with a constant overflow or skimming device and agitation equipment.

4.2.3 Calibrated clock or timer with a sweep second hand.

4.2.4 Light capable of ensuring 200 ft-candles (2150 lux) at the examination surface.

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 macro-etch examination of machined or ground high strength low alloy steel 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 macro-etch examination of machined or ground high strength low alloy steel 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 Macro-etch examination is not applicable to surface hardened steels produced by nitriding or carbonitriding. It is typically performed on the following groups of steels:

- Low alloy steels: e.g., SAE 52100, SAE 4140, SAE 4330, SAE 4340, 300M, D6AC, 440C, etc.
- Carburizing steels: e.g., SAE 4620, SAE 9310, AMS 6260, etc.
- Tool steels: e.g., H-11, M-50, M-2, H-13, etc.

5.1.2 This process may remove 0.0001" - 0.0005" from the surface of the part. Therefore, do not perform macro-etching examination on ground or machined areas of parts with a tolerance of ±0.0005" or less.

5.1.3 If specified on the engineering drawing, perform macro-etch examination for burn detection of machined or ground surfaces before any processing such as plating or shot peening which may interfere with the examination.

5.1.4 If stress relief is specified according to PPS 30.04, perform stress relieving before macro-etching and after machining or grinding. Always handle cleaned parts with clean cotton gloves to prevent contamination.

5.2 Preparation and Qualification of Solutions

5.2.1 Make up etchants according to Table 1.

5.2.2 Except ammonium persulfate etchant, analyze etching solutions and alkaline baths weekly to assure concentration limits.

5.2.3 Qualify the macro-etching solution each day before use by etching a controlled test standard having a machining or grinding burn. Controlled test standards used to measure the effectiveness of the processing facilities must meet the following requirements:

- Controlled test standards must be manufactured from the same alloy and be in the same heat treat condition as the parts to be examined.
- Controlled test standards must be tagged and indicate the date and facility where it was last heat treated.
- Every twelve months minimum, controlled test standards must be re-solution heat treated, quenched and tempered according to PPS 30.04. Abusive machining marks must then be re-imposed on it.

5.2.4 Examine the etched part according to section 5.5 to confirm that the overheating condition can be detected with the new solution and to determine the etching time to be used on production parts. The etch time is the time required to start turning the part a uniform gray.

5.2.5 If the test sample shows burned areas as described in section 6, the test solution is ready to process production parts.

Table 1 - Make-Up of Solutions

ETCHANTS	BATH MAKE-UP		OPERATING TEMPERATURE
	CHEMICALS	MEDIUM	
Ammonium persulfate etch (Note 1)	10% ammonium persulfate by weight	De-ionized water	Room
Alkaline bath (Note 2)	0.5 - 1.0 oz/gal sodium phosphate	De-ionized water	60 - 180°F (16 - 82°C)
Alkali solution (Note 3)	4 - 6% by weight sodium hydroxide	De-ionized water	60 - 180°F (16 - 82°C)
Nital etch	30 - 50 mL/L nitric acid	De-ionized water	Room
Hydrochloric acid etch	40 - 60 mL/L hydrochloric acid	Distilled or de-ionized water	Room

Notes:
1. Use within 72 hours of mixing.
2. Any common alkali solution with a pH greater or equal to 10 may be used instead of the alkaline baths shown.
3. This alkali solution may be used as an alternative alkaline bath, if desired.

5.3 Preparation of Parts

5.3.1 Ensure stress relief according to PPS 30.04 has been completed after machining and/or grinding.

5.3.2 Prepare parts for etch examination as follows:

Step 1. Abrasive blast clean areas to be etched with glass beads or aluminum oxide according to PPS 17.02. Use the minimum blasting required to produce a uniform matte or lustre finish.

Step 2. Clean part surfaces of grit, dust and other solid contaminants with oil-free compressed air.

Step 3. If necessary, solvent clean according to PPS 31.17 to remove all cutting oils, corrosion-preventive oils and fingerprints.

5.4 Application of Etching Solution

5.4.1 Perform macro-etch examination according to Flow Chart 1 or Flow Chart 2 as applicable.

5.5 Visual Examination

5.5.1 Visually examine the parts for indications of defects as described in section 6.

5.5.2 Perform all examinations under a light of not less than 200 ft-candles (2150 lux).

5.5.3 Refer parts that cannot be adequately macro-etch examined due to geometric restrictions to Bombardier Toronto (de Havilland) Liaison Engineering.

5.5.4 Maintain and store for future reference detailed process records containing the following information for each production batch:

- Etching solution make-up and control including any additions made to the bath
- Etching solution used for each part
- Processing times and temperatures
- Examination results

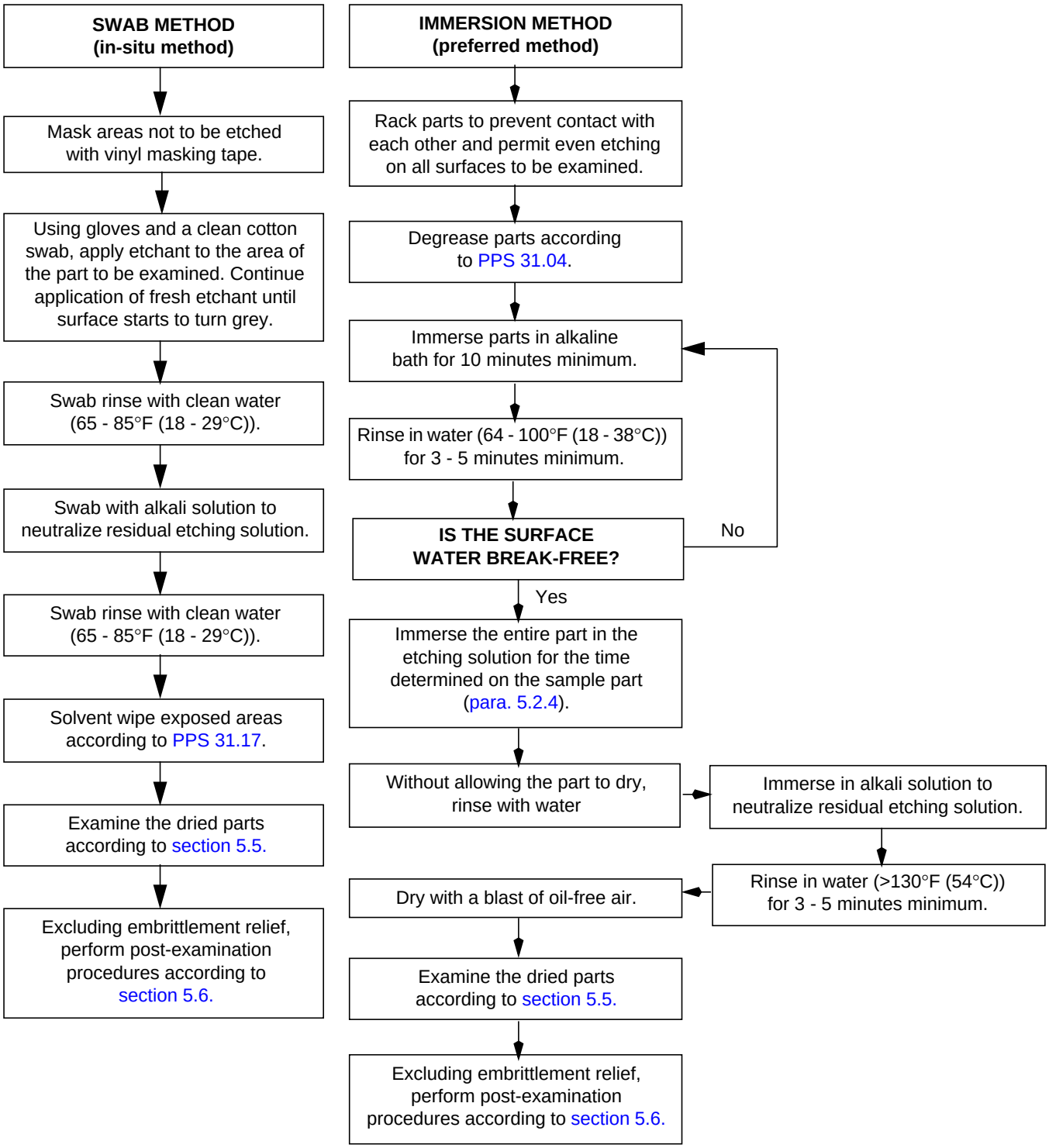
5.6 Post Examination Procedure

5.6.1 After macro-etch examination, indicate completion of the macro-etching operation on the product specification or Process Sheet.

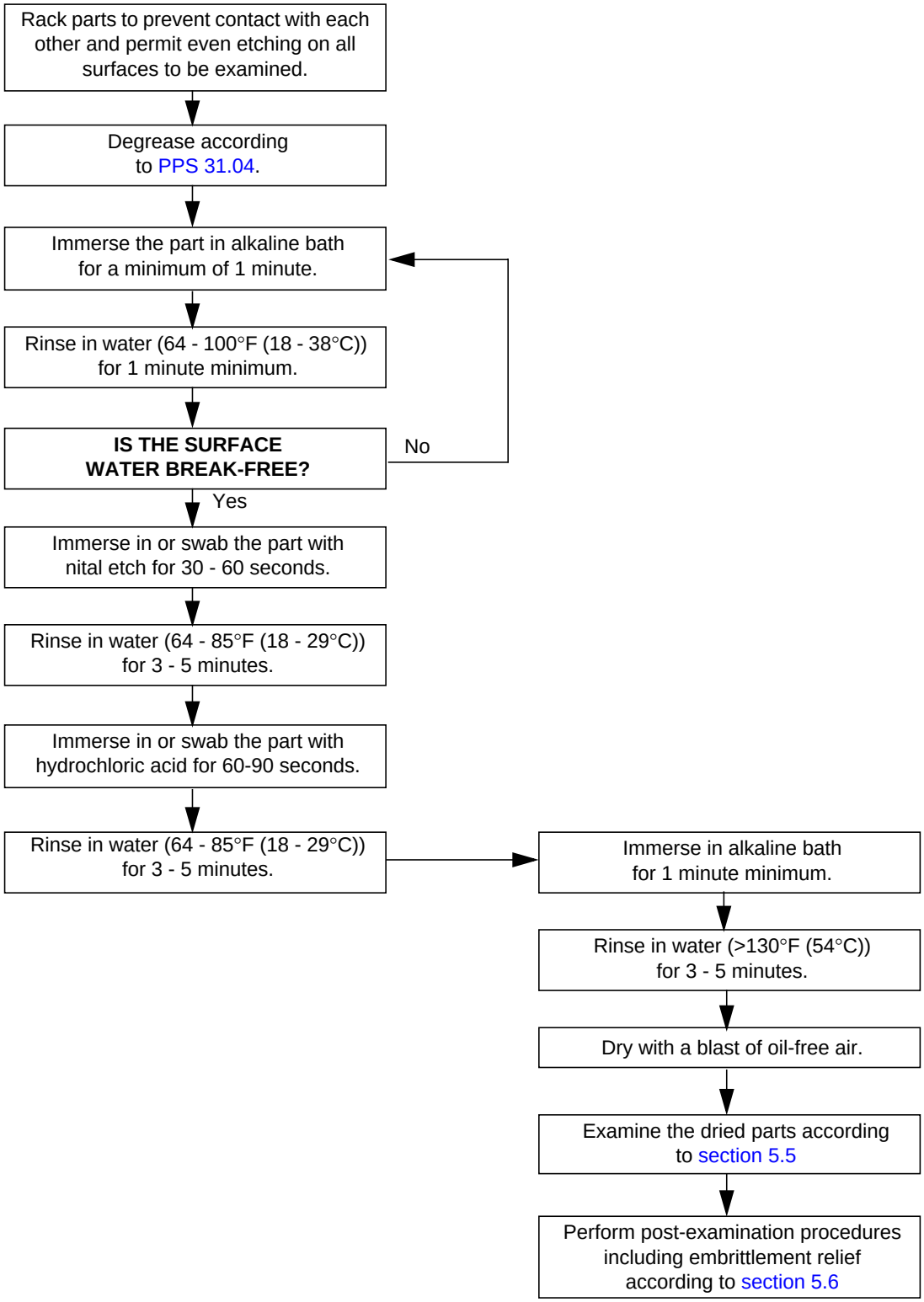
5.6.2 If specified in the applicable flow chart in section 5.4, embrittlement relieve all macro-etched parts according to PPS 30.04 within 4 hours of etching.

5.6.3 After macro-etch examination and, if required, embrittlement relief, coat with F13, Grade 3 or Grade 4, corrosion preventive compound according to PPS 16.01. It is acceptable to use either colourless (Type I) or coloured (Type II) F13, Grade 3 or Grade 4, compound, as appropriate.

Flow Chart 1 - Examination using Ammonium Persulfate Etch



Flow Chart 2 - Nital Etch followed by Hydrochloric Acid Etch



6 Requirements

6.1 Acceptable parts will be etched a uniform grey colour over their entire area (this discolouration is not detrimental to part performance). Over-tempered parts are indicated by areas etched a light brown to black colour in relation to the surrounding areas. Re-hardened parts are indicated by areas etched light grey to white surrounded by a light brown or black border. De-carburized areas will appear unusually lighter in colour than adjacent carburized areas and are not grinding related. Parts showing indications of over-tempering or re-hardening after etching are not acceptable, but may be cleaned, re-etched and re-examined as specified herein; if recurrence of over-tempering or re-hardening indications upon re-examination are observed, the part is not acceptable. Refer unacceptable parts to Bombardier Toronto (de Havilland) MRB or Bombardier Toronto (de Havilland) delegated MRB for disposition. If authorized in writing (e.g., via fastpath RNC), unacceptable parts may be salvaged by complete re-heat treatment to engineering drawing requirements but must be magnetic particle inspected according to PPS 20.01 before re-heat treatment.

7 Safety Precautions

7.1 The safety precautions specified herein are specific to Bombardier Toronto 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 Wear suitable protective apparel when performing macro-etching.

7.4 Take special care when working with etching solutions to prevent contact with bare skin or eyes. If contact occurs, wash the affected area with large quantities of clean water. Immediately contact the Health Centre if any irritation occurs after washing with water.

7.5 Do not use baths, including water baths, for heating or cooling food or drink, etc.

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.