**BOMBARDIER**
*Toronto Site*
**PROPRIETARY INFORMATION**

# PPS 20.03

**PRODUCTION PROCESS STANDARD**

# FLUORESCENT PENETRANT INSPECTION

Issue 38
- This standard supersedes PPS 20.03, Issue 37.
- Vertical lines in the left hand margin indicate technical changes over the previous issue.
- Direct PPS related questions to christie.chung@aero.bombardier.com or (416) 375-7641.
- This PPS is effective as of the distribution date.

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|---|---|---|
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| | NDT Level 3 | |
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| | Quality | |

Issue 38 **- 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 sections of this PPS for detailed procedure and requirements.

- Added Bombardier Toronto Level 3 NDT signatory approval.
- Added new DH 5115 Form. Revised forms DH 5113 and DH 5114 titles.
- Deleted reference to DH 5118 Form, as it is no longer relevant.
- Specified that laboratories performing process control tests as specified in section 9 must have a Quality Management System (QMS) accredited to ISO 9001, ISO 17025, NADCAP AC7006, or AS9100.
- Specified that acetone should be to ASTM D329.
- Specified that IPA should be to Federal Specification T-T-I-735 Grade A or B.
- Specified that wipers used in FPI should be lint-free.
- Added extra criterion for black light sources (see paragraph 4.2.8).
- Added extra criterion for LED black light sources (see paragraph 4.2.9).
- Added extra requirements for light meters.
- Added use of comparative gauges.
- Added use of magnifying glass with 10X magnification.
- For Facility approval, replaced “Bombardier Toronto Engineering” with “Bombardier Toronto NDT Level 3”.
- Defined the following terms to avoid repetitiveness throughout document: “MRB” (Material Review Board); the term “black light” vs “UVA light”; and the term “Level 3 NDT” (this does not include where Bombardier Toronto NDT Level 3 is specified, as this would be specific to a Bombardier Toronto Site personnel only).
- Added additional requirements for the use of LED black light. Specified that LED black light must meet the requirements of ASTM E3022.
- Specified that the temperature of the parts, penetrant and room should be within the range of 50°F to 125°F (10°C to 52°C) for penetrant inspection in place of 40°F to 120°F (4°C to 49°C).
- Added Inspection and Rinse Station requirements section.
- Modified white light and black light requirements (see Table I).
- Replaced DH 5114 Form with forms DH 5113, DH 5114 and DH 5115 in paragraph 9.1.
- Specified for immersion application of penetrant, the penetrant must be allowed to dwell on surfaces to be inspected for a minimum period of 20 minutes. The immersion time must be no longer than one half the total dwell time.
- Specified for solvent removable fluorescent penetrants (in-situ method), allow the penetrant to remain on the part for a dwell time of at least 35 minutes before removal of excess penetrant in place of 30 minutes.

- Specified for both dry powder and aqueous developers, the maximum developing dwell time must be 60 minutes in place of 4 hours for dry powder developers. Specified parts not inspected before the maximum developing dwell time must be cleaned, dried and re-processed.
- Specified that all calibrated equipment must display a calibration sticker noting, as a minimum; the company performing calibration, calibration and re-calibration date using traceable standards per ISO 10012-1.
- Specified when a UVA LED lamps repair is required, the repair must be performed by the original manufacturer or a repair centre authorized by the manufacturer. The manufacturer or authorized repair centre must warrant the lamp repair and demonstrate conformity to ASTM E3022.
- Specified for Qualification/Re-Qualification of Known Defect Standards and System Performance checks, it is not required for In-Situ applications.
- For Water Temperature Gauge, revised check frequency from 3 months to 6 months.
- Added requirement to perform LED UVA lamp beam uniformity and output stability check.
- Modified requirement for battery operated black light sources (see section 9.18).
- Modified dryer calibration testing requirements (see paragraph 9.21).
- Replaced ISO 10012 with ISO 10012-1.
- Specified at Bombardier Toronto, dispose of chemical wastes according to EHS-OP-005.

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**Flow Chart**

## 1 SCOPE

1.1 This Production Process Standard (PPS) specifies the procedure and requirements for detection of discontinuities which are open to the surface through the use of fluorescent penetrant inspection (FPI).

1.1.1 As an alternative to the procedure and requirements specified herein, it is acceptable to perform fluorescent penetrant inspection according to BAPS 176-002.

- Perform fluorescent penetrant inspection according to the procedure and requirements of either BAPS 176-002 or this PPS in their entirety; a piece meal approach utilizing certain sections or portions of BAPS 176-002 and this PPS is **not** acceptable.
- Subcontractor facilities which have been approved by Bombardier to perform fluorescent penetrant inspection according to BAPS 176-002 are considered approved to perform fluorescent penetrant inspection according to this PPS without further approval needed.
- PPS Process Standard Deviations (PSD's) issued against this PPS are **not** applicable to BAPS 176-002. Likewise, requests for deviation (RFD's) allowed against BAPS 176-002. Likewise, request for deviation (RFD's) allowed against BAPS 176-002 are not applicable to this PPS.
- When processing parts according to BAPS 176-002 as an alternative to processing parts according to PPS 20.03, deviations allowed by an approved RFD against BAPS 176-002 may be used unless a specific limitation regarding program applicability is specified by the RFD comments/restrictions.

1.1.2 This PPS complements the engineering drawings that specify its use as an authorized instruction. Except as noted in paragraph 1.1.1, 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.

1.1.3 Refer to PPS 13.26 for the subcontractor provisions applicable to this PPS.

## 2 HAZARDOUS MATERIALS

2.1 Before receipt at Bombardier Toronto, all materials must be approved and assigned Material Safety Data Sheet (MSDS) numbers by the Bombardier Toronto 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 Environment, Health and Safety Department.

## 3 REFERENCES

3.1 SAE-AMS 2644 - Inspection Material, Penetrant.

3.1.1 QPL-SAE-AMS 2644- Qualified Products List - Inspection Material, Penetrant.

3.2 AS9100 - Quality Systems - Aerospace - Model for Quality Assurance in Design, Development, Production, Installation and Servicing.

3.3 ASTM E1417 - Standard Practice for Liquid Penetrant Examination.

3.4 ASTM E3022 - Standard Practice for Measurement of Emission Characteristics and Requirements for LED UV-A Lamps Used in Fluorescent Penetrant and Magnetic Particle Testing.

3.5 BAERD GEN-007 - Quality Control of Heat Treating Equipment and Hot Forming Equipment.

3.6 BAERD GEN-012 - Non-Destructive Testing - Certification of Personnel.

3.7 BAERD GEN-023 - Contamination Control for Compressed Air.

3.8 BAPS 176-002 - Fluorescent Penetrant Inspection.

3.9 EHS-OP-005 - Hazardous Materials Management, *Bombardier Toronto internal operating procedure*.

3.10 Form DH 4255 - Penetrant Inspection Record Card - *Bombardier Toronto internal operating procedure*.

3.11 Form DH 5113 - Black Light Record Card - Daily Test - *Bombardier Toronto internal operating procedure*.

3.12 Form DH 5114 - Quality Assurance Penetrant System Control Card - *Bombardier Toronto internal operating procedure*.

3.13 Form DH 5115 - Quality Assurance Monthly Penetrant System Control Card - *Bombardier Toronto internal operating procedure*.

3.14 DHLPM Procedure No. 9080 - In-Situ Etching of Aluminum Surfaces for Fluorescent Penetrant Inspection - *Bombardier Toronto internal operating procedure*.

3.15 DHLPM Procedure No. 9082 - In-Situ Etching of Titanium and Steel Surface for Fluorescent Penetrant Inspection - *Bombardier Toronto internal operating procedure*.

3.16 NADCAP AC7006.

3.17 ISO 9001 - Quality Management Systems.

3.18 ISO 10012-1 - Quality Assurance Requirements for Measuring Equipment.

3.19 ISO 17025 - General Requirements for the Competence of Testing and Calibration Laboratories.

3.20 PPS 13.13 - Personal Protective Respiratory Equipment.

3.21 PPS 13.26 - General Subcontractor Provisions.

3.22 PPS 13.39 - Bombardier Toronto Engineering Process Manual.

3.23 PPS 15.01 - Part Marking of Aircraft Parts and Assemblies.

3.24 PPS 15.04 - Use of Felt Tip Markers for Marking Aircraft Parts and Assemblies.

3.25 PPS 16.01 - Application of Hard and Soft Film (F13) Corrosion Preventive Compound.

3.26 PPS 16.20 - Temporary Corrosion Protection of Carbon and Low Alloy Steel Parts.

3.27 PPS 31.02 - Cleaning Processes for Aluminum and Aluminum Alloys

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

3.29 PPS 31.05 - Surface Treatment of Corrosion Resistant Steels (C9).

3.30 PPS 31.06 - Cleaning of Copper and Copper Alloys.

3.31 PPS 31.07 - Cleaning and Stripping of Painted Surfaces.

3.32 PPS 31.09 - Cleaning of Titanium and Titanium Alloys.

3.33 PPS 31.12 - Cleaning Nickel and Nickel Alloys

3.34 PPS 31.17 - Solvent Usage.

3.35 PPS 35.04 - Requirements for Steel Forgings.

3.36 PPS 35.07 - Requirements for Investment and Sand Castings.

3.37 PPS 35.08 - Requirements for Aluminum Alloy Forgings.

3.38 PPS 35.09 - Requirements for Titanium Alloy Forgings.

3.39 PPS 37.10 - Requirements for Fusion Welds.

## 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 Suitable compatible fluorescent penetrants, penetrant removers and developers qualified for fluorescent penetrant inspection under AMS 2644 and listed in QPL-AMS-2644. The contents of all containers (e.g., tanks, drums, developer bulbs, etc.) must be labelled with, and be traceable to, the material and batch numbers.

- When using the spray or immersion application methods, use only water washable fluorescent penetrants of at least high sensitivity (i.e., Type 1 Method A Sensitivity Level 3) and dry powder developer (i.e., Form A) according to AMS 2644. The developer and penetrant used must be compatible.

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

4.1.4 Lint-fee cotton wipers (e.g., DSC 378-2).

4.1.5 2-Propanone (acetone) to ASTM D329.

4.1.6 Isopropyl alcohol (IPA) to Federal Specification T-T-I-735 Grade A or B, used for suspect indication evaluation according to paragraph 5.12.7.

### 4.2 Equipment

4.2.1 Compressed air must meet the requirements of BAERD GEN-023.

4.2.2 Penetrant immersion tanks, equipped with racks for draining and a cover for each tank. It is recommended (but not required) that the working level be marked on the interior of the tank and that whenever the depth of liquid drops below 90% of the original volume the tank should be replenished to 100%.

4.2.3 Conveyor and extension steel hooks for hanging of larger parts and for suspension of racks used for fluorescent penetrant inspection; must be electrically continuous to ground. Wire mesh racks must be equipped with metal frames.

4.2.4 Spray application system (e.g., Ardrox Hyspeed Electrostatic system).

4.2.5 Pneumatic hoist for large or heavy parts (e.g., Aro-Corp. #7750DT).

4.2.6 Water filtration system (e.g., Sethco Metpro Corp.) consisting of a storage tank, filtration unit and sump pump.

4.2.7 System performance known defect standards - chrome plated test panels containing 5 star like cracks for evaluating the penetrant system performance (e.g., Sherwin PSM-5, TAM-146040, Sherwin Twin KDS Panel, etc.).

4.2.8 Black light/UVA source, high pressure, mercury vapour sealed reflector type lamp. The black light source must be properly filtered to transmit wavelengths within 320 to 400 nanometers (nm), with those wavelengths near 365 nm predominating. The following criterion must be met:

- Warm up according to the manufacturer's recommendations before use or measurement of their intensity.
- Demonstrate evidence from their manufacture that validates their peak output wavelength of 365 ± 5 nm.
- Reflectors and filters must be clean and in good condition.
- Have a uniform beam pattern free of voids, blind spots, shadowing, or bright areas.
- Must not emit visible light exceeding 2 foot candles (20 lux) at the inspection surface.
- Must not have adjustable reflectors, variable focus or multiple out settings.
- Have a minimum irradiance intensity of 1200 $\mu W/cm^2$ and maximum of 10000 $\mu W/cm^2$ measured at 15" (38 cm) from the surface of the bulb to the inspection surface.
- Defective bulbs must be immediately replaced before any further use.

4.2.8.1 Special battery powered black light equipment may be used to supplement regular black light for inspecting inside surfaces of holes, tubing and otherwise inaccessible areas. Special black light equipment may be used for portable on-site inspections, when necessary provided that conditions noted in Table I are met. Compensate for drop-off in light intensity by positioning the black light source closer to the inspection surface.

4.2.9 The use of light emitting diode (LED) black light/UVA sources is permitted provided that they comply with the requirements of ASTM E3022 and additional monitoring specified in this document. Ensure the LED UVA source is functioning correctly and the adequate stability of their spectral emission is being maintained. LED UVA lamps must be allowed to stabilize according to the manufacturer's recommendations.

4.2.10 Light meters. Ensure light meters meet the following:

- The black light meter must be capable of measuring black light intensity in microwatts per square centimeter within the spectral range of 320 to 400 nm.
- The white light meter for measuring white light background in the inspection area must be capable of measuring a minimum light level of 1 foot-candle (10 lux).
- Black light and white light meters must be accurate to within ± 5% of the standard reading.

4.2.11 Re-circulating air-type electric drying oven capable of maintaining a consistent drying temperature.

4.2.12 Calibrated pressure gauges capable of measuring the pressure of fluid and/or air with an accuracy of ± 5 psi.

4.2.13 Calibrated temperature gauges capable of measuring the pressure of fluid and/or air with an accuracy of ± 5°F (± 3°C).

4.2.14 Calibrated timing devices.

4.2.15 Comparative gauge (e.g., TAM 135273, TAM 190466, or equivalent). In order to properly measure or size UVA indications during inspection, the use of a comparative gauge is recommended. All comparators used for inspection must be calibrated by the manufacturer. The certificate of conformance must be traceable to a NIST (National Institute Standards Technology) standard. Comparators must be verified annually for any damage or excessive wear and must be replaced when required.

4.2.16 Magnifying glasses with a magnification of 10X can be used for evaluating indications and discontinuities.

### 4.3 Facilities

4.3.1 This PPS has been categorized as a Controlled Critical Process according to PPS 13.39 and, except as noted in paragraph 4.3.1.1, only facilities specifically approved according to PPS 13.39 are authorized to perform fluorescent penetrant inspection according to this PPS.

4.3.1.1 Facilities approved to perform fluorescent penetrant inspection according to BAPS 176-002 are also considered approved to perform fluorescent penetrant inspection according to this PPS without further approval needed (i.e., approval according to PPS 13.39 is not required).

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 must 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 NDT Level 3 personnel 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 subcontractor facilities to perform fluorescent penetrant inspection according to this PPS does not require completion of a test program or submission of test samples.

4.3.3.2 Laboratories performing process control tests as specified in section 9 must have a Quality Management System (QMS) accredited to ISO 9001, ISO 17025, NADCAP AC7006, or AS9100.

## 5 PROCEDURE

### 5.1 General

5.1.1 For the purposes of this PPS, the term “MRB” (Material Review Board) is considered to include Bombardier Toronto MRB and Bombardier Toronto delegated MRB.

5.1.2 For the purposes of this PPS, the term “black light” is considered to be synonymous to “UVA light”.

5.1.3 For the purposes of this PPS, the term “Level 3 NDT” is considered to include the following: Bombardier Toronto NDT Level 3 personnel; and “Responsible Level 3” certified according to BAERD GEN-012 requirements.

5.1.4 All materials, equipment and facilities employed in carrying out the processes specified herein must be approved by Bombardier Aerospace as meeting the requirements of this standard and ASTM E1417.

5.1.5 The process specified herein meets the requirements of ASTM E1417.

5.1.6 Before Fluorescent penetrant inspection, ensure all equipment calibration stickers are valid and have not expired. Do not use any equipment if calibration stickers are not valid or have expired.

5.1.7 If possible, penetrant inspect parts in the NDT inspection stations meeting the requirements of section 5.2. Either the spray (conventional or electrostatic) method or immersion method of application may be used to inspect a particular part depending on the size and surface finish of the part. If penetrant may become entrapped in an assembly during inspection, do not use the immersion method of application. If it is not practical to penetrant inspect parts in the NDT inspection stations, inspect the parts in-situ. The electrostatic spray method of application is based on a physical process whereby charged particles are attracted to an electrically grounded object; the penetrant particles are charged by an electrode in the spray gun.

5.1.8 Fluorescent penetrant inspection may not detect defects such as large gouges or nicks.

5.1.9 Materials that would absorb penetrant (e.g., fibre reinforced composites, wood, cloth, etc.) cannot be inspected by the fluorescent penetrant inspection process.

5.1.10 If penetrant inspection after rework is specified, inspect both sides of the part in the rework area.

5.1.11 An approved documented part specific inspection technique or a generic procedure (for parts of a similar nature) may be used. All part specific and generic inspection written instructions, procedure and/or techniques must be approved by a Level 3 NDT.

5.1.12 Unless sampling is specified by the processing PPS, when fluorescent penetrant inspection according to this PPS is specified, inspect 100% of the production parts. If sampling is specified, the sample size and sample acceptance requirements shall be as specified in the applicable PPS. If the engineering drawing or PPS simply specifies flaw detection, perform 100% inspection. Inspection may also be required under the following circumstances:

- On receipt, Bombardier Toronto may choose to sample inspect parts or raw materials inspected by an approved subcontractor or supplier.
- If doubt exists as to the acceptability of a part or batch of parts (even if inspection according to this PPS is not specified by a PPS or engineering drawing).

5.1.13 Fluorescent penetrant inspection shall be performed after all manufacturing operations that may cause defects in the part or expose pre-existing internal defects to the part surface, but before any interfering surface treatments are, but not limited to: anodizing; plating (cadmium, chromium, nickel, copper); surface coatings (primers, topcoats, solid film lubricants); shot peening; chemical conversion coating; impregnation; and thermal barrier.

5.1.14 Perform fluorescent penetrant inspection according to Flow Chart 1.

## 5.2 Inspection and Rinse Stations

5.2.1 The rinse and inspection stations must be free of fluorescent material or other contaminants that may interfere with the inspection process.

5.2.2 The inspection area must be clean and free from excessive clutter and other contamination, including any white clothes, papers and any objects that might glow under fluorescent illumination, in order to avoid indirect eye glare.

**TABLE I - WHITE LIGHT AND BLACK LIGHT REQUIREMENTS**

| | BLACK LIGHT INTENSITY | AMBIENT AND WHITE LIGHT INTENSITY |
|---|---|---|
| Inspection Station | 1200 $\mu W/cm^2$ minimum (Note 2) | 2 foot candles (20 lux) maximum |
| | 10000 $\mu W/cm^2$ maximum (Note 2) | 100 foot candles (1000 lux) minimum (Note 1) |
| Rinse Station (Note 4) | 100 $\mu W/cm^2$ minimum (Note 3) | 10 foot candles (100 lux) maximum |
| | 50 $\mu W/cm^2$ minimum | 2 foot candles (20 lux) maximum |

Note 1. When evaluating fluorescent indications with white light, a minimum of 100 foot candles (1000 lux) is required.
Note 2. A minimum black light intensity of 1200 $\mu W/cm^2$ and a maximum of 10000 $\mu W/cm^2$ at part surface is required for inspection of parts
Note 3. A minimum black light intensity of 100 $\mu W/cm^2$ with a maximum of 10 foot candles (100 lux) white light intensity of 50 $\mu W/cm^2$ minimum with a maximum 2 foot candles (20 lux) ambient white light intensity at the part surface.
Note 4. The rinse station must be equipped with a warm water automatic and/or manual spray rinse.

## 5.3 Preparation of Parts for Inspection

5.3.1 Strip primed or painted parts according to PPS 31.07 before fluorescent penetrant inspection.

5.3.2 If parts will not begin the inspection process on the same day they were cleaned, cover or pack such parts appropriately to prevent contamination by shop soil, grease or other contaminants.

5.3.3 Ensure that the temperature of the parts, penetrant and room are within the range of 50°F to 125°F (10°C to 52°C) for penetrant inspection.

5.3.4 Except as noted in paragraph 5.3.4.1, all parts that have undergone metal smearing operations (see following list of examples), must be etched to remove 0.0002" - 0.0004" per surface according to PPS 31.02, PPS 31.05 or PPS 31.09, as applicable, before fluorescent penetrant inspection.

- Machining, grinding and/or blending
- Glass or bead blasting, vapour blasting (liquid honing)
- Abrasive heavy belt sanding
- Honing, buffing, burnishing, polishing, wire brushing
- Sanding (hand, pad disc or cone)
- Tumble or vibratory deburring
- Damage (e.g., impact damage, tool marks, snap marks, etc.). Etching is to be performed only after damage has been reworked (e.g., blending, etc.); under no circumstances shall etching be performed before rework of damage.

5.3.4.1 Etching shall not be performed on the following surfaces:

- Etching is not required inside close tolerance holes (i.e., holes with a tolerance in diameter of 0.002" or less). Holes opened to their final close tolerance dimensions shall be masked before chemical etching. Remove maskant before fluorescent penetrant inspection.
- Etching is not required for outer diameters of bushings that have close tolerance dimension of 0.002" or less. Their final close dimension shall be masked before chemical etching. Remove maskant before fluorescent penetrant inspection.
- Etching is not required on formed or straightened parts when forming or straightening operations took place after the metal smearing operations, provided the penetrant inspection is required only to detect cracks caused by straightening or forming operations.
- Etching shall not be performed more than once on the same surface. An area that has been submitted to a smearing operation (such as reworking, blending, etc.) is considered a new surface.
- Parts subjected to stripping of inorganic coating by chemical etching do not require additional etching, provided that a minimum amount of metal is removed and no interfering mechanical treatment was performed after the stripping.
- Etching is not required for rolled or machined threads. Remove maskant before fluorescent penetrant inspection.

5.3.4.2 Ensure that the minimum part thickness is maintained in the etched area. After etching, rinse thoroughly and remove any free standing water in pockets, recesses, etc. (e.g., with clean filtered compressed air or vacuum suction) before thoroughly drying the part using forced air or oven drying.

5.3.4.3 At Bombardier Toronto, it is acceptable to perform in-situ etching according to LPM 9080 or LPM 9082, as applicable, in place of etching according to PPS 31.02, PPS 31.05 or PPS 31.09.

5.3.5 Unless parts were etched as specified in paragraph 5.3.2, clean parts according to the relevant sections of PPS 31.02, PPS 31.03, PPS 31.05, PPS 31.06, PPS 31.09 or PPS 31.12 before fluorescent penetrant inspection.

5.3.6 Following etching or cleaning, remove any free standing water in pockets, recesses, etc. (e.g., with clean filtered compressed air or vacuum suction) and then thoroughly dry the part in a drying oven with a temperature range of 140°F to 174°F (60°C to 79°C) for a minimum of 45 minutes or a temperature range of 176°F to 194°F (80°C to 90°C) for a minimum of 30 minutes. As an alternative to oven drying, it is acceptable to dry the part by immersion in a hot water bath/rinse (176°F (80°C) minimum) for the time required for the part to reach approximately 176°F (80°C) followed by thorough blasting with forced air.

5.3.7 When inspecting parts in-situ, cap or plug all engine bleed air ducts, tubing, connectors, etc., as applicable, where penetrant or developer seepage may occur.

5.3.8 Mask areas which are not to be covered with penetrant.

5.3.9 If penetrant inspection is being carried out on parts situated within structural assemblies, mask adjacent structures.

## 5.4 Penetrant Application

5.4.1 Apply penetrant to prepared (etched or cleaned) parts as follows:

- For spray application, position the part so as to permit adequate drainage and prevent accumulation of pools of penetrant.
- For immersion application, immerse the part in the penetrant tank and then placed on the rack for the remaining dwell time (see section 5.5).
- For in-situ application, spray or brush the penetrant evenly onto the surface to be inspected. If penetrant seepage may occur, cap or plug any engine bleed air ducts, tubing, connectors, etc. as required.

5.4.1.1 All surfaces to be inspected must be completely covered with penetrant. Ensure that the penetrant coating is uniform over the part or inspection area. Check for penetrant coverage with UV light.

### 5.5 Penetrant Dwell Time

5.5.1 Allow the penetrant to remain on the part for the dwell time specified below:

- For water washable penetrants (immersion or spray applied), allow the penetrant to remain on the part for a minimum of 20 minutes before removal of excess penetrant according to section 5.6. For immersion application, the immersion time must be no longer than one half the total dwell time.
- For solvent removable fluorescent penetrants (in-situ method), allow the penetrant to remain on the part for a dwell time of at least 35 minutes before removal of excess penetrant according to section 5.6.

5.5.1.1 Do not allow penetrant to dry on the part; for dwell times exceeding 60 minutes, re-apply fresh penetrant after 60 minutes. The maximum allowable dwell time is 2 hours (120 minutes); if the dwell time has exceeded 2 hours, clean the part according to paragraph 5.3.5 and reprocess the part.

5.5.1.2 When the spray or immersion method has been used to apply penetrant, rotate or move the parts as necessary to prevent pooling of the penetrant during the dwell time.

### 5.6 Removal of Excess Penetrant

5.6.1 For solvent removal fluorescent penetrant (in-situ applied), excess penetrant shall be removed by wiping the surface under black light with a clean lint-free dry wiper and then with a clean wiper moistened with penetrant remover until all the penetrant has been removed. Do not spray the remover directly onto the surfaces under inspection. Use the black light source, in conjunction with the penetrant removal operation to ensure complete removal of all excess penetrant from the surfaces under inspection. On rough surfaces, it may be necessary to wipe the surface several times.

5.6.2 For water washable penetrants (immersion or spray applied) rinse parts with warm water under black light.

- Use a spray nozzle with a water pressure of no more than 40 psi (276 kPa).
- Maintain a minimum distance of 12" between the spray nozzle and the part, at an angle of approximately 45°.
- Ensure that water used for rinsing is 75 ± 25°F (24 ± 14°C).
- Hydro-air nozzles may be used at a maximum of 25 psi (172 kPa) added air pressure.
- There shall be no delay between automatic and final manual removal stations.
- Keep rinsing times to a minimum (less than 3 minutes) to prevent over-rinsing and excessive removal of water washable penetrant. If there is absolutely no trace of background fluorescence after removal of excess penetrant, or if over washing has occurred accidentally or inadvertently, re-clean the part according to section 5.3 (re-etching is not required) and re-apply penetrant according to section 5.4.

### 5.7 Drying after Removal of Excess Penetrant

5.7.1 Dry parts after removal of excess water washable penetrant by rinsing as follows:

Step 1. Remove any free standing water (i.e., pockets, recesses, etc.) with clean filtered compressed air (25 psi maximum) or vacuum suction.

Step 2. Place the parts in the drying oven (maximum temperature 160°F (71°C)).

Step 3. Allow the parts to remain in the drying oven just long enough to dry the part surfaces (30 minutes maximum). Ensure that the drying oven does not exceed 160°F (71°C) during the drying process.

5.7.2 For in-situ applications, allow the part to dry thoroughly after removal of excess penetrant using penetrant remover.

### 5.8 Application of Developer

5.8.1 If using dry powder developer (Form A), immediately after drying the part apply the dry developer powder in such a manner as to ensure complete part coverage. Application using an enclosed powder chamber which creates an effective and controlled powder cloud is recommended; however, other means suitable to the size and geometry of the part may also be used provided the powder is dusted evenly over the entire surface being inspected.

5.8.2 Non-aqueous developer (Form D) shall be applied to dry parts by spraying either from aerosol containers or using a suitable spray gun. Thoroughly mix by shaking the developer prior to application. Apply a light, uniform coating by spraying with a very fine nozzle and constant movement of the spray. Frequently agitate the developer during application. Two or three light coats are preferred to a single heavy coat of developer.

### 5.9 Developer Dwell Time

5.9.1 The minimum developing dwell time for all developer Forms must be 10 minutes, and the maximum developing dwell time must be 60 minutes.

- When using dry developer, the dwell time begins after application of dry developer.
- When using wet developer, the dwell time begins after complete drying of the developer coating.

5.9.2 Parts not inspected before the maximum developing dwell time must be cleaned, dried and re-processed.

### 5.10 Removal of Excess Dry Developer Powder

5.10.1 Remove excess dry developer after the dwell time specified in section 5.9 by light tapping or using clean filtered compressed air (5 psi maximum).

### 5.11 Inspection

5.11.1 Parts shall be inspected in a viewing area meeting the conditions specified in Table I.

5.11.2 Inspectors working in the black light booth shall be dark conditioned for at least 1 minute each time the black light booth is entered from white light.

5.11.3 The distance between the bulb of the black light and the inspection surface must be between 6" and 15" (15 cm and 38.5 cm).

5.11.4 Parts shall be inspected to the acceptance criteria of section 6.2. Acceptance criteria for welded assemblies shall be as per the applicable welding specification.

5.11.5 Magnifiers of 10X magnification may be used to examine areas not readily visible due to geometric irregularities.

5.11.6 Visual aids (mirrors, boroscopes, etc.) may be used to examine areas not readily visible due to geometric irregularities.

5.11.7 Mark areas of defect indications, if necessary, using a temporary marker according to PPS 15.04.

### 5.12 Evaluation of Indications

5.12.1 All fluorescent indications on the part surfaces shall be evaluated to determine whether the indications are relevant, non-relevant or false. Re-process all parts with excessive background fluorescence.

5.12.2 **Relevant indications** are true penetrant indications on the surface of the part. This indicates to the inspector that some sort of surface opening is present which, in all probability, constitutes a flaw. Further evaluations is needed before the material is deemed defective.

5.12.3 **Non-relevant indications** are true penetrant indications on the surface of the part, caused by surface discontinuities which are usually present by design. For example, threads will often trap penetrant in the roots, blind holes often retain a certain amount of penetrant causing bleed-out to occur around the hole resulting in an indication, however, the surface opening is there by design.

5.12.4 **False indications** are the result of some sort of penetrant contaminations; these indications do not refer to any sort of surface opening. False indications can be caused by penetrant on the hands of the inspector; penetrant in the developer; penetrant on any of the work surfaces, improper rinsing techniques; even a part with a heavy bleed-out which touches another part leaving a similar penetrant indications. Good housekeeping and control of chemicals will decrease the possibility of false indications.

5.12.5 **Linear indications** are those indications in which the length is more than three times the width. They can be caused by such discontinuities as cracks, laps, seams, cold shuts, etc.

5.12.6 **Rounded indications** are those indications in which the length is less than three times the width. Four or more rounded indications linearly disposed, where each is separated from the adjacent indication by less than 4 times the diameter of the largest adjacent indication (edge-to-edge), shall be considered as one linear indication.

5.12.7 Evaluate **suspect indications** as follows (this technique may be performed only twice for any given original indication).

Step 1. Lightly dampen a cotton swab or lint free cloth with an approved solvent penetrant removal/cleaner or isopropyl alcohol. Do not flush the inspection surface with solvent, if this occurs, the part must be cleaned and reprocessed, starting with penetrant application.

Step 2. Wipe the indication, in one direction only, rotating the cotton swab or new clean surface of the cloth between wipes as it passes over the indication.

Step 3. Allow the surface to dry completely.

Step 4. Apply non-aqueous or dry developer.

Step 5. Allow the re-applied developer to dwell as long as the original developer dwell time.

Step 6. If the indication re-appears, evaluate the indication according to section 6.2.

Step 7. If the indication fails to re-appear, interpret the original indication as false.

## 5.13 Post Inspection Cleaning

5.13.1 After inspection, clean all parts according to PPS 31.02, PPS 31.03, PPS 31.05, PPS 31.06, PPS 31.09 or PPS 31.12, as applicable.

## 5.14 Part Protection

5.14.1 If fluorescent penetrant inspected parts will not, or have not, undergone further processing within 5 days of post inspection cleaning, apply F13, Grade 3 corrosion preventive compound according to PPS 16.01 or a suitable non-detergent oil treatment according to PPS 16.20.

# 6 REQUIREMENTS

## 6.1 Inspection Requirements

6.1.1 Ensure that each part is inspected using the criteria shown on the applicable technique card or approved generic procedure.

6.1.2 If parts show indications of defects, determine the nature of these defects and classify them as rejectable or non-rejectable according to section 6.2.

## 6.2 Acceptance Criteria

6.2.1 Parts containing linear indications or exhibiting pitting caused by corrosion are not acceptable.

6.2.2 Parts with relevant indications which extend over to or into an edge, chamfer, corner, radius or fillet including holes are not acceptable.

6.2.3 A record shall be kept of all parts inspected. The record shall list the part number, lot size, quantity inspected; quantity accepted and rejected, rejection report number (if rejections are involved), date of inspection, and a statement specifying the method of inspection per this specification. The data listed above must be recorded in such a manner to be retrievable, traceable and archivable. Parts which fail to meet acceptance criteria, and cannot meet these criterion after reworking within engineering drawing tolerances, shall be submitted to MRB for final disposition.

6.2.4 The larger the defect the greater the volume of penetrant that seeps out during development; therefore, the extent of the defect can be estimated from its area of fluorescence. For estimating the extent of the defect, it is also helpful to examine the part under white light where penetrant on the surface can be seen as a coloured stain.

6.2.5 The probable type and extent of defects can be determined by noting the shape and area of the indications. Cracks are indicated as greenish yellow lines on a dark background. Seams, laps and cold shuts show up as lines or intermittent lines. Porosity is indicated by round glowing spots. Unless otherwise specified (i.e., by engineering drawing or PPS), reject parts with true indications of defects. If in doubt, submit the parts to a laboratory as specified by paragraph 4.3.3.2 for examination. Refer to PPS 37.10 for the defect limitations applicable to fusion welds.

## 6.3 Record of Inspection and Identification of Inspected Parts

6.3.1 Maintain a record for each part number inspected (e.g., on a DH 4255 Form).

6.3.2 Identify each part of an inspected and accepted lot with the appropriate NDT stamp. If individual stamping is not possible due to the size or quantity of parts, it is acceptable to use either a bagging or tagging method according to PPS 15.01 or to mark the parts with the appropriate dye. Use maroon dye to mark parts accepted on a 100% inspection basis and yellow dye to mark parts accepted on a sampling basis, if sampling was permitted. If possible, apply stamp or dye markings in a location such that it will not be removed by later handling. If the stamp or dye mark on a part is obliterated during subsequent processing, the NDT stamp in supporting records on file is sufficient evidence that the part has been non-destructive tested.

## *7 BOMBARDIER TORONTO 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 strongly 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 standard plant safety precautions when performing the procedure specified herein.*

*7.3 Ensure sufficient ventilation is provided for penetrant inspection. Install fume extraction facilities where the electrostatic method of application is used.*

*7.4 When working with electrostatic spray equipment, wear personal protective respiratory equipment as specified in PPS 13.13.*

*7.5 Ensure personnel using the electrostatic spray equipment are adequately grounded by wearing suitable approved grounding equipment.*

*7.6 Refer to PPS 31.17 for safety precautions associated with the use solvents.*

## 8 PERSONNEL REQUIREMENTS

8.1 Personnel responsible for performing fluorescent penetrant inspection must be certified according to BAERD GEN-012.

8.2 Personnel who are engaged in specifying, reviewing, monitoring or evaluating test methods must be a qualified Level 3 NDT personnel.

8.3 Subcontractor/supplier personnel performing NDT Level 3 activities must also be approved by a Bombardier Toronto NDT Level 3 personnel.

8.4 This PPS has been categorized as a Controlled Critical Process according to PPS 13.39. Refer to PPS 13.39 for additional personnel requirements.

## 9 MAINTENANCE OF MATERIALS AND EQUIPMENT

9.1 Refer to Table II for a listing of material or equipment checks required for each particular method of application and the required frequency of the check. Maintain a record of system checks performed or waived (e.g., DH 5113, DH 5114 and DH 5115 forms).

9.2 All laboratories must meet the requirements of paragraph 4.3.3.2.

9.3 All calibrated equipment must display a calibration sticker noting, as a minimum; the company performing calibration, calibration and re-calibration date using traceable standards per ISO 10012-1.

9.4 When a UVA LED lamps repair is required, the repair must be performed by the original manufacturer or a repair centre authorized by the manufacturer. The manufacturer or authorized repair centre must warrant the lamp repair and demonstrate conformity to ASTM E3022.

### TABLE II - MATERIAL AND EQUIPMENT CHECK APPLICABILITY AND FREQUENCY

| TYPE OF CHECK | APPLICABILITY OF METHOD | | | FREQUENCY (NOTE 1) |
|---|---|---|---|---|
| | SPRAY | IMMERSION | IN-SITU | |
| Qualification/Re-Qualification of Known Defect Standards (ref. paragraph 9.5) | Required | Required | Not Required | Yearly |
| System Performance (ref. paragraph 9.6) | Required | Required | Not Required | Daily or before each use |
| Dry Developer (ref. paragraph 9.7) | Required | Required | Required | Daily |
| All Black Light/UVA Intensity (ref. paragraph 9.8) | Required | Required | Required | Daily or before each use |
| White Light Intensity (ref. paragraph 9.9) | Required | Required | Required | Weekly or before each use |
| Ambient White Light Intensity (ref. paragraph 9.10) | Required | Required | Not Required (Note 2) | Weekly |
| Operating Controls (ref. paragraph 9.11) | Required | Required | Not Required | Start of each shift |
| Inspection Area (ref. paragraph 9.12) | Required | Required | Not Required | Weekly |
| Penetrant Removability (ref. paragraph 9.13) | Not Required | Note 3 | Not Required | Note 3 |
| Penetrant Sensitivity (ref. paragraph 9.14) | Not Required | Note 3 | Not Required | Note 3 |
| Penetrant Water Contamination (ref. paragraph 9.15) | Not Required | Required | Not Required | Monthly |

## TABLE II - MATERIAL AND EQUIPMENT CHECK APPLICABILITY AND FREQUENCY

| TYPE OF CHECK | APPLICABILITY OF METHOD | | | FREQUENCY (NOTE 1) |
|---|---|---|---|---|
| | SPRAY | IMMERSION | IN-SITU | |
| Penetrant Fluorescent Brightness (ref. paragraph 9.16) | Not Required | Required | Not Required | Monthly |
| Black Light Filter Verification (ref. paragraph 9.17) | Required | Required | Required | Daily or before each use |
| Special Battery Powered Black Light Source (ref. paragraph 9.18) | Required | Required | Required | Before and after each use |
| LED UVA Lamps Beam Uniformity | Required | Required | Required | Start of Each Shift |
| LED UVA Lamps Output Stability | Required | Required | Required | Monthly |
| Dryer Calibration (ref. paragraph 9.21) | Required | Required | Not Required | Every 3 Months |
| Black Light Meter Calibration (ref. paragraph 9.22) | Required | Required | Required | Every 6 Months |
| White Light Meter Calibration (ref. paragraph 9.23) | Required | Required | Required | Every 6 Months |
| Water Temperature Gauge (ref. paragraph 9.24) | Required | Required | Not Required | Every 6 Months |
| Pressure Gauge Calibration (ref. paragraph 9.25) | Required | Required | Not Required | Every 6 Months |
| Timing Device Calibration (ref. paragraph 9.26) | Required | Required | Required | Yearly |
| Penetrant Contamination, Re-used (ref. paragraph 9.27) | Required | Required | Required | Start of each shift |

Note 1. If no inspection will be performed within the check frequency shown in this table (i.e., if the check frequency required is daily and there will no inspection that day) then it is acceptable to waive that check. Before resuming inspection, perform each type of check which has been waived.

Note 2. Perform in-situ inspection in viewing areas using dark canvas (or another suitable method) to reduce the ambient white light background to the lowest possible level during inspection.

Note 3. Test to be performed immediately following the failure of the system performance test, when the sensitivity or performance of the in-use material falls below the performance of the unused material.

9.5 **Qualification/Re-Qualification of Known Defect Standards:** System performance known defect standards (ref. paragraph 4.2.7) must be qualified and/or re-qualified as follows:

- Inspection facilities must perform an initial check with unused materials to establish a baseline for each known defect standard. The requirement is that the performance of the in-use materials cannot fall below that of the unused materials. Therefore, a baseline performance of the known defect standard must be established to compare to the daily results. The baseline for the known defect standard shall consist of documenting the measurements of the largest dimension of each indication and the number of star-like crack indications detected if using Tam Panels. All measuring instruments must be calibrated and capable of measuring to an accuracy of 0.001".
- Known defect standards must be re-qualified annually for signs of degradation using the same method and penetrant system used for the baseline qualification. The measurements will determine whether the known defect standard indications are within the tolerance of 30 percent of either gain or loss of the baseline indication sizes. Known defect standards that exceed the tolerance of 30 percent shall be deemed rejectable and replaced. All test results must be documented, filed and made available for audit purposes.

9.6 **System Performance Check:** The penetrant system performance check includes all in use materials, recycled and not recycled. Results of the system performance test, utilizing the in-use materials, must at a minimum, indicate the same number and condition (appearance, size, etc.) of flaws detected originally when the baseline was established. The check shall be performed by processing a known defect (e.g., PSM5 panel, TAM panel, etc., re-qualified annually according to paragraph 4.2.7) through the system using appropriate processing parameters and comparing the indications thus obtained to those obtained with unused samples of the same penetrant inspection materials. This comparison may be made with reference photographs or with a similar known defect standard (2 similar test pieces must be used) processed with the unused penetrant inspection materials. If there is a significant difference between the indications, check the system and repeat the system performance check. Record the results of the system performance check (e.g., on a DH5114 Form).

9.6.1 To ensure that the known defect standards are sensitive enough to display a change in effectiveness of the penetrant process, it is necessary to fully remove any penetrant residue that remains entrapped in the discontinuities after performing the penetrant system test. There shall be maintenance procedures in place that assure that cleaning of the known defect standards, between usage, is adequate and that physical changes in the standard that make it unsuitable for use, can be detected. The procedure must define what is actually done by the facility (supplier). The auditor shall require the technician demonstrate that they know defect standard is clean and indication free prior to performance of the test; this does not require application of developer. The following procedure may be used as a guideline:

Step 1. Immediately after each use, wash the standard carefully with water to remove all traces of developer.

Step 2. Immerse standard in glass container filled with acetone (see paragraph 4.1.5) and place the glass container in an ultrasonic cleaner and operate for a minimum of 30 minutes.

Step 3. Dry the known defect standard by air blowing or wiping with a clean, dry lint-free cloth.

Step 4. Apply a thick coat of Form D developer (wet solvent based).

Step 5. Let the developer dwell between 10 to 15 minutes.

Step 6. Wash the known defect standard with water.

Step 7. Place known defect standard in an ultrasonic cleaner immersed in acetone (paragraph 4.1.5) for minimum of 1 hour.

Step 8. Repeat steps from Step 3 to Step 5, except apply the developer in a thin even coat and the dwell will be 30 minutes.

Step 9. Check the cleaning effectiveness under proper black light and white light conditions. If penetrant traces appear, repeat Step 1 through Step 8 until all traces of penetrant residues are gone.

Step 10. Rinse the known defect standard with water and dry.

Step 11. Store the known defect standard in a protective wrapping or immersed in acetone (see paragraph 4.1.5) to avoid any contamination and damage between uses.

9.7 **Dry Developer Check:** Visually check the dry developer. The developer should be light and fluffy. Record the results of the dry developer check (e.g., on a DH 5114 Form). Discard developer showing any contamination or lumps of powder due to excessive water content. Spread a suitable quantity of developer to form a thin layered 4" diameter circle on a clean flat surface and check the developer for signs of fluorescence under black light; discard the developer if there are more than 10 specks of fluorescence in the 4" diameter circle.

9.8 **Black Light/UVA Intensity Check:** All black lights and fluorescent lights in use must be checked with the black light intensity meter specified in paragraph 4.2.10 and must meet the requirements of Table I. Ensure that the black light meter has a valid calibration tag affixed to it. Record the intensity (e.g., on a DH 5114 Form). At Bombardier Toronto, if more than one black light source is used, record the black light intensity of each on the DH 5113 Form. Indicate qualification of the black light(s) to this PPS.

9.9 **White Light Intensity Check:** The white light source in the inspection station must be checked using the light meter specified in paragraph 4.2.10 and must meet the requirements of Table I. Ensure that the light meter has a valid calibration tag affixed to it. Record the intensity (e.g., on a DH 5114 Form).

9.10 **Ambient White Light Intensity Check:** Use a suitable white light meter to check that the ambient white light intensity in the inspection booth does not exceed 2 foot-candles (20 lux). For in-situ inspection, use dark canvas or another suitable method to reduce the white light background to the lowest possible level during inspection. Record the results of the ambient white light intensity check (e.g., on a DH 5114 Form).

9.11 **Operating Controls Check:** Check that all indicators and controls (e.g., electrostatic system control, water temperature, water and air pressure, drying oven temperature, etc.) have the proper settings.

9.12 **Inspection Area Check:** Check inspection areas for cleanliness, tidiness and freedom from fluorescent contamination.

9.13 **Penetrant Removability Check:** Check water washable penetrants for removability according to AMS 2644. If the removability of the penetrant is noticeably less than that of the reference penetrant, discard the penetrant and clean and re-fill the tank to the working level. Record the results of the penetrant removability check (e.g., on a DH 5114 Form). This test is not required for inspection facilities which do not re-use penetrant materials. This test to be performed immediately following the failure of the system performance test, when the sensitivity or performance of the in-use material falls below that performance of the unused material.

9.14 **Penetrant Sensitivity Check:** Test to be performed according to ASTM E1417 immediately following the failure of the system performance test, when the sensitivity or performance of the in-use material falls below the performance of the unused material.

9.15 **Penetrant Water Contamination Check:** Check water washable penetrants for water content. Do not allow water content to exceed 5% of the total volume; for example, if the results of a monthly check indicate that the water content at the next monthly check could exceed 5%, remove a suitable quantity of penetrant (e.g., at least 25% of the total volume recommended) and replace it with fresh penetrant. Record the results of the penetrant water contamination check (e.g., on a DH 5115 Form). This test is not required for inspection facilities which do not re-use penetrant materials.

9.16 **Penetrant Fluorescent Brightness Check:** Check penetrant for fluorescent brightness according to AMS 2644. If the brightness value of the penetrant is less than 90% or more than 110% that of the reference penetrant, discard the penetrant and clean and re-fill the tank to the working level. Record the results of the penetrant fluorescent brightness check (e.g., on a DH 5115 Form). This test is not required for inspection facilities which do not re-use penetrant materials.

9.17 **Black Light Filter Verification Check:** Check UVA sources for cleanliness and integrity of the filters.

9.18 **Special Battery Powered Black Light Source Test:** Before and after each use, test all battery operated black lights with the black light intensity meter specified in paragraph 4.2.10. The intensity of black light shall not be less than 1200 $\mu W/cm^2$ and should not exceed 10000 $\mu W/cm^2$ during the inspection process at the part surface. Maintain a record of all readings. The after use testing shall only apply for lamps that are not equipped with an automatic shut-off,

9.18.1 For battery powered black light source equipped with an automatic shut-off, a written procedure must be developed or evidence from the lamp manufacturer must be provided to demonstrate that the current black light intensity is being maintained throughout its period of use.

9.19 **LED UVA Lamps Beam Uniformity:** The verification of LED's shall be conducted by holding a white paper against the lamp so that the radiation is scattered and the individual LED's become easily visible. There shall be no obvious differences between the distinct LED's.

To achieve a visually uniform beam pattern at the examination surface it is recommended to establish a minimum working distance (i.e., distance from lamp to examination surface).

If there is a total failure of one single UVA LED element or more, the lamp shall switch off automatically.

9.20 **LED UVA Lamps Output Stability:** The output has to be measured at "switch on" position, at the stability time (specified by the lamp manufacturer) and then over at least 3 consecutive readings at 30 minutes intervals. When there is less than 3% variation in the radiation intensity, then stability is achieved.

9.21 **Dryer Calibration: Temperature Controlling Device** (see paragraph 9.21.1) and **Temperature Indicator** (see paragraph 9.21.2).

9.21.1 The temperature of the dryer oven must be controlled within a tolerance of ± 15°F (8.3°C) or better.

The calibration certificate at a minimum must indicate the set point, the maximum temperature reached during a cycle, and the minimum temperature reached during a cycle. In addition the variation must be recorded from the set point and must meet the required tolerance. This is a calibration of temperature variation with time. The dryer temperature must not vary more than ± 15°F (8.3°C) from the set value. The minimum test period used for the calibration must be representative of the duration of a drying cycle.

Temperature controlling device must be calibrated at a minimum of one point within its range of use. If multiple points are used, then they must encompass the range of use for that dryer.

9.21.2 The temperature indicator for the dryer must be calibrated to a tolerance of ± 10°F (5.6°C) or better. The temperature indicator must be calibrated at a minimum of one point within its range of use (e.g., the dryer should not be calibrated at 130°F (54°C), 140°F (60°C) and 150°F (66°C) and then used at 160°F (71°C)). If the indicator is to be calibrated at one point, then they must encompass the range of use for that dryer.

9.22 **Black Light Meter Calibration:** The black light meter must be calibrated using traceable standards per ISO 10012-1. A calibration tag marked with the expiry date must be attached to the meter. Maintain a record of calibration dates.

9.23 **White Light Meter Calibration:** The white light meter must be calibrated using traceable standards per ISO 10012-1. A calibration tag marked with the expiry date must be attached to the meter. Maintain a record of calibration dates.

9.24 **Water Temperature Gauge Calibration:** Water temperature gauges must be calibrated by an accredited laboratory using traceable standards per ISO 10012-1.

9.25 **Pressure Gauge Calibration:** Pressure gauges must be calibrated by an accredited laboratory using traceable standards per ISO 10012-1.

9.26 **Timing Device Calibration:** Timing devices must be calibrated by an accredited laboratory using traceable standards per ISO 10012-1.

9.27 **Penetrant Contamination Check (Re-Used):** A visual assessment shall be performed on re-used penetrant for contamination; penetrant is classified as re-used if it is from a tank, container or spray that is recovered. This test may be performed in any way that allows contamination to be detected in the penetrant material; for example, a clear glass tube may be inserted into the penetrant may be collected in a clear glass container and allowed to settle indicating contaminations, etc. Determine if any of the following conditions are evident: precipitates, waxy deposits, white coloration, separation of constituents, surface scum, or any other evidence of contamination or breakdown; when any of the above conditions are detected, the material shall be discarded or modified according to the manufacturers' instructions.

## 10 ADDITIONAL INFORMATION

10.1 Keep fluorescent penetrant materials dry and protected to avoid moisture contamination.

10.2 To ensure penetrant and developer dwell times are not exceeded, maintain a suitable timer/buzzer system.

10.3 Do not wear sunglasses (regular or prescription) or light sensitive glasses (photo-grey) when inspecting parts. It is recommended that glasses with lenses treated to absorb UV light be worn when inspecting parts. Allow at least one minute for eyes to become adapted to the darkness before inspecting parts.

10.4 At Bombardier Toronto, if fluorescent penetrant inspection is specified, include the following note on the manufacturing document (e.g., Process Sheet or Assembly Manual): "*Note: Fluorescent penetrant inspection must be carried out by certified personnel.*"

10.5 Dispose of all chemical wastes according to national legislation and local regulations. At Bombardier Toronto, dispose of chemical wastes according to EHS-OP-005.

10.5.1 At Bombardier Toronto, dispose of chemical contaminated work clothes, rags, etc., into Red Containers labelled "Waste Rags".

## FLOW CHART 1 - FLUORESCENT PENETRANT INSPECTION PROCESS