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

# PPS 24.01

**PRODUCTION PROCESS STANDARD**

# ALUMINUM WIRE SPRAY COATING (M1)

Issue 13
- This standard supersedes PPS 24.01, Issue 12.
- Vertical lines in the left hand margin indicate 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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| | Quality | |

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## 1 SCOPE

1.1 This Production Process Standard (PPS) specifies the procedure and requirements for the application of flame sprayed aluminum coating (protective treatment code M1) onto steel parts and assemblies.

1.1.1 This PPS complements the engineering drawings that specify its use as an authorized instruction. The procedure specified in this PPS shall 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, all materials shall 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 BAERD GEN-018 - Engineering Requirements for Laboratories.

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

3.3 PPS 13.13 - Personal Protective Respiratory Equipment.

3.4 PPS 13.26 - General Subcontractor Provisions.

3.5 PPS 13.39 - Bombardier Toronto Engineering Process Manual.

3.6 PPS 17.02 - Abrasive Blasting.

3.7 PPS 31.04 - Degreasing Processes.

3.8 PPS 33.02 - Removal of Metallic Coatings.

## 4 MATERIALS, EQUIPMENT AND FACILITIES

### 4.1 Materials

4.1.1 Spray gun aluminum wire alloy, Type II per MIL-W-6712B, 1/8” diameter.

4.1.2 Steel test pieces as listed in Table IV.

4.1.3 3M Shurtape (duct tape).

### 4.2 Equipment

4.2.1 Metco Model 12E Flame Spray Gun.

4.2.2 Metal spray booth equipped with a fume extraction system and adequate lighting.

4.2.3 Dry film thickness gauge (e.g., Mitotuyo, Model Number 179 - 711).

4.2.4 Surface pyrometer, 0°F to 500°F scale range (e.g., Pyro, Model 35 DR).

4.2.5 Leather gloves (e.g., DSC 422 -3).

4.2.6 Cotton gloves (e.g., DSC 422-1).

4.2.7 Flow meters, model number 2GF Gas flowmeter and model number 2AF Air flowmeter.

### 4.3 Facilities

4.3.1 This PPS has been identified as a “Critical or Special” process according to PPS 13.39 and as such only facilities specifically approved according to PPS 13.39 are authorized to perform the application of flame sprayed aluminum coating (protective treatment code M1) onto steel parts and assemblies according to this PPS.

4.3.2 Bombardier subcontractors shall direct requests for approval to Bombardier Supplier Quality Management. Bombardier Aerospace facilities shall 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 shall 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 shall be detailed in the facility report. Based upon the facility report, Bombardier Toronto Engineering may identify additional qualification and/or process control test requirements. During the facility survey, the facility requesting qualification shall 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 For approval of subcontractor facilities to perform the application of flame sprayed aluminum coating (protective treatment code M1) onto steel parts and assemblies according to this PPS, completion of a test program and submission of suitable test samples representative of production parts is required. Test samples shall meet the requirements specified in section 6.

4.3.3.2 All testing and evaluation specified herein shall only be performed by Bombardier Toronto Materials Laboratory or by laboratories accredited according to BAERD GEN-018.

## 5 PROCEDURE

### 5.1 General

5.1.1 Metal spraying consists of heating metal wire to a molten state by passing it through a high temperature heat source and depositing it on a metal substrate using compressed air. Process all parts according to Flow Chart 1.

### 5.2 Preparation of Parts

5.2.1 Abrasive blast clean all surfaces which are to be metal sprayed according to PPS 17.02. Following abrasive blast cleaning, degrease parts according to PPS 31.04.

5.2.2 Carry out metal spraying as soon as possible after abrasive blast cleaning and degreasing with a maximum delay of 4 hours. The maximum acceptable delay between cleaning and metal spraying parts of AMS 6418 (Hy Tuf) and 300M material is 30 minutes.

5.2.3 Place parts in a clean, dry area and keep parts free of any surface contamination after cleaning.

5.2.4 Pre-heat AMS 6418 (Hy Tuf), 300M and SAE 4130 material to the temperature specified in Table I immediately before metal spraying. When pre-heating parts using a warming torch, apply heat evenly to avoid localized overheating and use a surface pyrometer to ensure that the maximum specified temperature is not exceeded at any point on the part surface.

**TABLE I - PRE-HEATING PRIOR TO METAL SPRAYING**

| MATERIAL | PRE-HEAT TEMPERATURE (NOTE 1) |
|---|---|
| AMS 6418 | 425°F ± 25°F |
| 300M | 400°F ± 25°F |
| SAE 4130 | 250°F ± 25°F |
| Note 1. Ensure that the maximum temperature limit is not exceeded at any time during pre-heating. | |

### 5.3 Preparation of Equipment

5.3.1 Position the wire pay-off unit so that the wire will feed as straight as possible into the rear wire guide of the spray gun.

5.3.2 Check all fittings to ensure that there are no gas leaks.

5.3.3 Check the oxygen and fuel circuit as follows:

Step 1. Ensure that the spray gun is pointed into the spray booth.

Step 2. Turn on the spray booth exhaust system.

Step 3. Close the control valve on the Model 2AF air flowmeter (see Figure 1).

Step 4. Turn the cylinder valve on the spray gun to the running position. DO NOT light the spray gun.

Step 5. Adjust the oxygen and fuel gas pressures to the amounts shown on Table II.

Step 6. Close the fuel control valve on the gas flowmeter (see Figure 1).

Step 7. Open the oxygen flow control valve on the gas flowmeter, the oxygen flow shall be within 5 points of the value shown in Table II. If the flow is not within 5 points, check the equipment for leaks or obstructions.

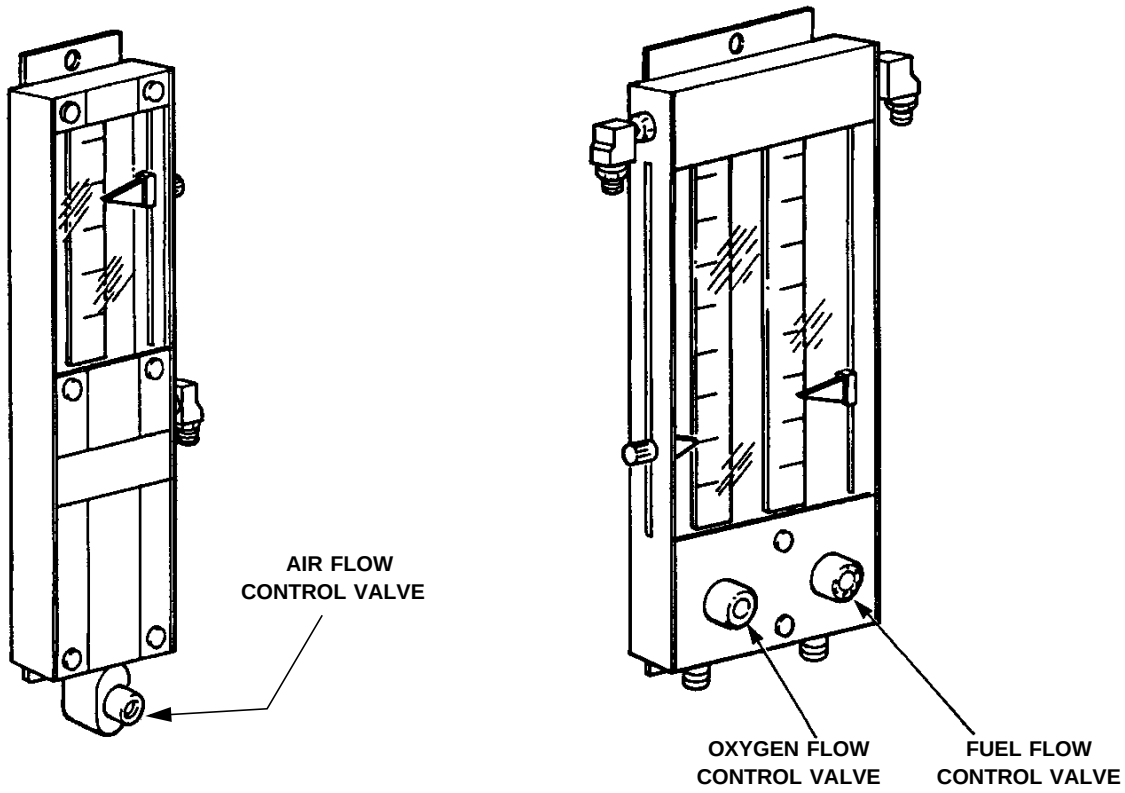
Step 8. Close the oxygen flow control valve.

Step 9. Open the fuel flow control valve on the gas flowmeter, the fuel flow shall be within 5 points of the value shown in Table II. If the flow is not within 5 points, check the equipment for leaks or obstructions.

Step 10. Close the fuel flow control valve.

**TABLE II - OXYGEN AND FUEL CIRCUIT TEST PRESSURES AND FLOW VALUES**

| WIRE DIAMETER | FUEL SYSTEM | PRESSURE | FLOW RATE (Note 1) |
|---|---|---|---|
| 1/8” | Acetylene | 15 psi | 83 |
| | Oxygen | 30 psi | 53 |
| Note 1. Flow rates shall be within 5 points. | | | |




**2AF AIR FLOWMETER** **2GF GAS FLOWMETER**

**FIGURE 1 - FLOWMETER**

### 5.4 Start-Up Operation

5.4.1 Perform start-up operation as follows:

Step 1. Open the gas head valve (see Figure 2) by moving the handle all the way up. This is the running position.

Step 2. With the gas head valve in the running position, turn the wire grip lever (see Figure 2) to the off position (up) and insert the wire into the rear wire guide and push it into the gun. Turn the wire grip lever to the on position (forward), this will start feeding the wire through the gun.

Step 3. Quickly set the oxygen and fuel gas pressures to the amounts given in Table III under lighting pressures.

Step 4. Adjust the gas flow control valves to the values given in Table III and then close the gas head valve.

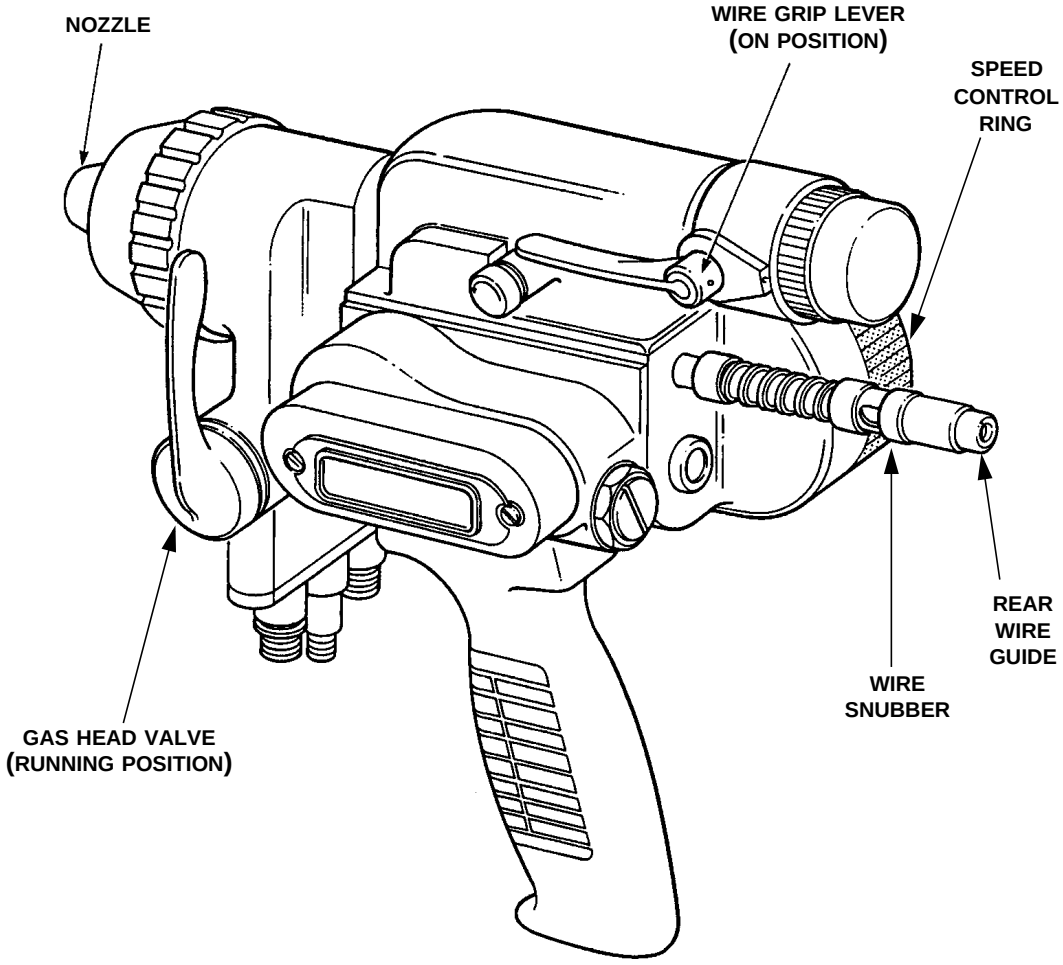



**FIGURE 2 - TYPE 12E FLAME SPRAY GUN**

## 5.5 Lighting

5.5.1 Light the spray gun as follows:

Step 1. Open the gas head valve fully (straight up), pause for three seconds, and close the valve halfway until it clicks into the lighting stop. Ensure that the wire is in the nozzle before lighting the spray gun.

Step 2. Strike a spark using a welders spark lighter. As soon as the flame ignites, open the gas head valve fully (straight up).

Step 3. When the turbine gets up to speed, start the wire feed, set the speed control for the wire to melt off just beyond the front of the air cap (see Figure 3).

Step 4. Re-adjust the gas control flow valves until they correspond to the values given in Table III.

**TABLE III - OXYGEN AND FUEL CIRCUIT PRESSURES AND FLOW VALUES**

| WIRE MATERIAL | WIRE DIAMETER | AIR CAP | FUEL SYSTEM | LIGHTING PRESSURE | FLOW RATE |
|---|---|---|---|---|---|
| Aluminum wire alloy, Type II according to MIL-W-6712B | 1/8” | EC | Acetylene | 15 psi | 40 |
| | | | Oxygen | 30 psi | 43 |
| | | | Air | 70 psi | 52 |

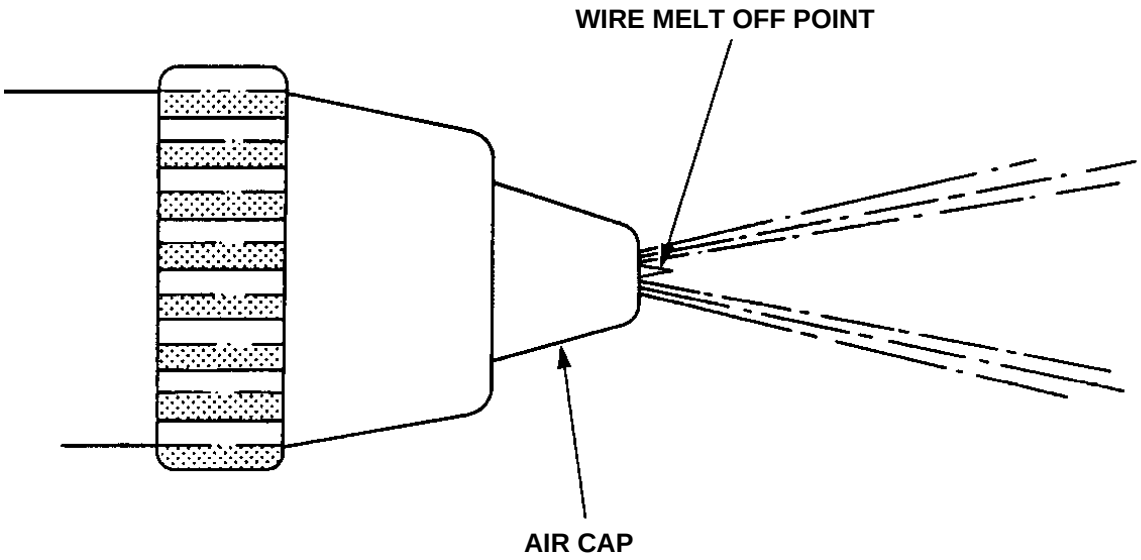



**FIGURE 3 - WIRE FEED MELT OFF POINT**

## 5.6 Metal Spraying

5.6.1 Hold the gun perpendicular to the surface of the work while maintaining a distance of 4" to 6" between the work and the nozzle, spray a ribbon of metal from one end to the other at an even travelling speed of approximately 6 inches per second. If it is not possible to hold the gun perpendicular to the work (e.g., where spraying the interior of small parts), maintain 4" to 6" between the work and the nozzle and apply the metal as evenly as possible. Ensure that each sprayed strip parallels and overlaps the previous pass by 1/3 of the sprayed arc. Control the thickness of the sprayed coating by the amount of layers applied. Do not allow the workpiece to overheat while metal spray is applied.

### 5.7 Start/Stop Operation

5.7.1 The wire feed can be stopped temporarily when spraying by carrying out the following procedure:

Step 1. Ensure that the wire snubber at the back of the gun is engaged.

Step 2. Turn the wire grip handle up to release the grip of the drive rolls.

5.7.2 To start the wire feed again, return the wire grip handle to the on position.

### 5.8 Equipment Shut Down

5.8.1 To shut down the spray gun, follow the following steps:

Step 1. Turn off the gas head valve.

Step 2. Turn the wire grip lever to the off position.

Step 3. Lock out the snubber by pushing the snubber outer sleeve forward and twisting it in the direction of the arrow.

Step 4. Shut off the oxygen and fuel cylinders.

Step 5. Shut off the air at the regulator on the air control unit.

Step 6. Back off the pressure regulating screws on the gas regulators and bleed off the pressure in the hoses and gun by opening the gas head valve momentarily.

### 5.9 Stripping Aluminum Coating

5.9.1 If complete stripping of the metal spray coating is necessary, chemically strip parts according to PPS 33.02.

5.9.2 Localized stripping of relatively small areas of parts may be accomplished by mechanical means using files or abrasive paper. When mechanically stripping parts, take extreme care not to damage either the base metal or adjacent metal coating.

5.9.3 Before re-spraying, abrasive clean stripped surfaces according to PPS 17.02.

## 6 REQUIREMENTS

### 6.1 General

6.1.1 All testing and evaluation specified herein shall only be performed by Bombardier Toronto Materials Laboratory or by laboratories accredited according to BAERD GEN-018.

### 6.2 Qualification of Equipment

6.2.1 Before production use of aluminum metal spray equipment, qualify the equipment by applying an aluminum wire spray coating to SAE 4130 and Hy-Tuf test piece samples, as specified in Table IV, according to the procedure specified herein and checking the prepared test samples for coverage, thickness and adhesion according to section 6.3.

**TABLE IV - TEST PIECE SAMPLES**

| MATERIAL | SIZE |
|---|---|
| SAE 4130 (MIL-T-6736) | 2.125" DIA X 5" X 0.065" tube |
| Hy-Tuf (AMS 6418) | Scrap pieces from production parts |

### 6.3 Test Samples - Coverage, Thickness and Adhesion Testing

6.3.1 Confirm 100% coating coverage of the sample by visual means using a stereomicroscope at 10X - 45X magnification.

6.3.2 Examine the samples metallographically. There shall be no bare area longer than 0.0010", the total cumulative bare area in any 1/2” length shall not exceed 0.0025"; and the average coating thickness (determined by drawing a straight line through the crests and troughs of the coating and then computing an arithmetic mean) shall be 0.0020" to 0.0100".

6.3.3 For SAE 4130 test samples, check coating adhesion as follows:

Step 1. Squeeze a sample in a vice to approximately half of its original diameter.

Step 2. Firmly apply 3M Shurtape around the deformed ends of the test sample

Step 3. Peel the tape off Cracking of the metal coating is acceptable; flaking or lifting of the metal coating is unacceptable.

6.3.4 For Hy-Tuf test samples, check coating adhesion as follows:

Step 1. Section the sample using a cut-off wheel.

Step 2. Apply 3M Shurtape tape to the cut edge.

Step 3. Remove the tape. Flaking or lifting of the metal coating is unacceptable.

### 6.4 Production Parts

6.4.1 Metal sprayed surfaces shall be completely covered, having a finely divided granular appearance. Evidence of globular deposits on the surface of the part is not acceptable. Refer unacceptable parts to Bombardier Toronto MRB or Bombardier Toronto delegated MRB for disposition.

6.4.2 Check the thickness of the metal spray coating (e.g., using a Mitotuyo #179 - 711 dry film thickness gauge). Unless otherwise specified on the engineering drawing, the thickness of the metal spray coating shall be 0.002" - 0.010".

## *7 SAFETY PRECAUTIONS*

*7.1 Observe standard plant safety precautions when performing the procedure specified herein.*

*7.2 Provide adequate ventilation when metal spraying is carried out. Wear protective respiratory equipment according to PPS 13.13 when performing metal spray operations.*

*7.3 Operators shall wear breathing masks, ear protection, safety glasses and protective gloves when performing metal spraying operations.*

*7.4 Do not light the spray gun without having the wire in the nozzle.*

*7.5 Do not operate the spray gun with the wire snubber locked out.*

*7.6 If the gun backfires, shut off the gun immediately.*

## 8 PERSONNEL REQUIREMENTS

8.1 This PPS has been categorized as a “Critical or Special” process according to PPS 13.39. Refer to PPS 13.39 for additional personnel requirements Certified and/or qualified personnel shall have a good working knowledge of the following, as applicable:

- be familiar with the engineering drawings and work order instructions regarding flame sprayed aluminum coating
- know how to operate the flame spray gun
- know how to perform the oxygen and fuel circuit check
- know how to prepare parts for metal spraying
- understand the importance of keeping the parts clean for metal spraying
- understand the procedure and requirements for metal spraying as outlined in this specification

8.2 Before being approved for metal spraying of production parts and every 3 months thereafter, personnel shall metal spray a SAE 4130 test sample (ref. Table IV) and submit the sprayed sample for evaluation according to section 6.3. Approval shall be granted upon the completion of a successful test. Maintain a record of all submissions and test results. Failure of the test sample to meet coverage, thickness and adhesion requirements is cause to suspend metal spraying operations until the cause of test sample failure has been determined, corrected and a subsequent test sample has proven satisfactory.

## 9 MAINTENANCE OF EQUIPMENT

9.1 Maintain equipment according to the manufacturer's instructions.

9.2 Blow through all hose lines before they are connected to their fittings and clean out all nipples and threaded connectors carefully in order to prevent moisture and dirt from entering the equipment.

## FLOW CHART 1 - METAL SPRAYING