BOMBARDIER
Toronto Site
PROPRIETARY INFORMATION

PPS 30.03

PRODUCTION PROCESS STANDARD

HEAT TREATMENT AND CONTROL OF 2024 (DD) RIVETS

Issue 15
- This standard supersedes PPS 30.03, Issue 14.
- 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.

Prepared By:	(Christie Chung)	June 12, 2014
	PPS Group	
Approved By:	(L.K. John)	June 13, 2014
	Materials Technology	
	(A. Gordon)	June 13, 2014
	Quality	

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1 SCOPE

1.1 This Production Process Standard (PPS) specifies the procedure and requirements for heat treating, issuing and the refrigerated storage control of 2024 (DD) aluminum alloy rivets.

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 This PPS is not applicable to rivets substituted for DD rivets (i.e., KE and DN rivets). Do not heat treat or refrigerate KE and DN rivets.

1.1.4 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-007 - Quality Control of Heat Treating Equipment and Hot Forming Equipment.

3.2 BAERD GEN-018 - Engineering Requirements for Laboratories.

3.3 DD Rivet Heat Treat/Transport Control Card (QA Form #29) - *Bombardier Toronto internal Quality procedure.*

3.4 de Havilland Laboratory Procedure Manual (DHLPM) Procedure No. 2075 - Shear Testing of Rivets.

3.5 Form DH3775 - Aluminum Alloy Heat Treatment (HT) Record - *Bombardier Toronto internal Quality procedure.*

3.6 PPS 13.26 - General Subcontractor Provisions.

3.7 PPS 13.39 - Bombardier Toronto Engineering Process Manual.

3.8 PPS 30.01 - Heat Treatment of Aluminum and Aluminum Alloys.

3.9 QDI-09-02 - Process Control - *Bombardier Toronto internal Quality procedure*.

4 MATERIALS, EQUIPMENT AND FACILITIES

4.1 Materials

4.1.1 Aluminum alloy rivets, alloy number 2024 (DD), types and sizes as required by Production.

4.1.2 Methyl alcohol (methanol).

4.1.3 Dry-ice (CO_2) pellets.

4.2 Equipment

4.2.1 Instrumentation and equipment shall be qualified according to BAERD GEN-007.

4.2.2 Circulating air oven and water quenching equipment meeting the requirements of PPS 30.01.

4.2.3 Rivet heat treat containers, perforated stainless steel construction, equipped with steel number tags as hinged lids.

4.2.4 Rivet heat treat baskets, stainless steel construction, capable of holding up to 12 heat treat containers.

4.2.5 Walk-in freezer located in the Heat Treat department, capable of maintaining 0°F (-18°C) or below at all times.

4.2.6 Rivet storage freezers, chest-type, capable of maintaining heat treated rivets at 0°F (-18°C) or below at all times, equipped with suitable interior storage racks. Locate the heat treat rivet storage freezer as closely as possible to the heat treat oven to facilitate refrigeration of the rivets immediately after quenching. Locate production line rivet storage freezers in the applicable manufacturing areas as closely as possible to the work.

4.2.7 Alcohol rinse tank, stainless steel construction, minimum size 24" x 18" x 12".

4.2.8 Protective leather gloves (e.g., DSC 422-3).

4.2.9 Funnels, plastic or aluminum, suitable for transferring rivets into heat treat containers.

4.2.10 Insulated transport boxes, 36" x 25" x 14", close-able, aluminum construction with 1" thick styrofoam insulation.

4.2.11 Wheeled transport dolly.

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 procedure and requirements for heat treating, issuing and the refrigerated storage control of 2024 (DD) aluminum alloy rivets according to this PPS.

4.3.2 Bombardier subcontractors shall direct requests for approval to Bombardier Supplier Quality Management. Bombardier 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 procedure and requirements for heat treating, issuing and the refrigerated storage control of 2024 (DD) aluminum alloy rivets 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 2024 (DD) rivets are high-strength aluminum alloy solid rivets used in primary aircraft structures where the utmost strength is required.

5.1.2 Because the final heat treat temper (T42) of the rivets is hard enough to crack the shop head when driving the rivets, these rivets are always driven in the solution heat treated condition.

5.1.3 The process of solution heat treating DD rivets consists of soaking at the solution heat treat temperature, a rapid quench in cold water, immersion in refrigerated methanol and then immediate refrigeration in a storage freezer.

5.1.4 Refrigerated storage of solution heat treated rivets slows down the age-hardening process and, at 0°F (-18°C), will maintain the rivets in a soft condition for up to 7 days. Alternatively, solution heat treated rivets may be stored up to a maximum of 30 days when refrigerated at -15°F (-26°C) or lower. Heat treated rivets will begin to age-harden within a few minutes of exposure to room temperature and shall be driven within 30 minutes of their removal from the storage freezer.

5.1.5 As the automatic age-hardening process occurs very quickly at room temperature, it is imperative that the procedures for heat treatment, refrigerated storage and transport specified herein are strictly followed at all times when handling DD rivets.

5.1.6 Refer to Table I for a listing of the standard types of DD rivets.

5.1.7 Store a bulk supply of each standard type of DD rivet in the Heat Treat area.

5.1.8 A batch of rivets is defined as a specific quantity and type of rivet that is solution heat treated together. Rivets from different heat treat batches shall not be mixed. Full traceability is required for each batch of rivets.

5.1.9 All facilities processing work according to this PPS shall complete a suitable form (e.g., DH Form #3775) for all heat treat operations. Each form shall be kept in the heat treat records.

TABLE I - DD RIVET TYPE DESIGNATIONS AND DESCRIPTIONS

RIVET DESIGNATION	HEAD STYLE	DESCRIPTION
BACR15BA-DD-C	FLUSH HEAD	BAC rivet - close tolerance shank
BACR15CE-DD-C	REDUCED FLUSH HEAD	BAC rivet
BACR15BB-DD-C	UNIVERSAL HEAD	BAC rivet - close tolerance shank
NAS1097DD	REDUCED FLUSH HEAD	Standard rivet
MS20426DD	FLUSH HEAD	Standard rivet
MS20470DD	UNIVERSAL HEAD	Standard rivet
MS20470DDJ4	UNIVERSAL HEAD	Jacketed rivet
CSP320DDJ4	FLUSH HEAD	Jacketed rivet
CSP372DDJ4	REDUCED FLUSH HEAD	Jacketed rivet
CSP374DDJ4	UNIVERSAL HEAD	Jacketed rivet - Chemical conversion coating finish

5.2 Rivet Requirement Lists

5.2.1 Each production line rivet storage freezer has a DD Rivet Weekly Requirement List, specifying the estimated DD rivet requirements (including individual rivet types, diameters, grip lengths and quantities).

5.2.2 If a change in the weekly DD rivet requirements occurs, the supervisor of the affected area shall contact the Rivet Control supervisor and request a revision to the Weekly Requirement List for the specific freezer.

5.2.3 Production shall ensure that the Weekly Requirement Lists accurately reflect production requirements.

5.2.4 Keep a separate Weekly Requirement List for each production line rivet storage freezer in the Rivet Control area.

5.2.5 According to each Weekly Requirement List, fill a rivet heat treat container with the required quantity of each type and size of rivet.

5.2.6 Metal stamp the rivet designation, diameter and grip length to be placed in each heat treat container onto the hinged lid of the container.

5.3 Heat Treating of DD Rivets

5.3.1 Perform batch rivet heat treatment as follows:

Step 1. Place heat treat containers into heat treat baskets.

Step 2. Load the rivet heat treat baskets in a single tier onto the air oven elevator platform. Do not load rivet heat treat baskets on top of one another because spillage and improper quenching may occur.

Step 3. Set the oven temperature control to 920 ± 10°F.

Step 4. Verify that the oven is at the set operating temperature.

Step 5. Load the oven elevator platform into the oven.

Step 6. Soak for 80 to 90 minutes.

Step 7. Lower the oven elevator into the water quench pit within 10 seconds. Quench for 1 to 2 minutes.

Step 8. Return the elevator to floor level. Ensure that the water temperature after quenching does not exceed 100°F.

Step 9. Immediately immerse each rivet heat treat basket in the refrigerated methanol rinse tank located inside the Heat Treat storage freezer. The maximum allowable elapsed time between quenching rivets and placing them in the storage freezer is 15 minutes.

Step 10. Immediately place the heat treat baskets in the Heat Treat storage freezer.

Step 11. Enter the date of heat treatment and the time the rivets were placed in the freezer on the Weekly Requirement List.

5.3.2 If the concentration of water in the methanol rinse becomes too high, as indicated by rivets freezing together in the storage freezer, replace the methanol. Then, immerse any rivets that have been frozen together into the fresh methanol bath until they separate.

5.3.3 Leave individual rivet heat treat containers in the heat treat baskets within the Heat Treat storage freezer until the rivets are issued to Production.

5.4 Rivet Distribution

5.4.1 Ensure heat treated DD rivets have been refrigerated in the rivet heat treat freezer for 1 hour minimum before being issued to Production.

5.4.2 Transport rivet storage bins in an insulated transport box that has been refrigerated for 1 hour minimum. Transport the insulated box on a wheeled transport dolly to the production line freezer in as short a time as practical. The maximum time allowed for transport of rivets is as specified in Table II. If a small rivet order is being delivered (e.g., to fill a line shortage), such containers of rivets may be hand carried provided that they are delivered to the production line storage freezer within 5 minutes of removal from the storage freezer.

5.4.3 A transport control card (e.g., QA Form #29) shall be completed and shipped with the applicable rivet order.

5.4.4 Upon receipt of the rivets at the production line rivet freezer, complete the appropriate areas of the transport control card and check the information on the card for conformance to the requirements of this PPS. If the condition of receipt or time of transport is found to conflict with the requirements of this PPS, quarantine the rivet order in a storage freezer pending disposition. Before placing the weekly order of DD rivets into the appropriate line freezer, remove all DD rivets left in the freezer from the previous week and return them for re-heat treatment (refer to section 5.6). Remove and discard all loose rivets and rivets in unmarked containers. Place the new rivet order into the production line freezer according to rivet type.

TABLE II - TRANSPORT OF DD RIVETS

TRANSPORT CONDITIONS	MAXIMUM TRANSPORT TIME (Note 1)	RECEIPT CONDITIONS (Note 2)
Carry in container without insulated transport box	5 minutes	Within 5 minutes of removal from storage freezer
Insulated transport box on transport dolly	20 minutes	Within 20 minutes of removal from storage freezer
Insulated transport box on transport dolly and rivets overlaid with approximately 1/4 Litre of dry-ice pellets per 12 heat treat containers	1 hour	Within 1 hour of removal from storage freezer and dry-ice still evident
Note 1. The transport control card shall be filled in upon issue and receipt. Note 2. As received at production line freezer.		

5.5 General Production Line Sequence

5.5.1 Follow this sequence to control handling of DD rivets:

Step 1. Perform any required preparation of parts for riveting, such as deburring, application of faying surface sealant and installation of Cleco fasteners.

Step 2. Obtain the required number of the particular type and size of rivet from the nearest production line storage freezer. Do not remove more rivets than what is expected to be driven within 30 minutes of removal from the storage freezer.

Step 3. Drive DD rivets within 30 minutes of their removal from the production line storage freezer.

Step 4. Return the unused rivets to the Heat Treat department according to section 5.6.

5.6 Unused Heat Treated Rivets

5.6.1 Return unused heat treated DD rivets that were removed from the production line freezers as follows:

Step 1. Place the rivets, in their heat treat containers, into the transport box that was used to deliver the newly heat treated rivets to the line freezer.

Step 2. Identify the rivets, by means of a suitable label taped to the top of the transport box, as being Time Expired for return to the Heat Treat Department.

Step 3. If the batch has already undergone solution heat treatment three times, discard the batch.

Step 4. Visually examine the remaining rivets and discard any obviously deteriorated rivets.

Step 5. Re-solution heat treat each batch of returned rivets.

Step 6. Place the batch in quarantine until they pass batch acceptance testing according to section 6.3.

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.

6.1.2 DD rivets shall be heat treated according to section 5.3.

6.1.3 Heat treated DD rivets shall be placed in the rivet storage freezer within 15 minutes of quenching.

6.1.4 All DD rivets shall be immersed in methanol before refrigeration to prevent rivets from freezing together. If rivets are freezing together, replace the diluted methanol in the bath with fresh methanol and rinse the rivets in the new methanol bath until the rivets separate completely.

6.1.5 Heat treated DD rivets shall be refrigerated for a minimum of 1 hour at 0°F (-18°C) before packaging for distribution to line freezers.

6.1.6 The maximum allowable transport time for heat treated DD rivets shall be as specified in Table II.

6.1.7 Check each order of heat treated rivets at the production line storage freezers according to the receipt conditions specified in Table II.

6.1.8 The maximum refrigerated storage time for DD rivets, at 0°F (-18°C), shall be 7 days. If the DD rivets are stored at -15°F (-26°C) or lower, then the maximum storage time shall be 30 days.

6.1.9 The time elapsed between removal from production line freezers and driving of DD rivets shall not exceed 30 minutes.

6.1.10 Batch acceptance testing according to section 6.3 is required for every batch of rivets heat treated more than once. Do not heat treat rivets more than three times (this includes the heat treatment performed by the mill). Solution heat treatment of rivets that have been previously heat treated by the mill, by Bombardier or by a subcontractor is considered re-heat treatment.

6.1.11 Each batch of rivets shall remain separate and traceable. Do not mix batches.

6.2 Refrigeration Control

6.2.1 At the start of each shift, check and record the temperatures of all freezers used for the refrigerated storage of DD rivets.

6.2.2 Maintain all rivet storage freezers at 0°F (-18°C) maximum at all times. If the temperature of any rivet storage freezer rises above 0°F (-18°C), disposition the applicable rivets accordingly and quarantine (e.g., according to QDI-09-02).

6.3 Batch Acceptance Testing

6.3.1 Take a random sample of 10 rivets from each batch of rivets submitted for testing. Place remaining rivets in quarantine until satisfactory lab testing is completed. Immediately after heat treating and quenching, submit the sample to the Bombardier Toronto Materials Laboratory or a Bombardier approved laboratory for testing as follows:

Step 1. After quenching, allow the rivets to age at room temperature for 24 hours.

Step 2. Shear test five rivets according to standard laboratory procedures (e.g., DHLPM Procedure No. 2075). The minimum acceptable shear strength shall be 37,000 psi.

Step 3. Longitudinally section and mount two rivets for metallographic examination at a minimum of 200X magnification. There shall be no evidence of eutectic melting or high temperature oxidation/porosity.

Step 4. Keep the three remaining rivets as spares to be tested if deemed necessary by the laboratory.

7 SAFETY PRECAUTIONS

7.1 Safety precautions applicable to the materials and procedures specified herein shall be defined by the subcontractor performing the work for Bombardier Toronto.

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:

- engineering drawings, work order instructions and PPS sections regarding the heat treatment and control of 2024 (DD) rivets.
- how to set up and operate the equipment used in the heat treatment of 2024 (DD) rivets.
- physical and mechanical properties of aluminum alloys as they apply to the aircraft industry.
- solution heat treating process and know the significance of quenching.
- effects of natural aging on the mechanical properties of aluminum alloys. Understand the importance of minimizing rivet exposure to room temperature, prompt rivet distribution, and maintaining storage freezer temperatures.
- breakdown and relevance of the American National Standards Institute (ANSI) four digit number alloy designation system for wrought and cast aluminum alloys.
- breakdown and relevance of the ANSI alpha or alpha-numeric temper designation, indicating the thermal or mechanical treatment to which the alloy has been subjected in order to produce specific mechanical properties.

9 RECORDS

9.1 Keep a record of transport control cards (e.g., QA Form #29) on file for a minimum of 6 months.

9.2 At the start of each shift, conduct temperature checks of the heat treat storage freezer and each of the production line freezers and record the results.

10 CALIBRATION AND MAINTENANCE OF EQUIPMENT

10.1 Calibration and maintenance of heat treating equipment and instrumentation shall conform to BAERD GEN-007.