BOMBARDIER

Toronto Site

PROPRIETARY INFORMATION

PPS 36.07

PRODUCTION PROCESS STANDARD

METAL TO METAL AND METAL TO METAL HONEYCOMB HIGH STRENGTH BONDING USING DHMS A6.03 ADHESIVE FILM AND PRIMER

Issue 12
- This standard supersedes PPS 36.07, Issue 11.
- 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.

- **THIS STANDARD SPECIFIES MANUFACTURING PROCESSES WHICH ARE CRITICAL TO THE STRUCTURAL INTEGRITY AND TRANSPORT CANADA CERTIFICATION OF BOMBARDIER TORONTO AIRCRAFT.**
- **IT IS IMPERATIVE THAT THE PROCEDURE SPECIFIED HEREIN BE STRICTLY ADHERED TO.**
- **THE CURRENT ISSUE OF THIS PPS AND ANY SUBSEQUENT REVISIONS TO THE PROCEDURE AND REQUIREMENTS SPECIFIED HEREIN MUST BE AUTHORIZED BY AN UNDERSIGNED TRANSPORT CANADA DESIGN APPROVAL DESIGNEE (DAD).**

(Ed Giovannetti, DAD 259) October 29, 2018

Prepared By: (Christie Chung) October 19, 2018

PPS Group

Approved By: (Stephen Mabee) October 30, 2018

Materials Technology

(Chris Schnitzler) November 5, 2018

Quality

Issue 12 - 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.

- Replaced where Cor-Fil 615 low density filler is specified with DHMS P1.30 honeycomb core filler. Specified to prepare and cure DHMS P1.30 epoxy resin according to PPS 13.23.
- Replaced where Frekote 33 is specified with DSC 234-13-3 or DSC 234-13-4 release agent.
- Specified Kraft paper should be neutral.
- Defined controlled contamination area (CCA) as the work area conditions and environmental control requirements that meet the requirements as specified in PPS 36.21.
- Specified to store, handle and prepare DHMS A6.03 and DHMS A6.06 film adhesives according to PPS 10.25. Deleted all details within this PPS to avoid conflict with information specified in PPS 10.25.
- Clarified that adhesive primer in section 5.2.2 is to DHMS A6.03-1.
- Specified the cotton gloves should be lint-free.
- Added new Step 8 in Autoclave Curing section.
- Added new details for when the engineering drawing specifies “Edge Filling” of panels (see section 5.10).
- Specified to use DHMS S3.01 Type II Class B sealant wherever PR1422 B2 and B1/2 sealant is specified. Specified to prepare and cure DHMS S3.01 according to PPS 21.20.
- As PPS 36.07 is categorized as a Controlled Critical Process, added new Personnel Requirements section and referred to PPS 13.39 for personnel requirements.
- Deleted Process Baths section as the processing PPS will determine the requirements (i.e., within PPS 31.13 and PPS 32.11).
- Added new Disposal of Chemical Waste section.
- Replaced “alodine” with “C1 coating”.

TABLE OF CONTENTS

1 SCOPE

1.1 This Production Process Standard (PPS) specifies the procedure and requirements for metal to metal and metal to metal honeycomb high strength bonding of aluminum alloys using DHMS A6.03 adhesive film and primer.

1.1.1 This PPS complements the engineering drawings that specify its use as an authorized instruction. The procedure specified in this PPS must be followed to ensure compliance with all applicable specifications. In general, if this PPS conflicts with the engineering drawing, follow the engineering drawing. The requirements specified in this PPS are necessary to fulfil the engineering design and reliability objectives.

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

1.1.3 Procedure or requirements specified in a Bombardier BAPS, MPS, LES or P. Spec. do not supersede the procedure or requirements specified in this PPS.

2 HAZARDOUS MATERIALS

2.1 Before receipt at Bombardier Toronto, 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 BAERD GEN-018 - Engineering Requirements for Laboratories.

3.2 DHMS A6.03 - Modified Epoxy Moderate Temperature Curing, High Strength, Structural Adhesive System.

3.3 DHMS A6.06 - Expandable Adhesive Film for Core Splice in Composite Construction.

3.4 DHMS P1.30 - Resin, Epoxy Base, Low Density, Honeycomb core Filler.

3.5 DHMS S3.01 - Sealing Compound, Temperature Resistant, Integral Fuel Tanks, High Adhesion.

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

3.7 PPS 13.23 - Preparation & Use of DHMS P1.30 Resin.

3.8 PPS 13.26 - General Subcontractor Provisions.

3.9 PPS 13.28 - Storage Life of Adhesives, Sealants, Paints and Composite Products.

3.10 PPS 13.39 - Bombardier Toronto Engineering Process Manual.

3.11 PPS 17.02 - Abrasive Blasting.

3.12 PPS 17.03 - Saturation Shot Peening.

3.13 PPS 21.03 - Priming, Sealing & Repair of Integral Fuel Tanks.

3.14 PPS 21.20 - Mixing and Handling Two-Part Sealants.

3.15 PPS 21.21 - General Sealing Practices.

3.16 PPS 31.04 - Degreasing Processes.

3.17 PPS 31.13 - Cleaning Aluminum Alloys for High Strength Adhesive Bonding.

3.18 PPS 31.17 - Solvent Usage.

3.19 PPS 32.02 - Manual Application of C1 Chemical Conversion Coatings.

3.20 PPS 32.11 - Chromic Acid Anodizing for High Strength Adhesive Bonding.

3.21 PPS 34.08 - Application of Epoxy-Polyamide Primer (F19 & F45).

3.22 PPS 36.21 - Environmental Control Requirements for High Strength Bonding Rooms.

3.23 PPS 36.22 - Requirements for Metal to Metal and Metal to Metal Honeycomb High Strength Bonding.

4 MATERIALS, EQUIPMENT AND FACILITIES

4.1 Materials

4.1.1 Abrasive paper, aluminum oxide, 180 - 240 grit size.

4.1.2 DHMS A6.03 supported epoxy film adhesive (see Table I).

4.1.3 DHMS A6.03-1 adhesive primer (see Table II).

4.1.4 DHMS A6.06 expandable epoxy film adhesive (see Table III).

4.1.5 Honeycomb core, aluminum alloy, “Dura-Core”.

4.1.6 Honeycomb core, flexible, aluminum alloy, “Flex-Core”.

4.1.7 Filler (for machining), low density, Epocast 167 with 9832 hardener.

4.1.8 Temporary filler (for machining) - polyethylene glycol, with fluorocene (Union Carbide Corp. Carbowax 3350, 4600, or equivalent).

4.1.9 DHMS P1.30 honeycomb core filler.

4.1.10 Epoxy resin, Hysol 4351 with 3426 and 3520 hardeners.

4.1.11 Epoxy resin filler, Cab-O-Sil.

4.1.12 Bleeder cloth, Type 5031 or equivalent.

4.1.13 Release fabric, Polytet 3A-108 or equivalent.

4.1.14 Vacuum bag material, nylon or Mylar.

4.1.15 Release agent, silicone-free, DSC 234-13-3 or DSC 234-13-4.

4.1.16 Sealant tape, Vac-Seal or equivalent.

4.1.17 Dry-ice pellets.

4.1.18 Scotch-Brite Pads, Type A, aluminum oxide, maroon, fine or medium, 3M Co.

TABLE I - DHMS A6.03 ADHESIVE FILM

DHMS DESIGNATION	FILM WEIGHT (lb/ft^2)	FILM THICKNESS (INCHES)	CARRIER
A6.03	0.030	0.005	Polyester (random mat)
	0.045	0.007	
	0.060	0.010	
	0.085	0.015	

TABLE II - DHMS A6.03-1 ADHESIVE PRIMER

DHMS DESIGNATION	COLOUR	VISCOSITY AT 74 ± 3°F
A6.03-1 (solvent based)	Yellow	24 - 30 seconds #1 Zahn cup

TABLE III - DHMS A6.06 CORE SPLICE EXPANDABLE FOAM ADHESIVE

DHMS DESIGNATION	FILM WEIGHT (lb/ft^2)	UNCURED FILM THICKNESS (INCHES)
A6.06	0.30 ± 0.05	0.05
	0.60 ± 0.05	0.10

4.2 Equipment

4.2.1 Autoclave or platen press capable of maintaining a temperature of 260°F and a differential pressure of 100 psi.

4.2.2 Equipment for indicating and recording cure cycle times, temperatures, pressures and, for the autoclave, vacuum.

4.2.3 Thermocouple wire, Iron-Constantan 1268T, B and S 30 gauge or finer, or equivalent.

4.2.4 Spray equipment, including spray guns equipped with mechanical agitation devices.

4.2.5 Curing oven, capable of maintaining a temperature of 270°F for curing primer, core splicing and filling materials.

4.2.6 Film thickness gauge, Lamina/Checker (Mitutoyo), Isoscope (Twin City Manufacturing Corp.), or equivalent.

4.2.7 Refrigeration units capable of maintaining temperatures of 0°F, or lower, for adhesive primer and film and 40°F, or lower, for foam.

4.2.8 Suitable brush anodizing equipment.

4.2.9 Wedge for removing bonded details, aluminum, Micarta or Nylon 6.6, 0.060" radiused edge, 1/8" thick, length as required.

4.2.10 Soldering iron or equivalent heat point tool.

4.2.11 Clean lint-free cotton glove (e.g., DSC 422-1).

4.2.12 Protective wrapping, neutral Kraft paper.

4.3 Facilities

4.3.1 This PPS has been categorized as a Controlled Critical Process according to PPS 13.39 and as such only facilities specifically approved according to PPS 13.39 are authorized to perform metal to metal and metal to metal honeycomb high strength bonding of aluminum alloys using DHMS A6.03 adhesive film and primer according to this PPS.

4.3.2 Bombardier subcontractors must direct requests for approval to Bombardier Aerospace Supplier Quality Management. Bombardier Aerospace facilities must direct requests for approval to the appropriate internal Quality Manager.

4.3.3 Facility approval must be based on a facility report, a facility survey and completion of a qualification test program. 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 Materials Technology may identify additional qualification and/or process control test requirements. During the facility survey, the facility requesting qualification must be prepared to demonstrate their capability. Once approved, no changes to subcontractor facilities may be made without prior written approval from Bombardier Toronto Materials Technology.

4.3.3.1 For approval of subcontractor facilities to perform metal to metal and metal to metal honeycomb high strength bonding of aluminum alloys using DHMS A6.03 adhesive film and primer according to this PPS, completion of a test program and submission of suitable test samples representative of production parts is required. Test samples must meet the requirements as defined by Bombardier Toronto Materials Technology.

4.3.3.2 All testing and evaluation specified herein must 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 For the purposes of this PPS, the term “MRB” (Material Review Board) must be considered to include Bombardier Aerospace Toronto MRB and Bombardier Aerospace Toronto delegated MRB.

5.1.2 For the purposes of this PPS, the term “CCA” (Controlled Contamination Area) is defined as the work area conditions and environmental control requirements that meet the requirements as specified in PPS 36.21.

5.2 Preparation of Materials and Equipment

5.2.1 General

5.2.1.1 Prepare DHMS P1.30 resin according to PPS 13.23.

5.2.1.2 Store, handle and prepare DHMS A6.03 and DHMS A6.06 film adhesives according to PPS 10.25.

5.2.1.3 Cut the adhesive film to the part shape or bond area as follows:

Step 1. Cut the film on a clean flat surface using scissors, a sharp knife blade or a heat point tool.

Step 2. When using detail parts as templates for cutting, prepare the details according to section 5.2.3, section 5.2.4 and section 5.2.5, as applicable, before placing them directly onto the unprotected adhesive film surface.

Step 3. If using a template for cutting, place a clean protective sheet between the adhesive film and the template.

5.2.1.4 Do not remove protective sheet from the adhesive film until applying the film to the bonding surface.

5.2.2 Preparation of Adhesive Primer

5.2.2.1 Prepare DHMS A6.03-1 adhesive primer as follows:

Step 1. Remove the required primer amount from the refrigerated storage facility (see PPS 10.25).

Step 2. Allow the primer to warm to within 10°F of the priming room temperature.

Step 3. Stir the primer thoroughly in its container and remove sufficient primer for immediate requirements. Do not thin primer.

Step 4. Re-seal the primer container and return it to the refrigerated storage facility.

Step 5. Dispose of primer showing signs of skinning, gelling, lumping or thickening.

Step 6. Use primer on subsequent shifts if stirred thoroughly before use and the total time out of the refrigerated storage facility is 4 days (96 hours) or less. If these requirements are not met, discard of adhesive primer according to section 11.

5.2.3 Aluminum Honeycomb Core

5.2.3.1 Store and handle honeycomb core material in a way that prevents damage and contamination.

5.2.3.2 Carefully straighten bent cell walls using tweezers. Reject the core if the following permanent damage remains after machining:

- Deformed cell shapes that deviate more than 1/16" from the original shape exceed 5 square inches per square foot of core surface area.
- More than 2 node bond separations per square foot of core area.
- Surface imperfections from 0.010" to 0.033" deep exceed 15 square inches per square foot of core surface area.
- Surface imperfections that exceed 0.033" in depth.

5.2.3.3 When necessary, the engineering drawing specifies core ribbon direction. If not specified, the ribbon direction is optional.

5.2.3.4 When splicing cores for ease of manufacturing, use DHMS A6.06 expandable film adhesive or Hysol 4351 core filler according to section 5.4. A maximum gap of one cell width between core edges is acceptable prior to splicing.

5.2.3.5 Machine core profiles when possible. Only crush the core to the required shape when specified on the engineering drawing.

5.2.3.6 Machine cores in the compressed block form or fill them with polyethylene glycol before machining. When specified on the engineering drawing, fill cores as follows:

- Prepare Epocast 167/9832 low density core filler according to Table IV for core filling to aid machining.
- Do not clean core received from the manufacturer in an uncontaminated condition before core filling. If the core becomes contaminated, clean according to PPS 31.13.
- The engineering drawings show the extent of areas to fill. Completely fill specified cells.
- Refer to Figure 1 for an example of edge filling before machining.

5.2.3.7 Honeycomb core surrounded by edge details on assembly may be cut up to 1/8 inch oversize to ensure contact with the edge details.

5.2.3.8 Use oil-free carbon dioxide (CO_2) gas and water containing not more than 105 ppm total suspended or dissolved solids if lubricants or liquid coolants are required for machining.

5.2.3.9 Deburr honeycomb cores after machining and, if necessary, straighten cell walls using tweezers.

5.2.3.10 Machined cores must meet the following requirements and dimensional tolerances:

- Node bond separation and crushing, tearing or cracking of core cell walls are unacceptable.
- Burred areas greater than 15 square inches per square foot of surface area are unacceptable.
- Lip-over areas greater than 7 square inches per square foot of surface area are unacceptable.
- Burrs or lip-over greater than 0.010 inches are unacceptable.
- Core surface variations greater than 0.002 inches per linear inch or 0.010 inches per 10 inches from the nominal contour are unacceptable.
- Machined slots, steps and recesses up to 0.060" wider than, but no narrower than, the nominal fitting dimension are acceptable.
- Machined slots, steps and recesses within ± 0.005" of the depth of the nominal fitting dimension are acceptable.
- Undercuts greater than 0.010" are unacceptable.

5.2.3.11 Wrap cores in clean, neutral Kraft paper and transport and store them on suitable boards to prevent distortion and damage.

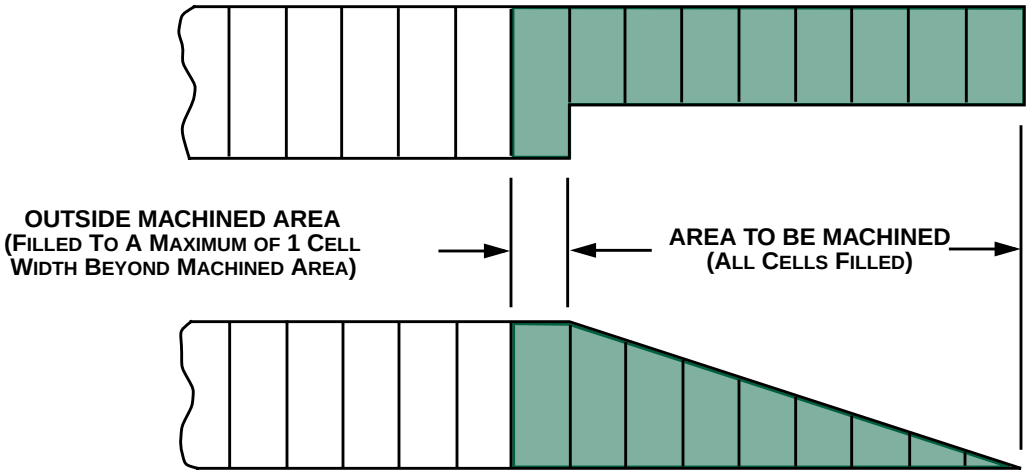


FIGURE 1 - CORE FILLING FOR MACHINING

TABLE IV - MIXING AND CURING DATA FOR CORE SPLICING, FILLING AND EDGE SEALING MATERIALS

MATERIAL	MIXING RATIO (PARTS/WEIGHT)	POT LIFE (NOTE 1)	CURING (NOTE 2)
CORE FILLING (FOR MACHINING) MATERIALS			
EPOCAST 167 BASE	100	1 hour	24 hours at 75 ± 5°F
EPOCAST 9832 HARDENER	15		
CORE SPLICING AND FILLING MATERIALS			
HYSOL 4351 RESIN (NOTE 3)	100	—	6 hours at 75 ± 5°F
HYSOL 3426 HARDENER	8.5		
HYSOL 4351 RESIN (NOTE 3)	100	—	12 hours at 75 ± 5°F or autoclave cure 1 hour at 250 ± 10°F
HYSOL 3520 HARDENER	12		
DHMS A6.06 CORE SPLICE ADHESIVE FOAM	—	—	1 hour heat up to 260 ± 10°F followed by: a) 1 hour soak at 250 ± 10°F; OR b) Autoclave cure 1 hour at 250 ± 10°F
CORE REINFORCING AND EDGE SEALING MATERIALS			
DHMS P1.30 epoxy resin according to PPS 13.23			

Note 1. The pot life is the time during which mixed adhesive remains suitable for application at 75 ± 5°F. The time indicated is for a 100 gram mix unless otherwise specified.
Note 2. All materials, after specified curing, may be exposed to a maximum of 260°F (i.e., autoclave curing).
Note 3. Cab-O-Sil epoxy resin filler, up to 20% by volume, may be added to Hysol 4351 core filler when mixing.

5.2.4 Sheet Metal and Machined Parts

5.2.4.1 Complete all fabricating operations, such as drilling and deburring, before cleaning parts for bonding.

5.2.4.2 Make a trial assembly to ensure all dimensions are correct and the degree of flatness or curvature permits a proper fit at the glue line using no more than light finger pressure.

5.2.4.2.1 It is acceptable to waive pre-fit requirements after first part qualification, when specified on the Work Order, for uncomplicated assemblies that do not require filing, trimming, hole drilling, etc., at the pre-fit stage. Reject parts that do not mate properly at the final lay-up stage. Do not work rejected parts in the CCA.

5.2.4.3 Identify all matched detail parts with the same mark or designation to prevent mismatch during re-assembly for bonding. Use a different identification mark for each assembly.

5.2.5 Cleaning and Anodizing

5.2.5.1 Clean and etch all aluminum and aluminum alloy parts, including parts to be anodized and all honeycomb cores, according to PPS 31.13.

5.2.5.2 When specified on the engineering drawing, anodize parts according to PPS 32.11. Do not hot water seal. If the engineering drawing specifies anodizing according to PPS 32.03, anodize according to PPS 32.11.

5.2.5.3 When possible, transport parts to a clean room or priming area within 30 minutes of cleaning or anodizing.

5.2.5.3.1 Protect the parts with clean neutral Kraft paper if the delay exceeds 30 minutes.

5.2.5.4 Handle cleaned or anodized parts only while wearing clean white lint-free cotton gloves, taking care not to touch bonding surfaces.

5.3 Application of Primer

5.3.1 Aluminum Honeycomb Core

5.3.1.1 Honeycomb core is pretreated by the core manufacturer and requires no priming.

5.3.2 Sheet Metal and Machined Parts

5.3.2.1 Prime parts within 16 hours of etching or anodizing.

5.3.2.2 Wrap parts in clean neutral Kraft paper if not primed within 16 hours of etching or anodizing. Prime wrapped parts within 30 days of etching or anodizing.

5.3.2.3 Constantly agitate the primer during the spraying operation to maintain uniform solid suspension.

5.3.2.4 Apply primer to areas noted on the engineering drawing and ensure complete and uniform coverage.

5.3.2.5 Primer dry film thickness must be 0.00015" - 0.00040". Measure film thickness using a suitable measuring device (see paragraph 4.2.6).

5.3.2.6 Dry the primer at room temperature for a minimum of 30 minutes followed by drying for 30 to 60 minutes at 250°F to 270°F.

5.3.2.6.1 Expose aluminum detail parts and assemblies to cure temperatures (including primer force cure, verification film cure and production autoclave or platen press cure) for an accumulated time of no more than 5.5 hours.

5.3.2.7 Store primed and cured detail parts unprotected in the CCA for a maximum of 30 days without having to further process before bonding.

5.3.2.7.1 Primed details stored unprotected in the CCA for more than 30 days must be solvent wiped twice according to PPS 31.17 or degreased according to PPS 31.04 before bonding.

5.3.2.8 Store primed and cured detail parts in the CCA for a maximum of 12 months, without having to further process before bonding, if protected by one of the following methods:

- Wrap individually or in groups with clean oil-free Kraft paper or black carbon-filled polyethylene film (0.006" minimum thickness).
- Stack on suitable racks with the top detail covered, protecting all bonding surfaces.

5.3.2.8.1 Clean primed details stored protected for more than 12 months according to paragraph 5.3.2.7.1 before bonding.

5.3.2.9 Store primed and cured detail parts protected by one of the methods listed in paragraph 5.3.2.8 in a clean dry area outside the CCA for a maximum of 5 years (60 months). Clean such parts according to paragraph 5.3.2.7.1 before bonding.

5.3.2.10 Only handle primed parts while wearing clean lint-free white cotton gloves.

5.4 Core Splicing and Filling

5.4.1 Except as noted in paragraph 5.4.1.1 and paragraph 5.4.1.2, use DHMS A6.06 core splice adhesive foam for the following applications when specified on the engineering drawing.

- Core splicing bonds (Figure 2-A).
- Core to rigid edge member bonds (Figure 2-B).
- Core to insert bonds and attachment points (Figure 2-C).
- Rise of core at edge of doublers greater than 0.040" thick (Figure 2-D).
- Milled steps in the core greater than 0.040" high (Figure 2-E).
- Taper cut edges of cores (Figure 2-F).

5.4.1.1 Use Hysol 4351 resin and Hysol 3426 or 3520 hardener instead of DHMS A6.06 adhesive foam for core to insert bonds and attachment points when specified on the engineering drawing.

5.4.1.2 Use DHMS P1.30 resin for core reinforcing when specified on the engineering drawing.

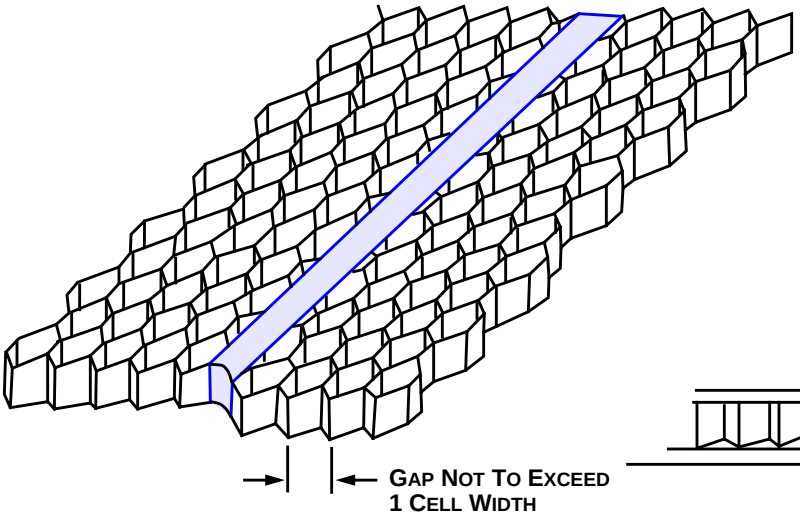


Fig. 2-A

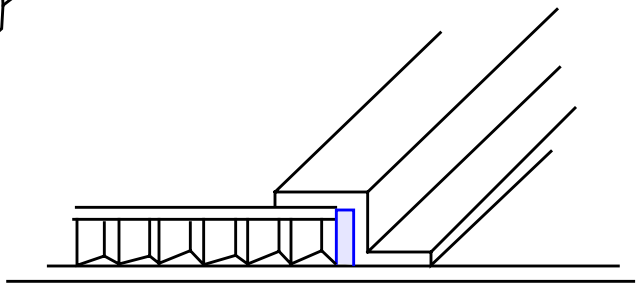


Fig. 2-B

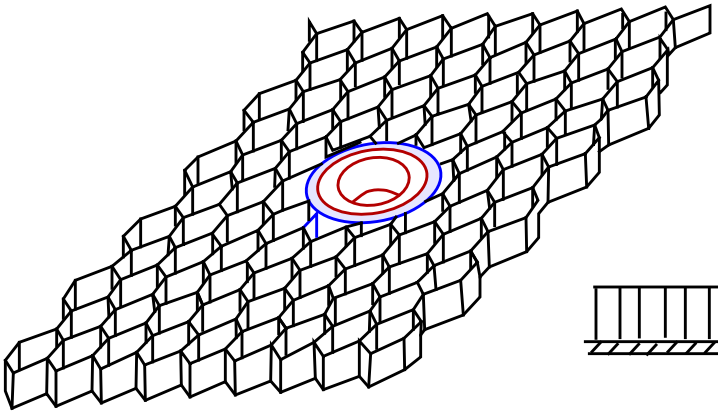


Fig. 2-C

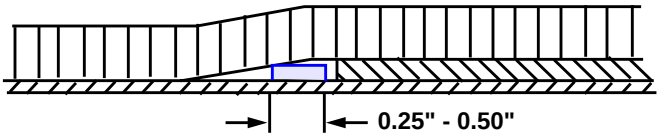


Fig. 2-D

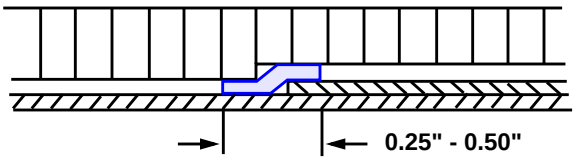


Fig. 2-E

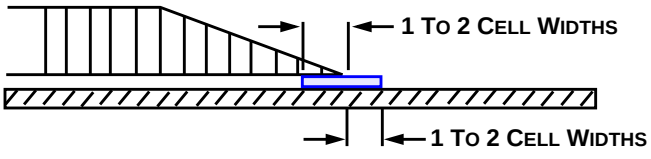


Fig. 2-F

FIGURE 2 - CORE SPLICING AND FILLING

5.4.2 When using DHMS A6.06 adhesive, remove the required adhesive foam amount of the appropriate thickness from the refrigerated storage facility (see PPS 10.25) and allow it to warm to within 10°F of ambient temperature.

5.4.3 Cut the adhesive foam to the required shape using scissors or a sharp knife blade.

5.4.4 Position the adhesive foam as specified on the engineering drawing and Figure 2. Making the adhesive foam more pliable and tacky by warming with air not exceeding 160°F is acceptable.

5.4.5 Use adhesive foam on subsequent shifts if protected from contamination and the total time out of the refrigerated storage facility is 5 days (120 hours) or less. Discard adhesive foam that does not meet these requirements.

5.4.6 Cure DHMS A6.06 adhesive using either of the cure cycles specified in Table IV.

5.4.7 Prepare and cure Hysol 4351 as specified in Table IV.

5.5 Application of Adhesive

5.5.1 Remove the protective sheet from one side of the adhesive film, if not already positioned on the detail according to paragraph 5.2.1.3 Step 2, and apply it to the detail surface.

5.5.2 Trim the adhesive film on assembly provided the trimming tool does not damage the metal details or the anodic or primer coating.

5.5.3 Note the following points when positioning adhesive film:

- A maximum gap of 0.060" between butt joints of adhesive film is acceptable.
- Filling voids such as joggles or machined gaps in glue lines using a second adhesive film layer is acceptable provided voids do not exceed 15 square inches per square foot of bond area. The second layer may extend a maximum of 1/16 inch beyond the void edges.

5.5.4 Lightly roll the film using a suitable roller to ensure even contact over the bond surface and to remove wrinkles and entrapped air.

5.5.5 It is acceptable to tack the film in position using a heat iron over the separator sheet.

5.5.6 Do not remove the separator film until immediately before assembling the parts for bonding.

5.6 Assembly

5.6.1 Jig Assembly

5.6.1.1 Assemble the parts into the fixture or jig in a way that the adhesive film contacts the mating part surfaces.

5.6.1.2 Construct jigs or fixtures to positively locate the parts and provide a uniform bearing surface for each bond. Jig bearing surfaces smaller in area than the bond area of the part are unacceptable. The upper surface of the bottom part of the jig must accommodate the assembly contour. In addition, the jig must facilitate the installation of additional parts and, if required, must include locating pins for positioning parts.

5.6.1.3 If the area of the jig pressure plate is greater than the bonding area, mark the correct differential pressure on top of the plate and the work order card.

5.6.1.4 Use of tape for local securing is acceptable. Do not use silicone tape.

5.6.1.5 If necessary, use release agent (see paragraph 4.1.15) to prevent the assembly from bonding to the jig or bleeder cloth

5.6.2 Assembly Without Jigs

5.6.2.1 Examples of assemblies bonded without using jigs or fixtures include bonding of doublers or stringers to flat skins and bonding honeycomb panels of uniform thickness.

5.6.2.1.1 On flat skins, apply the adhesive film to the doubler or stringer and, on honeycomb panels, apply the adhesive film to the skin.

5.6.2.1.2 If it is more convenient for production, trim the film to shape after assembly provided the trimming tool does not damage the metal details or the anodic coating.

5.6.2.2 Correctly position details by locating with tooling or rivet holes or by matching the detail profiles.

5.6.2.2.1 When using temporary fasteners for locating by holes, coat the fasteners with a suitable release agent (see paragraph 4.1.15) and allow them to dry.

5.6.2.3 Use tape to secure the parts in position. Do not use silicone tape.

5.7 Bagging of Parts for Curing

5.7.1 Bagging of Fixture or Work Tray

5.7.1.1 Locate the parts on a suitable fixture or autoclave work tray. Apply release fabric when necessary.

5.7.1.2 It is acceptable to group test panels (i.e., clean line process control, anodize process control, adhesive receipt test, etc.) on a dedicated work tray. Use the same bagging procedure as for production parts.

5.7.1.3 Using tape, secure the bare thermocouple wire ends to the assembly at the glue line or to the jig as close to the glue line as possible. Do not use silicone tape.

5.7.1.3.1 Use the number of thermocouples specified in Table V.

TABLE V - THERMOCOUPLES

NUMBER OF ASSEMBLIES	NUMBER OF THERMOCOUPLES
1 - 3 assemblies in one autoclave bag	2 per assembly (2 - 6 total)
4 - 9 assemblies in one autoclave bag	1 per assembly (4 - 9 total)
10 or more assemblies in one autoclave bag	1 for each 2 assemblies (5 minimum)
1 load on an autoclave table	4 minimum
Platen press load	1 for each 2 assemblies (4 minimum)
Test panel work tray in autoclave or platen press	2 per work tray

5.7.1.3.2 Position thermocouples to represent the minimum and maximum rate of heating of assemblies being bonded. On honeycomb panels, place thermocouples on both upper and lower glue lines.

5.7.1.4 Check thermocouples for continuity and polarity and identify them accordingly.

5.7.1.5 Position bleeder cloth over the parts.

5.7.1.5.1 Place extra bleeder cloth layers over sharp protrusions on the assemblies, test pieces, temporary fasteners or packing to protect the vacuum bag.

5.7.1.5.2 Wrap pressure pads, when used, in release fabric or use release agent.

5.7.1.6 Place two vacuum outlets in position as shown in Figure 3.

5.7.1.7 Position vacuum bag over the assembly and seal the edges using Vac-Seal tape.

5.7.1.8 Connect one vacuum outlet to the shop vacuum supply and apply a vacuum of 10 inches of mercury (5.0 psi).

5.7.1.9 Work the vacuum bag and bleeder cloth to eliminate voids and bridging between the work piece and the jig and close the valve at the lay-up table.

5.7.1.10 Ensure maximum loss of vacuum is one inch of mercury (0.5 psi) per two minutes.

5.7.1.10.1 If loss of vacuum exceeds the limits specified in paragraph 5.7.1.10, check for leaks and rectify.

5.7.1.11 Before beginning the bonding cycle, apply a vacuum of 15 inches of mercury (7.5 psi) for 30 minutes to metal to metal bonded assemblies with unvented bond areas greater than 18 inches by 36 inches.

5.7.1.11.1 Immediately before transporting to the autoclave, evacuate the bag, close the valve on the bag and disconnect the shop vacuum line.

5.7.2 Free Bagging

5.7.2.1 Perform free bagging as follows:

Step 1. Lay vacuum bag material on the autoclave work tray.

Step 2. Place bleeder cloth on the vacuum bag material.

Step 3. Locate the assembly, together with the necessary test pieces specified in PPS 36.22, on the bleeder cloth.

Step 4. Attach thermocouples according to paragraph 5.7.1.3 and paragraph 5.7.1.4.

Step 5. Fold the bleeder cloth and vacuum bag material over the assembly. Place extra bleeder cloth layers over sharp protrusions on the assemblies, test pieces, temporary fasteners or packing to protect the vacuum bag.

Step 6. Place two vacuum outlets in position as shown in Figure 3.

Step 7. Seal the vacuum bag edges with Vac-Seal tape and evacuate and test the bagged assembly according to paragraph 5.7.1.8 through paragraph 5.7.1.11.

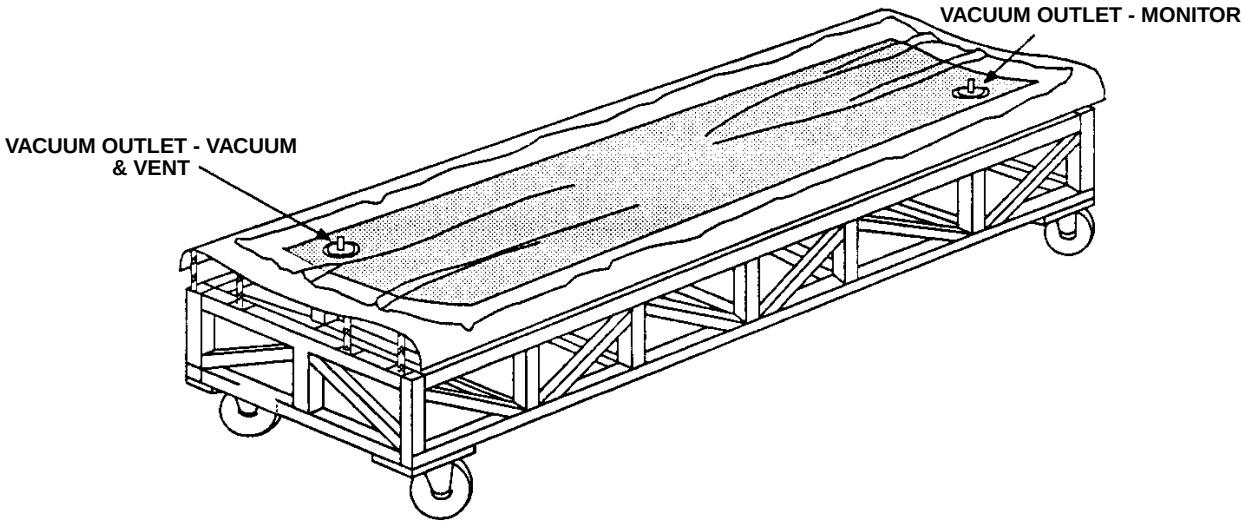


FIGURE 3 - POSITIONING VACUUM OUTLETS

5.7.3 Bagging for Platen Press

5.7.3.1 Attach thermocouples according to paragraph 5.7.1.3 and paragraph 5.7.1.4.

5.7.3.2 Vacuum bagging is not required for platen press curing.

5.8 Autoclave Curing

5.8.1 When using an autoclave not equipped with a vacuum monitor system, check the pressure under the bag at the start of the cure period, at the middle of the cure period, at the end of the cure period and immediately before releasing the temperature and pressure. Close the lines to the vacuum/vent for 30 seconds before each check and open them after each check.

5.8.2 Autoclave cure as follows:

Step 1. Load the tray containing the work into the autoclave, connect the vacuum and vacuum monitor lines, as shown in Figure 4, and connect the glue line thermocouples.

Step 2. Apply a minimum of 10 inches of mercury (5.0 psi) to the bagged assembly for metal to metal bonds, and 5 to 10 inches of mercury (2.5 to 5.0 psi) or vent to the atmosphere for metal honeycomb bonds. Do not interrupt the vacuum, once applied, until reaching the applicable differential pressure.

Step 3. Close and lock the autoclave door.

Step 4. Turn on heaters and begin heating the parts. Raise the autoclave temperature to 250 ± 10°F at a rate of 2 to 10°F per minute.

Step 5. Pressurize the autoclave to obtain a differential pressure selected for the particular assembly being bonded. During bonding, maintain the differential pressure within ± 5% of the selected pressure. Pressurize the autoclave to the applicable differential pressure before the glue line reaches 160°F.

- For metal to metal bonds, select a differential pressure from within the range of 35 to 100 psi.
- For honeycomb panels, select the maximum differential pressure allowable for the applicable core thickness, cell size and foil thickness from Table VI.

Step 6. After reaching the differential pressure, slowly release the vacuum and raise the autoclave pressure simultaneously to maintain the pressure differential.

Step 7. The maximum pressure allowed under the vacuum bag is 5 psi. If the gauge reading under the bag exceeds 5 psi before the lead part thermocouple attains a 140°F reading, release the autoclave pressure, remove the load, re-seal the bag and insert the load back into the autoclave.

Step 8. As each thermocouple reaches 140°F, maintain the heat up rate for that thermocouple at a rate of 2 to 10°F per minute until 250 ± 10°F is reached.

Step 9. Cure parts a minimum of 90 minutes at 250 ± 10°F while maintaining the applicable pressure.

Step 10. At the end of the curing time, reduce the temperature to 160°F or lower while maintaining pressure.

Step 11. When the temperature has dropped to 160°F or lower, release the pressure, remove the load from the autoclave and allow to cool to room temperature.

- Expose aluminum detail parts and assemblies to cure temperatures (including primer force cure, verification film cure and production autoclave or platen press cure) for an accumulated time of no more than 5.5 hours.
- Handle parts with care and do not stress them during the cool-down period.

Step 12. Hot water seal unprimed anodized surfaces according to PPS 32.11 within 72 hours of bonding and before any further operations.

Step 13. Protect unsealed surfaces with clean neutral Kraft paper.

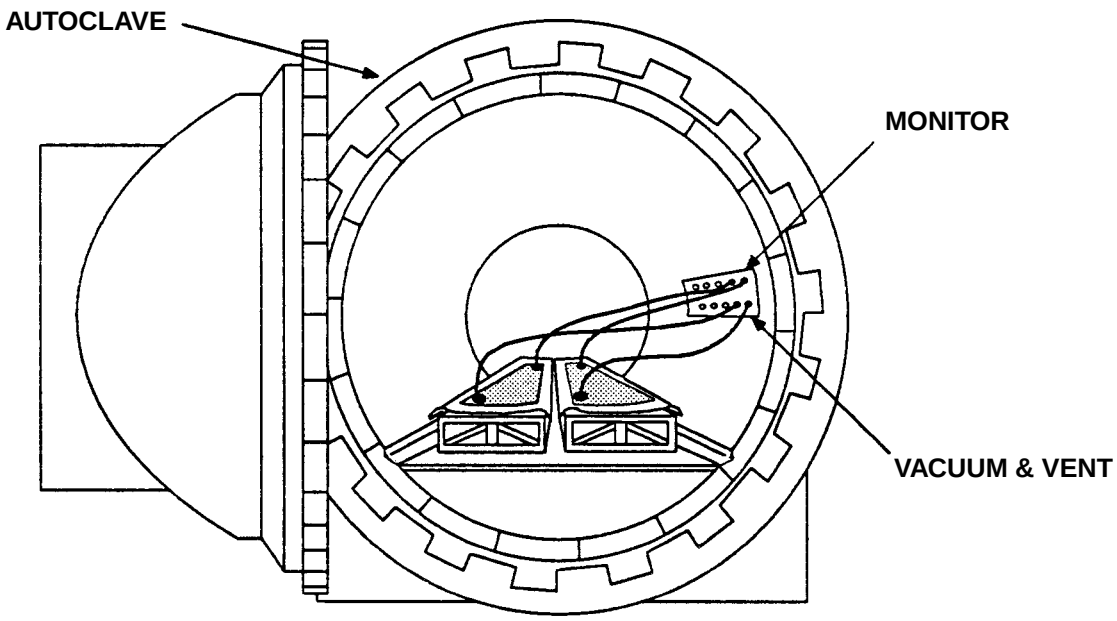


FIGURE 4 - CONNECTING VACUUM AND VACUUM MONITOR LINES

5.9 Platen Press Curing

5.9.1 If at any time during the temperature soak period the pressure drops more than ± 5% of the specified pressure or a temperature indication falls below 240°F, consider the cure cycle for that part to have stopped and restart only when the variance has been corrected. Extend the temperature soak period by the amount of time the cycle was out of tolerance.

5.9.2 Expose aluminum detail parts and assemblies to cure temperatures (including primer force cure, verification film cure and production autoclave or platen press cure) for an accumulated time of no more than 5.5 hours.

5.9.3 Perform high pressure platen press curing as follows:

Step 1. Locate the assemblies and test piece fixtures onto the lower platen of the press. Position parts according to the tool proving tests carried out before production.

Step 2. Connect the thermocouples to the press temperature recorders.

Step 3. Close the press and apply the pressure selected for the particular assembly being bonded. During bonding, maintain the pressure within ± 5% of the selected pressure.

- For metal to metal bonds, select a pressure from within the range of 35 to 100 psi.
- For honeycomb panels, select the maximum differential pressure allowable for the applicable core thickness, cell size and foil thickness as specified in Table VI.

Step 4. Once the pressure has stabilized, engage the heaters and raise the temperature of the parts to 250°F ± 10°F at a rate of 2°F to 10°F per minute (i.e. the heat-up rate for the lagging thermocouple must be at least 2°F per minute while the heat-up rate for the leading thermocouple must not exceed 10°F per minute).

Step 5. While maintaining the applicable pressure, maintain the parts at the cure temperature (250°F ± 10°F) for a minimum of 75 minutes. The parts must not remain at the cure temperature for more than 5.5 hours. Base the heat up rate and start of the cure cycle on the lagging thermocouple.

Step 6. Upon completion of the temperature soak period, while maintaining pressure, disengage the platen heaters and cool the parts at no more than 10°F per minute.

Step 7. When the temperature has dropped to 160°F or lower, release the pressure, remove the load from the press and allow to cool to room temperature.

Step 8. Handle parts with care and do not stress them during the cool-down period.

Step 9. Hot water seal unprimed anodized surfaces according to PPS 32.11 within 72 hours of bonding and before any further operations.

Step 10. Protect unsealed surfaces with clean neutral Kraft paper.

TABLE VI - MAXIMUM CORE PRESSURE

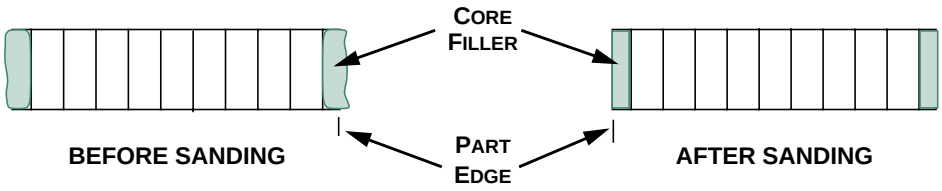
5052-H39 HONEYCOMB CORE			MAXIMUM DIFFERENTIAL PRESSURE	
CELL SIZE (INCHES)	FOIL THICKNESS (INCHES)	DENSITY (lb/ft^3)	CORE THICKNESS LESS THAN 0.60" (PSI)	CORE THICKNESS MORE THAN 0.60" (PSI)
1/8	0.0007	3.1	50	45
	0.001	4.5	100	100
	0.0015	6.1	100	100
	0.002	8.1	100	100
3/16	0.0007	1.8	25	20
	0.001	3.1	50	45
	0.0015	4.4	100	95
	0.002	5.7	100	100
	0.0025	6.9	100	100
	0.003	8.1	100	100
1/4	0.0007	1.6	15	10
	0.001	2.3	30	25
	0.0015	3.4	60	55
	0.002	4.3	95	90
	0.0025	5.1	100	100
	0.003	6.0	100	100
	0.004	7.9	100	100
3/8	0.001	1.6	15	10
	0.002	3.0	50	45
	0.0025	3.6	70	65
	0.003	4.2	90	85
	0.004	5.4	100	100
	0.005	6.5	100	100
	0.006	7.5	100	100

5.10 Edge Sealing/Finishing

5.10.1 When specified on the engineering drawing, seal exposed honeycomb core edges flush using DHMS P1.30 as specified herein after visual and non-destructive testing as specified in PPS 36.22.

5.10.2 Prepare and cure DHMS P1.30 according to PPS 13.23.

5.10.3 If the engineering drawing specifies “Edge Filling” of panels, use a suitable spatula to fill all open edge cells with the core filler specified. Allow DHMS P1.30 resin to cure according to PPS 13.23. Smooth to the required part profile by lightly sanding the edge with 180-240 grit abrasive paper.



5.11 Rebonding Due to Excessive Voids or Poor Fit (Metal to Metal Bonds)

5.11.1 If bonded assemblies fail to meet the inspection requirements specified in PPS 36.22, and MRB has authorized the repair, assemblies must be re-bonded by qualified personnel as follows:

Step 1. Using a wedge with radiused edges (see paragraph 4.2.9), carefully delaminate the detail to be removed, beginning along its leading edge.

Step 2. If no void in the bondline exists to use as a starting point for inserting the wedge, locally chill the starting point, by packing with dry ice, to facilitate disbonding of the adhesive.

Step 3. Take extreme care to avoid damaging the adhesive primer coat while removing bonded details.

Step 4. Inspect detail parts to the dimensional and surface finish requirements of the engineering drawings and, if acceptable, must be re-used in the re-bonded assembly.

Step 5. Except as noted below, it is not necessary to remove cured adhesive from the bond faying surfaces before re-bonding.

(1) If a detail has been removed due to incorrect positioning, reduce any adhesive flash at the original glue line edge which will interfere with correct fit-up for re-bonding to a maximum thickness as that of the cured bondline adhesive by sanding with 240 - 280 grit aluminum oxide abrasive paper (see Figure 5). If detail parts were severely mismatched, it may be necessary to fair the cured glue line edge toward the surrounding structure to prevent voids during re-bonding.

(2) Removal of adhesive flash by chemical means is prohibited.

(3) Take extreme care to avoid removing the adhesive primer coat or damaging the surface of the surrounding structure while removing flash.

(4) Solvent wipe the bondline area and surrounding structure according to PPS 31.17 to remove sanding residue.

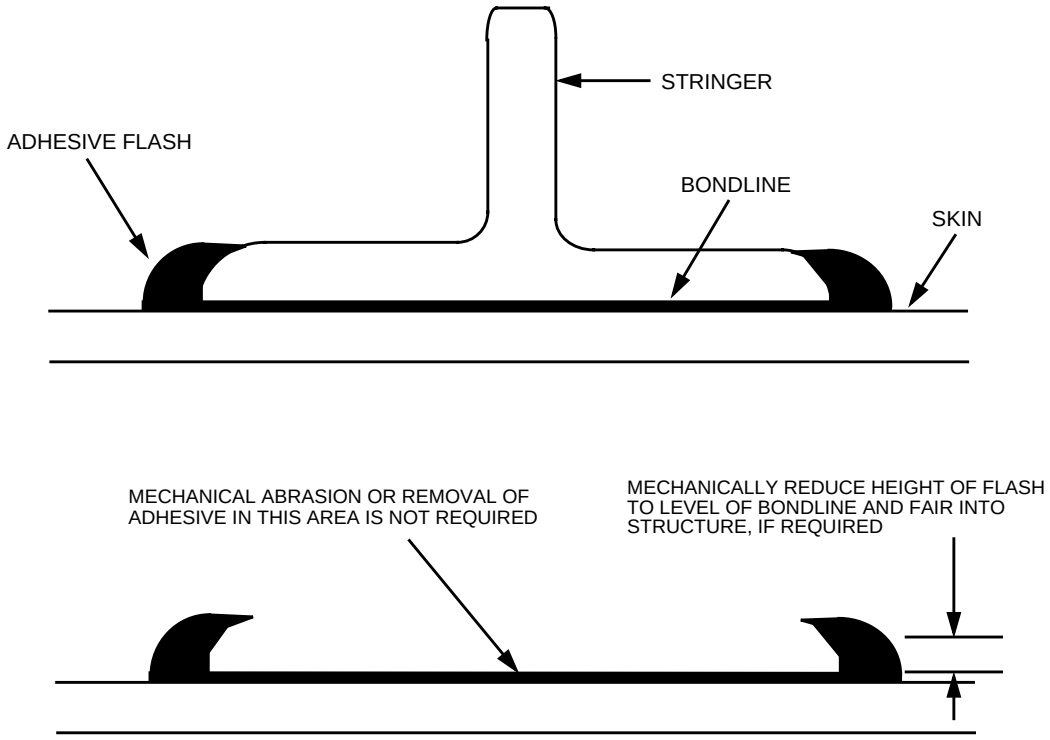


FIGURE 5 - REMOVAL OF ADHESIVE FLASH-OUT FOR REPOSITIONING OF DETAILS

5.11.2 If cured adhesive comes completely away from a bonding surface, inspect the substrate for adhesive primer removal in the rebond area. If the maximum single primer removal area is 0.5 in^2 and the total bare area is 5% of the bondline area, or less, chromic acid brush anodize the bare areas as follows:

Step 1. Abrade applicable surfaces using Scotch-Brite (see paragraph 4.1.18) to ensure complete removal of the original anodic coating and solvent wipe according to PPS 31.17.

Step 2. Perform final electrocleaning using the manufacturer's electrolyte solution according to the manufacturer's instructions.

Step 3. Brush anodize immediately after electrocleaning.

Step 4. Ground the actual part (anode) according to the equipment manufacturer's instructions.

Step 5. Use a stylus or probe (cathode), prepared according to the equipment manufacturer's instructions, to apply the anodic coating. Whenever possible, the cathode contacting surface area must be approximately 1/3 of the defect area. Back up thin parts, such as skin panels, with an aluminum block or plate in the region being treated to prevent overheating due to current resistance.

Step 6. Chromic acid brush anodize at a temperature of 70 to 75°F.

Step 7. Fill a polyethylene squeeze bottle with the applicable manufacturer's chromic acid anodizing solution.

Step 8. Set the power pack voltage at 20 volts. The original amperage should read less than 0.5 amperes. If the amperage is above 0.5 amperes, reduce the voltage accordingly.

Step 9. While swabbing the area according to Step 10, raise the voltage until reaching a maximum of 1.5 amperes and continue to work at an average of 1.5 amperes. Ensure the amperage never exceeds 2.0 amperes as localized overheating and arcing between the cathode and contact area will result.

Step 10. Swab the defective area in a circular motion for approximately 10 minutes, moving the probe at 5 to 20 surface feet per minute and maintaining a supply of chromic acid solution at the probe tip.

- Keep the probe in motion to prevent localized part overheating.
- Periodic flushing of the area with cold water is acceptable.

Step 11. Rinse brush anodized surfaces with cold water, dry, and touch-up with a brush coat of F19 primer.

Step 12. Cure F19 primed surfaces according to PPS 34.08.

Step 13. If areas of bare metal exceed the limits specified in paragraph 5.11.2, refer the assembly to MRB for disposition.

Step 14. If adhesive comes completely away from a bonding surface, leaving the adhesive primer intact, solvent wipe the surfaces according to PPS 31.17, lightly scuff with Scotch-Brite (see paragraph 4.1.18) and re-wipe according to PPS 31.17.

Step 15. Lay-up parts for rebonding, prepare and apply adhesive film, bag and cure parts according to the procedure specified herein. Localized bagging of repair areas only is not permitted.

Step 16. After rebonding, refer assemblies that fail to meet the requirements specified in PPS 36.22 to MRB for disposition.

5.12 Sealing Voids in Glue Line Edge

5.12.1 To prevent the ingress of moisture, fillet seal edge voids within the limits specified in PPS 36.22 using DHMS S3.01 Type II Class B sealant according to PPS 21.21.

5.12.2 Prepare and cure sealant according to PPS 21.20.

5.13 Removal of Excess Adhesive Film Protrusion

5.13.1 Only remove adhesive flash if the protrusion exceeds the limits specified in PPS 36.22.

5.13.1.1 Mechanically remove adhesive flash in a way that prevents damage to the skin or bonded joint. Do not use chemical strippers. Reject the assembly if there is evidence of metal removal, adhesive primer removal or chemical contamination of bondline adhesive.

5.14 Repair Bonding of Machined Aluminum Alloy Parts

5.14.1 When authorized by MRB, use the following procedure to repair machining defects in aluminum alloy parts.

5.14.1.1 Perform all manufacturing operations, including machining, non-destructive testing, shot peening, etc., before preparing part surfaces for bonding.

5.14.1.2 When applicable, locally strip parts of primer according to section 5.14.2 before preparing surfaces for repair bonding.

5.14.2 Stripping of Primed Surfaces for Repair Bonding

5.14.2.1 Mask the repair area of a primed surface, plus approximately 1 inch around the entire surface perimeter, using masking tape.

5.14.2.2 Locally strip F19 primed surfaces according to PPS 31.07.

5.14.2.3 Strip F21 primed surfaces by abrasive blasting with glass bead media according to PPS 17.02 or by hand abrading using 120 grit, or finer, aluminum oxide abrasive paper.

5.14.2.3.1 Take care to avoid scratching the base metal during primer removal.

5.14.2.4 Lightly abrade the exposed metal surface using Scotch-Brite (see paragraph 4.1.18), blending any minor scratches caused by primer removal.

5.14.2.5 Completely remove primer to the masking tape border showing a clear line between primed and bare surfaces.

5.14.3 Surface Preparation for Repair Bonding

5.14.3.1 Prepared surface for repair bonding according to section 5.14.4 as follows:

Step 1. Remove masking tape applied according to paragraph 5.14.2.1.

Step 2. Shot peen the repair areas of machined parts according to PPS 17.03 when specified by MRB.

Step 3. Degrease machined parts and repair doublers according to PPS 31.04 or solvent wipe according to PPS 31.17.

Step 4. Except as noted below, rack and clean parts and doublers according to PPS 31.13.

- Rack locally stripped primed parts in a way that immerses a minimum area of the part in the cleaning solution but completely immerses the bare repair area.

Step 5. Except as noted below, chromic acid anodize parts and doublers according to PPS 32.11. Do not seal the anodic coating.

- Only immerse the bare area of locally stripped primed parts in the anodizing solution. Do not seal the anodic coating.

Step 6. Include process control test panels, prepared according to PPS 32.11, with each load of parts processed for repair bonding.

Step 7. Before applying bonding primer to bare areas of previously primed parts, mask off the same area specified in paragraph 5.14.2.1 to avoid overlapping existing primer with bonding primer.

Step 8. Apply DHMS A6.03-1 primer to all surfaces of bare machined parts and repair doublers and to bare surfaces of locally stripped parts according to section 5.3.2.

5.14.4 Repair Bonding

5.14.4.1 Repair bond as follows:

Step 1. After curing the bonding primer, apply 0.060 lb/ft^2 FM 73M adhesive according to section 5.5 and assemble and tape parts and repair doublers together according to section 5.6.2.

Step 2. Except as noted below, bag parts according to section 5.7 and attach two thermocouples per repair area.

- Local bagging of repair areas only on rigid machined parts is acceptable.

Step 3. Cure parts according to section 5.8 or section 5.9, as applicable.

Step 4. Only remove adhesive flash from bondlines of fuel tank parts to an extent that will allow fillet sealing of the bondline edges according to Step 6.

Step 5. F19 prime according to PPS 34.08 or F21 prime according to PPS 21.03, as applicable.

Step 6. Seal bondlines of repaired fuel tank parts using DHMS S3.01 Type II Class B sealant according to PPS 21.03.

6 REQUIREMENTS

6.1 PPS 36.22 specifies the requirements for assemblies bonded according to the procedures detailed herein.

6.2 Ensure priming and bonding work areas meets PPS 36.21 requirements.

7 SAFETY PRECAUTIONS

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

8 PERSONNEL REQUIREMENTS

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

9 ADDITIONAL INFORMATION

9.1 Finish and Corrosion Protection of Bonded Joints

9.1.1 Except when trimming is necessary according to section 5.13, leave the adhesive flash to seal bonded joints.

9.1.2 Manually apply C1 coating to trimmed bare metal edges according to PPS 32.02 and apply two brush coats of F19 primer according to PPS 34.08.

9.2 Clothing

9.2.1 To maintain a condition of complete cleanliness, always wear new white cotton gloves during all bonding operations.

- Do not continue to use gloves that have become contaminated.
- Do not clean gloves for re-use in the bond shop.

9.2.2 Wear clean lab coats or coveralls in the bond lay-up area.

10 STORAGE LIFE OF MATERIALS

10.1 Refer to PPS 13.28 for the storage life of adhesives and resin (e.g., DHMS A6.03 and DHMS A6.06 and Hysol 4351).

10.2 Always use the oldest stock first (i.e., first in/first out (FIFO) basis).

11 DISPOSAL OF CHEMICAL WASTES

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