BOMBARDIER
Turboprops *(de Havilland)*

PPS 36.22

PRODUCTION PROCESS STANDARD

REQUIREMENTS FOR METAL TO METAL AND METAL TO METAL HONEYCOMB HIGH STRENGTH BONDING

Issue 6
- This standard supersedes PPS 36.22, Issue 5.
- PPS ACN's 36.22/1 through 36.22/4 and PPS PSD's 36.22-1 through 36.22-4 have been superseded in this or previous issues.
- Extensive changes and/or deletions have been made at this issue and, therefore, detail changes have not been noted (e.g., changes initiated by Bombardier Turboprops PPS Amendment Request AR #8255).

- **THIS STANDARD SPECIFIES MANUFACTURING PROCESSES WHICH ARE CRITICAL TO THE STRUCTURAL INTEGRITY AND TRANSPORT CANADA CERTIFICATION OF BOMBARDIER AEROSPACE 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) March 21, 2005

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This PPS is effective as of the distribution date specified on the accompanying distribution notice.

Direct any PPS related questions to the PPS Group (416) 375-7641.

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1 SCOPE

1.1 This Production Process Standard (PPS) specifies the procedure and requirements for metal to metal and metal to metal honeycomb assemblies bonded according to PPS 36.04 and PPS 36.07.

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. 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 Turboprops, all materials must be approved and assigned Material Safety Data Sheet (MSDS) numbers by the Bombardier Turboprops 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 Turboprops Environment, Health and Safety Department.

3 REFERENCES

3.1 PPS 13.26 - General Subcontractor Provisions.

3.2 PPS 10.35 - Fabrication of 250°F Cure, Epoxy Resin Pre-Impregnated, Fibre Reinforced Composite Parts.

3.3 PPS 31.04 - Degreasing Processes.

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

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

3.6 PPS 36.04 - Metal to Metal Honeycomb High Strength Bonding using FM 137/DHMS A6.03-1.

3.7 PPS 36.07 - Metal to Metal and Metal to Metal Honeycomb High Strength Bonding using DHMS A6.03 Adhesive Film and Primer.

3.8 Engineering Order (E.O.) 70015 - “First-Off” Bonded Pre-Production Assemblies That Shall Be Destructively Tested.

3.9 ASTM C297 -Standard Test Method for Tensile Strength of Flat Sandwich Constructions in Flatwise Plane.

3.10 ASTM D1002 - Metal Specimens, Single-Lap-Joint Adhesively Bonded, by Tensile Loading (Metal-to-Metal), Apparent Shear Strength.

3.11 ASTM D1781 - Adhesives, Climbing Drum Peel for.

4 MATERIALS AND EQUIPMENT

4.1 Materials

4.1.1 Tool proving film, FM 641 and FM 643 Verifilm.

4.2 Equipment

4.2.1 Suitable electronic testing apparatus for detecting unbonded areas.

4.2.2 Suitable ultrasonic testing equipment for detecting unbonded areas.

4.2.3 Industrial X-Ray equipment.

4.2.4 Tensile testing machine as specified in ASTM D1002.

4.2.5 Climbing Drum Peel Test apparatus as specified in ASTM D1781.

4.2.6 Flatwise Tension Testing apparatus as specified in ASTM C297.

5 PROCEDURE

5.1 Procedures for metal to metal and metal to metal honeycomb high strength bonding of aluminum alloys shall be as specified in PPS 36.04 or PPS 36.07, as applicable.

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

6 REQUIREMENTS

6.1 Inspection Schedule

6.1.1 Test all metal to metal bonded assemblies according to Table I.

6.1.2 Test all metal to metal honeycomb bonded assemblies according to Table II.

TABLE I - INSPECTION SCHEDULE (METAL TO METAL BONDS)

PPS	TEST	SECTION	QUALIFICATION TESTING (NOTE 1)	PRODUCTION TESTING
36.07	Tool Proving	6.2	Yes	1 assembly after 50 cycles in autoclave on any 1 tool
	Visual	6.3	Yes	100%
	Tapping or Electronic	6.4.1	Yes	100% except if the thinnest member in the bond area is over 0.050" thick
	Ultrasonic	6.4.2	Yes	1 assembly after production of each 50 assemblies
				100% if specified on the engineering drawing
				Assemblies too thick to be inspected by tapping
				Assemblies which have failed tap test
	Tensile Shear	6.5	2 test panels per assembly	N/A
	Peel	6.6	2 test panels per assembly	
	Destructive	6.8	First-off assembly specified by Bombardier Toronto Engineering	Any assembly specified by Bombardier Toronto Engineering
	Adhesive, Foam & Primer Acceptance & Storage Life Extension	6.10	N/A	Upon receipt from manufacturer
				Upon expiry of storage life
				Upon expiry of each storage life extension
	Recording of Processing Information	6.11	N/A	As specified in section 6.11

Note 1. Except as noted below, qualification testing (except destructive testing according to section 6.8) shall be carried out at the following times:
- First-off each new assembly
- First-off each modified assembly
- First-off assembly on each new bonding tool
- First-off assembly on each modified bonding tool

Multiple Use Tool - If 2 or more similar assemblies (e.g., left and right hand assemblies, flat stock, etc.) are bonded on a common bonding tool, the group of assemblies may be qualified by testing 1 representative assembly from the group, provide that prior written approval has been obtained from Bombardier Quality.

TABLE II - INSPECTION SCHEDULE (METAL TO METAL HONEYCOMB BONDS)

PPS	TEST	SECTION	QUALIFICATION TESTING (NOTE 1)	PRODUCTION TESTING
36.07	Tool Proving	6.2	Yes	25th, 100th and every 100th cycle thereafter in the autoclave on any 1 tool
	Visual	6.3	Yes	100%
	Tapping or Electronic	6.4.1	Yes	100%
	X-Ray	6.4.3	Yes	Assemblies subjected to pressures in excess of those specified in the bonding PPS
				Assemblies repaired structurally
				If specified on engineering drawings or EO's
	Peel	6.7	3 test panels per assembly	N/A
	Destructive	6.9	First-off assembly specified by Bombardier Toronto Engineering	Any assembly specified by Bombardier Toronto Engineering
	Adhesive, Foam and Primer Acceptance & Storage Life Extension	6.10	N/A	Upon receipt from manufacturer
				Upon expiry of storage life
				Upon expiry of each storage life extension
	Recording of Processing Information	6.11	N/A	As specified in section 6.11

Note 1. Except as noted below, qualification testing (except destructive testing according to section 6.8) shall be carried out at the following times:
- First-off each new assembly
- First-off each modified assembly
- First-off assembly on each new bonding tool
- First-off assembly on each modified bonding tool

Multiple Use Tool - If 2 or more similar assemblies (e.g., left and right hand assemblies, flat stock, etc.) are bonded on a common bonding tool, the group of assemblies may be qualified by testing 1 representative assembly from the group, provide that prior written approval has been obtained from Bombardier Quality.

When an assembly or tool must be re-qualified, the inspection shall be re-started at "first-off".

6.1.3 Qualification Test Reports

6.1.3.1 Qualification Test Reports must consist of a tool proving test report (see section 6.2) and, after bonding the first assembly, the results of the remaining qualification tests as specified in Table I or Table II, as applicable.

6.1.3.2 Each report must include the following information:

- Assembly identification
- Bonding tool identification
- Adhesive film and primer batch numbers and roll or lot numbers
- Thermocouple locations
- Processing information in detail (heat-up, cure time, temperature and pressure)
- Results of qualification tests as specified in Table I or Table II, as applicable

6.1.3.3 Qualification Test Reports must be approved by Bombardier Quality before commencing production of the relevant assembly.

6.1.3.4 Maintain each Qualification Test Report on file.

6.2 Tool Proving (Verification Film Test)

6.2.1 Complete all fabrication operations, including drilling and deburring, before assembling parts for tool proving.

6.2.1.1 Cleaning of parts according to PPS 31.13 is not required before tool proving. However, parts must be free of shop swarf, metal chips, etc. and may be degreased according to PPS 31.04 to remove shop oils or grease.

6.2.2 Process assemblies through the complete cure cycle using the tool proving film specified in Table III. The thickness of the tool proving film must correspond to the thickness of the adhesive film to be used on the production parts.

6.2.2.1 As an alternative to tool proving film, the adhesive film to be used for the assembly in production, laminated between approved non-perforated parting films (maximum thickness of 0.002" each) may be used as tool proving film.

6.2.3 Evaluate fit, cure pressure, time cycle and bondline thickness on the results of inspection of the tool proving film.

6.2.3.1 Measure the thickness of the tool proving film, to within ± 0.001", at enough locations to establish an adequate profile of the bondline thickness.

6.2.3.2 Bondline thickness shall be according to the values specified in Table III. Refer tool proving film thicknesses outside of the limits specified in Table III to Bombardier Toronto Engineering for disposition.

6.2.4 Include tool proving test results in the Qualification Test Report (see section 6.1.3) and submit to Bombardier Toronto for approval before commencing bonding on the assembly.

6.2.5 After tool proving, parts may be used for production assemblies provided they are processed according to PPS 31.13 and, if applicable, PPS 32.11 before bonding.

TABLE III - TOOL PROVING FILM AND BONDLINE THICKNESS REQUIREMENTS

PPS	ADHESIVE SYSTEM	FILM ADHESIVE THICKNESS (INCHES)	TOOL PROVING FILM	BONDLINE THICKNESS (NOTE 1) (INCHES)	
				MINIMUM	MAXIMUM
36.04	FM137/DHMS A6.03	0.005	FM643	0.002	0.010
		0.007		0.002	0.015
		0.010		0.002	0.020
		0.015			
36.07	DHMS A6.03	0.005		0.002	0.010
		0.007		0.002	0.015
		0.010		0.002	0.020
		0.015			
Note 1. Bondline thickness shall not vary more than 0.008" per inch of bondline in any direction.					

6.3 Visual Inspection

6.3.1 Before the application of any protective coating, visually inspect assemblies to the requirements of Table IV.

6.3.2 Consider metal to metal bonded portions of honeycomb panels as metal to metal bonds.

TABLE IV - DEFECTS FOUND ON VISUAL INSPECTION

PPS	TYPE OF DEFECT	DESCRIPTION	LIMITS	CORRECTIVE ACTION
METAL TO METAL BONDS				
36.07	Lack of Adhesive Flash	Discontinuities in adhesive flash on any edge	Acceptable provided there are no voids present	If necessary, see corrective action for voids on glue line edge.
	Voids on Glue Line Edge	Where glue line is less than flush with edges of bonded details	Up to 1/8 deep for doublers (except waffle doublers)	If limits are not exceeded, seal with polysulphide sealant according to the applicable bonding PPS. If limits are exceeded, refer to MRB for authorization to rebond per the applicable bonding PPS.
	Excess Adhesive Flash	See Figure 1	Areas critical for mating part fit-up and limits in such areas shall be determined and agreed upon between the bonding and assembly facilities. No limit in non-designated areas. No sharp edges allowed. Strings due to bag wrinkles and bleeder cloth perforations are acceptable provided they are a maximum of 0.020" in height in non-designated areas & do not exceed limits in designated areas. Flash-out shall be no higher than bonded details in fuel tank areas and a maximum of 0.003" higher than bonded details and beyond net trim lines in all other areas. No loose film allowed.	If necessary, trim excess flash according to the applicable bonding PPS.
METAL TO METAL HONEYCOMB BONDS				
36.04 and 36.07	Voids on Glue Line Edge	—	None allowed	If limits are exceeded, refer to MRB for disposition.
	Mark-Off or Printing	Depth of any single defect on aerodynamic surfaces, landings & attachment point	0.010" maximum	
		Depth of any single defect on surfaces not critical to aerodynamic flow, such as inner skins of access doors, etc.	0.025" maximum	
	Dents and Dimples	Diameter	1.00" maximum	
		Depth	0.020" maximum	
		Distance between edges of any 2 defects	Minimum 4X diameter of larger defect	
	Warpage	Deviation from true contour on panels not secured by mechanical fasteners on 2 or more sides	0.016"/foot maximum (Note 1)	
		Deviation from true contour on panels secured by mechanical fasteners on 2 or more sides	0.016"/foot maximum (Note 1)	
	Surface Irregularities (Non-Visible Side)	Deviations from true contour on non-visible side due to tolerance build-up, core machining deviations, core mismatch, doublers, hard points	0.006"/inch maximum. 0.030" maximum over overall length of part	

Note 1. Deviation in any direction measured along the edge of the part in a free state.

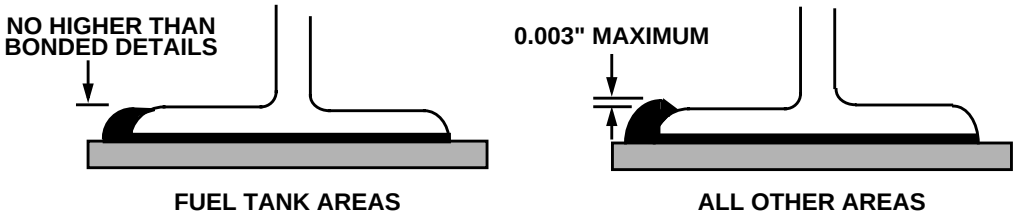

FIG. 1-A

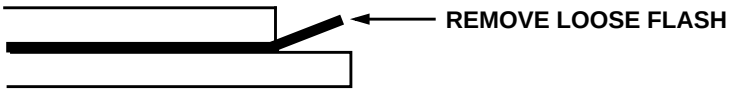

Fig. 1-B

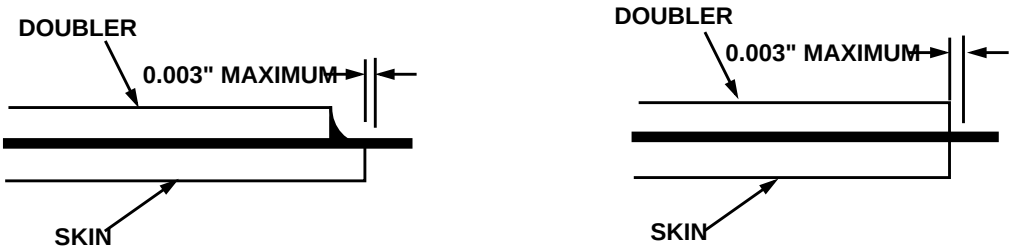

Fig. 1-C

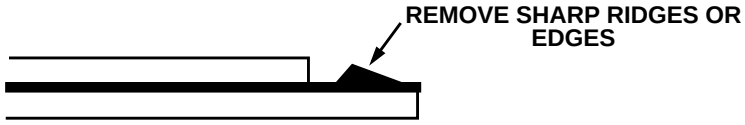

Fig. 1-D

FIGURE 1 - ADHESIVE FLASH LIMITS

6.4 Non-Destructive Testing

6.4.1 Tapping or Electronic Test

6.4.1.1 Test bonded assemblies for internal flaws such as voids, blisters and delaminations using a 1/2 inch diameter solid nylon rod, or 2024-T3 aluminum alloy rod, with the ends smoothly rounded to a 1/4 inch radius, or using an electronic test method approved by Bombardier Quality.

6.4.1.2 Wherever possible, carry out the tapping test in a sound proof area. Tap the entire bonded area lightly and rapidly. A well bonded area will produce a clear solid tone, while an unbonded area will produce a dull tone.

6.4.1.3 Ultrasonically test assemblies bonded according to PPS 36.07, showing indication of unbonded areas, porous areas, or voids in metal to metal bonds, according to section 6.4.2.

6.4.1.4 Mark assemblies bonded according to PPS 36.04 or PPS 36.07, showing indication of unbonded areas in honeycomb bonds, to show the extent of the defect. The defects must not exceed the limits specified in Table V.

6.4.1.4.1 Reject and refer assemblies not meeting the requirements of Table V to MRB for disposition.

6.4.1.4.2 Consider metal to metal bonded portions of honeycomb panels as metal to metal bonds.

6.4.2 Ultrasonic Inspection (Metal to Metal Bonds)

6.4.2.1 Unless otherwise specified, the requirements for ultrasonic testing shall be as specified in Table V.

6.4.3 X-Ray Test (Metal to Metal Honeycomb Bonds)

6.4.3.1 Carry out X-ray tests, if required according to Table II, after edge sealing.

6.4.3.2 Examine the X-ray film or viewer for evidence of the following defects in assemblies:

- Crushed or broken cell walls
- Honeycomb core pulled away from details
- Cell nesting condition (i.e., collapse of cells)
- Defective core filling, reinforcing and edge sealing
- Node bond separation

6.4.3.3 Reject and refer assemblies showing evidence of any of the above defects to MRB for disposition.

TABLE V - DEFECTS DETECTED DURING NON-DESTRUCTIVE TESTING

<table>
<tr><th>PPS</th><th>TYPE OF DEFECT</th><th>DESCRIPTION OF DEFECT</th><th colspan="2">LIMITS</th><th>CORRECTIVE ACTION</th></tr>
<tr><td colspan="6">ULTRASONIC TESTING OF METAL TO METAL BONDS</td></tr>
<tr><td rowspan="5">36.07</td><td rowspan="5">VOID, UNBONDED AREA OR POROUS AREA</td><td>Maximum Size of Single Defect</td><td colspan="2">Stringers & Waffle Doublers: 0.5 in^2
Doublers: 0.5" long or 0.5" wide</td><td rowspan="5">If limits are exceeded, refer to MRB for disposition</td></tr>
<tr><td>Maximum Total Defect Area</td><td colspan="2">4.50 in^2 per square foot of bond area</td></tr>
<tr><td>Minimum Distance from Bond Edge</td><td colspan="2">0.25"</td></tr>
<tr><td rowspan="2">Minimum Distance Between Defects (Note 1)</td><td>Area of Defect (in^2)</td><td>Minimum Distance (Inches)</td></tr>
<tr><td>0.13 - 0.25
0.26 - 0.38
0.39 - 0.50</td><td>1.00
2.00
3.00</td></tr>
<tr><td colspan="6">TAPPING OR ELECTRONIC TESTING OF METAL TO METAL HONEYCOMB BONDS</td></tr>
<tr><td rowspan="4">36.04 and 36.07</td><td rowspan="4">VOID, UNBONDED AREA OR POROUS AREA</td><td>Maximum Size of Single Defect</td><td colspan="2">1.0 in^2</td><td rowspan="4">If limits are exceeded, refer to MRB for disposition</td></tr>
<tr><td>Maximum Total Defect Area</td><td colspan="2">5.0 in^2 per square foot of bond area</td></tr>
<tr><td>Minimum Distance from Bond Edge</td><td colspan="2">0.5"</td></tr>
<tr><td>Minimum Distance Between Defects</td><td colspan="2">3.0"</td></tr>
<tr><td colspan="6">Note 1. Minimum acceptable distance between defects of different sizes shall be as specified for the smaller defect.</td></tr>
</table>

6.5 Tensile Shear Tests

6.5.1 Preparation of Shear Test Panels

6.5.1.1 Each test panel must consist of two test plates conforming to the dimensions shown in Figure 2.

6.5.1.1.1 Blank, shear or mill each test plate from 2024-T3/T4 Alclad aluminum alloy to QQ-A-250/5 except, where production parts are chem-milled, the test plates shall not be chem-milled but made from non-clad aluminum alloy to QQ-A-250/4.

- If the test plates are made from non-clad aluminum alloy to QQ-A-250/4, and are to be used to qualify assemblies whose detail parts are chem-milled, prepare the surfaces of the plates according to PPS 32.11.
- If the test plates are made from 2024-T3/T4 Alclad to QQ-A-250/5, and are to be used to qualify assemblies or adhesives, deoxidize the surfaces of the panels according to PPS 31.13.

6.5.1.1.2 Machine square all edges of the test plates (no bevels or burrs) and smooth (RMS 140 maximum) before any surface treatment.

6.5.1.1.3 Clean, dry, prime and bond the test plates according to the procedure specified in PPS 36.04 or PPS 36.07, as applicable.

6.5.1.2 Apply adhesive film, 6" long by 5/8" wide, to the surface of one of each pair of test plates and lightly rolled to obtain uniformity.

6.5.1.3 Apply the second plate over the plate containing the film as illustrated in Figure 2.

6.5.1.4 Locate the test panels in a suitable curing fixture and bag separately from the production parts.

6.5.1.5 After curing, cut each panel so as to produce 5 test pieces from each panel. Cutting may be accomplished using a band saw, ensuring that frictional heating of the bond is kept to a minimum.

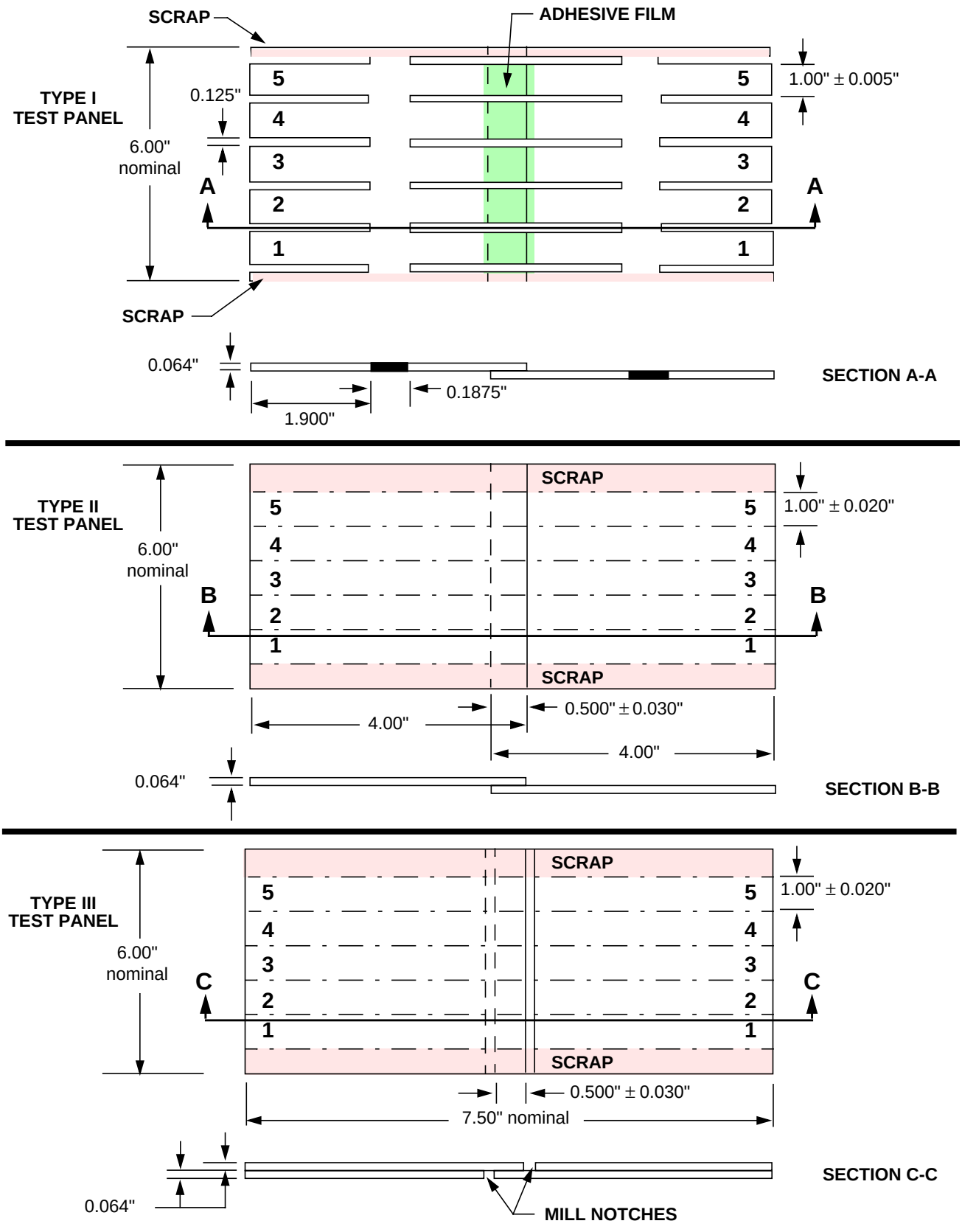

FIGURE 2 - TENSILE SHEAR TEST PANELS

6.5.2 Test Procedure

6.5.2.1 Grip each of the test pieces in the jaws of the testing machine and apply a load to provide a stress increase of 1200 to 1400 pounds per square inch of bonded area per minute until failure occurs.

6.5.2.1.1 The test apparatus shall conform to ASTM D1002.

6.5.2.1.2 Perform testing at a temperature of 80 ± 10°F.

6.5.2.1.3 Record the nature of the failure (i.e., adhesive, cohesive or contact), as well as the percentage of bond area affected by each type of failure. Base this on visual inspection of the fractured test piece.

6.5.2.2 Where samples have failed to meet the requirements specified in Table VI, record the type of test specimen, the nature of the failure and the amount of bond area affected. Determine the reason for the failure and take corrective action. Refer the relevant assemblies to MRB for disposition.

TABLE VI - REQUIREMENTS FOR TENSILE SHEAR TEST

PPS	ADHESIVE SYSTEM	FILM WEIGHT	TYPES I & II TEST PANELS		TYPE III TEST PANELS	
			AVERAGE SHEAR VALUES (MINIMUM)	INDIVIDUAL SHEAR VALUES (MINIMUM)	AVERAGE SHEAR VALUES (MINIMUM)	INDIVIDUAL SHEAR VALUES (MINIMUM)
36.04	FM137/DHMS A6.03	All	2800 psi	2600 psi	2500 psi	2350 psi
36.07	DHMS A6.03	0.030 psf	3700 psi	3200 psi	3900 psi	3450 psi
		0.045 psf, 0.060 psf & 0.085 psf	4200 psi	3500 psi		

Note 1. If the average test values for Type I or II test panels falls below 3000 psi or an individual test value for Type I or II test pieces falls below 2800 psi, initiate a daily test program according to section 6.10. The relevant assemblies are acceptable.

Note 2. If the average test values for Type III test panels falls below 3000 psi or an individual test value for Type III test pieces falls below 2800 psi, initiate a daily test program according to section 6.10. The relevant assemblies are acceptable.

6.6 Climbing Drum Peel Tests (Metal to Metal Bonds)

6.6.1 Preparation of Peel Test Panels

6.6.1.1 Each test panel must consist of two test plates conforming to the dimensions shown in Figure 3.

6.6.1.1.1 Cut both the base plate and the facing to be peeled from 2024-T3/T4 Alclad aluminum alloy to QQ-A-250/5.

6.6.1.1.2 Remove all burrs before surface treatment.

6.6.1.1.3 Deoxidize the surfaces of the test plates according to PPS 31.13.

6.6.1.1.4 Prime and bond the test plates according to PPS 36.04 or PPS 36.07, as applicable.

6.6.1.2 Apply a strip of adhesive film, 9 1/8" long by 3" wide, to one face of the base plate.

6.6.1.3 Apply the facing to be peeled over the base plate as shown in Figure 3.

6.6.1.4 Locate the test panels in a suitable curing fixture and bag separately from the production parts.

6.6.1.5 After curing, cut two 1 inch wide test pieces from the test panel, as shown in Figure 3, for climbing drum peel tests. Cutting may be accomplished using a band saw, ensuring that frictional heating of the bond is kept to a minimum.

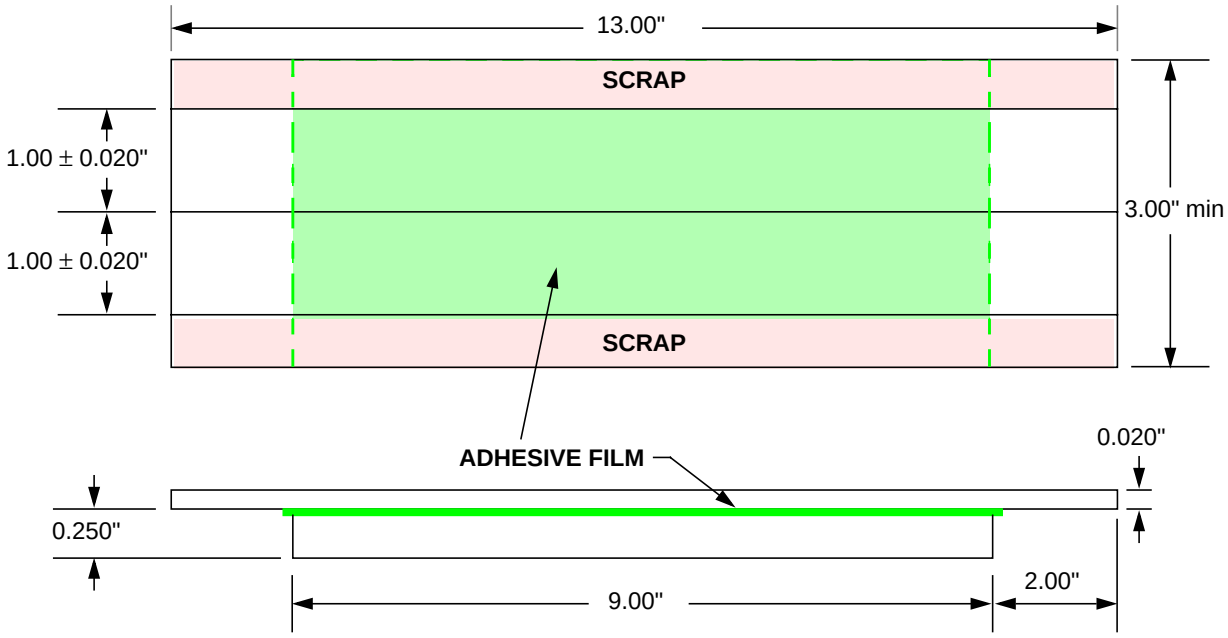

FIGURE 3 - CLIMBING DRUM PEEL TEST PANEL (METAL TO METAL BONDS)

6.6.2 Test Procedure

6.6.2.1 Clamp one end of the 2 inch overhang of the facing to be peeled in the climbing drum apparatus.

6.6.2.1.1 The apparatus shall conform to the dimensions specified in ASTM D1781.

6.6.2.1.2 Perform testing at a temperature of 80 ± 10°F.

6.6.2.2 Clamp the opposite end of the facing in the top jaws and clamp the straps of the peeling apparatus in the bottom jaws of the testing machine.

6.6.2.3 Apply the load so as to peel the facing from the backing plate, using a crosshead speed of 1.0 ± 0.10" per minute.

6.6.2.3.1 Make autographic recordings of the load versus distance peeled, or crosshead movement, and use the resulting graph to determine the average peel load.

6.6.2.3.2 Calculate the average peel torque as specified in ASTM D1781.

6.6.2.3.3 Record the nature of the failure (i.e., adhesive, cohesive or contact) as well as the percentage of bond area affected by each type of failure. Base this on visual inspection of the peeled test piece.

6.6.2.4 The minimum acceptable average peel torque shall be as specified in Table VII.

6.6.2.5 Where samples have failed to meet the minimum peel torque requirement, determine the reason for the failure and take corrective action. Refer the relevant assemblies to MRB for disposition.

TABLE VII - AVERAGE PEEL TORQUE REQUIREMENTS (METAL TO METAL BONDS)

PPS	ADHESIVE SYSTEM	FILM WEIGHT (lbs/ft^2)	PEEL TORQUE (PER INCH OF WIDTH)
36.07	DHMS A6.03	0.030	37 inch pounds
		0.045 and greater	56 inch pounds

6.7 Climbing Drum Peel Tests (Metal to Metal Honeycomb Bonds)

6.7.1 Preparation of Peel Test Panels

6.7.1.1 The test panel must consist of two facing plates and a core as shown in Figure 4.

6.7.1.1.1 The core shall be 0.50" thick 5052-H39 aluminum alloy honeycomb of the following type:

- Cell Size.....1/4 inch
- Foil Thickness.....0.004 inches
- Density.....7.9 lbs/cubic foot

6.7.1.1.2 The facings must be 0.020" thick 2024-T3 Alclad aluminum alloy to QQ-A-250/5.

6.7.1.1.3 Remove all burrs before surface treatment.

6.7.1.2 Deoxidize the test panel facing plates according to PPS 31.13.

6.7.1.3 Prime and bond the facing plates and core according to the procedure specified in PPS 36.04 or PPS 36.07, as applicable.

6.7.1.4 Apply adhesive film, 10" long by 11" wide, to one face of each of the facings and lightly roll to obtain uniformity.

6.7.1.5 Assemble the facings and core as shown in Figure 4.

6.7.1.6 Place the test panels in the vacuum bag according to PPS 36.04 or PPS 36.07, as applicable, and cure with the assemblies.

6.7.1.7 After curing, cut the test panel so as to produce 3 test pieces.

6.7.1.7.1 Cutting may be accomplished using a band saw, ensuring that frictional heating of the bond is kept to a minimum.

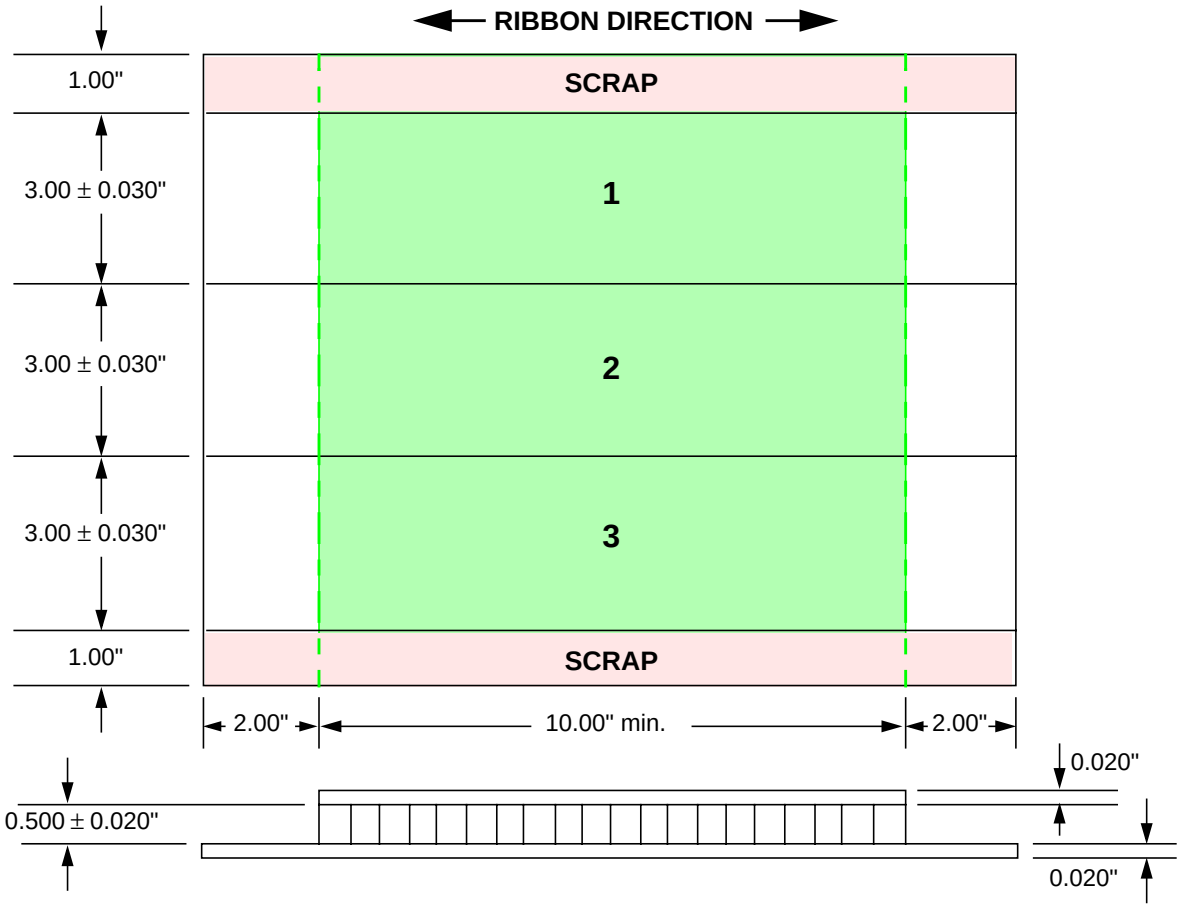

FIGURE 4 - CLIMBING DRUM PEEL TEST PANEL (METAL TO METAL HONEYCOMB BONDS)

6.7.2 Test Procedure

6.7.2.1 Clamp one end of the 2 inch overhang of the facing to be peeled in the climbing drum apparatus.

6.7.2.1.1 The peeling apparatus must conform to the dimensions specified in ASTM D1781.

6.7.2.1.2 Perform testing at a temperature of 80 ± 10°F.

6.7.2.2 Clamp the opposite end of the facing in the top jaws and clamp the straps of the peeling apparatus in the bottom jaws of the testing machine.

6.7.2.3 Apply the load so as to peel the facing from the core using a crosshead speed of 1.0 ± 0.10" per minute.

6.7.2.3.1 Make autographic recordings of the load versus distance peeled, or crosshead movement, and use the resulting graph to determine the average peel load.

6.7.2.3.2 The average peel torque of each individual test piece shall not be less than those specified in Table VIII.

6.7.2.4 Where samples have failed to meet the minimum peel torque requirements, determine the reason for failure and take corrective action. Refer the relevant assemblies to MRB for disposition.

TABLE VIII - AVERAGE PEEL TORQUE REQUIREMENTS (METAL TO METAL HONEYCOMB BONDS)

PPS	ADHESIVE SYSTEM	PEEL TORQUE (PER INCH OF WIDTH)
36.04	FM137/DHMS A6.03	12 inch pounds
36.07	DHMS A6.03	15 inch pounds

6.8 Destructive Testing (Metal to Metal Bonds)

6.8.1 Measure bondline thickness in areas of minimum and maximum tool proving film thickness as determined according to section 6.2. Bondline thickness must meet the requirements specified in Table III.

6.8.2 Fit-up and alignment of mating detail parts shall be according to the engineering drawing.

6.8.3 Test assemblies for destructive testing for tensile shear strength, crack extension or other destructive test, as specified by Bombardier Toronto Engineering, by the Bombardier Turboprops Materials Laboratory or by a Bombardier approved source.

6.8.4 Cut tensile shear and crack extension test pieces from the areas designated by Bombardier Toronto Engineering and Quality, on a marked-up drawing, to provide verification of the bonding integrity of the entire assembly.

6.8.4.1 Tensile shear test pieces must conform to the dimensions shown in Figure 5.

6.8.4.2 Crack extension test panel dimensions shall be according to PPS 31.13.

6.8.5 Carry out tensile shear tests according to section 6.5.2 and carry out crack extension tests according to PPS 31.13.

6.8.6 The average and individual shear test values for tensile shear test pieces shall not be less than those specified in Table IX.

6.8.7 The requirements for crack extension tests shall be as specified in PPS 31.13.

6.8.8 If the tensile shear test piece fails to meet the minimum requirements specified in Table IX, or if the crack extension test piece fails to meet the requirements specified in PPS 31.13, cut two additional test pieces, one on either side, from the area immediately adjacent to the failed test piece.

6.8.8.1 Failure of either of the two test pieces shall be a failure to qualify the represented assembly or shall be cause to reject the represented production parts, if applicable.

6.8.9 Submit a written report of each destructively tested assembly, showing the following information, to Bombardier Toronto Engineering for approval before commencing production:

- Results of applicable destructive tests, including size and location of test pieces, individual tensile shear strength, if applicable, bond line thickness, lap length and width, nature of failure and date of test.
- Test Observations - minimum and maximum bondline thickness measurements, according to paragraph 6.8.1, and any pertinent visual observations.

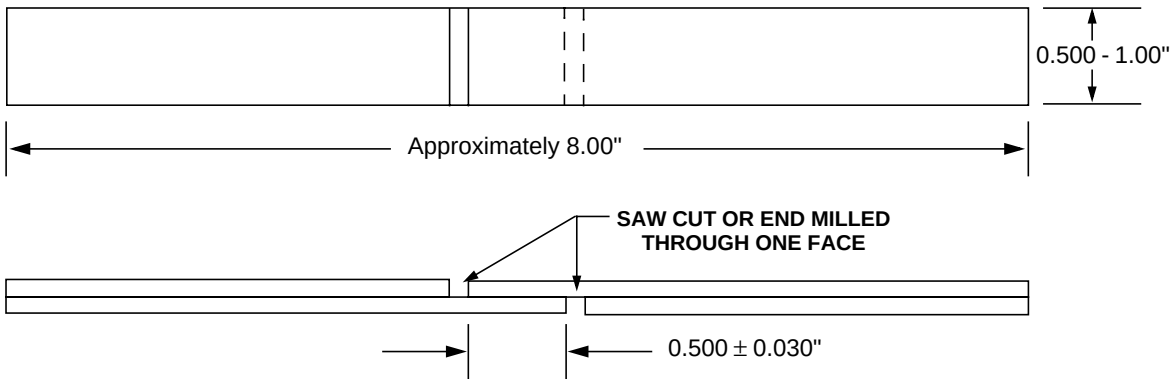

FIGURE 5 - TENSILE SHEAR TEST PIECE FOR DESTRUCTIVE TESTS

6.9 Destructive Testing (Metal To Metal Honeycomb Bonds)

6.9.1 Measure the bondline thickness in the areas of minimum and maximum tool proving film thickness as determined according to section 6.2. Bondline thickness must meet the requirements specified in Table III.

6.9.2 Fit-up and alignment of mating detail parts shall be according to the engineering drawing.

6.9.3 Test assemblies for destructive testing for flatwise tension (on the honeycomb portion of the assembly) and tensile shear strength, crack extension or other test, as specified by Bombardier Engineering (on the metal to metal portion of the assembly), by the Bombardier Turboprops Materials Laboratory or other Bombardier approved source.

6.9.4 Cut flatwise tension, tensile shear or crack extension test pieces from the areas designated by Bombardier Toronto Engineering and Quality, on a marked-up drawing, to provide verification of the bonding integrity of the entire assembly.

6.9.4.1 Flatwise tension test pieces must be 2" by 2" square and tensile shear test pieces must conform to the dimensions shown in Figure 5.

6.9.4.2 Crack extension test panel dimensions shall be according to PPS 31.13.

6.9.5 Carry out flatwise tension tests according to ASTM C297.

6.9.6 Carry out tensile shear tests according to section 6.5.2.

6.9.7 Carry out crack extension tests according to PPS 31.13.

6.9.8 The flatwise tension and tensile shear test requirements shall be as specified in Table IX.

6.9.9 The requirements for crack extension tests shall be as specified in PPS 31.13.

6.9.9.1 If a flatwise tension or tensile shear test piece fails to meet the minimum requirements specified in Table IX, or if a crack extension test fails to meet the requirements specified in PPS 31.13, cut two additional test pieces, one on either side, from the area immediately adjacent to the failed test piece.

6.9.9.1.1 Failure of either of these two test pieces shall be a failure to qualify the relevant assembly or shall be cause to reject the represented production parts, if applicable.

6.9.10 Submit a written report of each destructively tested assembly, showing the following information, to Bombardier Quality for approval before commencing production:

- Results of applicable destructive tests, including size and location of test pieces, individual strength values, if applicable, bond line thickness, nature of failure, date of test and, for tensile shear tests, lap length and width.
- Test Observations - minimum and maximum bondline thickness measurements, according to paragraph 6.9.1, and any pertinent visual observations.

TABLE IX - REQUIREMENTS FOR DESTRUCTIVE TESTING (SEE NOTE 1)

PPS	FLATWISE TENSION VALUES (PSI)					AVERAGE SHEAR TEST VALUES (PSI)	INDIVIDUAL SHEAR TEST VALUES (PSI)
	CELL SIZE				FLEX CORE		
	1/8	3/16	1/4	3/8			
36.04	840	735	700	440	440	2500	2350
36.07	900	800	750	500	500	3900	3450
Note 1. If failure of the honeycomb core occurs at values below the minimum specified, the sample is acceptable.							

6.10 Receipt and Storage Life Extension Testing of Adhesive Film, Primer and Foam

6.10.1 Test each roll of adhesive film before its use for production parts and re-test upon expiry of its storage life and subsequently re-tested upon the expiry of each storage life extension. Suitably identify each roll.

6.10.2 Receipt test each lot of adhesive primer and foam upon receipt from the manufacturer. Re-test the primer or foam upon expiry of its storage life and subsequently re-test upon the expiry of each storage life extension.

6.10.2.1 The term “lot” refers to all the adhesive primer or foam of the same batch number received as one shipment.

6.10.2.1.1 Suitably mark adhesive primer or foam with a lot number to separate it from other shipments having the same batch number.

6.10.3 Each receipt or storage life extension test for adhesive film or primer must consist of tensile shear tests and climbing drum peel tests.

6.10.3.1 The number of tensile shear test panels that shall be prepared and tested according to section 6.5 shall be as follows:

- Receipt testing of adhesive film - 1 test panel (5 test pieces).
- Receipt testing of adhesive primer - 2 test panels (10 test pieces).
- Storage life extension testing (adhesive primer and film) - 2 test panels (10 test pieces).

6.10.3.1.1 Shear test panels for receipt and storage life extension testing shall meet the requirements specified in Table VI.

6.10.3.2 The number of climbing drum peel test panels that shall be prepared and tested according to section 6.6 or section 6.7, as applicable, shall be as follows:

- Receipt testing of adhesive film - 1 test panel (2 test pieces).
- Receipt testing of adhesive primer - 2 test panels (4 test pieces).
- Storage life extension testing (adhesive primer and film) - 2 test panels (4 test pieces).

6.10.3.2.1 Peel test panels for receipt and storage life extension testing shall meet the requirements specified in Table VII.

6.10.3.3 Receipt test or storage life extension test pieces may be cleaned and bonded with a production autoclave load but shall not be used as production tests for assemblies.

6.10.4 Receipt or storage life extension tests of adhesive foam shall be as follows:

6.10.4.1 Testing of FM 37 shall consist of density determination.

6.10.4.1.1 The density of free foamed adhesive foam, cured according to the relevant PPS, shall be 25 to 40 pounds per cubic foot.

6.10.4.1.2 Testing of DHMS A6.06 foam shall consist of thickness expansion tests according to DHMS A6.06.

6.10.4.1.3 The expansion requirements shall be as specified in DHMS A6.06.

6.10.5 Adhesive film, primer or foam, which has met the test requirements for receipt testing, shall be given a storage life according to Table X. Adhesive film, primer or foam, which has met the test requirements on subsequent storage life extension tests, shall be given a storage life extension according to Table X.

6.10.5.1 Clearly mark film, primer and foam with the storage life expiry date.

6.10.6 Reject adhesive film, primer or foam which has failed to meet the storage life extension test requirements.

6.10.7 Maintain a file for each unit of adhesive film and each lot of adhesive primer and foam. The file must include the following information:

- Material identification
- Batch numbers
- Roll number or lot number
- Date of manufacture
- Date and results of receipt test and, if applicable, storage life extension tests

6.10.8 Provisions shall be made to record the total accumulated time out of the refrigerated storage facility for each roll of adhesive film, each container of primer and each sheet of adhesive foam.

6.10.8.1 Reject material which has exceeded the maximum shop life specified in Table X.

TABLE X - STORAGE LIFE - ADHESIVE FILM, PRIMER AND FOAM

PPS	MATERIAL	MAXIMUM STORAGE TEMPERATURE	STORAGE LIFE AFTER RECEIPT TESTING	STORAGE LIFE EXTENSION		MAXIMUM SHOP LIFE (NOTE 1)
				TEST METHOD	MAXIMUM EXTENSION	
36.04	Liquid primer DHMS A6.03	See PPS 36.07				
	Adhesive film FM137	0°F	90 days	Tensile shear per 6.5 Climbing drum peel per 6.7	14 days	240 hours (10 days)
	Foam FM37	40°F	45 days	Density per 6.10.4.1	7 days	120 hours (5 days)
36.07	Liquid primer DHMS A6.03	0°F	270 days (Note 3)	Tensile shear per 6.5 Climbing drum peel per 6.6	14 days	96 hours (4 days)
	Adhesive film DHMS A6.03	0°F	180 days	Tensile shear per 6.5 Climbing drum peel per 6.6	(Note 4)	240 hours (10 days)
	Foam DHMS A6.06	40°F	45 days	Density per 6.10.4.1	7 days	120 hours (5 days)

NOTES:
1. Maximum accumulated shop life at temperatures above the specified maximum storage temperature but not above 85°F and a relative humidity of 25 - 70%.
2. Daily testing to be initiated if required as specified in Table VI.
3. If storage and shipment is at ambient temperatures, the storage life shall be 180 days.
4. Extensions: 1st - 90 days
   2nd - 30 days
   Subsequent - Only if authorized by Bombardier Quality and Engineering.

6.11 Recording of Processing Information

6.11.1 Adequately thermocouple the assemblies and test panels according to the relevant bonding PPS, and connect to a recorder.

6.11.1.1 Record temperature measurements from each thermocouple during the entire bonding cycle.

6.11.1.1.1 Use multi-point recorders, ensuring that each thermocouple is monitored at least once every 6 minutes.

6.11.1.1.2 The thermocouples and recorder must be capable of recording the temperature to within ± 6°F.

6.11.1.1.3 Periodically carry out calibration against equipment of known accuracy traceable to the National Bureau of Standards.

6.11.1.2 Relate the temperature chart to time so that heat-up rates and cure times may be checked.

6.11.2 Record bag/vacuum pressure and autoclave pressure applied to the assemblies during bonding.

6.11.2.1 For autoclaves not equipped with a vacuum monitor system, close the lines to the vacuum/vent before each vacuum and pressure measurement. After each vacuum and pressure measurement, open the lines to the vacuum/vent.

6.11.3 Maintain and identify charts and records with the part numbers and serial numbers of the relevant assemblies and test pieces.

6.11.4 Where more than one assembly is to be loaded in the autoclave for curing, give the total load a lot number, which must be recorded, in addition to the assembly part and serial numbers.

6.11.5 Individual Tool Record

6.11.5.1 Maintain a file showing the following information for each bonding tool:

- Tool identification
- Identification of assembly, or assemblies, for which the tool is to be used
- Date of manufacture of tool
- Date of modification of tool, if applicable
- Qualification, production and, if applicable, destructive test reports according to section 6.1.3, paragraph 6.8.9 or paragraph 6.9.10
- Number of cycles through autoclave
- Results of all tool proving tests

6.11.6 Adhesive Film, Primer and Foam Receipt Test and Storage Life Record

6.11.6.1 Maintain an adhesive film, primer and foam receipt test and storage life file according to paragraph 6.10.7.

6.11.6.2 Retain reports of acceptance tests performed by the manufacturer on file.

6.11.7 Individual Assembly Record

6.11.7.1 Maintain a file for each assembly and include the following:

- Identification of the assembly
- Identification of the bonding tool
- Processing information (heat-up time, cure time, temperature, vacuum and pressure)
- Records of priming and bonding area temperatures and the relative humidity during the processing of each assembly
- Any other information pertaining to the particular assembly

6.11.8 Total Production Record

6.11.8.1 Maintain a Total Production Record to record the total number of assemblies bonded for Bombardier.

6.11.8.2 After the production of each 50 assemblies, ultrasonically test one assembly according to Table I.

7 SAFETY PRECAUTIONS

7.1 Safety precautions applicable to the procedures specified herein shall be as defined by the subcontractor performing such work for Bombardier.