de Havilland Inc.

Material Specification

TITLE:	**MODIFIED VINYL-PHENOLIC FILM ADHESIVE, (RESTRICTED TO METAL TO METAL BONDING OF DHC-6 AIRCRAFT PARTS)**
SPECIFICATION NUMBER:	**DHMS A 6.16**
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REVISION RECORD

Issue	Page	Description and Reason for Change
Org.		This is a new specification.
A	6,7	Section 4.2, Removed requirement for 100% cohesive mode of failure Re-paginate.

1 SCOPE

This specification covers the requirements for a two part system, consist of supported modified Vinyl-Phenolic film adhesive and liquid adhesive for metal to metal bonding of DHC-6 aircraft parts only.

1.1 Classification

The adhesive film and liquid adhesive (primer)-system covered by this specification shall be furnished as follows when specified by the procurement document

Table 1: Liquid Adhesive Primer

Liquid Adhesive	Color	% Solids By Weight
FM 47 Liquid FM 47 Thinner	Amber	19%-22%

Table 2: Film Adhesive

Film Adhesive	Form	Weight ($lb./ft.^2$)	% Volatile Content	Nominal Thickness (in)
FM 47 Type II	Light amber colored film, Open weave woven glass fiber 1659 carrier	0.07 ± 0.005	12% - 18%	0.010"

2 APPLICABLE DOCUMENTS

The following documents form a part of this specification to the extent specified herein. In the event of conflicting requirements between this and the specifications listed below, the requirements of this specification shall govern. Where a specific issue of a document is not specified, the current issue shall be used.

2.1 American Society for Testing & Materials

ASTM D1002 Strength Properties of Adhesives in Shear by Tension Loading (Metal to Metal)

3 REQUIREMENTS

3.1 Film Adhesive

3.1.1 The product shall be one of the type noted in **Table 2** of this specification, a "B" staged, vinyl-phenolic type, supported with a open weave woven glass carrier capable of meeting the requirements specified herein.

The adhesive film shall be of uniform quality and free from foreign materials or inclusions.

It shall be supplied in the form of a thin, uniform supported film adhesive of a thickness as noted in **Table 2**. The woven glass carrier shall be uniformly impregnated/coated with the resin system.

The adhesive film shall be capable of being readily applied to the cured adhesive primed surfaces of metal at a temperature of 60^{o}F - 90^{o}F, and a relative humidity not greater than 60%.

3.2 Film Adhesive Defects

Film adhesive may not contain defects in excess of the following limits: defects in excess of one in any 5 linear yards of materials or totalling more than 5% of the area of the complete roll. Defects shall be flagged by placing a strip of polyethylene backing, or other identifying material, at the location of the defect and extending it out one or both ends of the roll. Additional material may be added to the roll to compensate for all defect areas occurring in the roll or supplier will deduct the defect length from the roll length sold to the customer. Compensating material shall be the full roll width for each length of affected area. Alternatively, the purchase liability shall be reduced equal to the amount of compensating material otherwise due.

3.3 Liquid Adhesive

The Liquid Adhesive is supplied per **Table 1**, It shall mix readily with FM47 thinner to form a homogeneous mixture suitable for spraying. Dilute one part FM 47 adhesive with one and one-half (1:1.5) parts FM 47 thinner to give approximately 8% solids. The final solution is hereby referred to as "adhesive primer".

The adhesive primer shall be oven dried for 60 minutes at 220^{o}F - 235^{o}F. After drying the resulting dry film, after a single cross-coating, shall give a dry primer thickness of 0.001" to 0.003" and when

bonded with the adhesive film specified herein, shall produce the mechanical properties values noted in this document. See **Table 3**.

The shop life of the adhesive primer shall be not less than 5 days when stored in a closed container at 85°F with a relative humidity not greater than 60%.

The storage life of the liquid adhesive shall be 6 months from the date of shipment, when stored in a closed container at a temperature of 85F˚F or below (DO NOT FREEZE).

Primed, wrapped and sealed details in Kraft paper shall be capable of being stored for a minimum of 30 days at 75°F ± 10°F and 25% to 60% relative humidity with no loss of physical properties, as noted in **Table 3**.

3.4 Cure Cycle

3.4.1 Time/Temperature

The bonded assembly shall be cured at 300-335˚F for 30-35 minutes with a minimum heat-up rate of 0.5˚F to 6˚F per min. and a cool-down rate not exceeding 5˚F/min. to 140˚F.

3.4.2 Pressure

Pressurize the autoclave to 60 ± 5 psi pressure, venting the vacuum bag to the atmosphere at 15-20 psi autoclave pressure. After cure, cool to 175˚F and release autoclave pressure while applying minimum vacuum of 24" Hg as the pressure falls between 20 and 15 psi and maintain minimum vacuum of 24" Hg to 140˚F.

3.5 Physical Properties of Uncured film

3.5.1 Storage Life - The storage life of the adhesive shall be a minimum of 6 months from the date of shipment, when stored in a sealed vapor barrier bag at a temperature of 85˚F or below (DO NOT FREEZE).

3.5.2 Working Life - The product shall meet the requirements of this specification when tested after exposure to a temperature not exceeding 85˚F with a humidity not greater than 70%, for a continuous period of up to 6 months.

3.5.3 Separator Sheet - A release paper (non-silicone) shall cover the film adhesive in such a manner that it will function as a separator sheet.

3.5.4 Dimensions

Width - Unless otherwise specified, the overall width of the film adhesive, as supplied, shall be as specified on the purchase order.

Length - Unless otherwise specified, the overall length of the film adhesive, as supplied, shall be 25 ± 1 yard, 50, 100 or 150 ± 5 yards.

3.5.5 Workmanship - The film adhesive shall be of uniform quality and free from gaps, holes, resin pockets, areas lacking resin, excess resin, patches and other similar defects which would render the product unsuitable for its intended purpose.

3.6 Mechanical Properties

The combination of the liquid adhesive and adhesive film shall be capable of being used to fabricate test panels and when tested in accordance with ASTM D1002 shall meet the following average requirements with no individual value less than 90 percent of the minimum average strength requirement.

Specimens tested at room temperature shall be conditioned for 40 hours at 70 ± 5˚F and 50 ± 5% relative humidity immediately prior to testing.

Table 3: Properties of Metal to Metal Bonded Specimens

Test	Minimum Requirements (lb./in^2)Average
1. Tensile Shear at 75°F ± 5°F	3 300 psi
2. Tensile Shear at -67°F ± 5°F	2 500 psi
3. Tensile Shear at 180°F ± 5°F	3 300 psi
5. Tensile Shear at 75°F ± 5°F after 30 days with 100% RH at 120°F ± 5°F	3 300psi
6. Tensile Shear at 75°F ± 5°F after 30 days Salt Spray Exposure at 95°F ± 5°F	3 300 psi
7. Tensile Shear at 75°F ± 5°F after 7 days' immersion in JP4 Fuel (MIL-J-5624) at 75°F ± 5°F	3 300 psi
8. Tensile Shear at 75°F ± 5°F after 7 days' immersion in Type 3 Hydrocarbon Fluid (MIL-S-3136) at 75°F ± 5°F	3 300psi
9. Tensile Shear at 75°F ± 5°F after 7 days' immersion in Type III Hydraulic fluid (BMS 3-11) at 150°F ± 5°F	3 300 psi

4 TEST PANEL FABRICATION AND TEST METHODS

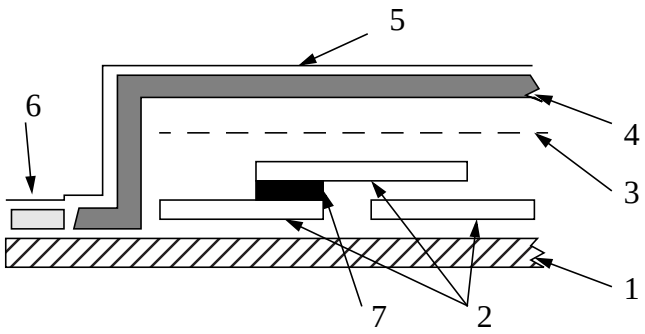
4.1 General

Unless otherwise specified, tests shall be conducted at 70 ± 5˚ F and a relative humidity of 50% ± 5%. At least five specimens shall be used per test, and the results averaged. No individual value shall be less than 90% of the value specified.

4.2 Shear Strength on Aluminum

Unless otherwise specified, the material and thickness for blanks shall be 0.063 inch thick 2024 T3 Clad or bare aluminum alloy in accordance with QQ-A-250/5. The blanks shall be flat within 0.010 inch. The bond surface of blanks shall be free of corrosion, burrs, or other surface irregularities, and shall have a surface finish of 125 RHR maximum.Test panels shall be FPL etched or Chromic Acid anodize surface treatment and primed with liquid adhesive primer (primer thickness 0.001"-0.003"). Two (7" x 6") panels shall be cut from the surface treated and primed aluminum sheet to manufacture shear strength panels according to the dimensions and orientation given in ASTM D1002. The adhesive bonded panels shall be bagged per **Figure 1** of this specification and cured at 60 psi per **Para.3.4**. Each

test specimen shall be tested per ASTM D1002.



Use DSC 234 expendable materials as noted below

1. Tool (coated with mould release Frekote 44NC or 700NC)
2. Lap Shear Panels and Packer Plate (same thickness as lap shear panels)
3. A4000 P3 Perforated Release Film
4. Airweave SS-FR Breather
5. Ipplon DP1000 Nylon Vacuum Bag
6. GS43 MR Vacuum Sealant Tape
7. Film Adhesive

FIGURE 1. Bagging Procedure for Lap Shear Panels

Note: Pressure sensitive tape shall not be used to seal any bond line edges

APPROVED EXPENDABLE MATERIALS TO DSC 234

Vacuum bag, Wrightlon 8400	(DSC 234-2-54)	Airtech International Inc., 2542 East Del Amo Blvd., P.O. Box 6207 Carson, Calif. 90749 (213) 603-9683
Airweave SS-FR Breather	(DSC 234-11)	
A4000 P3 Perforated Film	(DSC 234-5-48)	
Mould Release, Frekote 44NC or 700NC	(DSC 234-13)	Frekote Inc., 170 W. Spanish River Blvd., Boca Raton, Florida 33431 (305) 395-3082
Vacuum Sealant Tape, GS-43MR	(DSC 234-17-1)	

NOTE: Additional sources are listed in DSC 234.

5 QUALITY ASSURANCE

5.1 Qualification

5.1.1 A supplier is responsible for the performance of all qualification testing, as specified in **Table 3** of this specification. A three lots/batches qualification is required.

5.1.2 A supplier desiring qualification shall submit one copy of a report showing actual qualification test data and a sufficient quantity of product for Bombardier Aerospace, Toronto evaluation tests.

5.1.3 The manufacturer shall develop and maintain a Process Control Document (PCD) . The PCD shall define the manufacturing and quality control requirements and procedures for assuring consistent, uniform and compliant products. The PCD shall identify baseline chemical constituents, in-process test procedures and requirements, and manufacturing procedures. The PCD shall be approved and signed by Materials Technology and be available for inspection by authorized representatives of Bombardier Aerospace.

5.1.4 Upon review of supplier's data, PCD and Bombardier Aerospace Toronto tests, the supplier will be advised either of product qualification or reasons for disqualification.

5.1.5 Products that are qualified will be listed in the Qualified Products List of this specification.

5.1.6 No changes in the method of manufacture and/or formulation shall be made without notification and prior written approval of Bombardier Aerospace Toronto, Materials Technology Department.

5.1.7 Re-qualification of the product may be requested by the purchaser if there are any changes in the method of manufacture and/or formulation.

5.2 Qualification by Similarity

Where a product has been qualified to another similar specification, the supplier may submit the qualification data applicable to this specification for consideration. The similar specification may be a government, company, or other specification where the requirements are similar to this specification.

5.3 Acceptance Tests

5.3.1 Unless otherwise specified in the contract or purchase order, the supplier is responsible for all acceptance tests, as specified in **Table 3** of this specification.

5.3.2 The supplier, performing acceptance tests per **Para.5.3.1** shall furnish with each batch of product one copy of an Acceptance Test Report showing actual test data conformance to the acceptance tests specified in **Table 4**. The report shall include the supplier's batch identification.

5.3.3 Bombardier Aerospace reserves the right to perform any or all of the tests set forth in this specification to ensure that the product continues to meet specification requirements. Any product not meeting the requirements of this specification will be returned to the supplier at the supplier's expense.

Table 4: Qualification and Acceptance Tests

Test	Reference	Qualification[1]	Acceptance[2]
Liquid Adhesive			
Color	Table 1	x	x
Solids	Table 1	x	x
Adhesive Film			
Storage Life	Para. 3.5.1	x	
Working Life	Para. 3.5.2	x	
Volatile Content	Table 2	x	
Film Weight	Table 2	x	x
Adhesive Film, Liquid Adhesive Total System			
Tensile Shear at -67^{o} ± 5^{o}F	Table 3	x	
Tensile Shear at 75^{o} ± 5^{o}F	Table 3	x	x
Tensile Shear at 180^{o} ± 5^{o}F	Table 3	x	
Tensile Shear at 75^{o} ± 5^{o}F after 30 days with 100% RH at 120^{o} ± 5^{o}F	Table 3	x	
Tensile Shear at 75^{o} ± 5^{o}F after 30 days salt spray at 95^{o} ± 5^{o}F	Table 3	x	
Tensile Shear at 75^{o} ± 5^{o}F after 7 days immersion in JP4 (MIL-J-5624) at 75^{o}± 5^{o}F	Table 3	x	
Tensile Shear at 75^{o} ± 5^{o}F after 7 days immersion in Type 3 Hydrocarbon Fluid (MIL-S-3136) at 75^{o} ± 5^{o}F	Table 3	x	
Tensile Shear at 75^{o} ± 5^{o}F after 7 days immersion in Type 3 Hydrocarbon Fluid (BMS 3-11) at 150^{o} ± 5^{o}F	Table 3	x	

1. For Qualification, ten specimens are required for each batch.

2. For Acceptance test, five specimens are required for each batch.

5.4 Sampling

5.4.1 Sampling Schedule - Sampling shall be in accordance with **Table 5**.

Table 5: Sampling Schedule

Number of Rolls/can in Batch	Frequency of Inspection
1 - 10	1 roll/can

5.4.2 Batch - A batch shall be all the product produced in a single production run from the same lot of raw materials under the same fixed conditions and submitted for inspection at one time.

5.4.3 Lot - A lot shall consist of all of the adhesive, or adhesive liquid from one adhesive or adhesive liquid batch received in one shipment.

6 ORDERING DATA

6.1 Pre-requisite

Material furnished under this specification for production use shall be qualified and listed on the Qualified Products List prior to issuing of a Purchase Order.

6.2 Procurement Documents

Procurement documents shall specify the following:

- Title, Number, Issue and Amendment Number of this Specification
- Manufacturer's Material Designation
- Total Quantity

7 PREPARATION FOR DELIVERY

7.1 Identification

Each individual roll of adhesive shall have a legible identification label or marking securely affixed to the inside of the core. Each individual container of liquid adhesive shall have a legible identification label or marking securely affixed to the side of the container. Each of the above identification labels shall show the following listed information:

- Specification Number, Type and Weight of Adhesive
- Vendor's Name and Address
- Vendor's Batch Number
- Date of Manufacture

- Purchase Order Number (on outside of Individual Roll Containers)
- Unit Number of Container (applicable to Liquid Adhesive only)
- Perishable, Adhesive Film, Adhesive Liquid store at 85° F or below. DO NOT ALLOW TO FREEZE

7.2 Packaging

Each roll of tape adhesive shall be protected by a sealed, polyethylene film wrapper.

Liquid adhesive shall be packaged in a clean, air-tight, one or five gallon, metal container.

The exterior packaging shall be of such a nature as to prevent physical damage or contamination by foreign substances. Each package shall be suitably insulated and refrigerated, when necessary, to ensure maintenance of the shipping temperature requirements.

The amount of material from each roll may be adjusted to be compatible with the production cycle of the vendor, except that normal roll length shall be at least 20 yards.

The roll shall be packed in an exterior shipping container capable of protecting the adhesive film adequately during shipment and storage.

7.3 Shipping Documentation

7.3.1 Each shipping container shall have the exterior legibly marked with the following information in such a manner that the markings shall not smear or be obliterated during normal handling or use:

- Adhesive Film, or Liquid Adhesive
- DHMS A6.16, latest Issue and Amendment, Enter Class & Type
- Manufacturer's Material Designation
- Purchase Order Number
- Lot and Roll Numbers
- Quantity
- Perishable - Adhesive film and Adhesive Liquid-Store Below 85˚F. DO NOT ALLOW TO FREEZE

7.3.2 Containers shall be prepared for shipment in accordance with commercial practice to assure carrier acceptance and safe transportation to the point of delivery.

7.3.3 Each shipment shall contain a copy of the Material Safety Data Sheet.

8 HEALTH AND SAFETY DATA

When supplying samples for qualification per **Para.5.1.2**, the supplier shall submit a Material Safety Data Sheet (MSDS) complying with the "Controlled Products Regulations" of the Hazardous Products Act (also known as W.H.M.I.S. Regulations). The document must state all hazardous ingredients, safe-handling procedures, first-aid measures, fire and explosion data, re-activity data, physical properties, preparation information and procedures for storage and disposal.

This (MSDS) must then be supplied with a completed DH 4339 "Application To Introduce A New Material" form to the Material Safety Committee.

Upon receipt of DH 4340 "Recommendation" form that approves the use of the material, it can then be included on the Qualified Products List.

NOTE: Any changes in the formulation of the material require a re-submission of the Material Safety Data Sheet.

QUALIFIED PRODUCTS LIST

MANUFACTURER'S NAME AND ADDRESS	MANUFACTURER'S PRODUCT IDENTIFICATION NO.	MATERIAL SAFETY DATA SHEET NO.	DE HAVILLAND QUALIFICATION SHEET NO.	DATE OF PRODUCT APPROVAL
Cytec Engineered Materials., Havre de Grace Maryland 21078 U.S.A.	FM 47 Type II Film FM 47 Liquid Adhesive FM 47 Thinner			

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