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de Havilland

Material Specification

TITLE:	**EPOXY RESIN, FLAME RESISTANT, LOW PRESSURE LAMINATING**
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REVISION RECORD

Issue	Page	Description and Reason for Change
D	10	Para. 6.4.2 added.
Amd.5		Para. 7 Health and Safety Data added.
	11	Products CG1304 from Ciba Geigy and Epocast 50A/9816 from Furane were added to the QPL.
D	11	Ciba Geigy CG 1304 Resin and CG 1304 Hardener were deleted from QPL.
Amd.6		
Amd.7	i	Typing errors corrected.
	3	Para. 3.6 Storage Stability - revised
	11	Manufacturer's name revised.
D	11	Ciba-Geigy - A3326-18M resin deleted from QPL.
Amd.8		
E		This is a complete revised issue. Detail changes have not been noted.
Amd. 1	12	QPL: reference to Ciba-Geigy customer service has been added.
F		This is a complete revised issue. Detail changes have not been noted.
G		Heading changed. Product 50A/9816 is now 50A-1/9816. (re-formulate to remove Benta/Octa brominate).

EPOXY RESIN, FLAME RESISTANT, LOW PRESSURE LAMINATING

1 SCOPE

This specification establishes the requirements for a thermosetting, flame resistant, low pressure laminating, epoxy resin system. It shall be suitable for fabricating glass fabric based laminates and glass fabric/epoxy faced balsa wood composites for airframe applications, with or without an elevated post cure.

2 APPLICABLE DOCUMENTS

The following standards form a part of this document to the extent defined herein. In the event of conflicting requirements between this and specification 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 D790	-	Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials
ASTM D2196	-	Test Method for Viscosity Measurements and Rheological Properties of Non-Newtonian Materials by Rotational (Brookfield) Viscometer
ASTM D2471	-	Standard Test Method for Gel Time and Peak Exothermic Temperature of Reacting Thermosetting Resins
ASTM D2583	-	Indentation Hardness of Plastics by Means of a Barcol Impressor
ASTM D3039	-	Tensile Properties of Oriented Fiber Composites

2.2 Aerospace Material Specifications

SAE-AMS-C- 9084	-	Cloth, Glass Finished, for Resin Laminates

2.3 U.S. Government Specifications

2.3.1 Federal Aviation Administration

FAR 25.853(a) APP. F, Part I (1) (ii) Amd.25-83	-	Flammability Requirements

2.4 De Havilland Specifications

DHMS CS 8.01	-	End Grain Balsa Wood Panels

3 REQUIREMENTS

The epoxy resin material used in the manufacture of this product shall be of the highest quality, thermosetting, flame resistant, low pressure laminating, with or without an elevated post cure suitable for the intended purpose.

Component materials of the resin systems shall not be corrosive to metals.

3.1 Physical Properties of Resin

3.1.1 Handling

The resin components, at any production volume, shall be capable of being hand mixed to a smooth, homogeneous, lump free consistency suitable for hand application. The components shall not separate in any way within the gel time specified herein.

The base resin and hardener components, when hand mixed to the ratio supplied by the manufacturer, shall meet all the requirements specified herein.

3.1.2 Gel Time

When tested in accordance with ASTM D2471, the product shall have a gel time at $75^{o} \pm 2^{o}F$, as shown on the Qualified Products List of this specification unless otherwise specified.

3.1.3 Viscosity

When tested in accordance with ASTM D2196, the catalyzed resin, after mixing to obtain a homogeneous, air free mix, shall have a viscosity at $75^{o} \pm 2^{o}F$, as shown on the Qualified Products List of this specification unless otherwise specified.

3.1.4 Storage Life

The resin base component and the hardener, when stored in separate tightly closed containers for a minimum period of 12 months from date of shipment at a temperature of $77^{o}F \pm 10^{o}F$, shall meet all the requirements of this specification.

3.2 Physical Properties of a Cured Resin System

3.2.1 Cure - Full cure shall be obtained after 7 days at $75^{o} \pm 2^{o}F$ or 16 hours at $150^{o} \pm 15^{o}F$.

3.3 Mechanical Properties of a Cured Resin System

The resin system cured per **Para.3.2.1**, covered by this specification, shall meet all the requirements in **Table 1**. Fabricate test panels in accordance with **Section 4**. Unless otherwise specified, tests shall be conducted at $70^{o} \pm 5^{o}F$ and a relative humidity of 50% ± 5%. At least five specimens shall be used per test except for flammability testing which requires a minimum of three specimens, with the results averaged. No individual value shall be less than 90% of the values specified.

3.3.1 Laminate Mechanical Properties

3.3.1.1 Barcol Hardness - A Barcol hardness reading shall be obtained by a direct reading on a cured laminate with a Barcol impressor, in accordance with ASTM D2583. Readings shall be taken at 10 random locations over the laminate.

3.3.1.2 Resin Content - Prior to testing, verify that the resin content of the laminate is 40 ± 4% by weight by testing five 1" x 1" specimens taken from the laminates as follows:

Place specimens in tared porcelain crucibles. Weigh the charged crucibles to the nearest ten milligrams. Place the charged crucible in a muffle furnace at $1050^{o} \pm 50^{o}$F until the resin is completely burned away. (Evidenced by the appearance of white glass fabric with no dark areas).

Remove from furnace, cool in a desiccator, then weigh to the nearest ten milligrams.

Percent resin solids content = $\frac{A-B}{A} \times 100$

A = weight of cured laminate prior to burnout.

B = weight of residue after burnout.

3.3.1.3 Tensile Test - Specimens shall be tested in accordance with ASTM D3039. The ultimate tensile strength of each specimen shall be calculated and recorded and shall be not less than values given in **Table 1**.

3.3.1.4 Flexural Tests - The flexural strength (modulus of rupture) shall be calculated and recorded and shall be not less than the value given in **Table 1**. Specimens (2" warp x 1" fill, i.e. the long dimension parallel to the warp direction) shall be tested in accordance with ASTM D790, Procedure A, L/d=16 and test with a crosshead speed of 0.03"/minute, support span of 1". Test with load applied at tool side (smooth side) of the specimen.

3.3.1.5 Flammability Test - The panel shall meet the requirements of **Table 1**.

3.3.2 Sandwich Mechanical Properties

3.3.2.1 Shear Strength- Five shear test specimens 8" x 3" shall be cut from the composite test panel and loaded individually in a shear test fixture similar to that illustrated in **Figure 1** until shear occurs. Crosshead speed shall be chosen so that the test shear failure occurs between 3 and 6 minutes after initial load application. The shear value of each specimen shall be recorded and shall not be less than the value given in **Table 2**.

3.3.2.2 Bend Strength - Five test specimens 24" x 3" shall be cut from the composite test panel, loaded individually in a bending fixture similar to that illustrated in **Figure 1** until failure occurs. Crosshead speed shall be chosen so that the test shear failure occurs between 3 and 6 minutes after initial load application. The bend value of each specimen shall be recorded and shall not be less than the value given in **Table 2**.

3.3.2.3 Heat Distortion Temperature - Repeat shear test described in **Para.3.3.2.1** at a temperature of $140^{o} \pm 5^{o}$F.

TABLE 1. Mechanical and Physical Properties of Glass Fabric Base Epoxy Laminate

Properties	Test Method	Minimum Requirements
Ultimate Tensile Strength lbs., in., width	ASTM D3039	1,800
Ultimate Flexural, Flatwise psi	ASTM D790	45,000
Resin Content, Percent	Para.3.3.1.2	36 - 44
Flammability, in. per min.	FAR 25.853(a) APP. F, Part I (1) (ii) Amd.25-83	4.0 max.
Barcol Hardness	ASTM 2583	45

TABLE 2. Mechanical Properties of Glass Fabric Base Epoxy Sandwich Panel

Properties	Test Method	Minimum Requirements
Shear Strength lbs./ in., width	Figure 1	53
Bend Strength lbs./ in., width	Figure 1	148

4 TEST PANEL FABRICATION

4.1 Laminate Specimen

4.1.1 Mechanical Tests

A flat 4 ply glass fibre test laminate measuring 12" x 12" with a thickness of 0.040" ± 0.005", consisting of SAE-AMS-C-9084 Type VIII, Class 2, Style 181 glass fibre, shall be impregnated with the epoxy resin and manufactured using a minimum vacuum of 20" Hg (10 psi). The test panel shall be laid up with each glass fibre warp direction to be oriented at 90° to each preceding ply. The laminate shall cure to a handling state within 12 hours at 75° ± 2°F, or after 4 hours at 120° ± 2°F.

4.1.2 Flammability Tests

A flat, 2 ply glass fibre flammability test laminate, measuring 12" x 12" and 0.020" ± 0.003" in thickness, consisting of SAE-AMS-C-9084, Type VIII, Class 2, Style 181 glass fibre, shall be impregnated with the epoxy resin and manufactured using a minimum of 10 psi (20" Hg). The test panel shall be laid up with the glass fibre warp direction at 90° to each preceding ply. The laminate shall cure to a handling state within 12 hours at 75° ± 2°F, or after 4 hours at 120° ± 2°F.

4.2 Sandwich Specimen

A composite test panel 18" x 30" shall be manufactured, using the following materials and methods.

4.2.1 Materials

(a) 5/l6" thick, end grain balsa wood, 4-9 lb. density, conforming to DHMS CS8.01 Grade ALL.

(b) Three layers of SAE-AMS-C-9084, Type VIII, Class 2, Style 181 glass fibre impregnated with the epoxy resin to be qualified, for the upper surface of the composite.

(c) Two layers of SAE-AMS-C-9084, Type VIII, Class 2, Style 181 glass fibre impregnated with the epoxy resin to be qualified, for the lower surface of the composite.

4.2.2 Method

(a) Thoroughly stir the hardener and base resin in their respective containers prior to mixing as per the supplier's instructions.

Note - A fresh mix of material is required for each individual operations e.g. each layer of fabric.

(b) Prepare a 24" x 36" flat tool by coating the upper surface with a heat resistant release agent, e.g. fluorocarbon.

(c) Precoat the flat tool with the epoxy resin, approximately 0.015" thick, to which has been added 3-5 parts of Cab-O-Sil per hundred parts of base resin by weight. Stir thoroughly before applying to the tool. In the same operation, using the same mix, roll on a thin coating to the upper surface of the balsa core. Allow the mix to gel 30 minutes before the next operation.

(d) Position one layer of SAE-AMS-C-9084, Type VIII, Class 2, Style 181 glass fibre, with the warp direction parallel to the long sides of the tool, on to the precoated surface.

(e) Apply by roller a fresh mix of resin, mixed to the supplier's instructions, to the previously positioned SAE-AMS-C-9084, Type VIII, Class 2, Style 181 glass fibre. Roll out thoroughly. Allow to gel 30 minutes before next operation.

(f) Repeat operations (d) and (e) twice more, using a fresh mix each time with a 30 minute gel time between each coat. Each layer of SAE-AMS-C-9084, Type VIII, Class 2, Style 181 glass fibre shall be positioned with the warp direction at 90^{o} to the previous layer. Allow the last layer to gel for 30 minutes before the next operation.

(g) Apply by roller one coat of the resin, mixed to the supplier's instructions, onto the previously gel coated surface of the end grain balsa wood core panel. Place the end grain balsa core panel, resin coated side down, onto the last layer of resin coated fabric on the tool. Ensure that the core is positioned with its long sides parallel to the warp direction of the last layer of glass fabric. Allow to gel for 30 minutes.

(h) Place tool on vacuum table. Position breather/bleeder fabric over the lay-up and then bag with a PVA film. Apply 20-25 inches Hg vacuum and cure for 4-6 hours at 100^{o}F minimum.

(i) Debag test specimen.

(j) Apply by roller a fresh mix of resin, mixed to the supplier's instructions, to the other end grain balsa panel surface. Allow to gel for 30 minutes.

(k) Position one layer of SAE-AMS-C-9084, Type VIII, Class 2, Style 181 glass fibre, with the warp direction parallel to the long side of the specimen, onto the precoated surface.

(l) Apply by roller a fresh mix of resin, mixed to the supplier's instructions, to the previously positioned SAE-AMS-C-9084, Type VIII, Class 2, Style 181 glass fibre. Roll out thoroughly. Allow to gel 30 minutes.

(m) Repeat operations (k) and (l) but change the warp direction in the SAE-AMS-C-9084, Type VIII, Class 2, Style 181 glass fibre to be 90^{o} to the long side of the specimen. Allow to gel for 30 minutes.

(n) Place part on the vacuum table. Position perforated release film and bleeder fabric over the lay-up and then bag with PVA film. Apply 20-25 inches Hg vacuum and cure for 16 hours at 150^{o} ± 15^{o}F.

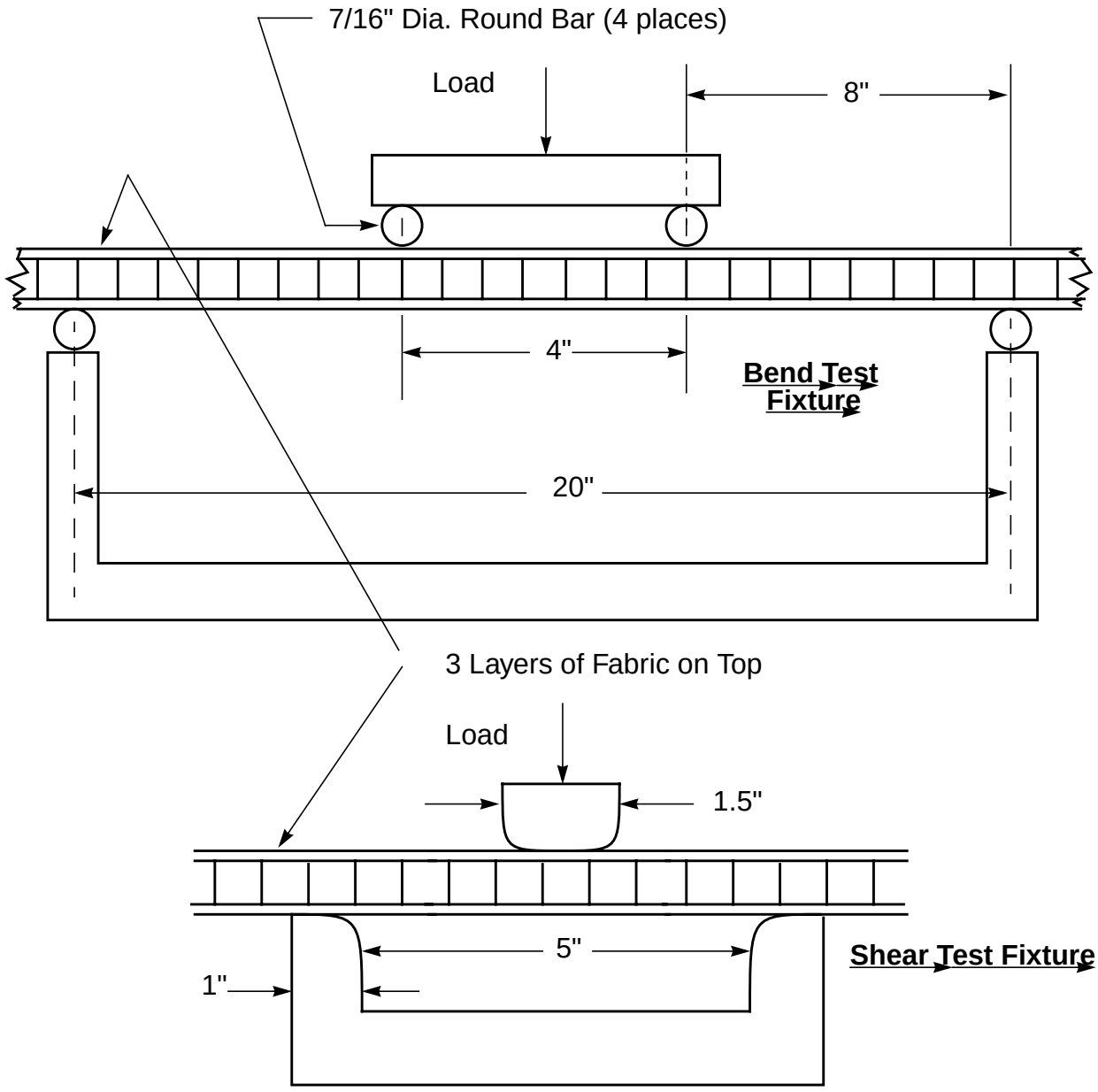

FIGURE 1. MECHANICAL PROPERTY TESTING FIXTURE FOR COMPOSITE TEST PANEL

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**. A three lots/batches qualification is required.

5.1.2 A suppliers desiring qualification shall submit one copy of a report showing actual qualification test data and a sufficient quantity of product for the de Havilland evaluation tests.

5.1.3 Upon review of supplier's data and de Havilland tests, the supplier will be advised either of product qualification or reasons for failure.

5.1.4 Products that are qualified wil1 be listed in the Qualified Products List of this specification.

5.1.5 No changes in the method of manufacture and/or formulation shall be made without notification and prior written approval of Materials Technology and Quality Assurance Departments of de Havilland Inc.

5.1.6 Requalification of the product may be requested by the purchaser for any changes in the method of manufacture and/or formulation.

5.2 Qualification by Similarity

Where a product has been qualified to another similar specifications, 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 3**. The report shall include the supplier's batch identification.

5.3.3 de Havilland Inc. 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 3. Qualification and Batch Acceptance Tests

Test	Paragraph	Qualification	Acceptance
Gel Time	Para.3.1.2	x	x
Viscosity	Para.3.1.3	x	x
Curing Time	Para.3.2.1	x	
Shear Strength	Table 2	x	
Bending Strength	Table 2	x	
Heat Distortion Temperature	Para.3.3.2.3	x	
Flammability	Table 1	x	x
Tensile Strength	Table 1	x	x
Resin Content	Table 1	x	
Barcol Hardness	Table 1	x	
Ultimate Flexural, Flatwise, psi	Table 1	x	

5.3.4 Definitions

Batch is defined as the end product of all the raw materials mixed and/or manufactured at the same time and place. The weight or volume may vary, depending upon the capacity of the manufacturer's facilities.

Lot is defined as the total quantity of product in a shipment taken from the same batch.

6 ORDERING DATA

6.1 Prerequisite

Products 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
- Type and Size of Containers
- Total Quantity
- Manufacturer's Material Designation

7 PREPARATION FOR DELIVERY

7.1 Identification

The material containers shall be identified with a label or marking securely affixed, which shall be legible and shall not be obliterated by normal handling and shall contain the following information.

- DHMS P1.15, latest issue and amendment
- Manufacturer's Material Designation
- Purchase Order Number
- Net Quantity (U.S., Imperial or Metric)
- Recommended Storage Temperatures
- Date of Manufacture
- Manufacturer's Batch
- Mixing Ratio
- Base Resin or Hardener (as applicable)

7.2 Packaging

7.2.1 The base resin and hardener shall be packaged in such a manner as to assure that, during shipment and storage, the product will be protected against damage from exposure to hazards which would affect adversely the property conformance to the requirements of this specification.

7.2.2 The product shall be supplied in 1 quart kits packaged as a unit, consisting of the base resin and the hardener which, when mixed as a unit, will meet all the requirements of this specification.

Each component of each unit shall be packaged in clean, air-tight containers of a type that will not contaminate the contents.

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:

- DHMS P1.15, latest Issue and Amendment
- Manufacturer's Material Designation
- Purchase Order Number
- Net Quantity (U.S., Imperial or Metric)
- Recommended Storage Temperatures
- Date of Manufacture
- Manufacturer's Batch or Lot Number
- Mixing Ratio
- Base Resin or Hardener (as applicable)

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 from 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.

EPOXY RESIN, FLAME RESISTANT, LOW PRESSURE LAMINATING

QUALIFIED PRODUCTS LIST

MANUFACTURER'S NAME AND ADDRESS	MANUFACTURER'S PRODUCT IDENTIFICATION NO.	MSDS NO.	DE HAVILLAND QUALIFICATIO SHEET NO.	DATE OF PRODUCT APPROVAL
Vantico 5121 San Fernando Road West Los Angeles, CA 90039 (818) 247-6210	Epocast 50A-1/9816 Gel Time: 30-180 min. Viscosity: Resin: 2000-6000 cps (50A) Hardener: 150-650 cps (9816) Mixed: 1500-6000 cps	0322 0320	PQS #5	February 14, 2008