BOMBARDIER

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Material Specification

TITLE:	**EPOXY LAMINATING RESIN**
SPECIFICATION NUMBER:	**DHMS P 1.49**
ISSUE:	**D**
AMENDMENT:	**--**
DATE:	**January 23, 2015**
PAGE:	**1 of 13**

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EPOXY LAMINATING RESIN

REVISION RECORD

Issue	Page	Description and Reason for Change
Original	3	Para. 3.2.5 - Revised to include the viscosity of individual resin and hardener.
Amd. 2		
	7	Table 1 - Requirements for viscosity are listed in QPL.
	12	Manufacturer's name and addresses revised.
		Viscosity of the resin, hardener and the mixed material added to QPL.
Amd.3	12	QPL - Revised Viscosity of the material FR 7127 A/B.
A		This is a complete revised issue. Detail changes have not been noted.
A	8	Acceptance test updated. Remove acceptance test requirement Storage life,
Amd. 1		and add Gel time requirement.
	11	QPL updated: Product Epocast 50A/946 is added.
		Specification extended to page 12.
Amd.2	11	QPL - Fiber Resin Corp. address has been changed.
Amd. 3	2, 3, 6	ASTM D2393 has been replaced with ASTM D2196.
	6	Table 1: Flexural Strength has been changed from 50,000 psi to 45,000 psi.
	12	QPL: CIBA-GEIGY Corp. has been changed to CIBA Specialty Chemicals Corporation.
B	All	This is a complete revised issue. Detail changes have not been noted.
	11	QPL: Reference to Furane Aerospace Products was deleted.
	12	QPL: CIBA-GEIGY Corp. Formulated Systems Group. was changed to CIBA Specialty Chemicals Corporation.
	12	QPL: Dexter product EA9390 was added
Amd. 1	4	Cure data updated.
	12	QPL: Dexter product EA 9396 was added.
Amd. 2	3, 11,12	Specified storage life: 12 months @ 77F from date of shipment, unless otherwise specified in QPL.

REVISION RECORD

Issue	Page	Description and Reason for Change
B	12	QPL: Ciba Specialty Chemicals Corp. changed to Vantico
Amd. 3		Referenced MSDS # for product EA9396
Amd. 4	12	QPL: Dexter Adhesive name changed to Loctite Aerospace
C		This is a complete revised issue. Detail changes have not been noted.
	12	QPL: Changed viscosity range for CG1304
		CG1304 Hardener from 150-250 cps to 350-650 cps
		CG1304 Mixed from 1300-2300 cps to 1800-2500 cps
Adm. 1	11, 12	Removed the following products containing banned chemicals :Penta and Octa Bro modiphenyl Ether.
		Class 1: FR 7127 A/B
		Class 2: Epocast 50A/946, Epocast 50A/9816, CG 1304
	11	Added to Class 2: Loctite Aerospace EA 9396 Resin / EA9396 Hardener
Adm. 2	11	QPL: Added new product to Class 1: L-363 FR
Amd. 3	9	Re-phrased para. 6.2.2
	11	QPL: Gel time requirements changed for EA 9396 and EA 9390.
D		Updated over all format.
	3	3.1.5 Added alternative viscosity test method.
		Updated Section 4, Qualification requirements , standardize with other specs.
	9	Table 2: Clarified acceptance testing requirements for supplier and user.
	12, 13	Revised company name. Was : " JD.Lincoln " Now: " Cytec"
		Was: " Loctite", Now: " Henkel"

1 SCOPE

This specification establishes the requirements for a thermosetting, flame resistant and non flame resistant, low pressure laminating, epoxy resin system used for glass fabric lay-ups for exterior and interior components.

1.1 Classification

The materials supplied to this specification shall be one of the following classes:

Class 1	-	For interior repair
Class 2	-	For exterior repair of 250^{o}F cured composite parts
Class 3	-	For exterior repair of 350^{o}F cured composite parts

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 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	-	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 U.S. Government Specifications

2.2.1 Federal Aviation Administration

FAR 25.853(a), APP. F, PART I(a) (1) (i)- Flammability Requirements

Amd. 25-83

2.2.2 Military Specifications

MIL-C-9084C	-	Cloth, Glass, Finished, for Resin Laminates
MIL-STD-401B	-	Sandwich Constructions and Core Materials: General Test Methods de Havilland Inc. Specifications
DHMS P1.26	-	Honeycomb Core, Aramid Base, Phenolic Coated

3 REQUIREMENTS

The epoxy resin material used in the manufacture of this product shall be of the highest quality, thermosetting, flame resistant and non flame resistant, low pressure laminating, with or without an elevated post cure and 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 Blending - The manufacturer shall furnish information on the proper blending proportions of Parts A and B with qualification samples. The amount of hardener (Part B) shall be expressed in terms of 100 parts by weight of base material (Part A). Parts A and B shall blend readily to produce a uniform product, with 2 to 3 minutes of hand mixing.

3.1.2 Working Characteristics - 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.

3.1.3 Odour - The epoxy resin, cured and uncured, shall be free from any objectionable odour.

3.1.4 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.

3.1.5 Viscosity - The viscosity of the resin and hardener shall be as specified in **Table 1**, when tested at $75^{o} \pm 2^{o}F$ and in accordance with ASTM D2196.

Alternatively,viscosit can be tested using Brookfield RV type

Part A: Brookfield RV type (regular viscosity), Spindle no.5, 2.5 RPM

Part B: Brookfield RV type (regular viscosity), Spindle no.4, 100 RPM

3.1.6 Storage Life - Unless specified in QPL, storage life of the epoxy resin shall be 12 months from date of shipment, when stored at a temperature of $77^{o}F \pm 10^{o}F$ in its original containers.

3.2 Physical Properties of a Cured Resin System

3.2.1 Cure

3.2.1.1 Class 1 & 2 epoxy resin shall meet all the requirements of this specification after curing for 3 days at $75^{o} \pm 5^{o}F$.

3.2.1.2 Class 3 epoxy resin shall meet all the requirements of this specification after curing for 220 minutes at $200^{o}F$ for EA 9390, 180 minutes at $120^{o}F$ for EA 9396.

3.3 Mechanical Properties

The resin systems cured per **Para.3.2.1**, covered by this specification, shall meet all the requirements in **Table 1**.

3.3.1 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:

3.3.1.1 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).

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

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

A = weight of cured laminate prior to burnout.

B = weight of residue after burnout.

3.3.2 Unless otherwise specified, tests shall be conducted at $70^{o} \pm 10^{o}$F and a maximum relative humidity of 60%. 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.

3.4 Laminate Properties

3.4.1 Mechanical Tests - A flat 4 ply glass fibre test laminate measuring 12" x 12" with a thickness of 0.040" ± 0.005", consisting of MIL-C-9084C 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^{o} to each preceding ply. The laminate shall cure to a handling state within 24 hours at $75^{o} \pm 5^{o}$F.

3.4.1.1 Tensile Tests - The ultimate tensile strength and the tensile modulus of each specimen shall be calculated and recorded and shall be not less than values given in **Table 1**. Five tensile test specimens shall be tested in accordance with ASTM D3039.

3.4.1.2 Flexural Tests - The flexural strength (modulus of rupture) and flexural modulus (tangent modulus of elasticity) shall be calculated and recorded and shall be not less than the values given in **Table 1**. A set of five flexural specimens, 2" warp x 1" fill, with the long dimension parallel to the warp direction and 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.

3.4.2 Flammability Test (for Class 1 only) - A flat, 2 ply glass fibre flammability test laminate, measuring 12" x 12" and 0.020" ± 0.003" in thickness, consisting of MIL-C-9084C, 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 24 hours at $75^{o} \pm 5^{o}$F. The panel construction shall meet the requirements of FAR 25.853(a), APP. F, PART I (a) (1) (i) Amd. 25-83.

3.4.3 Barcol Hardness - A Barcol hardness reading shall be obtained by a direct reading on laminates manufactured per **Para.3.4.1** and **Para.3.4.2** and cured per **Para.3.2.1** with a Barcol impressor, in accordance with ASTM D2583.

3.5 Sandwich Properties

3.5.1 The test specimens for flammability, flexure, flatwise tension and resin content shall be obtained from a 30" (parallel to ribbon) x 24" (parallel to warp) sandwich panel manufactured from MIL-C-9084C Type VIII, Class 2, Style 181 glass fibre and DHMS P1.26 1/4"t, 1/8" c, 3 pcf honeycomb core. The individual plies shall have a resin content of 40 ± 4% by weight when tested per **Para.3.3.1**, and shall be impregnated with catalyzed resin prior to assembly of the sandwich panels.

The specimens shall then be burned out per **Para.3.3.1.1** and the resin content calculated in accordance with **Para.3.3.1.2**.

The configuration of the sandwich panels shall be as illustrated in **Figure 1**.

Cure the panels under 20 in. Hg. minimum vacuum bag pressure in accordance with the cure schedule in **Para.3.2.1**.

3.5.2 Flatwise Tensile Strength

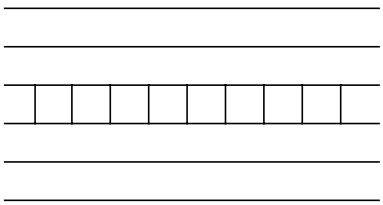
The test specimens shall be 1" x 1". A minimum of five tests shall be made from each panel. Determination of flatwise tensile strength shall be in accordance with Military Standard 401B.

3.5.3 Long Beam Flexure Strength

The test specimens shall be 3" x 24", with the 24" dimension in the warp direction of the panel. All specimens shall be tested bag side up. The test shall be single-point loading on an 18 inch span, employing 1" wide steel blocks with a 60 D (durometer) rubber pad (1" x 3" x 1/8") at the center loading point. Except for the above, test procedure shall be in accordance with Military Standard 401B. Ultimate load, in pounds, shall be reported. P/Y 1/ in pounds/inch shall be reported. A minimum of four specimens shall be tested.

1/ P/Y is the slope of the tangent to the initial portion of the loads deflection curve.

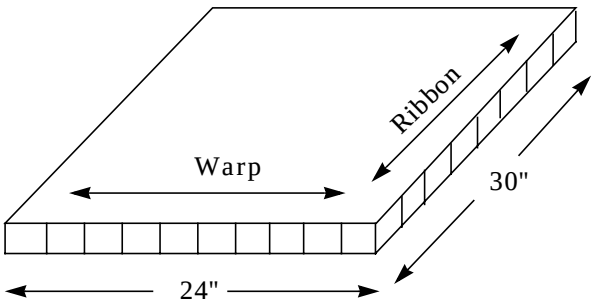
3.5.4 Flammability Test (for Class 1 only) - Sandwich panel construction shall meet the requirements of FAR 25.853(a), APP. F, PART I (a) (1) (i) Amd. 25-83 (per **Table 1**).



DHMS P1.49 Preimpregnated 181 glass fibre to MIL-C-9084C Type VIII CL.2

DHMS P1.26 1/4"t, 1/8"c, 3.0 pcf

DHMS P1.49 Preimpregnated 181 glass fibre to MIL-C-9084C Type VIII CL.2



NOTE: Warp face of fabric must face core

FIGURE 1.

TABLE 1. Physical and Mechanical Properties

Test	Reference	Requirements	
Viscosity	ASTM D2196	As specified in QPL	
Resin Content	Para.3.3.1 Para.3.5.1	36-44%	
Laminate Properties:			
Barcol Hardness	ASTM D2583	45	
Tensile Strength	ASTM D3039	1800 psi	
Tensile Modulus	ASTM D3039	Class 1 & 2 3.0×10^6 psi	Class 3 2.7×10^6 psi
Flexural Strength	ASTM D790	45,000 psi	
Flexural Modulus	ASTM D790	Class 1 & 2 2.4×10^6 psi	Class 3 2.0×10^6 psi
Flammability[1]	FAR 25.853(a), APP. F, PART I (a)(1) (i) Amd. 25-83		
Sandwich Properties:			
Flatwise Tensile	MIL-STD-401B	300 psi	
Long Beam Flexure UH Load P/Y[2]	MIL-STD-401B	 105 lb. 55 lb/in.	
Flammability[1]	FAR 25.853(a), APP. F, PART I (a)(1) (i) Amd. 25-83		

1. For Class 1 only

2. P/Y is the slope of the tangent drawn to the initial portion of the stress-strain (load deflection) curve.

4 MATERIAL QUALIFICATION REQUIREMENTS

4.1 Request For Qualification

All requests for qualification to this specification shall be addressed to Bombardier Aerospace Materials Technology Engineering department for approval.

All material qualification shall be site specific.

An audit of the manufacturers and/or test facilities by Materials Technology Engineering may be necessary prior to approval.

4.2 Qualification testing

Potential suppliers shall submit a written qualification test report based on 3 batches/lots of materials showing compliance with the requirements contained in section 3. The test report shall contain actual numerical test values, average test results as well as failure modes where applicable.

4.2.1 A sample shall be submitted for testing at the discretion of Bombardier Aerospace Materials Technology for evaluation.

4.3 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 aerospace specifications where the requirements are similar to this specification.

4.4 Process Control Document

4.4.1 The manufacturer shall develop and maintain a Process Control Document (PCD).

4.4.2 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. All specifications and test procedures employed during the process shall also be listed and issue/date controlled.

4.4.3 When qualification has been granted, the PCD shall be signed by the supplier and Bombardier Aerospace Materials Technology Engineering and shall not be changed without prior written approval.

4.4.4 The PCD and all production data shall be available to Bombardier Aerospace auditors when requested.

4.5 Qualification Approval

4.5.1 Upon review of supplier's data, PCD and de Havilland tests, the supplier will be advised either of product qualification or reasons for not qualifying the product.

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

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

4.5.4 Re-qualification of the product may be requested by the Bombardier Materials Technology if there are any changes in the method of manufacture and/or formulation.

5 QUALITY ASSURANCE REQUIREMENTS

5.1 Manufacturer/Supplier Batch/Lot Acceptance Tests

5.1.1 The manufacturer/supplier is responsible for the performance of all sampling, inspection and testing of each batch/lot as specified in **Table 2.**

5.1.2 The manufacturer/supplier shall issue with each batch of product one copy of an Acceptance Test report showing actual test data conformance to the acceptance tests specified in **Table 2** The report shall include the supplier's batch identification, materials specification and date of testing.

5.1.3 Bombardier Aerospace Materials Technology Engineering 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.

5.1.4 The manufacturer/supplier shall certify with a Certificate Conformance that each batch of each shipment meets the requirements of this specification.

5.2 Purchaser/User Batch/Lot acceptance tests

5.2.1 The purchaser/user is required to perform of all sampling, inspection and testing of each batch/lot as specified in **Table 2.**

TABLE 2. Qualification and Batch Acceptance Tests

Test	Reference	Qualification (Manufacturer/ Supplier)	Acceptance (Manufacturer/ Supplier/User)
Blending	Para.3.1.1	x	
Working Characteristics	Para.3.1.2	x	
Odour	Para.3.1.3	x	
Gel Time	Para.3.1.4	x	x
Viscosity	Para.3.1.5	x	x
Storage Life	Para.3.1.6	x	
Cure	Para.3.2.1	x	
Resin Content	Table 1	x	
Barcol Hardness	Table 1	x	
Ultimate Tensile Strength	Table 1	x	
Tensile Modulus	Table 1	x	
Ultimate Flexural Strength	Table 1	x	
Flexural Modulus	Table 1	x	
Flammability[1]	Table 1	x	x[2]

1. For Class 1 material only.

2. For 2 plies laminate only.

5.3 Definitions

5.3.1 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.

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

6 ORDERING DATA

6.1 Prerequisite

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
- Class
- Size of Container (Imperial, U.S., or Metric Measure)
- Manufacturer's Material Designation
- Total Quantity.

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 P1.49, latest Issue and Amendment (Enter Class)
- Manufacturer's Material Designation
- Purchase Order Number
- Net Quantity (U.S., Imperial or Metric)
- Recommended Storage Temperature
- Date of Manufacture
- Manufacturer's Batch or Lot #
- 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 unless otherwise specified by purchaser.

7.2.3 Each component of each kit 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 P1.49, latest Issue and Amendment (Enter Class)
- 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.4.2.1**, 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 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.

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QUALIFIED PRODUCTS LIST

MANUFACTURER'S NAME AND ADDRESS	MANUFACTURER'S PRODUCT IDENTIFICATION NO.	MATERIALS SAFETY DATA SHEET NO.	DE HAVILLAND QUALIFICATION SHEET NO.	DATE OF PRODUCT APPROVAL
Class 1				
Cytec Materials 851 W. 18th Street Costa Mesa, Ca 92627	L-363-A FR L-363-B FR Gel time: 30-80 minutes Viscosity: Resin: 25,000 - 50,000 cps Hardener: 30 - 180 cps Mixed: 1000 - 4000 cps	3690 3691	PQS #7	September 17, 2004
Class 2				
Henkel Aerospace 2850 Willow Pass Road Bay Point, CA 94565 (925)458-8000	EA 9396 Resin EA 9396 Hardener Gel time: 75 minutes (Min.) Viscosity: Resin: 400-1400 ps Hardener: 0.7-1.1 ps Mixed: 35 ps	28/95 29/95	PQS#6	March 6 2000

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MANUFACTURER'S NAME AND ADDRESS	MANUFACTURER'S PRODUCT IDENTIFICATION NO.	MATERIALS SAFETY DATA SHEET NO.	DE HAVILLAND QUALIFICATION SHEET NO.	DATE OF PRODUCT APPROVAL
Class 3				
Henkel Aerospace 2850 Willow Pass Road Bay Point, CA 94565 (925)458-8000	EA 9390 Resin EA 9390 Hardener Gel Time: 2 hours (Min.) Storage Life: 12 months @ 40°F or 6 months @ 77°F Viscosity: Resin: 660-1140 ps Hardener: 0.66-1.14 ps Mixed: 45-120 ps	2648 2649	PQS #5	December 22, 1999
Henkel Aerospace 2850 Willow Pass Road Bay Point, CA 94565 (925)458-8000	EA 9396 Resin EA 9396 Hardener Gel time: 75 minutes (Min.) Viscosity: Resin: 400-1400 ps Hardener: 0.7-1.1 ps Mixed: 35 ps	28/95 29/95	PQS#6	March 6 2000