DE HAVILLAND AIRCRAFT OF CANADA LIMITED

BOMBARDIER

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Material Specification

TITLE:	**HIGH TEMPERATURE EPOXY ADHESIVE/ LIQUID SHIM MATERIAL**
SPECIFICATION NUMBER:	**DHMS A 6.09**
ISSUE:	**E**
AMENDMENT:	**--**
DATE:	**March 9, 2021**
PAGE:	**1 of 13**

Prepared by:	**Approved by:**	**Approved by:**
SIGNED ORIGINAL ON FILE		
Shiraz Haniff	**Hai Yen Tran**	**Kenneth Quon**
Materials Technology	Materials Technology	Materials & Processess
De Havilland Canada	De Havilland Canada	Bombardier Inc.

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REVISION RECORD

Issue	Page	Description and Reason for Change
E		This is a complete revised issue. Detail changes have not been noted. Company name changed. Removed Dynamold Inc. product DMS-4-828 A/B. Use current stock to depletion. General updated to standardize with other specs

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Material Specification

HIGH TEMPERATURE EPOXY ADHESIVE/LIQUID SHIM MATERIAL

1 SCOPE

This specification covers the requirements for a room temperature cure high viscosity epoxy material suitable for use as: (a) a liquid shim material and (b) an adhesive in composite structures with service temperatures up to 350^{o}F (177^{o}C).

1.1 Classification

The epoxy materials shall be available in 2-component kit (including Sem-kits) , precatalysed (frozen) sheet or precatalysed (frozen) extrusion cartridge forms.

Availability from suppliers as indicated in the QPL

-1 Precatalysed frozen sheet, 0.005" minimum thickness

-2 Precatalysed frozen cartridge

-3 High temperature performance up to 350^{o}F

2 APPLICABLE DOCUMENTS

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

2.1 Federal Specification

QQ-A-250/5 - Aluminum Alloy Alclad 2024, Plate and Sheet

2.2 American Society for Testing and Materials

ASTM D695 - Compressive Properties of Rigid Plastics

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

ASTM D2295 - Strength Properties of Adhesives in Shear By Tension Loading at Elevated Temperatures (Metal to Metal).

2.3 de Havilland Material Specifications

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

DHMS P1.24 - Fabric, Aramid Fiber, High Modulus 250^{o}F Cure, Epoxy and Resin Impregnated

DHMS P1.39 - Fabric, Aramid Fiber, High Modulus 350^{o}F Cure, Epoxy Resin Impregnated (for Exterior Use)

DSC 234 - Composite Manufacture Expendable Materials

3 REQUIREMENTS

3.1 Uncured Properties

3.1.1 Material - The adhesive shall be a thermosetting epoxy type containing a non asbestos filler and being capable of meeting the requirements of this specification.

3.1.2 Components - (a) Kits shall consist of resin and hardener, packaged separately in pint, quart or gallon containers, and the two components shall not be batch oriented. The components may be contained in a two compartment cartridge (sem-kit) if specifically requested in the procurement document.

(b) Precatalysed sheets and extrudable forms shall be packaged in dry ice in such a way as to prevent any degradation of the product with respect to the requirements contained in this section.

3.1.3 Storage Life - (a) Unless specified in the **QUALIFIED PRODUCTS LIST** the storage life of two components shall be 12 months from the date of shipment when stored at or below 40°F (4°C), or 3 months between 40°F(4°C) - 75°F (24°C) in its original containers.

(b) The storage life of the precatalysed forms shall be 4 months from the date of shipment when stored at -20°F (-30°C) or 2 months at 0°F (-18°C).

3.1.4 Mixing Ratio - When mixed according to the manufacturer's recommendation, the product shall meet the requirements specified herein.

3.1.5 Working Characteristics - (a) The two components shall be capable of being mixed by hand to a smooth consistency suitable for application by spatula.

(b) Precatalysed forms, upon removal from the freezer, shall be capable of being applied to the work piece within the time recommended by the manufacturer which shall not be more than 30 minutes.

3.1.6 Working Life - The working life of the mixed product shall be 40 minutes minimum when tested per **Para. 4.2** and not used after it fails to wet out the faying surfaces. There shall be no separation of the components during this time.

3.1.7 Cure Time - The product shall meet the relevant requirements of this specification after being cured for 7 days at 75° ± 5°F (24°±3°C) and 50% ± 5% relative humidity, or 2 hours at 160°F.

3.1.8 Handling Strength Test Panels - Test panels shall be prepared per **Para. 4.5** and tested 18 hrs. after bonding.

3.2 Cured Properties

The cured material shall meet the requirements given in Table 1.

Table 1: Cured Properties

Properties	Preparation	Test Procedure	Requirement (Average)
Specific Gravity	Para. 4.3	Para. 4.3	1.5 max
Compressive Strength at 75°F (24°C)	Para. 4.4	ASTM D695	15 000 psi min
Handling Strength	Para. 4.6	ASTM D1002	500 psi min
Shear Strength at 75°F (24°C)	Para. 4.7	ASTM D1002	750 psi min
Shear Strength at 300°F (150°C)	Para. 4.8	ASTM D2295	300 psi min
Shear Strength (on aluminum)	Para. 4.9	ASTM D1002	2 500 psi min

4 TEST PROCEDURES

4.1 General

Unless otherwise specified, all tests shall be performed at 75° ± 5°F (24° ± 3°C) and 50% ± 5% relative humidity. At least three specimens shall be used per test and the results averaged.

4.2 Working Life

For kits, a minimum 100g (or one sem-kit) shall be mixed in the recommended proportions. Frozen precatalysed forms shall be removed from the freezer and allowed to come to room temperature, 1-2 minutes for sheet stock and 30-40 minutes for extrusion cartridges. Adhesive which is supplied in extrusion tubes shall be extrudable within the specified working life; all other forms shall be tested with a spatula at 5 minute intervals.

4.3 Specific Gravity

A suitable quantity of the mixed product shall be degassed under vacuum and cured per Para. 3.1.7 (two-component kits shall be degassed under vacuum after mixing). Three blocks, approximately one cubic inch, shall be cut, dimensions measured and volume determined, and then weighed to the nearest 0.1g. The average specific gravity shall be calculated from the recorded weights divided by the volumes.

4.4 Compressive Strength

Test specimens shall be 0.5 in. thick (not applicable to precatalysed sheet forms) with circular or rectangular faces whose area is 2 square inches, and cured per **Para. 3.1.7** prior testing to ASTM D695.

4.5 Shear Strength Test Panels

Test specimens shall be made to the dimensions given in ASTM D1002, Figure 2, using 6 ply cured laminates made from preimpregnated aramid fabric per DHMS P1.24, Type 2. A light coat of the product shall be applied to the faying surfaces and cured per **Para. 3.1.7**. Sufficient pressure (1 psi) shall be applied to ensure contact throughout the bond area and to produce a glue line thickness of 0.002" – 0.008".

4.6 Handling Strength

Test panels prepared per **Para. 4.5**, shall be tested at $75^{o} \pm 5^{o}$F after 18 hours cure.

4.7 Shear Strength at 75°F

Test panels prepared per **Para. 4.5**, shall be tested at $75^{o} \pm 5^{o}$F after cure per **Para. 3.1.7**.

4.8 * Shear Strength at 300°F (150°C)

Test specimens shall be prepared per **Para. 4.5** using 6 ply cured laminates made from preimpregnated aramid fabric per DHMS P1.39 Class 2 Type 3. The specimens shall be allowed a 15 minute soak at 300^{o}F prior to the test load being applied.

* Laminates will be available from De Havilland Canada upon request.

Alternatively, test can be carried out using aluminum substrate as per **Para. 4.9.**

4.9 Shear Strength on Aluminum

Test panels shall be made to the dimensions given in ASTM D1002 Figure 2 using 0.063" thick 2024-T3 aluminum to QQ-A-250/5 or QQ-A -250/4. Surface pretreatment shall consist of either phosphoric acid anodize or Forest Products Laboratory (FPL) etch, followed by the application and cure of a corrosion inhibiting bond primer per DHMS A6.03-1. The bond area shall be cleaned with a solvent (e.g. MEK) immediately prior to applying a light coat of the product to the faying surfaces and cured per **Para. 3.1.7**. Enough pressure shall be applied to ensure contact throughout the bond area and to produce a glue line thickness of (0.002" - 0.008")

5 MATERIAL QUALIFICATION REQUIREMENTS

5.1 Request For Qualification

All requests for qualification to this specification shall be addressed to De Havilland Canada Materials Technology Department for approval.

All material qualification shall be site specific.

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

5.2 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.

5.2.1 A sample shall be submitted for testing at the discretion of De Havilland Canada Materials Technology Engineering for evaluation.

5.3 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 specification where the requirements are similar to this specification.

5.4 Process Control Document

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

5.4.2 When qualification has been granted, the PCD shall be signed by the supplier and DHC Materials technology Engineering and shall not be changed without prior written approval.

5.4.3 The PCD and all production data shall be available to De Havilland auditors when requested.

5.5 Qualification Approval

5.5.1 Upon review of supplier's data, PCD and De Havilland tests, the supplier will be advised either of product qualification or reasons for disqualification.

5.5.2 Products that are qualified will be listed in the Qualified Products List (QPL) of this specification.

5.5.3 No changes in the method of manufacture and/or formulation of the adhesive prime shall be made without notification and prior written approval of the Materials Technology department.

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

6 QUALITY ASSURANCE REQUIREMENTS

6.1 Batch Acceptance Tests

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

6.1.2 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.

6.1.3 DHC Materials Technology 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.

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

6.2 Purchaser Batch/Lot acceptance tests

6.2.1 The purchaser is required to perform, inspection and testing of each batch/lot as specified in Table 2

Definition

6.2.2 **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

Table 2: Qualification And Batch Acceptance Tests

Properties	Paragraph	Qualification	Aceeptance	
			Manufacturer/ Supplier	Purchaser/User
Components	Para. 3.1.2	x		
Storage Life	Para. 3.1.3	x		
Mixing Ratio	Para. 3.1.4	x		
Working Characteristics	Para. 3.1.5	x	x*	
Working Life	Para. 3.1.6	x	x*	
Cure Time	Para. 3.1.7	x	x	x
Specific Gravity	Table 1	x	x	
Compressive Strength	Table 1	x		
Shear Strength	Table 1	x		
Handling Strength	Table 1	x		
Shear Strength at 75°F (24°C)	Table 1	x		
Shear Strength at 300°F (150°C)	Table 1	x		
Shear Strength on Aluminum	Table 1	x	x	x

* Precatalysed forms only

7 ORDERING DATA

7.1 Prerequisite

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

7.2 Procurement Documents

Procurement documents should specify the following:

- Title, Number, Issue and Amendment Number of this Specification

- Size of Containers (Imperial or U.S. measure)
- Total Quantity (Imperial or U.S. measure)
- Acceptance Test Report.

8 PREPARATION FOR DELIVERY

8.1 Preservation and Packing

The adhesive shall be packed 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 Section 3 of this specification.

Precatalysed forms shall be packed in an exterior shipping container capable of maintaining the contents at 0°F or lower during shipment and storage.

8.2 Marking

Each container shall be legibly marked with the following information:

- Adhesive/Liquid Shim, High Temperature Epoxy
- DHMS A6.09, DHMS A6.09-1, DHMS A6.09-2 or DHMS A6.09-3
- Manufacturer's Name and Product Identification
- Date of Manufacture
- Date of Mixing
- Container Size
- Expiry Date
- Batch Number
- Net Quantity (Imperial, US or Metric Measure)
- Perishable - Store below 0°F (if precatalysed)

8.3 Shipping Documentation

The shipping document shall show:

- De Havilland Purchase Order No.
- DHMS A6.09, DHMS A6.09-1, DHMS A6.09-2 or DHMS A6.09-3
- Number of Containers
- Batch Number
- Total Quantity (Imperial, US or Metric Measure)
- Acceptance Test Reports

- Perishable - Store below 0°F (if shipping precatalysed)

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

9 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.

9.1 Environmental Compliance

Materials and ingredients use in manufacturing the product shall comply to environmental regulations such as REACH, EPA, CEPA. Prohibited substances or restricted from certain uses under an Environmental Regulation shall not be used for the specified prohibited applications.

Supplier shall notify De Havilland Materials Technology if the product contains targeted substances.

QUALIFIED PRODUCTS LIST

MANUFACTURER'S NAME AND ADDRESS	MANUFACTURER'S PRODUCT IDENTIFICATION NO.	DE HAVILLAND QUALIFICATION SHEET NO.	DATE OF PRODUCT APPROVAL
	DHMS A6.09		
Henkel Loctite Corp. 2850 Willow Pass Rd., Bay Point, CA 94565 U.S.A. (510) 458-8000	EA 934 NA Part A EA 934 NA Part B Storage Life: 12 months @/below 40^{o}F (4^{o}C) from date of Shipment	PQS #2	Feb.,1984
	EA 9394 Part A EA 9394 Part B Storage Life: 12 months @ 75^{o}F (24^{o}C) from date of Shipment	PQS #8	Aug, 1997
~~Dynamold, Inc~~.	~~DMS-4-828 A~~ ~~DMS-4-828 B~~ **PRODUCT REMOVED . USE STOCK TO DEPLETION**		

QUALIFIED PRODUCTS LIST

MANUFACTURER'S NAME AND ADDRESS	MANUFACTURER'S PRODUCT IDENTIFICATION NO.	DE HAVILLAND QUALIFICATION SHEET NO.	DATE OF PRODUCT APPROVAL
	DHMS A6.09-1		
	(Frozen Sheet)		
Dynamold, Inc. 2905 Shamrock Ave. Fort Worth, Texas 76107 P.O.Box 9617 U.S.A. (817) 335-0862	DMS-4-828	PQS #4	May, 1994

QUALIFIED PRODUCTS LIST

MANUFACTURER'S NAME AND ADDRESS	MANUFACTURER'S PRODUCT IDENTIFICATION NO.	DE HAVILLAND QUALIFICATION SHEET NO.	DATE OF PRODUCT APPROVAL
	DHMS A6.09-2		
	(Frozen catridge)		
Henkel Loctite Corp. 2850 Willow Pass Rd., Bay Point, CA 94565 U.S.A. (510) 458-8000	EA 934 NA A/B Storage Life: 12 months @/below 40°F (4°C) From date of shipment	PQS #6	May, 1994
~~Dynamold, Inc~~.	~~DMS-4-828 A/B~~ **PRODUCT REMOVED . USE STOCK TO DEPLETION**		
	DHMS A6.09-3 (Hi-Temp)		
Henkel Loctite Corp. 2850 Willow Pass Rd., Bay Point, CA 94565 U.S.A. (510) 458-8000	EA 9394 Part A EA 9394 Part B Storage Life: 12 months @ 75°F (24°C) from date of shipment	PQS #8	Aug. 25, 1997