DE HAVILLAND AIRCRAFT
OF CANADA LIMITED

de Havilland

Material Specification

TITLE:	**CORE SPLICE, EXPANDABLE FILM ADHESIVE**
SPECIFICATION NUMBER:	**DHMS A 6.06**
ISSUE:	**D**
AMENDMENT:	**--**
DATE:	**July 10, 2019**
PAGE:	**1 of 15**

Prepared by: Approved by:

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REVISION RECORD

Issue	Page	Description and Reason for Change
Org.	9	Para. 6.0 was revised regarding MSDS.
Amd. 6	11	Para. 8.2.6 was added regarding MSDS.
Amd. 7	12	QPL - Removed MA 552 from Qualified Products. QPL - Added MA 554 to Qualified Products.
Amd. 8	12	QPL - FM 41 was replaced by Fm 410-1.
Amd. 9		Amd. 9 Cover Sheet specifies HMS A1-001 is equivalent to DHMS A6.06.
Amd. 10	4 6	Para. 3.2.5 - Cure Cycle revised. Para. 4.4 Lap Shear and Para. 4.5 Core Shear revised.
Amd. 11	12	PL 657 manufactured by B.F. Goodrich added to the QPL.
Amd. 12	12	American Cyanamid Co. - U.S. address added to QPL.
A		This is a complete revised issue. Deleted changes have not been noted.
Amd.1	11	QPL: American Cyanamid Co. changed to CYTEC Engineered Materials Inc. QPL: McCann Manufacturing Adhesives and Prepregs purchased by B.F. Goodrich; B.F. Goodrich changed to Sovereign Engineered Adhesives.
Amd.2	5	Para. 4.3 Thickness Expansion has been revised.
Amd. 3	7	Note 2: Load bar dimension corrected.

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REVISION RECORD

Issue	Page	Description and Reason for Change
B	11	L-311 manufactured by J.D.Lincoln added to QPL.
		The name Sovereign Engineered changed to SIA Adhesives.
	3	Add tolerance to adhesive weight.
		Pages number changed.
C	QPL	Removed manufacturer SIA Adhesive from QPL (per manufacturer's request).
D		This is a completed revised issue.
	3	3.2.3 Volatile Content Was: <3%, Now: <2%
	3	3.2.4 Thickness expansion Was: >70%, Now: 170%-350%.
	4	Table 3, Lap Shear values Was: 1000 Psi, Now: 1500 Psi.
		Thickness expansion Was: >70%, Now:170%-350%.
		Volatile Content Was:<3%, Now <2%
		Core shear has minimum requirement
		Added Tube Shear value.
	5	4.4 Specified Nominal bondline thickness for lap shear.
	6,9	Added Tube Shear testing.
	10-12	Revised section 5, 6 standardize with other specifications.
		Table 4, clarified batch acceptance test requirement for supplier, purchaser/ user.
	12	Sampling, batch , lot definition changes as per supplier request.
	14	Revised section 9, Health and Safety
	QPL	Removed obsolete product L-311 . Material can be used to depletion.
		Removed Canadian distributor.

1 SCOPE

This specification covers the requirements for a thermosetting foaming adhesive suitable for splicing honeycomb or foam cores, core to metal and core to cured detail. This material shall be suitable for vacuum or autoclave pressure curing in a temperature range of 250^{o} to 350^{o} F.

1.1 Classification

The film adhesive covered by this specification shall be furnished in one of the following weights and thicknesses as specified by the procurement document. See Table 1.

TABLE 1: EXPANDABLE FILM ADHESIVE

Film Weight (psf)	Film Thickness (in) Nominal
0.30 ± 0.05	0.05
0.60± 0.05	0.10

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)
ASTM D792	Specific Gravity and Density of Plastics by Displacement
ASTM C393	Flexure Test of Flat Sandwich Constructions

2.2 De Havilland 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 Resin, Impregnated
DHMS P1.26	Honeycomb Core, Aramid Base Phenolic Coated
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 General

Material furnished under this specification shall be a product which has been tested and has passed the tests and other requirements specified herein. The manufacturer and/or supplier shall be responsible for the performance of all tests required for qualification to this specification.

Material - The expandable adhesive covered by this specification shall be a thermosetting, modified epoxy, supplied in a uniform, unsupported sheet form. Table 2 lists the film thickness to be used for the different Honeycomb core cell sizes.

TABLE 2: EXPANDABLE FILM ADHESIVE

Film Thickness Nominal	Cell Sizes
0.05"	1/8"
0.10"	3/16" and 1/4"

3.2 Properties of Uncured Expandable Adhesive

Tests shall be performed on the product as received, after warming to above the due point prior to sampling and in accordance with the test methods specified herein.

3.2.1 Storage Life - The storage life of the product shall be a minimum of 180 days from the date of manufacture, when stored at 0°F, or below.

3.2.2 Working Life - The product shall meet the requirements of this specification when tested after exposure to a temperature not greater than 70°F with a humidity not greater than 70%, for a continuous period of up to 7 days.

3.2.3 Volatile Content - When tested in accordance with Para.4.2, the volatile content by weight shall not be greater than 2%.

3.2.4 Thickness Expansion - When tested in accordance with Para.4.3, the product is capable of 170% -350% expansion.

3.2.5 Cure Cycle

For 250°F Cure - Heat cure at 250°F to 270°F for 60 to 70 minutes with heat-up rates 2°F to 8°F per minute.

For 350°F Cure - Heat cure at 345°F to 365°F for 120 to 135 minutes with heat-up rates 1°F to 5°F per minute.

Cool down rate shall not exceed 5° F per minute.

3.3 Physical and Meachanical Properties

TABLE 3: PHYSICAL AND MECHANICAL PROPERTIES

Test	Reference	Requirement
Storage Life	Para.3.2.1	Meet specification requirements up to 180 days, when stored at 0°F, or below.
Working Life	Para.3.2.2	Meet specification requirements after exposure to 77°F, 70% RH for 7 days.
Volatile Content	Para.3.2.3	Less than 2%
Thickness Expansion	Para.3.2.4	Capable of expanding 170%-350%
Lap Shear (psi min Ave)	Para.3.3.1	1500
Core Shear (Psi min Ave)	Para.3.3.2	225 (failure in joints not permitted).
Tube Shear	Para.3.3.3	Min Ave: 600 Psi Min Indv: 450 Psi

3.3.1 Lap Shear - Lap shear test pieces, conforming to Figure 1, shall be tested in accordance with Para.4.4. The lap shear for each specimen shall be calculated and recorded and shall not be less than the values given in Table 3.

3.3.2 Core Shear - Three core shear test pieces, conforming to Figure 2, shall be tested in accordance with Para.4.5. Three control samples with no splice in the core will be tested for comparison. The product shall not fail in the spliced area lower than the control samples.

3.3.3 Tube shear - Five Tube shear test pieces, conforming to Figure 4,Figure 5, shall be tested in accordance with Para.4.6. The Shear Strength shall be determined by shearing the inner tube The Tube Shear Strength of each specimen shall be calculated and recorded and shall not be less than the values given in Table 3

4 TEST METHODS

4.1 General

Unless otherwise specified in the individual test method, tests shall be conducted at 75 ± 5° F and a relative humidity of maximum 70%.

4.2 Volatile Content

Three, 4 x 4 inch specimens of the uncured material shall be weighed individually on an analytical balance to the nearest 10 mg and placed in an air circulating type oven at 260° ± 10°F for 15 minutes, removed from oven and placed in a desiccator. The specimens shall then be cooled to room temperature, reweighed, and the volatile content calculated as follows:

$$\text{Volatile Content, \% by weight} = \frac{W1 - W2}{W1} \times 100$$

W1 = Original Weight

W2 = Weight After Heating Cycle

4.3 Thickness Expansion

Measure and record the thickness of each of three specimens (approximately 2 x 2 inch). Samples shall be placed individually on a Teflon sheet or a sheet of aluminum alloy prepared with release agent. Insert in an air circulating type oven at 260° ± 10 °F for 60-90 minutes, removed from the oven, and allowed to cool to room temperature. Remeasure and record the thickness of the specimens. Calculate the thickness expansion as follows:

$$\text{Thickness Expansion} = \frac{T2 - T1}{T1} \times 100$$

T1 = Original Thickness

T2 = Thickness After cured.

4.4 Lap Shear

Eight test specimens shall be made from 0.063" ± .003" thick 2024-T3 or T4 alclad aluminum to QQ-A-250/5, using FPL etch or phosphoric acid anodize surface treatment and primed with DHMS A6.03-1. The bond area shall be cleaned with a solvent (e.g. M.E.K.) and wiped off before it evaporates prior to the application of the adhesive. Eight specimens shall be vacuum cure, four cured at 250° F and four cured at 350° F, per **Para.3.2.5**. A packer plate of the same thickness as the aluminum plate shall be used for support. Bonded edges shall be taped with DSC 234-15-1 (Flashbreaker tape) to prevent movement. Nominal bondline thickness of 0.010 inch.

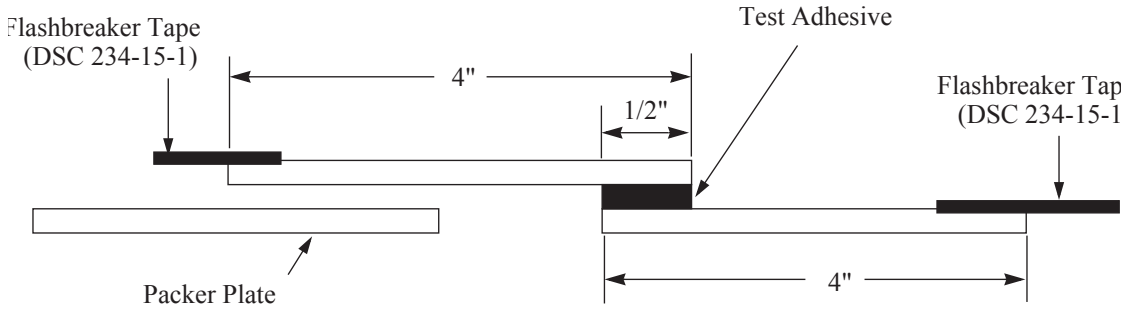

FIGURE 1. TENSILE LAP SHEAR

4.5 Core Shear

The following specimens shall be manufactured with the construction shown below:

Six with core splice (co-cured), using DHMS P1.24 Type 2 - cured per Para.3.2.5 -Three with core spliced parallel to the ribbon direction

- Three with core spliced perpendicular to the ribbon direction.

Six with core splice (co-cured), using DHMS P1.39 Class 2 Type 3 -cured per Para. 3.2.5

- Three with core spliced parallel to the ribbon direction
- Three with core spliced perpendicular to the ribbon direction.

Three without core splice, using DHMS P1.24 Type 2 -cure per Para. 3.2.5

Three without core splice, using DHMS P1.39 Class 2 Type 3 -cure per Para. 3.2.5.

NOTE: 0.05" thick sheet shall be used to splice 1/8" cell required for this test.

Specimens with no core splice will be used as control samples.

4.6 Tube Shear

Two drawn aluminum tubes, 1.0" OD, 0.5" OD, 5052, 2024 or equivalent aluminum alloy, Each tube is 9 "long, and have wall thickness of 0.049" shall be PAA or FPL etch.

Assemble the tubes concentrically within each other. Fill the tube shear assembly annular volume (approximately 4 cubic inches) with a predetermine amount of each adhesive. Typically, in the range of 35 to 45 grams. Use the same quantity (± 1 gram) for all tube shear tests with the same adhesive.

Cover each end with suitable flow retardant cloth and assemble in a curing jig as shown in Figure 4. Tighten bolts by hand. Cure the jig in horizontal position using applicable cure cycle as per Para.3.2.5

Cut test specimens 0.5" ± 0.02" long with flat faces normal to the tube axis. Discard one specimen from each end.,debur specimens.

Test by shearing the inner tube using the tube shear test fixture as shown in **Figure 5**. Apply load using cross head speed of 0.06 ± 0.02 inch/min.

The Shear Strength is calculated using the outer surface of the inner tube as the shear surface.

$$S = \frac{L_c}{A_s}$$

Where

S = Shear Strength (Psi)

L_c = Ultimate compressive Load (Lbs)

A_s = Shearing surface sq.in.

$$A_s = \pi D_{e2} h$$

Where: D_{e2} = Outer diameter of the inside (smaller) tube

h = Length of tube segment

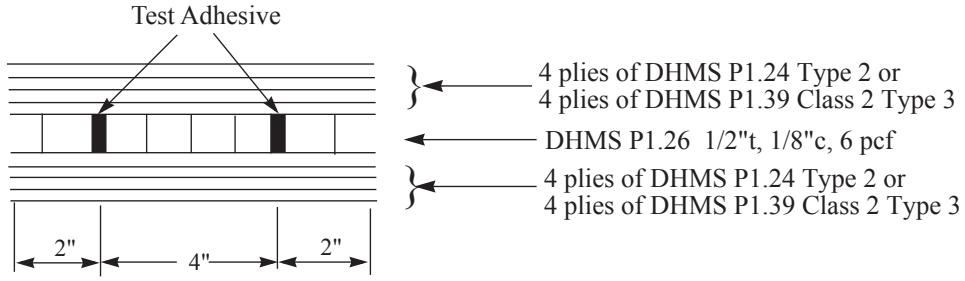

FIGURE 2.

Control samples are identical to the test panel except that there is no splice in the core. The panel shall be tested in accordance with ASTM C393. The position of load and support shall be to **Figure 3**.

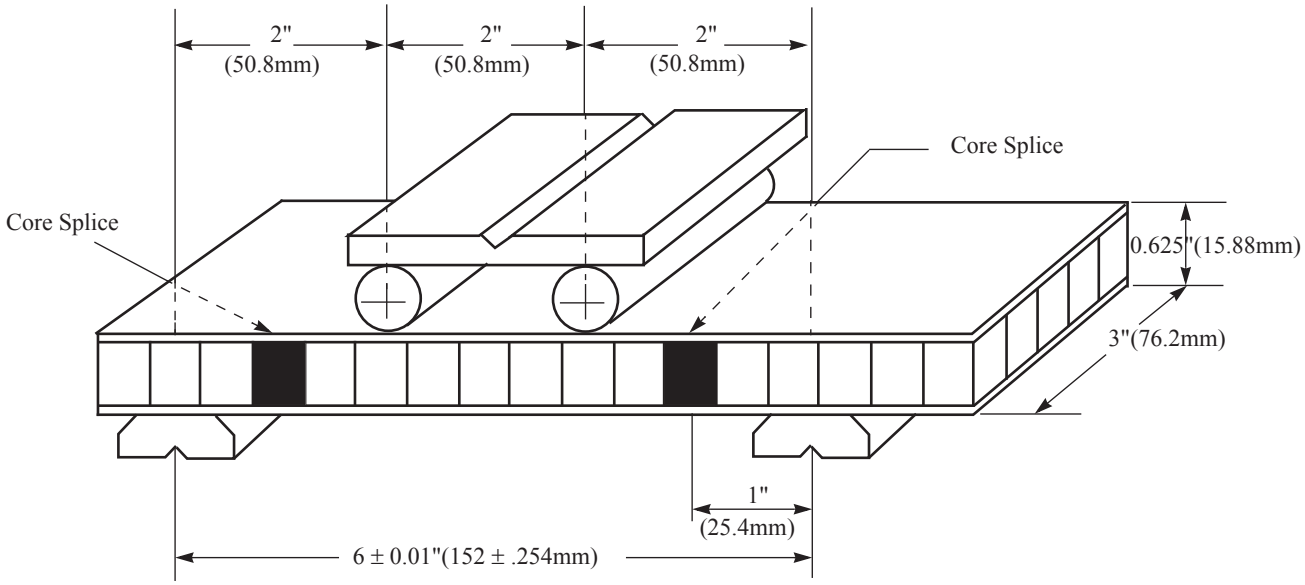

FIGURE 3. CORE SHEAR TEST

Notes:

1. End support plates are 1" x 3" x 0.250" (25.4 x 76.2 x 6.35 mm) with grooves for alignment edges rounded to 0.06" (1.52 mm).
2. Load bars are 0.50" (12.7 mm) round or as per ASTM C393

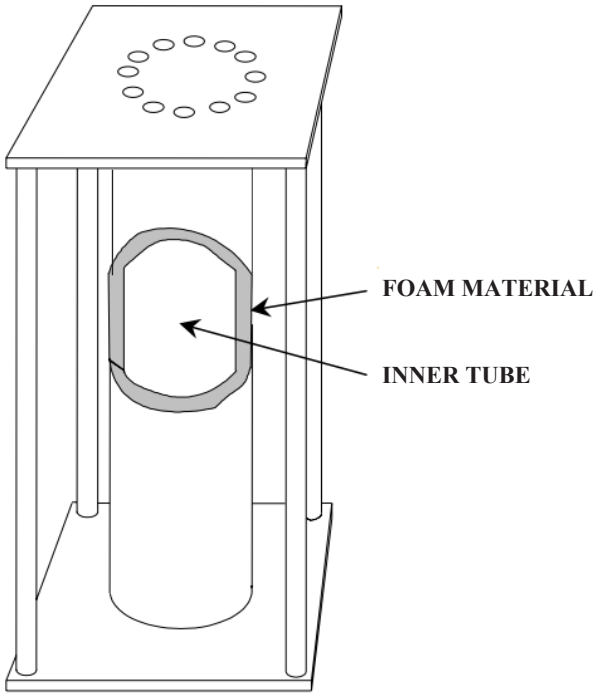

FIGURE 4. TUBE SHEAR CURE FIXTURE

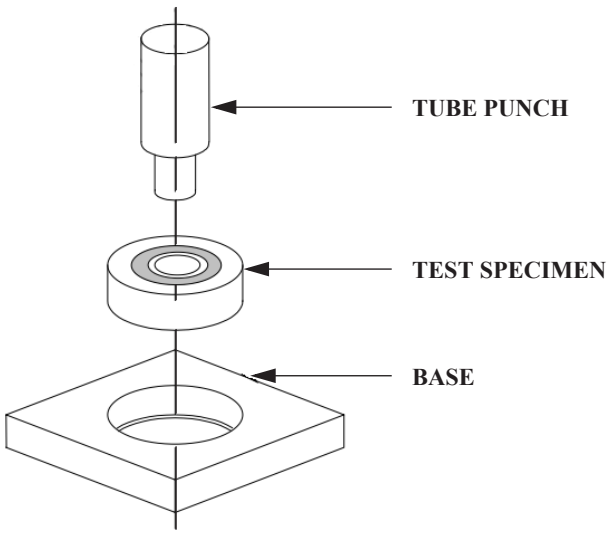

FIGURE 5. TUBE SHEAR TEST FIXTURE

5 MATERIAL QUALIFICATION REQUIREMENTS

5.1 Request For Qualification

All requests for qualification to this specification shall be addressed to De Havilland 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.

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 Materials Technology 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 aerospace specifications 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).

5.4.2 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.

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

5.4.4 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 not qualifying the product.

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

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

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

6 QUALITY ASSURANCE REQUIREMENTS

6.1 Supplier Batch/Lot 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 4.

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 4 The report shall include the supplier's batch identification, materials specification and date of testing.

6.1.3 De Havilland 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.

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/user is required to perform of all sampling, inspection and testing of each batch/lot as specified in Table 4.

TABLE 4. QUALIFICATION AND BATCH ACCEPTANCE TESTS

Property	Requirement	Qualification (Supplier)	Acceptance	
			Manufacturer/ Supplier	Purchaser/User
Storage Life	Para.3.2.1	x		
Working Life	Para.3.2.2	x		
Volatile Content	Para.3.2.3	x		
Thickness Expansion	Para.3.2.4	x	x	x
Cure Cycle	Para.3.2.5	x		
Tensile Lap Shear	Para.3.3.1	x		
Honeycomb Sandwich core Shear	Para.4.5	x		
Tube Shear	Para.4.6	x	x	x

6.3 Sampling

6.3.1 Sampling Schedule - For user/purchaser, sampling shall be in accordance with **Table 5**.

TABLE 5. USER/PURCHASER SAMPLING SCHEDULE

Number of/Sheet in Batch	Frequency of Inspection
1 - 10	1 sheet
11 - 39	2 sheets
40 and more	3 sheets

For manufacturer, sampling plan is as per manufacturer process. As a minimum test for physical properties at the beginning, middle and end of a batch , and mechanical properties on the beginning of the batch.

6.3.2 Batch - A batch is considered a homogeneous unit of finished adhesive of the same formulation manufactured under same controlled conditions in a continuous operation .

6.3.3 Lot - A lot is considered all of the shipment from one adhesive batch received in one shipment.

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 of a Purchase Order.

7.2 Procurement Documents

Procurement documents shall specify the following:

- Title, Number, Issue and Amendment Number of this Specification
- Film Weight, as required
- Total Quantity

8 PREPARATION FOR DELIVERY

8.1 Identification

8.1.1 Each unit package of expandable adhesive shall be identified with a label or marking securely affixed to the inside of the case or with a removable tag.

8.1.2 The label or removable tag shall use characters of a size such as to be clearly legible and which will not be obliterated by normal handling. Each label or tag shall show the following information:

- Core Splice Expandable Film Adhesive
- DHMS A6.06, latest Issue and Amendment, Weight
- Manufacturer's Material Designation
- Purchase Order Number
- Lot and Package Numbers
- Quantity
- Perishable - Store Below 0°F
- Date of Manufacture

8.2 Packaging

8.2.1 The film adhesive shall be supplied in flat sheets and interleaved with a non-adherent film.

8.2.2 The film adhesive shall be sealed in a bag of suitable non-adherent material to prevent penetration of moisture or loss of impregnating resin solvent.

8.2.3 The adhesive shall be packed in an exterior shipping container capable of protecting the adhesive film adequately at 0°F during shipment and storage.

8.3 Shipping Documentation

8.3.1 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:

- Core Splice Expandable Film Adhesive
- DHMS A6.06, latest Issue and Amendment, Weight
- Manufacturer's Material Designation
- Purchase Order Number
- Lot and Package Numbers
- Quantity
- Perishable - Store Below 0°F

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

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

9 HEALTH AND SAFETY DATA

When supplying samples for qualification per **Para.5.2.1**, the supplier shall submit a Safety Data Sheet (SDS) complying with Workplace Hazardous Material Information System (WHIMIS) 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 (SDS) must then be supplied with a completed EHS-FO-025 "Application To Introduce A New Material" form to the Material Safety Review Committee.

Upon receipt of EHS-FO-025 "Recommendation" form that approves the use of the material, it can then be included on the Qualified Products List.

9.1 Environmental Compliance

Materials and ingredients use in manufacturing the product shall comply to REACH regulations. 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.	MATERIAL SAFETY DATA SHEET NO.	DE HAVILLAND QUALIFICATION SHEET NO.	DATE OF PRODUCT APPROVAL
Cytec Solvay Group 1300 Revolution Street Havre de Grace Maryland 21078-3899 U.S.A. (410) 939-8127	FM 410-1	1437	PQS #4	January 18, 1989