BOMBARDIER

de Havilland
Material Specification

TITLE:	**FLYSCREEN, EPOXY PREIMPREGNATED 250°F CURE**
SPECIFICATION NUMBER:	**DHMS P 1.48**
ISSUE:	**F**
AMENDMENT:	**2**
DATE:	**December 1, 2017**
PAGE:	**1 of 17**

Prepared by

Approved by

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REVISION RECORD

Issue	Page	Description and Reason for Change
A		This is a revised specification. Detailed changes will not be noted.
B		This is a revised specification. Detailed changes will not be noted.
Amd. 1	4-6	Resin Content test method has been changed.
C	2	Added new style 8800 to Table 1.
	3	Reference to 8800 style fabric. Storage Life definition changed.
	4	Specified an Alternative Resin Content test in 3.4.4
	5	The Length Dimension Changed from ±1 to ± 5
	6	Clarify Table 2 Requirement is Average Minimum Requirement.
	9	Updated Figure 4 to Specify Cure time for J.D.Lincoln Product is 60-70 minutes.
	12	Updated Table 3 note to Specify Climbing Drum Peel Test Tool Side, Bag Side Parallel to Warp direction.
	14	Specified Packaging, Shipping Temperature is 10°F or below
	16	Add J.D.Lincoln Product L-501-8800 to QPL
Amd. 1	2	Table 1: Resin Content of fabric 8800 changed to 39%-44% as per supplier requested.
Amd. 2	8	Specified the use of pre impregnated peel ply, DSC 234-12-3 if J.D. Lincoln's product L501-8800 is used during first stage lay up.

REVISION RECORD

Issue	Page	Description and Reason for Change
D		This is a revised specification.
		Removed Flow test from acceptance test listing in Table 3.
Amd. 1		Revised Table 3
E	4	This is a revised specification
		Updated Resin Content test.
F		This is a complete revised issue.
	5	Reword Tack Test.
	6	Updated section 3.5, specified 60% max relative humidity. Condition of test specimens Was :"40hrs", Now: " 24 hrs".
	8	Added note to specifies removal of peel ply prior to layup of stage 2.
		Added for Axiom product, use peel ply DSC 234-12 (dry peel ply).
	11,12	Reword sections 5,6 standardize with other specifications.
	13	Table 3, clarified batch acceptance test requirements for supplier and user.
	15	Revised requirement for packaging standardize with other specifications.
	17	QPL, Added Axiom product AX-3114FR-8800 .
Amd. 1	15	8.2.2 Revised standardize with other specifications.
Amd. 2	17	QPL, Revised Cytec manufacturing location. Was " Costa Mesa", Now:"Winona"

1 SCOPE

This specification establishes the requirements for open weave glass fabric preimpregnated with epoxy resin to be used for core stabilization during fabrication of sandwich panels.

1.1 Classification

The materials supplied to this specification shall be furnished in the following type.

TABLE 1. Classification

Type	Style	Resin Content	Weight of Fabric
1	1507A	33 - 38%	10 ± 1 oz/sq.yd.
	8800	39%-44%	7.8 ± 1 oz/sq.yd

2 APPLICABLE DOCUMENTS

The following documents form a part of this specification to the extent defined 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 U.S. Government Specifications

2.1.1 Federal aviation Administration

Advisory Circular- 21-26 - Quality Control for the Manufacture of Composite Structures

2.2 American Society for Testing and Materials

ASTM C297 - Tension Test of Flat Sandwich Constructions in Flatwise Plane

ASTM C613 - Resin Content of Carbon and Graphite by Solvent Extraction.

ASTM D1781 - Climbing Drum Peel Test for Adhesives

ASTM D2584 - Resin Content by burn off method.

2.3 de Havilland Specifications & Standards

DHMS P1.24 - Fabric, Aramid Fiber, High Modulus, 250°F cure, Epoxy Resin Impregnated

DHMS P1.26 - Core, Honeycomb, Fibrous Aramid Base, Phenolic Coated

DSC 234 - Composite Manufacture Expendable Materials

3 REQUIREMENTS

3.1 Fabric

The glass fabric used in the manufacture of the prepreg shall be commercial fabric Style 1507A or 8800 unless otherwise specified.

3.1.1 Ends - The fabric shall not contain any unspliced yarns or tow ends.

3.2 Preimpregnated, Glass Fiber Fabric

The prepreg shall be constructed from continuous glass fabric and pre-impregnated with an epoxy resin system and supplied in the "B" stage condition, and shall be formulated to meet the requirements specified herein.

3.3 Defects

Materials 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.

3.4 Physical Properties and Test Methods of Uncured Impregnated Fabric

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

3.4.1 Storage Life - The storage life shall be a minimum 180 days from the date of shipment, 270 days from the date of manufacture, when stored at a temperature of 10°F or below.

3.4.2 Working Life - The product shall meet the requirements of this specification when tested after exposure to a temperature not greater than 77°F, with a humidity not greater than 70%, for a continuous period of up to 10 days.

3.4.3 Formability - Formability is defined as the ability of the product to be deformed or contoured over a mould and be cured in that position. The product shall be formable over, or into, a 0.15 inch minimum radius and remain in position throughout fabrication. Heat may be applied locally to aid in achieving this requirement.

3.4.4 Volatile Content - Three 4 inch 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. The specimens shall be removed from the oven, placed in a desiccator, cooled to room temperature and reweighed, in order to calculate the volatile content.

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

W1 = Original Weight

W2 = Weight After Heating Cycle

The volatile content, by weight, shall not be greater than 1.5%.

3.4.5 Resin Content by Weight/ Fabric Weight - The resin content by weight shall be calculated and recorded and

shall meet the requirements of **Table 1**. Three specimens, approximately 4" x 4" each, shall be cut from the roll so that one sample comes from the centre of the width and the other two from the edges.

Note: volatile content must be performed on different samples.

The three samples shall be individually weighed on an analytical balance and weights recorded to the nearest 10 mg. Completely submerge the three samples in separate beakers containing a minimum of 50 ml Methyl Ethyl Ketone, Acetone, or Methylene Chloride for at least 5 minutes. Decant the solvent, being careful to retain all fibers and replace with clean solvent. Continue to extract and decant the sample for a minimum of 3 extractions, until all traces of resin have been removed. Dry the fibers at $210^{o} \pm 10^{o}$ F for 15 minutes. The specimens shall then be cooled to room temperature in a desiccator, reweighed, and the resin content /fabric weight calculated as follows:

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

Fabric Weight = W2

W1 = Original Weight

W2 = Weight After Extraction

Alternatively, the resin content can be tested as per ASTM D2584.

3.4.6 Resin Flow by Weight - Three specimens, each 4 inches x 4 inches x 4 plies, of the uncured material shall be laid up cross plied (90° to each other) and weighed on an analytical balance to the nearest 10 mg. The specimens shall be positioned between two plies of porous Teflon coated glass. Three plies of 1581 or 181 style fibre glass and aluminum foil shall be placed on both sides. The entire lay-up should be placed individually in a press, preheated to 260 ± 10°F and cured for 15 minutes at 50 ± 5 psi. The foil, fibre glass and porous Teflon shall be removed, the flash removed, if any, and each specimen individually reweighed to the nearest 10 mg and the percent flow calculated.

The resin flow shall be as specified on the Qualified Products List of this specification.

3.4.7 Gel Time

Method 1

Three specimens, each being approximately 1/4" square, shall be cut from the uncured material. A hot plate shall be preheated to $260^{o} \pm 10^{o}$ F, unless otherwise specified, and a micro cover glass placed on the hot plate, allowing a minimum of 20 seconds for it to reach equilibrium. One specimen shall be placed at the centre of the micro cover glass and timing shall be commenced. Within 5 seconds, a second micro cover glass shall be placed over the specimen. When the resin softens during the first 30 seconds, the top micro cover glass shall be probed to isolate a drop of resin. The fluidity and colour of the isolated drop shall be observed periodically at first, and continuously as the end point approaches. The lateral spreading movement of the resin, upon probing, will decrease and the colour will change as the gel point approaches. The timer shall be stopped at the first indication of resin immobility and the elapsed time to the nearest minute shall be recorded.

Method 2

Apparatus:

1. Fisher-Johns melting point apparatus
2. Thickness No.2 18 mm cover glasses
3. Timer or stopwatch

4. Wooden picks or equivalent.

Procedure:

1. Preset the Fisher-Johns melting point apparatus to read 260° ± 10° F of the specified temperature.
2. Insert a 1/4'1 x 1/4" sample between 2 cover glasses and place on the Fisher-Johns apparatus.
3. Start the timer and probe the specimen with a wooden pick.
4. When resin gels (this is usually evident when no resin movement is seen when moderate pressure is applied to the specimen), stop the timer and report the gel time to the nearest 0.1 minute.

The product shall have a gel time at 260° F, as shown on the Qualified Products List of this specification, unless otherwise specified.

3.4.8 Tack - The product shall exhibit a degree of tackiness to enable easy handling during normal fabrication processes at a temperature range of 65- 77°F, with a humidity not greater than 70% anytime during the defined shelf life. Both sides of the fabric shall exhibit a degree of tackiness so that the fabric, when folded 180°, will adhere lightly to itself. It shall also be capable of being removed, after light hand pressure during lay-up, without disturbing the previously positioned mating ply.

3.4.9 Colour - For all products, the material shall be supplied in the natural colour of the resin fiber system.

3.4.10 Marking - The warp direction of the woven impregnated fabric shall be marked in a manner that is acceptable to Materials Technology,de Havilland.

3.4.11 Dimensions

Width - Unless otherwise specified, the overall width of the product, shall be 38" or 50" inclusive of the selvedge . Width tolerance shall be ±0.50 inch.

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

3.4.12 Workmanship - The impregnated fabric shall be evenly impregnated, uniform in quality, and free of defects which will render the product unsuitable for its intended purpose.

3.4.13 Bias or Bowed Filling - The filling strands of the fabric shall not be distorted from the horizontal by more than 3" for 38" width and proportionately for all other widths.

3.5 Mechanical Properties and Test Methods of Cured Impregnated Fabric

3.5.1 Unless otherwise specified, tests shall be conducted at 70°F ± 10°F and a relative humidity of maximum 60%. Specimens tested at room temperature shall be conditioned for a minimum of 24 hours at 70 ± 10°F and maximum 60% relative humidity immediately prior to the test 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.

Unless otherwise specified, all test pieces shall be cut with the longer dimension parallel to the warp direction fo the the fabric

3.6 Sandwich Mechanical Properties

Honeycomb sandwich panel test specimens fabricated per Figure 1 shall meet the requirements of Table 2.

3.6.1 Flatwise Tensile - Five specimens, each 2" x 2", shall be tested in accordance with ASTM C297. Tensile Strength

shall be calculated and recorded and shall be not less than the values given in Table 2.Alternatively, the specimen size can be 3" x 3".

3.6.2 Peel Torque - Five specimens for each configuration, 3" x 12", shall be tested in accordance to ASTM D1781. The Peel Torque shall be calculated and recorded and shall be not less than the values given in Table 2.

TABLE 2. Honeycomb Sandwich Panel Tests

Test	Reference	Minimum Average Values
Flatwise Tensile Strength	ASTM C297	250 Psi
Peel Torque	ASTM D1781	20 in.lb/3 in.width

Note: Peel strength testing shall be performed on both toolside and bagside surfaces, tested parallel and transverse to the warp direction

4 TEST PANEL FABRICATION

4.1 Sandwich Panel

Test panel 32" warp x 36" fill depicted in Figure 1, shall be vacuum bagged per Figure 2 and figure 3, cured per Figure 4 and Figure 5 in two stages.

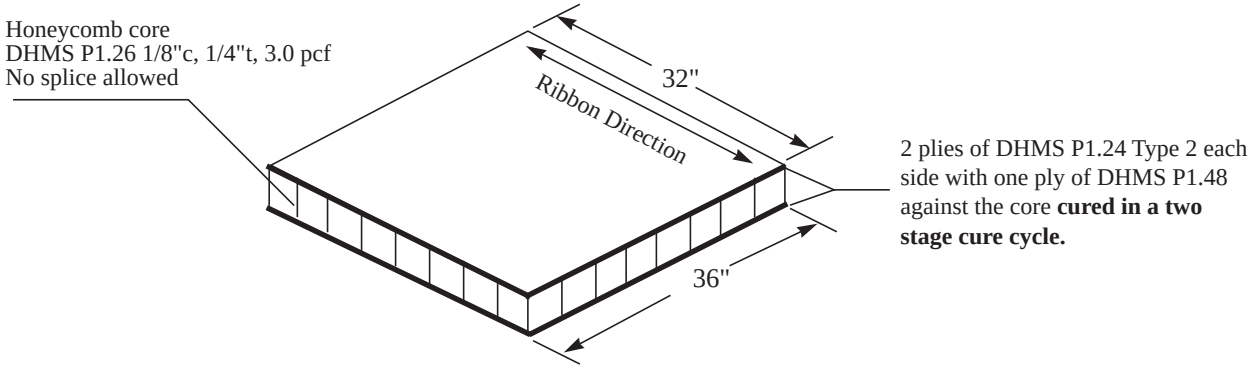
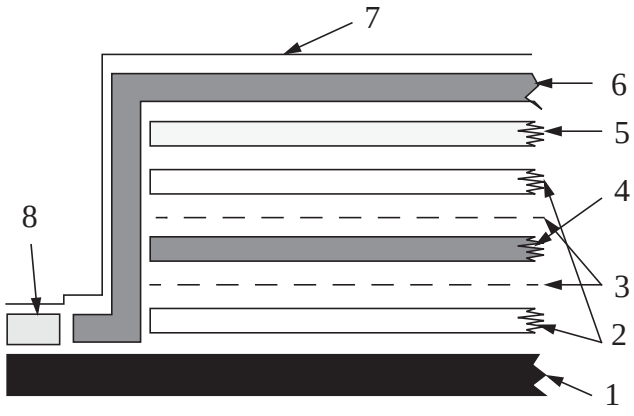


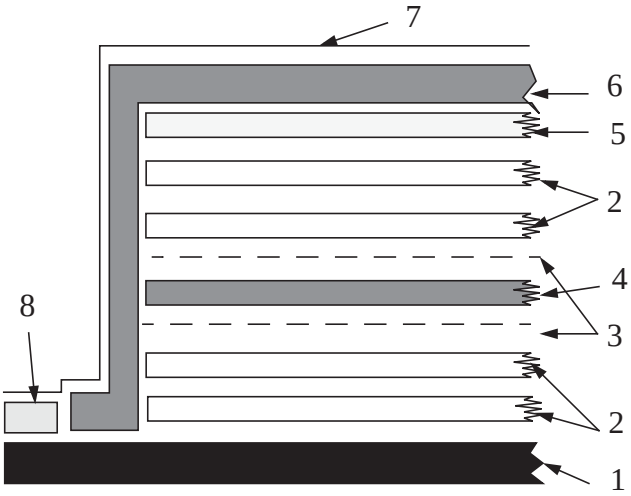
FIGURE 1. Sandwich Test Panel



Use DSC 234 expendable materials

1. Tool (coated with mould release Frekote 44NC or 700NC)
2. Peel Ply (see note)*
3. Flyscreen, DHMS P1.48
4. DHMS P1.26 1/8"c,3.0 pcf, 1/4"t
5. A4000 P3 Perforated Release Film
6. Airweave SS-FR Breather
7. Nylon Vacuum Bag
8. GS 43 MR Vacuum Sealant Tape

FIGURE 2. Layup and Bagging Procedure for Stage 1 Cure



Use DSC 234 expendable materials

1. Tool (coated with mould release Frekote 44NC or 700NC)
2. DHMS P1.24 Type 2
3. Flyscreen, DHMS P1.48, Cured in Stage 1.
4. DHMS P1.26 1/8"c,3.0 pcf, 1/4"t
5. A4000 P3 Perforated Release Film
6. Airweave SS-FR Breather
7. Nylon Vacuum Bag
8. GS 43 MR Vacuum Sealant Tape

FIGURE 3. Layup and Bagging Procedure for Stage 2

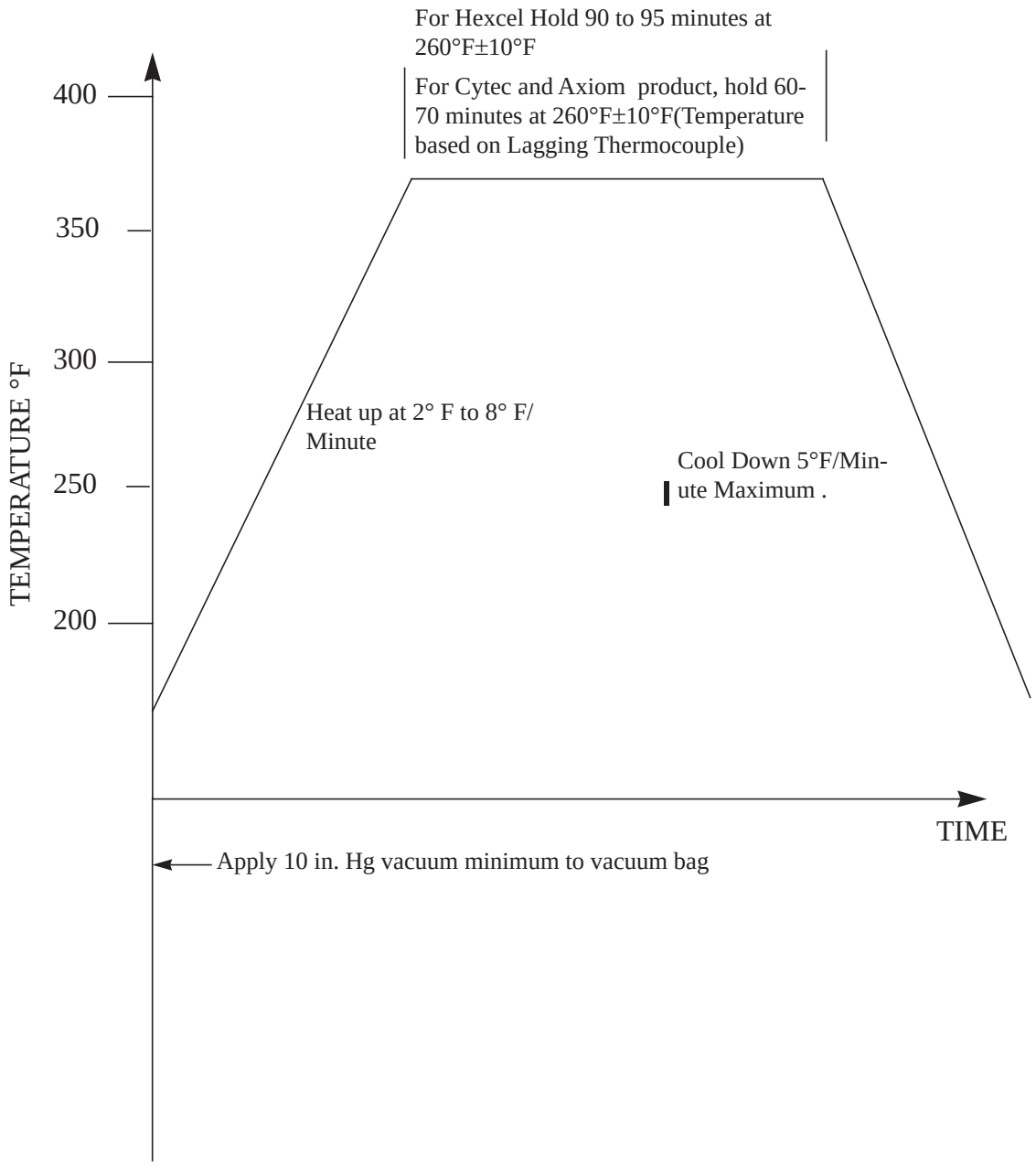
Remove Peel ply from stage 1 cured panel immediatly prior to layup stage 2

Note: Additional sources are listed in DSC 234.

APPROVED EXPENDABLE MATERIALS TO DSC 234

Wrightlon 8400	(DSC 234-2-54)	Airtech International Inc., 2542 East Del Amo Blvd., P.O. Box 6207 Carson, CA 90749 (213) 603-9683
Perforated Release Film A4000P3	(DSC 234-5-48)	
Airweave SS-FR Breather	(DSC 234-11)	
Mould Release, Frekote 44NC or 700NC	(DSC 234-13-3/4)	Frekote Inc., 170 W. Spanish River Blvd., Boca Raton, FL 33431 (305) 395-3082
Vacuum Sealant Tape, GS 43 MR	(DSC 234-17-1)	
* Peel Ply	For Cytec product (L501/8800)use prepreg peel ply DSC234-12-3.	
	For Hexcel's product (1507A/F155-110) and Axiom product (AX-3114FR-8800) use dry peel ply DSC 234-12 available width (Peel ply F)	

FIGURE 4. Cure Cycle Stage 1


For Hexcel Hold 90 to 95 minutes at 260°F±10°F
For Cytec and Axiom product, hold 60-70 minutes at 260°F±10°F(Temperature based on Lagging Thermocouple)
400
350
300
250
200
TEMPERATURE °F
Heat up at 2° F to 8° F/ Minute
Cool Down 5°F/Min-ute Maximum .
TIME
Apply 10 in. Hg vacuum minimum to vacuum bag

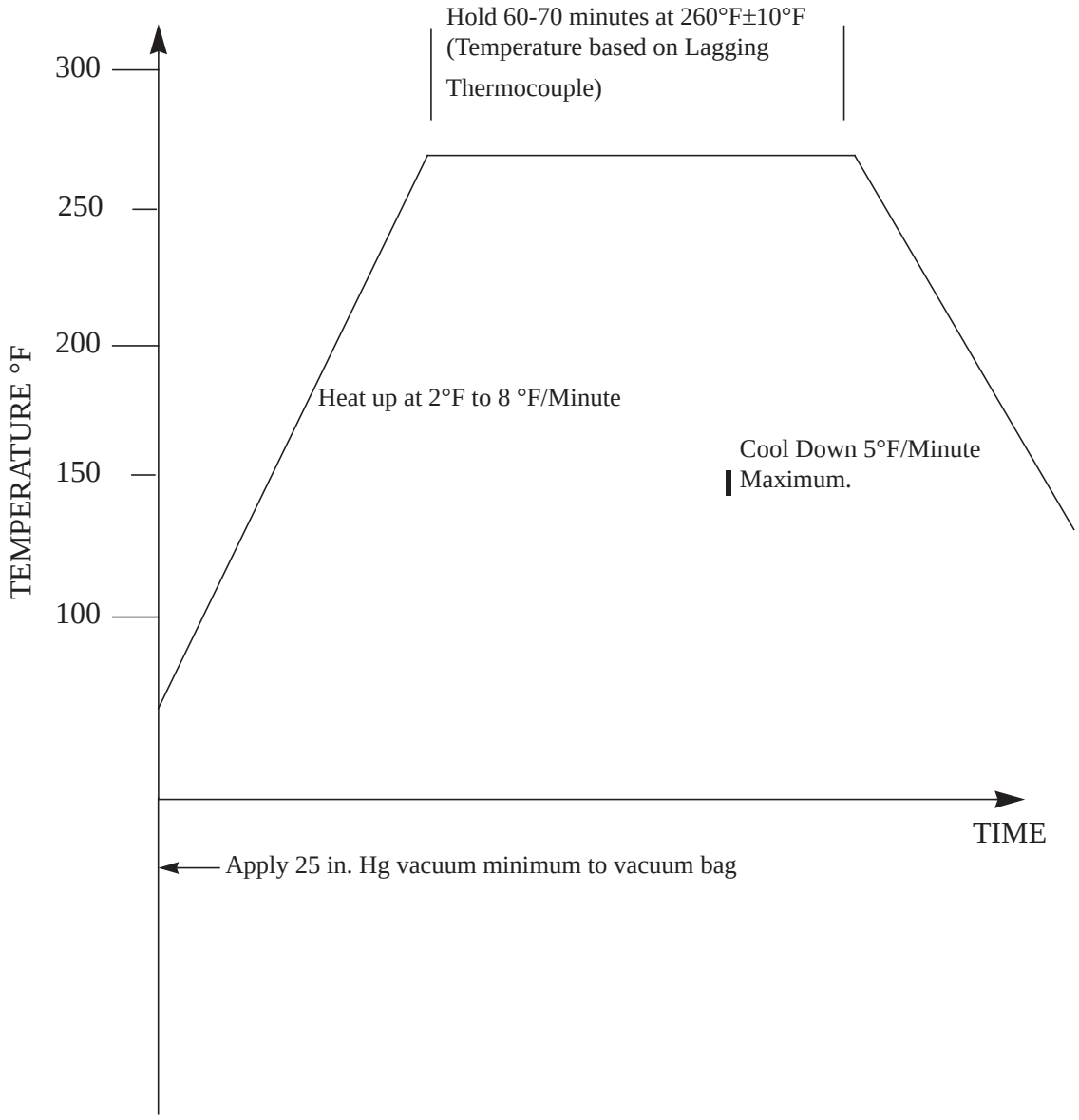


FIGURE 5. Cure Cycle , Stage 2

5 MATERIAL QUALIFICATION REQUIREMENTS

5.1 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.

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

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

5.5.3 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.

6 QUALITY ASSURANCE REQUIREMENTS

6.1 Manufacturer/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 3.**

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

6.1.3 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.

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/User 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 3.**

TABLE 3. Qualification and Batch Acceptance Tests

Property	Requirement	Qualification (Manufacturer/ Supplier)	Acceptance	
			Manufacturer/ Supplier	Purchaser/User
Fabric Weight	Table 1	x	x	
Storage Life	Para.3.4.1	x		
Working Life	Para.3.4.2	x		
Formability	Para.3.4.3	x		
Volatile Content	Para.3.4.4	x	x	
Resin Content	Para.3.4.5	x	x	x
Resin Flow	Para.3.4.6	x	x	
Gel Time	Para.3.4.7	x	x	x
Tack	Para.3.4.8	x	x	x
Colour	Para.3.4.9	x		
Dimensions	Para.3.4.11	x	x	
Workmanship	Para.3.4.12	x	x	
Bias or Bowed Filling	Para.3.4.13	x		
Cure Cycle	Figure 4 Figure 5	x		
Flatwise Tensile Strength	Table 2	x		
Climbing Drum Peel *	Table 2	x	x	x

Note: * Peel strength testing shall be performed on both toolside and bagside surfaces, tested parallel to the warp direction. For acceptance test, condition at 70°± 5°F, 60% RH max for a minimum of 24hrs. Test specimens at room temperature immediately after conditioned.

6.3 Sampling

6.3.1 Sampling Schedule - Sampling shall be in accordance with **Table 4**.

TABLE 4. Sampling Schedule

Number of Rolls in Batch	Frequency of Inspection
1 - 10	1 roll
11 - 39	2 rolls

6.3.2 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. When more than one lot of fibre fabric is used in production of a batch of prepreg to this specification, acceptance test shall be conducted so as to cover all lots of fabric batches utilized.

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
- Type of Pre-Impregnated Fabric
- Manufacturer's Material Designation
- Total Quantity

8 PREPARATION FOR DELIVERY

8.1 Identification

8.1.1 Each roll of impregnated fabric shall be identified with a label or marking, securely affixed to the inside of the core 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:

- Flyscreen Epoxy Impregnated 250°F cure
- DHMS P1.48 latest issue and amendment (Enter Type)
- Manufacturer's Material Designation
- Purchase Order Number
- Lot and Roll Numbers
- Quantity
- Perishable - Store Below 10°F
- Date of Manufacture

8.2 Packaging

8.2.1 The impregnated fiber shall be wound on spools not less than 3 inches in hub diameter and interleaved with a non-adherent film /paper backing. The non-adherent film/paper backing must be on the outside to prevent penetration of moisture or loss of impregnating resin solvent.The backing type shall be that is acceptable to Materials Technology.

Winding shall be uniform and shall provide for proper unreeling. Fabric ends shall be secure.

8.2.2 Each roll shall be adequate support at both ends through the center of the core.

8.2.3 Each roll shall be sealed in a bag of suitable non-adherent material to prevent penetration of moisture or loss of impregnating resin solvent.

8.2.4 The roll shall be packed in an exterior shipping container capable of protecting the impregnated materials adequately at 10°F or lower 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:

- Flyscreen Epoxy Impregnated 250°F Cure
- DHMS P1.48, latest Issue & Amendment (Enter Type)
- Manufacturer's Material Designation
- Purchase Order Number
- Lot and Roll Numbers
- Quantity
- Perishable - Store Below 10°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**, 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.

FLYSCREEN EPOXY PRE-IMPREGNATED 250°F CURE

QUALIFIED PRODUCTS LIST

MANUFACTURER'S NAME AND ADDRESS	MANUFACTURER'S PRODUCT IDENTIFICATION NO.	DE HAVILLAND QUALIFICATION SHEET NO.	MSDS #	DATE OF PRODUCT APPROVAL
	Type 1			
Hexcel 11555 Dublin Blvd., Dublin, CA 94568 (415) 828-4200 1-800-688-7734	1507A -60"- F155 - 110 Resin Flow: 5 - 15% Gel Time: 4 - 10 min	PQS#2	999	June 25, 1987
Cytec Solvay Group 501 West Third Street Winona, MN 55987	L-501-8800 Resin Flow: 7 - 15% Gel Time: 6 - 12 min.	PQS #3	2889	May 31, 2000
Axiom Materials Inc. 2322 Pullman Street Santa Ana CA92705	AX-3114FR-8800 Resin Flow: 3-13% Gel Time: 6-12 min	PQS#4		September 30, 2015