BOMBARDIER

de Havilland

Material Specification

TITLE:	**EXPANDED ALUMINUM FOIL PREIMPREGNATED WITH EPOXY RESIN OR FILM ADHESIVE, 250^{O}F, 350^{O}F CURE**
SPECIFICATION NUMBER:	**DHMS P 1.64**
ISSUE:	**F**
AMENDMENT:	**5**
DATE:	**March 14, 2017**
PAGE:	**1 of 17**

Prepared by: Approved by:

SIGNED ORIGINAL ON FILE

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REVISION RECORD

Issue	Page	Description and Reason for Change
Original	4	Figure 1 has been updated.
Amd. 1		
Amd. 2	6	The range of resin content is to be determined after 20 batches.
	12	Resin Flow is to be determined after 20 batches.
	8	Table 3 has been updated.
A	All	This is a complete revised issue. Detail changes have not been noted.
Amd.1	12	Supplier Sovereign Engineered Adhesives is added to the QPL.
Amd. 2	6	Resin Content test method has been changed.
Amd. 3	3	Para. 3.1.1 - Width has been changed. Table 1 has been changed
	5	Para. 3.2.3 - Volatile Content requirements have been changed.
	6	Para. 3.2.6 - Foil Thickness for Type 2 has been changed.
Amd. 4	5	Para. 3.2.1 - Storage Life requirements have been changed.
Amd. 5	6	Reference resin content to QPL
	8, 9	Table 3: Reference to foot note deleted.
	12	Specify resin content and resin flow requirements.
Amd. 6	12	QPL: Resin Flow values for PL795-1 LSA changed.
Amd. 7	1	Page count changed.
	12, 13	QPL: Supplier's name changed from Sovereign Engineered Adhesive, L.L.C. to SIA Adhesives, Inc.
	13	QPL: Resin Content values changed for Type 2 SIA material.
	12, 13	QPL: J.D. Lincoln, Inc. materials added.
Amd. 8	6	Resin Flow test method changed.
	12, 13	QPL: J.D. Lincoln, Inc. Resin Content changed.

REVISION RECORD

Issue	Page	Description and Reason for Change
B		Specification title changed to include 350F cure.
	6	Correct flow test method.
C		SIA Adhesive name and location changed to Henkel Loctite. Product PL795-1 LSA re-qualified.
Adm. 1	8	Table 3, removed tack testing from Batch Acceptance test.
D		This is a complete revised issue. Detail changes have not been noted. Expanded foil Supplier Dexmet is added to the QPL.
E		This is a complete revised issue. Detail changes have not been noted.
	7	Updated Resin Content test method.
Adm. 1	14, 15	QPL Resin flow values for JDL products L- 636-** changes Type 1: Was " 32-50%", Now "28-48%" Type 2: Was " 42-60%", Now "35-60%"
F		Updated Section 4, Section 5, Table 3 . Clarified acceptance testing is required for both supplier and purchaser.
	13	Storage temperature below 10°F
	QPL	Manufacturer name changed Was: J.D.Lincoln Now: Umeco Structural Materials (CA) Inc.
Adm. 1	4	Table 1, added range for % opening and foot note clarifying Resistivity value is for reference only. Agreed by EMC DAD.
Amd. 2	16, 17, QPL	Removed Henkel Loctite Corp. as products no longer available. Added Axiom Materials products to type 1 and type 2.

REVISION RECORD

Issue	Page	Description and Reason for Change
F		
Adm. 3	7	Specified foil maximum thickness is 0.020"
	8	Reword Tack requirement
	16,17 QPL	Added Cytec Winona to Type 1 and Type 2
Amd 4	13	7.2 Revised, standardize with other specifications
Amd 5	16, 17 QPL	Removed Cytec Costa Mesa manufacturing site, as no longer available. Revised Gel time of Axiom products based on statistical data.

1 SCOPE

This specification establishes the requirements for 250°F/350°F cure epoxy resin or film adhesive impregnated expanded aluminum foil to be used for dispersing static electricity, High Intensity Radiated Field (HIRF) protection and for providing lightning strike protection to composite parts.

1.1 Classification

The materials supplied to this specification shall be furnished in the following types:

Type Type designation is based on the expanded foil weight

Type 1: 0.028 psf expanded aluminum foil.

Type 2: 0.018 psf expanded aluminum foil.

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 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 US Government Specifications

MIL-STD-1751 - Lightning Qualification Test Techniques for Aerospace Vehicles and Hardware

2.2 American Society for Testing and Materials

ASTM B373 - Specification For Aluminum Foil for Capacitors

ASTM C613 - Resin content

ASTM E34 - Test Method for Chemical Analysis of Aluminum and Aluminum-Base Alloys

2.3 de Havilland Inc. Specifications and Standards

DSC 163-26 - Perforated Sheet, Aluminum (Type 1)

DSC 163-27 - Perforated Sheet, Aluminum (Type 2)

3 REQUIREMENTS

3.1 Properties of Expanded Aluminum Foil, Unimpregnated

Aluminum foil is 1145 Series Electrical Grade Annealed Aluminum, capable of exceeding lightning protection and High Intensity Radiated Field (HIRF) requirement for composite aircraft components.

The Aluminum foil shall meet the chemical composition requirements of ASTM B373. Test in accordance with ASTM E34.

The foil is produced from solid foil or film and perforated, expanded with certain percentage open area, major pitch, minor pitch or LWD, SWD as required in **Table 1**, **Figure 1**.

The foil shall be bare and cleaned as such to ensure cleanliness and increase adhesion bondability.Any added surface coating treatment to the foil shall be approved by Materials Technology prior to qualification. The coating shall be identified as part of the product's code listed in the QPL.

The foil shall be clean, uniform in appearance and free from visible defects of foreign matter which may be detrimental to fabrication and bonding. The material shall be free from stains or discolorations. Creases or folds and broken or bent strands shall not be allowed after the first three feet of material. Roll edges shall be evenly aligned, with no damaged strands or edges.

3.1.1 Dimension:

3.1.1.1 Width: - Unless otherwise specified by purchaser, the overall width of the product, as supplied, shall be 35" or 36".

3.1.1.2 Length: - The foil shall be supplied in continuous roll form, free from foreign materials, and uniform in appearance. Unless otherwise specified by purchaser, the overall length of the product, as supplied, shall be 25 ± 5, 50 ± 5 yards.

TABLE 1. Unimpregnated Metallic Foil Physical Properties

Type	Weight Lb/ft^2	Material Designation Per QPL	Nominal Thickness (inches)	% Open Area	Major Pitch or LWD (inches)	Minor Pitch or SWD (inches)	Resistivity Micro ohm.cm
1	0.028±0.0025	ASTROSEAL	0.006±0.0015	61 Nominal	Major Pitch 0.056±0.0075	Minor Pitch 0.029±0.0075	2.89*
		DEXMET	0.0057-0.0077	61 -75 %	LWD 0.075 -0.085	SWD 0.041-0.050	
2	0.018±0.0025	ASTROSEAL	0.004±0.001	61 Nominal	Major Pitch 0.057±0.007	Minor Pitch 0.026±0.007	2.89*
		DEXMET	0.0047-0.0067	65-77 %	LWD 0.075-0.085	SWD 0.041-0.050	

*. Measured as solid aluminum sheet, for reference only.

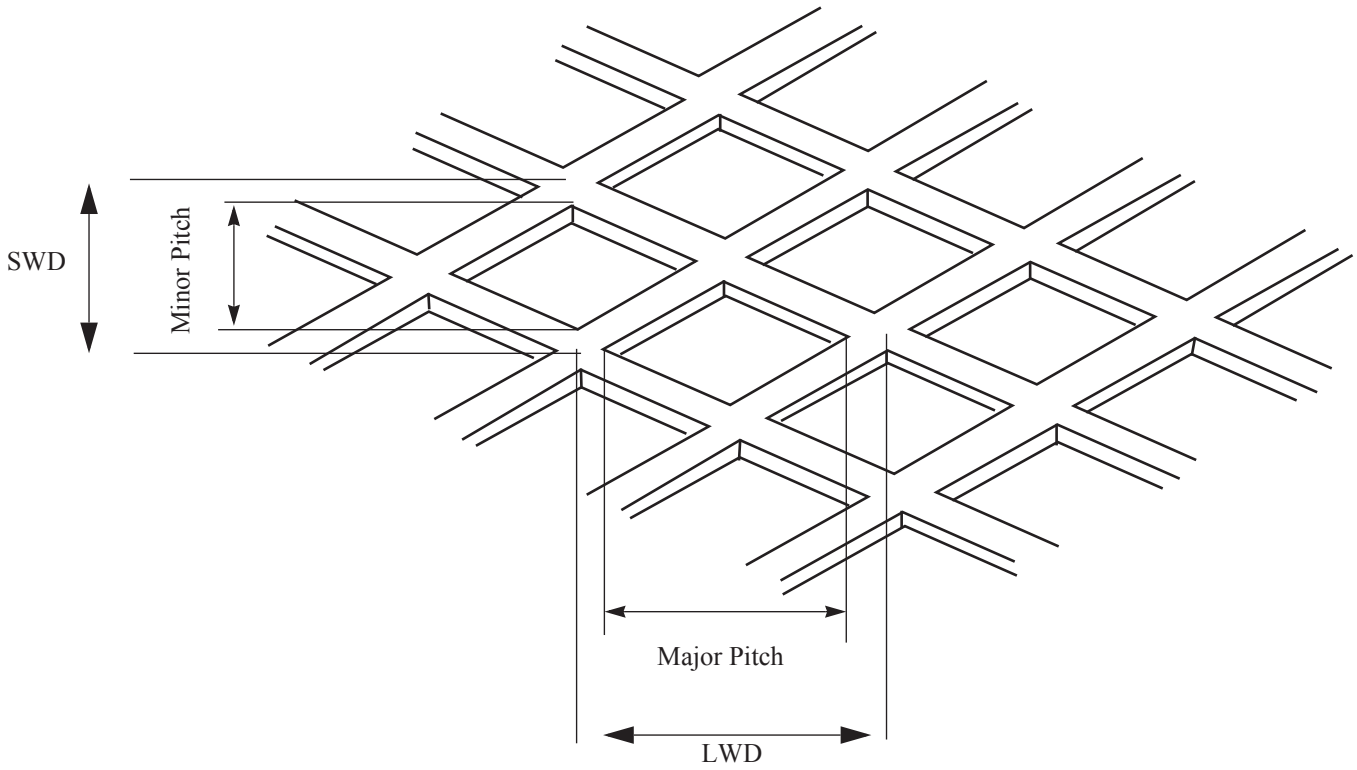

FIGURE 1. Illustration of Foil

3.1.2 Defects -Materials may not contain defects in excess of the following limits: Defects in excess of one in any 5 linear yards of material or totaling more then 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. A log of defects should be provided with each roll. Additional material shall be added to the roll to compensate for all defect areas occurring in the roll. Compensating material shall be the full roll width for each length of affected area. Alternatively, the purchase liability shall be reduced equal to amount of compensating material otherwise due. Compensation for defective material may be calculated on an equivalent weight basis, at the supplier's option.

3.2 Properties of Uncured Impregnated Aluminum Foil

Expanded Aluminum foil can be impregnated with epoxy resin or adhesive film suitable for co-curing with other composite components.

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

TABLE 2. Preimpregnated Aluminum Foil Physical Properties

Type	Weight lb/ft^2	Nominal Thickness (inches)
1	0.088±0.010	0.010±0.001
2	0.078±0.010	0.008±0.001

3.2.1 Storage Life -The storage life of the prepreg shall be a minimum of 180 days from date of shipment, 270 days from the date of manufacture.

3.2.2 Working Life -The working life of the prepreg shall have a total accumulative outtime of maximum 10 days when exposed to an environment of +65°F to +77°F and a maximum relative humidity of 63%.

3.2.3 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 circulate type oven at 250° F ± 10° F for 60 minutes. Remove specimens from the oven and place in a dessicator. 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

The volatile content, by weight, shall not be greater than 2%.

3.2.4 Resin Content by Weight

Three specimens approximately 4 X 4 inch 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. Reserve the specimens after test for foil weight determined in **Para.3.2.5**.

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, 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 foil 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 calculated as follows:

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

W1 = Original Weight

W2 = Weight After Extraction

The product shall have a resin content within the range specified on the Qualified Products List.

3.2.5 Foil Weight

Weigh each specimen (after the resin has been removed) and record the weight within 0.001 lb/ft^2. Record the three individual weight measurements and the average weight. Reserve the specimens for foil thickness determined in **Para.3.2.6**. The foil weight shall meet the requirement of **Table 1**

3.2.6 Foil Thickness

Measure the overall thickness of the perforated, expanded foil at five different locations using a micrometer. Record the five individual thickness measurements and the average thickness. Thickness shall meet the requirement of **Table 1.**

3.2.7 Resin Flow by Weight

Three specimens, each 4 x 4 inch, 4 plies, of the uncured material shall be laid up and weighed on an analytical balance to the nearest 10 mg. The specimens shall be positioned between aluminum foil (maximum thickness 0.020") coated with release agent and placed individually in a press, preheated to 260°F ± 10°F and cured for 15 minutes at 50 psi ± 5 psi pressure. The foil shall be removed, the flash broken off, each specimen individually reweighed to the nearest 10 mg, and the percent flow calculated.The resin flow shall be as stated on the Qualified Products List of this specification.

3.2.8 Gel Time

Method 1

Three specimens, approximately 1/4" square each, shall be cut from the uncured material. A hot plate shall be preheated to 260°F ± 10°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 center 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 elapsed time to the nearest minute shall be recorded.

Method 2

Apparatus:

1. Fisher-Johns melting point apparatus
2. Thickness No. 218 mm cover glasses
3. Timer or stopwatch
4. Wooden picks or equivalent.

Procedure:

1. Preset the Fisher-Johns melting point apparatus to read 260°F±10°F.
2. Insert a 1/4" 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 epoxy resin product shall have a gel time within the range specified on the Qualified Products List.

3.2.9 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 material shall exhibit a degree of tackiness so that , when folded 180°, will adhere lightly to itself. It shall also be capable of adhere to an aluminum plate at 77°F, 50% R.H.

3.2.10 Workmanship -The aluminum foil shall be evenly impregnated, uniform in quality, free from resin pockets, areas lacking resin, excess resin, patches and other similar defects which will render the product unsuitable for its intended purpose.

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 approva l.

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 specification 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). 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.

4.4.2 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.

4.4.3 The PCD and all production data shall be available to any 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 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 3.

5.1.2 The Prepreg 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.

5.1.3 The expanded foil supplier shall provide the prepreg supplier for each batch a certification showing the base metal composition of the coil used to make the expanded metal foil comply with the requirements in Para.3.1. Actual test data showing conformance to the requirements of Table 1 (weight, Thickness, % opening).

5.1.4 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.

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

5.2 Purchaser 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 3.

TABLE 3. Qualification and Batch Acceptance Tests on Materials

Properties	Paragraph	Qualification (Manuacturer/ Supplier)	Acceptance	
			Manufacturer/ Supplier	Purchaser/ User
Foil Physical Properties	Table 1 Para.5.1.3	x	x*	
Dimension	Para.3.1.1	x		
Storage Life	Para.3.2.1	x		
Working Life	Para.3.2.2	x		
Volatile Content	Para.3.2.3	x		
Resin Content	Para.3.2.4	x	x	x
Foil Weight	Para.3.2.5	x	x	
Foil Thickness	Para.3.2.6	x	x	
Resin Flow	Para.3.2.7	x	x	x
Gel Time	Para.3.2.8	x	x	x
Tack	Para.3.2.9	x		
Workmanship	Para.3.2.10	x		

*. Applicable to Foil Supplier only.

5.3 Sampling

5.3.1 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
40 and more	3 rolls

5.3.2 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.

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

-Type, Class, Grade of Pre-Impregnated foil

-Manufacturer's Material Designation

-Total Quantity

7 PREPARATION FOR DELIVERY

7.1 Identification

7.1.1 Each roll of impregnated foil shall be identified with a label or marking, securely affixed to the inside of the core or with a removable tag.

7.1.2 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:

- Aluminum Foil, Epoxy Impregnated

- DHMS P 1.64, Issue & Amendment number (Enter Type)

- Manufacturer's Material Designation
- Purchase Order Number
- Batch and Roll Numbers
- Perishable-Store Below 10°F
- Date of Manufacture

7.2 Packaging

7.2.1 The impregnated foil shall be wound on spools not less than 3 inches in hub diameter and interleaved with a non-adherent film. The non-adherent film 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. Foil ends shall be secure.

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

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

7.2.4 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.

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:

- Aluminum Foil, Epoxy Impregnated
- DHMS P1.64, Issue & Amendment number (Enter Type)
- Manufacturer's Material Designation
- Purchase Order Number
- Lot and Roll Numbers
- Perishable-Store Below 10°F
- Date of Manufacture

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, 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.

QUALIFIED PRODUCTS LIST

MANUFACTURER'S NAME AND ADDRESS	MANUFACTURER'S PRODUCT IDENTIFICATION NO.	MATERIALS SAFETY DATA SHEET NO	PRODUCT QUALIFICATION SHEET NO'S	DATE OF PRODUCT APPROVAL
Expanded Aluminum Foil Suppliers				
	TYPE 1			
ASTROSEAL Product MFG. Corp. 85 Winthrop Rd. Chester, CT 06412	AL028CXMC	N/A		1996
DEXMET Corp. 7 Great Hill Road Naugatuck, CT 06770	6AL10-080	N/A		2008
	TYPE 2			
ASTROSEAL Products MFG	AL018CXMC	N/A		1996
DEXMET Corp.	5AL8-080	N/A		2008

QUALIFIED PRODUCTS LIST

MANUFACTURER'S NAME AND ADDRESS	MANUFACTURER'S PRODUCT IDENTIFICATION NO.	MATERIALS SAFETY DATA SHEET NO	PRODUCT QUALIFICATION SHEET NO'S	DATE OF PRODUCT APPROVAL
Pre-impregnated Aluminum Foil Suppliers				
	TYPE 1			
Cytec Engineered Materials Inc. 1300 Revolution Street Harve de Grace, Maryland 21078-3899 (410) 939-1910	FM300-2U-HT-AL028CXMC Gel Time: 10-20 min. Resin Flow: 32-45% Resin Content: 65-70%	1211	PQS 1	April 11, 1996
	FM300-2U-HT-6AL10-080 Gel Time: 10-20 min. Resin Flow: 32-45% Resin Content: 65-70%	1211		Jan. 15, 2008
Axiom Materials, Inc. 2320 Pullman St. Santa Ana, CA 92705 USA	AX-2114-6AL10-080F Gel Time: 5-15 min. Resin Flow: 30-54% Resin Content: 64-74%	N/A	PQS 3	March 4, 2015
Cytec Industries Inc. Winona Division 501 West Third Street Winona, MN 55987	L-636-AL28 Gel Time: 6-16 min. Resin Flow: 28-48% Resin Content: 60-70%	2828	PQS 5	June 12, 2015
	L-636-6AL10-080 Gel Time: 6-16 min. Resin Flow: 28-48% Resin Content: 60-70%	2828		

QUALIFIED PRODUCTS LIST

MANUFACTURER'S NAME AND ADDRESS	MANUFACTURER'S PRODUCT IDENTIFICATION NO.	MATERIALS SAFETY DATA SHEET NO	PRODUCT QUALIFICATION SHEET NO'S	DATE OF PRODUCT APPROVAL
Pre-impregnated Aluminum Foil Supplier				
	TYPE 2			
Cytec Engineered Materials Inc.	FM300-2U-HT-AL018CXMC Gel Time: 10-20 min. Resin Flow: 46-62% Resin Content: 74-80%	1211	PQS 2	April 11, 1996
	FM300-2U-HT-5AL8-080 Gel Time: 10-20 min. Resin Flow: 46-62% Resin Content: 74-80%	1211		Jan. 15, 2008
Axiom Materials, Inc. 2320 Pullman St. Santa Ana, CA 92705 USA	AX-2114-5AL8-080F Gel Time: 5-15 min. Resin Flow: 32-56% Resin Content: 71-81%	N/A	PQS 4	March 4, 2015
Cytec Industries Inc. Winona Division 501 West Third Street Winona, MN 55987	L-636-AL18 Gel Time: 6-16 min. Resin Flow: 35-60% Resin Content: 70-80%	2828	PQS 6	June 12, 2015
	L-636-5AL8-080 Gel Time: 6-16 min. Resin Flow: 35-60% Resin Content: 70-80%	2828		