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Material Specification

TITLE:	**GRAPHITE FIBRE, PREIMPREGNATED FABRIC AND TAPE 250^{O}F CURE, HIGH MODULUS**
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GRAPHITE FIBRE, PREIMPREGNATED FABRIC AND TAPE 250^{O}F CURE, HIGH MODULUS

REVISION RECORD

Issue	Page	Description and Reason for Change
C	--	Revised issue - material call-out for DHMS P1.35 Class 1 is referenced in BMS 8-168F
C Amd. 1	2	Short Beam Shear Test is required for acceptance test of materials referenced in BMS 8-168F.
D		Revised issue
Amd. 1	19	Table 7: Note 2 has been added.
Amd. 2	19	Table 7: Note 3 has been added.
Amd. 3	14	Table 5: Remove requirement for class 1. Minimum requirement changed from 575 psi to 300 psi..
	15	Figure 4 and 5: Core changed from 3/16"c, 1/2"t, 4pcf to 1/8"c, 1/4"t, 3pcf to standardized with Kevlar layup.
	23	Cytec product designations clarified.
Amd. 4	10	Specified Flex and Short Beam Shear tests with load applied at tool side (smooth side) of the specimen.
Amd. 5	10	Specified Flex test with support span of 2", load span of 0.67" Shear test with support span of 0.5", crosshead speed of 0.05"/min.
E	4	Changed ASTM D790 to ASTM D6272
	10	Changed ASTM D790 to ASTM D6272
	QPL	Added J.D. Lincoln

REVISION RECORD

Issue	Page	Description and Reason for Change
F		This is a complete revised issue.
	6	Reword Tack test.
	7	Temperature and Humidity changed to Maximum 60%
	9	Clarified Flex test is 4 point bend
	18, 19	Updated Material Qualification Requirements, Quality Assurance Requirements
	QPL	Removed Products: Cycom 919GT3092, 919GT3190,GF3070PW, GF313 5H8,HYE30714AC, HYE30714AK as products no longer available at Cytec Havre de Grace and Greenville site.
	QPL	Added Cytec Winona site.
G		
	4	3.3 Defect: Max defect allowable 5%
		3.4.2 Working Life: Maximum humidity of 60%
	5	3.4.3 Formability: Clarified temperature and humidity
	6	3.4.8 Tack: Maximum humidity of 60%
		3.4.10 Marking: Added example of marking
	7	3.4.12 Reword Workmanship
	11-12	Table 2, 3:Specified test within an hour of conditioning.
	20	Table 7, Revised acceptance test requirement for both Supplier and Purchaser/ User.
		Revised note 1 regarding test temperature and humidity.
	24	QPL: Cytec name changed to Cytec Solvay Group.

GRAPHITE FIBRE, PREIMPREGNATED FABRIC AND TAPE 250°F CURE, HIGH MODULUS

1 SCOPE

This specification establishes the requirements for a 250˚F cure epoxy resin impregnated graphite fabric and unidirectional tape, supplied in a "B" stage condition, suitable for autoclave pressure laminating/sandwich construction for exterior composite panels.

1.1 Classification

The materials supplied to this specification shall be one of the following Classes, Types, Grades and Styles:

1.1.1 Classes (specifies the graphite prepreg form)

Class 1: Unidirectional prepreg tape

Class 2: Woven fabric prepreg

1.1.2 Types (specifies the resin system)

Type I Nonadhesive resin system

Type II Self adhesive resin system

1.1.3 Grades (specifies the nominal areal weight of unidirectional graphite gm/m^2)

Grade 95

Grade 190

1.1.4 Styles (specifies the weave style of the graphite fabric)

3K-135-8H	3K yarn, 13.5 mil, 8-Harness Satin Weave
3K-70-PW	3K yarn, 7 mil Plain Weave

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 U.S. Government Specifications

2.1.1 Federal Aviation Administration

Advisory Circular No: 21-26 - Quality Control for the Manufacture of Composite Structures.

2.1.2 American National Standard Institute

ANSI B46.1-78 - Surface Texture

2.2 American Society for Testing and Materials

ASTM C297	-	Tension Test of Flat Sandwich Constructions in Flatwise Plane
ASTM D6272	-	Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials by Four-Point Bending
ASTM D2344	-	Apparent Horizontal Shear Strength of Reinforced Plastics by Short Beam Method
ASTM D3039	-	Tensile Properties of Oriented Fiber Composites
ASTM D695	-	Compressive Properties of Rigid Plastics

2.3 de Havilland Specifications & Standards

DHMS P1.26	-	Core, Honeycomb, Fibrous Aramid Base, Phenolic Coated
DHMS A6.09	-	High Temperature Epoxy Adhesive/Liquid Shim Material
DSC 234	-	Composite Manufacture Expendable Materials

2.4 Boeing Materials Specifications

BMS 3-11G	-	Hydraulic Fluid, Fire Resistant
BMS 9-8F	-	Graphite Reinforcements, Yarn and Fabric

3 REQUIREMENTS

The Graphite fiber shall be polyacrylonitrile (PAN), treated with surface finish to provide superior mechanical properties and must be compatible with the resin system qualified. Reinforcement used in the manufacture of prepreg to this specification shall meet the requirements of BMS 9-8 with traceability to original yarn lots.

3.1 Fabric/Unidirectional

3.1.1 Fabric

The Warp and Fill yarns shall be perpendicular to each other and parallel to the warp and fill directions of the impregnated fabric within 2 inches over the full fabric width and within 1 inch in any 21 inches of fabric width or length. Fabric shall not contain any unspliced yarns or tow ends.

3.1.2 Unidirectional

a. The gaps between fibres shall not exceed 0.032 inches wide nor 10 inches long. No more than one such defect shall be allowed per 10 sq ft.

b. The orientation of the yarn within the prepreg shall not deviate from a straight line parallel to the centerline of the prepreg by more than 0.032 inches in 1 foot of length.

3.2 Preimpregnated, Graphite Fiber Fabric/Unidirectional

The product shall be one of the fabrics or tape noted in **Para.1.1** of this specification, impregnated with an epoxy resin system, 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 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 Method of Uncured Impregnated Fabric/Unidirectional

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 of the prepreg shall be a minimum of 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 60%, 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 during normal fabrication processes at a temperature range of 65-77˚F with maximum humidity of 60% 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 - The volatile content by weight shall be calculated and recorded and shall meet the requirement in **Table 1**. Three, 4 x 4 inches 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

3.4.5 Resin Content by Weight/Carbon Areal Weight - The resin content by weight/carbon areal weight shall be calculated and recorded and shall meet the requirements of **Table 1**. Three specimens approximately 10 square inches 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. The three samples shall be individually weighted on an analytical balance and weights recorded to the nearest 10 mg. Extract the three samples in separate beakers containing 500 ml of Methyl Ethyl Ketone 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. Dry the fibers at 300˚F for 15 minutes. The specimens shall then be cooled to room temperature, reweighed, and the resin content/Carbon weight calculated as follows:

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

W1 = Original Weight

W2 = Weight After extraction

$$\text{Carbon Areal Weight} = \frac{W2}{A} \times 10^4 \quad \text{gm/m}^2$$

3.4.6 Resin Flow by Weight - The resin flow shall be calculated and recorded and shall meet the requirements of **Table 1**. Three specimens, each 4 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 specimen shall be positioned between two plies of porous teflon (DSC 234-5-48) coated glass cloth. Three plies of 1581 or 181 style glass fibre and 0.0015" aluminum foil shall be placed on both sides. The entire layup should be placed individually in a press, preheated to 260˚F ± 10˚F at 50 psi ± 5 psi and cured for 15 minutes. The foil, glass fibre 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.

3.4.7 Gel Time

3.4.7.1 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˚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 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.

3.4.7.2 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 of the specified temperature.

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 product shall have a gel time 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 60% 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 - Unless otherwise specified, the colour shall be natural, uniform 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 Matereials Technology de Havilland . The warp face of the woven impregnated fabric

shall contain the warp direction marking.Acceptable methods include but are not limited to ink arrows, ink lines, incorporated tracer yarns.

3.4.11 Dimensions

3.4.11.1 Width - Unless otherwise specified, the overall width of Class 1 products, shall be 12 inches with a tolerance of ± 1 inch. And the overall width of Class 2 products shall be 42 or 50 inches ± 0.50 inch inclusive of the selvedge.

3.4.11.2 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 graphite fiber fabric/tape shall be evenly impregnated, uniform in quality and free from gaps, holes, resin pockets, cured resin particles, foreign materials, creases and other similar defects which would render the product unsuitable for its intended purpose.

Table 1: Physical Properties of Prepreg

Property	Requirement			Test Method
	Type I	Type II		
	Class 1 and 2	Class 1	Class 2	
Volatile Content (percent wt.)	2.0 max	2.0 max	2.0 max	Para.3.4.4
Resin Content (percent wt.)	35 ± 2.0	40 ± 2.0	42 ± 2.0	Para.3.4.5
Resin Flow (percent wt.)	QPL	QPL	QPL	Para.3.4.6
Gel Time	QPL	QPL	QPL	Para.3.4.7
Areal Weight of carbon only	gm/m^2	Oz/yd^2		Para.3.4.5
Grade 95	95 ± 5	2.80 ± 0.15		
Grade 190	190 ± 5	5.60 ± 0.15		
Style 3K-135-8H	364 ± 14	10.7 ± 0.40		
Style 3K-70-PW	193 ±8	5.70 ± 0.25		

3.5 Mechanical Properties and Test Methods of Cured Impregnated Fabric/Unidirectional

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

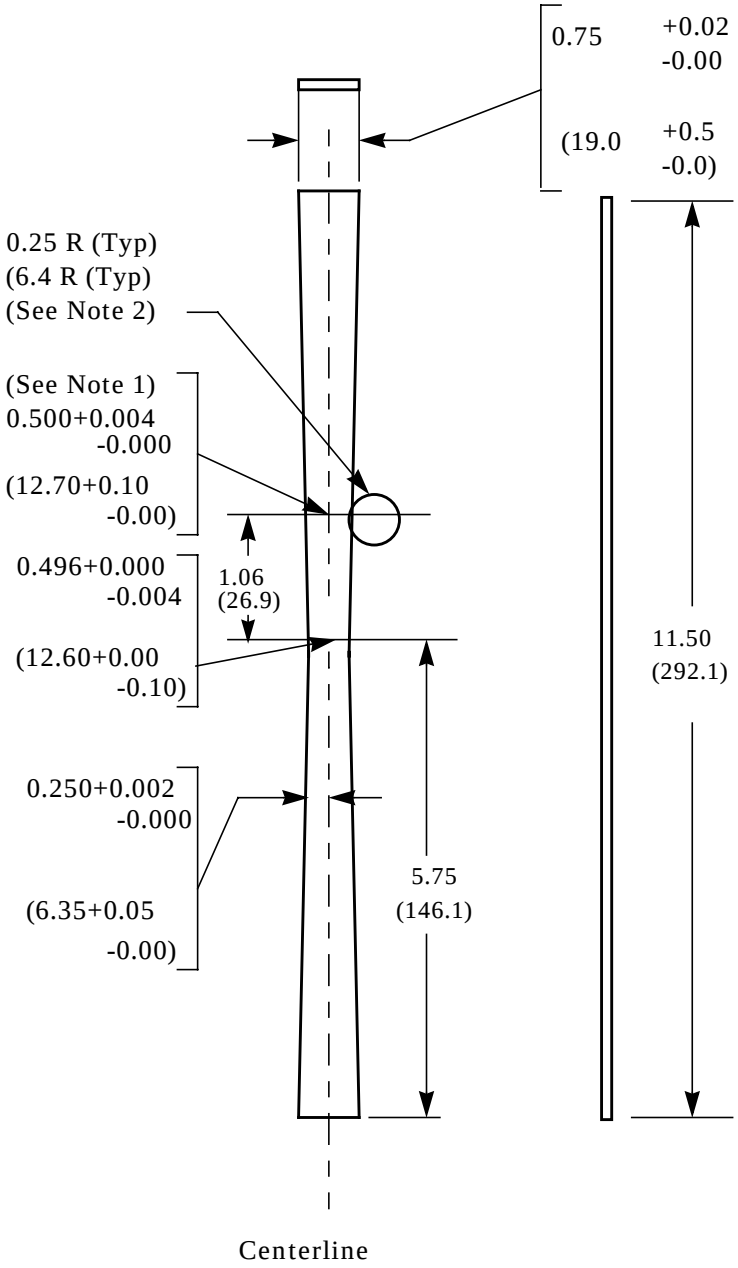
warp direction of the fabric or fiber direction of unidirectional material.

3.6 Laminate Mechanical Properties

3.6.1 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 2** for Type I materials, and **Table 3** for Type II materials. Five tensile test specimens shall be tested in accordance with ASTM D3039 except that the specimens for Class 2 testing shall conform to **Figure 1** .

3.6.2 Flexural Tests - The flexural strength (modulus of rupture) and flexural modulus (tangent modulus of elasticity) of each specimen shall be calculated and recorded and shall be not less than the values given in **Table 2** for Type I materials, and **Table 3** for Type II materials. Five flexural specimens, 3" warp x 1" fill, with the long dimension parallel to the warp direction or fiber direction shall be tested in accordance with ASTM D6272, Four Point bending and test with a crosshead speed of 0.06"/ minute, support span of 2", load span of 0.67". Test with load applied at the tool side (smooth side) of the specimen.

3.6.3 Horizontal Shear Strength Test - The Horizontal Shear strength shall be calculated and recorded and shall be not less than the value given in **Table 2** for Type I materials, and **Table 3** for Type II materials. Five test specimens 1.125" long (parallel to warp or fiber direction) by 0.25" wide (parallel to fill), shall be tested in according to ASTM D2344, with a crosshead speed of 0.05"/minute and support span of 0.50". Test with load applied at the tool side (smooth side) of the specimen.



Dimensions are in inches (millimeters)

Notes:
1. The width outward from 0.496 (12.60) shall be increased gradually and equally on each side up to 0.500 (12.70) so that no abrupt change in dimensions results.

2. Transition from straight sided center section to tapered section shall be smoothly joined in the area of the 0.250 (6.35) rad.

3. Test at crosshead speed of 0.15”/min.

FIGURE 1. Tensile Strength Specimen for Woven Fabric (Class 2)

3.6.4 Compressive Tests - The ultimate compressive strength of each specimen shall be calculated and recorded and shall be not less than the value given in **Table 2** for Type I materials, and **Table 3** for Type II materials. Five specimens conform to **Figure 2** shall be tested in accordance with ASTM D695.

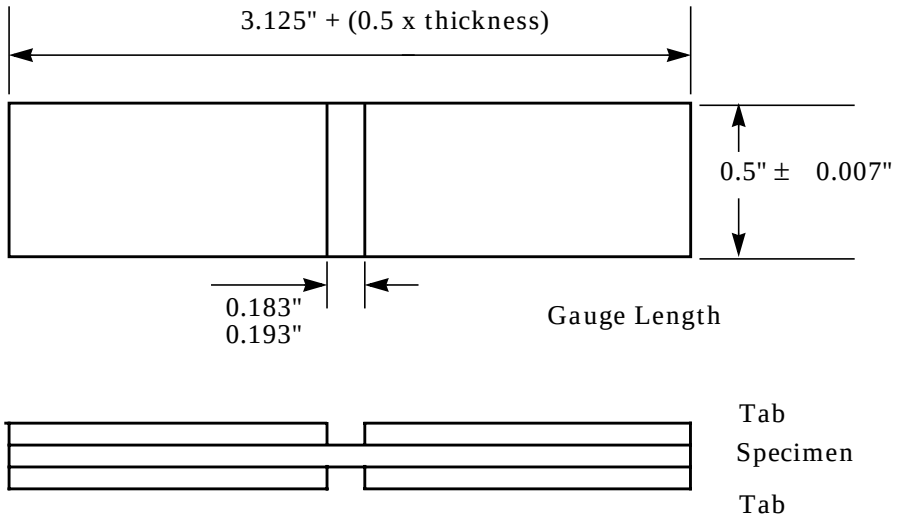


FIGURE 2. Compressive Test Specimen

Notes:

1 Tabs to be manufactured from 10 plies DHMS P1.22 Type 1 or the material to be tested and cured at 260˚F ± 10˚F, 35 ± 5 psi for one hour.

2 Use Frekote 44NC or 700NC on caul plate (0.032 - 0.060 thick) on upper surface. Do not use Tooltec.

3 Tab face which is to be bonded to specimen shall be cured with peel ply to DSC-234-12 to provide adequate bond surface.

4 Tab thickness is 0.100 ± 0.010" but all 4 tabs on a specimen must be within 0.002" of each other.

5 Maximum mismatch between tab transition edges is 0.005".

6 Warp direction shall be ± 5˚ for specimen and tab layup.

7 Tab layup may be done in panels and cut to size; no tab may be cut from material within 1/2 inch of the edge of the panel. Bond surface is surface which was cured with peel ply on it.

8 Bond tabs to specimen using 3M, 2 part adhesive EC 2216, DHMS A6.09 liquid shim or de Havilland Inc. (DHI) approved equivalent. Lightly abrade specimen surface (320 grit abrasive) only where tabs are to be bonded on. Use a fixture to maintain warp direction of tab during layup. Peel ply must be removed from tab before bonding commences. Wipe bond surfaces with MEK immediately before bonding

9 125 √edge finish is required in accordance with ANSI B46.1-7

Table 2: Mechanical Properties of Laminate for Type I, Class 1 and Class 2

Property	Minimum Requirement						Test Method
	Class 1 (Tape)			Class 2 (Fabric)			
	Dry[1]	Wet[2]	Fluid[3]	Dry	Wet	Fluid	
Ultimate Tensile Strength (Ksi)	185	N/R	N/R	75	N/R	N/R	Para.3.6.1
Tensile Modulus (Msi)	19.5-22.5	N/R	N/R	8-10.0	N/R	N/R	Para.3.6.1
Ultimate Tensile Strain (μ in/in)	9500	N/R	N/R	8500	N/R	N/R	Para.3.6.1
Flexural Strength (Ksi)	135	N/R[4]	N/R	95	N/R	N/R	Para.3.6.2
Flexural Modulus (Msi)	17	N/R	N/R	8.5	N/R	N/R	Para.3.6.2
Compressive Strength (Ksi)	175	165	N/R	80	70	N/R	Para.3.6.4
Compressive Modulus (Msi)	18.5-21.5	N/R	N/R	7.5-10.0	N/R	N/R	Para.3.6.4
Horizontal Shear Strength (Ksi)	11.0-15.0	N/R	N/R	5.5-8.5	N/R	N/R	Para.3.6.3

1. Conditioned at 70°± 10°F, 60% maximum relative humidity for a minimum of 24 hrs. Test specimens at room temperature after conditioned.

2. Conditioned at 170°± 5°F, 98±5% relative humidity until a moisture content level of 3-5% by weight (relative to the condition 1 specimens) has been achieved. Test specimens at room temperature within an hour after conditioning.

3. Immersed specimens in BMS 3-11 Type IV, Class 1, Grade A fluid at 160± 5°F for 7 days. Tested specimens at room temperature within an hour after conditioning.

4. N/R - not required at this issue. The value shall be added at a later time.

Table 3: Mechanical Properties of Laminate for Type II, Class 1 and Class 2

Property	Minimum Requirement						Test Method
	Class 1 (Tape)			Class 2 (Fabric)			
	Dry[1]	Wet[2]	Fluid[3]	Dry	Wet	Fluid	
Ultimate Tensile Strength (Ksi)	170	Not required	Not required	75	Not required	Not required	Para.3.6.1
Tensile Modulus (Msi)	16.0-19.0	Not required	Not required	7-9.5	Not required	Not required	Para.3.6.1
Ultimate Tensile Strain (μ in/in)	8200	Not required	Not required	7500	Not required	Not required	Para.3.6.1
Flexural Strength (Ksi)	135	N/R[4]	N/R	95	N/R	N/R	Para.3.6.2
Flexural Modulus (Msi)	15	N/R	N/R	7.5	N/R	N/R	Para.3.6.2
Compressive Strength (Ksi)	150	80	N/R	75	50	N/R	Para.3.6.4
Compressive Modulus (Msi)	16.0-19.0	N/R	N/R	7.0-9.5	N/R	N/R	Para.3.6.4
Horizontal Shear Strength (Ksi)	8.0	N/R	N/R	8.0	N/R	N/R	Para.3.6.3

1. Conditioned at 70°± 5°F, 60% maximum relative humidity for a minimum of 24 hrs. Test specimens at room temperature after conditioning.

2. Conditioned at 170°± 5°F, 98±5% relative humidity until a moisture content level of 3-5% by weight (relative to the condition 1 specimens) has been achieved. Test specimens at room temperature within an hour after conditioning.

3. Immersed specimens in BMS 3-11 Type IV, Class 1, Grade A fluid at 160± 5°F for 7 days. Tested specimens at room temperature within an hour after conditioning.

4. N/R - not required at this issue. The value shall be added at a later time.

3.6.5 Ply Thickness - Measure the cured ply thickness from laminates prepared for mechanical testing using a micrometer. Report thickness as the average of at least 10 determinations uniformly dispersed over the laminate surface. The average ply thickness for each laminate must meet the requirements of **Table 4**.

Table 4: Cured Ply Nominal Thickness (inch)

Type I, Class 1		Type I, Class 2		Type II, Class 1		Type II, Class 2	
Grade 95	Grade 190	3K-135-8H	3K-70-PW	Grade 95	Grade 190	3K-135-8H	3K-70-PW
0.0032-0.0039	0.0065-0.0076	0.0132-0.0158	0.0069-0.0082	0.0037-0.0045	0.0075-0.0088	0.0144-0.0174	0.0075-0.0091

3.6.6 Hydraulic fluid resistance - Cut two specimens 1" X 3" (warp) from each of the prepared laminate for mechanical testing. Obtain drawing pencils ranging in hardness from 4H through 9H and square the tips as in **Figure 3**. Place the specimen bag side up in a horizontal position. Hold the pencil at a 45 degree angle an push it across the specimen using firm steady pressure. Test with the various hardness pencils until one is found that will just cut or scratch the panel. Report pencil hardness as the softest pencil lead that will just cut or scratch the panel. Immerse the specimens in Hydraulic fluid BMS 3-11 Type IV, Class 1, Grade A for 48 hours at 160˚F . Test specimen immediately after removing from bath and dry using a dry gauze. Test at room temperature, at bag side. Surface hardness of the exposed panel shall not decrease more than 2 pencil lead hardness nor shall more than one original panel hardness fall below 6H nor shall any test value fall below 4H. Examine exposed panel edges. There shall be no evidence of delamination due to exposure.

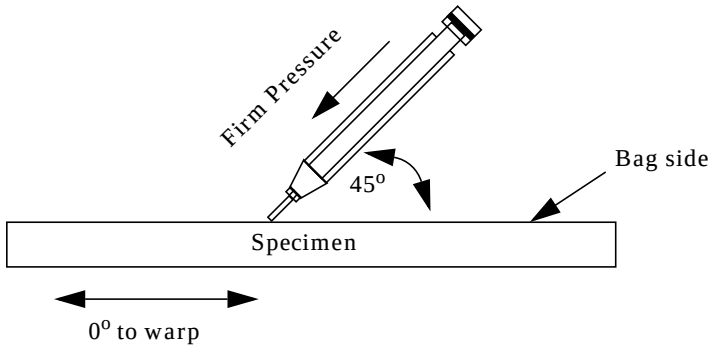


FIGURE 3. Hydraulic Fluid Resistance Test Configuration

3.7 Sandwich Mechanical Properties

3.7.1 Flatwise Tensile - The Flatwise Tensile strength shall be calculated and recorded and shall be not less than the value given in **Table 5**. Five specimens, each 2" x 2" shall be tested in accordance to ASTM C297.

Table 5: Mechanical Properties of Sandwich Panel for Class 2, Type I and II materials

Property	Minimum Requirement	Test Method
	Class 2	
Flatwise Tensile (Psi)	300	Para.3.7.1

4 TEST PANEL FABRICATION

4.1 Laminate Specimen

Test laminate 18" warp x 12" fill shall lay up with number of plies specified in **Table 6** with the long dimension parallel to the fiber direction or warp direction. Laminate shall be vacuum bagged per the applicable **Figure 6** & **Figure 7** and cured per **Figure 8**.

Table 6: Number of Ply requirement for laminate specimens

Test specimen	# plies for Class 1, Grade 95	# plies for Class 1 Grade 190	# plies for Class 2, Style 3K-135-8H	# plies for Class 2, Style 3K-70-PW
Flexural	12	15	8	14
Horizontal Shear	30	15	8	14
Tensile	12	6	8	14
Compressive	12	6	8	14

4.2 Sandwich Panel

Test panel 24" fill x 36" warp shall be lay up according to **Figure 4** or **Figure 5**, vacuum bag per the applicable **Figure 6** & **Figure 7** and cured per **Figure 8**.

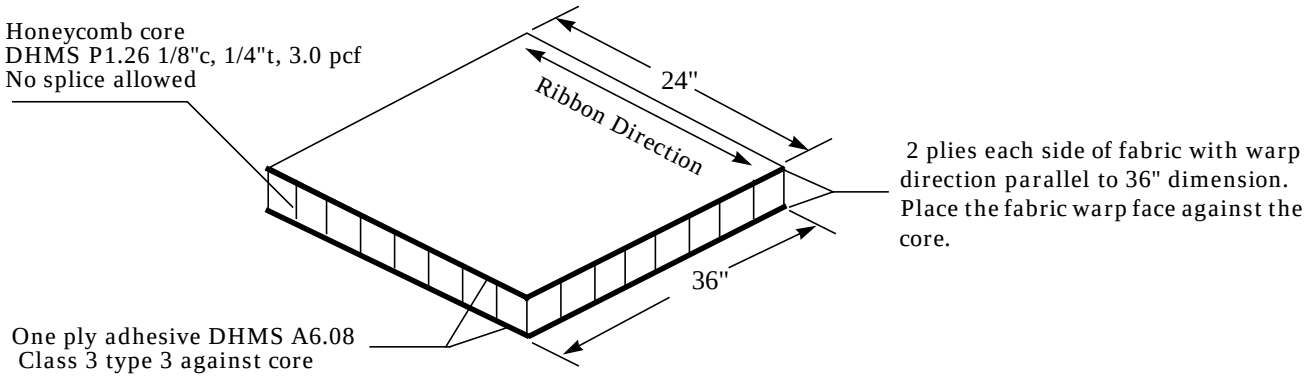


FIGURE 4. Sandwich Test Panel for Type I Material

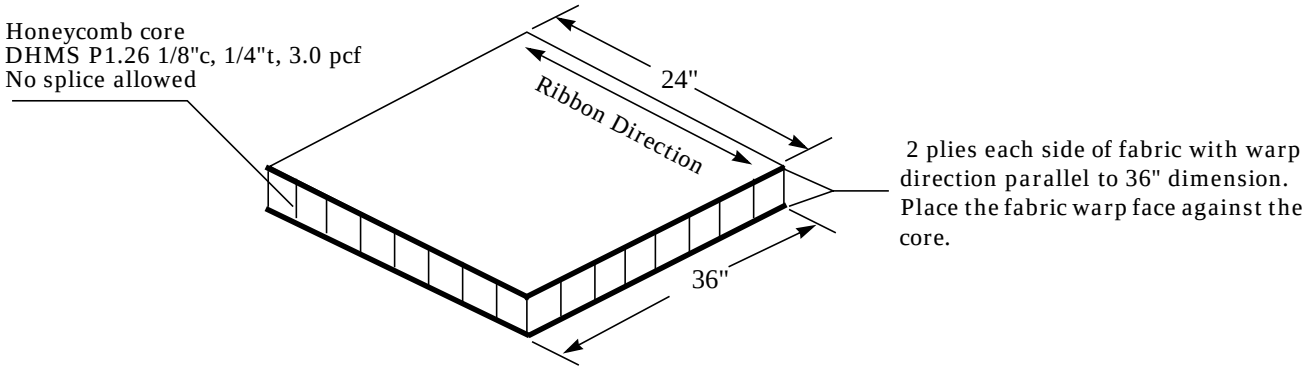
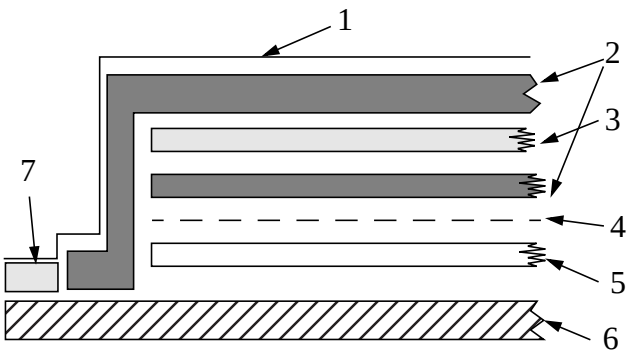


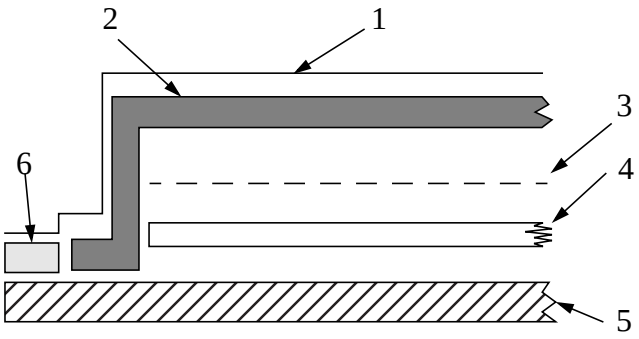
FIGURE 5. Sandwich Test Panel for Type II Material



Use DSC 234 expendable materials

1. Nylon Vacuum Bag
2. Airweave SS-FR Breather
3. Intensifier (0.032" to 0.060" Al. Plate)
4. Perforated Release Film A4000P3
5. PART
6. Tool (coated with mould release Frekote 44NC or 700NC)
7. GS 43 MR Vacuum Sealant Tape

FIGURE 6. Bagging Procedure for Class 1 Laminate And Sandwich Panels



Use DSC 234 expendable materials

1. Nylon Vacuum Bag
2. Airweave SS-FR Breather
3. Perforated Release Film A4000P3
4. PART
5. Tool (coated with mould release Frekote 44NC or 700NC)
6. GS 43 MR Vacuum Sealant Tape

FIGURE 7. Bagging Procedure for Class 2 Laminate And Sandwich Panels

APPROVED EXPENDABLE MATERIALS TO DSC 234

Vacuum bag, Ipplon DP1000	(DSC 234-1-54)	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)	Frekote Inc., 170 W. Spanish River Blvd., Boca Raton, FL 33431 (305) 395-3082
Vacuum Sealant Tape, GS 43 MR	(DSC 234-17-1)	

NOTE: Additional sources are listed in DSC 234.

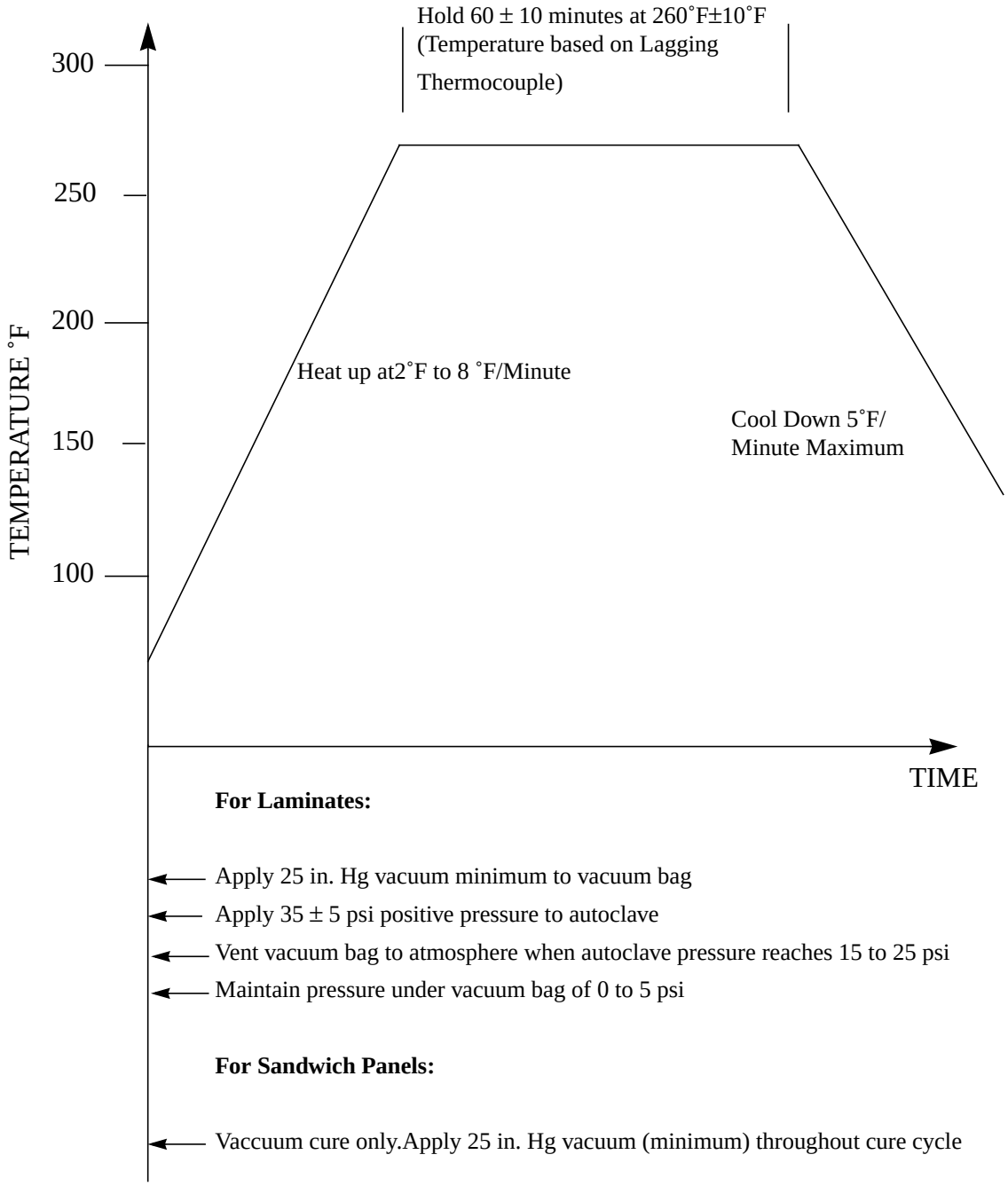


FIGURE 8. Cure Cycle

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.

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 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 Bombardier Materials Technology if there are any changes in the 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 7.**

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 7** 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 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 7.**

Table 7: Qualification and Batch Acceptance Tests

Property	Requirements	Qualification (Manufacturer/ Supplier)	Acceptance	
			Supplier	Purchaser/User
Fiber/Fabric Weight	Table 1	x	x	x
Storage Life	Para.3.4.1	x		
Working Life	Para.3.4.2	x		
Formability	Para.3.4.3	x	x	
Volatile Content	Table 1	x	x	
Resin Content	Table 1	x	x	x
Resin Flow	Table 1/ QPL	x	x	x
Gel Time	Table 1/QPL	x	x	x
Tack	Para.3.4.8	x	x	x
Colour	Para.3.4.9	x		
Marking	Para.3.4.10	x		
Dimensions	Para.3.4.11	x		
Workmanship	Para.3.4.12	x	x	
Tensile Strength	Table 2/Table 3	x		
Tensile Modulus	Table 2/Table 3	x		
Flexural Strength	Table 2/Table 3	x	x	x
Flexural Modulus	Table 2/Table 3	x		
Horizontal Shear Strength	Table 2/Table 3	x	x	x
Compressive Strength	Table 2/Table 3	x		
Compressive Modulus	Table 2/Table 3	x		
Cure Ply Thickness	Table 4	x		
Hydraulic Fluid Resistance	Para.3.6.6	x		
Flatwise Tensile	Table 5	x	x*	x*

1. For acceptance test condition at 70˚± 5˚F, 60% maximum relative humidity for a minimum of 24 hrs. Test specimens at room temperature .

* 2. Require for acceptance test of Class 2 materials only.

6.3 Sampling

6.3.1 Sampling Schedule - Sampling shall be in accordance with **Table 8**.

Table 8: Sampling Schedule

Number of Rolls in Batch	Frequency of Inspection
1 - 10	1 roll
11 - 39	2 rolls
40 and more	3 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 graphite 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 Preimpregnated 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:

- Graphite Fiber Fabric, Epoxy Impregnated
- DHMS P1.35, latest Issue & Amendment (Enter Type, Class, Grade and Style)
- 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 or 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 sealed in a bag of suitable nonadherence material to prevent penetration of moisture or loss of impregnating resin solvent.

8.2.3 The roll shall be packed in an exterior shipping container capable of protecting the impregnated fabric adequately at 10˚F or lower during shipment and storage.

8.3 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:

- Graphite Fiber Fabric, Epoxy Impregnated
- DHMS P1.35, latest Issue & Amendment (Enter Type, Class, Grade and Style)
- Manufacturer's Material Designation
- Purchase Order Number
- Lot and Roll Numbers
- Quantity
- Perishable - Store Below 10˚F
- Date of Manufacture

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

8.3.2 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 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.

GRAPHITE FIBRE, PREIMPREGNATED FABRIC AND TAPE 250°F CURE, HIGH MODULUS

QUALIFIED PRODUCTS LIST

MANUFACTURER'S NAME AND ADDRESS	MANUFACTURER'S PRODUCT IDENTIFICATION NO.	MATERIALS SAFETY DATA SHEET NO	PRODUCT QUALIFICATION SHEET NO.	DATE OF PRODUCT APPROVAL
	Class 1 Type II			
Cytec Industries Inc. 851 W. 18th Street Costa Mesa, CA 92627 (949) 650-8106 Cytec Solvay Group 501 West Third Street Winona, MN 55987	Grade 95 L930HT % Resin Flow: 10-22 % Gel Time: 5-15 min. Grade 190 L930HT (GT700) % Resin Flow: 10-22 % Gel Time: 5-15 min.	2653	PQS #6 PQS#8	October 1, 2001 June 26, 2015
	Class 2 Type II			
	Style 3K-70-PW L930HT (100) % Resin Flow: 10-30 % Gel Time: 5-15 min. Style 3K-135-8H L930HT (139) % Resin Flow: 10-30 % Gel Time: 5-15 min.	2653	PQS #7 PQS#8	October 1, 2001 June 26, 2015

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