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Material Specification

TITLE:	**ARAMID FIBER (KEVLAR® 49), HIGH MODULUS, 250°F CURE EPOXY RESIN IMPREGNATED**
SPECIFICATION NUMBER:	**DHMS P 1.24**
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ARAMID FIBER (KEVLAR® 49), HIGH MODULUS, 250°F CURE EPOXY RESIN IMPREGNATED

REVISION RECORD

Issue	Page	Description and Reason for Change
H		This is a complete revision and detailed changes have not been noted. Fiberite was deleted from QPL
H Amd. 1	24-26	American Cyanamid name changed to CYTEC and address changed to Harve de Grace, Maryland.
H Amd. 2	6	Para. 3.3.11 revise to add 60" width to the allowable overall width of the product.
H Amd. 3	24-26	Structural Polymer Systems, inc. changed to Culver City Composites.
J		This is a complete revised issue. Detailed changes have not been noted.
J Amd.1	8 16	Figure 1 has been changed. Figure 9 has been changed.
J Amd.2	5-8	Resin Content test method has been changed.
Amd.3	3 4 5	Para. 2.2 - Reference to ASTM C613 has been deleted. Para. 3.1.2 - Fabric Weight has been changed. Para. 3.4.5 - Fabric weight has been added.
Amd. 4	8 18	Figure 1 has been corrected. Table 6: Note 3 has been added.
Amd. 5	14 16	Figure 5: "Cure at 35 psi" deleted (extra note). Figure 9: Notes changed. All laminates shall be cured at 35 psi.

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Issue	Page	Description and Reason for Change
K	All	This is a complete revision and detailed changes have not been noted.
Amd. 1	2	Table 1: Requirements for Type 6 have been updated.
	10	Table 3: Requirements for Type 6 Compression Strength and Flexural Modulus to be re-evaluated and added at the later revision of the spec.
	20, 21	QPL: Culver City Composites has been removed from QPL.
	20, 21	QPL: JD. Lincoln products have been added for Type 1, 3, and 6.
Amd. 2	20, 21	QPL: Cytec Engineered Materials has been removed from QPL.
Amd. 3	18	Para. 7.2.1 has been updated.
Amd. 4	2	Table 1: Cured Ply Thickness value for Type 6 material has been corrected.
Amd. 5	13	Add DSC 234-9 as an alternative to DSC 234-11.
Amd. 6	8,10	Specified Load to be applied at tool side (smooth side) for Flex and Short Beam Shear tests.
Amd. 7	8, 10	Specified Flex test with support span of 2", load span of 0.67" Shear test with support span of 0.5" for thickness up to 0.130"; 0.65" for thickness greater than 0.130". Crosshead speed 0.05"/min.
Amd. 8	11	Revised para 3.7.1, 3.7.2 and Table 4 to specified the requirement values is average.
Amd. 9	15	Added Requirement for PCD from Manufacturer
Amd. 10	7	Para. 3.4.11 , added 24" width option for type 6

REVISION RECORD

Issue	Page	Description and Reason for Change
L	All	This is a complete revision and detailed changes have not been noted. Flexural test, ASTM D790 changed to ASTM D 6272.
M	All	This is a complete revision and detailed changes have not been noted.
	5	Resin content testing updated.
	10	Table 3, added values for Compressive and Flex Mod for type 6
	QPL	Flow range for type 2 revised. Added Adelanto site for Type 1, 2 and 3
N	7, 11	Para. 3.5.1,Table 3 foot note , conditioning of test specimens Was: 40 hrs, Is: 24 hrs.
	15, 16	Added Material Qualification Requirements, Quality Assurance Requirements sections.
	16-17	Table 6: clarified supplier and purchaser testing. Tabe 6 ,Foot note 3: conditioning of specimens Was: 40hrs, Is: 24 hrs.
	QPL	J.D.Lincoln name changed to Umeco Structural Materials (CA) Inc.
P	7	Tack test updated. Specified R.H. of maximum 60%.
	8	Clarified Flex test is 4 point bending.
	QPL	Added Cytec Winona site . Costa Mesa site will be removed at later date upon depletion of stock. Added Axiom products for type 1,2,3. Removed reference to Amd # in FAR 25.853.
Amd. 1	QPL	Removed note regarding intermixing. Added Axiom product for Type 6

ARAMID FIBER (KEVLAR® 49), HIGH MODULUS, 250°F CURE EPOXY RESIN IMPREGNATED

REVISION RECORD

Issue	Page	Description and Reason for Change
Q	4	3.3 Defect: Max defect allowable 5%.
	5	3.4.2 Working Life: Maximum humidity of 60%
		3.4.3 Formability:Clarified temperature and humidity
	7	3.4.8 Tack: Maximum humidity of 60%
		3.4.10 Marking: Added example of marking
		3.4.12 Reword Workmanship.
	11	Table 3, specified test within an hour after conditioning.
	17, 18	Table 6, Revised acceptance test requirement for both Supplier and Purchaser/ User.
		Revised note 3 regarding test temperature and humidity.
	22	QPL: Cytec name changed to Cytec Solvay Group

ARAMID FIBER (KEVLAR® 49), HIGH MODULUS, 250°F CURE EPOXY RESIN IMPREGNATED

1 SCOPE

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

1.1 Classification

The materials supplied to this specification shall be one of the following types:

TABLE 1. Classification

Type	Style	Resin Content	Cured Ply Thickness (Nominal)
1	220	56% - 64%	0.005"
2	281	50% - 55%	0.011"
3	285	50% - 55%	0.011"
6	Unidirectional Tape (4560 Denier)	50% - 55%	0.010"-0.014"

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

FAR 25.853(a) APP. F, Part I (a)(1) (i) - Flammability Requirements

FAR 25.853(a) APP. F, Part I (a)(2) (ii) - Flammability Requirements

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 Reinforced Plastics by Four Point Loading
ASTM D1781	-	Climbing Drum Peel Test for Adhesives
ASTM D2344	-	Apparent Horizontal Shear Strength of Reinforced Plastics by Short Beam Method
ASTM D3039	-	Tensile Properties of Oriented Fiber Composites
ASTM D3410	-	Compressive Properties of Unidirectional or Crossply Fiber Resin Composites
ASTM E162	-	Surface Flammability of Materials Using a Radiant Heat Energy Source

2.3 De Havilland Specifications & Standards

DHMS P1.26	-	Core, Honeycomb, Fibrous Aramid Base, Phenolic Coated
DHMS P1.27	-	Plastic Sheet and Film Polyvinyl Fluoride
DHMS A6.09	-	High Temperature Epoxy Adhesive/Liquid Shim Material
DSC 234	-	Composite Manufacture Expendable Materials

2.4 Boeing Materials Specifications

BMS 3-11	-	Hydraulic Fluid, Fire Resistant

2.5 Aerospace Material Specifications

AMS 3901	-	Organic Fiber, Yarn & Roving, High Modulus, For Structural Composites
AMS 3902	-	Cloth, Organic Fiber, High Modulus, For Structural Composites
AMS 3903	-	Cloth, Organic Fiber, High Modulus Epoxy Resin Impregnated

3 REQUIREMENTS

3.1 Fabric/Unidirectional Tape (Kevlar® 49)[1]

The fabric/unidirectional supplied to this specification shall be Kevlar® 49 and one of the styles listed in **Table 2**. The Aramid fiber fabric, Types 2 and 3, shall meet all the requirements of AMS 3902. The filaments used in the fabrication of the Type 6 tape shall meet the requirements of AMS 3901.

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

3.1.2 Fabric Weight - The basic weight of the fabric shall meet the requirements given in **Table 2**. For acceptance test, the weight of the fabric shall be determined as per **Para.3.4.5**.

TABLE 2. Unimpregnated Fabric/Unidirectional Tape

Type	Style	Construction Ends/Inch (Denier)	Weave	Basic Weight oz/sq. yd.	Thickness Inches (Nominal)
1	220	22(380) x 22(380)	Plain	2.2 ± 0.20	0.005"
2	281	17(1140) x 17(1140)	Plain	5.0 ± 0.30	0.010"
3	285	17(1140) x 17(1140)	Crowfoot	5.0 ± 0.30	0.010"
6	Unidirectional Tape*	4560 Denier	N/A	7.0 ± 0.35	0.010"

3.2 Preimpregnated, Aramid Fiber Fabric/Unidirectional

The product shall be Kevlar® 49 and one of the fabrics or tape noted in **Table 2** 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.

1. Du Pont T.M.

3.4 Physical Properties and Test Method 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 of the prepreg shall be a minimum of 180 days from the date of shipment, 210 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 - 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

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

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 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.

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 mininum 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 trace of resin has been removed. Dry the fibers at 210° ± 10° 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:

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

Fabric Weight = $W2$

$W1$ = Original Weight

$W2$ = Weight After Extraction

3.4.6 Resin Flow

3.4.6.1 (Type 1-3) - Three specimens, each 4 inches x 4 inches x 4 plies, except for Type 1 material which shall be 8 plies thick, of the uncured material shall be 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 at 50 psi ± 5 psi pressure and cured for 15 minutes. The foil shall be removed, the flash broken off, each specimen individually reweighed to the nearest 10 mg and the percent flow calculated.

3.4.6.2 (Type 6) - 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 specimen shall be positioned between porous PTFE coated glass fabric(Release Ease 234TFP or equivalent). Three plies of 1581 or 181 style glass fabric and aluminum foil (0.020" thick max.)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 fabric and porous PTFE glass fabric shall be removed, the flash broken off, if any, and 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.

3.4.7 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. 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˚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 Materials Technology . Acceptable methods include but are not limited to ink arrows, ink lines, incorporated tracer yarns.

3.4.11 Dimensions

Width - Unless otherwise specified, the overall width of the product, shall be 38" or 50" inclusive of the selvedge for Types 1 to 3. Width tolerance shall be ± 0.50 inches. Type 6 material shall be 12" or 24" wide, width tolerance shall be ± 0.25".

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 aramid fiber fabric and 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.

3.4.13 Bias or Bowed Filling - The filling strands of Types 1, 2, and 3 fabric shall not be distorted from the horizontal by more than 3" for 38" widths and proportionally for all other widths.

3.5 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 prior to the test At least five specimens shall be used per test except for flammability test which requires a minimum of three specimens, and the results averaged. No individual value shall be less than 90% of the value specified; this shall not apply to flammability tests.

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.

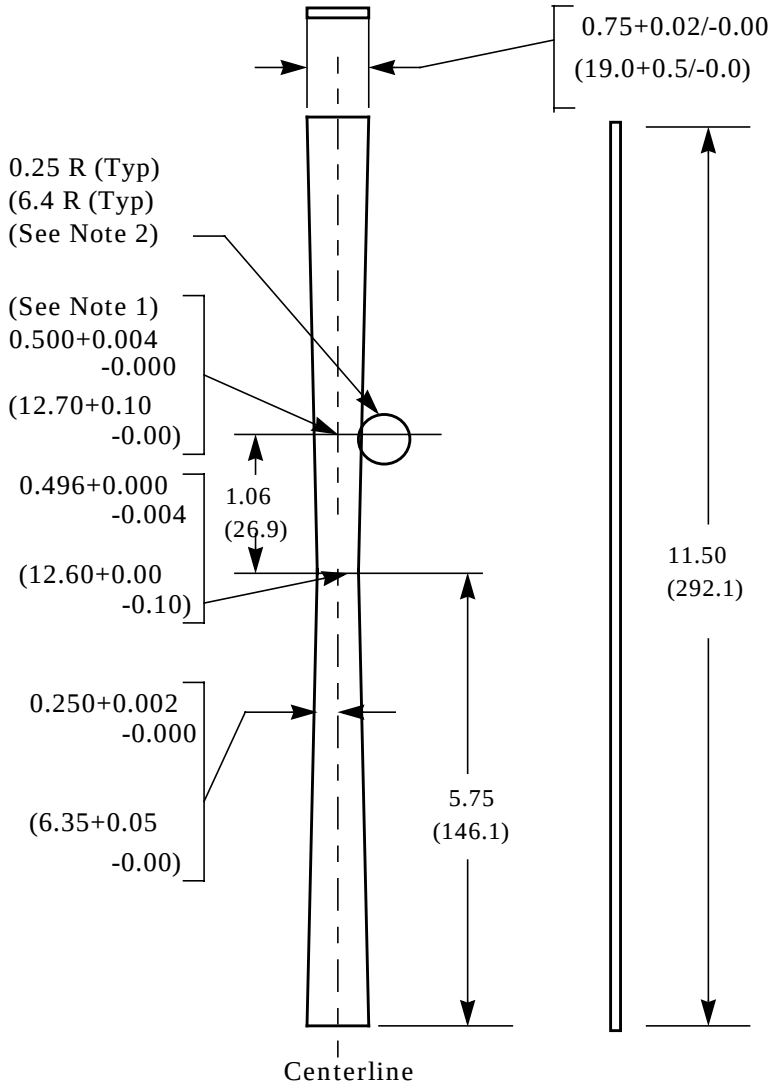
3.5.2 Flammability -

For Types 1, 2, and 3, a two ply cured laminate fabricated per **Para.4.1** and a sandwich panel manufactured to **Para.4.2** , shall meet the requirements of FAR 25.853(a) APP. F, Part I(a)(1)(i) and FAR 25.853(a) APP. F, Part I(a)(1)(ii) .

Type 6 - No flammability requirement.

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 3**. For Types 1-3, five tensile test specimens shall be tested in accordance with ASTM D3039 except that the specimens shall conform to **Figure 1**. For Type 6, five tensile test specimens shall be in accordance with ASTM D3039.



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

3.6.2 Flexural Tests - The flexural strength (modulus of rupture) and flexural modulus (tangent modulus of elasticity) shall be calculated and recorded and shall be not less than the values given in **Table 3**. Flexural specimens, 3" warp x 1" fill, with the long dimension parallel to the warp direction shall be conditioned as specified in **Table 3** and shall be tested in accordance to ASTM D 6272, Four Point.

Bending.Test with a crosshead speed of 0.06"/minute, support span of 2", load span of 0.67". Test with load applied at tool side (smooth side) of the specimen.

3.6.3 Compressive Tests - The ultimate compressive strength of each specimen shall be not less than the value given in **Table 3**. Five specimens conform to **Figure 2** shall be conditioned as specified in **Table 3** and shall be tested in accordance with ASTM D3410.Alternatively, SACMA IR can be used to perform Compressive test.

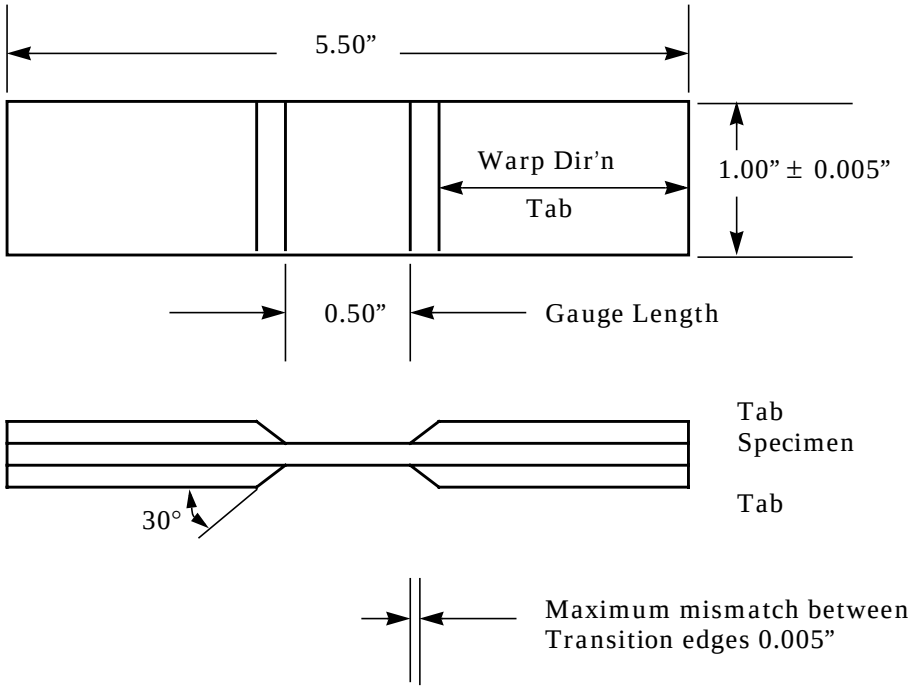


FIGURE 2. Compressive Test Specimen

Notes:

1 Specimen thickness for Type 1 shall be 20 plies.

2 Specimen thickness for Type 2, 3, and 6 shall be 10 plies.

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

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

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

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

7 Maximum mismatch between tab transition edges is 0.005".

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

9 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.

10 Bond tabs to specimen using 3M, 2 part adhesive EC 2216 or DHMS A6.09 liquid shim. 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.

11 125 √edge finish is required in accordance with ANSI B46.1-78

3.6.4 Horizontal Shear Strength Test - The Horizontal Shear strength shall be calculated and recorded and shall be not less than the values given in **Table 3**. Five test specimens 1.125" long (parallel to fill) by 0.25" wide (parallel to warp), for Type 1-3 material, for Type 6 material the fibre direction must be in the 1.125" long direction, shall be conditioned as specified in **Table 3** and shall be tested in according to ASTM D2344 with a crosshead speed of 0.05"/minute .

-Suport span of 0.50"- for specimen thicknesses up to 0.130".

-Suport span of 0.65"- for specimen thickneses greater than 0.130"

-Test with load applied at tool side (smooth side) of the specimen

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TABLE 3. Laminate Mechanical Properties

		Minimum Average Values (psi)		
Test	**Reference**	**Type 1**	**Types 2 & 3**	**Type 6**
Tensile Strength	AMS 3903, ASTM D3039	60,000	50,000	120,000
Tensile Modulus		3.2×10^6	3.2×10^6	7.8×10^6
Flexural Strength	ASTM D790			
Condition 1		40,000	50,000	72,500
Condition 2		32,000	36,000	58,000
Condition 3		30,000	33,750	54,375
Flexural Modulus @ RT		2.4×10^6	2.5×10^6	$7x\ 10^6$
Compressive Strength	ASTM D3410			
Condition 1		18,000	20,000	30,000
Condition 2		16,200	18,000	28,000
Condition 3		13,500	15,000	28,000
Horizontal Shear Strength	ASTM D2344			
Condition 1		5000	4000	7500
Condition 2		4000	3200	6000
Condition 3		3750	3000	5600

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

Condition 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.

Condition 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.

3.7 Sandwich Mechanical Properties

3.7.1 Flatwise Tensile - Five specimens, each 2" x 2" shall be tested in accordance to ASTM C297. Tensile Strength shall be calculated and recorded and shall be not less than the values given in **Table 4**.

3.7.2 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 4**.

TABLE 4. Sandwich Mechanical Properties

Test	Reference	Minimum Average Values (Types 2-3) unless otherwise specified
Flatwise Tensile Strength	ASTM C297	300 psi
Types 2 and 3 Peel Torque *	ASTM D1781	20 in.lb. / 3 in. width

* Both toolside and bagside must meet the minimum value. Tested parallel and transverse to warp direction.

4 TEST PANEL FABRICATION

4.1 Laminate Specimen

A test laminate 18" x 12" shall be laid up with the number of plies specified in **Table 5** and with the long dimension parallel to the fiber or warp direction. The laminate shall be vacuum bagged per **Figure 4** or **Figure 5** and cured at 35 psi per **Figure 6**.

TABLE 5. Test Panel layup

Test Specimen	# Plies for Type 1	# Plies for Types 2 & 3	# Plies for Type 6
Flexural	20	10	10
Horizontal Shear	20	10	10
Tensile	20	10	6
Compression	20	10	10
Flammability	2	2	2

4.2 Sandwich Panel

A test panel 24" warp x 36" fill shall be laid up according to **Figure 3**, vacuum bagged per **Figure 4** and cured using 25 in. Hg (minimum) vacuum per **Figure 6**.

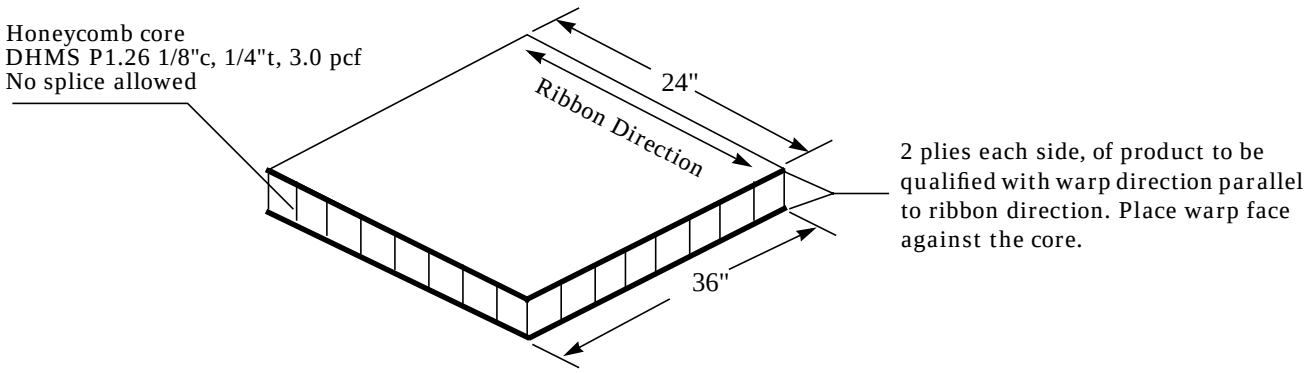
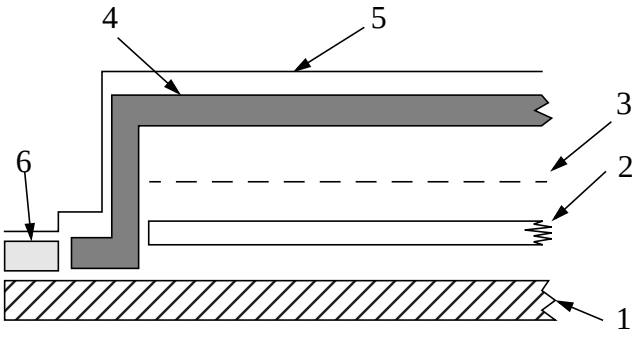


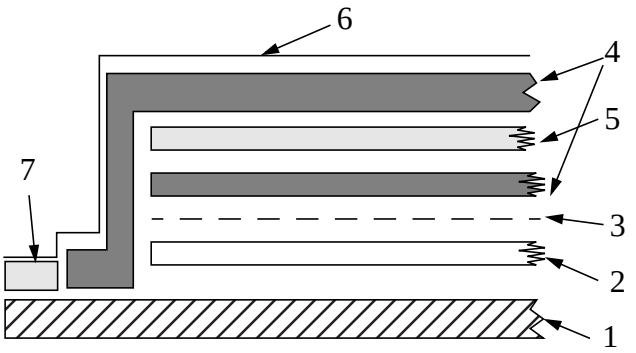
FIGURE 3. Sandwich Test Panel



Use DSC 234 expendable materials

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

FIGURE 4. Bagging Procedure for Types 1, 2, 3 Laminate And Sandwich Panels



Use DSC 234 expendable materials

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

FIGURE 5. Bagging Procedure for Type 6 Laminate

APPROVED EXPENDABLE MATERIALS TO DSC 234

Vacuum bag, Ipplon DP1000	(DSC 234-1-54)	Airtech International Inc., 2542 East Del Amo Blvd.,
Perforated Release Film A4000P3	(DSC 234-5-48)	
Airweave Breather	(DSC 234-11) or (DSC 234-9)	
Mould Release, Frekote 44NC or 700NC	(DSC 234-13)	Frekote Inc.,
Vacuum Sealant Tape, GS 43 MR	(DSC 234-17-1)	

NOTE: Additional sources are listed in DSC 234.

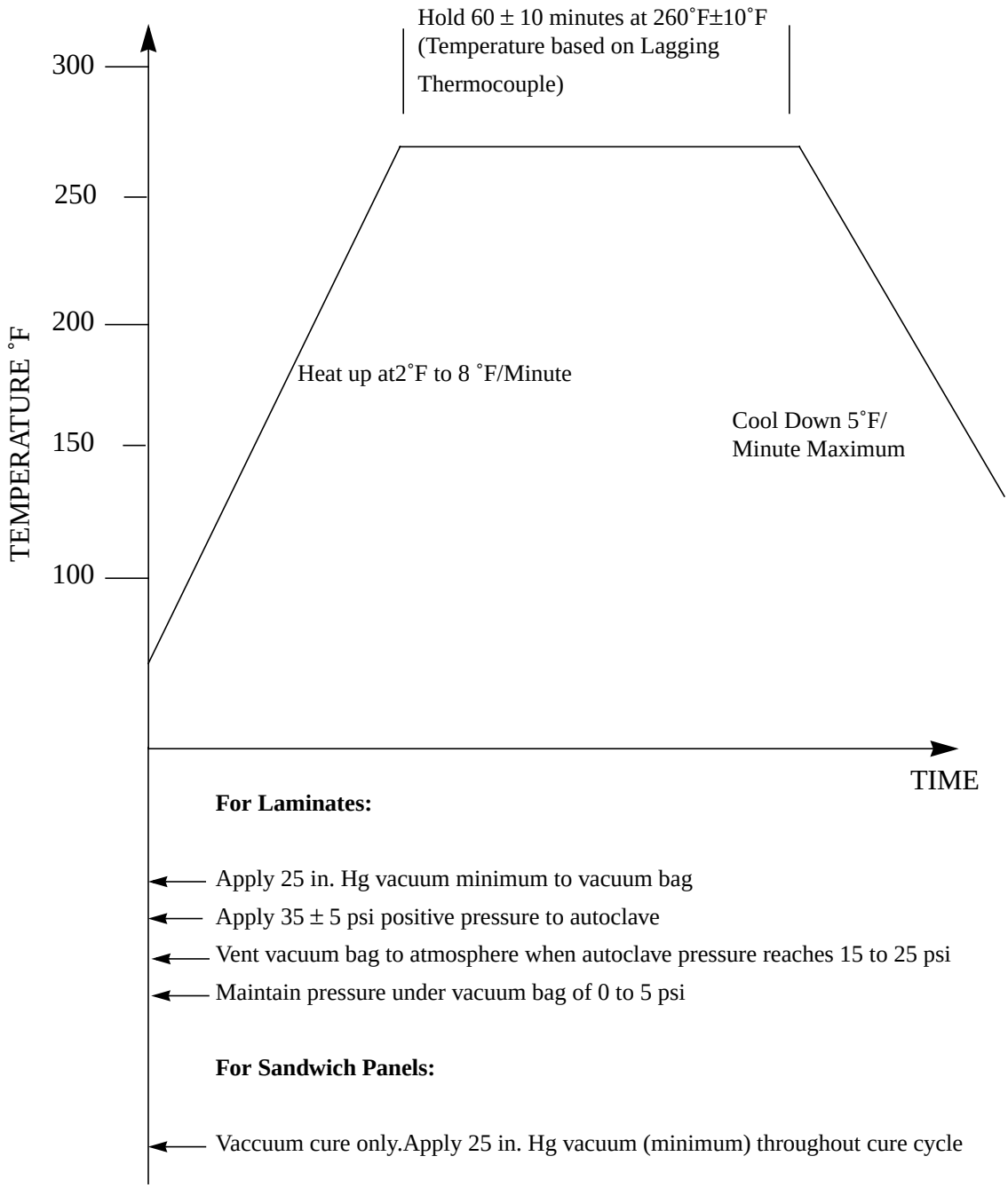


FIGURE 6. Cure Cycle

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 6.**

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 6** 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 6.**

TABLE 6. Qualification and Batch Acceptance Tests

Property	Requirement	Qualification (Supplier)	Acceptance	
			Supplier	Purchaser/User
Fabric Weight	**Para.3.1.2**	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	**Para.3.4.4**	x	x	
Resin Content	**Para.3.4.5**	x	x	x
Resin Flow	**Para.3.4.6**	x	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		

TABLE 6. Qualification and Batch Acceptance Tests

Property	Requirement	Qualification (Supplier)	Acceptance	
			Supplier	Purchaser/User
Dimensions	Para.3.4.11	x		
Workmanship	Para.3.4.12	x	x	
Bias or Bowed Filling	Para.3.4.13	x		
Cure Cycle	Figure 6	x		
Flatwise Tensile	Table 4	x		
Peel Torque	Table 4	x	x **	x **
Flammability	Para.3.5.2	x		
Tensile Strength	Table 3	x		
Tensile Modulus	Table 3	x		
Flexural Strength	Table 3	x	x	x
Flexural Modulus	Table 3	x		
Compressive Strength	Table 3	x		
Horizontal Shear Strength	Table 3	x	x*	x *

* 1. Applicable for Type 6 and Condition 1 of Table 3 only.

** 2. For acceptance, peel testing parallel to ribbon direction on both tool side and bag side is required.

3. For mechanical properies acceptance test , condition at 70˚± 10˚F, 60% maximum relative humidity for a minimum of 24hrs. Test specimens at room temperature .

6.3 Sampling

6.3.1 Sampling Schedule - Sampling shall be in accordance with **Table 7**.

TABLE 7. 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 aramid 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:

- Aramid Fiber ., Epoxy Impregnated
- DHMS P1.24, latest Issue & 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 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 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:

- Aramid Fiber , Epoxy Impregnated
- DHMS P1.24, 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**, 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.

QUALIFI ED 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
Cytec Industries Inc. 851 W. 18th Street Costa Mesa, CA 92627 (949) 650-8106 Cytec Solvay Group 501 West Third Street Winona, MN 55987	**Type 1** L-730-220K Resin Flow 15-35% Gel Time 4-10 minutes	2653	PQS #24 PQS #26	Feb. 26, 1999 June 10, 2015
	Type 2 L-730-281K Resin Flow 20-35% Gel Time 4-10 minutes	2653	PQS #22 PQS#26	Jan. 25, 1999 June 10, 2015
	Type 3 L-730-285K Resin Flow 20-35% Gel Time 4-10 minutes	2653	PQS #25 PQS#26	Feb. 26, 1999 June 10, 2015
	Type 6 L-730-4560UD Resin Flow 15-35% Gel Time 4-10	2653	PQS #23 PQS#26	Feb. 26, 1999 June 10, 2015

ARAMID FIBER (KEVLAR® 49), HIGH MODULUS, 250°F CURE EPOXY RESIN IMPREGNATED

QUALIFI ED 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
Axiom Materials Inc. 2320 Pullman St. Santa Ana, CA 92705	**Type 1** AX-4112T-220 Resin Flow 18-38% Gel Time 6-12 minutes		PQS#27	June 10, 2015
	Type 2 AX-4112T-281 Resin Flow 20-35% Gel Time 6-12 minutes		PQS #27	June 10, 2015
	Type 3 AX-4112T-285 Resin Flow 20-35% Gel Time 6-12minutes		PQS#27	June 10, 2015
	Type 6 AX-6201FR-237A/4560UD Resin Flow: 20-35% Gel Time:6-12 minutes		PQS#28	May 30, 2016