Advanced General Aviation Transport Experiments

B-Basis Design Allowables for Wet Layup / Field Repair Fiber Reinforced Composite Material Systems

7781 Glass Fabric / MGS 418

AGATE-WP3.3-033051-114

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1.0 INTRODUCTION

1.1 Scope

The Advanced General Aviation Transport Experiments (AGATE) consortium is an industry-university-government partnership initiated by NASA to create the technological basis for revitalization of the United States general aviation industry. It was founded in 1994 to develop affordable new technology as well as the industrial standards and certification methods for composite airframe, cockpit, flight systems and airspace infrastructure for Federal Aviation Regulations (FAR) Part 23 aircraft. The composite material properties contained within the document were generated under Work Package 3: Integrated Design and Manufacturing Methods.

Although AGATE was focused towards the small general aviation aircraft (Part 23), the test methods and results contained in this document are consistent with MIL-HDBK-17-1E,2D,3E - Military Handbook for Polymer Matrix Composites. All material, specimens, fixtures and test results contained within this document were traceable and conformed by the Federal Aviation Administration (FAA) as part of the AGATE effort. It should be noted that before application of the basis values presented in this document to design, demonstration of the ability to consistently produce equivalent material properties as that evaluated during this program should be substantiated through an acceptable test program.

The test methods and results described in this document are intended to provide basic composite properties essential to most methods of analysis. These properties are considered to provide the initial base of the “building block” approach. Additional coupon level tests and subelement tests may be required to fully substantiate the full-scale design.

1.2 Symbols Used

ν_{21}^{t}	Poisson's ratio, tension – relating contraction in the 1 direction as a result of extension in the 2 direction
$\mu\varepsilon$	micro-strain
E_2^{c}	compressive modulus, transverse
E_2^{t}	tensile modulus, transverse
F_{12}^{su}	in – plane shear strength
F_{13}^{su}	apparent interlaminar shear strength
F_2^{cu}	compressive strength, transverse
F_2^{tu}	tensile strength, transverse
G_{12}^{s}	in – plane shear modulus

Superscripts

bu	bearing ultimate
c	compression
cu	compression ultimate
s	shear
su	shear ultimate
t	tension
tu	tension ultimate

Subscripts

1	1 – axis; longitudinal
2	2 – axis; transverse (parallel to fill direction of reinforcement)
12	in – plane shear
13	interlaminar shear (apparent)

1.3 Acronyms and Definitions

A – Basis	95% lower confidence limit on the first population percentile
AGATE	Advanced General Aviation Transport Experiments
ASTM	American Society for Testing and Materials
B – Basis	95% lower confidence limit on the tenth population percentile
C. V.	coefficient of variation
CTD	cold temperature dry
CPT	cured ply thickness
DMA	dynamic mechanical analysis
dry	specimen tested with an “as fabricated” moisture content
ETD	elevated temperature dry
ETW	elevated temperature wet
FAR	Federal Aviation Regulations
FAW	fiber areal weight
G/Ep	Glass/Epoxy
NASA	National Aeronautics and Space Administration
RTD	room temperature dry
SACMA	Suppliers of Advanced Composite Materials Association
SRM	SACMA Recommended Method
T_g	glass transition temperature
t_{ply}	cured ply thickness
wet	specimen tested with an equilibrium moisture content per section 1.5.2

1.4 References

ASTM Standards

D3039-95	Tensile Properties of Polymer Matrix Composite Materials
D5379-93	Shear Properties of Composite Materials by the V-Notched Beam Method
D2344-89	Apparent Interlaminar Shear Strength of Parallel Fiber Composites by Short – Beam Method
D792-91	Density and Specific Gravity (Relative Density) of Plastics by Displacement
D2584-94	Ignition Loss of Cured Reinforced Plastics
D2734-94	Void Content of Reinforced Plastics
D695-91	Compressive Properties of Rigid Plastics
D953-95	Standard Test Method for Bearing Strength of Plastics

SACMA Standards

SRM 1-94	Compressive Properties of Oriented Fiber-Resin Composites
SRM 8-94	Short Beam Shear Strength of Oriented Fiber-Resin Composites
SRM 18-94	Glass Transition Temperature (T_g) Determination by DMA of Oriented Fiber-Resin Composites

Other Documents

FAA Document DOT/FAA/AR-00/47: Material Qualification and Equivalency for Polymer Matrix Composite Material Systems, J.S. Tomblin, Y.C. Ng and K.S. Raju, 2001.

MIL-HDBK-17 1E, 2D, 3E – Military Handbook for Polymer Matrix Composites

PACUSA Lancair Document No: AX513001 Rev. B1, Initial Material Qualification of MGS 418 Resin System with 7781 Glass Fabric and Plain Weave Carbon Cloth for Structural Wet Layup Epoxy Laminates, February 1997.

1.5 Methodology

1.5.1 Test Matrix

Testing was performed according to the test methods delineated in the test matrix, with modifications as referenced in the AGATE report, *Material Qualification and Equivalency for Polymer Matrix Composite Material Systems*. The test matrix for properties included in this document is listed on the next page, with the following notation cited in each column:

X#

where the X represents the required material batch letter defined as: material containing 7781 glass fabric from one mill roll, impregnated with one batch of resin in one continuous manufacturing operation with traceability to all components. and the # represents the required number of replicates for that batch. For example, “A6, B6, C6” refers to three material batches A, B, and C; with six specimens per batch for a total requirement of 18 test specimens. The minimum sample requirements are shown, but more samples may have been tested.

Table 1.5.1: Test Matrix and Standards Used

TEST	METHOD	NO. OF REPLICATES PER TEST CONDITION			
		CTD[1,5]	RTD[3,5]	ETW[3]	ETD[4,5]
90° (fill) Tension Strength	ASTM D3039-95	B4	A4, B4, C4	A4, B4, C4, D4, E4	A4, B4, C4
90° (fill) Tension Modulus and Strength	ASTM D3039-95	B2	A2, B2, C2	A2, B2, C2, D2, E2	A2, B2, C2
90° (fill) Compression Strength	SACMA SRM 1-94	B6	A6, B6, C6	A6, B6, C6, D6, E6	A6, B6, C6
90° (fill) Compression Modulus	SACMA SRM 1-94	B2	A2, B2, C2	A2, B2, C2, D2, E2	A2, B2, C2
In-Plane Shear Strength	ASTM D5379-93	B4	A4, B4, C4	A4, B4, C4, D4, E4	A4, B4, C4
In-Plane Shear Modulus and Strength	ASTM D5379-93	B2	A2, B2, C2	A2, B2, C2, D2, E2	A2, B2, C2
Short Beam Shear	ASTM D2344-89	--	A6, B6, C6, D6	--	--
Fiber Volume	ASTM D2584-94	One sample per panel			
Resin Volume	ASTM D2584-94	One sample per panel			
Void Content[6]	ASTM D2734-94	One sample per panel			
Cured Neat Resin Density	---	Supplied by manufacturer for material			
Glass Transition Temperature	SACMA SRM 18-94	3 dry, 3 wet per material batch			

Notes :

1 CTD: One batch of material tested (test temperature = -65 ± 5° F, moisture content = as fabricated, soak time at –65 was 3 min.)

2 RTD: Three batches of material tested (test temperature = 70 ± 10° F, moisture content = as fabricated)

3 ETW: Five batches of material tested (test temperature = 180 ± 5° F, moisture content = equilibrium per section 1.5.2, soak time at 180 was 60 sec.)

4 ETD: Three batches of material tested (test temperature = 180 ± 5° F, moisture content = as fabricated, soak time at 180 was 3 min.)

5 Dry specimens are “as fabricated” specimens that have been maintained at ambient conditions in an environmentally controlled laboratory.

6 The generic 418 resin density value (1.2 g/cc) is used to calculate void content and does not take into account the effects of the resin/hardener mix ratio or the cure cycle.

1.5.2 Environmental Conditioning

All 'wet' conditioned samples were exposed to elevated temperature and humidity conditions to establish moisture saturation of the material. Specimens were exposed to 85 ± 5 % relative humidity and 145 ± 5 °F until an equilibrium moisture weight gain of traveler, or witness coupons (1" x 1" x specimen thickness) was achieved. ASTM D5229 and SACMA SRM 11 were used as guidelines for environmental conditioning and moisture absorption.

Effective moisture equilibrium was achieved when the average moisture content of the traveler specimen changed by less than 0.05% for two consecutive readings within a span of 7 ± 0.5 days and was expressed by:

$$\frac{W_i - W_{i-1}}{W_b} < 0.0005$$

where W_i = weight at current time
W_{i-1} = weight at previous time
W_b = baseline weight prior to conditioning

It is common to see small fluctuations in an unfitted plot of the weight gain vs. time curve. There were no fluctuations that made significant errors in results or caused rejection in the moisture equilibrium criteria. Once the traveler coupons passed the criteria for two consecutive readings, the samples were removed from the environmental chamber and placed in a sealed bag with a moist paper or cotton towel for a maximum of 14 days until mechanical testing. Strain gauged specimens were removed from the controlled environment for a maximum of 2 hours for application of gages in ambient laboratory conditions.

1.5.3 Fluid Sensitivity Screening

Although epoxy-based materials historically have not been shown to be sensitive to fluids other than water or moisture, the influence of some fluids other than water or moisture on the mechanical properties were characterized. These fluids fell into two exposure classifications. The first class was considered to be in contact with the material for an extended period of time, and the second class was considered to be wiped on and off (or evaporate) with relatively short exposure times.

To assess the degree of sensitivity of fluids other than water or moisture, Table 1.5.2 shows the fluids which were used in this qualification plan.

Table 1.5.2: Fluid Types Used for Sensitivity Studies

Fluid Type	Specification	Exposure Classification
Jet Fuel (JP-4)	MIL-T-5624	Extended Period
Hydraulic Fluid (Tri-N-butyl phosphate ester)	MIL-H-5606G	Extended Period
Solvent (Methyl Ethyl Ketone)	Laboratory Grade	Wipe On and Off

To assess the influence of various fluids types, a test method sensitive to matrix degradation was used as an indicator of fluid sensitivity and compared to the unexposed results at both room temperature dry and elevated temperature dry conditions. Table 1.5.3 describes the fluid sensitivity-testing matrix with respect to the fluids defined in Table 1.5.2. Engineering judgment and statistical tests were used to assess the degree of material degradation. The results of this screening are included following the data sheets in section 3.2.2.

Table 1.5.3: Material Qualification Program for Fluid Resistance

Fluid Type	Test Method	Test Temp. (^{o} F)	Exposure[1]	Number of Replicates[2]
Jet Fuel JP-4	ASTM D5379[3]	180	See note 4	5
Hydraulic Fluid	ASTM D5379[3]	180	See note 5	5
Solvent (MEK)	ASTM D5379[3]	Ambient	See note 5	5

Notes :

1 Soaking in fluid at ambient temperature (immersion).
2 Only a single batch of material is required.
3 Shear strength only.
4 Immersion duration = 500 hours $\pm$ 50 hours
5 Immersion duration = 60 to 90 minutes

1.5.4 Normalization Procedures

The normalization procedure attempts to reduce variability in fiber-dominated material properties by adjusting raw test values to a specified fiber volume content. Only the following properties were normalized:

- 90° (fill) Tension Strength and Modulus
- 90° (fill) Compression Strength and Modulus

The normalization procedure was adopted from MIL-HDBK-17-1E, section 2.4.3.3. The procedure which was used to normalize the data is based on two primary assumptions:

- The relationship between fiber volume fraction and ultimate laminate strength is linear over the entire range of fiber/resin ratios. (It neglects the effects of resin starvation at high fiber contents.)

- Fiber volume is not commonly measured for each test sample, so this method accounts for the fiber volume variation between individual test specimens by utilizing a relationship between fiber volume fraction and laminate cured ply thickness. This relationship is virtually linear in the 0.45 to 0.65 fiber volume fraction range.

Additional information is detailed in *Material Qualification and Equivalency for Polymer Matrix Composite Material Systems.* For all normalized data contained in this document, the test values are normalized by cured ply thickness according to:

$$Normalized\ \ Value = Test\ Value \times \frac{CPT_{specimen}}{CPT_{normalizing}}$$

where:

$$CPT_{specimen} = \frac{Average\ \ Sample\ Thickness}{\#\ of\ \ plies}$$

1.5.5 Statistical Analysis

When compared to metallic materials, fiber reinforced composite materials exhibit a high degree of material property variability. This variability is due to many factors, including but not limited to: raw material and prepreg manufacture, material handling, part fabrication techniques, ply stacking sequence, environmental conditions, and testing techniques. This inherent variability drives up the cost of composite testing and tends to render smaller data sets than those produced for metallic materials. This necessitates the usage of statistical techniques for determining reasonable design allowables for composites.

The analyses and design allowable generation for both A and B basis values were performed using the procedure detailed in section 5.3 of FAA Document DOT/FAA/AR-00/47: *Material Qualification and Equivalency for Polymer Matrix Composite Material Systems*.

1.5.6 Material Performance Envelope and Interpolation

Using the B-basis numbers, a material performance envelope may be generated for the material system by plotting these values as a function of temperature. Figure 1.5.1 shows an example material performance envelope using B-basis values.

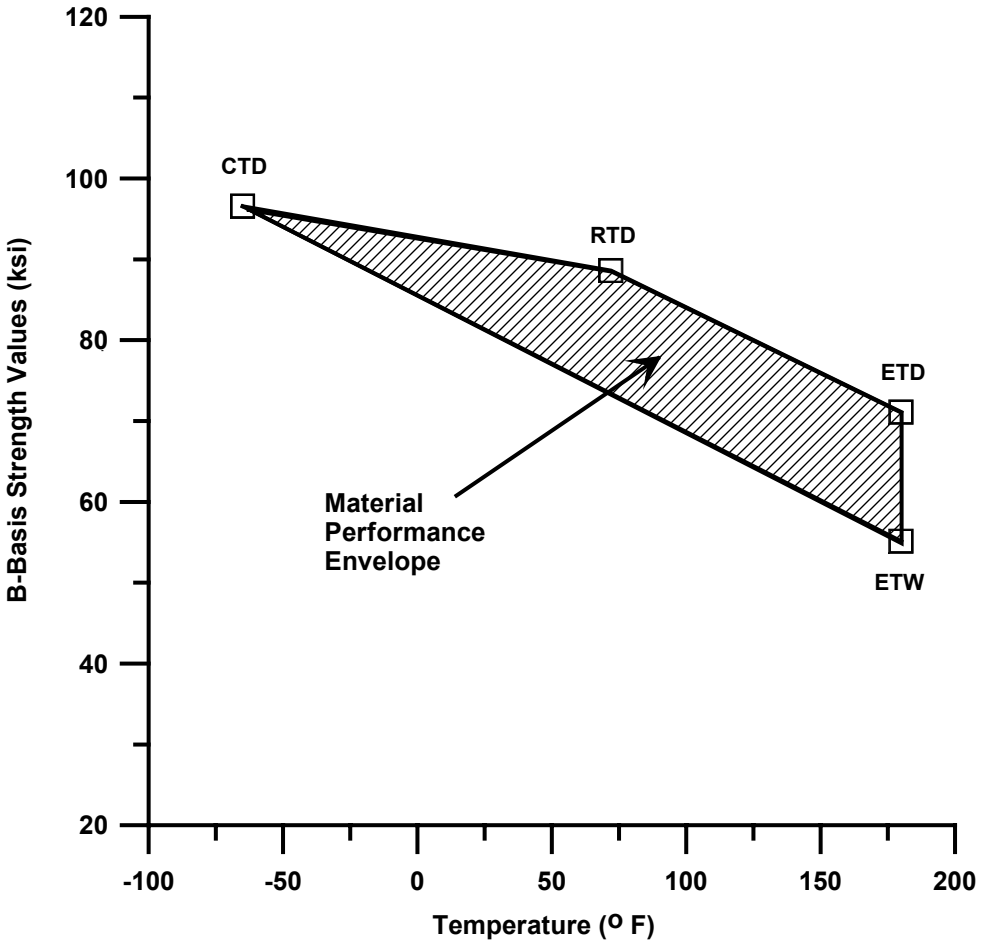


Figure 1.5.1 Material performance envelope.

Since each specific aircraft application of the qualified material may have different Maximum Operational Limits (MOL) than those tested in the material qualification (which is usually the upper limit), some applications may require a reduced MOL. In this case, simple linear interpolation may be used to obtain the corresponding basis values at the new application MOL.

This interpolation may be accomplished using the following simple relationships assuming $T_{RTD} < T_{MOL} < T_{ETD}$:

For the corresponding MOL "dry" basis value, the "interpolated" basis value using the qualification data is

$$B_{MOL} = B_{RTD} - \frac{(B_{RTD} - B_{ETD})(T_{RTD} - T_{MOL})}{(T_{RTD} - T_{ETD})}$$

where B_{MOL} = new application basis value interpolated to T_{MOL}
B_{RTD} = basis RTD strength value
B_{ETD} = basis ETD strength value
T_{RTD} = RTD test temperature
T_{ETD} = ETD test temperature
T_{MOL} = new application MOL temperature

For the corresponding MOL "wet" basis value, an estimated Room Temperature Wet (RTW) value must be calculated. This may be accomplished by the simple relation

$$B_{RTW} = B_{RTD} - (B_{ETD} - B_{ETW})$$

The "interpolated" wet basis value using the qualification data may then be obtained by

$$B_{MOL} = B_{RTW} - \frac{(B_{RTW} - B_{ETW})(T_{RTW} - T_{MOL})}{(T_{RTW} - T_{ETW})}$$

where B_{MOL} = new application basis value interpolated to T_{MOL}
B_{RTW} = estimated basis RTW strength value
B_{ETW} = basis ETW strength value
T_{RTW} = RTW (i.e., RTD) test temperature
T_{ETW} = ETW test temperature
T_{MOL} = new application MOL temperature

These equations may also be used for interpolated mean strengths as well as A-basis values with the appropriate substitutions. It should be noted that because unforeseen material property drop-offs with respect to temperature and environment can occur, *extrapolation* to a higher MOL should not be attempted without additional testing and verification. In addition, the interpolation equations shown above are practical for materials obeying *typical* mechanical behavior. In most cases, some minimal amount of testing may also be required to verify the interpolated values.

1.5.6.1 Interpolation Example

This section provides an example of linear interpolations to a specific application environment less than the tested upper material limit used in qualification. Assuming a specific application environment of 150° F, Figure 1.5.2 depicts the linear interpolation of the B-basis design allowable to this environment. Using the above equations along with the nominal testing temperatures (see Table 1.5.1), the interpolated basis values at 150° F become

ETD : B_{MOL} = 75.106 ksi

ETW : B_{MOL} = 59.746 ksi

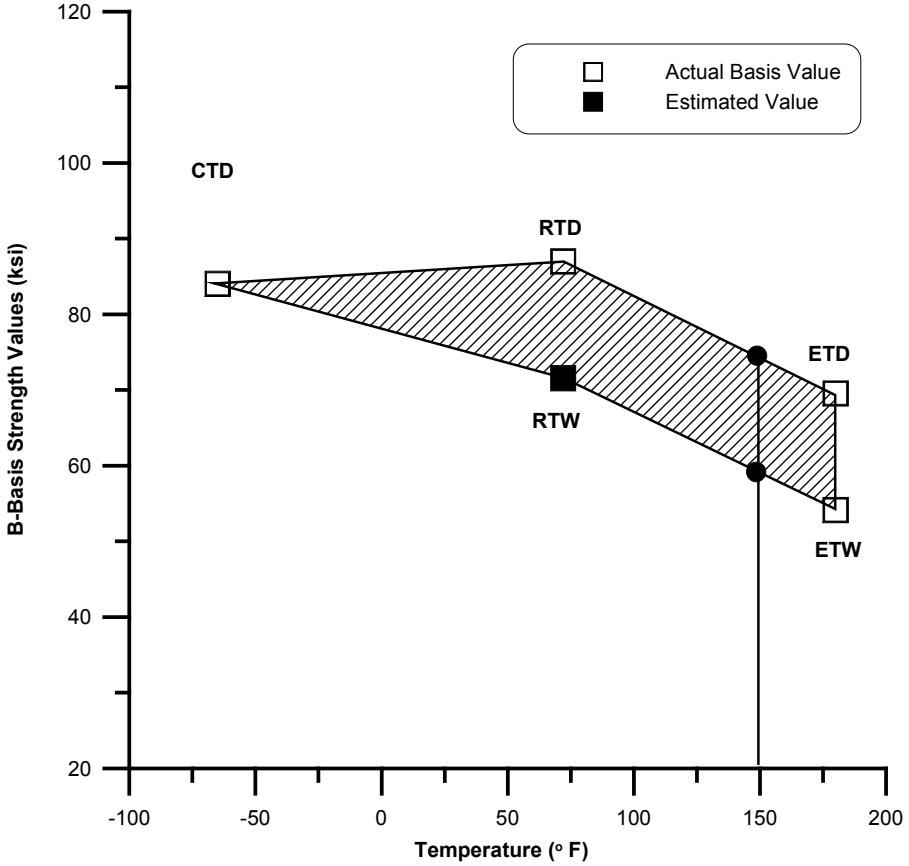


Figure 1.5.2 Example of 150° F interpolation for B-basis values.

2.0 LANCAIR 7781 GLASS FABRIC / MGS 418 WET LAY-UP PROPERTIES

2.1 Material Documentation by Material Batch

Wet Lay-up Documentation	**Manufacturer & Product ID: PAC** **Material Identification (weave, form, class, etc.):** **Impregnation Method: Wet Layup**				
Resin : Hardener Ratio	100:37 by wt.	100:40 by wt.	100:43 by wt.	100:40 by wt.	
Batch (Lot) ID as labeled on samples	**A**	**B**	**C**	**D**	**E**
Date of Manufacture (layup & post cure)	3/99	1/99-2/99	3/99	3/99	
Expiration Date	N/A	N/A	N/A	N/A	
Resin Content [wt %]	38%	38%	38%	46%	
Reinforcement Areal Weight & Test Method	See Fabric Info.				
Resin Flow & Test Conditions	Not Tested				
Gel Time & Test Conditions	Not Tested				
Volatile Content					
Pot Life per ASTM D2471	9 hrs, 3 min				
Reinforcement Documentation	**Fiber/Fabric Manufacturer & Product ID: BGF 7781** **Precursor Type: ---** **Nominal Filament Count: ---** **Finish/Sizing Type and %: 497A** **Nominal tow or yarn count/inch: 52.5 yarns/inch warp; 54.0 yarns/inch fill** **Twist: ---**				
Fabric Batch or Lot #	00897391	00895391	00895391	00895391	
Date of Manufacture	10-9-98	10-9-98	10-9-98	10-9-98	
Average Fiber Density per Lot & Test Method	8.71 oz/yd^2	8.71 oz/yd^2	8.71 oz/yd^2	8.71 oz/yd^2	
Matrix Documentation	**Resin Manufacturer & Product ID: MGS 418**				
Matrix Batch or Lot # (Resin)	803003	649007	725006	803003	
Matrix Batch or Lot # (Hardener)	803004	648016	742017	803004	
Date of Manufacture	Unknown	Unknown	Unknown	Unknown	
Average Neat Resin Density by Lot & Test Method (Resin)	9.60 lb/gal	No Certs.	9.60 lb/gal	9.60 lb/gal	
Average Neat Resin Density by Lot & Test Method (Hardener)	7.84 lb/gal	No Certs.	7.89 lb/gal	7.84 lb/gal	

Note: Test Methods used to determine resin content, reinforced areal weight, resin flow, gel time, and volatile content are defined in PAC USA Lancair AX513001 Rev. B1 specification

Wet Lay-up Documentation	**Manufacturer & Product ID: PAC** **Material Identification (weave, form, class, etc.):** **Impregnation Method: Wet Layup**				
Resin: Hardener Ratio					100:40 by wt.
Batch (Lot) ID as labeled on samples	**A**	**B**	**C**	**D**	**E**
Date of Manufacture (Post Cure)					6/98
Expiration Date					N/A
Resin Content [wt %]					38 %
Reinforcement Areal Weight & Test Method					See Fabric (unknown)
Resin Flow & Test Conditions					Not Tested
Gel Time & Test Conditions					Not Tested
Volatile Content					WSU Test
Reinforcement Documentation	**Fiber/Fabric Manufacturer & Product ID: Ashland Chemical 7781** **Precursor Type: ---** **Nominal Filament Count: ---** **Finish/Sizing Type and %: F16** **Nominal tow or yarn count/inch: Unknown** **Twist: ---**				
Fabric Batch or Lot #					Unknown
Date of Manufacture					Unknown
Average Fiber Density per Lot & Test Method					Unknown
Matrix Documentation	**Resin Manufacturer & Product ID: MGS 418**				
Batch or Lot # (Resin)					649007?
Batch or Lot # (Hardener)					648016?
Date of Manufacture					Unknown
Average Neat Resin Density by Lot & Test Method					No Certs.

Note: Test Methods used to determine resin content, reinforced areal weight, resin flow, gel time, and volatile content are defined in PAC USA Lancair AX513001 Rev. B1 specification

2.2 Process Specification

This specification does not address issues relating to safety, quality control, bagging material selection, bagging procedure, tool preparation, or equipment selection. Although these may affect overall part quality, it is the responsibility of the end user to develop procedures related to these issues in a manner that produces parts with high quality and consistency.

The following processing procedures are excerpts from PACUSA Lancair Document No: AX513001 Rev. B1, *Initial Material Qualification of MGS 418 Resin System with 7781 Glass Fabric and Plain Weave Carbon Cloth for Structural Wet Layup Epoxy Laminates* . All test specimens were cured per this specification by Pacific Aviation Composites.

Panel Processing Parameters

Table 2.2.1 defines how the four batches of panels will be processed. Definitions for each of the process variables follow the table.

Table 2.2.1: Panel Processing

Panel Batch	Resin Content	Fiber Content (by weight %)		Curing Agent Content	Cure Cycle
		Glass	Carbon		
A	Nominal	62 ± 1	53 ± 1	Minimum	Minimum
B	Nominal	62 ± 1	53 ± 1	Nominal	Nominal
C	Nominal	62 ± 1	53 ± 1	Maximum	Over
D	Maximum	54 ± 1	45 ± 1	Nominal	Nominal
E	Nominal	62 ± 1	53 ± 1	Nominal	Nominal

Panel Batch A ..... Minimum curing agent content in combination with the minimum cure cycle and nominal resin content.

Panel Batch B ..... Nominal curing agent content in combination with the nominal cure cycle and nominal resin content.

Panel Batch C ..... Maximum curing agent content in combination with an over cure cycle and nominal resin content.

Panel Batch D ..... Nominal curing agent content in combination with the nominal cure cycle and maximum resin content.

Panel Batch E ..... Nominal curing agent content in combination with the nominal cure cycle and the nominal resin content, using glass fabric from full-scale fatigue test.

Nominal Resin Content ..... Layup with 62 ± 1% glass fiber by weight and 53 ± 1% carbon fiber by weight.

Max Resin Content ..... Layup with 54 ± 1% glass fiber by weight and 45 ± 1% carbon fiber by weight.

Curing Agent Content ..... Nominal, Minimum and Maximum in Table 2.1.2.

Minimum Cure Cycle..... Nominal cure cycle temperature minus 30°F with nominal cure time minus 1 hour.

Over Cure Cycle ..... Nominal cure cycle temperature plus 30°F plus three extra nominal cure cycle times.

Table 2.1.2: Curing Agent Content

Minimum curing agent content	100:37 by weight
Nominal curing agent content	100:40 by weight
Maximum curing agent content	100:43 by weight

Oven Cure Procedure

Nominal Cure Cycle[1]:

a. Pre-cure undisturbed at room temperature until resin is "set", defined as does not stick to the finger when touched.

b. Install the assembly in a cool oven (temperatures less than 100° F). Verify the functioning of the thermocouple recording equipment before initiating the cure.

c. Perform post-cure to the following steps:
- Ramp from ambient to 150 ± 10°F over a period of 120 ± 10 minutes (2 hrs).
- Hold at 150 ± 10°F for 240 (+10, -0) minutes (4 hrs.).
- Ramp to 200 ± 10°F over a period of 120 ± 10 minutes (2 hrs.).
- Hold at 200 ± 10°F for 360 (+10, -0) minutes (6 hrs.).
- Ramp down below 170°F at a rate not to exceed 10°F per minute before removing the cured panel from the oven.

Minimum Cure Cycle[1]:

a. Pre-cure undisturbed at room temperature until resin is "set", defined as does not stick to the finger when touched.

b. Install the assembly in a cool oven (temperatures less than 100° F). Verify the functioning of the thermocouple recording equipment before initiating the cure.

c. Perform post-cure to the following steps:
- Ramp from ambient to 120 ± 10°F over a period of 120 ± 10 minutes (2 hrs.).
- Hold at 120 ± 10°F for 210 (+10, -0) minutes (3-1/2 hrs.).

[1] All temperatures are oven temperature.

- Ramp to 170 ± 10°F over a period of 120 ± 10 minutes (2 hrs.).
- Hold at 170 ± 10° F for 330 (+10, -0) minutes (5-1/2 hrs.).
- Ramp down below 140°F at a rate not to exceed 10°F per minute before removing the cured panel from the oven.

Over Cure Cycle[1]:

a. Pre-cure undisturbed at room temperature until resin is "set", defined as does not stick to the finger when touched.

b. Install the assembly in a cool oven (temperatures less than 100° F). Verify the functioning of the thermocouple recording equipment before initiating the cure.

c. Perform post-cure to the following steps:
   - Ramp from ambient to 180 ± 10°F over a period of 120 ± 10 minutes (2 hrs.).
   - Hold at 180 ± 10°F for 960 ± 10 minutes (14 hrs.).
   - Ramp to 230 ± 10°F over a period of 120 ± 10 minutes (2 hrs.).
   - Hold at 230 ± 10° F for 1440 ± 10 minutes (24 hrs).
   - Ramp down below 170°F at a rate not to exceed 10°F per minute before removing the cured panel from the oven.

3.0 LANCAIR 7781 GLASS FABRIC / MGS 418 LAMINA PROPERTIES

3.1 Test Results

3.1.1 Summary

MATERIAL:	Lancair 7781 Glass Fabric / MGS 418 Wet Layup	**7781/MGS 418 Summary**
FIBER:	BGF 7781 Glass Fabric	**RESIN:** MGS 418
T_g (dry): 216.4°F	**T_g (wet):** 209.9°F	**T_g METHOD:** DMA (SRM 18-94)
PROCESSING:	Vacuum bag cure (22+ in. Hg.): 170-230 ± 10°F for 5.5-24 hours	

Date of fiber manufacture	10/9/98	**Date of testing**	10/26/99 – 12/15/99
Date of resin manufacture	Unknown	**Date of data submittal**	12/15/99
Date of composite manufacture	6/98 – 3/99	**Date of analysis**	10/28/99 – 12/15/99

LAMINA MECHANICAL PROPERTY SUMMARY
Data Reported as: Measured
(Normalized by CPT=0.0108 in.)

	CTD		RTD		ETD		ETW	
	B-Basis	Mean	B-Basis	Mean	B-Basis	Mean	B-Basis	Mean
F_2^{tu} (ksi)	52.02 (54.54)	60.89 (59.83)	41.85 (41.25)	48.99 (47.89)	36.06 (35.48)	42.21 (41.19)	31.05 (33.00)	36.34 (38.31)
E_2^t (Msi)	---	3.42 (3.37)	---	2.39 (2.33)	---	2.10 (2.05)	---	2.65 (2.82)
ν_{21}^{tu} (ksi)	---	0.175	---	0.118	---	0.087	---	0.107
F_2^{cu} (ksi)	58.13 (57.17)	66.72 (67.30)	45.11 (42.64)	51.77 (50.19)	27.41 (25.93)	31.45 (30.52)	25.35 (25.20)	29.10 (29.67)
E_2^c (Msi)	---	2.27 (2.31)	---	3.16 (3.07)	---	3.06 (2.97)	---	2.14 (2.17)
F_{12}^{su} (ksi)	19.67	21.16	14.36	15.45	8.74	9.41	7.68	8.26
G_{12}^s (Msi)	---	0.63	---	0.44	---	0.23	---	0.25
F_{13}^{su**} (ksi)	---	---	7.00	7.59	---	---	---	---

** *Apparent* interlaminar shear strength

3.1.2 Individual Test Summaries

3.1.2.1 Tension, 2-axis

Tension, 2-axis
G/Ep
7781 Glass Fabric/ MGS 418 Wet Layup
$[0]_{12}$

Material:	Lancair 7781 Glass Fabric/ MGS 418 Wet Layup										
Resin content:	35 - 44 wt%			**Comp. density:**	1.63 - 1.73 g/cc						
Fiber volume:	38 - 44 vol%			**Void content:**	0.0 to 6.7 %						
Ply thickness:	0.0103 - 0.0126 in.										
Ply range:	12 plies										
Test method:	D3039-95			**Modulus calculation:**	N/A						
Normalized by:	0.0108 in. ply thickness										
		CTD (B)		**RTD (A)**		**ETD (G)**		**ETW (F)**			
Test Temperature [°F]		-65		75		180		180			
Moisture Conditioning		dry		dry		dry		equilibrium			
Equilibrium at T, RH		as fabricated		as fabricated		as fabricated		145 F, 85 %			
Source code		MVUXXXXB		MVUXXXXA		MVUXXXXG		MVUXXXXF			
		Normalized	**Measured**	**Normalized**	**Measured**	**Normalized**	**Measured**	**Normalized**	**Measured**	**Normalized**	**Measured**
	Mean	59.83	60.89	47.89	48.99	41.19	42.21	38.31	36.34		
	Minimum	57.84	58.78	42.89	43.47	34.76	36.18	31.83	32.28		
	Maximum	62.40	63.96	56.35	58.82	47.71	48.53	43.10	44.27		
	C.V.(%)	3.39	3.57	9.78	11.08	9.46	9.28	8.91	9.22		
F_2^{tu} (ksi)	**B-value**	54.54	52.02	41.25	41.85	35.48	36.06	33.00	31.05		
	A-value	45.32	45.36	36.27	36.50	31.20	31.45	29.02	27.08		
	No. Specimens	6		19		18		32			
	No. Batches	1		3		3		4			
	Mean	3.37	3.42	2.33	2.39	2.05	2.10	2.82	2.65		
	Minimum	3.29	3.36	2.28	2.32	2.00	2.05	2.56	2.45		
	Maximum	3.45	3.48	2.41	2.51	2.10	2.15	3.03	3.12		
E_2^t (Msi)	**C.V.(%)**	3.40	2.54	1.91	2.73	1.67	1.52	5.07	9.16		
	No. Specimens	2		6		6		7			
	No. Batches	1		3		3		4			
	Mean	0.175		0.118		0.087		0.107			
ν_{21}^t	**No. Specimens**	2		6		6		7			
	No. Batches	1		3		3		4			

3.1.2.2 Compression, 2-axis

Compression, 2-axis
G/Ep
7781 Glass Fabric/ MGS 418 Wet Layup
$[0]_{12}$

Material:	Lancair 7781 Glass Fabric/ MGS 418 Wet Layup		
Resin content:	35 - 40 wt%	**Comp. density:**	1.66 - 1.73 g/cc
Fiber volume:	40 - 44 vol%	**Void content:**	2.9 to 6.7 %
Ply thickness:	0.0103 - 0.0125 in.		
Ply range:	12 plies		
Test method:	SRM 1-94, D695-91 (mod)	**Modulus calculation:**	N/A
Normalized by:	0.0108 in. ply thickness		

		CTD (B)		RTD (A)		ETD (G)		ETW(F)			
Test Temperature [°F]		-65		75		180		180			
Moisture Conditioning		dry		dry		dry		equilibrium			
Equilibrium at T, RH		as fabricated		as fabricated		as fabricated		145 F, 85 %			
Source code		MVWXXXXB		MVWXXXXA		MVWXXXXG		MVWXXXXF			
		Normalized	**Measured**	**Normalized**	**Measured**	**Normalized**	**Measured**	**Normalized**	**Measured**	**Normalized**	**Measured**
	Mean	67.30	66.72	50.19	51.77	30.52	31.45	29.67	29.10		
	Minimum	59.44	59.41	45.82	47.44	25.40	25.82	22.60	23.52		
	Maximum	73.44	72.33	58.07	60.32	35.89	37.21	35.59	34.35		
	C.V.(%)	6.64	6.19	6.60	6.77	10.79	11.28	11.16	7.80		
F_2^{cu} (ksi)	**B-value**	57.17	58.13	42.64	45.11	25.93	27.41	25.20	25.35		
	A-value	49.55	51.68	36.96	40.10	22.47	24.36	21.84	22.54		
	No. Specimens	8		18		18		34			
	No. Batches	1		3		3		4			
	Mean	2.31	2.27	3.07	3.16	2.97	3.06	2.17	2.14		
	Minimum	2.29	2.26	2.94	3.03	2.89	2.99	2.01	1.94		
	Maximum	2.33	2.31	3.16	3.24	3.06	3.13	2.28	2.31		
E_2^c (Msi)	**C.V.(%)**	0.89	1.28	2.49	2.50	2.16	2.04	4.41	6.17		
	No. Specimens	3		6		6		8			
	No. Batches	1		3		3		4			

3.1.2.3 Shear, 12 axis

Shear, 12-axis
G/Ep
7781 Glass Fabric/MGS 418 Wet Layup
$[0/90]_6$

Material:	Lancair 7781 Glass Fabric/ MGS 418 Wet Layup			
Resin content:	35 - 43 wt%	**Comp. density:**	1.63 - 1.73 g/cc	
Fiber volume:	38 - 43 vol%	**Void content:**	0.5 to 10.8 %	
Ply thickness:	0.0103 - 0.0126 in.			
Ply range:	12 plies			
Test method:	D5379-93	**Modulus calculation:**	N/A	
Normalized by:	N/A			

		CTD (B)		RTD (A)		ETD (G)		ETW(F)			
Test Temperature [°F]		-65		75		180		180			
Moisture Conditioning		dry		dry		dry		equilibrium			
Equilibrium at T, RH		as fabricated		as fabricated		as fabricated		145 F, 85 %			
Source code		MVNXXXXB		MVNXXXXA		MVNXXXXG		MVNXXXXF			
		Normalized	**Measured**	**Normalized**	**Measured**	**Normalized**	**Measured**	**Normalized**	**Measured**	**Normalized**	**Measured**
F_{12}^{su} (ksi)	**Mean**		21.16		15.45		9.41		8.26		
	Minimum		20.51		14.56		8.47		7.71		
	Maximum		22.24		16.42		10.32		9.07		
	C.V.(%)		3.38		3.95		6.41		3.71		
	B-value		19.67		14.36		8.74		7.68		
	A-value		18.54		13.53		8.24		7.24		
	No. Specimens	7		21		23		33			
	No. Batches	1		3		3		4			
G_{12}^{s} (Msi)	**Mean**		0.63		0.44		0.23		0.25		
	Minimum		0.62		0.38		0.19		0.23		
	Maximum		0.64		0.48		0.25		0.27		
	C.V.(%)		2.47		8.06		10.07		4.97		
	No. Specimens	2		6		6		8			
	No. Batches	1		3		3		4			

3.1.2.4 Shear, 13 axis

Shear, 13-axis
G/Ep
7781 Glass Fabric/ MGS 418 Wet Layup
$[0]_{12}$

Material:	Lancair 7781 Glass Fabric/ MGS 418 Wet Layup		
Resin content:	35 - 40 wt%	**Comp. density:**	1.66 - 1.73 g/cc
Fiber volume:	40 - 44 vol%	**Void content:**	2.9 to 6.7 %
Ply thickness:	0.0103 - 0.0125 in.		
Ply range:	12 plies		
Test method:	D2344	**Modulus calculation:**	N/A
Normalized by:	N/A		

				RTD (A)							
Test Temperature [°F]				75							
Moisture Conditioning				dry							
Equilibrium at T, RH				as fabricated							
Source code				MVQXXXXA							
		Normalized	**Measured**	**Normalized**	**Measured**	**Normalized**	**Measured**	**Normalized**	**Measured**	**Normalized**	**Measured**
	Mean				7.59						
	Minimum				6.96						
	Maximum				8.21						
	C.V.(%)				4.22						
F_{13}^{su} (ksi)	**B-value**				7.00						
	A-value				6.58						
	No. Specimens			24							
	No. Batches			4							

NOTE: These values represent the apparent interlaminar shear properties and are to be used for quality control purposes only. Do not use these values for interlaminar shear strength design values.

3.1.2.5 Bearing Strength

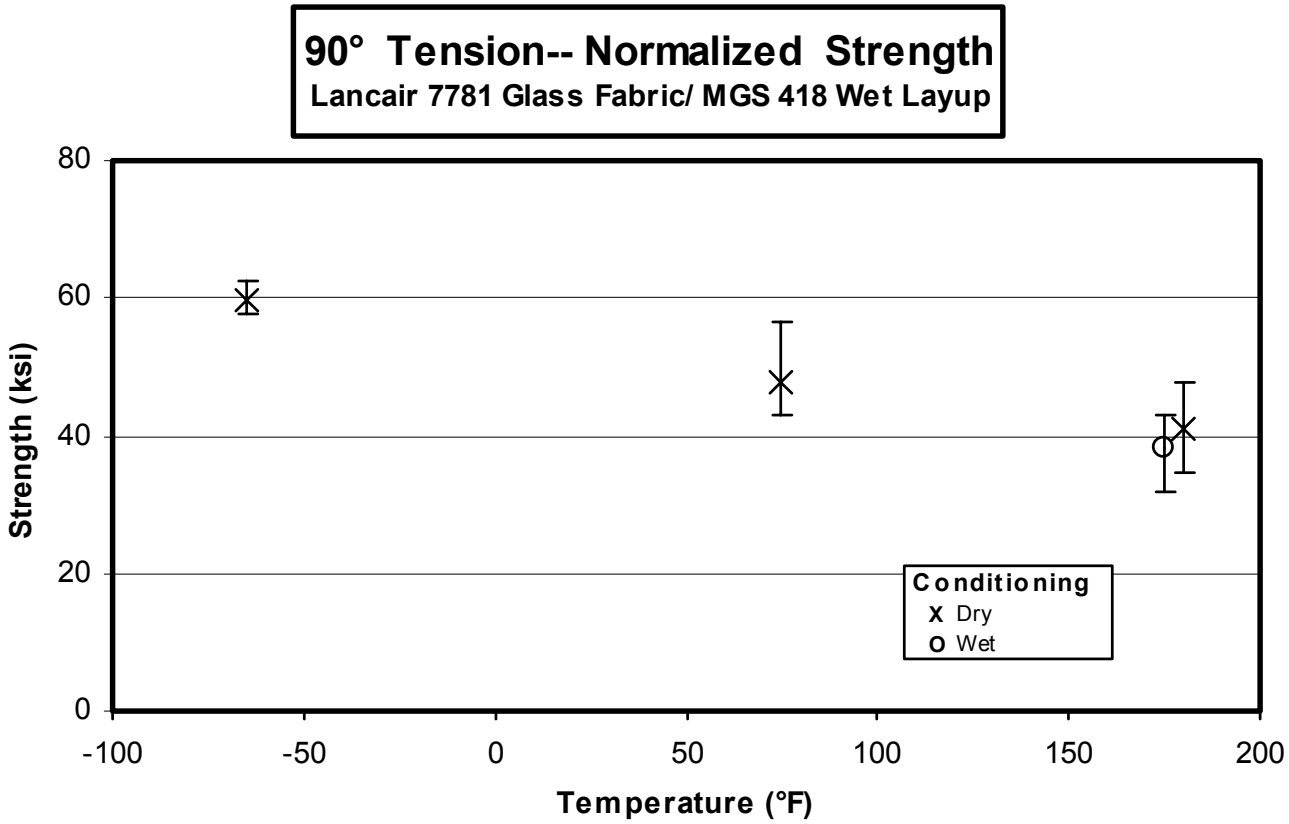
Bearing Strength
G/Ep
7781 Glass Fabric/ MGS 418 Wet Layup

Material:	Lancair 7781 Glass Fabric/ MGS 418 Wet Layup		
Resin content:	34 - 36 wt%	**Comp. density:**	1.70 - 1.74 g/cc
Fiber volume:	43 - 45 %	**Void content:**	5.5 to 6.4 %
Test method:	ASTM D953-95		
Type of bearing test:	Double Shear Pin Bearing		
Fastener Type:	Hardened Steel Pin		
Torque:	N/A		
Normalized by:	Not normalized		

		CTD			RTD						ETW		
Test Temperature [°F]		-65			75						180		
Moisture Conditioning		dry			dry						equilibrium		
Equilibrium at T, RH		as fabricated			as fabricated						145F, 85%		
Source code		MV#XXXXB			MV#XXXXA						MV#XXXXF		
Diameter[in]		0.1875	0.250	0.375	0.1875	0.250	0.375	0.1875	0.250	0.375	0.1875	0.25	0.375
F^{bu} (ksi) $[0/45/0]_s$ (6 plies)	**Mean**	51.32	51.56		36.12	39.05					23.67	23.47	
	Minimum	49.23	49.16		34.87	36.52					22.75	22.52	
	Maximum	53.19	53.23		38.14	40.71					25.23	25.12	
	C.V.(%)	2.92	3.29		3.35	3.35					3.72	3.79	
t_{ply}: 0.0098 - 0.0107 in.													
	Failure Mode	Bearing	Bearing		Bearing	Bearing					Bearing	Bearing	
	No. Specimens	6	7		7	8					8	9	
	No. Batches	1	1		1	1					1	1	
F^{bu} (ksi) $[(0/45)_5]_s$ (20 plies)	**Mean**		74.96	52.17		54.05	44.06					33.56	31.71
	Minimum		70.82	50.11		53.01	42.91					31.49	30.62
	Maximum		79.15	53.84		54.83	44.86					36.31	32.75
	C.V.(%)		3.95	2.35		1.15	1.70					4.78	2.03
t_{ply}: 0.0104 - 0.0107 in.													
	Failure Mode		Bearing	Lateral		Bearing	Lateral					Bearing	Bearing
	No. Specimens		7	6		6	6					9	9
	No. Batches		1	1		1	1					1	1

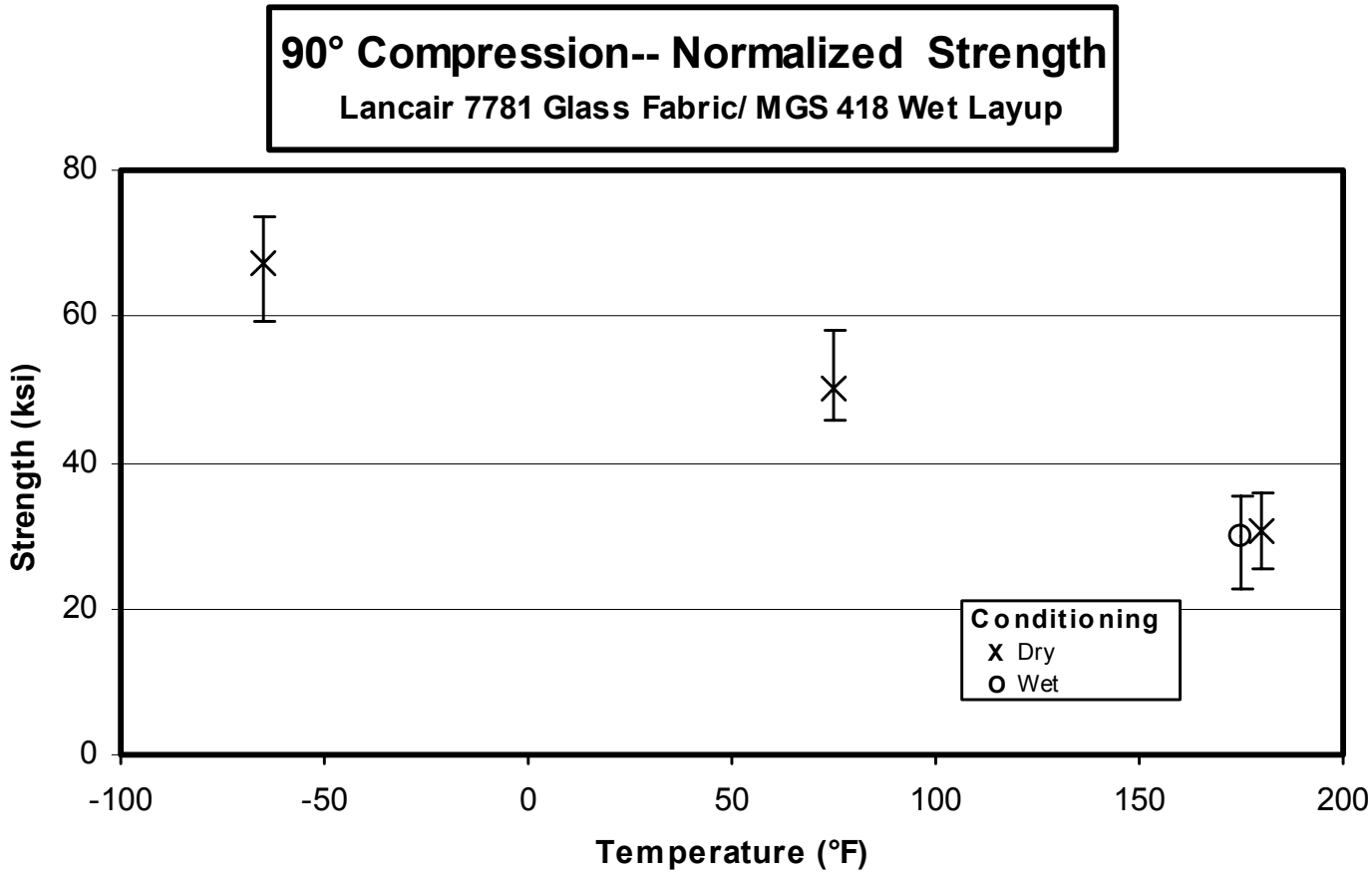
3.1.3 Individual Test Charts

3.1.3.1 Tension, 2-axis



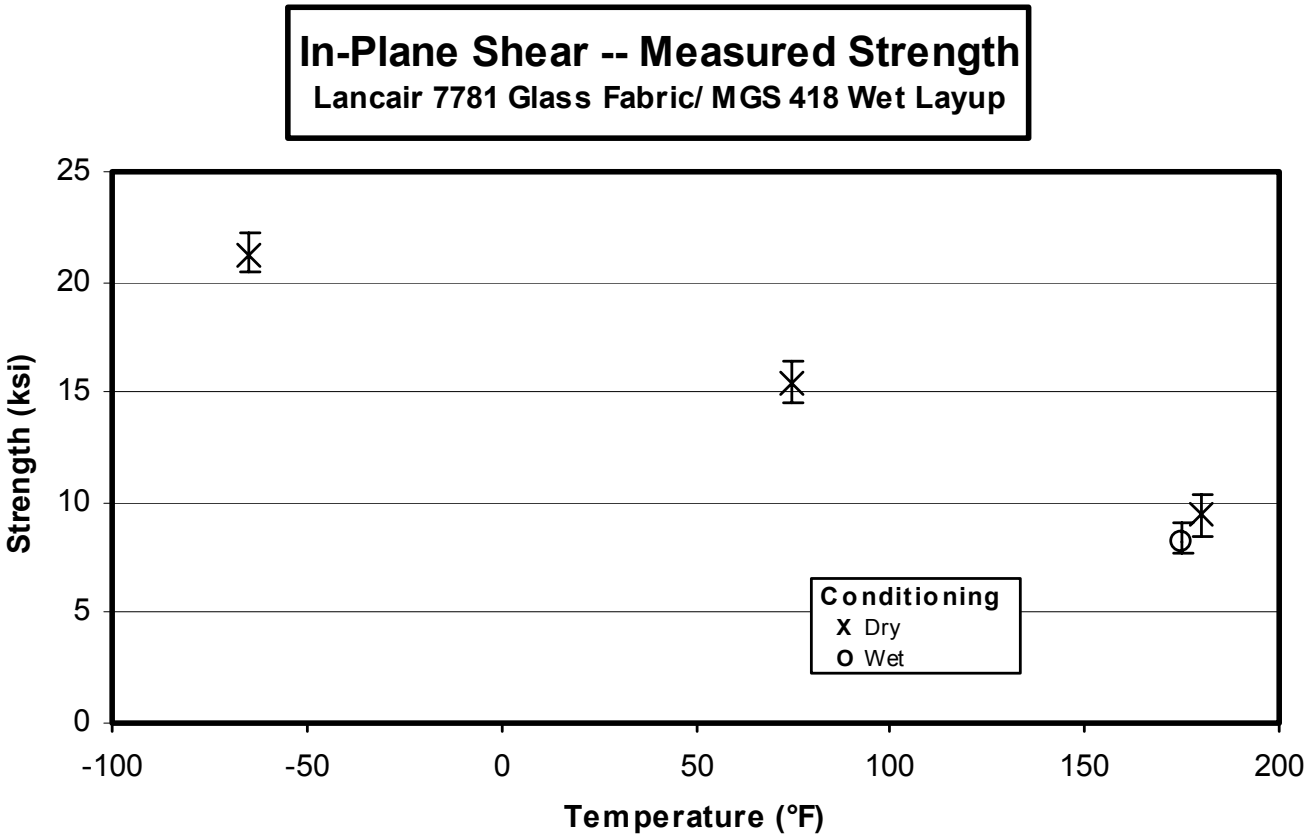
NOTE: The symbols represent the 'pooled' average of all tests, and the bars represent the upper and lower limit of the data. The 180° dry and wet data have been staggered for clarity.

3.1.3.2 Compression, 2-axis



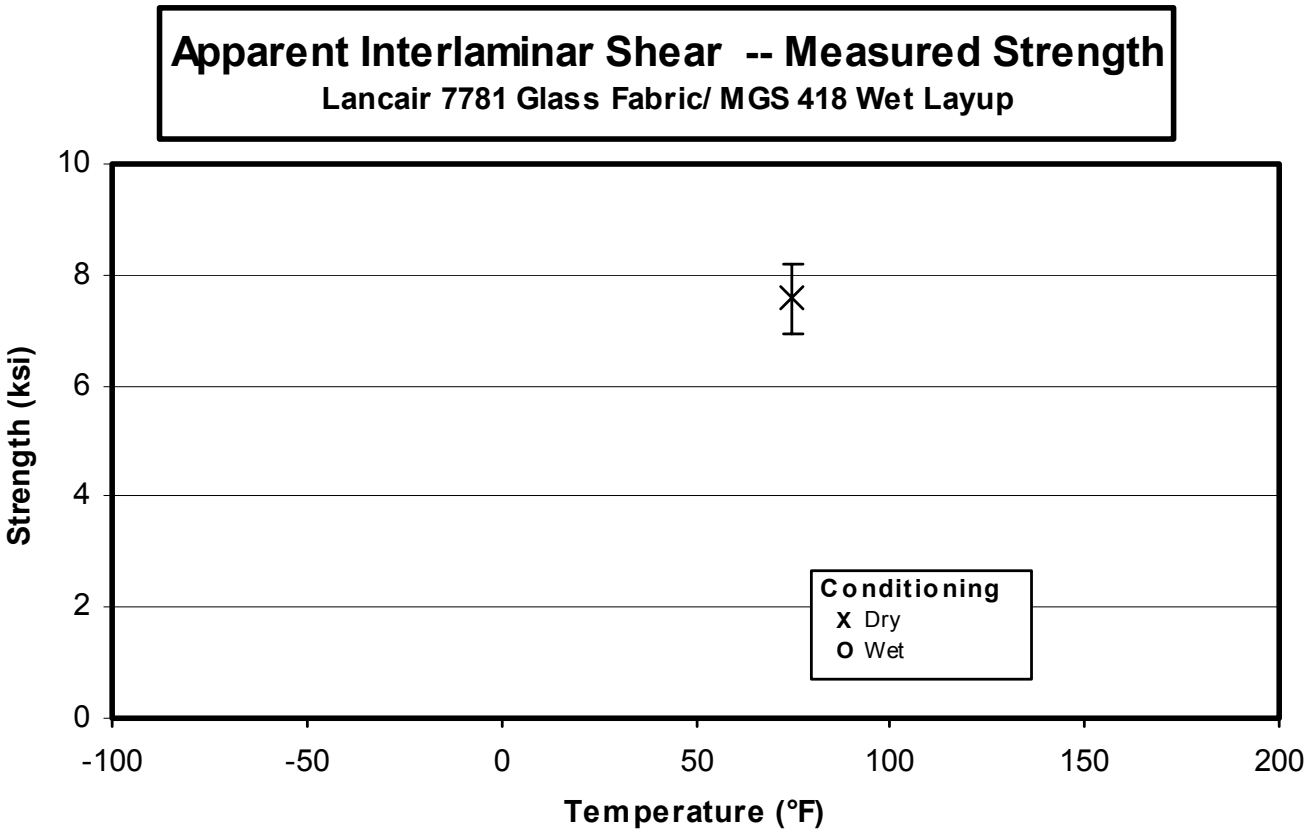
NOTE: The symbols represent the 'pooled' average of all tests, and the bars represent the upper and lower limit of the data. The 180° dry and wet data have been staggered for clarity.

3.1.3.3 Shear, 12 axis



NOTE: The symbols represent the 'pooled' average of all tests, and the bars represent the upper and lower limit of the data. The 180° dry and wet data have been staggered for clarity.

3.1.3.4 Shear, 13 axis



NOTE: The symbols represent the 'pooled' average of all tests, and the bars represent the upper and lower limit of the data.

3.2 Raw Data

Specimen Naming Convention

Test coupons were identified using an eight-digit specimen code, with the significance of each digit delineated below. A representative sample ID is shown for reference purposes.

M V U 2 1 2 5 F

1st Character: Fabricator
'M' designates Lancair

2nd Character: Material System
'V' designates 7781 Glass Fabric / MGS 418

3rd Character: Test Type
'U' designates 90° Tension Strength and Modulus, other test types will be clearly labeled at the top of each sheet

4th Character: Material Batch ID
See Table 2.1 for Lancair Batch ID Documentation.

5th Character: Panel Number
The panel(s) fabricated for a specific test method.

6th Character: Subpanel Number
The sub-panel(s) cut from each panel, with subpanel numbers labeled increasing from reference edge.

7th Character: Sample Number
The sample(s) cut from each subpanel, with samples numbered 1,2…9,A,B,….

8th Character: Test Condition
'A' --- RTD
'B' --- CTD
'F' --- ETW
'G' --- ETD
See Table 1.5.1 for condition parameters.

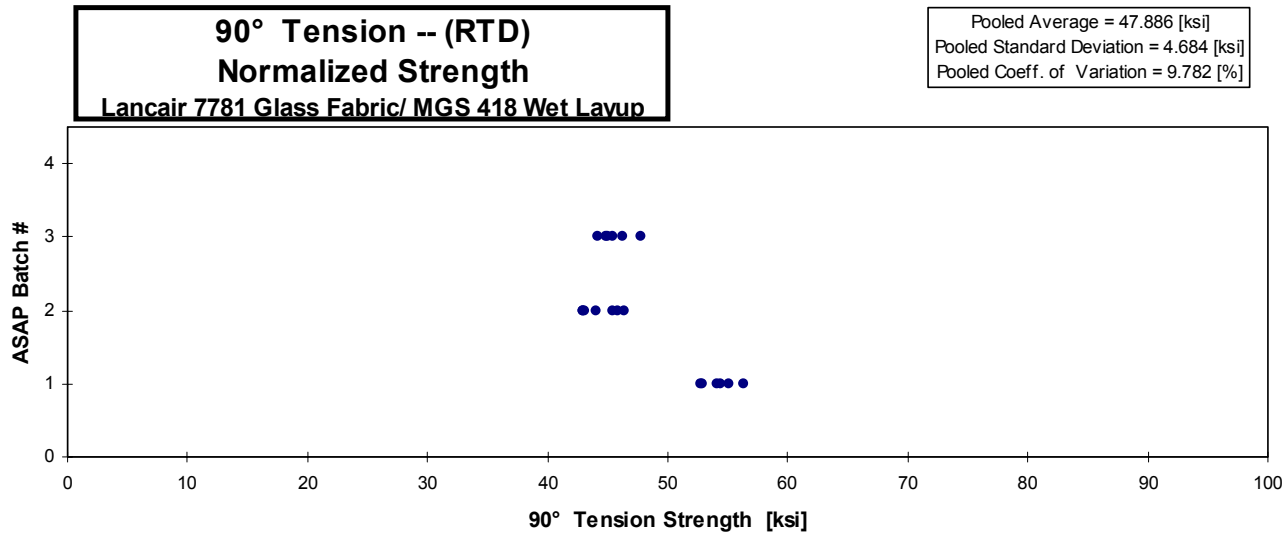
3.2.1 Raw Data Spreadsheets and Scatter Charts

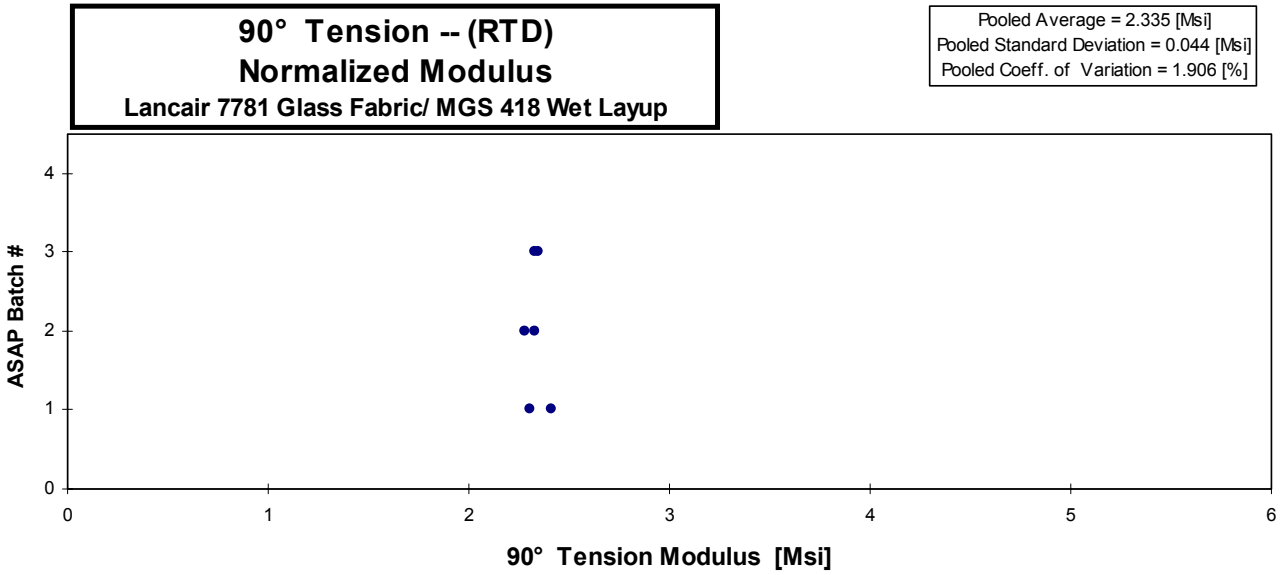
90° Tension-- (RTD)
Strength & Modulus
Lancair 7781 Glass Fabric/ MGS 418 Wet Layup

normalizing t_{ply} [in]: 0.0108

Specimen Number	Panel Batch #	ASAP Batch #	Strength [ksi]	Modulus [Msi]	Poisson's Ratio	Avg. Specimen Thickn. [in]	# Plies in Laminate	Avg. t_{ply} [in]	$Strength_{norm}$ [ksi]	$Modulus_{norm}$ [Msi]
MVUA111A	A	1	54.991	2.391	0.102	0.124	12	0.01036	52.954	2.303
MVUA112A	A	1	56.444	2.513	0.106	0.124	12	0.01033	54.171	2.412
MVUA113A	A	1	57.580			0.124	12	0.01031	55.136	
MVUA114A	A	1	56.575			0.124	12	0.01035	54.385	
MVUA115A	A	1	54.665			0.125	12	0.01038	52.746	
MVUA116A	A	1	58.822			0.124	12	0.01031	56.347	
MVUB211A	B	2	43.472			0.127	12	0.01062	42.895	
MVUB212A	B	2	46.537	2.368	0.102	0.127	12	0.01060	45.841	2.332
MVUB213A	B	2	47.121			0.127	12	0.01061	46.459	
MVUB214A	B	2	43.471			0.128	12	0.01063	42.932	
MVUB215A	B	2	44.977			0.126	12	0.01053	43.996	
MVUB216A	B	2	45.950			0.128	12	0.01063	45.387	
MVUB217A	B	2	43.851	2.321	0.099	0.127	12	0.01059	43.138	2.283
MVUC111A	C	3	44.740	2.364	0.095	0.127	12	0.01062	44.140	2.332
MVUC112A	C	3	45.676	2.381	0.094	0.127	12	0.01061	45.016	2.347
MVUC113A	C	3	45.600			0.127	12	0.01060	44.895	
MVUC114A	C	3	47.891			0.129	12	0.01073	47.761	
MVUC115A	C	3	46.511			0.128	12	0.01070	46.235	
MVUC116A	C	3	45.992			0.127	12	0.01062	45.398	

Average	**48.993**	**2.390**	**0.100**	**$Average_{norm}$**	**0.01053**	**47.886**	**2.335**
Standard Dev.	**5.430**	**0.065**	**0.005**	**$Standard\ Dev._{norm}$**		**4.684**	**0.044**
Coeff. of Var. [%]	**11.084**	**2.734**	**4.571**	**$Coeff.\ of\ Var.\ [\%]_{norm}$**		**9.782**	**1.906**
Min.	**43.471**	**2.321**	**0.094**	**Min.**	**0.0103**	**42.895**	**2.283**
Max.	**58.822**	**2.513**	**0.106**	**Max.**	**0.0107**	**56.347**	**2.412**
Number of Spec.	**19**	**6**	**6**	**Number of Spec.**		**19**	**6**



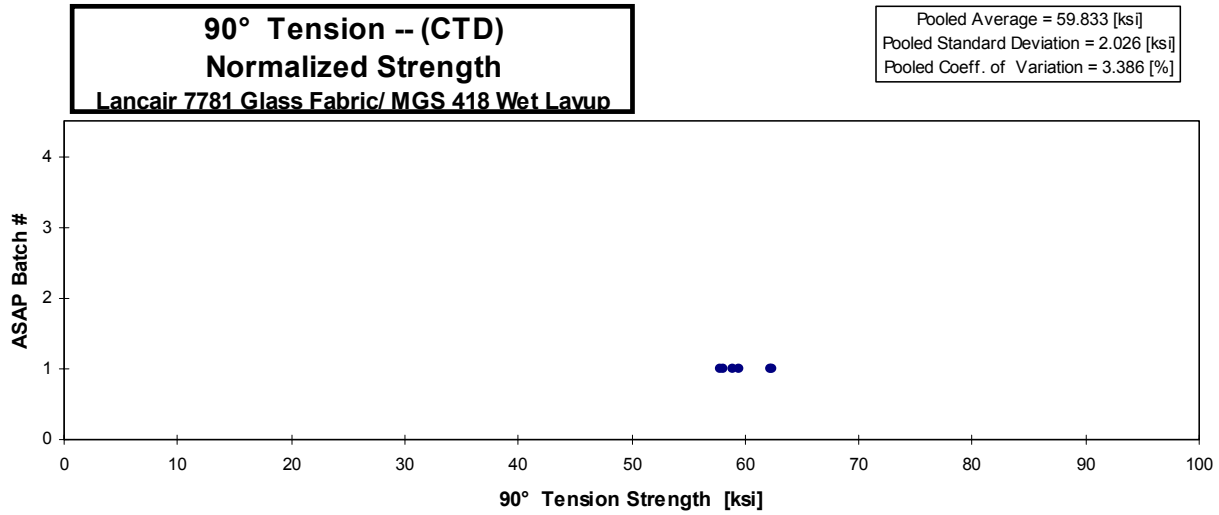


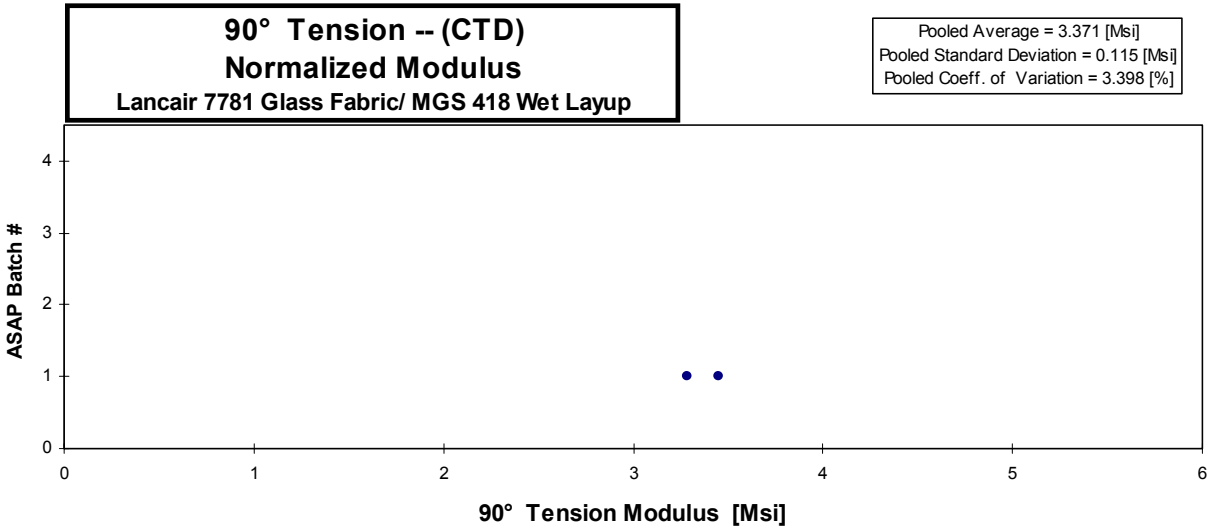
90° Tension-- (CTD)
Strength & Modulus
Lancair 7781 Glass Fabric/ MGS 418 Wet Layup

normalizing t_{ply} [in]: 0.0108

Specimen Number	Panel Batch #	ASAP Batch #	Strength [ksi]	Modulus [Msi]	Poisson's Ratio	Avg. Specimen Thickn. [in]	# Plies in Laminate	Avg. t_{ply} [in]	$Strength_{norm}$ [ksi]	$Modulus_{norm}$ [Msi]
MVUB112B	B	1	60.206	3.360	0.157	0.126	12	0.01054	58.948	3.290
MVUB113B	B	1	59.100			0.127	12	0.01057	58.033	
MVUB115B	B	1	58.780			0.127	12	0.01059	57.839	
MVUB117B	B	1	63.216			0.127	12	0.01060	62.246	
MVUB118B	B	1	63.964			0.126	12	0.01050	62.404	
MVUB119B	B	1	60.065	3.483	0.159	0.128	12	0.01067	59.531	3.452

Average	60.888	3.421	0.158	$Average_{norm}$	0.01058	59.833	3.371
Standard Dev.	2.176	0.087	0.001	$Standard\ Dev._{norm}$		2.026	0.115
Coeff. of Var. [%]	3.573	2.537	0.672	$Coeff.\ of\ Var.\ [\%]_{norm}$		3.386	3.398
Min.	58.780	3.360	0.157	Min.	0.0105	57.839	3.290
Max.	63.964	3.483	0.159	Max.	0.0107	62.404	3.452
Number of Spec.	6	2	2	Number of Spec.		6	2





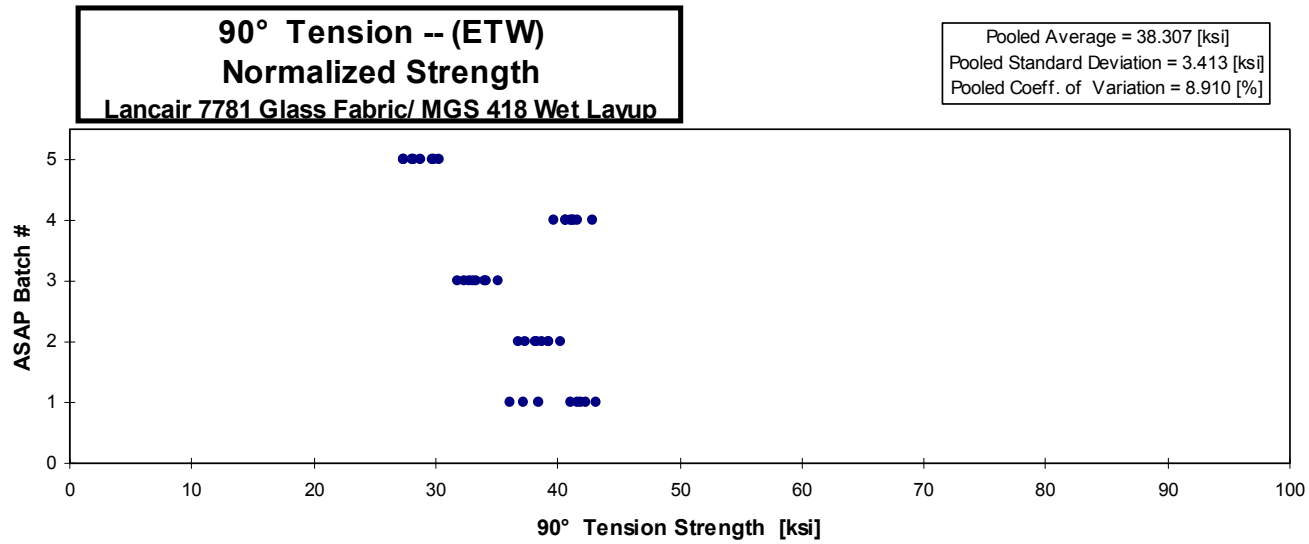
90° Tension-- (ETW)
Strength & Modulus
Lancair 7781 Glass Fabric/ MGS 418 Wet Layup

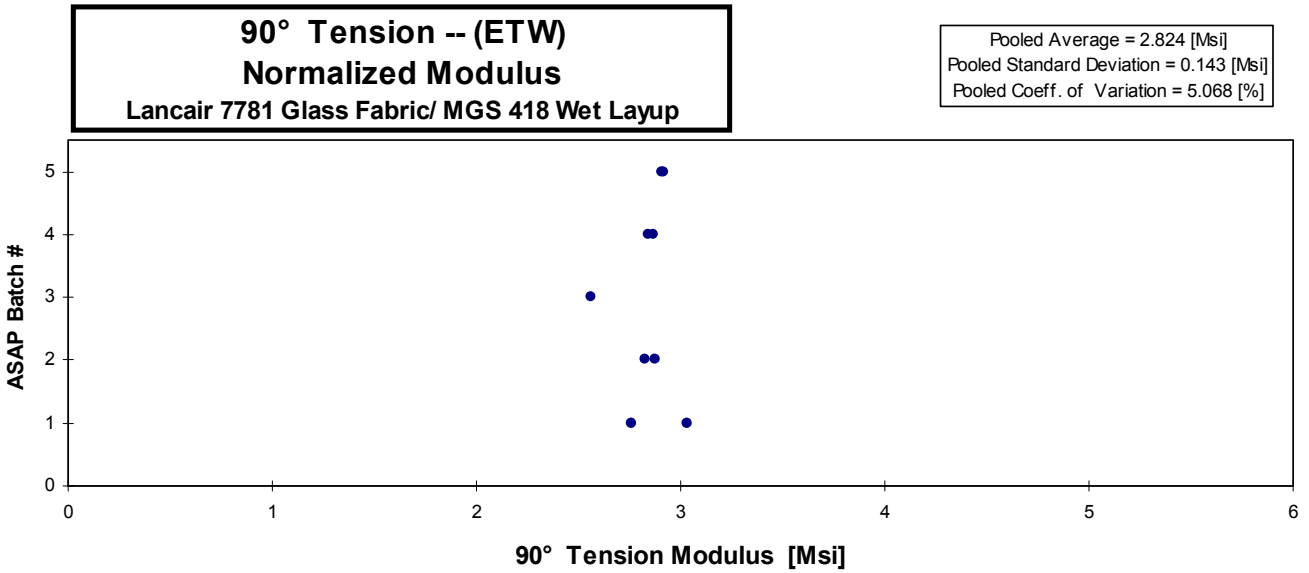
normalizing t_{ply} [in]: 0.0108

Specimen Number	Panel Batch #	ASAP Batch #	Strength [ksi]	Modulus [Msi]	Poisson's Ratio	Avg. Specimen Thickn. [in]	# Plies in Laminate	Avg. t_{ply} [in]	$Strength_{norm}$ [ksi]	$Modulus_{norm}$ [Msi]
MVUA211F	A	1	44.273	3.117	0.119	0.126	12	0.01048	43.096	3.034
MVUA212F	A	1	42.531	2.821	0.075	0.126	12	0.01053	41.593	2.759
MVUA213F	A	1	42.300			0.125	12	0.01044	41.028	
MVUA214F	A	1	39.604			0.125	12	0.01045	38.469	
MVUA215F	A	1	43.167			0.126	12	0.01046	41.964	
MVUA216F	A	1	43.403			0.126	12	0.01048	42.255	
MVUA217F	A	1	37.351			0.125	12	0.01039	36.069	
MVUA218F	A	1	38.131			0.126	12	0.01050	37.201	
MVUB311F	B	2	35.587	2.538	0.095	0.146	12	0.01218	40.281	2.873
MVUB312F	B	2	32.280	2.479	0.090	0.147	12	0.01228	36.817	2.828
MVUB313F	B	2	33.346			0.145	12	0.01205	37.344	
MVUB314F	B	2	33.181			0.151	12	0.01257	38.743	
MVUB315F	B	2	33.667			0.147	12	0.01224	38.290	
MVUB316F	B	2	34.496			0.143	12	0.01193	38.236	
MVUB317F	B	2	34.276			0.148	12	0.01234	39.315	
MVUB318F	B	2	33.368			0.152	12	0.01265	39.216	
MVUC211F	C	3	35.263			0.125	12	0.01044	34.198	
MVUC212F	C	3	34.259	2.673	0.083	0.124	12	0.01031	32.813	2.560
MVUC213F	C	3	36.229			0.125	12	0.01045	35.168	
MVUC214F	C	3	33.129			0.124	12	0.01034	31.833	
MVUC215F	C	3	34.579			0.125	12	0.01039	33.392	
MVUC216F	C	3	35.422			0.124	12	0.01033	34.014	
MVUC217F	C	3	33.435			0.125	12	0.01041	32.335	
MVUC218F	C	3	34.168			0.125	12	0.01040	33.008	
MVUD111F	D	4	35.309	2.495	0.083	0.149	12	0.01238	40.604	2.869
MVUD112F	D	4	34.975	2.448	0.079	0.150	12	0.01250	40.609	2.842
MVUD113F	D	4	37.196			0.149	12	0.01241	42.879	
MVUD114F	D	4	35.824			0.149	12	0.01240	41.275	
MVUD115F	D	4	35.875			0.149	12	0.01242	41.389	
MVUD116F	D	4	35.709			0.148	12	0.01237	41.055	
MVUD117F	D	4	34.642			0.148	12	0.01231	39.636	
MVUD118F	D	4	36.066			0.149	12	0.01244	41.684	
MVUE111F*	E	5	26.142	2.789	0.085	0.135	12	0.01127	27.383	2.921
MVUE112F*	E	5	25.958	2.756	0.081	0.136	12	0.01135	27.375	2.907
MVUE113F*	E	5	26.764			0.136	12	0.01132	28.142	
MVUE114F*	E	5	28.930			0.135	12	0.01127	30.304	
MVUE115F*	E	5	26.847			0.136	12	0.01133	28.261	
MVUE116F*	E	5	27.384			0.136	12	0.01133	28.819	
MVUE117F*	E	5	28.371			0.136	12	0.01135	29.917	
MVUE118F*	E	5	28.104			0.137	12	0.01138	29.722	

*Batch E results are not included in the final totals

Average	**36.345**	**2.653**	**0.089**	**$Average_{norm}$**	**0.01138**	**38.307**	**2.824**
Standard Dev.	**3.351**	**0.243**	**0.015**	**Standard $Dev._{norm}$**		**3.413**	**0.143**
Coeff. of Var. [%]	**9.221**	**9.156**	**16.502**	**Coeff. of Var. $[\%]_{norm}$**		**8.910**	**5.068**
Min.	**32.280**	**2.448**	**0.075**	**Min.**	**0.0103**	**31.833**	**2.560**
Max.	**44.273**	**3.117**	**0.119**	**Max.**	**0.0126**	**43.096**	**3.034**
Number of Spec.	**32**	**7**	**7**	**Number of Spec.**		**32**	**7**



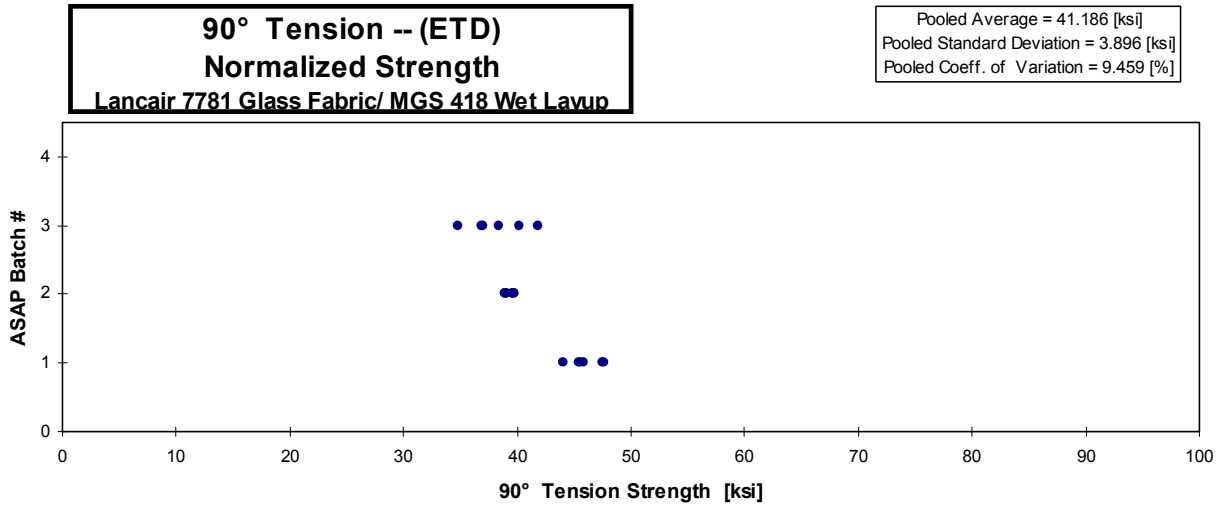


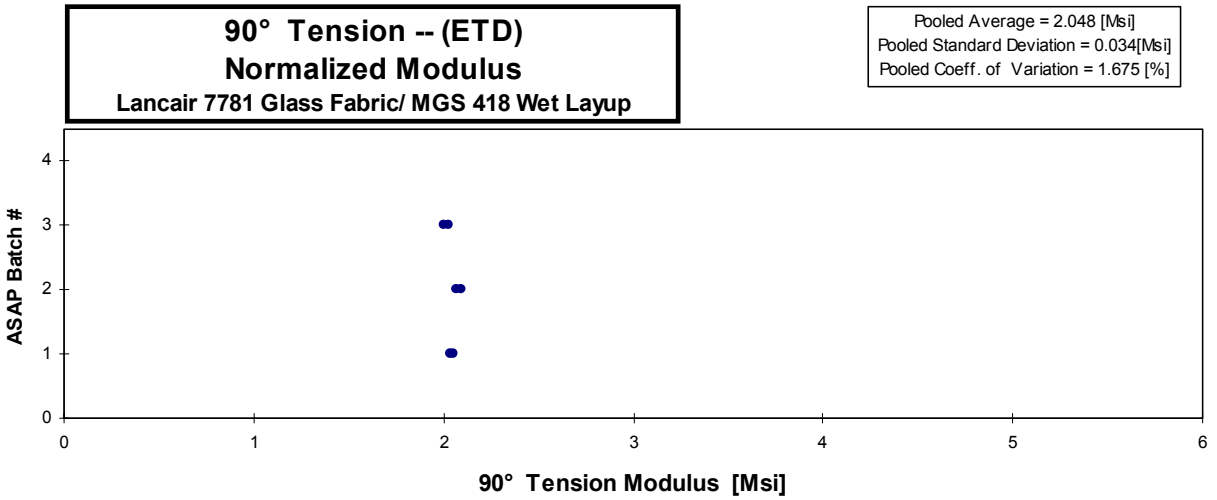
90° Tension-- (ETD)
Strength & Modulus
Lancair 7781 Glass Fabric/ MGS 418 Wet Layup

normalizing t_{ply} [in]: 0.0108

Specimen Number	Panel Batch #	ASAP Batch #	Strength [ksi]	Modulus [Msi]	Poisson's Ratio	Avg. Specimen Thickn. [in]	# Plies in Laminate	Avg. t_{ply} [in]	$Strength_{norm}$ [ksi]	$Modulus_{norm}$ [Msi]
MVUA311G	A	1	46.809	2.079	0.095	0.127	12	0.01054	45.861	2.037
MVUA312G	A	1	46.862	2.117	0.071	0.125	12	0.01043	45.417	2.052
MVUA313G	A	1	45.033			0.127	12	0.01055	44.126	
MVUA314G	A	1	48.527			0.127	12	0.01058	47.714	
MVUA315G	A	1	48.395			0.127	12	0.01056	47.496	
MVUA316G	A	1	47.110			0.125	12	0.01041	45.585	
MVUB411G	B	2	39.555	2.107	0.076	0.127	12	0.01059	38.917	2.073
MVUB412G	B	2	40.696	2.146	0.082	0.126	12	0.01051	39.756	2.096
MVUB413G	B	2	40.458			0.127	12	0.01056	39.696	
MVUB414G	B	2	39.978			0.126	12	0.01048	38.947	
MVUB415G	B	2	39.671			0.127	12	0.01060	39.057	
MVUB416G	B	2	40.357			0.127	12	0.01056	39.597	
MVUC311G	C	3	39.476	2.055	0.062	0.126	12	0.01047	38.396	1.999
MVUC312G	C	3	37.915	2.086	0.055	0.126	12	0.01047	36.873	2.029
MVUC313G	C	3	43.119			0.125	12	0.01045	41.873	
MVUC314G	C	3	38.109			0.125	12	0.01046	37.022	
MVUC315G	C	3	41.560			0.125	12	0.01043	40.262	
MVUC316G	C	3	36.175			0.124	12	0.01034	34.761	

Average	**42.211**	**2.098**	**0.073**	**$Average_{norm}$**	**0.01050**	**41.186**	**2.048**
Standard Dev.	**3.915**	**0.032**	**0.014**	**$Standard\ Dev._{norm}$**		**3.896**	**0.034**
Coeff. of Var. [%]	**9.276**	**1.520**	**19.611**	**$Coeff.\ of\ Var.\ [\%]_{norm}$**		**9.459**	**1.675**
Min.	**36.175**	**2.055**	**0.055**	**Min.**	**0.0103**	**34.761**	**1.999**
Max.	**48.527**	**2.146**	**0.095**	**Max.**	**0.0106**	**47.714**	**2.096**
Number of Spec.	**18**	**6**	**6**	**Number of Spec.**		**18**	**6**



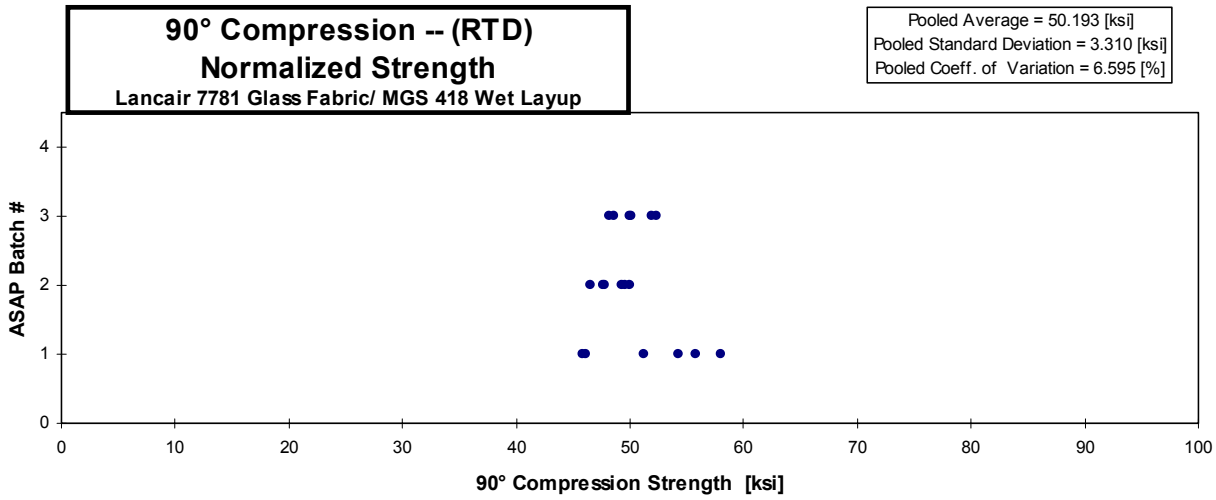


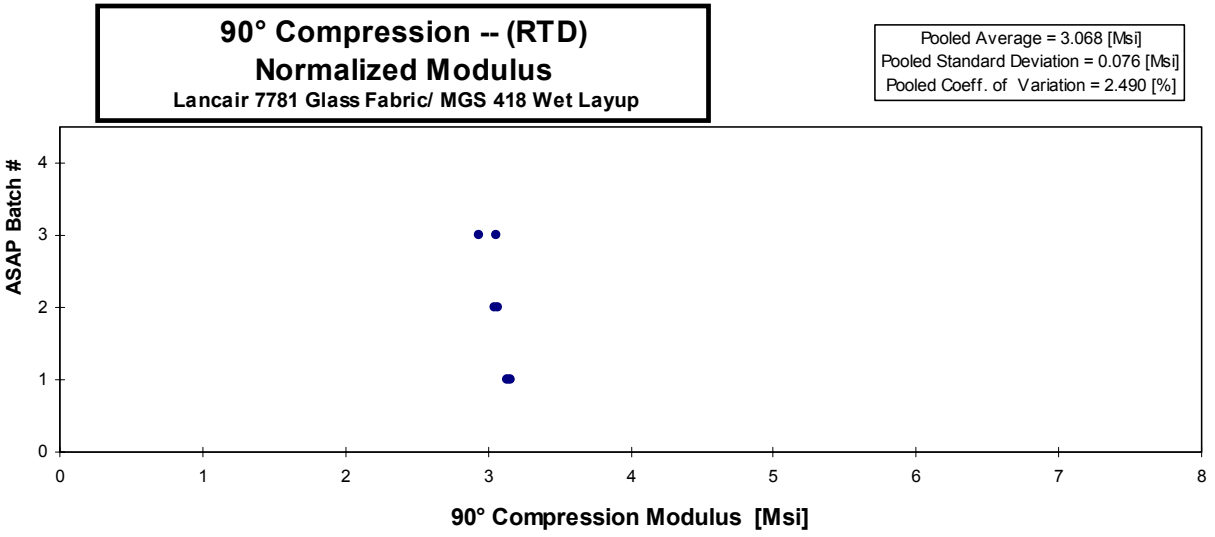
90° Compression-- (RTD)
Strength & Modulus
Lancair 7781 Glass Fabric/ MGS 418 Wet Layup

normalizing t_{ply} [in]: 0.0108

Specimen Number	Panel Batch #	ASAP Batch #	Strength	Modulus	Avg. Specimen	# Plies in Laminate	Avg. t_{ply} [in]	$Strength_{norm}$ [ksi]	$Modulus_{norm}$ [Msi]
MVWA125A	A	1	48.020		0.124	12	0.01035	46.170	
MVWA126A	A	1	47.437		0.125	12	0.01040	45.821	
MVWA127A	A	1	52.897		0.125	12	0.01042	51.208	
MVWA128A	A	1	57.911		0.124	12	0.01036	55.737	
MVWA129A	A	1	56.110		0.125	12	0.01041	54.275	
MVWA12AA	A	1	60.325		0.124	12	0.01036	58.072	
MVZA226A	A	1		3.230	0.125	12	0.01043		3.132
MVZA227A	A	1		3.239	0.126	12	0.01049		3.158
MVWB221A	B	2	50.530		0.126	12	0.01050	49.318	
MVWB222A	B	2	48.067		0.125	12	0.01044	46.607	
MVWB223A	B	2	51.243		0.126	12	0.01050	50.013	
MVWB224A	B	2	48.933		0.126	12	0.01048	47.645	
MVWB225A	B	2	51.145		0.125	12	0.01042	49.521	
MVWB226A	B	2	49.000		0.126	12	0.01049	47.739	
MVZB236A	B	2		3.140	0.126	12	0.01051		3.067
MVZB237A	B	2		3.116	0.126	12	0.01053		3.049
MVWC124A	C	3	49.963		0.126	12	0.01048	48.639	
MVWC125A	C	3	53.690		0.126	12	0.01050	52.401	
MVWC126A	C	3	51.458		0.126	12	0.01046	50.034	
MVWC127A	C	3	49.841		0.125	12	0.01042	48.259	
MVWC128A	C	3	53.296		0.126	12	0.01048	51.873	
MVWC129A	C	3	52.012		0.125	12	0.01038	50.150	
MVZC226A	C	3		3.032	0.125	12	0.01043		2.939
MVZC227A	C	3		3.194	0.124	12	0.01031		3.061

Average	**51.771**	**3.159**	**$Average_{norm}$**	**0.01044**	**50.193**	**3.068**
Standard Dev.	**3.503**	**0.079**	**$Standard\ Dev._{norm}$**		**3.310**	**0.076**
Coeff. of Var. [%]	**6.767**	**2.497**	**$Coeff.\ of\ Var.\ [\%]_{norm}$**		**6.595**	**2.490**
Min.	**47.437**	**3.032**	**Min.**	**0.0103**	**45.821**	**2.939**
Max.	**60.325**	**3.239**	**Max.**	**0.0105**	**58.072**	**3.158**
Number of Spec.	**18**	**6**	**Number of Spec.**		**18**	**6**



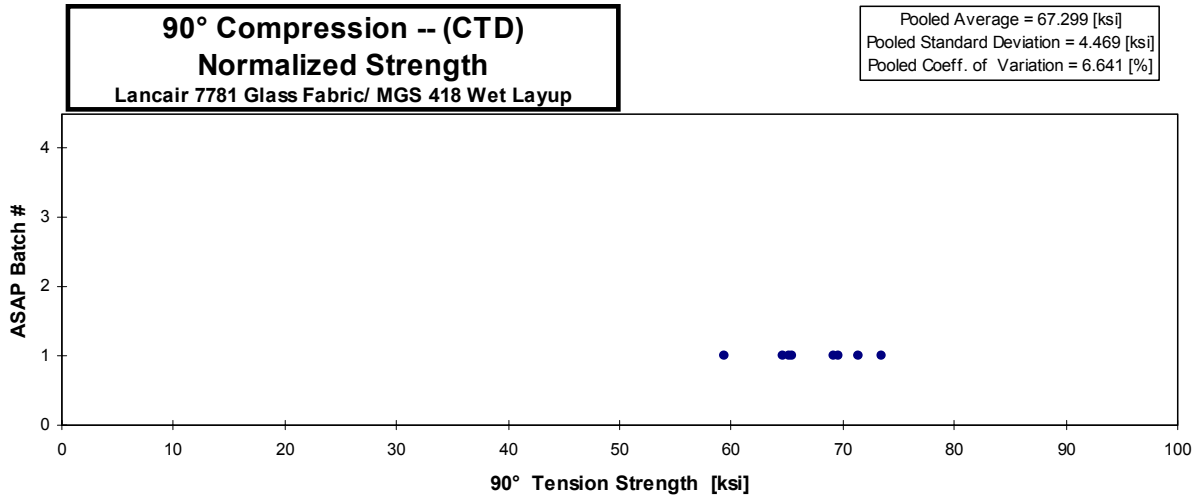


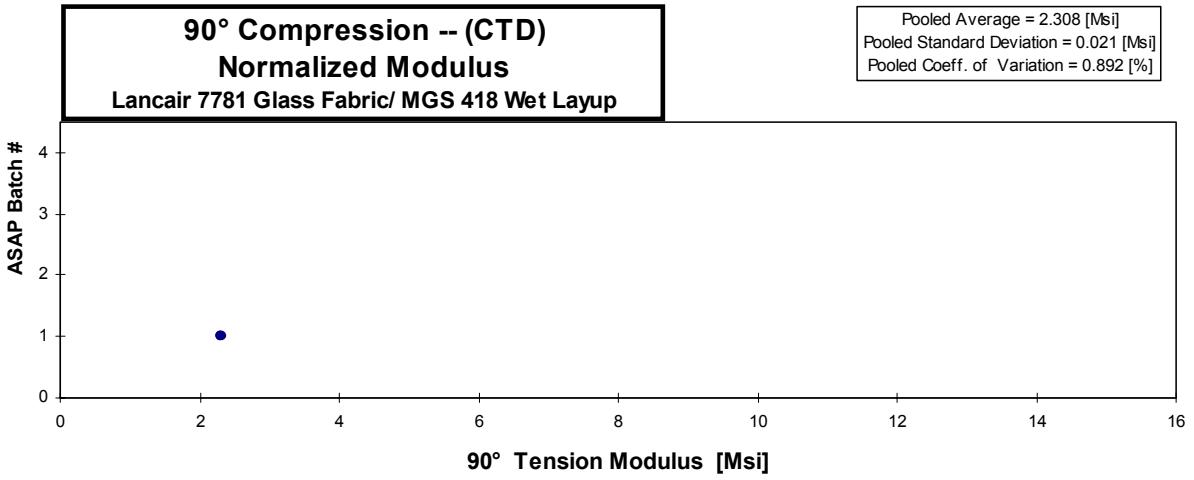
90° Compression-- (CTD)
Strength & Modulus
Lancair 7781 Glass Fabric/ MGS 418 Wet Layup

normalizing t_{ply} [in]: 0.0104

Specimen Number	Panel Batch #	ASAP Batch #	Strength [ksi]	Modulus [Msi]	Avg. Specimen Thickn. [in]	# Plies in Laminate	Avg. t_{ply} [in]	$Strength_{norm}$ [ksi]	$Modulus_{norm}$ [Msi]
MVWB13CB	B	1	59.409		0.125	12	0.01041	59.445	
MVWB13EB	B	1	70.480		0.126	12	0.01053	71.384	
MVWB13FB	B	1	64.554		0.127	12	0.01056	65.537	
MVWB22AB	B	1	68.283		0.127	12	0.01054	69.213	
MVWB22BB	B	1	65.451		0.124	12	0.01035	65.150	
MVWB22CB	B	1	64.209		0.126	12	0.01047	64.634	
MVWB22DB	B	1	69.057		0.126	12	0.01048	69.583	
MVWB22EB	B	1	72.328		0.127	12	0.01056	73.443	
MVZB239B	B	1		2.258	0.127	12	0.01061		2.303
MVZB23AB	B	1		2.258	0.127	12	0.01055		2.290
MVZB23BB	B	1		2.308	0.126	12	0.01050		2.330

Average	**66.721**	**2.275**	**$Average_{norm}$**	**0.01050**	**67.299**	**2.308**
Standard Dev.	**4.133**	**0.029**	**$Standard\ Dev._{norm}$**		**4.469**	**0.021**
Coeff. of Var. [%]	**6.194**	**1.279**	**$Coeff.\ of\ Var.\ [\%]_{norm}$**		**6.641**	**0.892**
Min.	**59.409**	**2.258**	**Min.**	**0.0104**	**59.445**	**2.290**
Max.	**72.328**	**2.308**	**Max.**	**0.0106**	**73.443**	**2.330**
Number of Spec.	**8**	**3**	**Number of Spec.**		**8**	**3**





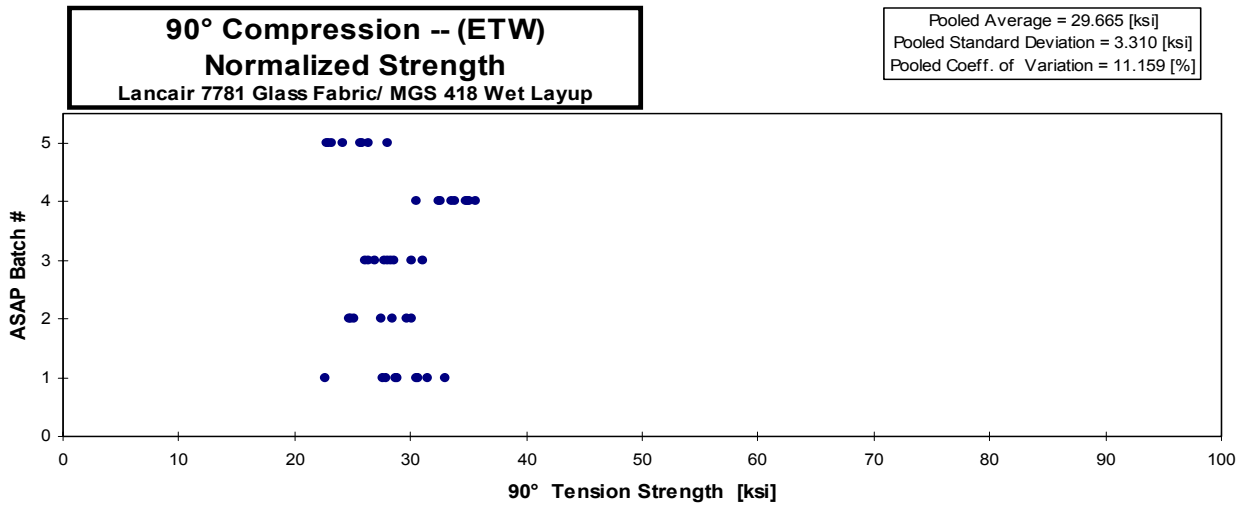
90° Compression-- (ETW)
Strength & Modulus
Lancair 7781 Glass Fabric/ MGS 418 Wet Layup

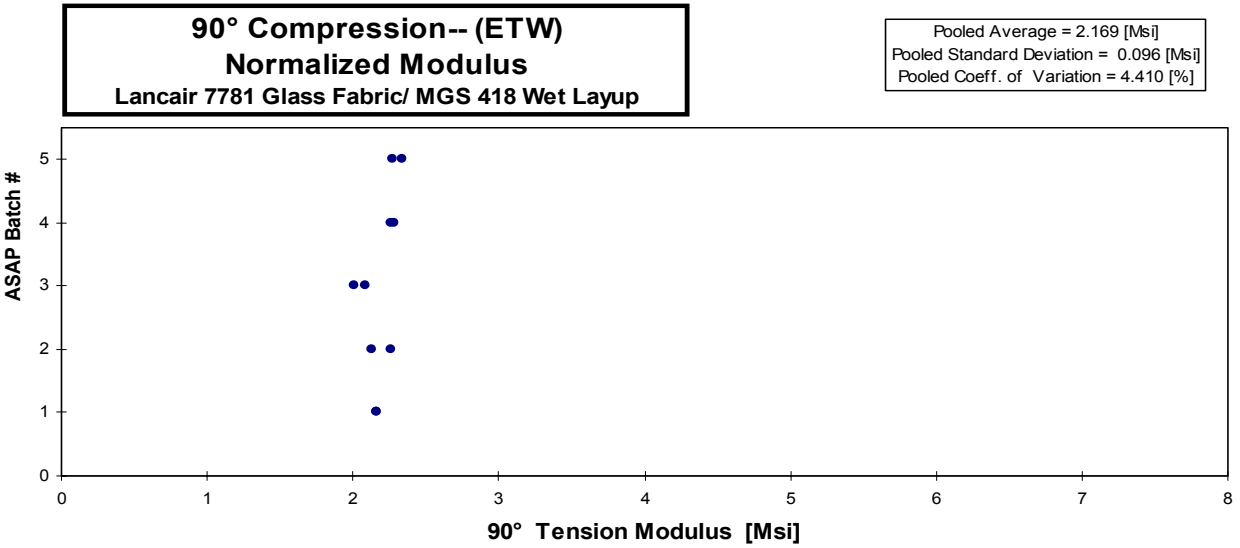
normalizing t_{ply} [in]: 0.0108

Specimen Number	Panel Batch #	ASAP Batch #	Strength [ksi]	Modulus [Msi]	Avg. Specimen Thickn. [in]	# Plies in Laminate	Avg. t_{ply} [in]	$Strength_{norm}$ [ksi]	$Modulus_{norm}$ [Msi]
MVWA131F	A	1	30.007		0.124	12	0.01035	28.845	
MVWA132F	A	1	29.066		0.124	12	0.01033	27.896	
MVWA133F	A	1	31.922		0.124	12	0.01034	30.674	
MVWA134F	A	1	31.455		0.125	12	0.01042	30.457	
MVWA135F	A	1	28.713		0.124	12	0.01036	27.640	
MVWA136F	A	1	29.922		0.124	12	0.01034	28.752	
MVWA137F	A	1	34.350		0.124	12	0.01036	33.067	
MVWA138F	A	1	32.700		0.124	12	0.01036	31.472	
MVWA139F	A	1	23.516		0.124	12	0.01034	22.597	
MVZA221F	A	1		2.272	0.123	12	0.01026		2.166
MVZA222F	A	1		2.211	0.126	12	0.01050		2.158
MVWB131F	B	2	30.345		0.126	12	0.01051	29.634	
MVWB134F	B	2	25.077		0.127	12	0.01059	24.669	
MVWB135F	B	2	28.151		0.126	12	0.01049	27.432	
MVWB136F	B	2	25.590		0.126	12	0.01046	24.877	
MVWB138F	B	2	29.281		0.125	12	0.01045	28.420	
MVWB13AF	B	2	25.806		0.126	12	0.01048	25.137	
MVWB13BF	B	2	30.789		0.126	12	0.01050	30.044	
MVZB231F	B	2		2.182	0.126	12	0.01051		2.132
MVZB233F	B	2		2.311	0.126	12	0.01054		2.263
MVWC131F	C	3	30.928		0.126	12	0.01046	30.066	
MVWC132F	C	3	28.535		0.126	12	0.01047	27.751	
MVWC133F	C	3	32.013		0.126	12	0.01047	31.145	
MVWC134F	C	3	26.888		0.126	12	0.01047	26.159	
MVWC135F	C	3	27.477		0.127	12	0.01058	26.999	
MVWC137F	C	3	29.532		0.125	12	0.01043	28.606	
MVWC138F	C	3	27.077		0.126	12	0.01047	26.349	
MVWC139F	C	3	28.977		0.126	12	0.01052	28.332	
MVWC13AF	C	3	28.650		0.127	12	0.01054	28.062	
MVZC221F	C	3		2.159	0.125	12	0.01038		2.082
MVZC222F	C	3		2.081	0.125	12	0.01040		2.011
MVWD121F	D	4	28.164		0.149	12	0.01243	32.520	
MVWD122F	D	4	30.203		0.150	12	0.01250	35.091	
MVWD123F	D	4	30.208		0.150	12	0.01246	34.980	
MVWD124F	D	4	26.487		0.149	12	0.01240	30.517	
MVWD125F	D	4	29.223		0.149	12	0.01244	33.782	
MVWD126F	D	4	30.111		0.149	12	0.01244	34.803	
MVWD127F	D	4	29.046		0.149	12	0.01245	33.612	
MVWD128F	D	4	30.747		0.149	12	0.01246	35.586	
MVWD129F	D	4	28.348		0.149	12	0.01240	32.651	
MVZD131F	D	4		1.978	0.149	12	0.01240		2.280
MVZD132F	D	4		1.944	0.150	12	0.01253		2.263
MVWE121F	E	5	26.105		0.131	12	0.01088	26.383	
MVWE122F	E	5	26.000		0.129	12	0.01072	25.895	
MVWE123F	E	5	22.552		0.131	12	0.01093	22.893	
MVWE124F	E	5	23.053		0.130	12	0.01082	23.173	
MVWE125F	E	5	23.513		0.133	12	0.01106	24.169	
MVWE127F	E	5	27.676		0.131	12	0.01089	28.003	
MVWE128F	E	5	25.584		0.130	12	0.01082	25.718	
MVWE129F	E	5	22.651		0.130	12	0.01084	22.809	
MVZE131F	E	5		2.247	0.131	12	0.01090		2.276
MVZE132F	E	5		2.328	0.130	12	0.01079		2.334

*Batch E results are not included in the final totals

Average	**29.097**	**2.142**	**$Average_{norm}$**	**0.01097**	**29.665**	**2.169**
Standard Dev.	**2.271**	**0.132**	**$Standard\ Dev._{norm}$**		**3.310**	**0.096**
Coeff. of Var. [%]	**7.805**	**6.167**	**$Coeff.\ of\ Var.\ [\%]_{norm}$**		**11.159**	**4.410**
Min.	**23.516**	**1.944**	**Min.**	**0.0103**	**22.597**	**2.011**
Max.	**34.350**	**2.311**	**Max.**	**0.0125**	**35.586**	**2.280**
Number of Spec.	**34**	**8**	**Number of Spec.**		**34**	**8**



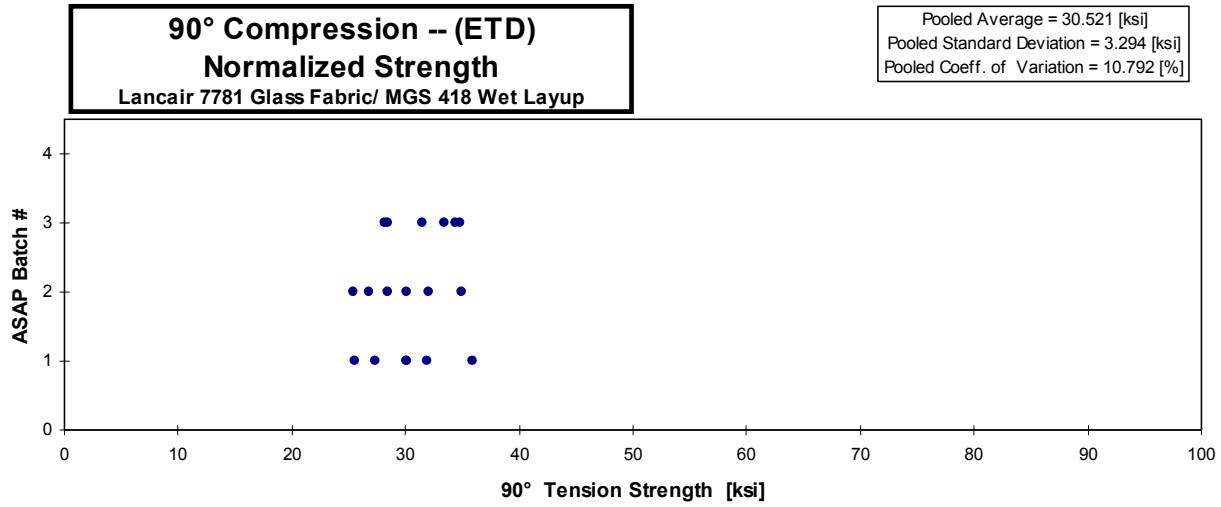


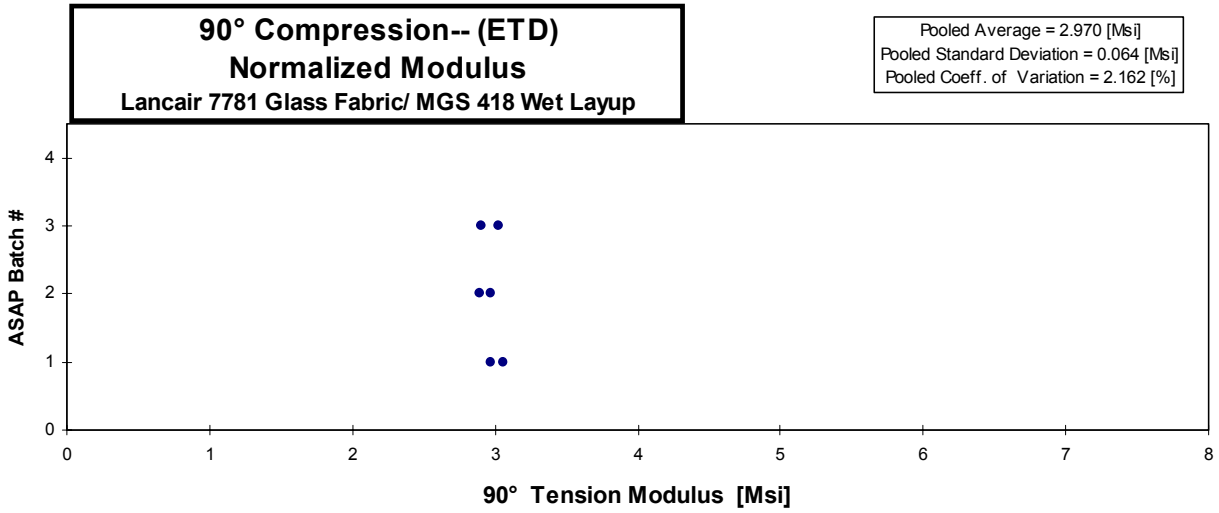
90° Compression-- (ETD)
Strength & Modulus
Lancair 7781 Glass Fabric/ MGS 418 Wet Layup

normalizing t_{ply} [in]: 0.0108

Specimen Number	Panel Batch #	ASAP Batch #	Strength [ksi]	Modulus [Msi]	Avg. Specimen Thickn. [in]	# Plies in Laminate	Avg. t_{ply} [in]	$Strength_{norm}$ [ksi]	$Modulus_{norm}$ [Msi]
MVWA123G	A	1	31.157		0.125	12	0.01040	30.102	
MVWA124G	A	1	37.212		0.125	12	0.01038	35.887	
MVWA13AG	A	1	28.247		0.125	12	0.01042	27.350	
MVWA13BG	A	1	26.599		0.124	12	0.01036	25.600	
MVWA13CG	A	1	32.947		0.125	12	0.01041	31.876	
MVWA13DG	A	1	31.108		0.125	12	0.01041	30.084	
MVZA22AG	A	1		3.048	0.126	12	0.01049		2.970
MVZA22BG	A	1		3.131	0.126	12	0.01050		3.056
MVWB123G	B	2	29.105		0.126	12	0.01053	28.463	
MVWB124G	B	2	30.685		0.127	12	0.01054	30.061	
MVWB125G	B	2	27.407		0.127	12	0.01054	26.844	
MVWB126G	B	2	33.008		0.125	12	0.01045	32.043	
MVWB127G	B	2	36.243		0.125	12	0.01038	34.938	
MVWB128G	B	2	25.822		0.127	12	0.01059	25.402	
MVZB23CG	B	2		3.055	0.126	12	0.01049		2.977
MVZB23DG	B	2		2.989	0.125	12	0.01042		2.894
MVWC121G	C	3	32.711		0.124	12	0.01035	31.451	
MVWC122G	C	3	36.039		0.123	12	0.01026	34.351	
MVWC123G	C	3	35.961		0.125	12	0.01043	34.862	
MVWC13BG	C	3	28.846		0.127	12	0.01059	28.394	
MVWC13CG	C	3	28.793		0.126	12	0.01053	28.180	
MVWC13DG	C	3	34.297		0.126	12	0.01051	33.488	
MVZC22AG	C	3		2.993	0.125	12	0.01043		2.902
MVZC22CG	C	3		3.129	0.125	12	0.01040		3.023

Average	**31.455**	**3.057**	**$Average_{norm}$**	**0.01045**	**30.521**	**2.970**
Standard Dev.	**3.547**	**0.062**	**$Standard\ Dev._{norm}$**		**3.294**	**0.064**
Coeff. of Var. [%]	**11.277**	**2.038**	**$Coeff.\ of\ Var.\ [\%]_{norm}$**		**10.792**	**2.162**
Min.	**25.822**	**2.989**	**Min.**	**0.0103**	**25.402**	**2.894**
Max.	**37.212**	**3.131**	**Max.**	**0.0106**	**35.887**	**3.056**
Number of Spec.	**18**	**6**	**Number of Spec.**		**18**	**6**

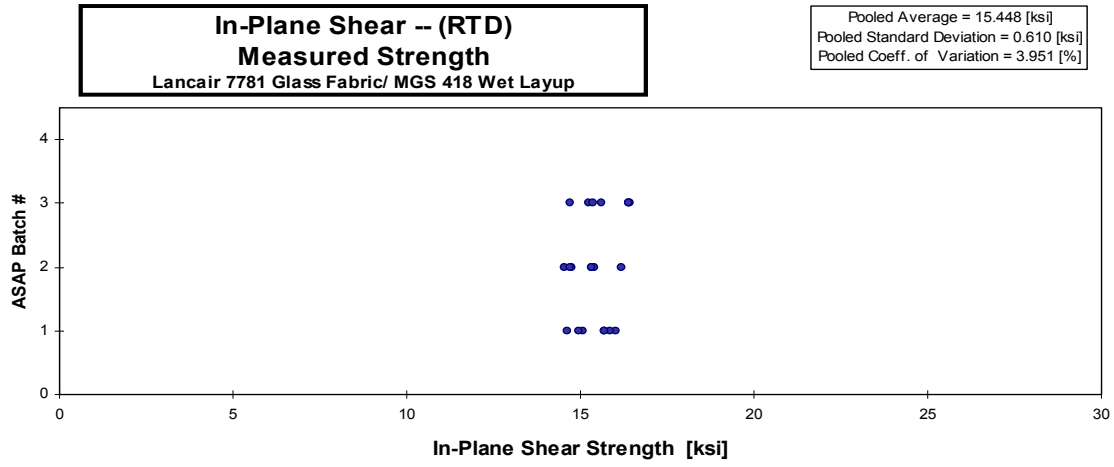


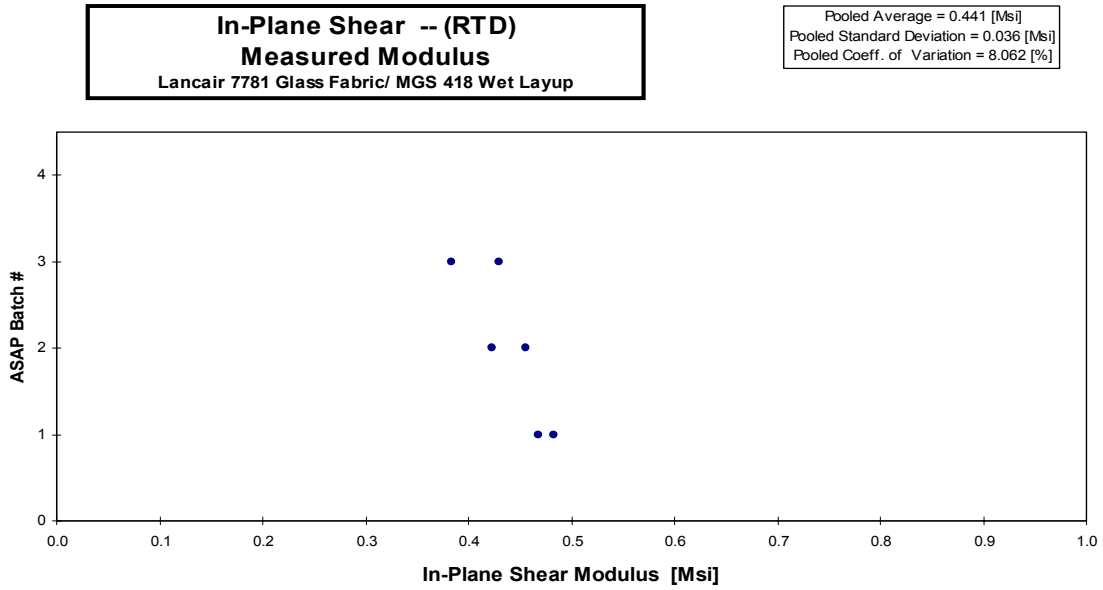


In-Plane Shear -- (RTD)
Strength & Modulus
Lancair 7781 Glass Fabric/ MGS 418 Wet Layup

Specimen Number	Panel Batch #	ASAP Batch #	Strength [ksi]	Modulus [Msi]	Avg. Specimen Thickn. [in]	# Plies in Laminate	Avg. t_{ply} [in]
MVNA129A	A	1	14.612	0.482	0.127	12	0.01060
MVNA12AA	A	1	15.070	0.467	0.128	12	0.01063
MVNA12BA	A	1	14.954		0.126	12	0.01053
MVNA12CA	A	1	16.024		0.127	12	0.01056
MVNA12DA	A	1	15.849		0.127	12	0.01060
MVNA12EA	A	1	15.694		0.127	12	0.01062
MVNA12FA	A	1	15.687		0.127	12	0.01059
MVNB129A	B	2	15.316	0.424	0.130	12	0.01083
MVNB12AA	B	2	16.198	0.456	0.129	12	0.01077
MVNB12BA	B	2	14.564		0.129	12	0.01074
MVNB12CA	B	2	15.427		0.130	12	0.01083
MVNB12DA	B	2	14.744		0.128	12	0.01066
MVNB12EA	B	2	14.729		0.129	12	0.01072
MVNB12FA	B	2	15.333		0.129	12	0.01072
MVNC119A	C	3	14.720	0.430	0.124	12	0.01035
MVNC11AA	C	3	15.614	0.384	0.124	12	0.01035
MVNC11BA	C	3	15.253		0.124	12	0.01031
MVNC11CA	C	3	16.422		0.124	12	0.01030
MVNC11DA	C	3	16.404		0.124	12	0.01037
MVNC11EA	C	3	15.388		0.124	12	0.01035
MVNC11FA	C	3	16.401		0.124	12	0.01035

Average	**15.448**	**0.441**		**0.0106**
Standard Dev.	**0.610**	**0.036**		
Coeff. of Var. [%]	**3.951**	**8.062**		
Min.	**14.564**	**0.384**	**Min.**	**0.0103**
Max.	**16.422**	**0.482**	**Max.**	**0.0108**
Number of Spec.	**21**	**6**		





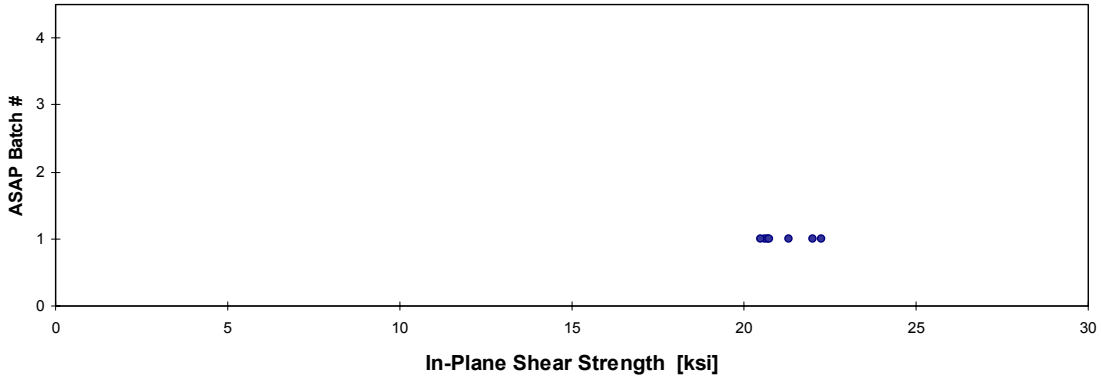
In-Plane Shear -- (CTD)
Strength & Modulus
Lancair 7781 Glass Fabric/ MGS 418 Wet Layup

Specimen Number	Panel Batch #	ASAP Batch #	Strength [ksi]	Modulus [Msi]	Avg. Specimen Thickn. [in]	# Plies in Laminate	Avg. t_{ply} [in]
MVNB132B	B	1	21.322	0.615	0.126	12	0.01051
MVNB133B	B	1	20.677	0.637	0.126	12	0.01048
MVNB134B	B	1	20.608		0.128	12	0.01069
MVNB135B	B	1	20.511		0.126	12	0.01052
MVNB136B	B	1	22.237		0.127	12	0.01056
MVNB137B	B	1	22.026		0.128	12	0.01064
MVNB138B	B	1	20.751		0.127	12	0.01059

Average	**21.162**	**0.626**		**0.0106**
Standard Dev.	**0.714**	**0.015**		
Coeff. of Var. [%]	**3.376**	**2.471**		
Min.	**20.511**	**0.615**	**Min.**	**0.0105**
Max.	**22.237**	**0.637**	**Max.**	**0.0107**
Number of Spec.	**7**	**2**		

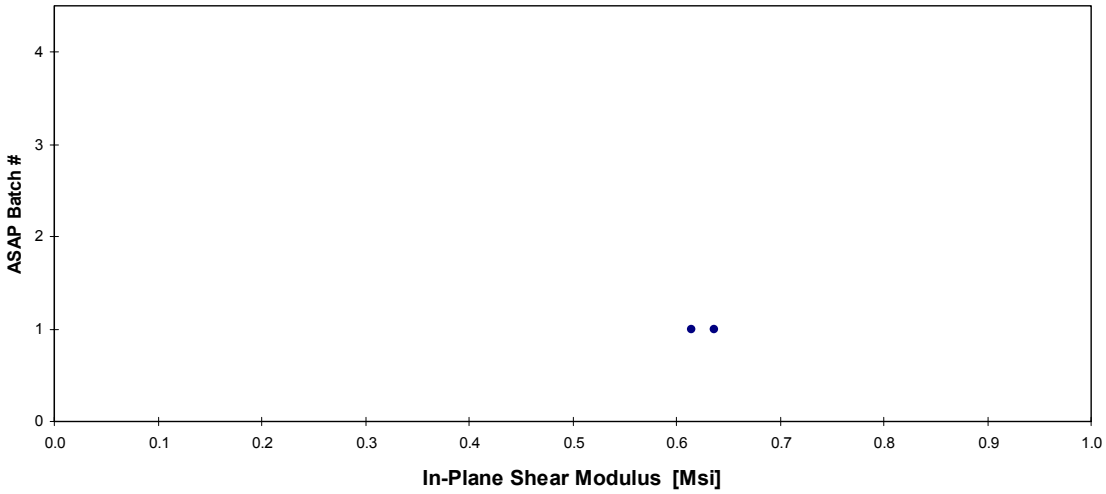
In-Plane Shear -- (CTD)
Measured Strength
Lancair 7781 Glass Fabric/ MGS 418 Wet Layup

Pooled Average = 21.162 [ksi]
Pooled Standard Deviation = 0.714 [ksi]
Pooled Coeff. of Variation = 3.376 [%]



In-Plane Shear -- (CTD)
Measured Modulus
Lancair 7781 Glass Fabric/ MGS 418 Wet Layup

Pooled Average = 0.626 [Msi]
Pooled Standard Deviation = 0.015 [Msi]
Pooled Coeff. of Variation = 2.471 [%]

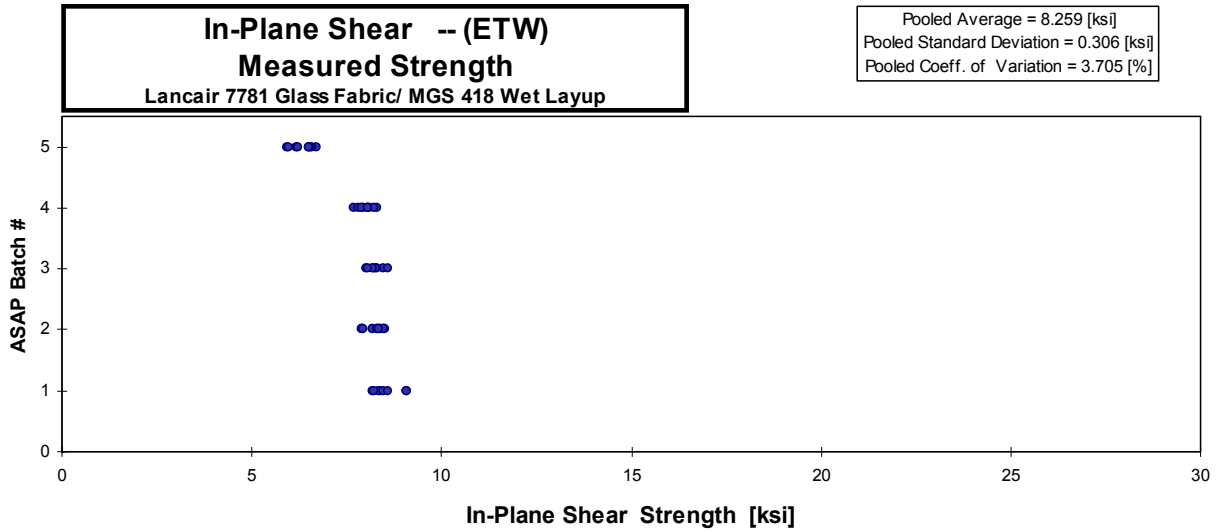


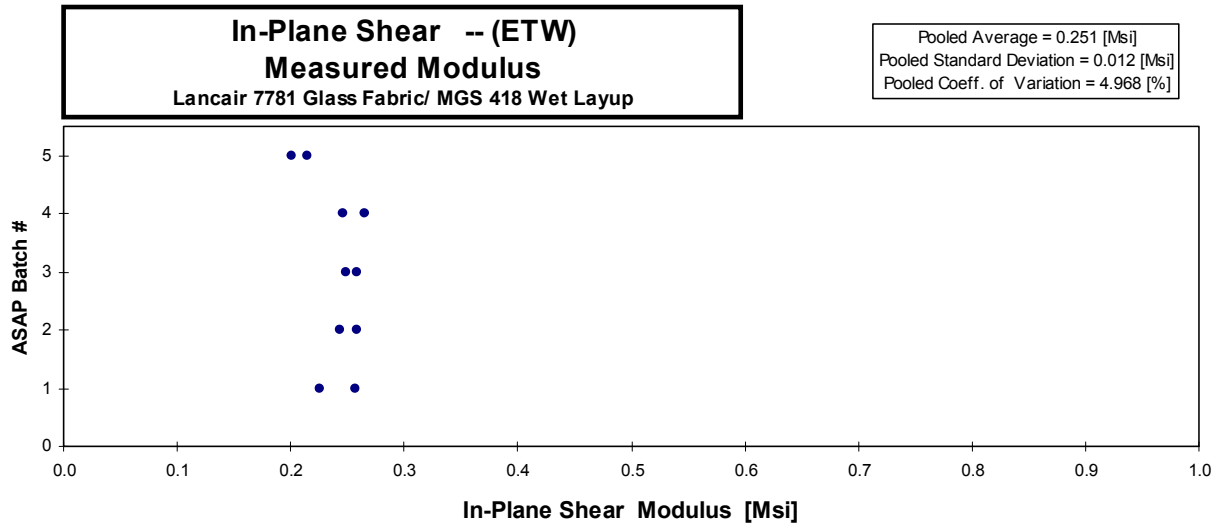
In-Plane Shear -- (ETW)
Strength & Modulus
Lancair 7781 Glass Fabric/ MGS 418 Wet Layup

Specimen Number	Panel Batch #	ASAP Batch #	Strength [ksi]	Modulus [Msi]	Avg. Specimen Thickn. [in]	# Plies in Laminate	Avg. t_{ply} [in]
MVNA121F	A	1	8.383	0.258	0.128	12	0.01065
MVNA122F	A	1	8.348	0.226	0.126	12	0.01051
MVNA123F	A	1	9.067		0.127	12	0.01060
MVNA124F	A	1	9.073		0.127	12	0.01059
MVNA125F	A	1	8.490		0.126	12	0.01049
MVNA126F	A	1	8.167		0.128	12	0.01064
MVNA127F	A	1	8.209		0.127	12	0.01060
MVNA128F	A	1	8.575		0.126	12	0.01046
MVNB121F	B	2	8.527	0.258	0.129	12	0.01074
MVNB122F	B	2	8.191	0.244	0.130	12	0.01087
MVNB123F	B	2	8.372		0.129	12	0.01074
MVNB124F	B	2	8.455		0.130	12	0.01080
MVNB125F	B	2	7.919		0.128	12	0.01065
MVNB126F	B	2	8.307		0.128	12	0.01070
MVNB127F	B	2	7.934		0.128	12	0.01063
MVNB128F	B	2	8.354		0.129	12	0.01072
MVNC111F	C	3	8.468	0.249	0.124	12	0.01032
MVNC112F	C	3	8.314	0.259	0.124	12	0.01036
MVNC113F	C	3	8.579		0.125	12	0.01039
MVNC114F	C	3	8.243		0.125	12	0.01041
MVNC115F	C	3	8.248		0.124	12	0.01032
MVNC116F	C	3	8.005		0.125	12	0.01039
MVNC117F	C	3	8.174		0.125	12	0.01043
MVNC118F	C	3	8.064		0.124	12	0.01034
MVND111F	D	4	8.091	0.266	0.150	12	0.01246
MVND112F	D	4	7.706	0.246	0.149	12	0.01243
MVND113F	D	4	8.314		0.150	12	0.01246
MVND114F	D	4	8.215		0.151	12	0.01255
MVND115F	D	4	7.934		0.148	12	0.01233
MVND116F	D	4	8.044		0.149	12	0.01244
MVND117F	D	4	7.799		0.149	12	0.01243
MVND118F	D	4	7.885		0.149	12	0.01244
MVND119F	D	4	8.082		0.150	12	0.01246
MVNE111F*	E	5	6.191	0.215	0.137	12	0.01138
MVNE112F*	E	5	6.703	0.201	0.135	12	0.01123
MVNE113F*	E	5	6.226		0.135	12	0.01121
MVNE114F*	E	5	5.926		0.135	12	0.01128
MVNE115F*	E	5	6.596		0.132	12	0.01103
MVNE116F*	E	5	6.553		0.133	12	0.01106
MVNE117F*	E	5	6.511		0.134	12	0.01114
MVNE118F*	E	5	5.977		0.136	12	0.01133
MVNE119F*	E	5	6.526		0.133	12	0.01108

*Batch E results are not included in the final totals

Average	**8.259**	**0.251**		**0.0111**
Standard Dev.	**0.306**	**0.012**		
Coeff. of Var. [%]	**3.705**	**4.968**		
Min.	**7.706**	**0.226**	**Min.**	**0.0103**
Max.	**9.073**	**0.266**	**Max.**	**0.0126**
Number of Spec.	**33**	**8**		

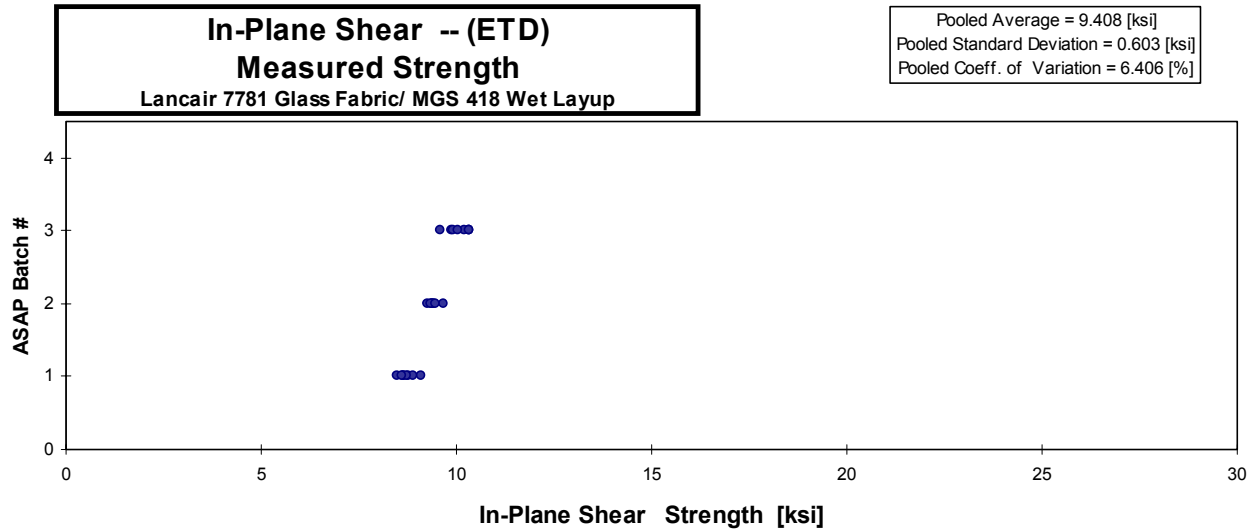


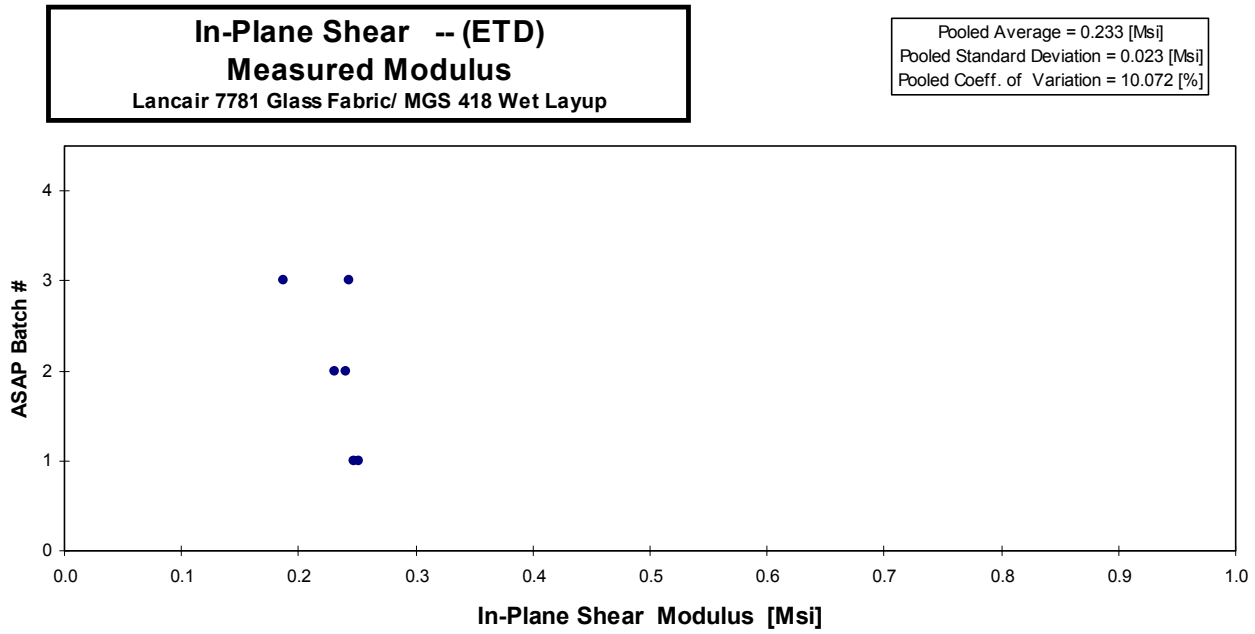


In-Plane Shear -- (ETD)
Strength & Modulus
Lancair 7781 Glass Fabric/ MGS 418 Wet Layup

Specimen Number	Panel Batch #	ASAP Batch #	Strength [ksi]	Modulus [Msi]	Avg. Specimen Thickn. [in]	# Plies in Laminate	Avg. t_{ply} [in]
MVNA112G	A	1	9.107	0.252	0.129	12	0.01073
MVNA117G	A	1	8.643	0.247	0.129	12	0.01075
MVNA118G	A	1	8.466		0.129	12	0.01071
MVNA11AG	A	1	8.780		0.129	12	0.01072
MVNA11BG	A	1	8.883		0.129	12	0.01071
MVNA11DG	A	1	8.661		0.129	12	0.01074
MVNA11HG	A	1	8.746		0.129	12	0.01072
MVNA11IG	A	1	8.616		0.127	12	0.01058
MVNB139G	B	2	9.440	0.230	0.127	12	0.01058
MVNB13AG	B	2	9.681	0.240	0.127	12	0.01062
MVNB13BG	B	2	9.367		0.129	12	0.01071
MVNB13CG	B	2	9.243		0.130	12	0.01079
MVNB13DG	B	2	9.393		0.129	12	0.01072
MVNB13EG	B	2	9.340		0.128	12	0.01069
MVNB13FG	B	2	9.459		0.126	12	0.01054
MVNC121G	C	3	10.317	0.188	0.123	12	0.01028
MVNC122G	C	3	9.887	0.243	0.125	12	0.01040
MVNC123G	C	3	10.320		0.124	12	0.01037
MVNC124G	C	3	10.212		0.124	12	0.01037
MVNC125G	C	3	9.901		0.125	12	0.01040
MVNC126G	C	3	9.582		0.125	12	0.01038
MVNC127G	C	3	10.021		0.124	12	0.01035
MVNC128G	C	3	10.324		0.124	12	0.01037

Average	**9.408**	**0.233**			**0.0106**
Standard Dev.	**0.603**	**0.023**			
Coeff. of Var. [%]	**6.406**	**10.072**			
Min.	**8.466**	**0.188**		**Min.**	**0.0103**
Max.	**10.324**	**0.252**		**Max.**	**0.0108**
Number of Spec.	**23**	**6**			



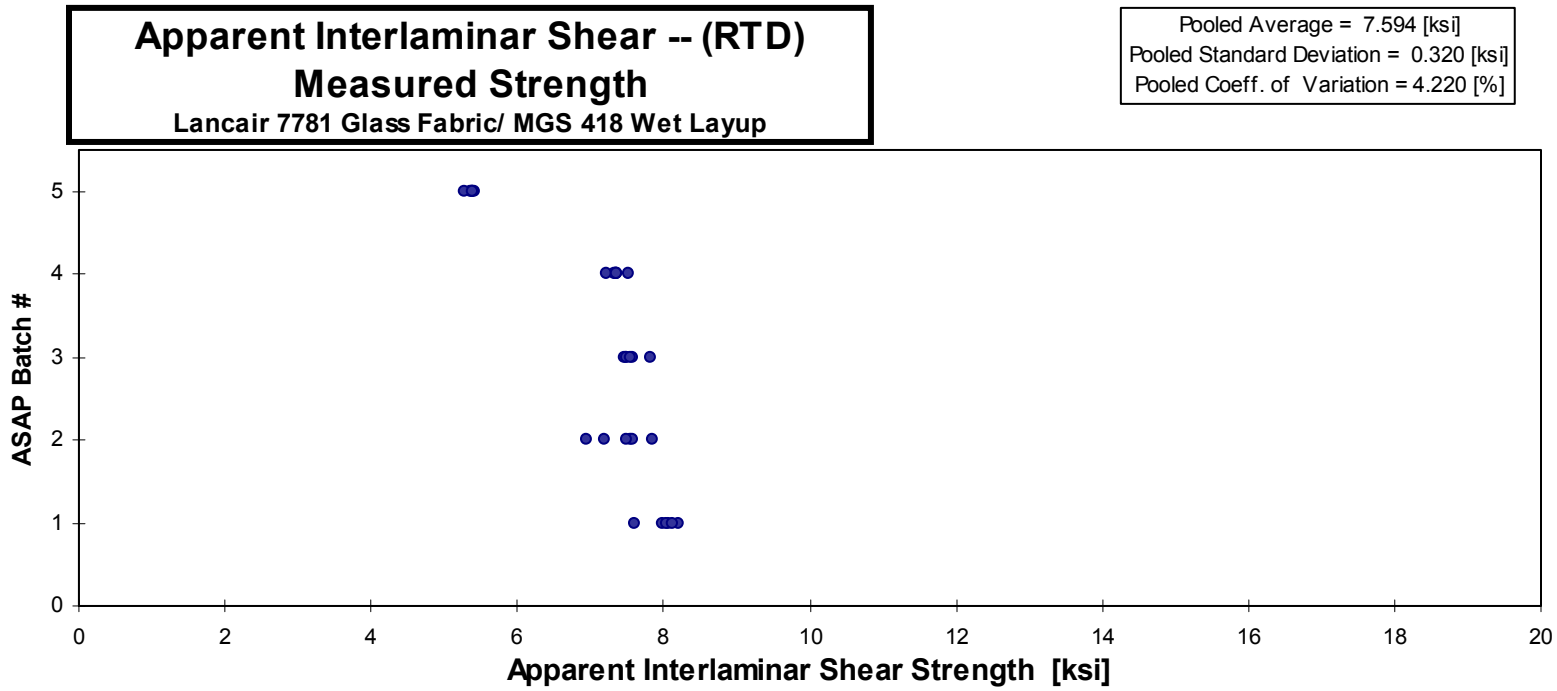


Apparent Interlaminar Shear -- (RTD)
Strength & Modulus
Lancair 7781 Glass Fabric/ MGS 418 Wet Layup

Specimen Number	Panel Batch #	ASAP Batch #	Strength [ksi]	Avg. Specimen Thickn. [in]	# Plies in Laminate	Avg. t_{ply} [in]
MVQA143A	A	1	7.990	0.126	12	0.01046
MVQA144A	A	1	8.210	0.125	12	0.01045
MVQA145A	A	1	8.066	0.125	12	0.01042
MVQA146A	A	1	7.594	0.125	12	0.01043
MVQA147A	A	1	8.048	0.125	12	0.01044
MVQA148A	A	1	8.138	0.125	12	0.01043
MVQB141A	B	2	7.856	0.125	12	0.01039
MVQB142A	B	2	7.539	0.125	12	0.01041
MVQB143A	B	2	7.571	0.125	12	0.01043
MVQB144A	B	2	7.492	0.124	12	0.01034
MVQB145A	B	2	6.956	0.123	12	0.01028
MVQB146A	B	2	7.208	0.124	12	0.01036
MVQC141A	C	3	7.571	0.126	12	0.01049
MVQC142A	C	3	7.485	0.126	12	0.01049
MVQC143A	C	3	7.482	0.126	12	0.01049
MVQC144A	C	3	7.823	0.124	12	0.01036
MVQC145A	C	3	7.488	0.125	12	0.01044
MVQC146A	C	3	7.562	0.125	12	0.01044
MVQD145A	D	4	7.342	0.150	12	0.01254
MVQD14BA	D	4	7.370	0.149	12	0.01245
MVQD14DA	D	4	7.352	0.150	12	0.01252
MVQD14FA	D	4	7.210	0.149	12	0.01239
MVQD14GA	D	4	7.528	0.149	12	0.01238
MVQD14HA	D	4	7.371	0.149	12	0.01244
MVQE141A*	E	5	5.366	0.133	12	0.01106
MVQE142A*	E	5	5.410	0.128	12	0.01067
MVQE143A*	E	5	5.396	0.132	12	0.01102
MVQE144A*	E	5	5.385	0.129	12	0.01078
MVQE145A*	E	5	5.282	0.124	12	0.01034
MVQE147A*	E	5	5.398	0.134	12	0.01114

*Batch E results are not included in the final totals

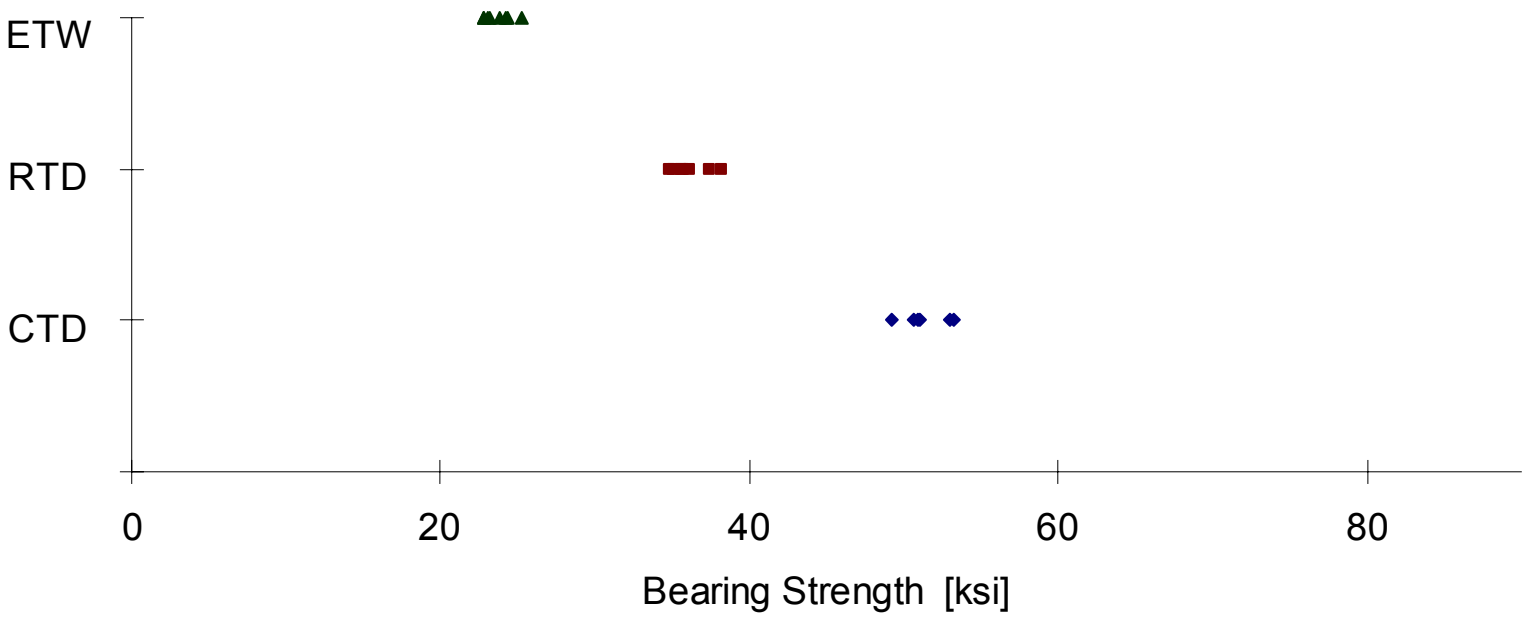
Average	**7.594**		**0.0109**
Standard Dev.	**0.320**		
Coeff. of Var. [%]	**4.220**		
Min.	**6.956**	**Min.**	**0.0103**
Max.	**8.210**	**Max.**	**0.0125**
Number of Spec.	**24**		



Bearing Strength
$[45/0/45]_s$ t=0.060" ,d=0.1875"
Lancair 7781 Glass Fabric/ MGS 418 Wet Layup

Condition	Specimen Number	Prepreg Lot #	Strength [ksi]	Avg. Specimen Thickn. [in]	# Plies in laminate	Avg. tply [in]		
CTD	MV1B121B	B	50.945	0.061	6	0.01013	51.318	Average
	MV1B123B	B	51.051	0.061	6	0.01013	1.497	Standard Dev.
	MV1B124B	B	52.926	0.061	6	0.01011	2.918	Coeff. of Var. [%]
	MV1B125B	B	50.574	0.061	6	0.01013	49.228	Min.
	MV1B126B	B	53.187	0.061	6	0.01010	53.187	Max.
	MV1B127B	B	49.228	0.061	6	0.01009	6	Number of Spec.
RTD	MV1B111A	B	38.139	0.064	6	0.01066		
	MV1B112A	B	35.063	0.060	6	0.00998	36.118	Average
	MV1B115A	B	36.074	0.060	6	0.01000	1.210	Standard Dev.
	MV1B116A	B	35.745	0.060	6	0.00999	3.351	Coeff. of Var. [%]
	MV1B117A	B	35.556	0.060	6	0.01008	34.872	Min.
	MV1B118A	B	37.376	0.060	6	0.00993	38.139	Max.
	MV1B119A	B	34.872	0.060	6	0.01006	7	Number of Spec.
ETW	MV1B211F	B	25.232	0.060	6	0.00994		
	MV1B212F	B	22.747	0.060	6	0.00995		
	MV1B213F	B	23.079	0.059	6	0.00989	23.666	Average
	MV1B214F	B	23.881	0.059	6	0.00988	0.881	Standard Dev.
	MV1B215F	B	24.180	0.062	6	0.01037	3.723	Coeff. of Var. [%]
	MV1B216F	B	24.291	0.060	6	0.00992	22.746	Min.
	MV1B217F	B	23.173	0.059	6	0.00988	25.232	Max.
	MV1B218F	B	22.746	0.060	6	0.00995	8	Number of Spec.

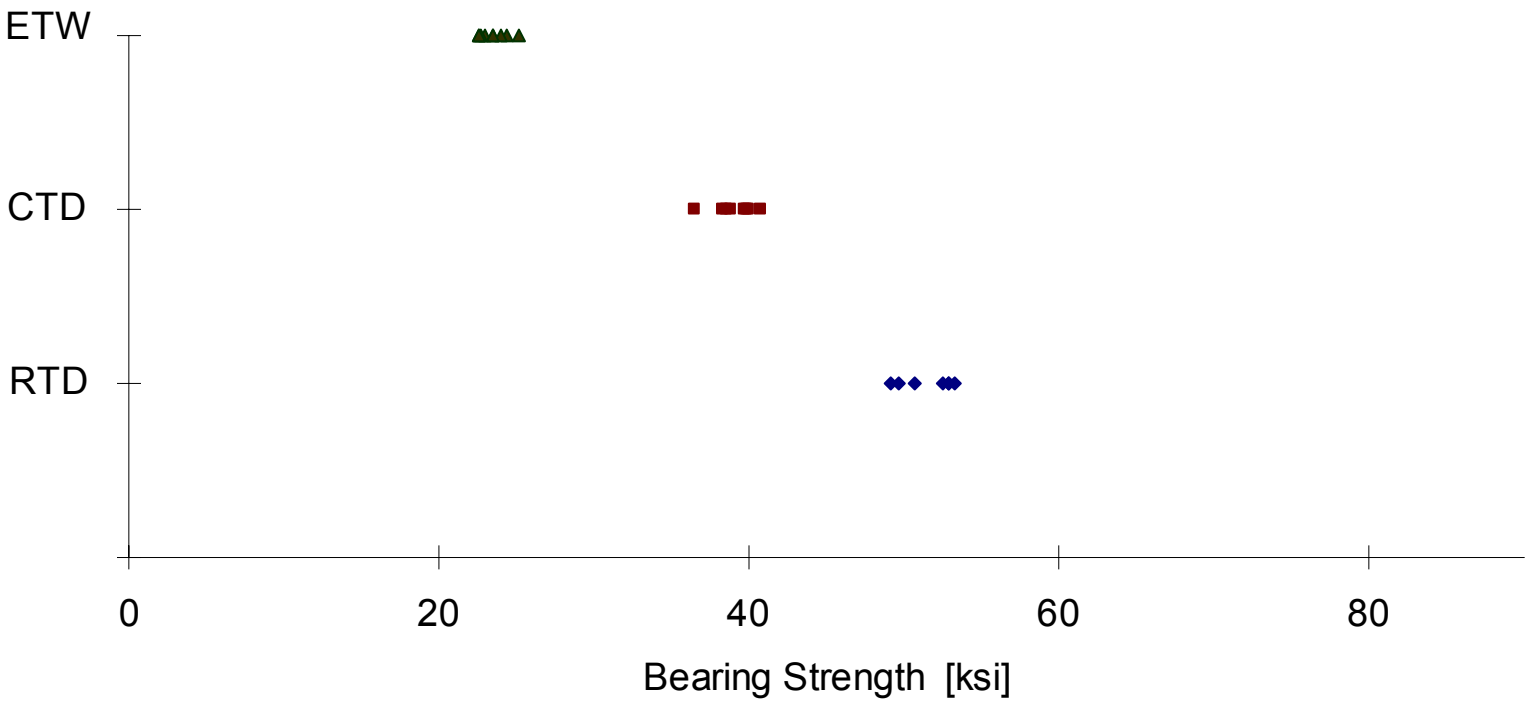
Bearing Strength
[45/0/45]s t=0.060" ,d=0.1875"
Lancair 7781 Glass Fabric/ MGS 418 Wet Layup



Bearing Strength
$[45/0/45]_s$ t=0.060" ,d=0.250"
Lancair 7781 Glass Fabric/ MGS 418 Wet Layup

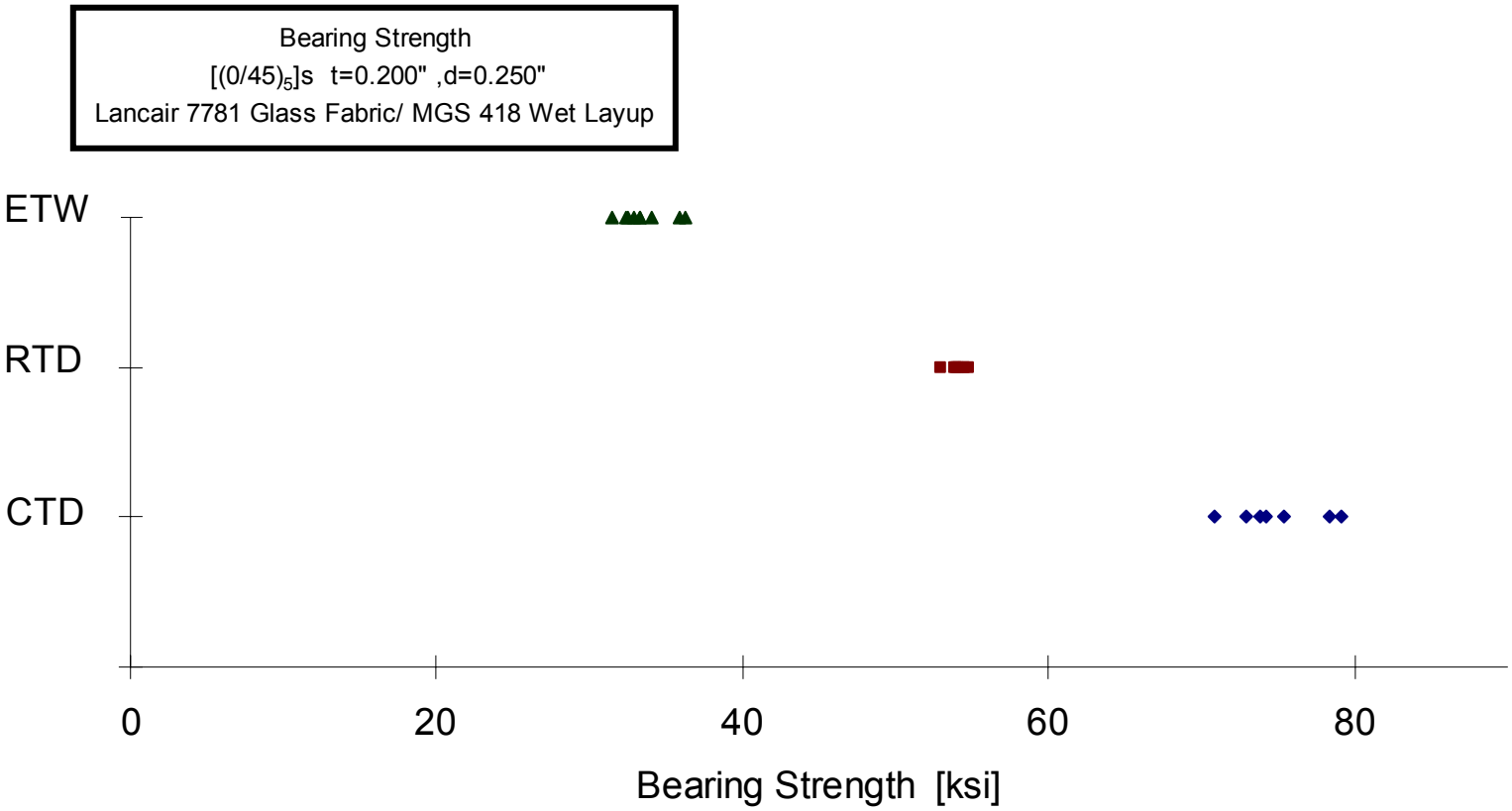
Condition	Specimen Number	Prepreg Lot #	Strength [ksi]	Avg. Specimen Thickn. [in]	# Plies in laminate	Avg. tply [in]		
CTD	MV2B111B	B	50.688	0.059	6	0.00986		
	MV2B112B	B	52.439	0.060	6	0.00994	51.555	**Average**
	MV2B114B	B	53.227	0.060	6	0.00993	1.696	**Standard Dev.**
	MV2B115B	B	52.820	0.059	6	0.00990	3.290	**Coeff. of Var. [%]**
	MV2B116B	B	52.927	0.062	6	0.01027	49.155	**Min.**
	MV2B117B	B	49.155	0.059	6	0.00986	53.227	**Max.**
	MV2B118B	B	49.632	0.059	6	0.00986	7	**Number of Spec.**
RTD	MV2B121A	B	39.881	0.059	6	0.00988		
	MV2B122A	B	39.973	0.059	6	0.00978		
	MV2B123A	B	38.570	0.060	6	0.00993	39.051	**Average**
	MV2B124A	B	38.821	0.060	6	0.00995	1.310	**Standard Dev.**
	MV2B126A	B	36.517	0.059	6	0.00990	3.353	**Coeff. of Var. [%]**
	MV2B127A	B	39.664	0.059	6	0.00989	36.517	**Min.**
	MV2B128A	B	40.715	0.060	6	0.00993	40.715	**Max.**
	MV2B129A	B	38.264	0.059	6	0.00990	8	**Number of Spec.**
ETW	MV2B221F	B	25.116	0.060	6	0.01001		
	MV2B222F	B	22.969	0.060	6	0.01008		
	MV2B223F	B	24.384	0.060	6	0.01007		
	MV2B224F	B	23.412	0.061	6	0.01012	23.465	**Average**
	MV2B225F	B	22.524	0.061	6	0.01020	0.888	**Standard Dev.**
	MV2B226F	B	23.979	0.060	6	0.01008	3.786	**Coeff. of Var. [%]**
	MV2B227F	B	22.737	0.061	6	0.01008	22.524	**Min.**
	MV2B228F	B	23.500	0.060	6	0.01008	25.116	**Max.**
	MV2B229F	B	22.564	0.061	6	0.01010	9	**Number of Spec.**

Bearing Strength
[45/0/45]s t=0.060" ,d=0.250"
Lancair 7781 Glass Fabric/ MGS 418 Wet Layup



Bearing Strength
$[(0/45)_5]_s$ t=0.200" ,d=0.250"
Lancair 7781 Glass Fabric/ MGS 418 Wet Layup

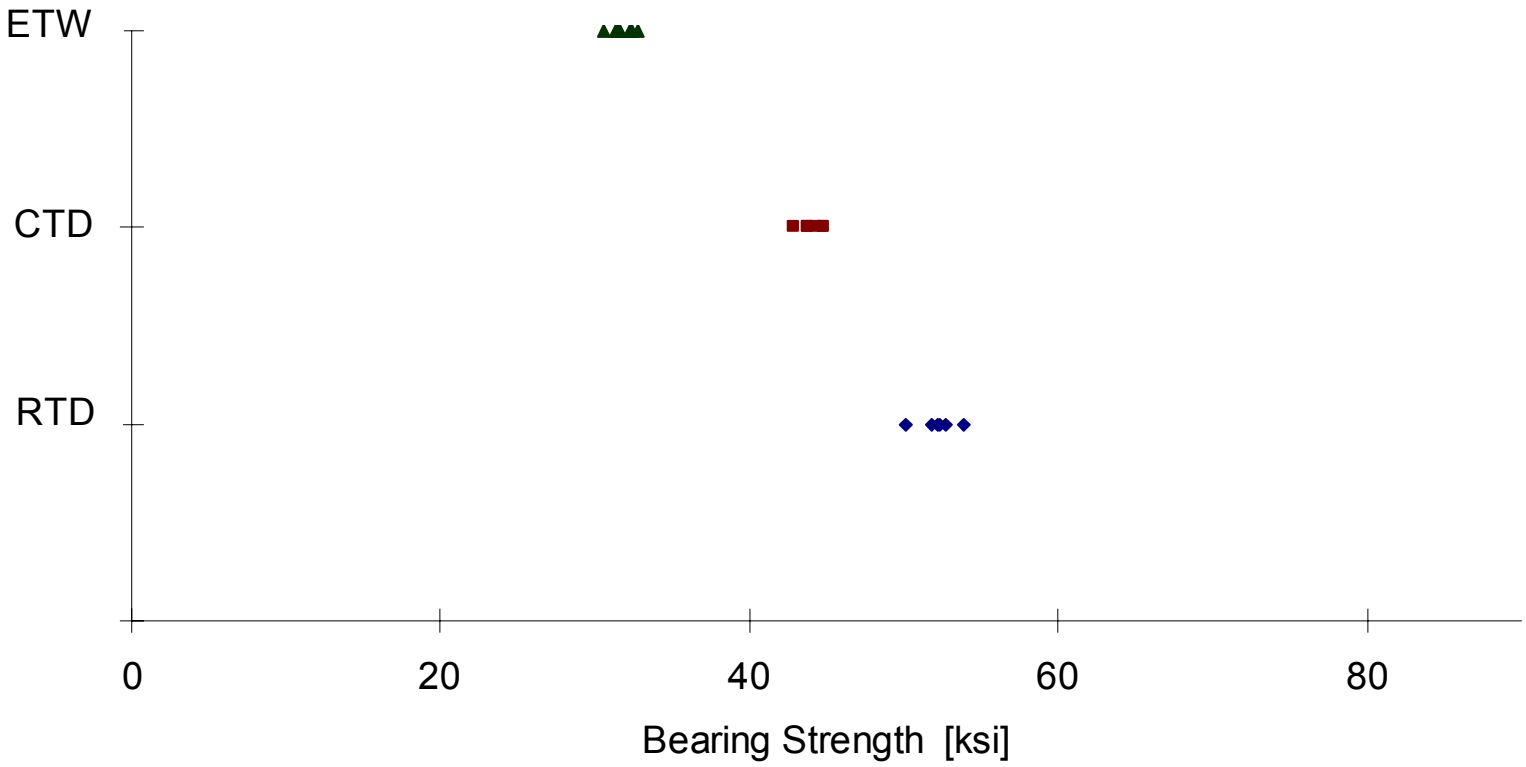
Condition	Specimen Number	Prepreg Lot #	Strength [ksi]	Avg. Specimen Thickn. [in]	# Plies in laminate	Avg. tply [in]		
CTD	MV3B111B	B	73.830	0.210	20	0.01048		
	MV3B112B	B	78.407	0.210	20	0.01049	74.961	Average
	MV3B113B	B	74.244	0.210	20	0.01051	2.959	Standard Dev.
	MV3B114B	B	79.152	0.211	20	0.01056	3.947	Coeff. of Var. [%]
	MV3B115B	B	75.315	0.211	20	0.01054	70.818	Min.
	MV3B116B	B	72.962	0.210	20	0.01049	79.152	Max.
	MV3B117B	B	70.818	0.209	20	0.01044	7	Number of Spec.
RTD	MV3B221A	B	53.829	0.211	20	0.01054	54.053	Average
	MV3B222A	B	54.473	0.211	20	0.01057	0.622	Standard Dev.
	MV3B223A	B	54.830	0.210	20	0.01050	1.151	Coeff. of Var. [%]
	MV3B224A	B	53.988	0.211	20	0.01055	53.012	Min.
	MV3B225A	B	53.012	0.214	20	0.01071	54.830	Max.
	MV3B226A	B	54.184	0.209	20	0.01047	6	Number of Spec.
ETW	MV3B211F	B	32.870	0.209	20	0.01046		
	MV3B212F	B	32.513	0.210	20	0.01048		
	MV3B213F	B	31.494	0.212	20	0.01060		
	MV3B214F	B	32.338	0.210	20	0.01048	33.558	Average
	MV3B215F	B	33.321	0.209	20	0.01047	1.605	Standard Dev.
	MV3B216F	B	34.095	0.210	20	0.01051	4.783	Coeff. of Var. [%]
	MV3B217F	B	33.229	0.209	20	0.01046	31.494	Min.
	MV3B218F	B	35.858	0.209	20	0.01047	36.306	Max.
	MV3B219F	B	36.306	0.209	20	0.01046	9	Number of Spec.



Bearing Strength
$[(0/45)_5]_s$ t=0.200" ,d=0.375"
Lancair7781 Glass Fabric/ MGS 418 Wet Layup

Condition	Specimen Number	Prepreg Lot #	Strength [ksi]	Avg. Specimen Thickn. [in]	# Plies in laminate	Avg. tply [in]		
CTD	MV4B211B	B	53.838	0.211	20	0.01053	52.167	Average
	MV4B212B	B	52.751	0.210	20	0.01049	1.226	Standard Dev.
	MV4B213B	B	51.815	0.211	20	0.01057	2.349	Coeff. of Var. [%]
	MV4B214B	B	52.189	0.212	20	0.01059	50.109	Min.
	MV4B223B	B	52.301	0.210	20	0.01048	53.838	Max.
	MV4B225B	B	50.109	0.209	20	0.01045	6	Number of Spec.
RTD	MV4B111A	B	42.914	0.214	20	0.01070	44.056	Average
	MV4B112A	B	44.833	0.210	20	0.01050	0.750	Standard Dev.
	MV4B113A	B	43.730	0.210	20	0.01048	1.703	Coeff. of Var. [%]
	MV4B114A	B	44.859	0.209	20	0.01046	42.914	Min.
	MV4B115A	B	44.270	0.210	20	0.01051	44.859	Max.
	MV4B116A	B	43.727	0.211	20	0.01054	6	Number of Spec.
ETW	MV4B121F	B	31.426	0.211	20	0.01056		
	MV4B122F	B	32.187	0.210	20	0.01052		
	MV4B123F	B	31.306	0.209	20	0.01047		
	MV4B124F	B	32.417	0.209	20	0.01043	31.713	Average
	MV4B125F	B	30.625	0.209	20	0.01043	0.643	Standard Dev.
	MV4B126F	B	31.441	0.209	20	0.01043	2.028	Coeff. of Var. [%]
	MV4B127F	B	32.747	0.209	20	0.01044	30.625	Min.
	MV4B128F	B	31.629	0.209	20	0.01045	32.747	Max.
	MV4B129F	B	31.636	0.208	20	0.01042	9	Number of Spec.

Bearing Strength
$[(0/45)_5]s$ t=0.200" ,d=0.375"
Lancair 7781 Glass Fabric/ MGS 418 Wet Layup



3.2.2 Fluid Sensitivity Raw Data Spreadsheets and Scatter Charts

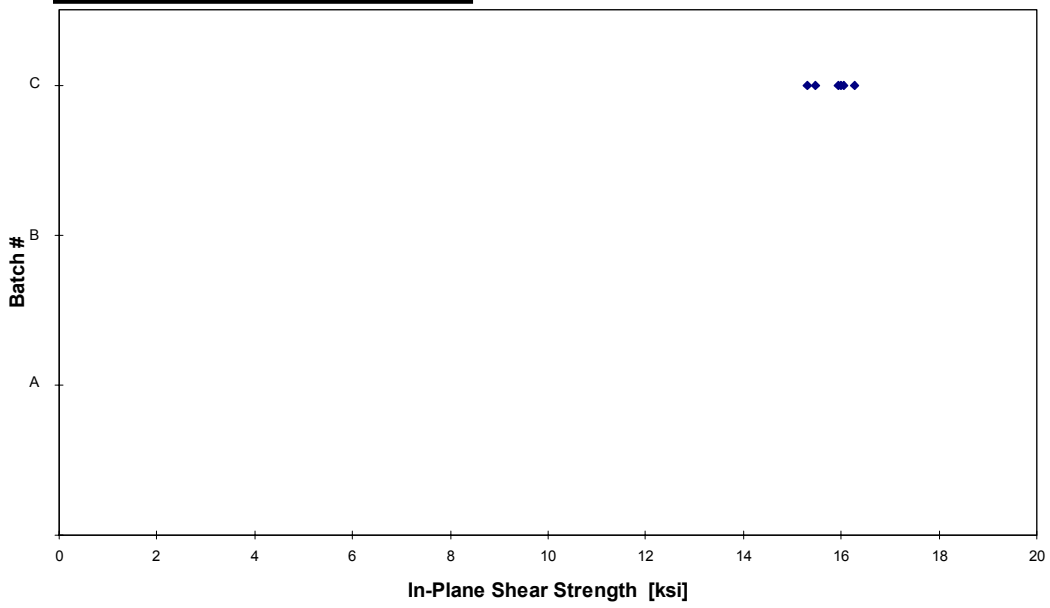
In-Plane Shear -- (MEK - RTD)
Strength & Modulus
Lancair 7781 Glass Fabric/ MGS 418 Wet Layup

Specimen Number	Batch Number	Strength [ksi]	Avg. Specimen Thickn. [in]	# Plies in Laminate	Avg. t_{ply} [in]
MVNC129T	C	15.996	0.125	12	0.01038
MVNC12AT	C	15.939	0.124	12	0.01034
MVNC12BT	C	15.462	0.124	12	0.01036
MVNC12CT	C	16.272	0.125	12	0.01043
MVNC12DT	C	15.318	0.125	12	0.01039
MVNC12ET	C	16.061	0.124	12	0.01037

Average	**15.841**		**0.0104**
Standard Dev.	**0.370**		
Coeff. of Var. [%]	**2.337**		
Min.	**15.318**	**Min.**	**0.0103**
Max.	**16.272**	**Max.**	**0.0104**
Number of Spec.	**6**		

In-Plane Shear -- (MEK - RTD)
Measured Strength
Lancair 7781 Glass Fabric/ MGS 418 Wet Layup

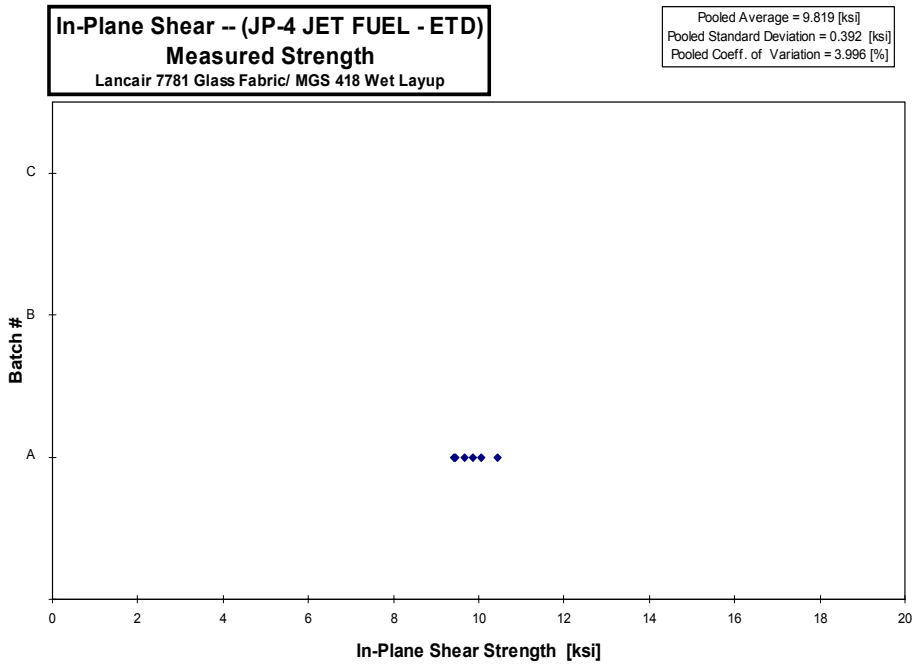
Pooled Average = 15.841 [ksi]
Pooled Standard Deviation = 0.370 [ksi]
Pooled Coeff. of Variation = 2.337 [%]



In-Plane Shear -- (JP-4 JET FUEL - ETD)
Strength & Modulus
Lancair 7781 Glass Fabric/ MGS 418 Wet Layup

Specimen Number	Batch Number	Strength [ksi]	Avg. Specimen Thickn. [in]	# Plies in Laminate	Avg. t_{ply} [in]
MVNB111R	B	10.442	0.129	12	0.01075
MVNB113R	B	10.059	0.126	12	0.01051
MVNB114R	B	9.681	0.129	12	0.01077
MVNB115R	B	9.873	0.128	12	0.01066
MVNB116R	B	9.412	0.130	12	0.01083
MVNB117R	B	9.449	0.130	12	0.01082

Average	**9.819**		**0.0107**
Standard Dev.	**0.392**		
Coeff. of Var. [%]	**3.996**		
Min.	**9.412**	**Min.**	**0.0105**
Max.	**10.442**	**Max.**	**0.0108**
Number of Spec.	**6**		



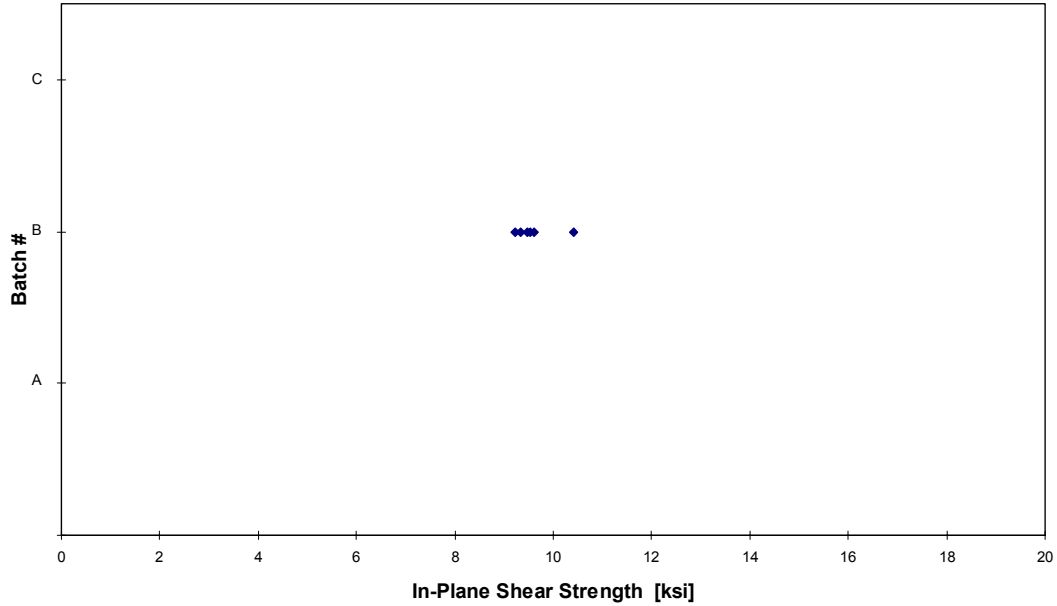
In-Plane Shear -- (Hydraulic Fluid - ETD)
Strength & Modulus
Lancair 7781 Glass Fabric/ MGS 418 Wet Layup

Specimen Number	Batch Number	Strength [ksi]	Avg. Specimen Thickn. [in]	# Plies in Laminate	Avg. t_{ply} [in]
MVNB118V	B	10.401	0.129	12	0.01075
MVNB119V	B	9.613	0.131	12	0.01094
MVNB11AV	B	9.530	0.129	12	0.01074
MVNB11BV	B	9.223	0.131	12	0.01088
MVNB11CV	B	9.323	0.130	12	0.01081
MVNB11DV	B	9.465	0.129	12	0.01075

Average	**9.592**		**0.0108**
Standard Dev.	**0.420**		
Coeff. of Var. [%]	**4.381**		
Min.	**9.223**	**Min.**	**0.0107**
Max.	**10.401**	**Max.**	**0.0109**
Number of Spec.	**6**		

In-Plane Shear -- (Hydraulic Fluid - ETD)
Measured Strength
Lancair 7781 Glass Fabric/ MGS 418 Wet Layup

Pooled Average = 9.592 [ksi]
Pooled Standard Deviation = 0.420 [ksi]
Pooled Coeff. of Variation = 4.381 [%]



Fluid Sensitivity Comparison:

Average In-Plane Shear Strength with Fluid (ksi)	**Same Environment In-Plane Shear Strength without Fluid (ksi)**	**Worst Case Environment In-Plane Shear Strength (ksi)**
MEK (RTD)	(RTD)	(ETW)
15.84	15.44	8.26

The RTD average in-plane shear strength was not reduced after exposure to MEK.

Average In-Plane Shear Strength with Fluid (ksi)	**Same Environment In-Plane Shear Strength without Fluid (ksi)**	**Worst Case Environment In-Plane Shear Strength (ksi)**
JP-4 JET FUEL (ETD)	(ETD)	(ETW)
9.82	9.41	8.26

The ETD average in-plane shear strength was not reduced after exposure to JP-4 Jet Fuel.

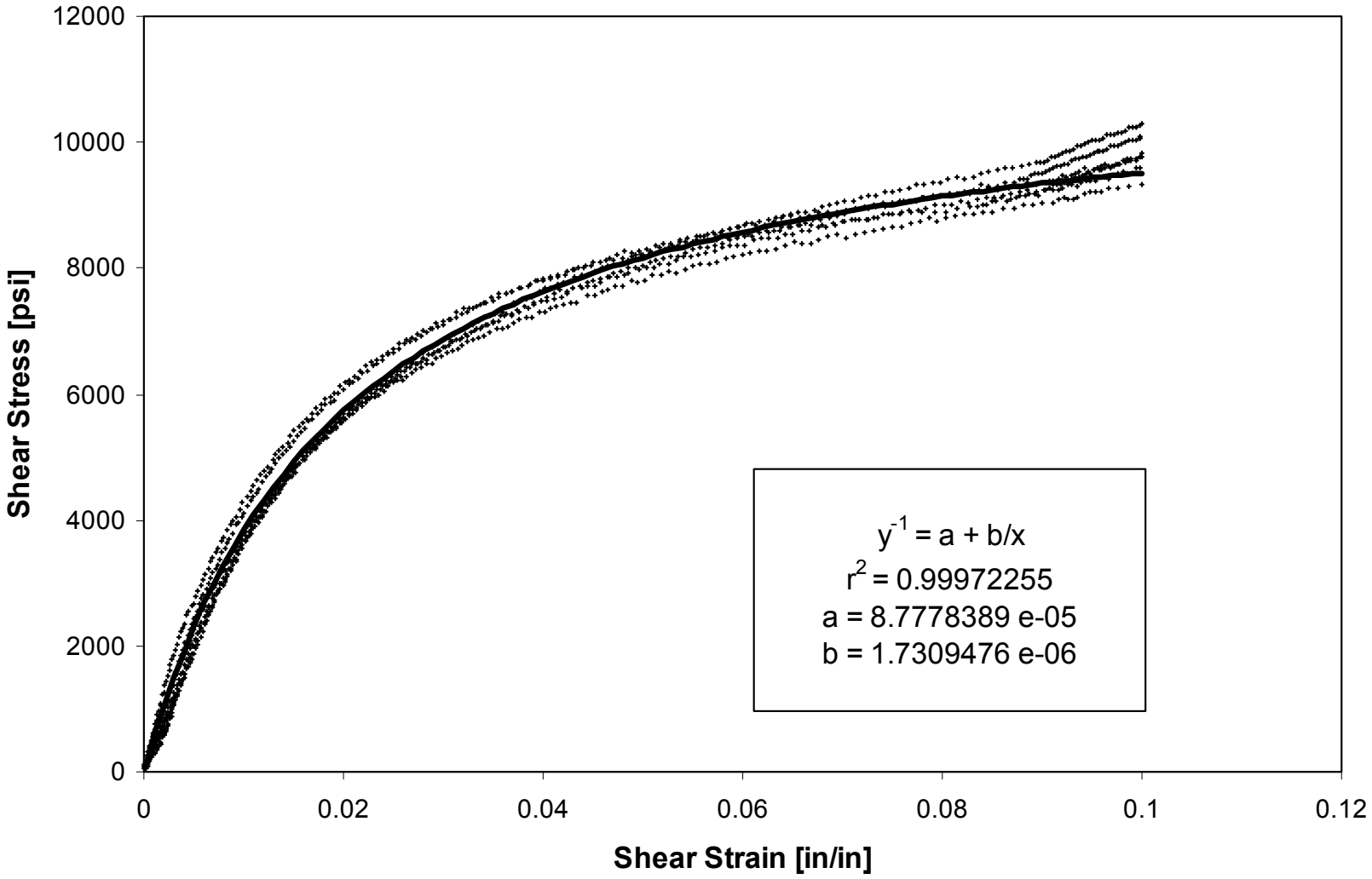
Average In-Plane Shear Strength with Fluid (ksi)	**Same Environment In-Plane Shear Strength without Fluid (ksi)**	**Worst Case Environment In-Plane Shear Strength (ksi)**
HYDRAULIC FLUID (ETD)	(ETD)	(ETW)
9.59	9.41	8.26

The ETD average in-plane shear strength was not reduced after exposure to Hydraulic Fluid.

3.2.3 Representative Shear Stress-Strain Curve

The following shear stress-strain curve is representative of the 7781 Glass / MGS 418 Wet Lay-up system. The tension and compression stress-strain curves are not presented in graphical form. If strain design allowables from these tests are required, simple one-dimensional linear stress-strain relationships may be used to obtain corresponding strain design values. This process should approximate tensile and compressive strain behavior relatively well but may produce extremely conservative strain values in shear due to the nonlinear behavior. A more realistic approach for shear strain design allowables is to use a maximum strain value of 5% (reference MIL-HDBK-17-1E, section 5.7.6). If a nonlinear analysis of the material's shear behavior is required, the curve-fit of the shear stress-strain curve may be used. The representative shear stress-strain curve was obtained by taking the average of all the sample shear curves and determining the best-fit line through the data. The actual data points also presented on the chart to demonstrate material variability.

Shear Stress vs. Shear Strain, RTD

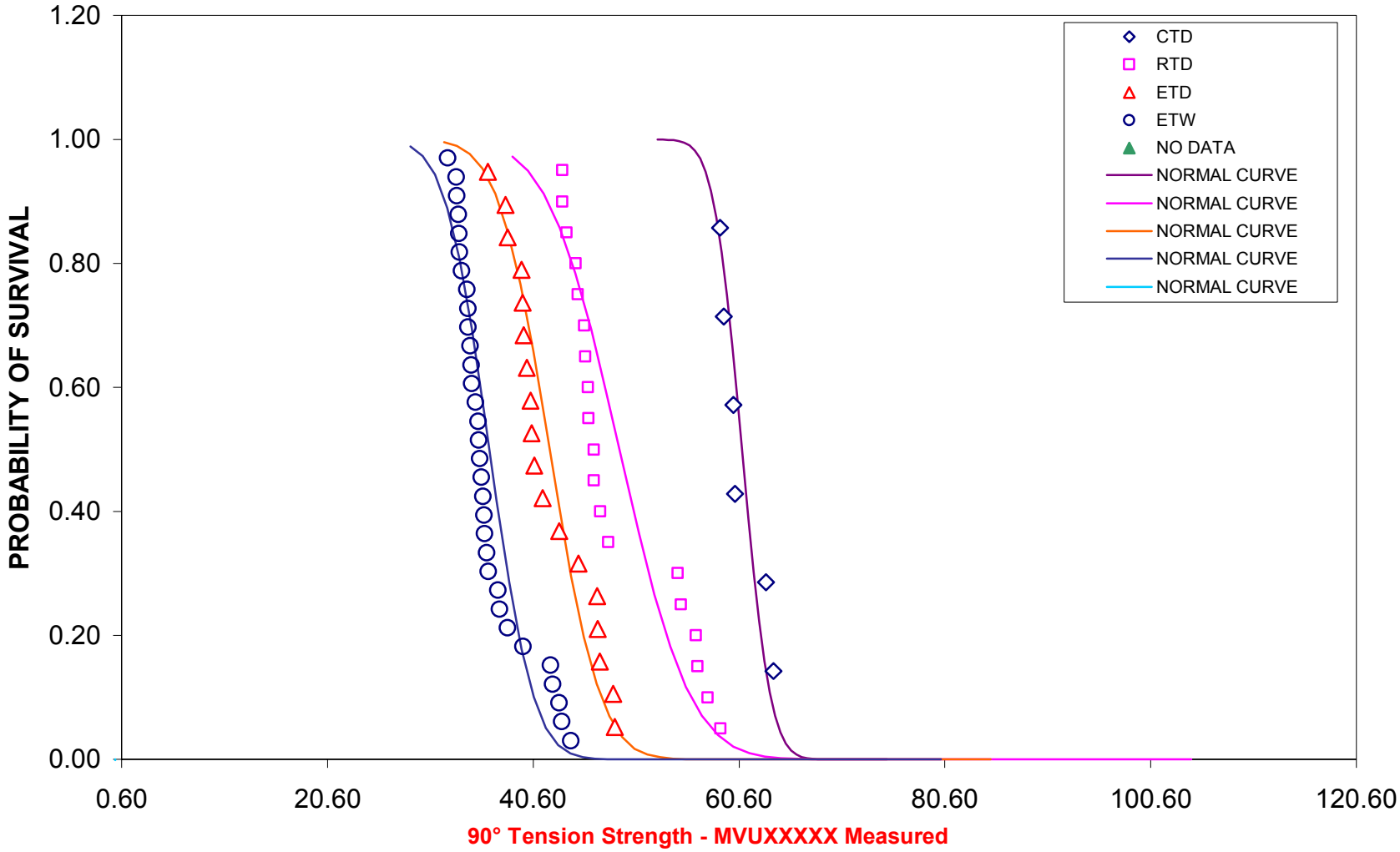


3.3 Statistical Results

3.3.1 Plot by Condition

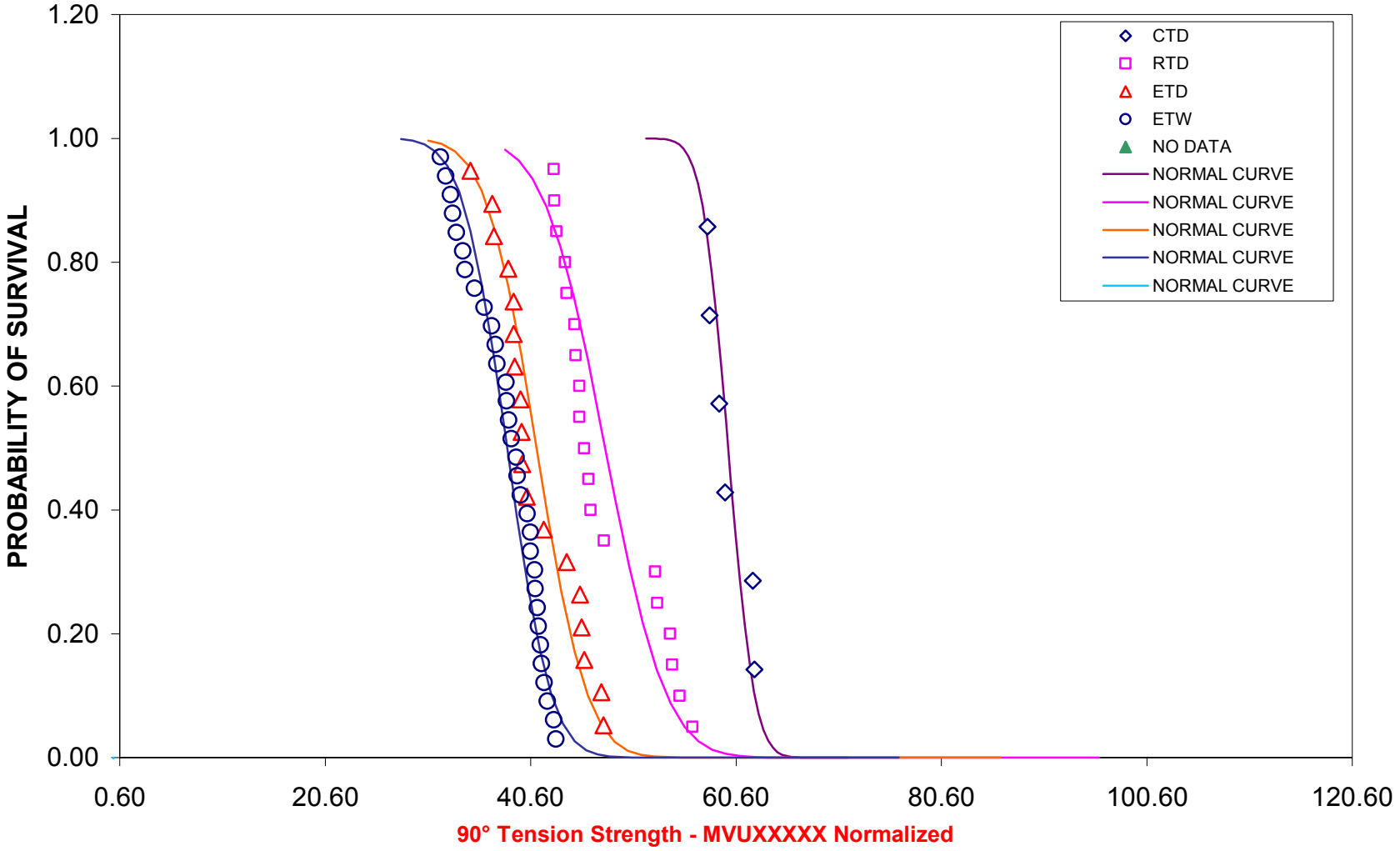
DISTRIBUTION OF GROUPED DATA FOR DIFFERENT TEST CONDITIONS

7781 Glass Fabric/ MGS 418 Wet Layup
Lancair



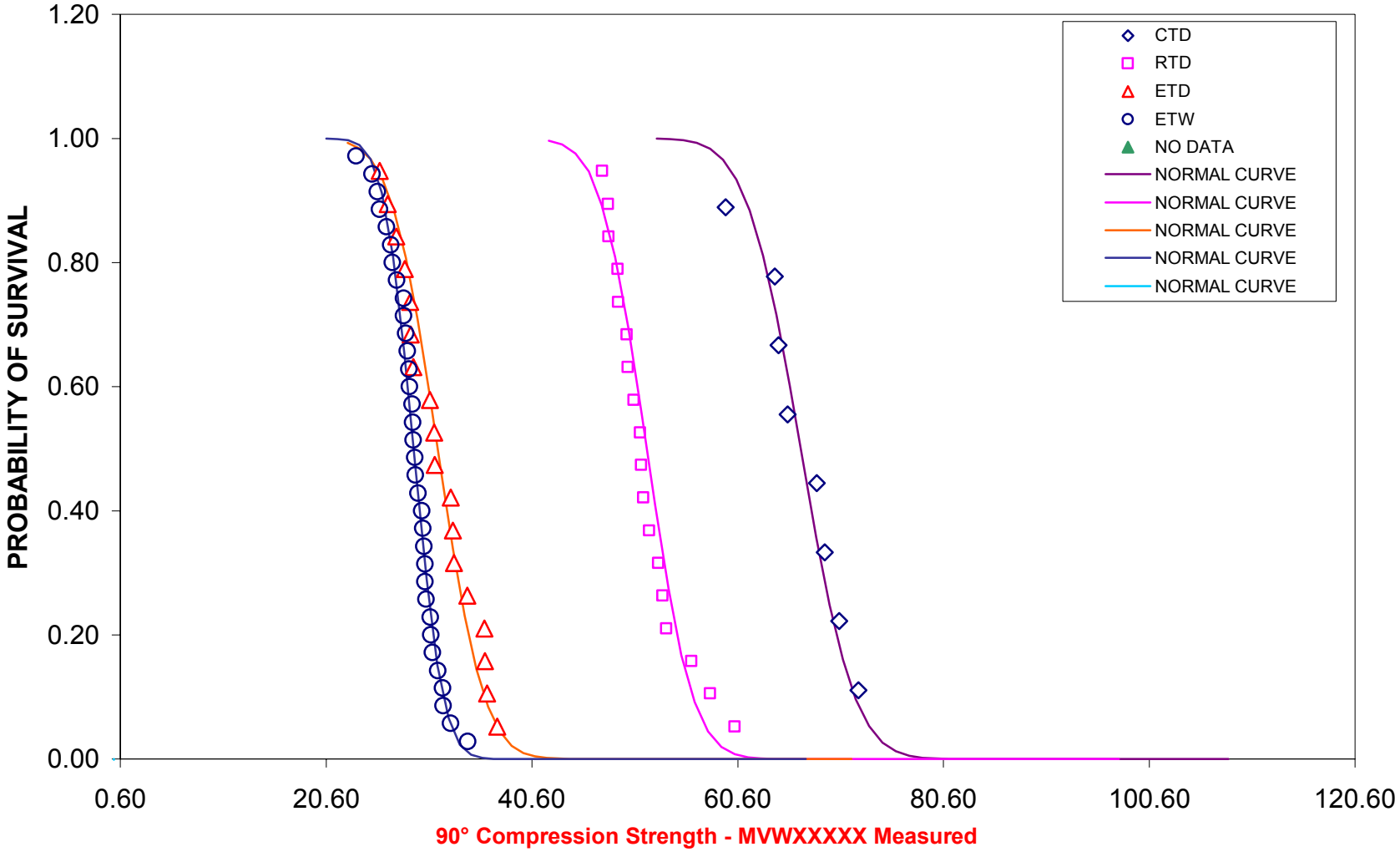
DISTRIBUTION OF GROUPED DATA FOR DIFFERENT TEST CONDITIONS

7781 Glass Fabric/ MGS 418 Wet Layup
Lancair



DISTRIBUTION OF GROUPED DATA FOR DIFFERENT TEST CONDITIONS

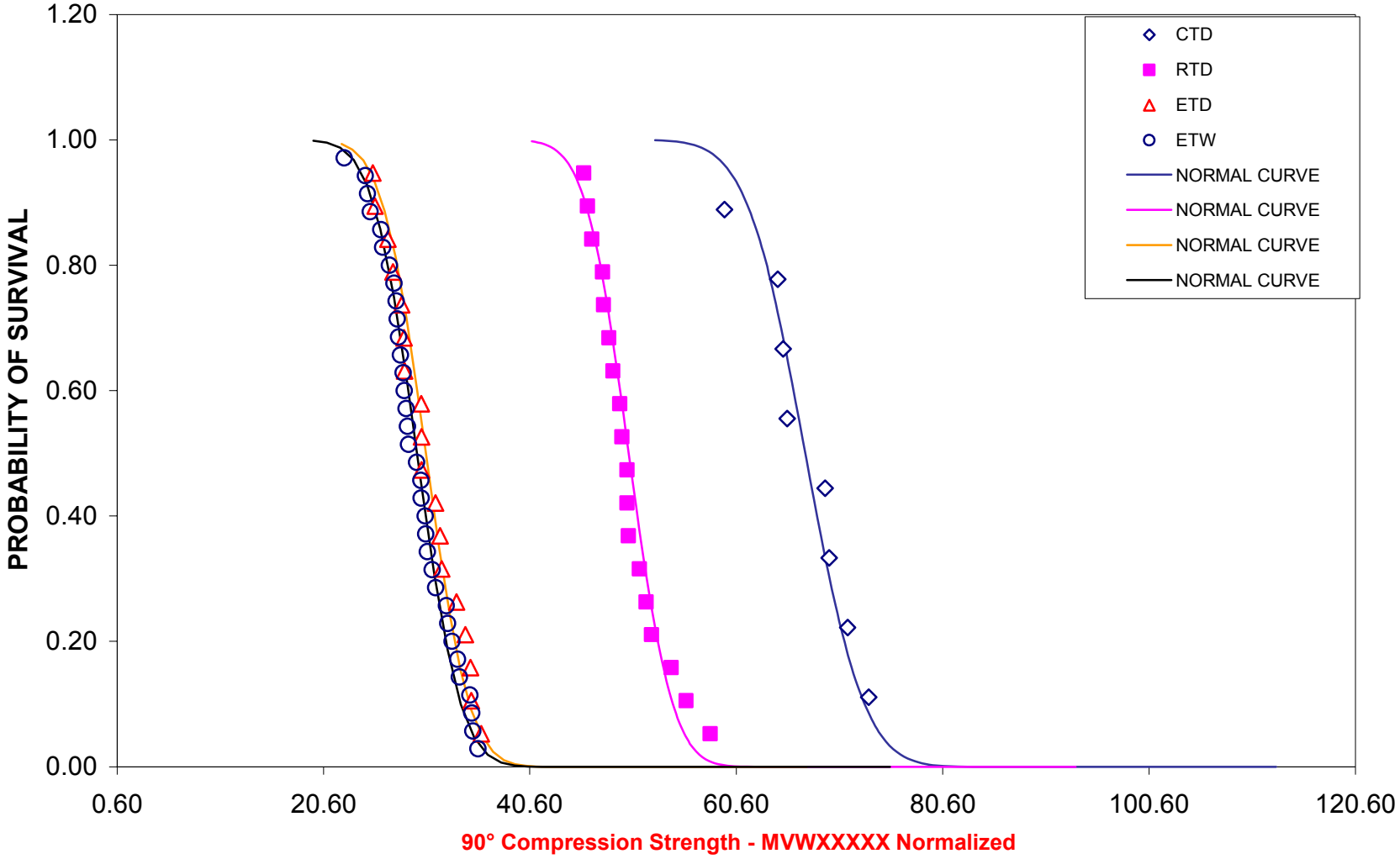
7781 Glass Fabric/ MGS 418 Wet Layup
Lancair



DISTRIBUTION OF GROUPED DATA FOR DIFFERENT TEST CONDITIONS

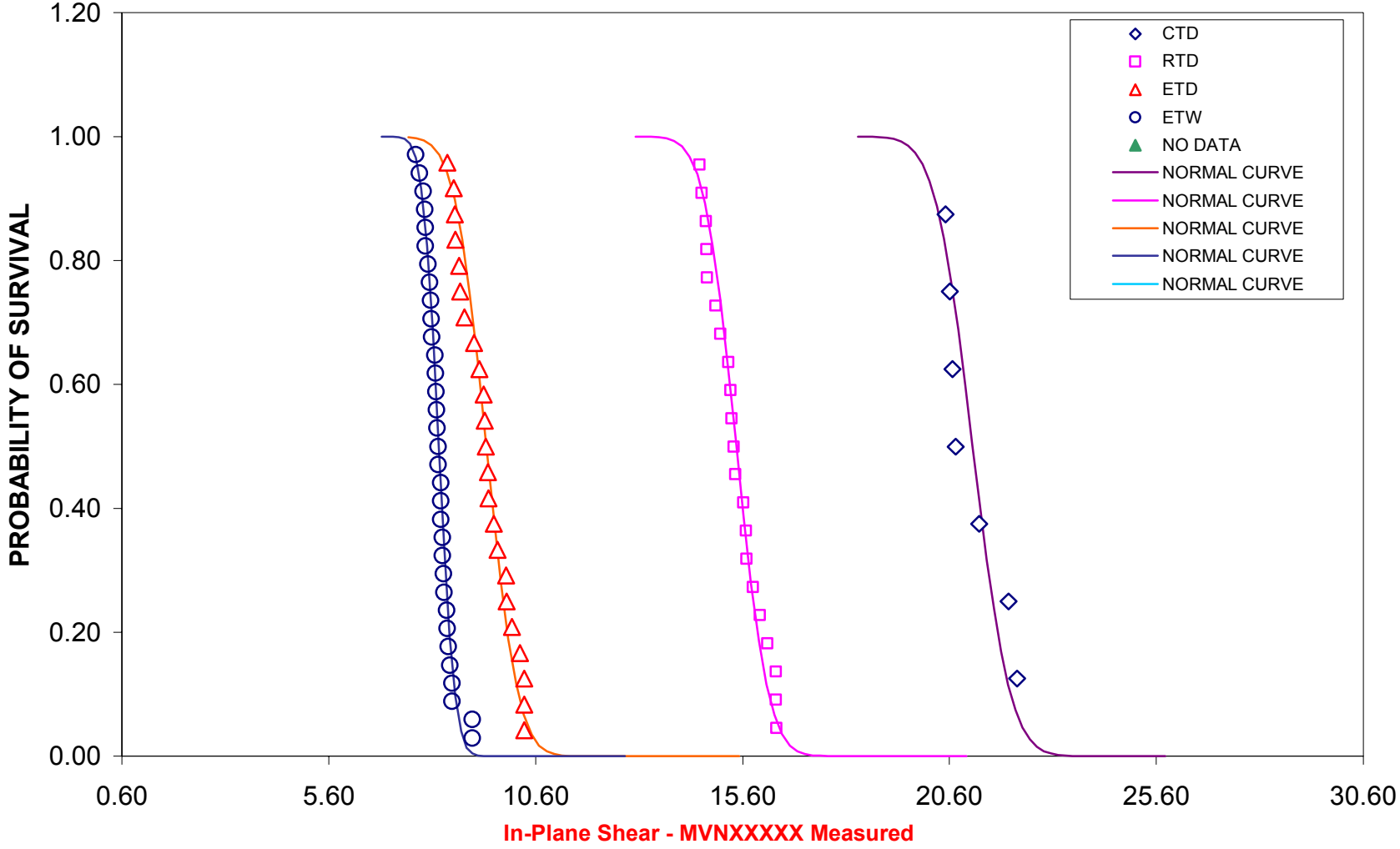
7781 Glass Fabric/ MGS 418 Wet Layup

Lancair



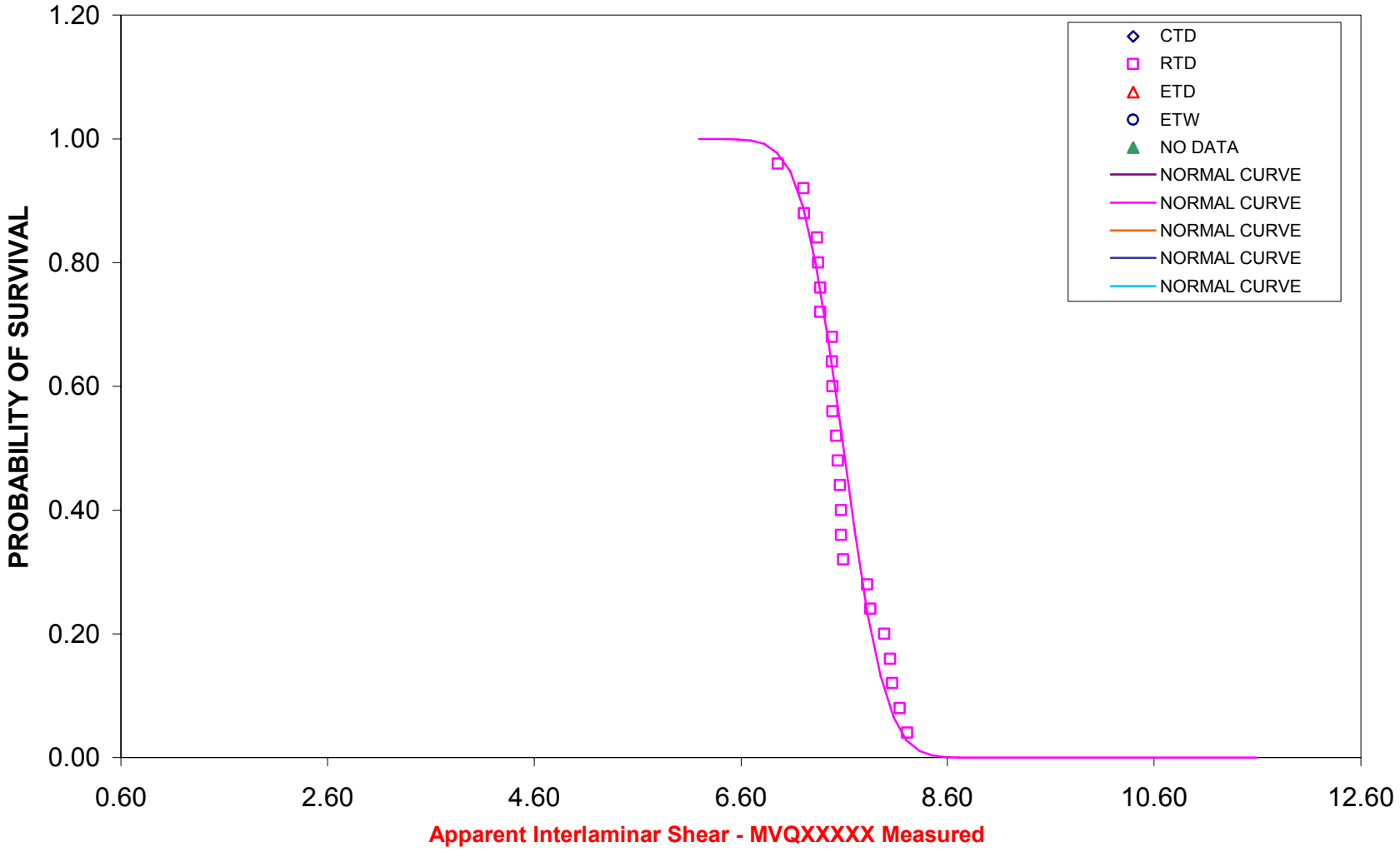
DISTRIBUTION OF GROUPED DATA FOR DIFFERENT TEST CONDITIONS

7781 Glass Fabric/ MGS 418 Wet Layup
Lancair



DISTRIBUTION OF GROUPED DATA FOR DIFFERENT TEST CONDITIONS

7781 Glass Fabric/ MGS 418 Wet Layup
Lancair



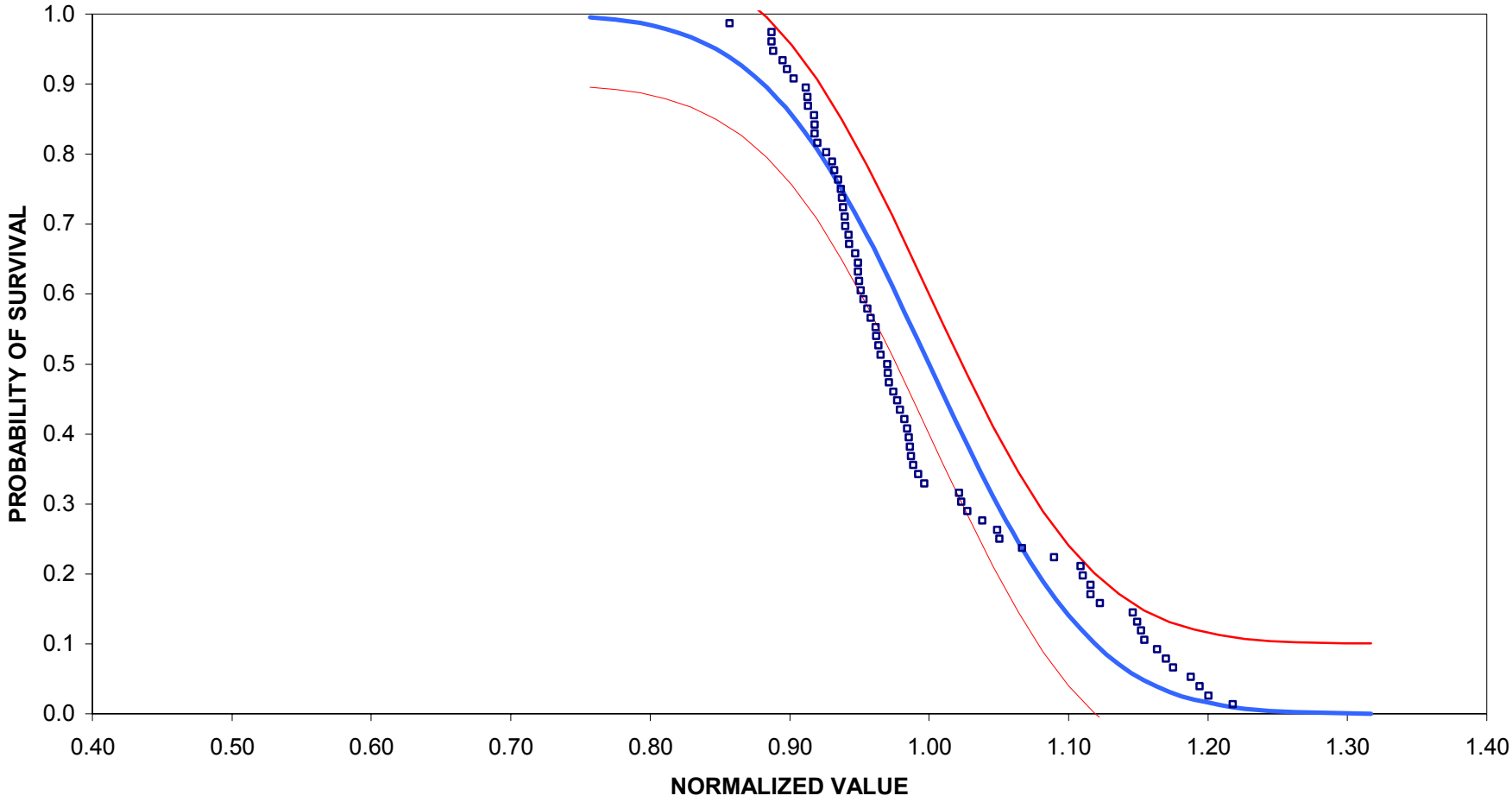
3.3.2 Plot of Pooled Data

DISTRIBUTION OF POOLED DATA

7781 Glass Fabric/ MGS 418 Wet Layup

Lancair

90° Tension Strength - MVUXXXXX Measured

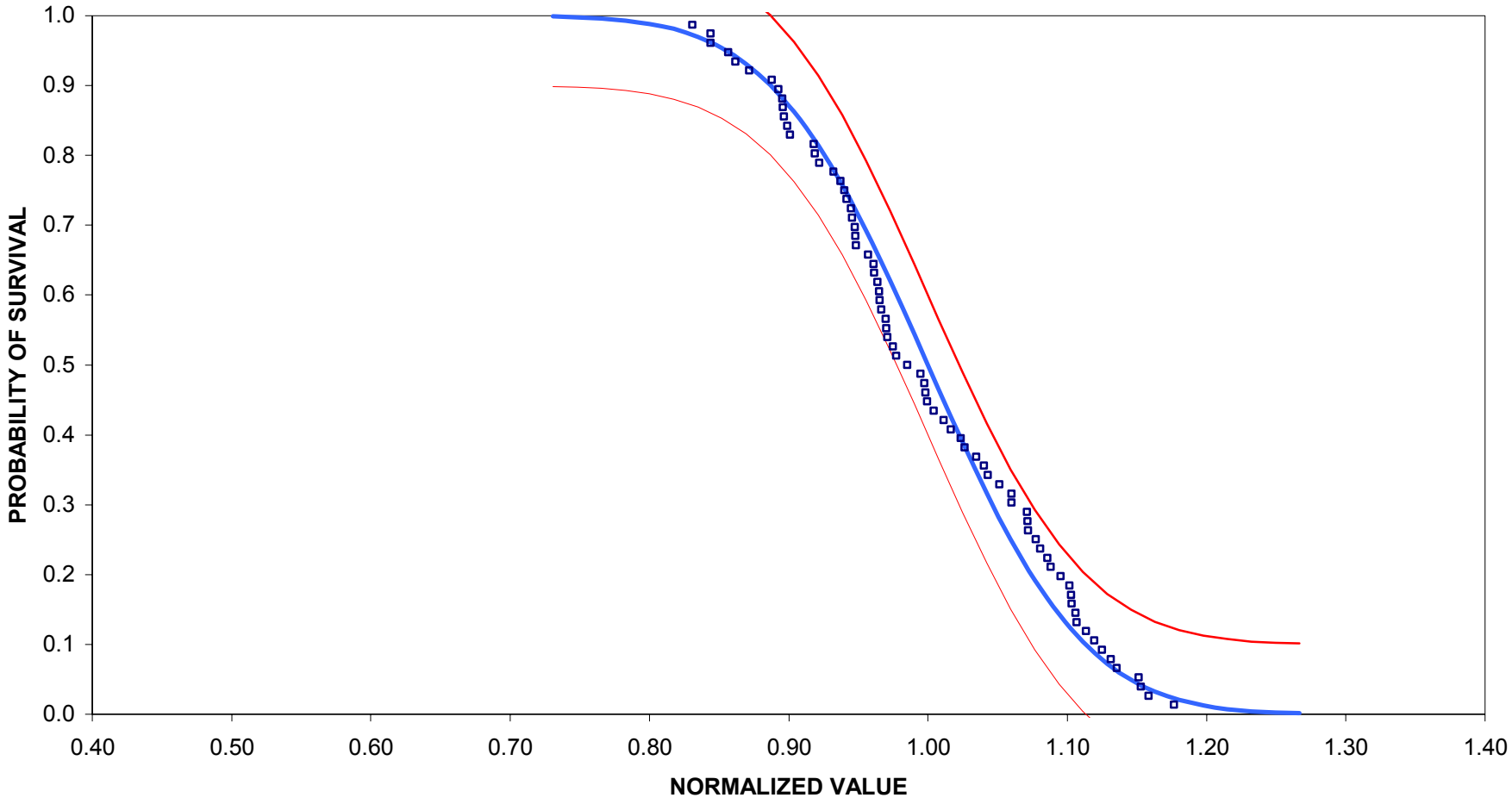


DISTRIBUTION OF POOLED DATA

7781 Glass Fabric/ MGS 418 Wet Layup

Lancair

90° Tension Strength - MVUXXXXX Normalized

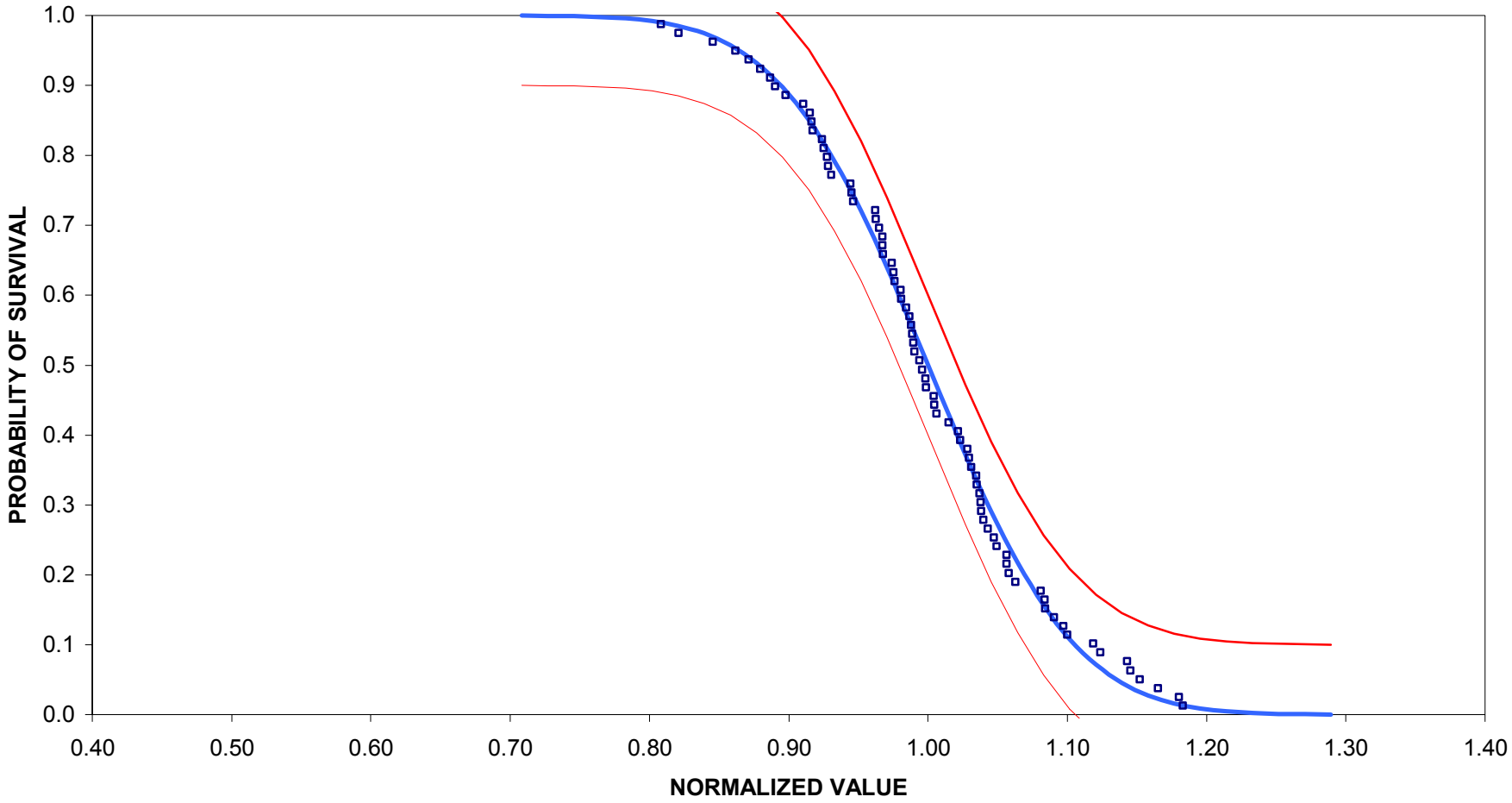


DISTRIBUTION OF POOLED DATA

7781 Glass Fabric/ MGS 418 Wet Layup

Lancair

90° Compression Strength - MVWXXXXX Measured

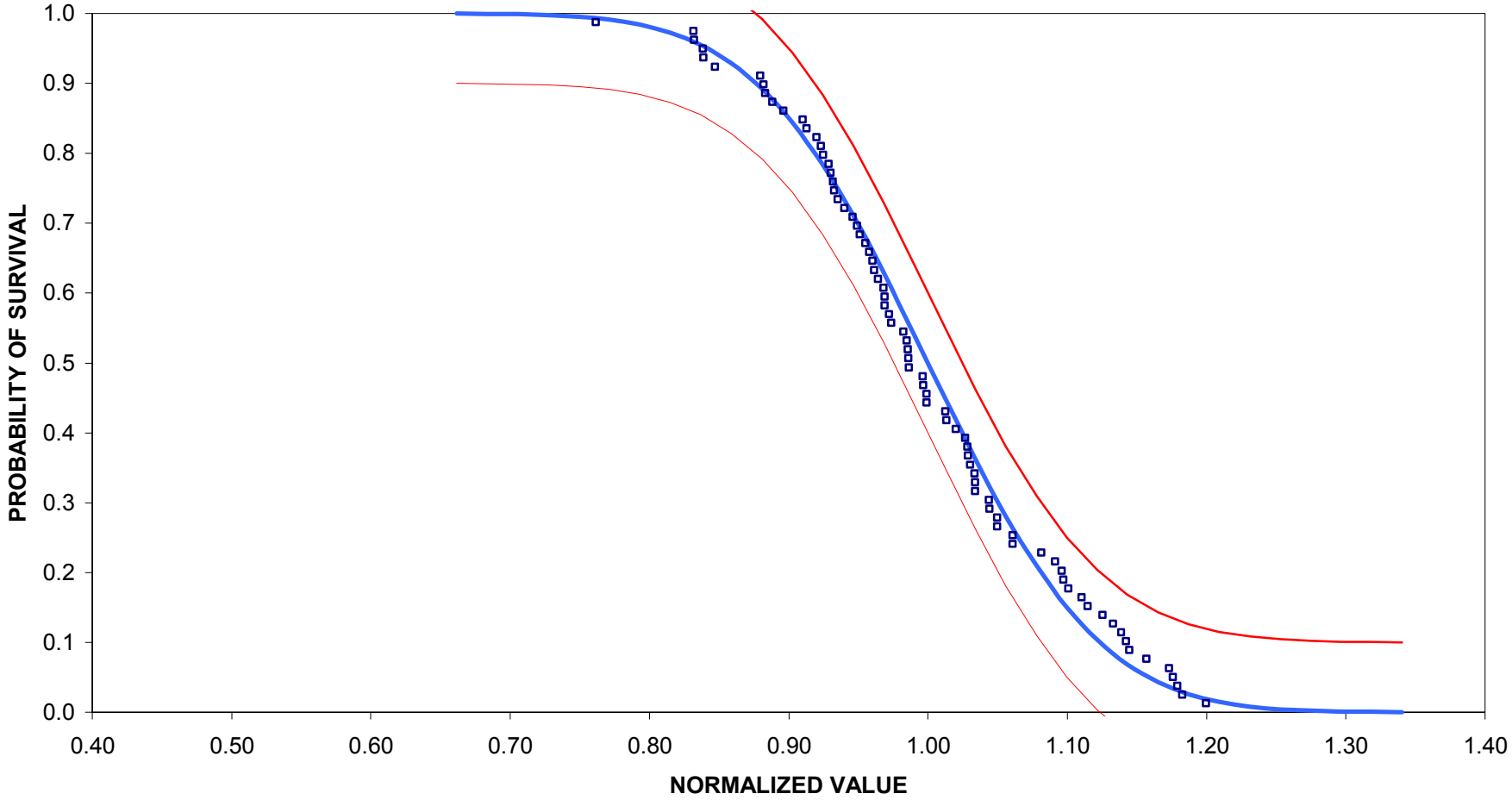


DISTRIBUTION OF POOLED DATA

7781 Glass Fabric/ MGS 418 Wet Layup

Lancair

90° Compression Strength - MVWXXXXX Normalized

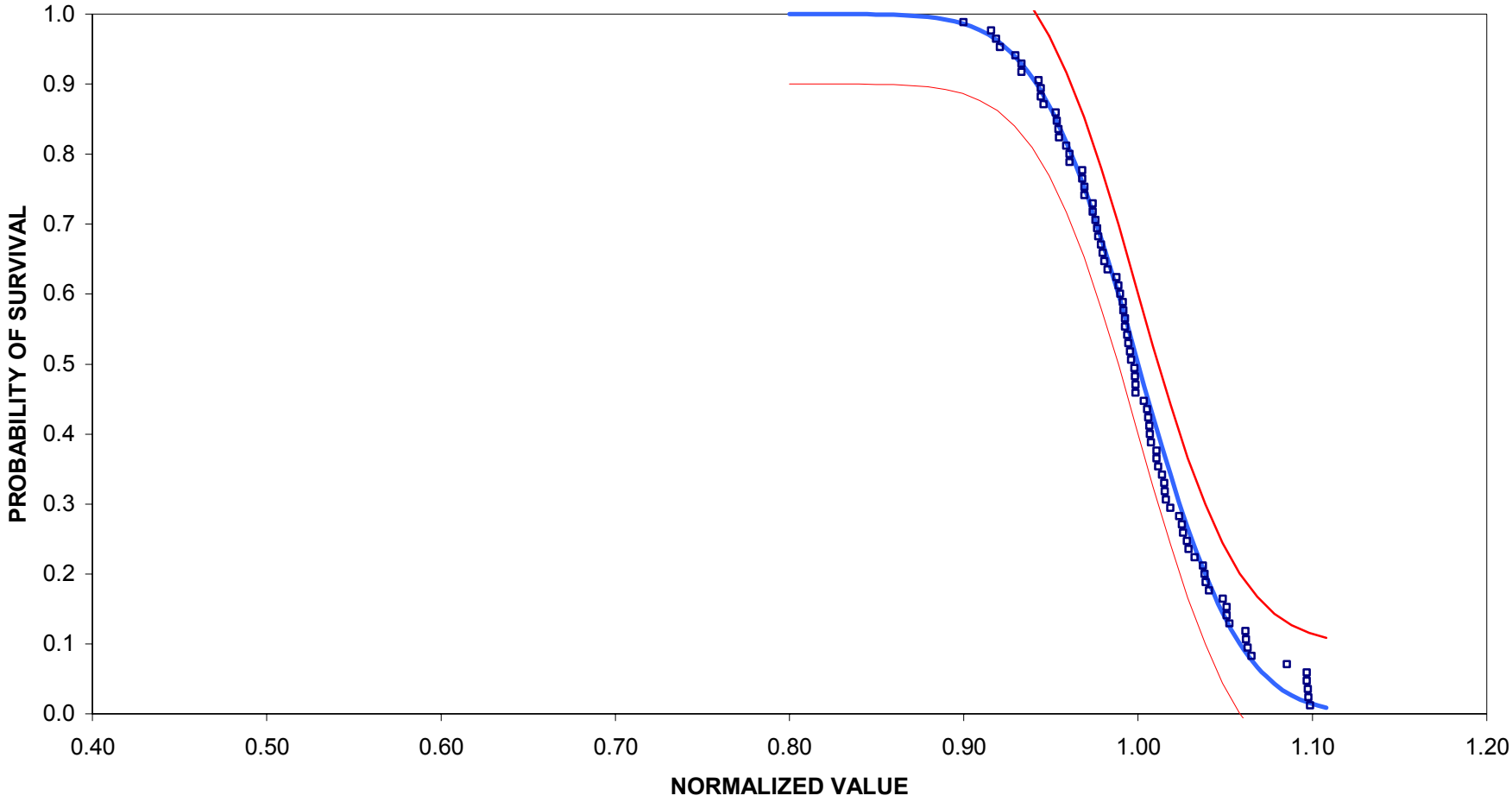


DISTRIBUTION OF POOLED DATA

7781 Glass Fabric/ MGS 418 Wet Layup

Lancair

In-Plane Shear - MVNXXXXX Measured

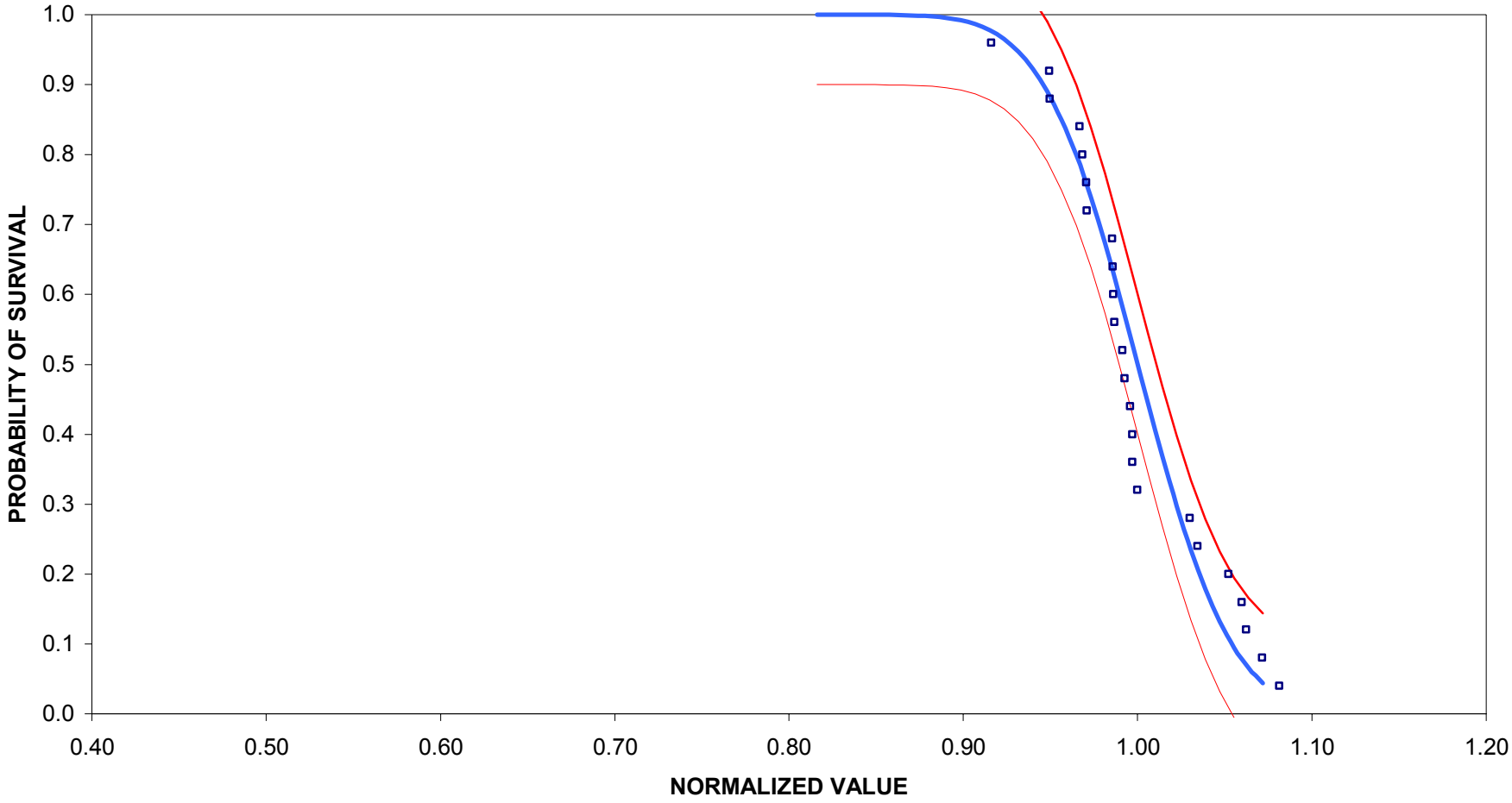


DISTRIBUTION OF POOLED DATA

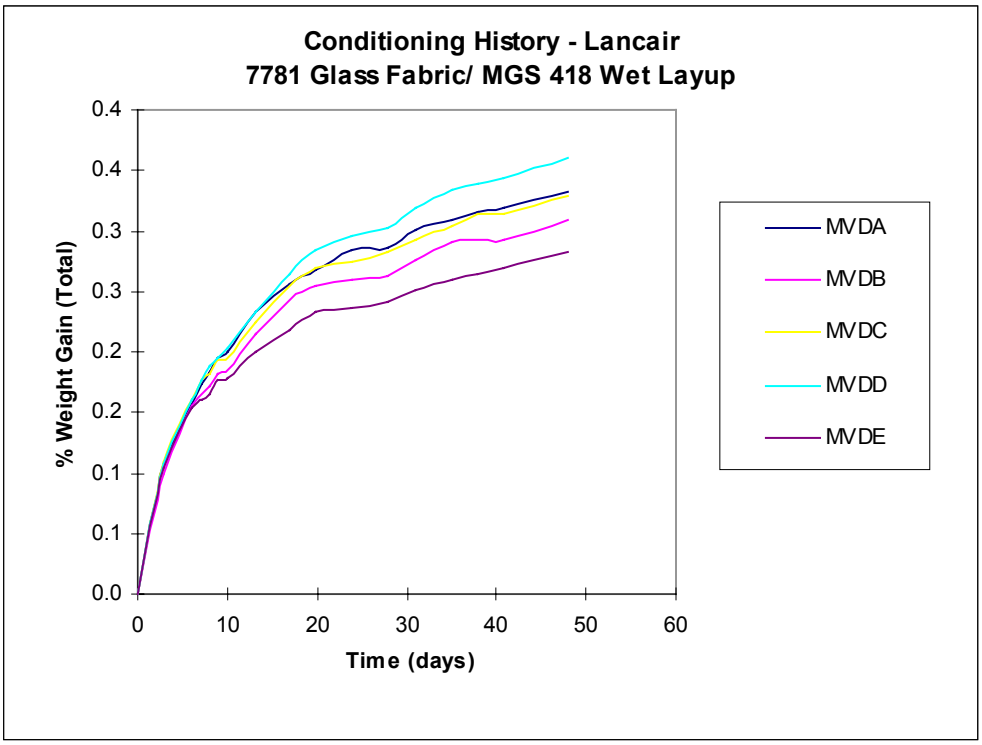
7781 Glass Fabric/ MGS 418 Wet Layup

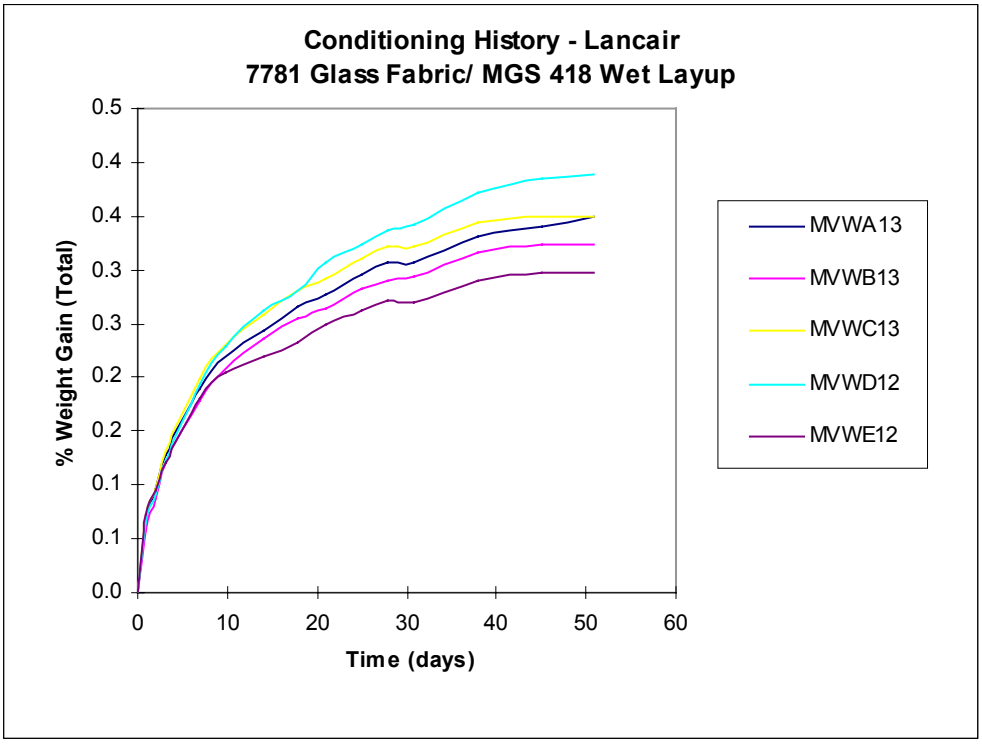
Lancair

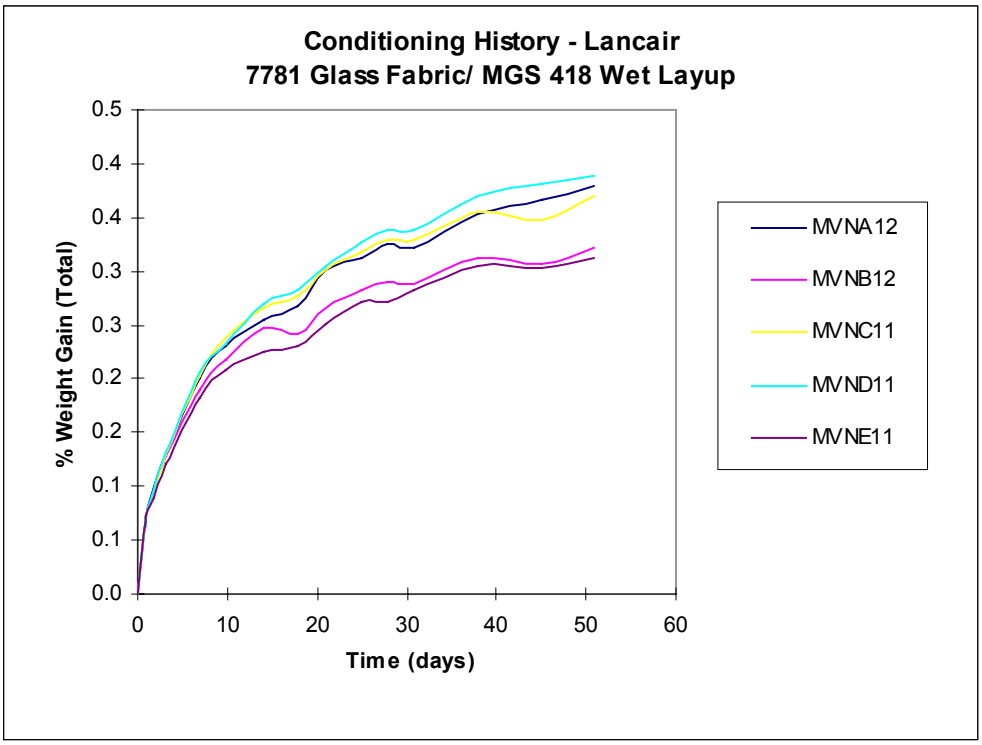
Apparent Interlaminar Shear - MVQXXXXX Measured

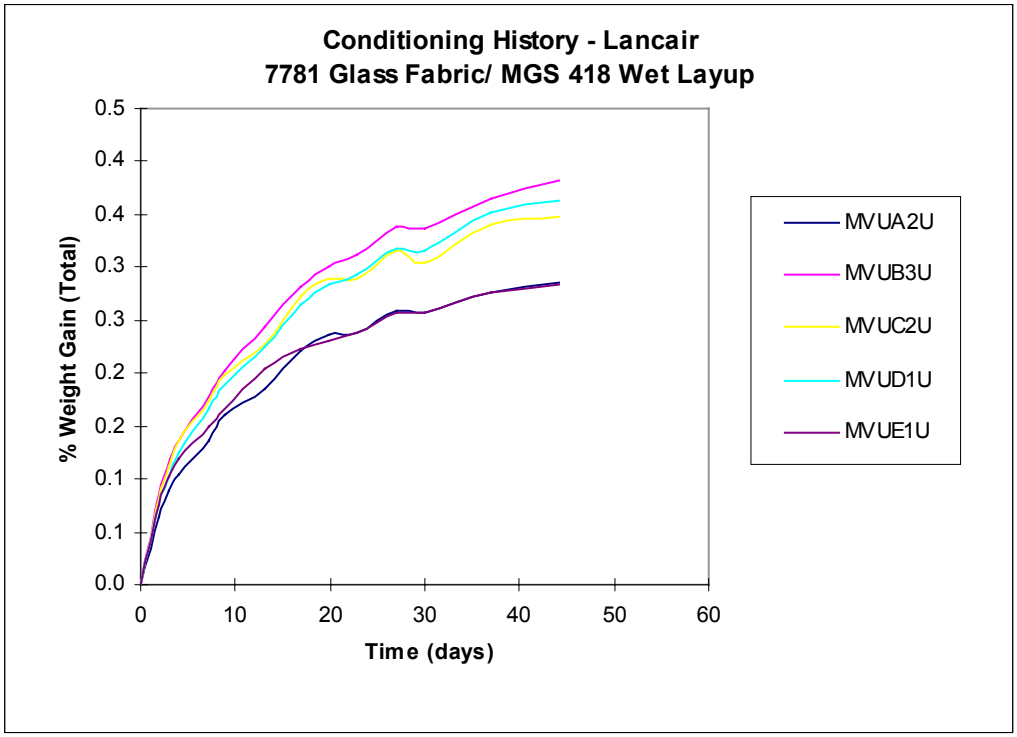


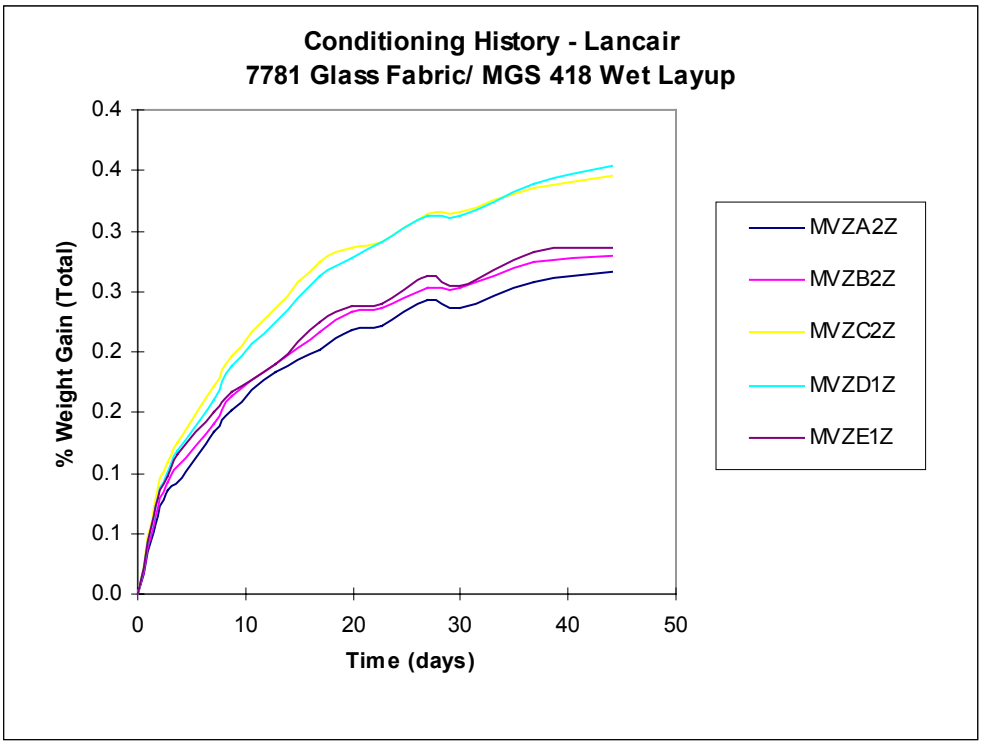
3.4 Moisture Conditioning History Charts

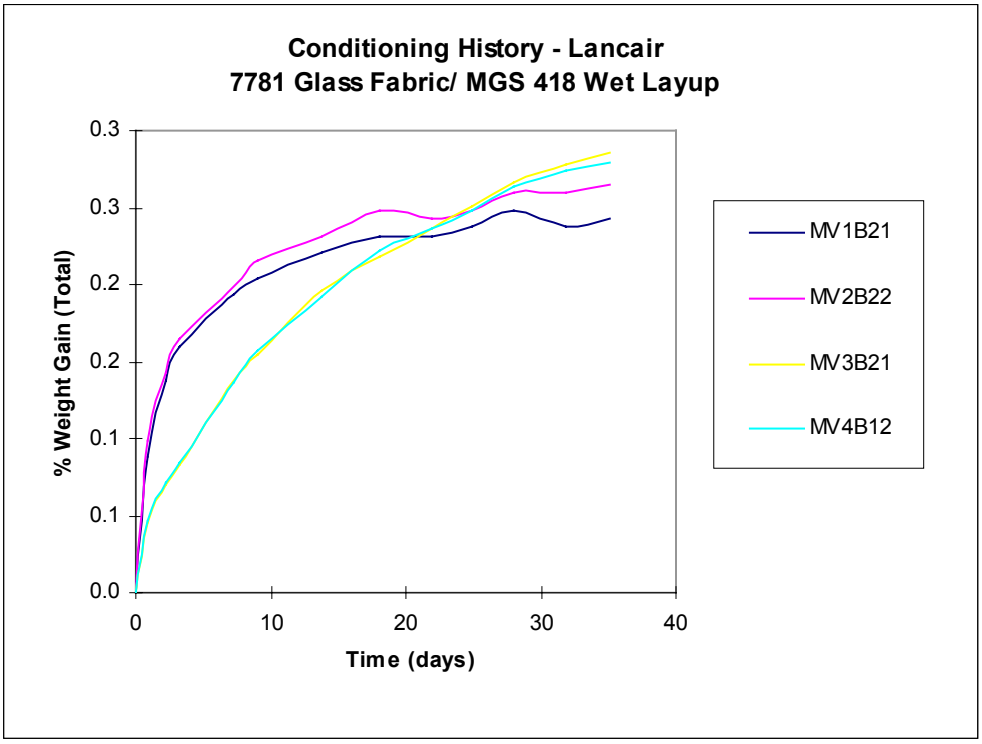












3.5 DMA Results

COMPANY: Lancair
MATERIAL SYSTEM: 7781 Glass Fabric / MGS 418 Wet Layup
PROJECT: 981111C1

DMA Results -- Onset Storage Modulus

DRY

As Fabricated		
Sample #	**Tg [°C]**	**Tg [°F]**
MVDA1D1A	91.71	197.08
MVDA1D2A	92.81	199.06
MVDA1D3A	89.92	193.86
MVDB1D1A	104.42	219.95
MVDB1D2A	102.79	217.02
MVDB1D4A	104.01	219.22
MVDC1D2A	105.58	222.04
MVDC1D3A	111.02	231.84
MVDC1D4A	108.66	227.59
MVDD1D1A	107.52	225.53
MVDD1D2A	105.58	222.04
MVDD1D3A	105.11	221.20
MVDE1D1A	108.37	227.07
MVDE1D2A	106.18	223.12
MVDE1D3A	106.21	223.17
Average [°F]		**216.37**
Standard Dev. [°F]		**12.56**
Coeff. Of Var. [%]		**5.81**

WET

Moisture Equilibrium at 85% RH		
Sample #	**Tg [°C]**	**Tg [°F]**
MVDA1DAF	96.15	205.07
MVDA1DBF	97.10	206.78
MVDA1DCF	96.87	206.36
MVDB1DAF	100.59	213.06
MVDB1DBF	102.21	215.97
MVDB1DCF	102.45	216.41
MVDC1DAF	99.30	210.75
MVDC1DBF	97.85	208.13
MVDC1DCF	97.97	208.35
MVDD1DAF	100.32	212.58
MVDD1DBF	98.38	209.08
MVDD1DCF	99.41	210.93
MVDE1DAF	95.96	204.72
MVDE1DBF	97.65	207.76
MVDE1DCF	96.97	206.55
Average [°F]		**209.86**
Standard Dev. [°F]		**3.84**
Coeff. Of Var. [%]		**1.83**

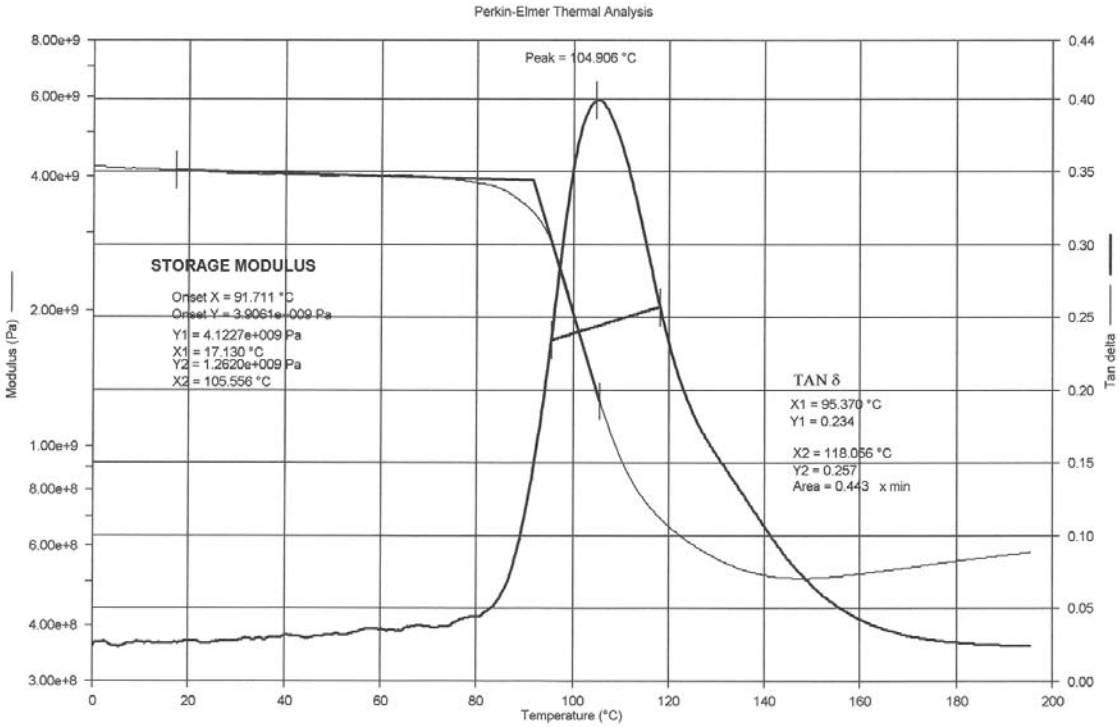
DMA Results - Peak Tan Delta

DRY

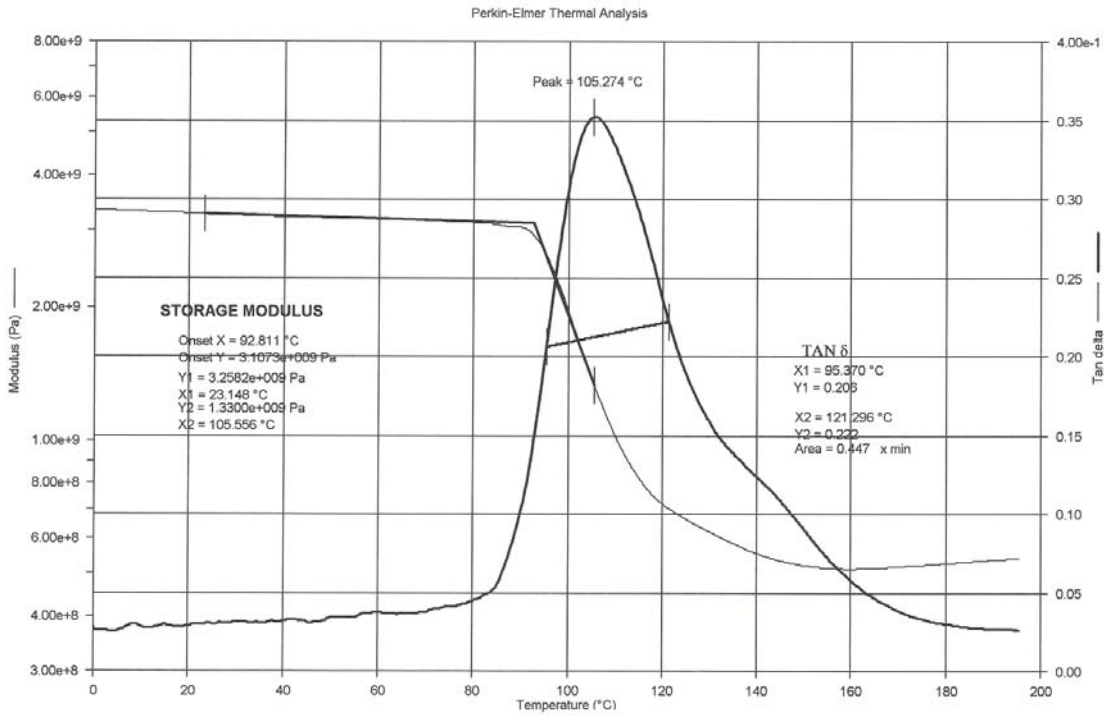
As Fabricated		
Sample #	**Tg [°C]**	**Tg [°F]**
MVDA1D1A	104.91	220.83
MVDA1D2A	105.27	221.49
MVDA1D3A	104.15	219.47
MVDB1D1A	115.25	239.44
MVDB1D2A	115.48	239.86
MVDB1D4A	114.78	238.61
MVDC1D2A	116.19	241.14
MVDC1D3A	119.80	247.64
MVDC1D4A	118.18	244.72
MVDD1D1A	116.19	241.14
MVDD1D2A	116.33	241.39
MVDD1D3A	115.45	239.81
MVDE1D1A	116.46	241.64
MVDE1D2A	115.68	240.23
MVDE1D3A	115.24	239.44
Average [°F]		**236.29**
Standard Dev. [°F]		**9.79**
Coeff. Of Var. [%]		**4.14**

WET

Moisture Equilibrium at 85% RH		
Sample #	**Tg [°C]**	**Tg [°F]**
MVDA1DAF	110.66	231.19
MVDA1DBF	112.10	233.78
MVDA1DCF	111.19	232.13
MVDB1DAF	114.16	237.49
MVDB1DBF	115.84	240.52
MVDB1DCF	115.76	240.37
MVDC1DAF	110.90	231.62
MVDC1DBF	110.94	231.70
MVDC1DCF	109.74	229.53
MVDD1DAF	115.40	239.73
MVDD1DBF	114.94	238.88
MVDD1DCF	114.68	238.43
MVDE1DAF	109.59	229.26
MVDE1DBF	111.66	232.99
MVDE1DCF	113.24	235.84
Average [°F]		**235.45**
Standard Dev. [°F]		**4.14**
Coeff. Of Var. [%]		**1.76**



MVDA1D1A



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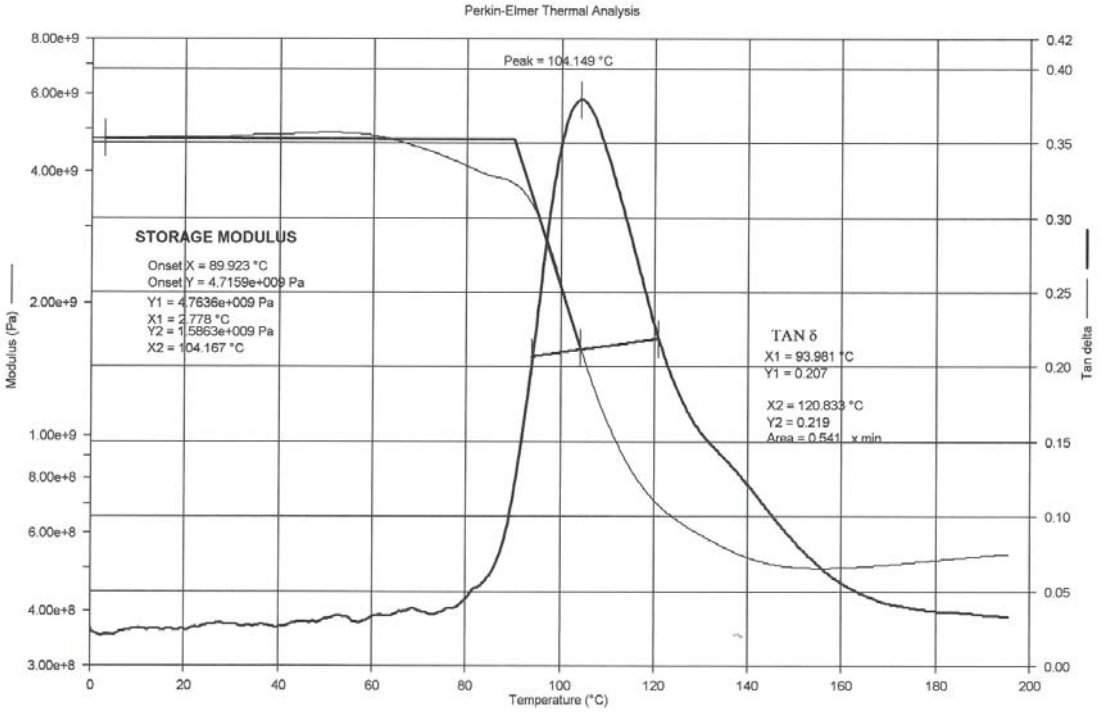

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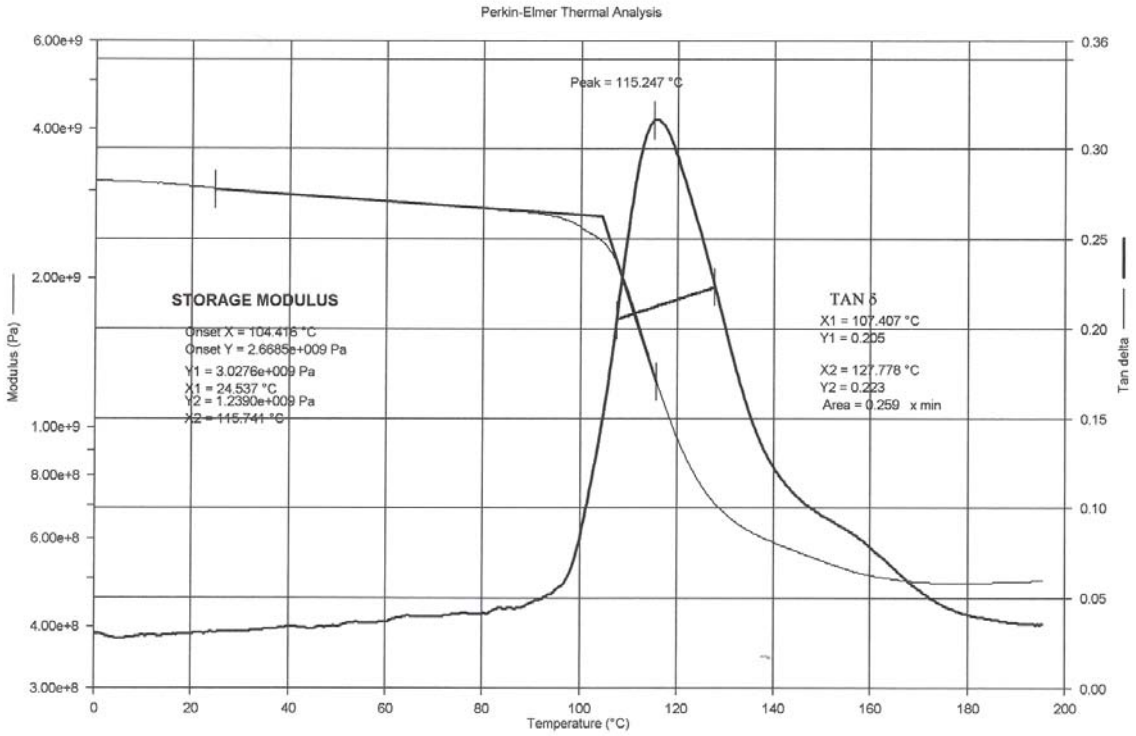

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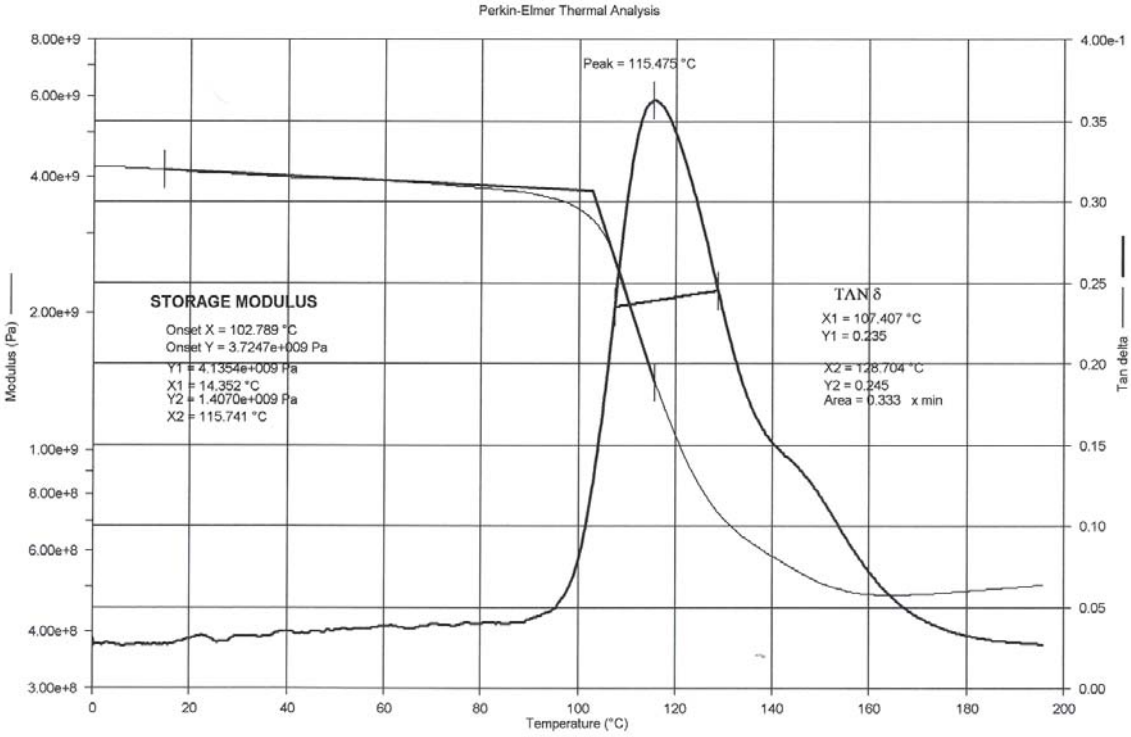

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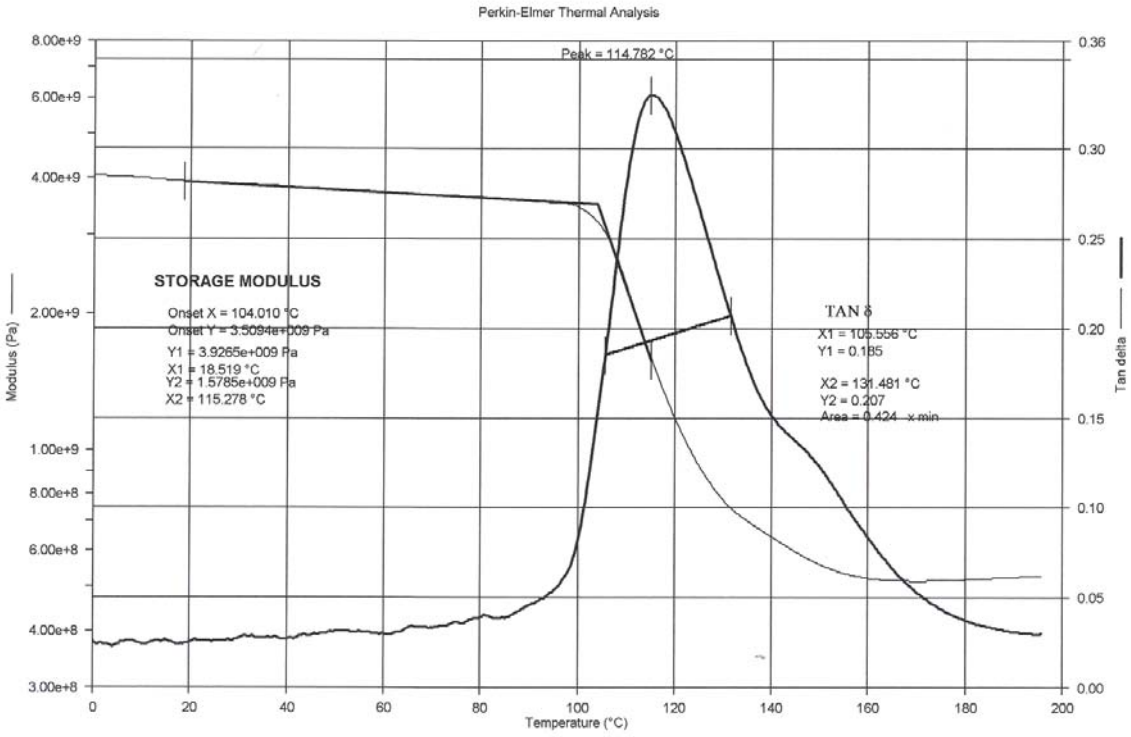

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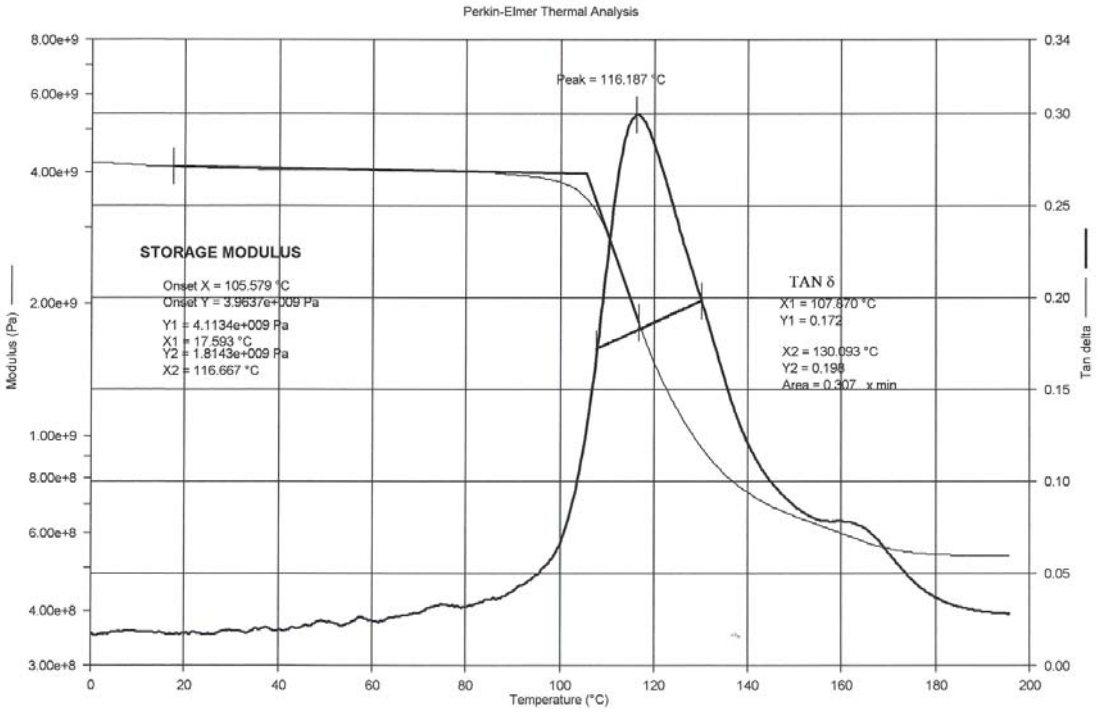

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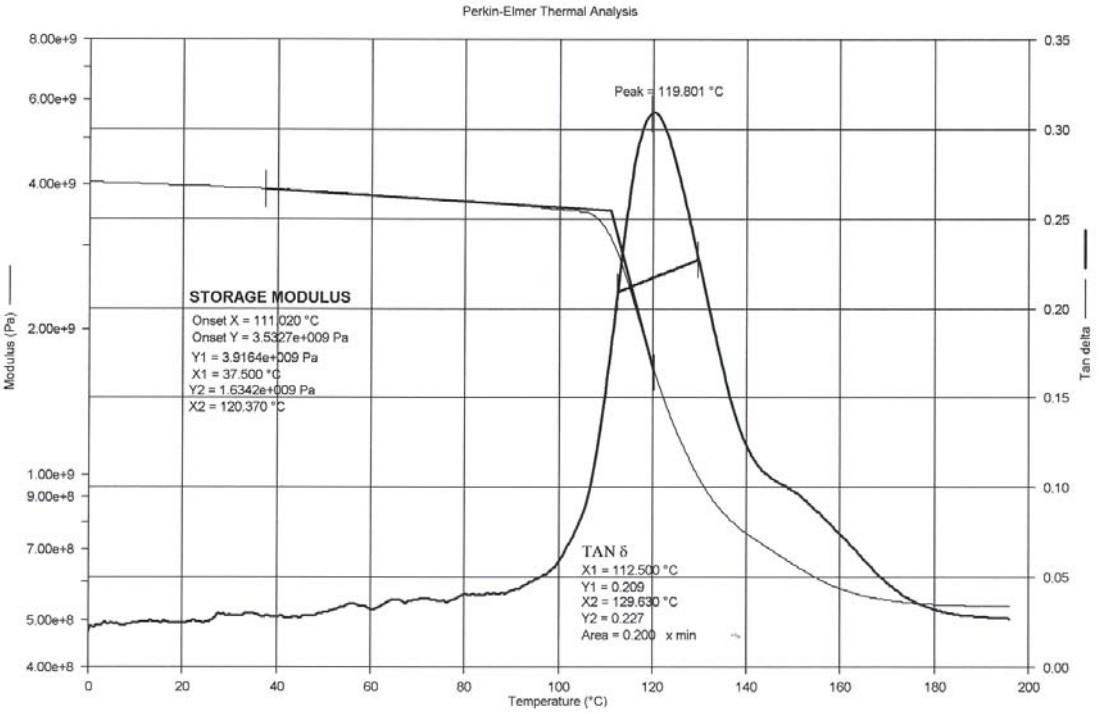

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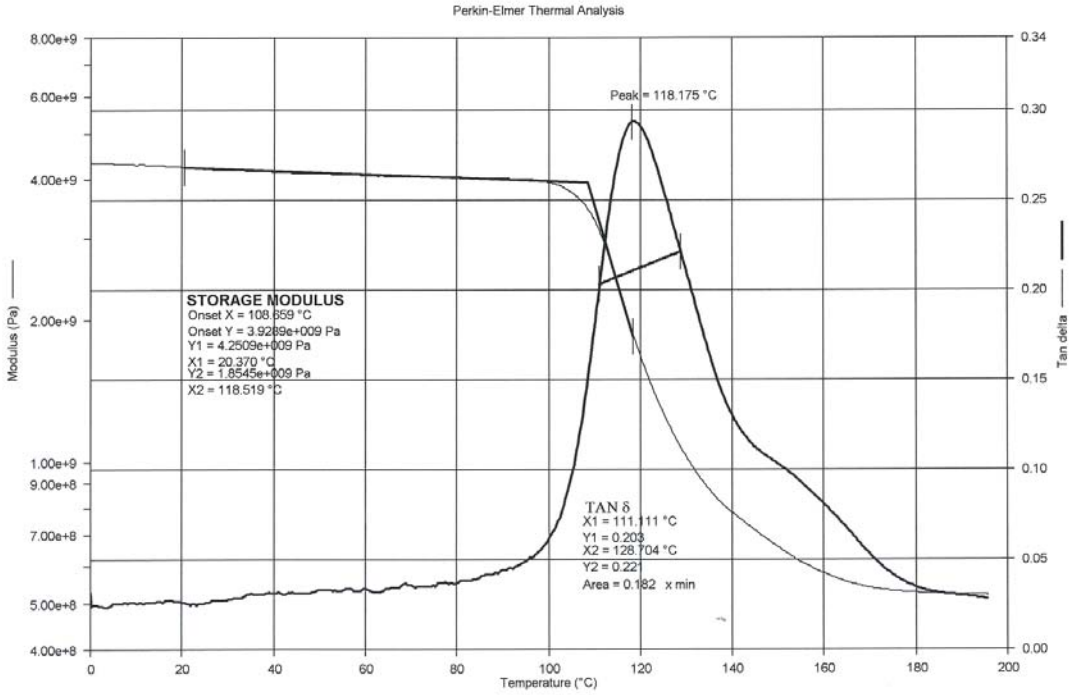

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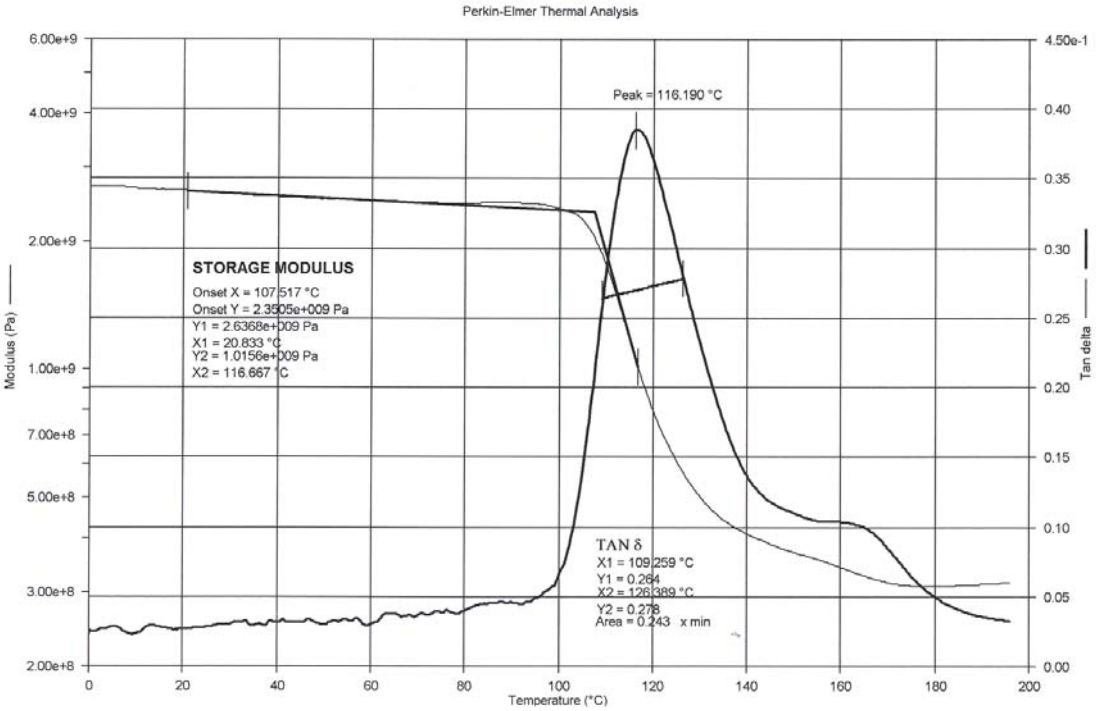

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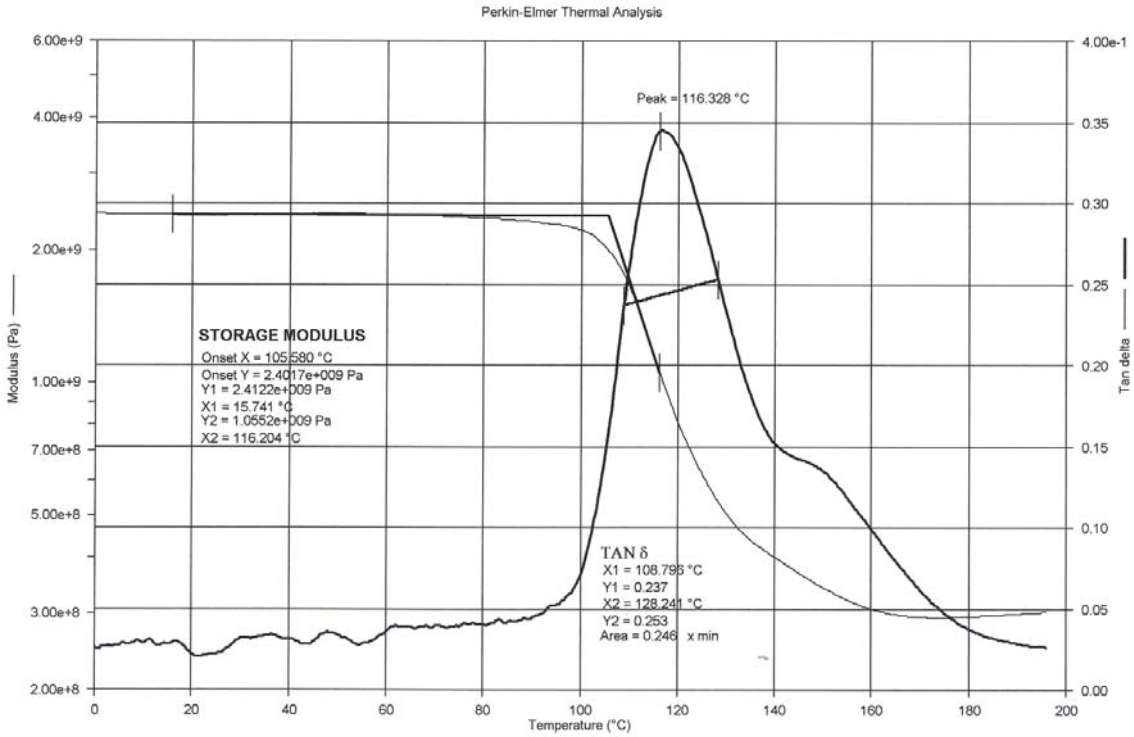

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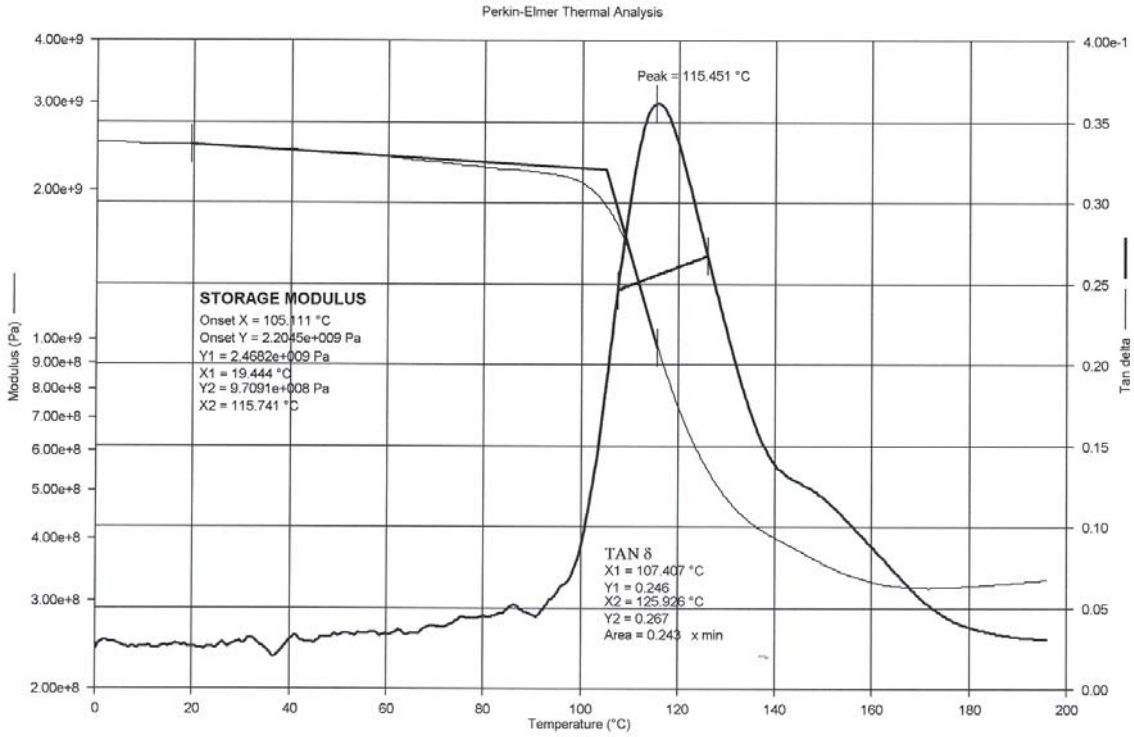

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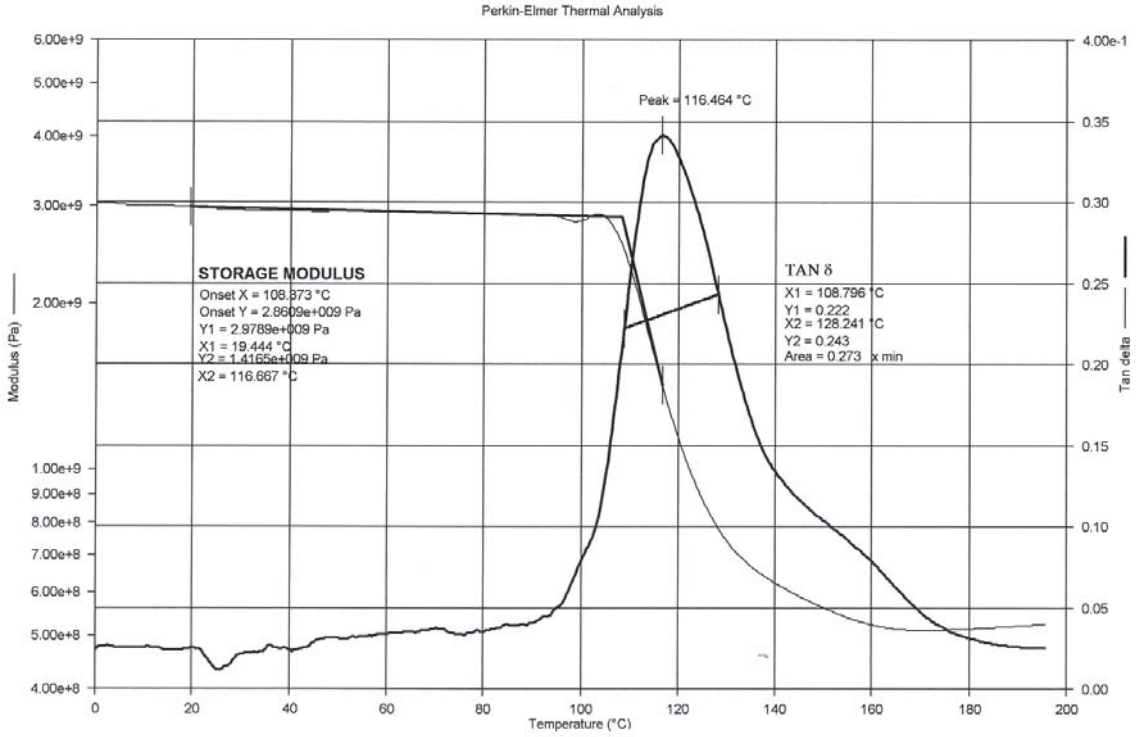

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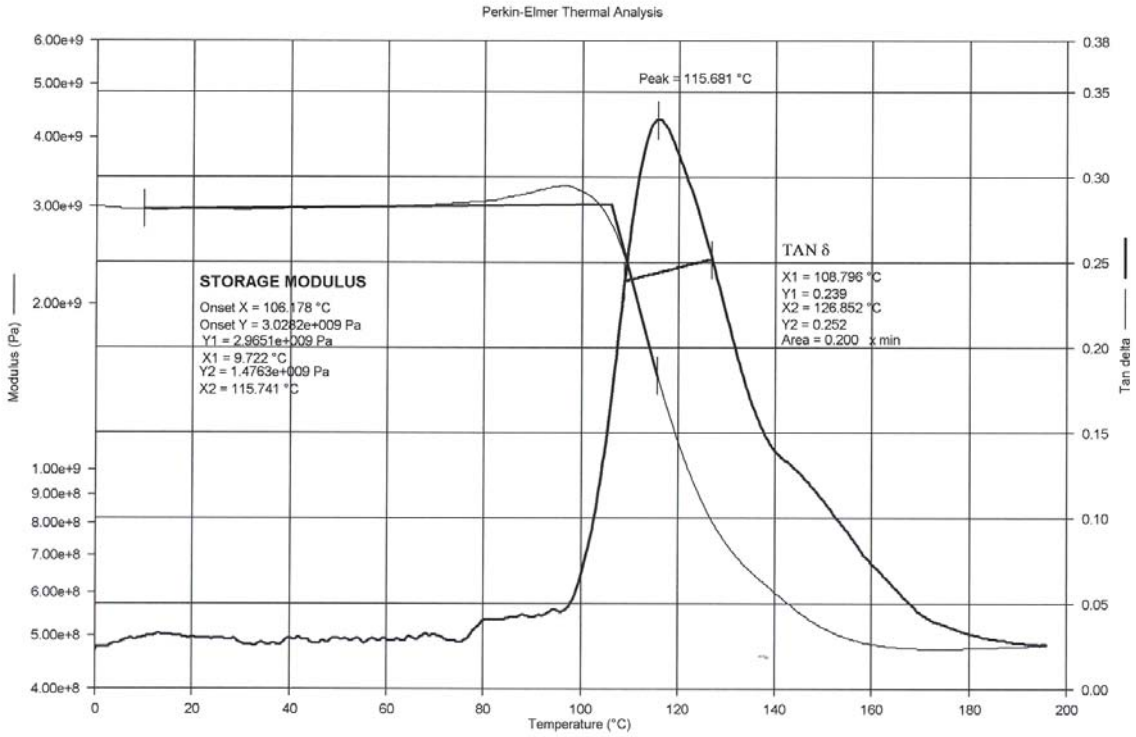

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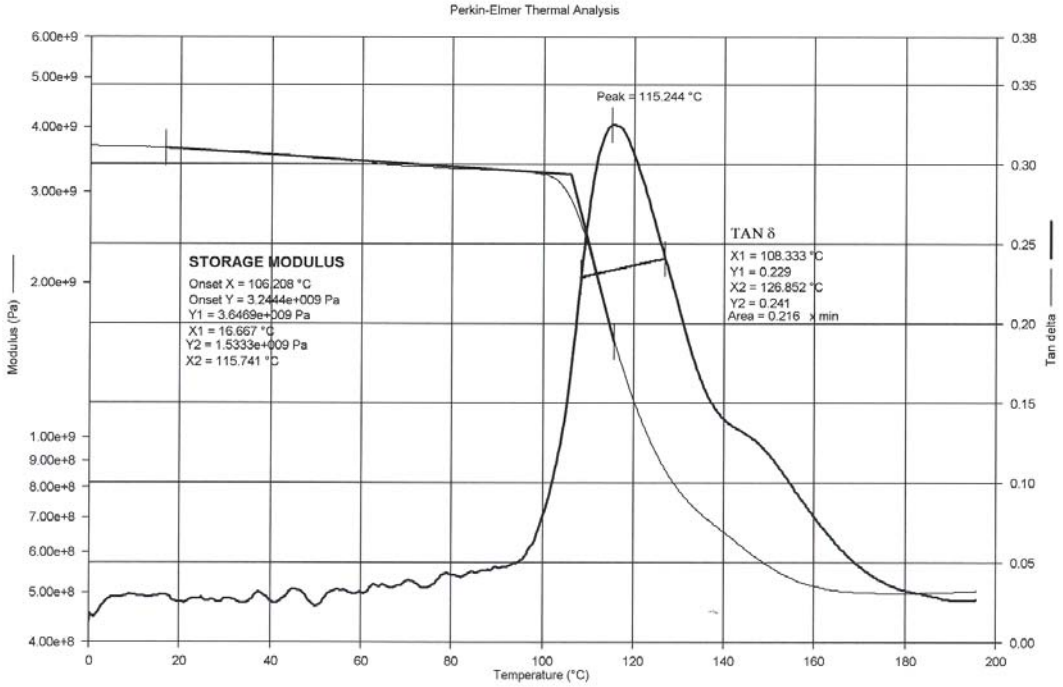

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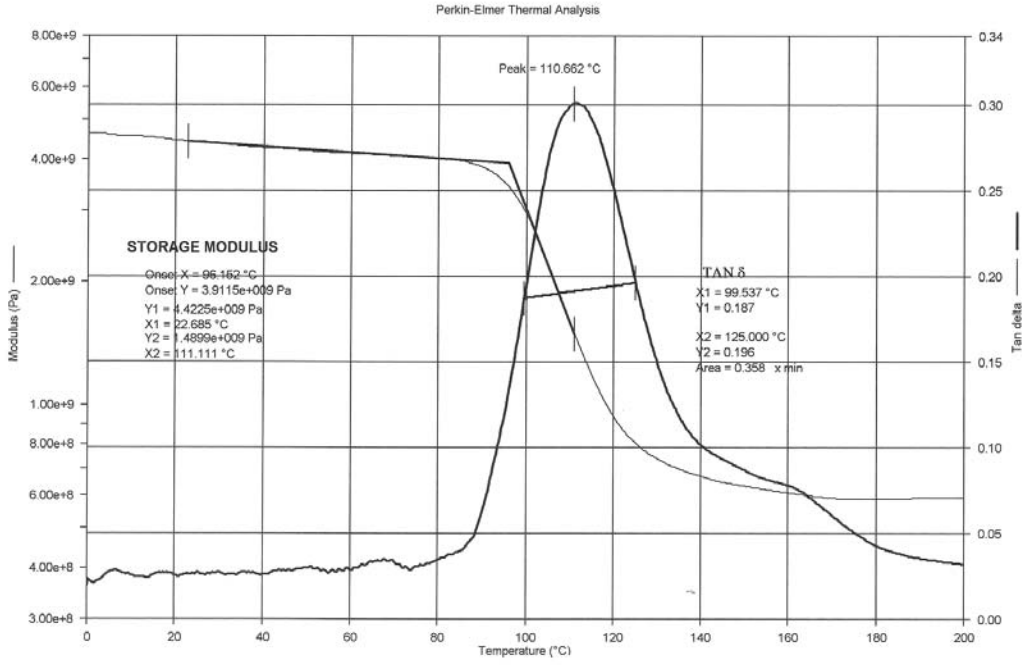

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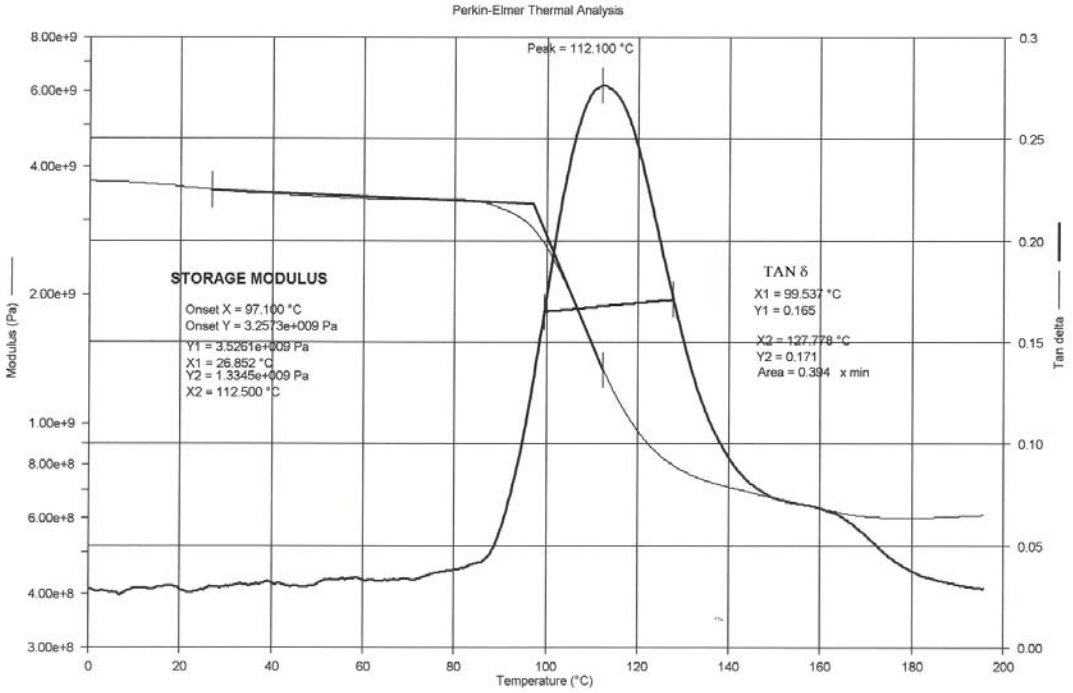

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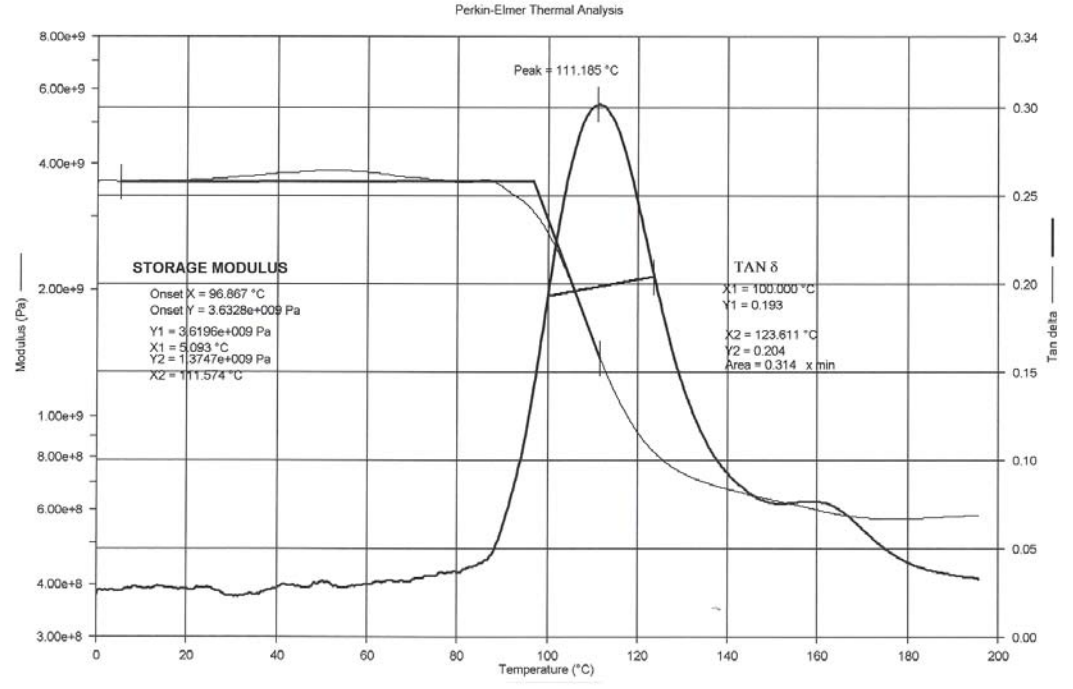

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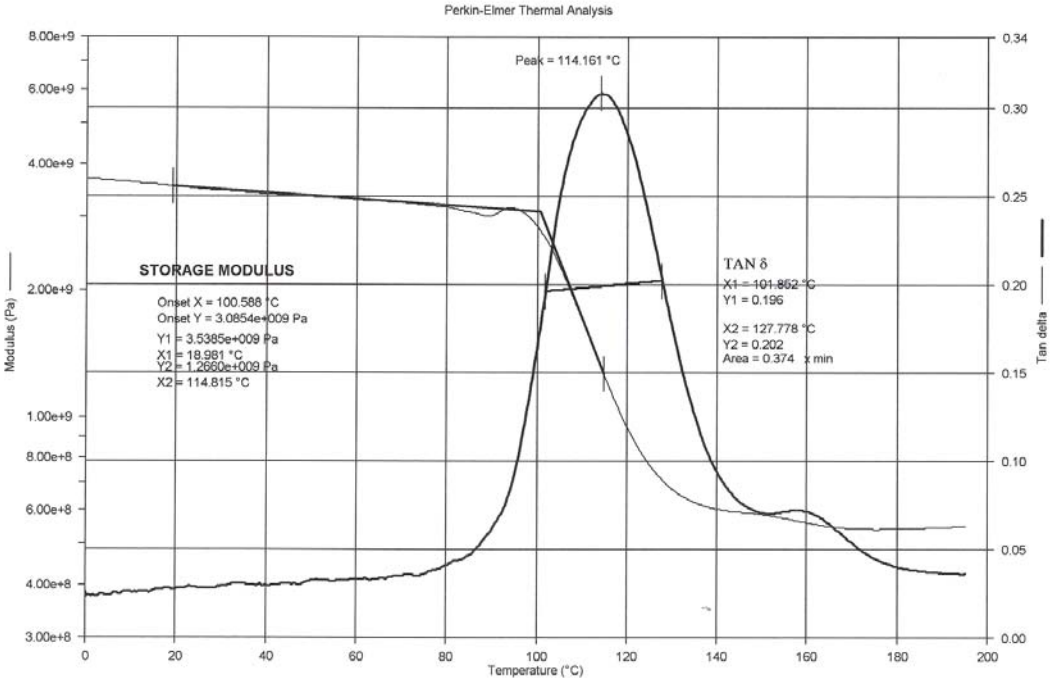

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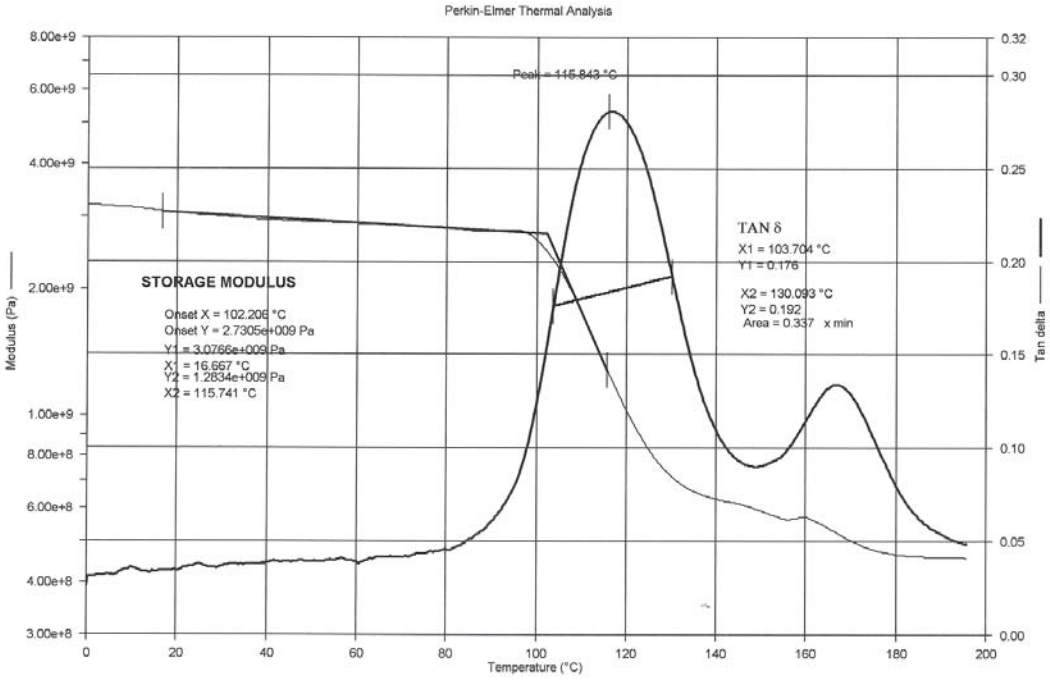

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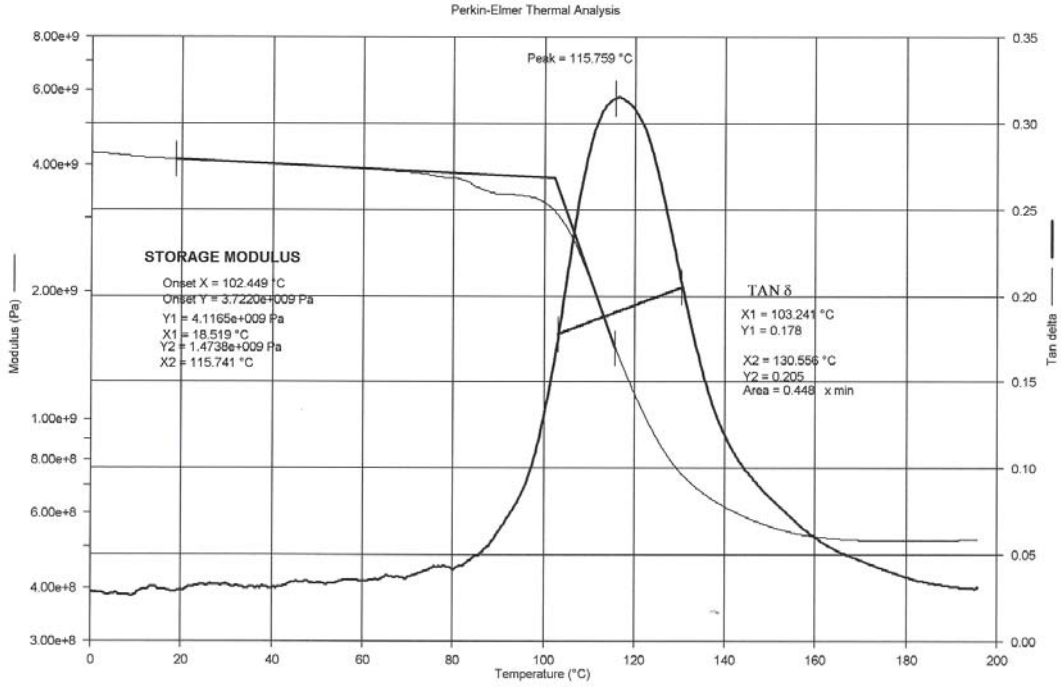

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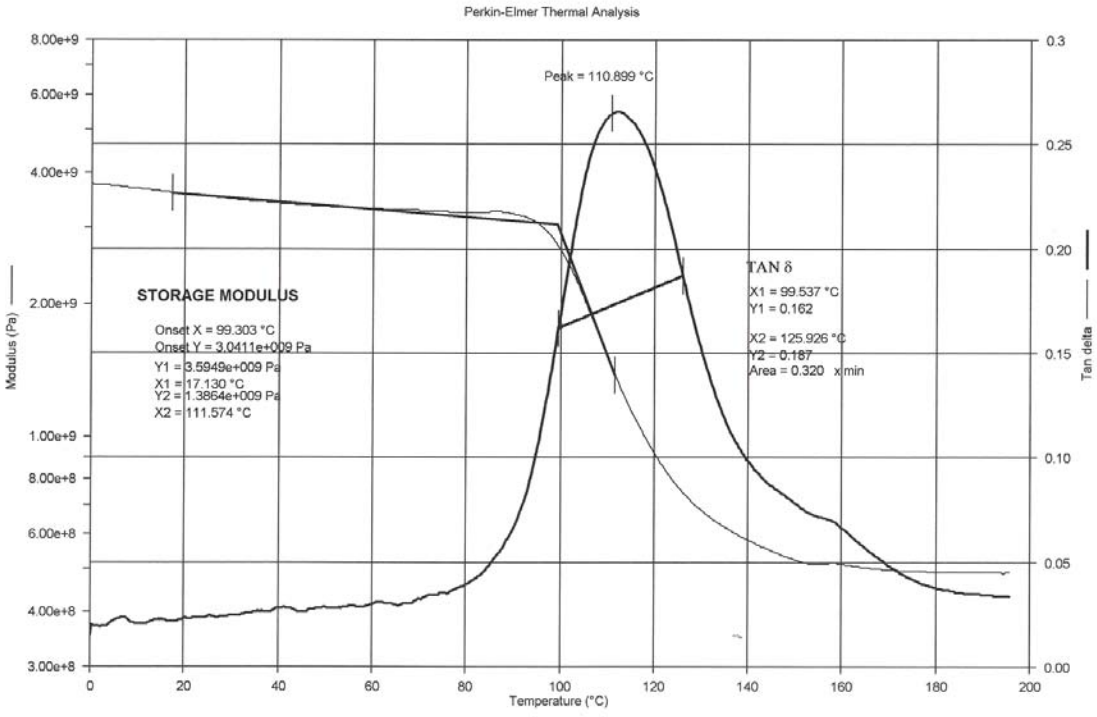

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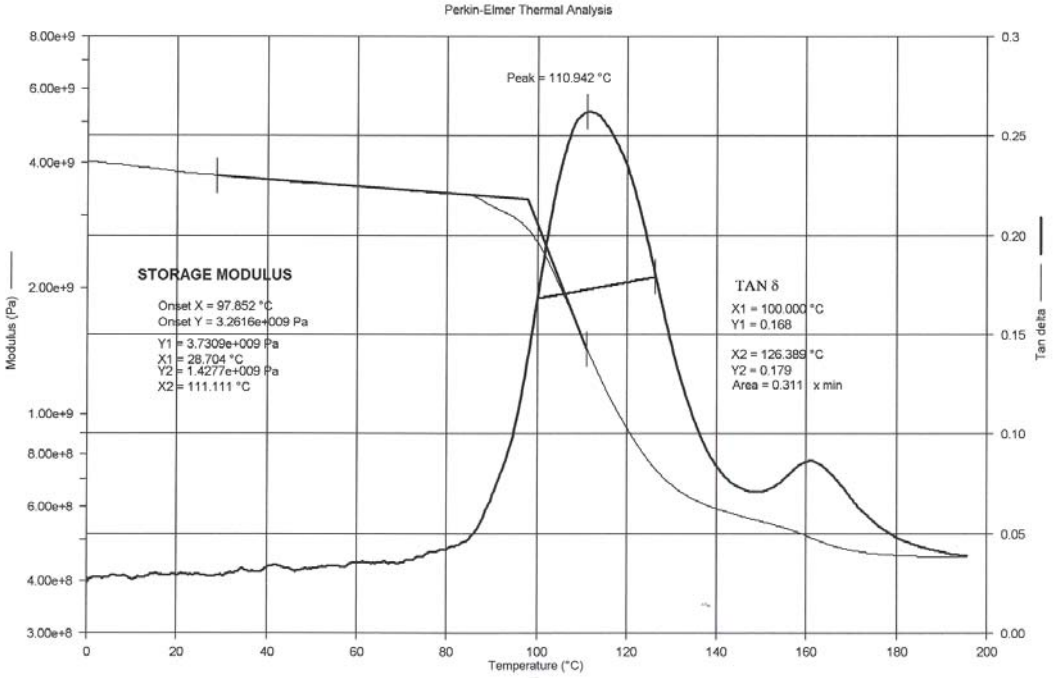

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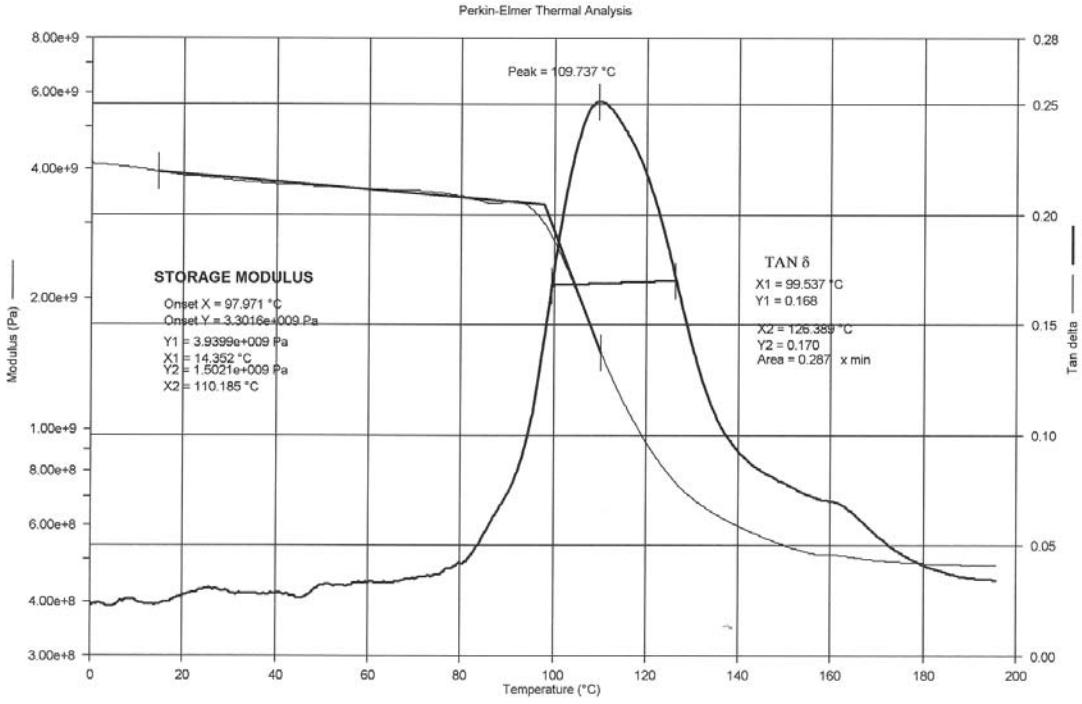

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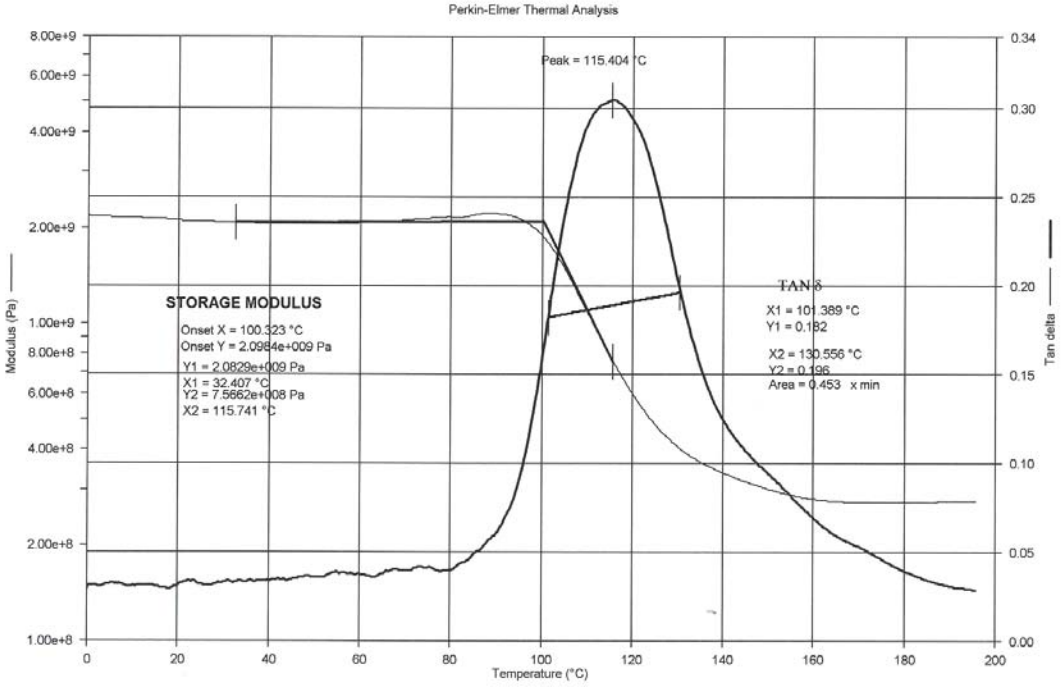

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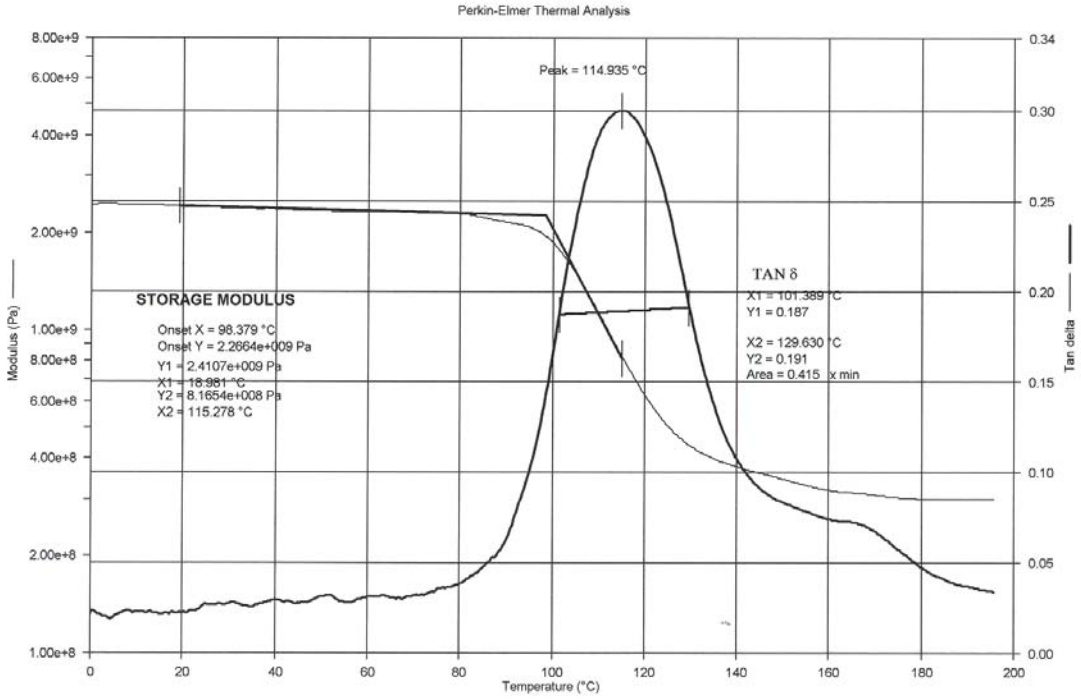

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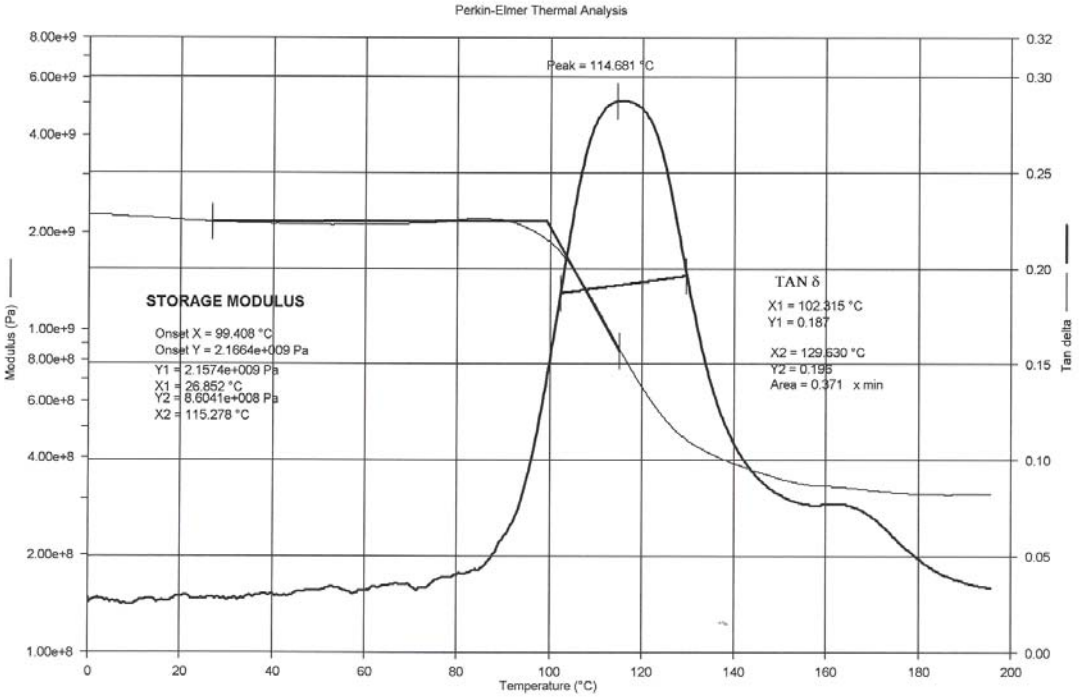

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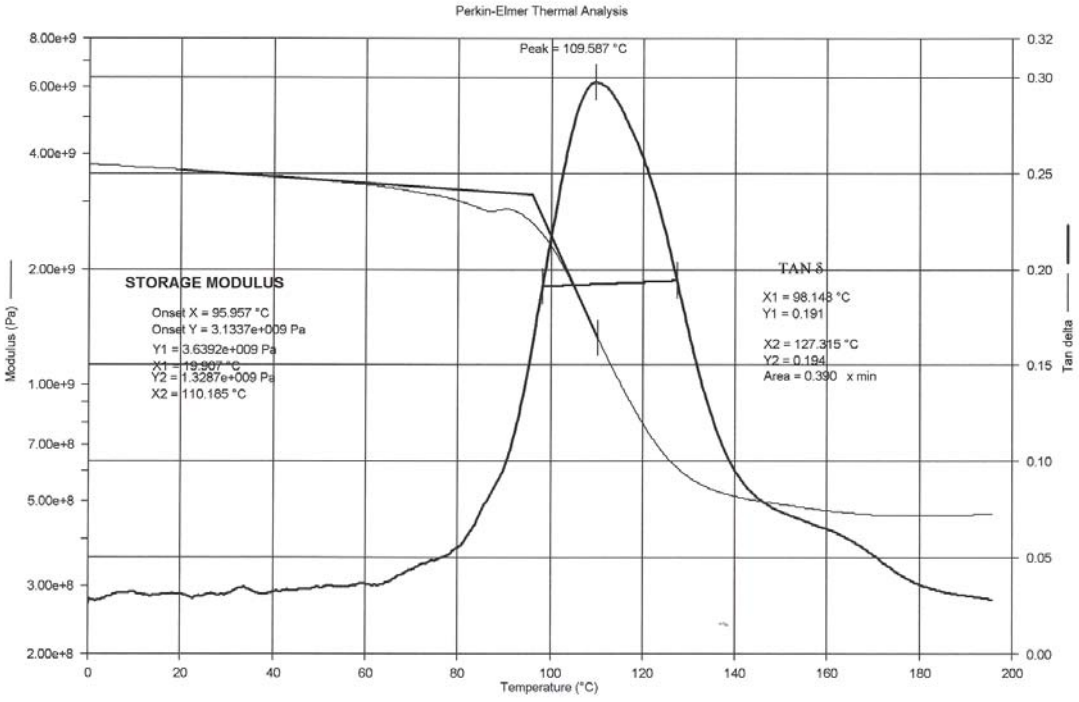

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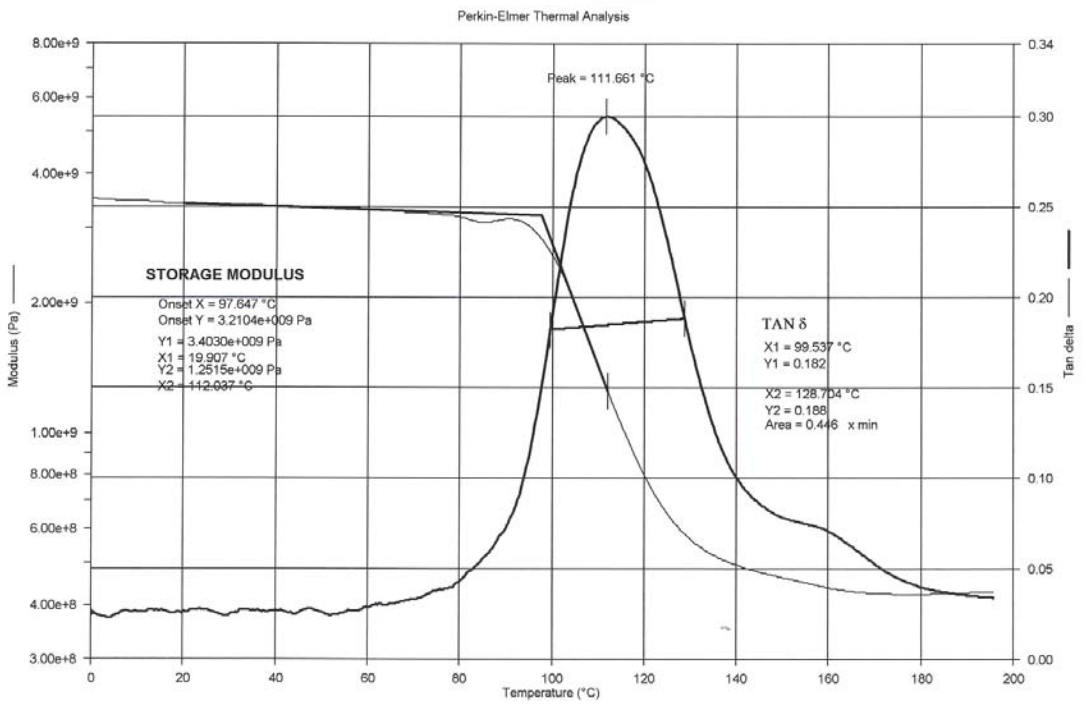

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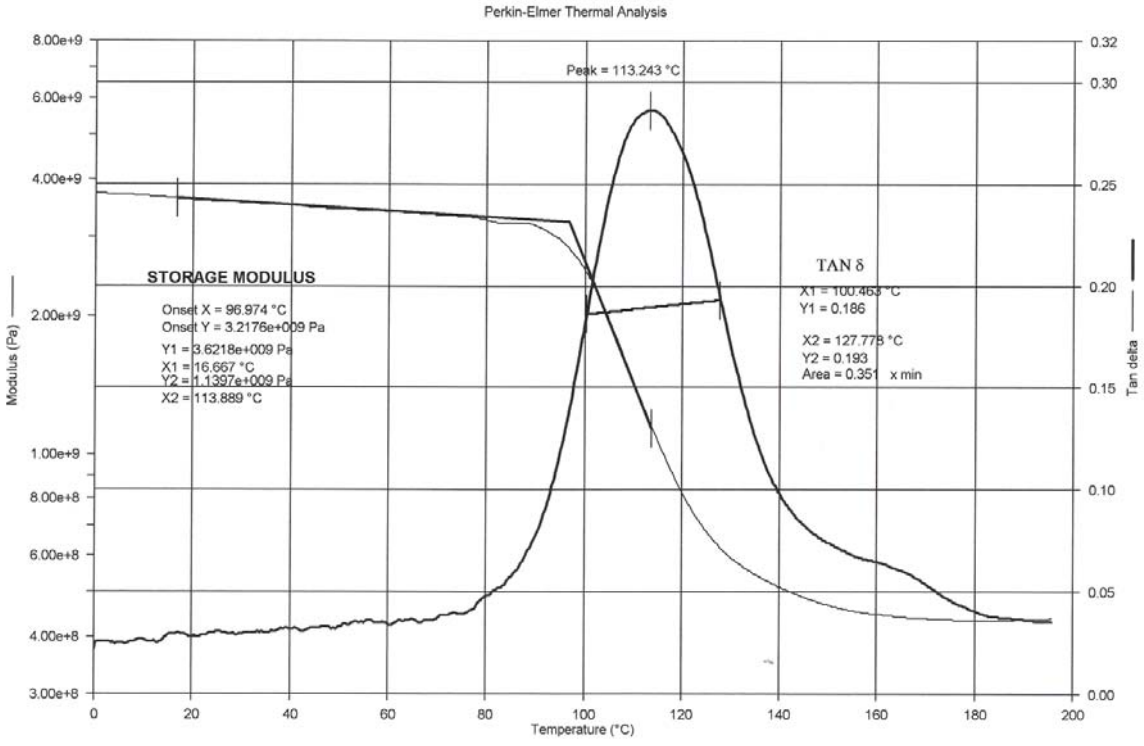

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4.0 TESTING AND REPORTING COMMENTS

Conformity data is documented and archived as part of the Lancair certification program. FAA project No. TC 1616SE-A.

APPENDIX A. DATES OF PANEL MANUFACTURE AND COPY OF FAA FORM 8130-3

1. UNITED STATES

2. **FAA FORM 8130-3**
AIRWORTHINESS APPROVAL TAG
U.S. Department of Transportation
Federal Aviation Administration

3. System Tracking Ref. No.: 990525 JWD-1

4. Organization: PAC
22550 NELSON RD, BEND, OR 97701

5. Work Order, Contract, or Invoice Number:

6. Item	7. Description	8. Part Number	9. Eligibility *	10. Quantity	11. Serial/Batch Number	12. Status/Work
1	LAYUP PANELS	AX 513001	TEST	12 EA	N/A	TEST

13. Remarks

PROJECT # TC1616SE-A DTD 3/19/99
TEST SPEC AX 513001, REV B1, DTD 9/27/99
PANELS #'S ARE 1, 2, 3, 4, 5, 6, 32, 32A, 33, 35, 36, 37

Limited life parts must be accompanied by maintenance history including total time/total cycles/time since new.

14. New [X]
Newly Overhauled [ ]

Certifies that the new or newly overhauled part(s) identified above, except as otherwise specified in block 13 was (were) manufactured in accordance with FAA approved design data and airworthiness.

NOTE: In case of parts to be exported, the special reqirements of the importing country have been met.

19. **Return to Service in Accordance with FAR 43.9**

Certifies that the work specified in block 13 (or attached) above was carried out in accordance with FAA airworthiness regulations and in respect to the work performed the part(s) is (are) approved for return to service.

15. Signature	16. FAA Authorization No.:	20. Authorized Signature:	21. Certificate Number:
	SEATTLE MIDO		
17. Name *(Typed or Printed)*: JAMES W. DOYLE	**18. Date:** 5/25/99	**22. Name *(Typed or Printed)***	**23. Date:**

FAA Form 8130-3 (11-93)

* (Optional) Installer must cross check eligibility with applicable technical data.

1. UNITED STATES

2. **FAA FORM 8130-3**
AIRWORTHINESS APPROVAL TAG
U.S. Department of Transportation
Federal Aviation Administration

3. System Tracking Ref. No.
PAC-99- 0004

4. Organization
Pacific Aviation Composites USA LLC. 22550 Nelson Road. Bend, Or. 97701

5. Work Order, Contract, or Invoice Number:
99-0005, 99-0006, 99-0008
99-0007, 99-0012

6. Item	7. Description	8. Part Number	9. Eligibility *	10. Quantity	11. Serial/Batch Number	12. Status/Work
1	Test Panels	N/A	N/A	19	N/A	Test Specimes

13. Remarks

"CONFORMITY INSPECTION only". Test panels for testing I/A/W Document No. AX513001, Rev B1, dated 1/27/99, "Initial Material Qualification of MGS 418 Resin System with 7781 Glass Fabric and Plain Weave Carbon Cloth for Structural Wet Layup Epoxy Laminates.". Conformed test panels I/A/W Appendix B.Panel Requirements, Table B1, Glass Cloth Panel Requirements. Panel numbers 7-25 and 34 conformed at this time . Remainder of panels weill be presented and conformed at a later date.

Limited life parts must be accompanied by maintenance history including total time/total cycles/time since new.

14.
New [x]
Newly Overhauled [ ]

Certifies that the new or newly overhauled part(s) identified above, except as otherwise specified in block 13 was (were) manufactured in accordance with FAA approved design data and airworthiness.

NOTE: In case of parts to be exported, the special reqirements of the importing country have been met.

19.
Return to Service in Accordance with FAR 43.9

Certifies that the work specified in block 13 (or attached) above was carried out in accordance with FAA airworthiness regulations and in respect to the work performed the part(s) is (are) approved for return to service.

15. Signature	16. FAA Authorization No.:	20. Authorized Signature:	21. Certificate Number:
George B. Pittelkau	DARF351006NM		
17. Name *(Typed or Printed)*:	**18. Date:**	**22. Name *(Typed or Printed)***	**23. Date:**
George B. Pittelkau	03/22/99		

FAA Form 8130-3 (11-93)

* (Optional) Installer must cross check eligibility with applicable technical data.

1. UNITED STATES

2. **FAA FORM 8130-3**
AIRWORTHINESS APPROVAL TAG
U.S. Department of Transportation
Federal Aviation Administration

3. System Tracking Ref. No.: PAC-99-0005

4. Organization: PACIFIC AVIATION COMPOSITES USA LLC, 22550 NELSON RD. BEND, OR. 97701

5. Work Order, ~~Contract, or Invoice~~ Number: 99-0009, 99-0010.

6. Item	7. Description	8. Part Number	9. Eligibility *	10. Quantity	11. Serial/Batch Number	12. Status/Work
1	TEST PANELS	N/A	N/A	6	N/A	TEST SPECIMENS

13. Remarks

"CONFORMITY INSPECTION ONLY". TEST PANELS FOR TESTING I/A/W DOCUMENT NO. AX-513001, REV B1, DATED 1/27/99." INITIAL MATERIAL QUALIFICATION OF MGS 418 RESIN SYSTEM WITH 7781 GLASS FABRIC AND PLAIN WEAVE CARBON CLOTH FOR STRUCTURAL WET LAY UP EPOXY LAMINATES." CONFORMED TEST PANELS I/A/W APPENDIX B. PANEL REQUIREMENTS, TABLE B1, GLASS CLOTH PANEL REQUIREMENTS. PANEL NUMBERS 26-31 CONFORMED AT THIS TIME. REMAINDER OF PANELS WILL BE PRESENTED AND CONFORMED AT A LATER DATE.

Limited life parts must be accompanied by maintenance history including total time/total cycles/time since new.

14. New [X]
Newly Overhauled [ ]

Certifies that the new or newly overhauled part(s) identified above, except as otherwise specified in block 13 was (were) manufactured in accordance with FAA approved design data and airworthiness.

NOTE: In case of parts to be exported, the special reqirements of the importing country have been met.

19. **Return to Service in Accordance with FAR 43.9**

Certifies that the work specified in block 13 (or attached) above was carried out in accordance with FAA airworthiness regulations and in respect to the work performed the part(s) is (are) approved for return to service.

15. Signature	16. FAA Authorization No.:	20. Authorized Signature:	21. Certificate Number:
George B. Pittelkau	DARF357006NM		
17. Name *(Typed or Printed)*:	**18. Date:**	**22. Name *(Typed or Printed)***	**23. Date:**
GEORGE B. PITTELKAU	3/29/99		

FAA Form 8130-3 (11-93)

* (Optional) Installer must cross check eligibility with applicable technical data.