

CHAPTER 6 GLASS FIBER COMPOSITES

6.1 INTRODUCTION

6.2 GLASS\EPOXY COMPOSITES

6.2.1 S2-449 43k/SP381 unidirectional tape

Material Description:

Material: S2-449 17k/PR381

Form: Unidirectional tape, fiber areal weight of 111 g/m², typical cured resin content of 28-33%, typical cured ply thickness of 0.0033 - 0.0037 inches.

Processing: Autoclave cure; 260° F, 50 psi for two hours

General Supplier Information:

Fiber: S2 glass has enhanced properties in strength, modulus, impact resistance and fatigue when compared to conventional E glass roving. The sizing for these fibers is an epoxy compatible 449 finish. Roving of 17,000 filaments. Typical tensile modulus is 12.5 to 13.0 Msi. Typical tensile strength is 665,000 psi.

Matrix: PR381 is a 250°F curing epoxy resin providing properties similar to conventional 350°F curing systems. Light tack for up to 30 days at 75°F.

Maximum Short Term Service Temperature: 220°F (dry), 160°F (wet)

Typical applications: Primary and secondary structural applications where improved fatigue and excellent mechanical strength is important such as helicopters and general aviation.

6.2.1 S2-449 43k/SP381 unidirectional tape

MATERIAL:	S2-449 43.5k/SP 381 unidirectional tape			SG/Ep 284-UT S2-449/SP 381 Summary
FORM:	3M Scotchply SP 381 Uni S29 284 BW 33RC Prepreg			
FIBER:	Owens Corning S2-449, no twist, no surface treatment, typical 449 glass sizing	MATRIX:	3M PR 381	
T _g (dry):	280°F	T _g (wet):	234°F	
PROCESSING:	Autoclave cure: 260±10°F, 120±20 min., 50 psi			

Date of fiber manufacture	5/92 - 12/94	Date of testing	5/93 - 4/95
Date of resin manufacture	1/93 - 12/94	Date of data submittal	6/96
Date of prepreg manufacture	4/93 - 3/95	Date of analysis	2/97
Date of composite manufacture	12/91 - 3/96		

LAMINA PROPERTY SUMMARY

	75°F/A		-65°F/A	180°F/A		160°F/W		
Tension, 1-axis	BM-B		SS-S	SS-S		SS-S		
Tension, 2-axis	SS-S		SS-S	SS-S		SS-S		
Tension, 3-axis								
Compression, 1-axis	SS-S		SS-S	SS-S		SS-S		
Compression, 2-axis								
Compression, 3-axis								
Shear, 12-plane	SS--		SS--	SS--		SS--		
Shear, 23-plane								
Shear, 31-plane								
SBS, 31-plane	S---		S---	S---		S---		

Classes of data in Strength/Modulus/Poisson's Ratio/Strain-to-Failure order: A = A75, a = A55, B = B30, b = B18, M = Mean, I = Interim, S = Screening, - = no data (See Table 1.4.2(c))

Data are also included for F^{sbs} conditioned in eight fluids.

		Nominal	As Submitted	Test Method
Fiber Density	(g/cm ³)	2.49		ASTM C 693
Resin Density	(g/cm ³)	1.216		ASTM D 792
Composite Density	(g/cm ³)	1.85	1.84 - 1.97	
Fiber Areal Weight	(g/m ²)	284	283 - 291	SRM 23B
Fiber Volume	(%)	50	47.3 - 56.1	
Ply Thickness	(in)	0.009	0.0070 - 0.0097	

LAMINATE PROPERTY SUMMARY

	73°F/A							
[±45/0/∓ 45]								
Tension, x-axis	SS-S							
Tension, y-axis	SS-S							

Classes of data in Strength/Modulus/Poisson's Ratio/Strain-to-Failure order: A = A75, a = A55, B = B30, b = B18, M = Mean, I = Interim, S = Screening, - = no data (See Table 1.4.2(c))

MATERIAL:		S2-449 43.5k/SP 381 unidirectional tape				Table 6.2.1(a) SGI/Ep 284-UT S2-449/SP 381 Tension, 1-axis [0]₅ 73/A, -65/A, 180/A B30, Mean, Screening	
RESIN CONTENT:	29-34 wt%	COMP: DENSITY:	1.84-1.97 g/cm ³				
FIBER VOLUME:	47.3-54.7 %	VOID CONTENT:	0-0.07%				
PLY THICKNESS:	0.0080-0.0096 in.						
TEST METHOD:	SRM 4-88		MODULUS CALCULATION:				
			Chord between 1000 and 6000 μe				
NORMALIZED BY:	Specimen thickness and batch fiber areal weight to 50% (0.0090 in. CPT)						
Temperature (°F)	73		-65		180		
Moisture Content (%)	Ambient		Ambient		Ambient		
Equilibrium at T, RH							
Source Code	69		69		69		
	Normalized	Measured	Normalized	Measured	Normalized	Measured	
F ₁ ^{tu} (ksi)	Mean	246	243	236	246	208	211
	Minimum	217	228	204	218	200	200
	Maximum	287	267	257	261	220	228
	C.V.(%)	6.45	3.89	7.44	5.19	3.62	4.79
	B-value	198	219	(1)	(1)	(1)	(1)
Distribution	ANOVA	ANOVA	ANOVA	Weibull	ANOVA	ANOVA	
C ₁	16.8	9.78	21.4	252	8.15	11.7	
C ₂	2.82	2.45	16.6	28.3	9.69	14.1	
No. Specimens	32		11		11		
No. Batches	6		2		2		
Data Class	B30		Screening		Screening		
E ₁ ^t (Msi)	Mean	6.91	6.83	6.93	7.24	6.62	6.70
	Minimum	6.32	6.47	6.41	6.91	6.42	6.55
	Maximum	7.54	7.22	7.24	7.53	6.78	7.09
	C.V.(%)	4.34	2.68	3.03	3.26	1.62	2.48
	B-value	198	219	(1)	(1)	(1)	(1)
Distribution	ANOVA	ANOVA	ANOVA	Weibull	ANOVA	ANOVA	
C ₁	16.8	9.78	21.4	252	8.15	11.7	
C ₂	2.82	2.45	16.6	28.3	9.69	14.1	
No. Specimens	32		11		11		
No. Batches	6		2		2		
Data Class	Mean		Screening		Screening		
ν ₁₂ ^t	Mean						
	No. Specimens						
	No. Batches						
	Data Class						
ε ₁ ^{tu} (μe)	Mean	35600		34100		31500	
	Minimum	33400		29500		30000	
	Maximum	38300		36700		33800	
	C.V.(%)	3.83		6.23		4.21	
	B-value	32400		(1)		(1)	
Distribution	ANOVA		ANOVA		ANOVA		
C ₁	1400		2440		1390		
C ₂	2.28		13.9		7.11		
No. Specimens	32		11		11		
No. Batches	6		2		2		
Data Class	B30		Screening		Screening		

(1) Basis values are presented only for A and B data classes.

MATERIAL: S2-449 43.5k/SP 381 unidirectional tape		Table 6.2.1(b) SGI/Ep 284-UT S2-449/SP 381 Tension, 1-axis [0]₅ 160/W Screening				
RESIN CONTENT: 32-33 wt%	COMP: DENSITY: 1.89-1.97 g/cm ³					
FIBER VOLUME: 49.3-51.1 %	VOID CONTENT: 0-0.07%					
PLY THICKNESS: 0.0088-0.0092 in.						
TEST METHOD: SRM 4-88	MODULUS CALCULATION: Chord between 1000 and 6000 $\mu\epsilon$					
NORMALIZED BY: Specimen thickness and batch fiber areal weight to 50% (0.0090 in. CPT)						
Temperature ($^{\circ}$ F)	160					
Moisture Content (%)	Wet					
Equilibrium at T, RH	(2)					
Source Code	69					
	Normalized	Measured	Normalized	Measured	Normalized	Measured
F_1^{tu} (ksi)	Mean	113	115			
	Minimum	105	106			
	Maximum	119	120			
	C.V.(%)	3.90	3.22			
	B-value	(1)	(1)			
	Distribution	Weibull	Weibull			
	C_1	115	116			
	C_2	32.6	40.5			
	No. Specimens	13				
	No. Batches	2				
Data Class	Screening					
E_1^t (Msi)	Mean	6.86	6.95			
	Minimum	6.52	6.71			
	Maximum	7.25	7.16			
	C.V.(%)	3.19	2.06			
	No. Specimens	13				
No. Batches	2					
Data Class	Screening					
ν_{12}^t	Mean					
	No. Specimens					
	No. Batches					
Data Class						
ϵ_1^{tu} ($\mu\epsilon$)	Mean		16500			
	Minimum		15600			
	Maximum		17100			
	C.V.(%)		2.76			
	B-value		(1)			
	Distribution		Weibull			
	C_1		16700			
	C_2		45.9			
	No. Specimens	13				
	No. Batches	2				
Data Class	Screening					

(1) Basis values are presented only for A and B data classes.

(2) Conditioned in 160°F water for 14 days.

Table 6.2.1(c)
SGI/Ep 284-UT
S2-449/SP 381
Tension, 2-axis
[90]₁₀
73/A, -65A, 180/A, 160/W
Screening

MATERIAL: S2-449 43.5k/SP 381 unidirectional tape
 RESIN CONTENT: 31-32 wt% COMP: DENSITY: 1.84-1.86 g/cm³
 FIBER VOLUME: 51.0-53.2 % VOID CONTENT: 0-0.99%
 PLY THICKNESS: 0.0081-0.0092 in.
 TEST METHOD: SRM 4-88 MODULUS CALCULATION: Chord between 1000 and 3000 με (2)
 NORMALIZED BY: Not normalized

Temperature (°F)	73	-65	180	160		
Moisture Content (%)	Ambient	Ambient	Ambient	Wet		
Equilibrium at T, RH				(3)		
Source Code	69	69	69	69		
F ₂ ^{tu} (ksi)	Mean	9.0	9.1	7.5	4.2	
	Minimum	8.7	8.3	7.1	3.8	
	Maximum	9.3	9.8	7.6	4.7	
	C.V.(%)	2.3	4.7	2.7	7.5	
	B-value	(1)	(1)	(1)	(1)	
	Distribution	Weibull	Weibull	Normal	Weibull	
	C ₁	9.1	9.3	7.5	4.3	
	C ₂	49	24	0.20	14	
	No. Specimens	10	11	6	10	
	No. Batches	2	2	1	2	
Data Class	Screening	Screening	Screening	Screening		
E ₂ ^t (Msi)	Mean	1.93	2.10	1.53	1.07	
	Minimum	1.85	1.88	1.47	1.00	
	Maximum	2.07	2.31	1.59	1.12	
	C.V.(%)	3.31	5.57	2.58	3.23	
	No. Specimens	10	11	6	10	
No. Batches	2	2	1	2		
Data Class	Screening	Screening	Screening	Screening		
ν ₂₁ ^t	Mean					
	No. Specimens					
	No. Batches					
	Data Class					
ε ₂ ^{tu} (με)	Mean	4700	4300	4900	3900	
	Minimum	4200	3800	4600	3400	
	Maximum	5100	4800	5100	4300	
	C.V.(%)	4.6	7.2	4.6	6.7	
	B-value	(1)	(1)	(1)	(1)	
	Distribution	Nonpara.	Weibull	Normal	Weibull	
	C ₁	6	4500	4900	4000	
	C ₂	2.1	16	220	17	
	No. Specimens	10	11	6	10	
	No. Batches	2	2	1	2	
Data Class	Screening	Screening	Screening	Screening		

(1) Basis values are presented only for A and B data classes.
 (2) Exception to SRM 4-88.
 (3) Conditioned in 160°F water for 14 days.

MATERIAL: S2-449 43.5k/SP 381 unidirectional tape		Table 6.2.1(d) SGI/Ep 284-UT S2-449/SP 381 Compression, 1-axis [0]_s 73/A, -65/A, 180/A Screening					
RESIN CONTENT: 28-33 wt%	COMP: DENSITY: 1.90-1.94 g/cm ³						
FIBER VOLUME: 49.3-56.1 %	VOID CONTENT: 0.12-0.50%						
PLY THICKNESS: 0.0080-0.0094 in.							
TEST METHOD: SRM 1-88	MODULUS CALCULATION: Chord between 1000 and 3000 με						
NORMALIZED BY: Specimen thickness and batch fiber areal weight to 50% (0.0090 in. CPT)							
Temperature (°F)	73 Ambient	-65 Ambient		180 Ambient			
Moisture Content (%)							
Equilibrium at T, RH							
Source Code	69	69		69			
	Normalized	Measured	Normalized	Measured	Normalized	Measured	
Mean	168	182	170	177	150	166	
Minimum	141	149	153	162	137	154	
Maximum	199	215	184	196	166	179	
C.V.(%)	10.4	10.8	5.20	5.59	6.70	4.93	
F_1^{cu} (ksi)	B-value	(1)	(1)	(1)	(1)	(1)	
	Distribution	Weibull	Weibull	Weibull	ANOVA	ANOVA	Weibull
	C ₁	176	191	174	10.9	12.3	170
	C ₂	10.6	10.5	22.0	11.3	16.6	22.2
No. Specimens	20		14		12		
No. Batches	2		2		2		
Data Class	Screening		Screening		Screening		
Mean	6.96	7.06	6.87	7.20	6.76	6.95	
Minimum	6.71	6.67	6.75	6.75	6.54	6.75	
Maximum	7.20	7.34	7.01	7.68	6.94	7.16	
C.V.(%)	2.43	2.68	1.40	4.16	1.74	2.22	
E_1^c (Msi)	No. Specimens	10		10		10	
	No. Batches	2		2		2	
	Data Class	Screening		Screening		Screening	
Mean							
No. Specimens							
No. Batches							
Data Class							
Mean							
Minimum							
Maximum							
C.V.(%)							
ϵ_1^{cu} (με)	B-value						
	Distribution						
	C ₁						
C ₂							
No. Specimens							
No. Batches							
Data Class							

(1) Basis values are presented only for A and B data classes.

MATERIAL: S2-449 43.5k/SP 381 unidirectional tape		Table 6.2.1(e) SGI/Ep 284-UT S2-449/SP 381 Compression, 1-axis [0]_s 160/W Screening				
RESIN CONTENT: 28-33 wt%	COMP: DENSITY: 1.90-1.94 g/cm ³					
FIBER VOLUME: 49.3-56.1 %	VOID CONTENT: 0.12-0.50%					
PLY THICKNESS: 0.0082-0.0090 in.						
TEST METHOD: SRM 1-88	MODULUS CALCULATION: Chord between 1000 and 3000 με					
NORMALIZED BY: Specimen thickness and batch fiber areal weight to 50% (0.0090 in. CPT)						
Temperature (°F)	160					
Moisture Content (%)	Wet					
Equilibrium at T, RH	(2)					
Source Code	69					
	Normalized	Measured	Normalized	Measured	Normalized	Measured
F_1^{cu} (ksi)	Mean	139	146			
	Minimum	130	131			
	Maximum	146	157			
	C.V.(%)	3.48	5.27			
	B-value	(1)	(1)			
	Distribution	Weibull	Weibull			
	C ₁	141	149			
	C ₂	37.4	22.6			
	No. Specimens	10				
	No. Batches	2				
Data Class	Screening					
E_1^c (Msi)	Mean	6.92	7.16			
	Minimum	6.69	6.85			
	Maximum	7.08	7.43			
	C.V.(%)	2.11	2.83			
	No. Specimens	10				
No. Batches	2					
Data Class	Screening					
ν_{12}^c	Mean					
	No. Specimens					
	No. Batches					
Data Class						
ϵ_1^{cu} (με)	Mean					
	Minimum					
	Maximum					
	C.V.(%)					
	B-value					
	Distribution					
	C ₁					
	C ₂					
	No. Specimens					
	No. Batches					
Data Class						

(1) Basis values are presented only for A and B data classes.
 (2) Conditioned in 160°F water for 14 days.

MATERIAL:		S2-449 43.5k/SP 381 unidirectional tape				Table 6.2.1(f) SGI/Ep 284-UT S2-449/SP 381 Shear, 12-plane [±45]_{2S} 73/A, -65A, 180/A, 160/W Screening
RESIN CONTENT:	29-32 wt%	COMP: DENSITY:	1.88-1.94 g/cm ³			
FIBER VOLUME:	51.1-54.5 %	VOID CONTENT:	0.21-0.60%			
PLY THICKNESS:	0.0081-0.0090 in.					
TEST METHOD:	SRM 7-88		MODULUS CALCULATION:			
			Chord between 500 and 3000 με, axial			
NORMALIZED BY:	Not normalized					
Temperature (°F)	73	-65	180	160		
Moisture Content (%)	Ambient	Ambient	Ambient	Wet		
Equilibrium at T, RH				(2)		
Source Code	69	69	69	69		
F ₁₂ ^{SU} (ksi)	Mean	14.3	13.6	11.8	9.5	
	Minimum	13.2	12.9	10.8	9.0	
	Maximum	14.7	14.5	12.3	9.8	
	C.V.(%)	3.52	3.77	3.66	2.9	
	B-value	(1)	(1)	(1)	(1)	
	Distribution	Nonpara.	Normal	Weibull	Weibull	
	C ₁	6	13.6	12.0	9.6	
	C ₂	2.14	0.515	38.4	44	
	No. Specimens	10	9	10	12	
	No. Batches	2	2	2	2	
Data Class	Screening	Screening	Screening	Screening		
G ₁₂ (Msi)	Mean	0.689	0.881	0.555	0.470	
	Minimum	0.648	0.837	0.541	0.455	
	Maximum	0.729	0.952	0.578	0.480	
	C.V.(%)	3.62	5.06	2.26	1.76	
	No. Specimens	9	6	10	10	
No. Batches	2	2	2	2		
Data Class	Screening	Screening	Screening	Screening		

(1) Basis values are presented only for A and B data classes.
 (2) Conditioned in 160°F water for 14 days.

MATERIAL:	S2-449 43.5k/SP 381 unidirectional tape		
RESIN CONTENT:	30-34 wt%	COMP: DENSITY:	1.84-1.94 g/cm ³
FIBER VOLUME:	47.6-53.1 %	VOID CONTENT:	0.0-0.64%
PLY THICKNESS:	0.0070-0.0092 in.		
TEST METHOD:	MODULUS CALCULATION:		
SRM 8-88			
NORMALIZED BY:	Not normalized		

<p>Table 6.2.1(g) SGL/Ep 284-UT S2-449/SP 381 SBS, 31-plane [0]₁₂ 73/A, -65A, 180/A, 160/W Screening</p>
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Temperature (°F)	73	-65	180	160		
Moisture Content (%)	Ambient	Ambient	Ambient	Wet		
Equilibrium at T, RH				(2)		
Source Code	69	69	69	69		
Mean	12.4	14.6	8.7	7.2		
Minimum	11.6	13.9	8.2	7.0		
Maximum	13.2	15.6	9.0	7.4		
C.V.(%)	4.16	3.32	2.9	1.7		
B-value	(1)	(1)	(1)	(1)		
Distribution	ANOVA	Normal	ANOVA	Weibull		
F ₃₁ ^{sbs}						
(ksi) C ₁	0.573	14.6	0.31	7.3		
C ₂	3.85	0.485	18	67		
No. Specimens	25	14	14	13		
No. Batches	4	2	2	2		
Data Class	Screening	Screening	Screening	Screening		

(1) Short beam strength test data are approved for Screening Data Class only.
(2) Conditioned in 160°F water for 14 days.

MATERIAL: S2-449 43.5k/SP 381 unidirectional tape		Table 6.2.1(h) SGI/Ep 284-UT S2-449/SP 381 SBS, 31-plane [0]₁₂ 73/Fluids Screening				
RESIN CONTENT: 30 wt%	COMP: DENSITY: 1.93-1.94 g/cm ³					
FIBER VOLUME: 52.9-53.1 %	VOID CONTENT: 0.0-0.64%					
PLY THICKNESS: 0.00792-0.00925 in.						
TEST METHOD: SRM 8-88	MODULUS CALCULATION:					
NORMALIZED BY: Not normalized						
Temperature (°F)	73	73	73	73		
Moisture Content (%)	(2)	(3)	(4)	(5)		
Equilibrium at T, RH						
Source Code	69	69	69	69		
Mean	11.8	12.3	11.6	11.9		
Minimum	11.0	11.8	9.40	11.4		
Maximum	12.3	13.0	12.8	12.6		
C.V.(%)	3.49	2.87	8.23	3.17		
B-value	(1)	(1)	(1)	(1)		
F ₃₁ ^{sbs} Distribution	Weibull	Normal	ANOVA	Normal		
(ksi) C ₁	11.9	12.4	1.07	11.9		
C ₂	34.7	0.355	12.2	0.376		
No. Specimens	14	14	14	14		
No. Batches	2	2	2	2		
Data Class	Screening	Screening	Screening	Screening		

- (1) Short beam strength test data are approved for Screening Data Class only.
- (2) Conditioned in MIL-A-8243 Anti-Icing Fluid at 32°F for 30 days.
- (3) Conditioned in MIL-H-83282 hydraulic Fluid at 160°F for 90 days. MIL-H-83282 was converted to MIL-PRF-83282 on September 30, 1997.
- (4) Conditioned in MIL-H-5606 hydraulic fluid at 160°F for 90 days.
- (5) Conditioned in MIL-T-5624 fuel at 75°F for 90 days. MIL-T-5624 was converted to MIL-PRF-5624 on November 22, 1996.

MATERIAL:	S2-449 43.5k/SP 381 unidirectional tape			Table 6.2.1(i) SGI/Ep 284-UT S2-449/SP 381 SBS, 31-plane [0]₁₂ 73/Fluids Screening
RESIN CONTENT:	30 wt%	COMP: DENSITY:	193-1.94 g/cm ³	
FIBER VOLUME:	52.9-53.1 %	VOID CONTENT:	0.0-0.64%	
PLY THICKNESS:	0.00758-0.00933 in.			
TEST METHOD:	MODULUS CALCULATION:			
	SRM 8-88			
NORMALIZED BY:	Not normalized			

Temperature (°F)	73	73	73	73		
Moisture Content (%)	(2)	(3)	(4)	(5)		
Equilibrium at T, RH						
Source Code	69	69	69	69		
Mean	11.8	12.1	11.7	11.8		
Minimum	11.1	10.9	10.6	11.3		
Maximum	12.6	12.6	12.3	12.3		
C.V.(%)	3.47	3.84	4.02	2.91		
B-value	(1)	(1)	(1)	(1)		
F ₃₁ ^{sbs} (ksi)	Distribution	Weibull	Weibull	Weibull	ANOVA	
C ₁	12.0	12.3	11.9	0.386		
C ₂	30.7	39.5	37.2	12.6		
No. Specimens	14	14	13	14		
No. Batches	2	2	2	2		
Data Class	Screening	Screening	Screening	Screening		

- (1) Short beam strength test data are approved for Screening Data Class only.
- (2) Conditioned in MIL-L-23699 lubricating oil at 160°F for 90 days. MIL-L-23699 was converted to MIL-PRF-23699 on May 21, 1997.
- (3) Conditioned in MIL-L-7808 lubricating oil at 160°F for 90 days. MIL-L-7808 was converted to MIL-PRF-7808 on May 2, 1997.
- (4) Conditioned in MIL-C-87936 cleaning fluid at 75°F for 7 days. MIL-C-87936 was canceled on March 1, 1995 and replaced with MIL-C-87937. MIL-C-87937 was converted to MIL-PRF-87937 on August 14, 1997.
- (5) Conditioned in ASTM D 740 methyl ethyl ketone (MEK) at 75°F for 7 days.

Table 6.2.1(j)
SGI/Ep 284-UT
S2-449/SP 381
Tension, x-axis
[±45/0/±45]_s
73/A
Screening

MATERIAL: S2-449 43.5k/SP 381 unidirectional tape

RESIN CONTENT: 30-31wt% COMP: DENSITY: 1.92-1.94 g/cm³
 FIBER VOLUME: 51.6-53.5 % VOID CONTENT: 0-0.50%
 PLY THICKNESS: 0.0086-0.0089 in.

TEST METHOD: SRM 4-88 MODULUS CALCULATION: Chord between 1000 and 3000 µε

NORMALIZED BY: Specimen thickness and batch fiber areal weight to 50% (0.0090 in. CPT)

Temperature (°F)		73					
Moisture Content (%)		Ambient					
Equilibrium at T, RH		69					
Source Code							
		Normalized	Measured	Normalized	Measured	Normalized	Measured
F_x^{tu} (ksi)	Mean	69.5	72.9				
	Minimum	66.7	71.4				
	Maximum	71.3	75.6				
	C.V.(%)	2.18	1.67				
	B-value	(1)	(1)				
	Distribution	ANOVA	Normal				
	C ₁	1.74	72.9				
	C ₂	13.7	1.22				
	No. Specimens	10					
	No. Batches	2					
Data Class	Screening						
E_x^t (Msi)	Mean	2.87	3.01				
	Minimum	2.78	2.94				
	Maximum	2.96	3.11				
	C.V.(%)	2.21	1.58				
	No. Specimens	10					
No. Batches	2						
Data Class	Screening						
ν_{xy}^t	Mean						
	No. Specimens						
	No. Batches						
	Data Class						
ϵ_x^{tu} (µε)	Mean		24200				
	Minimum		23600				
	Maximum		24900				
	C.V.(%)		1.69				
	B-value		(1)				
	Distribution		Weibull				
	C ₁		24400				
	C ₂		65.4				
	No. Specimens	10					
	No. Batches	2					
Data Class	Screening						

(1) Basis values are presented only for A and B data classes.

MATERIAL:	S2-449 43.5k/SP 381 unidirectional tape			Table 6.2.1(k) SGI/Ep 284-UT S2-449/SP 381 Tension, y-axis [±45/90/±45]_s 73/A Screening
RESIN CONTENT:	30-31 wt%	COMP: DENSITY:	1.92-1.94 g/cm ³	
FIBER VOLUME:	51.6-53.5 %	VOID CONTENT:	0-0.50%	
PLY THICKNESS:	0.0083-0.0090 in.			
TEST METHOD:	SRM 4-88	MODULUS CALCULATION:	Chord between 1000 and 3000 µε	
NORMALIZED BY:	Specimen thickness and batch fiber areal weight to 50% (0.0090 in. CPT)			

Temperature (°F)		73					
Moisture Content (%)		Ambient					
Equilibrium at T, RH		69					
Source Code							
		Normalized	Measured	Normalized	Measured	Normalized	Measured
F_y^{tu} (ksi)	Mean	24.9	26.2				
	Minimum	23.9	24.7				
	Maximum	25.9	27.3				
	C.V.(%)	2.29	2.94				
	B-value	(1)	(1)				
	Distribution	Weibull	Weibull				
	C ₁	25.1	26.5				
	C ₂	47.1	42.2				
	No. Specimens	10					
	No. Batches	2					
Data Class	Screening						
E_y^t (Msi)	Mean	2.15	2.26				
	Minimum	2.10	2.18				
	Maximum	2.20	2.39				
	C.V.(%)	1.33	3.50				
	No. Specimens	10					
No. Batches	2						
Data Class	Screening						
ν_{yx}^t	Mean						
	No. Specimens						
	No. Batches						
	Data Class						
ϵ_y^{tu} (µε)	Mean		11600				
	Minimum		10900				
	Maximum		12000				
	C.V.(%)		2.65				
	B-value		(1)				
	Distribution		Weibull				
	C ₁		11700				
	C ₂		49.8				
	No. Specimens		10				
	No. Batches		2				
Data Class		Screening					

(1) Basis values are presented only for A and B data classes.

6.2.2 S2-449 17k/SP 381 unidirectional tapeMaterial Description:

Material: S2-449 43.5k/3M PR381

Form: Unidirectional tape, fiber areal weight of 284 g/m², typical cured resin content of 28-33%, typical cured ply thickness of 0.0081 - 0.009 inches.

Processing: Autoclave cure; 260° F, 50 psi for two hours

General Supplier Information:

Fiber: S2 glass has enhanced properties in strength, modulus impact resistance and fatigue when compared to conventional E glass roving. The sizing for these fibers is an epoxy compatible 449 finish material. Rovings of 43,500 filaments. Typical tensile modulus is 12.5 to 13.0 Msi. Typical tensile strength is 665,000 psi.

Matrix: PR381 is a 250°F curing epoxy resin providing properties similar to conventional 350°F curing systems. Light tack for up to 30 days at 75°F.

Maximum Short Term Service Temperature: 220°F (dry), 160°F (wet)

Typical applications: Primary and secondary structural applications where improved fatigue and excellent mechanical strength is important such as helicopters and general aviation.

6.2.2 S2-449 17k/SP 381 unidirectional tape

MATERIAL:	S2-449 17k/SP 381 unidirectional tape			SG/Ep 111-UT S2-449/SP 381 Summary	
FORM:	3M Scotchply SP 381 Uni S29 111BW 33 RC				
FIBER:	Owens Corning S2-449, no twist, no surface treatment, typical 449 glass sizing	MATRIX:	3M SP 381		
T _g (dry):	291°F	T _g (wet):	234°F		T _g METHOD: SRM 18, RDA, G" peak
PROCESSING:	Autoclave cure: 260±10°F, 120±20 min., 50 psi				

Date of fiber manufacture	8/91 - 12/94	Date of testing	6/93 - 4/96
Date of resin manufacture	11/91 - 5/95	Date of data submittal	6/96
Date of prepreg manufacture	11/91 - 2/96	Date of analysis	2/97
Date of composite manufacture	12/91 - 3/96		

LAMINA PROPERTY SUMMARY

	73°F/A		-65°F/A	180°F/A		160°F/W		
Tension, 1-axis	bM-b		SS-S	SS-S		SS-S		
Tension, 2-axis	SS-S		SS-S	SS-S		SS-S		
Tension, 3-axis								
Compression, 1-axis	SS-S		SS-S	SS-S		SS-S		
Compression, 2-axis								
Compression, 3-axis								
Shear, 12-plane	IS--		IS--	IS--		SS--		
Shear, 23-plane								
Shear, 31-plane								
SBS, 31-plane	S---		S---	S---		S---		

Classes of data in Strength/Modulus/Poisson's Ratio/Strain-to-Failure order: A = A75, a = A55, B = B30, b = B18, M = Mean, I = Interim, S = Screening, - = no data (See Table 1.4.2(c))

Data are also included for F^{sbs} conditioned in eight fluids.

		Nominal	As Submitted	Test Method
Fiber Density	(g/cm ³)	2.49		ASTM C 693
Resin Density	(g/cm ³)	1.216		ASTM D 792
Composite Density	(g/cm ³)	1.85	1.82 - 1.94	
Fiber Areal Weight	(g/m ²)	111	111 - 113	SRM 23B
Fiber Volume	(%)	50	47.6 - 55.2	
Ply Thickness	(in)	0.0035	0.00303 - 0.00375	

LAMINATE PROPERTY SUMMARY

	73°F/A							
[±45/0/∓ 45]								
Tension, x-axis	SS-S							
Tension, y-axis	SS-S							

Classes of data in Strength/Modulus/Poisson's Ratio/Strain-to-Failure order: A = A75, a = A55, B = B30, b = B18, M = Mean, I = Interim, S = Screening, - = no data (See Table 1.4.2(c))

Table 6.2.2(a)
SGI/Ep 111-UT
S2-449/SP 381
Tension, 1-axis
[0]₁₂
73/A, -65/A, 180/A
B18, Mean, Interim,
Screening

MATERIAL: S2-449 17k/SP 381 unidirectional tape

RESIN CONTENT: 29-36 wt% COMP: DENSITY: 1.85-1.93 g/cm³
 FIBER VOLUME: 47.6-54.0 % VOID CONTENT: 0.0-0.17%
 PLY THICKNESS: 0.0032-0.0038 in.

TEST METHOD: SRM 4-88 MODULUS CALCULATION: Chord between 1000 and 6000 με

NORMALIZED BY: Specimen thickness and batch fiber areal weight to 50% (0.0035 in. CPT)

Temperature (°F) Moisture Content (%) Equilibrium at T, RH Source Code	73 Ambient		-65 Ambient		180 Ambient	
	70		70		70	
	Normalized	Measured	Normalized	Measured	Normalized	Measured
Mean	255	248	267	274	225	225
Minimum	243	228	233	251	218	216
Maximum	277	274	287	302	237	234
C.V.(%)	3.40	5.07	6.52	5.96	3.13	2.59
F_1^{tu} (ksi)	238	(2)	(1)	(1)	(1)	(1)
B-value Distribution	Normal	ANOVA	Weibull	Weibull	Weibull	Weibull
C ₁	255	13.6	274	281	228	228
C ₂	8.65	3.53	21.3	18.1	32.9	43.2
No. Specimens	21		11		11	
No. Batches	4		2		2	
Data Class	B18		Screening		Screening	
Mean	6.93	6.75	7.01	7.19	6.73	6.73
Minimum	6.61	6.26	6.70	6.98	6.50	6.50
Maximum	7.18	7.16	7.31	7.49	7.09	7.09
C.V.(%)	2.29	4.37	2.98	2.19	2.80	2.95
E_1^t (Msi)	21		11		11	
No. Batches	4		2		2	
Data Class	Mean		Screening		Screening	
Mean						
No. Specimens						
No. Batches						
Data Class						
ν_{12}^t						
Mean	36800		38000		33400	
Minimum	34600		33500		31000	
Maximum	38600		40900		35100	
C.V.(%)	3.09		5.85		3.84	
ϵ_1^{tu} (μϵ)	34100		(1)		(1)	
B-value Distribution	Weibull		Weibull		Weibull	
C ₁	37300		39000		34000	
C ₂	37.9		22.5		34.9	
No. Specimens	21		11		11	
No. Batches	4		2		2	
Data Class	B18		Screening		Screening	

(1) Basis values are presented only for A and B data classes.
 (2) B-basis values calculated from less than five batches of data using the ANOVA method are not presented.

Table 6.2.2(b)
SGI/Ep 111-UT
S2-449/SP 381
Tension, 1-axis
[0]₁₂
160/W
Screening

MATERIAL: S2-449 17k/SP 381 unidirectional tape

RESIN CONTENT: 29-31 wt% COMP: DENSITY: 1.90-1.93 g/cm³
 FIBER VOLUME: 49.0-50.1 % VOID CONTENT: 0.00%

PLY THICKNESS: 0.0034-0.0038 in.

TEST METHOD: SRM 4-88 MODULUS CALCULATION: Chord between 1000 and 6000 $\mu\epsilon$

NORMALIZED BY: Specimen thickness and batch fiber areal weight to 50% (0.0035 in. CPT)

Temperature (°F)		160					
Moisture Content (%)		Wet					
Equilibrium at T, RH		(2)					
Source Code		70					
		Normalized	Measured	Normalized	Measured	Normalized	Measured
F_1^{tu} (ksi)	Mean	116	113				
	Minimum	107	108				
	Maximum	123	123				
	C.V.(%)	4.34	3.54				
	B-value	(1)	(1)				
	Distribution	Weibull	Normal				
	C ₁	118	113				
	C ₂	26.8	4.01				
	No. Specimens	13					
	No. Batches	2					
Data Class	Screening						
E_1^t (Msi)	Mean	6.84	6.71				
	Minimum	6.50	6.49				
	Maximum	7.12	6.97				
	C.V.(%)	2.57	1.99				
	No. Specimens	13					
No. Batches	2						
Data Class	Screening						
ν_{12}^t	Mean						
	No. Specimens						
	No. Batches						
Data Class							
ϵ_1^{tu} ($\mu\epsilon$)	Mean		16900				
	Minimum		15800				
	Maximum		18100				
	C.V.(%)		3.90				
	B-value		(1)				
	Distribution		Weibull				
	C ₁		17200				
	C ₂		28.7				
	No. Specimens		13				
	No. Batches		2				
Data Class		Screening					

(1) Basis values are presented only for A and B data classes.
 (2) Conditioned in 160°F water for 14 days.

MATERIAL:		S2-449 17k/SP 381 unidirectional tape				Table 6.2.2(c) SGI/Ep 111-UT S2-449/SP 381 Tension, 2-axis [90]₂₀ 73/A, -65/A, 180/A, 160/W Screening	
RESIN CONTENT:	29-31 wt%	COMP: DENSITY:	1.88-1.92 g/cm ³				
FIBER VOLUME:	48.8-50.1 %	VOID CONTENT:	0.0%				
PLY THICKNESS:	0.0033-0.0036 in.						
TEST METHOD:	SRM 4-88		MODULUS CALCULATION:				
NORMALIZED BY:		Not normalized		Chord between 1000 and 3000 $\mu\epsilon$ (2)			
Temperature (°F)	73	-65	180	160			
Moisture Content (%)	Ambient	Ambient	Ambient	Wet			
Equilibrium at T, RH				(3)			
Source Code	70	70	70	70			
Mean	8.7	10.0	6.4	3.6			
Minimum	8.1	9.6	5.9	3.1			
Maximum	9.0	10.3	6.7	3.9			
C.V.(%)	3.9	3.6	4.0	9.0			
F_2^{tu}	(1)	(4)	(1)	(1)			
Distribution	Normal		Normal	Normal			
C ₁	8.7		6.4	3.6			
C ₂	0.34		0.26	0.32			
No. Specimens	5	3	8	5			
No. Batches	1	1	2	1			
Data Class	Screening	Screening	Screening	Screening			
Mean	1.84	2.11	1.42	1.10			
Minimum	1.82	2.06	1.34	1.05			
Maximum	1.91	2.15	1.55	1.16			
C.V.(%)	2.05	2.14	6.43	4.59			
E_2^t							
(Msi)							
No. Specimens	5	3	4	5			
No. Batches	1	1	1	1			
Data Class	Screening	Screening	Screening	Screening			
Mean							
ν_{21}^t							
No. Specimens							
No. Batches							
Data Class							
Mean	4700	4730	4450	3280			
Minimum	4400	4500	4200	3000			
Maximum	4900	5000	4800	3600			
C.V.(%)	4.26	5.32	5.95	8.18			
ϵ_2^{tu}	(1)	(4)	(1)	(1)			
Distribution	Normal		Normal	Normal			
C ₁	4700		4450	3280			
C ₂	200.0		265	268			
No. Specimens	5	3	4	5			
No. Batches	1	1	1	1			
Data Class	Screening	Screening	Screening	Screening			

- (1) Basis values are presented only for A and B data classes.
- (2) Exception to SRM 4-88.
- (3) Conditioned in 160°F water for 14 days.
- (4) The statistical analysis is not completed for less than four specimens.

Table 6.2.2(d)
SGI/Ep 111-UT
S2-449/SP 381
Compression, 1-axis
[0]₁₂
73/A, -65/A, 180/A
Screening

MATERIAL: S2-449 17k/SP 381 unidirectional tape

RESIN CONTENT: 28-29 wt% COMP: DENSITY: 1.85-1.92 g/cm³
 FIBER VOLUME: 50.1-54.0 % VOID CONTENT: 0.22-1.53%
 PLY THICKNESS: 0.0032-0.0035 in.

TEST METHOD: SRM 1-88 MODULUS CALCULATION: Chord between 1000 and 3000 $\mu\epsilon$

NORMALIZED BY: Specimen thickness and batch fiber areal weight to 50% (0.0035 in. CPT)

Temperature (°F) Moisture Content (%) Equilibrium at T, RH Source Code	73 Ambient		-65 Ambient		180 Ambient		
	70		70		70		
	Normalized	Measured	Normalized	Measured	Normalized	Measured	
F_1^{cu} (ksi)	Mean	172	178	166	177	165	175
	Minimum	145	142	147	152	146	155
	Maximum	193	198	184	198	185	196
	C.V.(%)	8.09	9.35	6.62	7.46	6.81	7.28
	B-value	(1)	(1)	(1)	(1)	(1)	(1)
	Distribution	Weibull	Weibull	Weibull	Weibull	Weibull	Weibull
	C ₁	178	185	171	183	170	181
	C ₂	15.2	14.7	17.7	16.0	16.6	16.4
	No. Specimens	13		13		12	
	No. Batches	2		2		2	
	Data Class	Screening		Screening		Screening	
E_1^c (Msi)	Mean	6.86	7.14	6.91	7.19	6.97	7.47
	Minimum	6.43	6.81	6.63	6.96	6.63	7.19
	Maximum	7.24	7.52	7.10	7.49	7.24	7.59
	C.V.(%)	3.79	3.39	2.35	2.22	3.18	1.85
	No. Specimens	10		10		10	
	No. Batches	2		2		2	
	Data Class	Screening		Screening		Screening	
ν_{12}^c	Mean						
	No. Specimens						
	No. Batches						
	Data Class						
ϵ_1^{cu} ($\mu\epsilon$)	Mean						
	Minimum						
	Maximum						
	C.V.(%)						
	B-value						
	Distribution						
	C ₁						
	C ₂						
	No. Specimens						
	No. Batches						
	Data Class						

(1) Basis values are presented only for A and B data classes.

Table 6.2.2(e)
SGI/Ep 111-UT
S2-449/SP 381
Compression, 1-axis
[0]₁₂
160/W
Screening

MATERIAL: S2-449 17k/SP 381 unidirectional tape

RESIN CONTENT: 28-29 wt% COMP: DENSITY: 1.85-1.92 g/cm³
 FIBER VOLUME: 50.1-54.0 % VOID CONTENT: 0-1.15%
 PLY THICKNESS: 0.0033-0.0037 in.

TEST METHOD: SRM 1-88 MODULUS CALCULATION: Chord between 1000 and 3000 $\mu\epsilon$

NORMALIZED BY: Specimen thickness and batch fiber areal weight to 50% (0.0035 in. CPT)

Temperature (°F)	160				
Moisture Content (%)	Wet				
Equilibrium at T, RH	(2)				
Source Code	70				

		Normalized	Measured	Normalized	Measured	Normalized	Measured
F_1^{cu} (ksi)	Mean	135	137				
	Minimum	124	123				
	Maximum	143	146				
	C.V.(%)	3.51	4.83				
	B-value	(1)	(1)				
	Distribution	Nonpara.	ANOVA				
	C ₁	6	8.02				
	C ₂	2.14	16.7				
	No. Specimens	10					
	No. Batches	2					
	Data Class	Screening					
E_1^c (Msi)	Mean	6.96	6.97				
	Minimum	6.69	6.75				
	Maximum	7.24	7.23				
	C.V.(%)	2.44	2.16				
	No. Specimens	10					
	No. Batches	2					
	Data Class	Screening					
ν_{12}^c	Mean						
	No. Specimens						
	No. Batches						
	Data Class						
ϵ_1^{cu} ($\mu\epsilon$)	Mean						
	Minimum						
	Maximum						
	C.V.(%)						
	B-value						
	Distribution						
	C ₁						
	C ₂						
	No. Specimens						
	No. Batches						
Data Class							

(1) Basis values are presented only for A and B data classes.
 (2) Conditioned in 160°F water for 14 days.

Table 6.2.2(f)
SGI/Ep 111-UT
S2-449/SP 381
Shear, 12-plane
[±45]_{ss}
73/A, -65/A, 180/A,
160/W
Interim, Screening

MATERIAL: S2-449 17k/SP 381 unidirectional tape

RESIN CONTENT: 29-32 wt% COMP: DENSITY: 1.85-1.89 g/cm³
 FIBER VOLUME: 48.8-51.6 % VOID CONTENT: 0-0.74%
 PLY THICKNESS: 0.0032-0.0037 in.

TEST METHOD: SRM 7-88 MODULUS CALCULATION: Chord between 1000 and 3000 με , axial

NORMALIZED BY: Not normalized

Temperature (°F)	73	-65	180	160		
Moisture Content (%)	Ambient	Ambient	Ambient	Wet		
Equilibrium at T, RH				(2)		
Source Code	70	70	70	70		
F ₁₂ ^{su} (ksi)	Mean	19.7	25.7	15.0	11.1	
	Minimum	18.9	24.7	14.0	10.7	
	Maximum	20.3	26.2	15.5	11.9	
	C.V.(%)	2.18	1.85	2.67	3.43	
	B-value	(1)	(1)	(1)	(1)	
	Distribution	Weibull	Weibull	ANOVA	ANOVA	
	C ₁	20.0	25.9	0.452	0.442	
	C ₂	61.1	73.2	4.88	5.83	
	No. Specimens	16	16	16	14	
	No. Batches	3	3	3	3	
Data Class	Interim	Interim	Interim	Screening		
G ₁₂ (Msi)	Mean	0.681	0.808	0.539	0.467	
	Minimum	0.627	0.772	0.513	0.440	
	Maximum	0.745	0.850	0.583	0.490	
	C.V.(%)	5.29	3.32	4.06	2.96	
	No. Specimens	9	9	10	10	
No. Batches	2	2	2	2		
Data Class	Screening	Screening	Screening	Screening		

(1) Basis values are presented only for A and B data classes.
 (2) Conditioned in 160°F water for 14 days.

MATERIAL:		S2-449 17k/SP 381 unidirectional tape				Table 6.2.2(g) SGI/Ep 111-UT S2-449/SP 381 SBS, 31-plane [0]₃₀ 73/A, -65/A, 180/A, 160/W Screening
RESIN CONTENT:	27-35 wt%	COMP: DENSITY:	1.85-1.94 g/cm ³			
FIBER VOLUME:	48.3-55.2 %	VOID CONTENT:	0.0-0.12%			
PLY THICKNESS:	0.0029-0.0035 in.					
TEST METHOD:	SRM 8-88	MODULUS CALCULATION:				
NORMALIZED BY:	Not normalized					
Temperature (°F)	73	-65	180	160		
Moisture Content (%)	Ambient	Ambient	Ambient	Wet		
Equilibrium at T, RH				(2)		
Source Code	70	70	70	70		
Mean	12.6	14.9	9.5	7.6		
Minimum	11.6	13.1	9.1	7.0		
Maximum	13.7	16.8	9.8	8.7		
C.V.(%)	4.64	6.89	2.2	7.1		
B-value	(1)	(1)	(1)	(1)		
F_{31}^{sbs} Distribution	ANOVA	Weibull	Normal	ANOVA		
(ksi) C ₁	0.613	15.4	9.5	0.63		
C ₂	2.77	17.1	0.21	5.2		
No. Specimens	32	14	17	18		
No. Batches	5	2	3	3		
Data Class	Screening	Screening	Screening	Screening		

(1) Short beam strength test data are approved for Screening Data Class only.
 (2) Conditioned in 160°F water for 14 days.

MATERIAL: S2-449 17k/SP 381 unidirectional tape						Table 6.2.2(h) SGI/Ep 111-UT S2-449/SP 381 SBS, 31-plane [0]₃₀ 73/Fluids Screening
RESIN CONTENT: 27-30 wt%	COMP: DENSITY: 1.92-1.94 g/cm ³					
FIBER VOLUME: 50.1-51.6 %	VOID CONTENT: 0.0-0.12%					
PLY THICKNESS: 0.0033-0.0037 in.						
TEST METHOD: SRM 8-88	MODULUS CALCULATION:					
NORMALIZED BY: Not normalized						
Temperature (°F)	73	73	73	73		
Moisture Content (%)	(2)	(3)	(4)	(5)		
Equilibrium at T, RH						
Source Code	70	70	70	70		
Mean	12.0	12.4	12.6	12.1		
Minimum	10.7	10.9	11.3	10.5		
Maximum	13.0	13.4	13.5	12.8		
C.V.(%)	5.20	5.81	4.44	5.22		
B-value	(1)	(1)	(1)	(1)		
Distribution	Weibull	Weibull	Weibull	ANOVA		
F_{31}^{sbs}						
(ksi) C ₁	12.3	12.7	12.9	0.683		
C ₂	24.0	21.9	27.8	9.78		
No. Specimens	12	14	14	14		
No. Batches	2	2	2	2		
Data Class	Screening	Screening	Screening	Screening		

- (1) Short beam strength test data are approved for Screening Data Class only.
- (2) Conditioned in MIL-A-8243 Anti-Icing Fluid at 32°F for 30 days.
- (3) Conditioned in MIL-H-83282 hydraulic fluid at 160°F for 90 days. MIL-H-83282 was converted to MIL-PRF-83282 on September 30, 1997.
- (4) Conditioned in MIL-H-5606 hydraulic fluid at 160°F for 90 days.
- (5) Conditioned in MIL-T-5624 fuel at 75°F for 90 days. MIL-T-5624 was converted to MIL-PRF-5624 on November 22, 1996.

MATERIAL: S2-449 17k/SP 381 unidirectional tape		Table 6.2.2(i) SGI/Ep 111-UT S2-449/SP 381 SBS, 31-plane [0]₃₀ 73/Fluids Screening				
RESIN CONTENT: 27-30 wt%	COMP: DENSITY: 1.92-1.94 g/cm ³					
FIBER VOLUME: 50.1-51.6 %	VOID CONTENT: 0.0-0.12%					
PLY THICKNESS: 0.0033-0.0037 in.						
TEST METHOD: SRM 8-88	MODULUS CALCULATION:					
NORMALIZED BY: Not normalized						
Temperature (°F)	73	73	73	73		
Moisture Content (%)	(2)	(3)	(4)	(5)		
Equilibrium at T, RH						
Source Code	70	70	70	70		
Mean	12.6	12.6	11.8	11.9		
Minimum	10.3	11.6	11.1	10.2		
Maximum	13.5	13.6	12.4	12.9		
C.V.(%)	6.49	3.86	3.79	6.19		
B-value	(1)	(1)	(1)	(1)		
F_{31}^{sbs} Distribution	Weibull	Weibull	Weibull	Weibull		
(ksi) C ₁	12.9	12.8	12.0	12.2		
C ₂	23.1	26.6	32.8	21.5		
No. Specimens	14	14	13	13		
No. Batches	2	2	2	2		
Data Class	Screening	Screening	Screening	Screening		

- (1) Short beam strength test data are approved for Screening Data Class only.
- (2) Conditioned in MIL-L-23699 lubricating oil at 160°F for 90 days. MIL-L-23699 was converted to MIL-PRF-23699 on May 21, 1997.
- (3) Conditioned in MIL-L-7808 lubricating oil at 160°F for 90 days. MIL-L-7808 was converted to MIL-PRF-7808 on May 2, 1997.
- (4) Conditioned in MIL-C-87936 cleaning fluid at 75°F for 7 days. MIL-C-87936 was canceled on March 1, 1995 and replaced with MIL-C-87937. MIL-C-87937 was converted to MIL-PRF-87937 on August 14, 1997.
- (5) Conditioned in ASTM D 740 methyl ethyl ketone (MEK) at 75°F for 7 days.

Table 6.2.2(j)
SGL/Ep 111-UT
S2-449/SP 381
Tension, x-axis
[±45/0/±45]_{2S}
73/A
Screening

MATERIAL: S2-449 17k/SP 381 unidirectional tape

RESIN CONTENT: 29-32 wt% COMP: DENSITY: 1.88-1.89 g/cm³
 FIBER VOLUME: 50.1-51.6 % VOID CONTENT: 0.0-0.74%
 PLY THICKNESS: 0.0034-0.0036 in.

TEST METHOD: MODULUS CALCULATION:
 SRM 4-88 Chord between 1000 and 3000 με

NORMALIZED BY: Specimen thickness and batch fiber areal weight to 50% (0.0035 in. CPT)

Temperature (°F)		73					
Moisture Content (%)		Ambient					
Equilibrium at T, RH							
Source Code		70					
		Normalized	Measured	Normalized	Measured	Normalized	Measured
F_x^{tu} (ksi)	Mean	69.7	71.4				
	Minimum	68.1	69.8				
	Maximum	72.5	73.9				
	C.V.(%)	1.78	1.92				
	B-value	(1)	(1)				
	Distribution	Normal	Weibull				
	C ₁	69.7	72.1				
	C ₂	1.24	55.0				
	No. Specimens	10					
	No. Batches	2					
Data Class	Screening						
E_x^t (Msi)	Mean	2.90	2.97				
	Minimum	2.80	2.85				
	Maximum	2.96	3.08				
	C.V.(%)	1.86	2.30				
	No. Specimens	10					
No. Batches	2						
Data Class	Screening						
ν_{xy}^t	Mean						
	No. Specimens						
	No. Batches						
Data Class							
ϵ_x^{tu} (με)	Mean		24100				
	Minimum		23300				
	Maximum		25200				
	C.V.(%)		2.49				
	B-value		(1)				
	Distribution		Weibull				
	C ₁		24400				
	C ₂		40.9				
	No. Specimens	10					
	No. Batches	2					
Data Class	Screening						

(1) Basis values are presented only for A and B data classes.

Table 6.2.2(k)
SGI/Ep 111-UT
S2-449/SP 381
Tension, y-axis
[±45/90/±45]_{2s}
73/A
Screening

MATERIAL: S2-449 17k/SP 381 unidirectional tape

RESIN CONTENT: 30-32 wt% COMP: DENSITY: 1.87-1.88 g/cm³
 FIBER VOLUME: 50.1 % VOID CONTENT: 0.0-0.60%
 PLY THICKNESS: 0.0035-0.0036 in.

TEST METHOD: MODULUS CALCULATION:
 SRM 4-88 Chord between 1000 and 3000 µε

NORMALIZED BY: Specimen thickness and batch fiber areal weight to 50% (0.0035 in. CPT)

Temperature (°F)		73					
Moisture Content (%)		Ambient					
Equilibrium at T, RH							
Source Code		70					
		Normalized	Measured	Normalized	Measured	Normalized	Measured
F _y ^{tu} (ksi)	Mean	36.2	36.6				
	Minimum	35.3	35.8				
	Maximum	37.1	37.6				
	C.V.(%)	1.77	1.77				
	B-value	(1)	(1)				
	Distribution	ANOVA	ANOVA				
	C ₁	0.813	0.755				
	C ₂	18.6	14.8				
	No. Specimens		10				
	No. Batches		2				
Data Class		Screening					
E _y ^t (Msi)	Mean	2.21	2.24				
	Minimum	2.14	2.17				
	Maximum	2.28	2.31				
	C.V.(%)	1.88	2.01				
	No. Specimens		10				
No. Batches		2					
Data Class		Screening					
ν _{xy} ^t	Mean						
	No. Specimens						
	No. Batches						
Data Class							
ε _y ^{tu} (µε)	Mean		16400				
	Minimum		15600				
	Maximum		16800				
	C.V.(%)		2.40				
	B-value		(1)				
	Distribution		Weibull				
	C ₁		16500				
	C ₂		58.7				
	No. Specimens		10				
	No. Batches		2				
Data Class		Screening					

(1) Basis values are presented only for A and B data classes.

6.2.3 7781G 816/PR381 plain weave fabricMaterial Description:

Material: 7781 E-glass/3M PR381

Form: Fiber areal weight of 300 g/m², typical cured resin content of 32-38%, typical cured ply thickness of 0.009 - 0.0105 inches.

Processing: Autoclave cure; 260° F, 50 psi for two hours

General Supplier Information:

Fiber: Continuous, E-glass fiber. Typical tensile modulus is 10×10^6 psi. Typical tensile strength is 500,000 psi.

Matrix: PR381 is a 250°F curing epoxy resin providing properties similar to conventional 350°F curing systems. Light tack for up to 30 days at 75°F.

Maximum Short Term Service Temperature: 220°F (dry), 160°F (wet)

Typical applications: Aircraft secondary structure, fuselage skins and general industrial applications where improved fatigue and excellent mechanical strengths are required.

6.2.3 7781 G-816/PR381 plain weave fabric

MATERIAL:	7781G 816/PR 381 plain weave fabric			EGI/Ep 300-PW 7781G/PR 381 Summary	
FORM:	3M SP 381/7781 E-Glass Fabric Prepreg, 57 Yarn Count/in. (Warp), 54 Yarn Count/in. (Fill)				
FIBER:	Clark-Schwebel 7781 E-glass Fabric, per MIL-C-9084C Type VIII B, Yarn DE-75 1/0.0 twist, no surface treatment, 558 Finish	MATRIX:	3M PR 381		
T _g (ambient):	282/F	T _g (wet):	225 /F		T _g METHOD: SRM-18, DMA E' knee
PROCESSING:	Autoclave cure: 260/F, 100 min., 50 psi				

Date of fiber manufacture	11/92 - 7/95	Date of testing	3/93 - 4/96
Date of resin manufacture	12/92 - 3/96	Date of data submittal	6/96
Date of prepreg manufacture	12/92 - 3/96	Date of analysis	8/97
Date of composite manufacture	3/93 - 4/96		

LAMINA PROPERTY SUMMARY

	73/F/A		220/F/A				
Tension, 1-axis	II-I		SS-S				
Tension, 2-axis							
Tension, 3-axis							
Compression, 1-axis							
Compression, 2-axis							
Compression, 3-axis							
Shear, 12-plane							
Shear, 23-plane							
Shear, 31-plane							
SBS, 31-plane	S---						
Flexure	I---		S---				

Classes of data in Strength/Modulus/Poisson's Ratio/Strain-to-Failure order: A = A75, a = A55, B = B30, b = B18, M = Mean, I = Interim, S = Screening, - = no data (See Table 1.4.2(c))

		Nominal	As Submitted	Test Method
Fiber Density	(g/cm ³)	2.6		ASTM C 693
Resin Density	(g/cm ³)			ASTM D 792
Composite Density	(g/cm ³)	1.85	1.75 - 2.04	ASTM D 792
Fiber Areal Weight	(g/m ²)	300	288 - 297	SRM 23B
Fiber Volume	(%)	48	43.0 - 50.9	SRM 10
Ply Thickness	(in)	0.0099	0.0087 - 0.0104	

LAMINATE PROPERTY SUMMARY

Classes of data in Strength/Modulus/Poisson's Ratio/Strain-to-Failure order: A = A75, a = A55, B = B30, b = B18, M = Mean, I = Interim, S = Screening, - = no data (See Table 1.4.2(c))

MATERIAL: 7781G 816/PR 381 plain weave fabric		Table 6.2.3(a) EGI/Ep 300-PW 7781G/PR 381 Tension, 1-axis [0]_s 73/A, 220/A Interim, Screening			
RESIN CONTENT: 34-36 wt%	COMP. DENSITY: 1.75-1.97 g/cm ³				
FIBER VOLUME: 43.0-48.4%	VOID CONTENT: -				
PLY THICKNESS: 0.0091-0.0104 in.					
TEST METHOD: SRM 4-88 (1)	MODULUS CALCULATION: Chord between 1000 and 6000 $\mu\epsilon$				
NORMALIZED BY: Specimen thickness and batch fiber areal weight to 50% (0.0091 in. CPT)					
Temperature(°F)	73 Ambient		220 Ambient		
Moisture Content(%)	72		72		
Equilibrium at T, RH	Normalized	Measured	Normalized	Measured	
Source Code					
F ₁ ^{tu} (ksi)	Mean	74.9	70.9	71.3	67.5
	Minimum	70.4	62.9	67.0	60.5
	Maximum	79.6	77.8	77.4	74.4
	C.V. (%)	3.66	7.07	4.02	5.89
	B-value	(2)	(2)	(2)	(2)
	Distribution	ANOVA	ANOVA	Weibull	ANOVA
	C ₁	2.90	5.37	72.7	4.22
C ₂	3.10	3.26	24.9	3.45	
No. Specimens	16		13		
No. Batches	5		4		
Data Class	Interim		Screening		
E ₁ ^t (Msi)	Mean	3.83	3.64	3.64	3.44
	Minimum	3.70	3.37	3.45	3.24
	Maximum	3.97	3.96	3.75	3.77
	C.V. (%)	2.63	4.51	2.78	5.40
	No. Specimens	15		13	
No. Batches	5		4		
Data Class	Interim		Screening		
v ₁₂ ^t	Mean				
	No. Specimens				
	No. Batches				
Data Class					
ε ₁ ^{tu} (μϵ)	Mean		17800		19600
	Minimum		15200		18400
	Maximum		19600		21100
	C.V. (%)		6.23		4.01
	B-value		(2)		(2)
	Distribution		ANOVA		Weibull
	C ₁		1310		20000
C ₂		3.32		25.7	
No. Specimens	15		13		
No. Batches	5		4		
Data Class	Interim		Screening		

- (1) Three batches were tested according to SRM 4R-94 with modulus calculated as noted above.
(2) Basis values are presented only for A and B data classes.

MATERIAL: 7781G 816/PR 381 plain weave fabric		Table 6.2.3(b) EGI/Ep 300-PW 7781G/PR 381 SBS, 13-axis [0]_{5s} 73/A Screening				
RESIN CONTENT: 34-36 wt%	COMP. DENSITY: 1.76-2.04 g/cm ³					
FIBER VOLUME: 43.0-50.9%	VOID CONTENT: %					
PLY THICKNESS: 0.0088-0.0103 in.						
TEST METHOD: SRM 8-88 (1)	MODULUS CALCULATION: NA					
NORMALIZED BY: Not normalized						
Temperature(°F)	73					
Moisture Content(%)	Ambient					
Equilibrium at T, RH						
Source Code	72					
F ₁₃ ^{sbs} (ksi)	Mean	10.4				
	Minimum	9.6				
	Maximum	11.5				
	C.V. (%)	4.8				
	B-value	(2)				
	Distribution	ANOVA				
	C ₁	0.53				
C ₂	3.2					
No. Specimens	22					
No. Batches	5					
Data Class	Screening					

- (1) Three batches were tested according to SRM 8R-94.
- (2) Short beam strength test data are approved for Screening Data Class only.

MATERIAL: 7781G 816/PR 381 plain weave fabric		Table 6.2.3(c) EGI/Ep 300-PW 7781G/PR 381 Flexure [0]_{5s} 73/A, 220/A Interim, Screening				
RESIN CONTENT: 34-36 wt%	COMP. DENSITY: 1.76-1.97 g/cm ³					
FIBER VOLUME: 43.4-48.7%	VOID CONTENT: %					
PLY THICKNESS: 0.0091-0.0103 in.						
TEST METHOD: ASTM D 790 Method 1	MODULUS CALCULATION: NA					
NORMALIZED BY: Not normalized						
Temperature(°F)	73	220				
Moisture Content(%)	Ambient	Ambient				
Equilibrium at T, RH						
Source Code	72	72				
F ^{flex} (ksi)	Mean	109	93.2			
	Minimum	94.2	83.4			
	Maximum	121	104			
	C.V. (%)	7.52	8.15			
	B-value	(1)	(1)			
	Distribution	ANOVA	ANOVA			
	C ₁	8.92	8.45			
	C ₂	3.33	4.13			
	No. Specimens	21	14			
	No. Batches	5	4			
Data Class	Interim	Screening				

(1) Basis values are presented only for A and B data classes.

6.2.4 E-Glass 7781/EA9396 8-harness satin weave fabricMaterial Description:

Material: E7781/EA9396

Form: Eight harness satin fabric of style 7781, fiber areal weight of 295 g/m², dry fabric impregnated in a wet lay-up process, typical cured resin content of 25.9 to 30.4%, typical cured ply thickness of 0.008 inches.

Processing: Vacuum Bag cure; 200°F, 25 inches Hg, 45 minutes

General Supplier Information:

Fiber: Continuous E-glass fiber woven by Hexcel using F-16 (Volan-A) sizing. Typical tensile modulus is 10×10^6 psi. Typical tensile strength is 500,000 psi.

Matrix: EA9396 is a 200°F curing toughened epoxy resin with improved hot/wet properties. 75 minute pot life for 1 lb batch. This resin is a two part, unfilled version of EA 9394.

Maximum Short Term Service Temperature: Not determined from available data, but at least 150°F.

Typical applications: Aircraft repair

Data Analysis Summary:

1. This material was tested at fiber volumes that may be higher than what are typically used for repair. Data should be substantiated if used at lower fiber volumes.
2. Glass transition temperature (T_g) values were not reported because they were determined on neat resin using a non-standard method.
3. Wet properties are very low because of the glass and sizing combination.
4. Contrary to expectations, the fill tensile strengths and stiffnesses were greater than the warp properties.
5. Most tension failures were under the tabs, but were included since the strengths were consistent with correct failure modes.
6. Variability between batches is high. Documentation does not reveal a reason.
7. High end outliers for the following properties were discarded:
 - a. Transverse tension strain at 72°F ambient
 - b. Transverse tension modulus at -65°F ambient and 72°F wet
 - c. Transverse compression modulus at 72°F wet
8. Data are from publicly available report, Reference 4.2.27.
9. Test method dates were assumed from the testing dates rather than obtained from the data source.

6.2.4 E-Glass 7781/EA 9396 8-harness satin weave fabric *

**EGI/Ep 295-8HS
E-7781/EA 9396
Summary**

MATERIAL:	E-Glass 7781/EA 9396 8-harness satin weave fabric		
FORM:	Dry E-Glass fabric impregnated with epoxy resin in a wet lay-up impregnation process.		
FIBER:	Hexcel/Burlington 7781, F-16 Volan A-Type/538 Silane sizing	MATRIX:	Dexter-Hysol EA 9396
T _g (dry):	(1)	T _g (wet):	(1)
		T _g METHOD:	
PROCESSING:	Vacuum Bag Cure: 200°F, 45 min., 25 in. Hg.		

(1) See Data Analysis Note #2 in data set description

* ALL DOCUMENTATION PRESENTLY REQUIRED WERE NOT SUPPLIED FOR THIS MATERIAL.

Date of fiber manufacture		Date of testing	11/88-5/91
Date of resin manufacture	8/88-10/88	Date of data submittal	3/98
Date of prepreg manufacture	NA	Date of analysis	8/98
Date of composite manufacture	11/88-5/91		

LAMINA PROPERTY SUMMARY

	72°F/A		-65°F/A	200°F/A		-65°F/W	72°F/W	200°F/W
Tension, 1-axis	IISI						IISI	
Tension, 2-axis	IISS		IISS	IISI		IISI	ISSI	IISI
Tension, 3-axis								
Compression, 1-axis	II-I						II-I	
Compression, 2-axis	II-I		II-I	SS-S		II-I	SS-S	II-I
Compression, 3-axis								
Shear, 12-plane	II--		II--	II--		II--	II--	II--
Shear, 23-plane								
Shear, 31-plane								

Classes of data in Strength/Modulus/Poisson's Ratio/Strain-to-Failure order: A = A75, a = A55, B = B30, b = B18, M = Mean, I = Interim, S = Screening, - = no data (See Table 1.4.2(c))

* ALL DOCUMENTATION PRESENTLY REQUIRED WERE NOT SUPPLIED FOR THIS MATERIAL.

	Nominal	As Submitted	Test Method
Fiber Density (g/cm ³)	2.54		D 792
Resin Density (g/cm ³)	1.14		
Composite Density (g/cm ³)	1.91	1.88-1.96	D 792
Fiber Areal Weight (g/m ²)	295		
Fiber Volume (%)	54	51.2-56.9	D 2584
Ply Thickness (in)	0.0085	0.0083-0.0087	

Nominal composite densities assume void content of 0%.

LAMINATE PROPERTY SUMMARY

Classes of data in Strength/Modulus/Poisson's Ratio/Strain-to-Failure order: A = A75, a = A55, B = B30, b = B18, M = Mean, I = Interim, S = Screening, - = no data (See Table 1.4.2(c))

* ALL DOCUMENTATION PRESENTLY REQUIRED WERE NOT SUPPLIED FOR THIS MATERIAL.

MATERIAL:		E-Glass 7781/EA 9396 8-harness satin weave fabric				Table 6.2.4(a) EGI/Ep 295-8HS E-7781/EA 9396 Tension, 1-axis [0_f]₈ 72/A,72/W Interim, Screening	
RESIN CONTENT:	25.9-27.7 wt%	COMP: DENSITY:	1.89-1.93 g/cm ³				
FIBER VOLUME:	54.1-55.8 %	VOID CONTENT:	3.7-5.4%				
PLY THICKNESS:	0.0085-0.0086 in.						
TEST METHOD:	ASTM D 3039-76		MODULUS CALCULATION:		Chord between 1000 and 3000μϵ		
NORMALIZED BY:	Specimen thickness and batch fiber areal weight to 50% fiber volume (0.0085 in. CPT)						
Temperature (°F)	72		72				
Moisture Content (%)	Ambient		(1)				
Equilibrium at T, RH			140, 95-100				
Source Code	30		30				
		Normalized	Measured	Normalized	Measured	Normalized	Measured
F ₁ ^{tu} (ksi)	Mean	48.3	51.8	15.7	16.4		
	Minimum	45.5	48.0	13.4	13.6		
	Maximum	54.1	57.9	17.0	18.3		
	C.V.(%)	4.77	5.17	6.44	7.74		
	B-value	(2)	(2)	(2)	(2)		
	Distribution	Nonpara.	Normal	Weibull	Weibull		
	C ₁	8	51.8	16.1	16.9		
	C ₂	1.54	2.68	17.8	15.8		
	No. Specimens	15		15			
	No. Batches	3		3			
Data Class	Interim		Interim				
E ₁ ^t (Msi)	Mean	3.39	3.62	3.16	3.30		
	Minimum	3.25	3.45	2.97	3.07		
	Maximum	3.48	3.77	3.30	3.52		
	C.V.(%)	2.18	2.51	2.64	3.93		
	No. Specimens	15		15			
No. Batches	3		3				
Data Class	Interim		Interim				
v ₁₂ ^t	Mean	0.115		0.084			
	No. Specimens	6		7			
	No. Batches	3		3			
	Data Class	Screening		Screening			
ε ₁ ^{tu} (μϵ)	Mean	17700		5100			
	Minimum	16400		4260			
	Maximum	21800		5850			
	C.V.(%)	7.72		8.83			
	B-value	(2)		(2)			
	Distribution	Nonpara.		Weibull			
	C ₁	8		5290			
	C ₂	1.54		13.8			
	No. Specimens	15		15			
	No. Batches	3		3			
Data Class	Interim		Interim				

- (1) Unknown weight gain
- (2) Basis values are presented only for A and B data classes.
- (3) Most failures were under the tabs, but were included since the strengths were consistent with correct failure modes.

* ALL DOCUMENTATION PRESENTLY REQUIRED WERE NOT SUPPLIED FOR THIS MATERIAL.

MATERIAL:	E-Glass 7781/EA 9396 8-harness satin weave fabric			Table 6.2.4(b) EGI/Ep 295-8HS E-7781/EA 9396 Tension, 2-axis [0]_f₈ 72/A, -65/A, 200/A Interim, Screening
RESIN CONTENT:	25.9-27.7 wt%	COMP: DENSITY:	1.89-1.94 g/cm ³	
FIBER VOLUME:	54.0-56.5 %	VOID CONTENT:	3.7-5.4 %	
PLY THICKNESS:	0.0085-0.0086 in.			
TEST METHOD:	MODULUS CALCULATION:			
ASTM D 3039-76	Chord between 1000 and 3000µε			
NORMALIZED BY:	Specimen thickness and batch fiber areal weight to 50% fiber volume (0.0085 in. CPT)			

Temperature (°F)		72 Ambient		-65 Ambient		200 Ambient	
Moisture Content (%)		30		30		30	
Equilibrium at T, RH		30		30		30	
Source Code		30		30		30	
		Normalized	Measured	Normalized	Measured	Normalized	Measured
	Mean	50.5	54.3	67.2	71.9	42.4	45.2
	Minimum	45.1	48.5	56.7	59.2	35.4	37.0
	Maximum	54.1	59.0	78.7	83.2	47.9	50.5
	C.V.(%)	5.96	6.14	8.62	9.03	6.42	6.80
F ₂ ^{tu}	B-value	(1)	(1)	(1)	(1)	(1)	(1)
	Distribution	Weibull	Weibull	Weibull	ANOVA	Weibull	Weibull
(ksi)	C ₁	51.8	55.7	69.7	74.7	43.6	46.5
	C ₂	19.5	20.5	11.2	36.8	15.4	18.3
No. Specimens		15		15		15	
No. Batches		3		3		3	
Data Class		Interim		Interim		Interim	
E ₂ ^t	Mean	3.41	3.67	3.89	4.15	3.31	3.53
	Minimum	3.25	3.38	3.74	3.97	3.19	3.36
	Maximum	3.82	4.15	3.96	4.30	3.48	3.68
	C.V.(%)	5.39	6.11	1.63	2.68	2.50	2.79
(Msi)	No. Specimens	15		14		15	
	No. Batches	3		3		3	
	Data Class	Interim		Screening		Interim	
v ₂₁ ^t	Mean	0.127		0.157		0.101	
	No. Specimens	6		7		6	
	No. Batches	3		3		3	
	Data Class	Screening		Screening		Screening	
	Mean	18200		24000		14400	
	Minimum	15400		20500		9750	
	Maximum	20300		26200		16500	
	C.V.(%)	8.37		7.76		11.6	
ε ₂ ^{tu}	B-value	(1)		(1)		(1)	
	Distribution	Weibull		Normal		Weibull	
(µε)	C ₁	18900		24000		15000	
	C ₂	15.7		1870		13.0	
No. Specimens		14		7		15	
No. Batches		3		3		3	
Data Class		Screening		Screening		Interim	

(1) Basis values are presented only for A and B data classes.

* ALL DOCUMENTATION PRESENTLY REQUIRED WERE NOT SUPPLIED FOR THIS MATERIAL.

MATERIAL:	E-Glass 7781/EA 9396 8-harness satin weave fabric			Table 6.2.4(c) EGI/Ep 295-8HS E-7781/EA 9396 Tension, 2-axis [0_f]₈ -65/W, 72/W, 200/W Interim, Screening
RESIN CONTENT:	25.9-27.7 wt%	COMP. DENSITY:	1.89-1.94 g/cm ³	
FIBER VOLUME:	54.0-56.5 %	VOID CONTENT:	3.7-5.4 %	
PLY THICKNESS:	0.0085-0.0086 in.			
TEST METHOD:	ASTM D 3039-76			MODULUS CALCULATION:
				Chord between 1000 and 3000µε
NORMALIZED BY:	Specimen thickness and batch fiber areal weight to 50% fiber volume (0.0085 in. CPT)			

Temperature (°F)	-65	72	200
Moisture Content (%)	(1)	(1)	(1)
Equilibrium at T, RH	140, 95-100	140, 95-100	140, 95-100
Source Code	30	30	30

		Normalized	Measured	Normalized	Measured	Normalized	Measured
F ₂ ^{tu} (ksi)	Mean	19.7	21.2	16.3	17.5	12.6	13.5
	Minimum	14.4	15.5	14.6	15.7	11.2	11.9
	Maximum	23.0	25.2	18.8	20.4	14.3	15.9
	C.V.(%)	10.9	12.3	8.11	8.42	6.17	7.04
	B-value Distribution	(2) Weibull	(2) Weibull	(2) ANOVA	(2) ANOVA	(2) Weibull	(2) Normal
C ₁		20.5	22.3	1.44	1.59	13.0	13.5
	C ₂	10.5	10.1	4.06	4.37	14.3	0.953
No. Specimens		15		15		15	
No. Batches		3		3		3	
Data Class		Interim		Interim		Interim	
E ₂ ^t (Msi)	Mean	3.54	3.81	3.01	3.22	2.81	3.01
	Minimum	3.32	3.47	2.89	3.09	2.44	2.58
	Maximum	3.74	4.03	3.11	3.36	3.52	3.67
	C.V.(%)	2.97	3.65	1.96	2.47	11.7	11.5
	No. Specimens	15		13		15	
No. Batches	3		3		3		
Data Class	Interim		Screening		Interim		
v ₂₁ ^t	Mean	0.135		0.066		0.079	
	No. Specimens	6		6		6	
	No. Batches	3		3		3	
	Data Class	Screening		Screening		Screening	
ε ₂ ^{tu} (µε)	Mean	6240		5420		4470	
	Minimum	4000		3040		3360	
	Maximum	7300		6510		4900	
	C.V.(%)	14.2		19.2		10.6	
	B-value Distribution	(2) ANOVA		(2) ANOVA		(2) Nonpara.	
C ₁		936		1120		8	
	C ₂	3.88		4.58		1.54	
No. Specimens		15		15		15	
No. Batches		3		3		3	
Data Class		Interim		Interim		Interim	

- (1) Unknown weight gain
- (2) Basis values are presented only for A and B data classes.

* ALL DOCUMENTATION PRESENTLY REQUIRED WERE NOT SUPPLIED FOR THIS MATERIAL.

MATERIAL:		E-Glass 7781/EA 9396 8-harness satin weave fabric				Table 6.2.4(d) EGI/Ep 295-8HS E-7781/EA 9396 Compression, 1-axis [0]₁₆ 72/A,72/W Interim	
RESIN CONTENT:	27.6-30.4 wt%	COMP: DENSITY:	1.89-1.93 g/cm ³				
FIBER VOLUME:	54.1-55.8%	VOID CONTENT:	3.7-5.4%				
PLY THICKNESS:	0.0085-0.0086 in.						
TEST METHOD:	ASTM D 3410B-87		MODULUS CALCULATION:		Chord between 1000 and 3000µε		
NORMALIZED BY:		Specimen thickness and batch fiber areal weight to 50% fiber volume (0.0085 in. CPT)					
Temperature (°F)	72		72				
Moisture Content (%)	Ambient		1.68-2.33				
Equilibrium at T, RH			(1)				
Source Code	30		30				
		Normalized	Measured	Normalized	Measured	Normalized	Measured
F _I ^{cu} (ksi)	Mean	46.4	49.6	20.3	21.0		
	Minimum	41.1	43.9	11.2	11.0		
	Maximum	51.2	55.5	26.3	27.0		
	C.V.(%)	5.96	5.84	27.6	27.8		
	B-value	(2)	(2)	(2)	(2)		
	Distribution	Weibull	Weibull	ANOVA	ANOVA		
	C ₁	47.6	51.0	6.40	6.71		
	C ₂	17.5	18.5	4.91	5.67		
	No. Specimens	15		15			
	No. Batches	3		3			
Data Class	Interim		Interim				
E _I ^c (Msi)	Mean	3.45	3.68	3.06	3.18		
	Minimum	2.96	3.17	2.56	2.56		
	Maximum	3.86	4.11	3.77	3.85		
	C.V.(%)	6.24	5.98	10.1	10.1		
	No. Specimens	15		15			
No. Batches	3		3				
Data Class	Interim		Interim				
v ₁₂ ^c	Mean						
	No. Specimens						
	No. Batches						
Data Class							
ε _I ^{cu} (µε)	Mean		14700		7160		
	Minimum		11700		4160		
	Maximum		19600		10600		
	C.V.(%)		12.8		27.3		
	B-value		(2)		(2)		
	Distribution		ANOVA		ANOVA		
	C ₁		3.25		4.72		
	C ₂		1940		2130		
	No. Specimens	15		15			
	No. Batches	3		3			
Data Class	Interim		Interim				

(1) Specimens conditioned at 140°F, 95-100% R.H for 68-180 days.

(2) Basis values are presented only for A and B data classes.

* ALL DOCUMENTATION PRESENTLY REQUIRED WERE NOT SUPPLIED FOR THIS MATERIAL.

MATERIAL:		E-Glass 7781/EA 9396 8-harness satin weave fabric				Table 6.2.4(e) EG/Ep 295-8HS E-7781/EA 9396 Compression, 2-axis [0]₁₆ -65/A, 72/A, 200/A Interim, Screening	
RESIN CONTENT:	27.6-30.4 wt%	COMP: DENSITY:	1.89-1.93 g/cm ³				
FIBER VOLUME:	51.2-53.8 %	VOID CONTENT:	4.0-5.0 %				
PLY THICKNESS:	0.0083-0.0085 in.						
TEST METHOD:	ASTM D 3410B-87		MODULUS CALCULATION: Chord between 1000 and 3000µε				
NORMALIZED BY:		Specimen thickness and batch fiber areal weight to 50% fiber volume (0.0085 in. CPT)					
Temperature (°F)	72 Ambient		-65 Ambient		200 Ambient		
Moisture Content (%)	30		30		30		
Equilibrium at T, RH	30		30		30		
Source Code	30		30		30		
		Normalized	Measured	Normalized	Measured	Normalized	Measured
F ₂ ^{cu} (ksi)	Mean	37.7	40.8	59.2	63.8	26.9	29.0
	Minimum	32.4	35.3	50.8	55.8	20.4	23.4
	Maximum	42.9	46.0	68.9	73.5	34.4	37.2
	C.V.(%)	8.72	7.60	9.72	9.58	16.1	15.1
	B-value	(1)	(1)	(1)	(1)	(1)	(1)
	Distribution	Weibull	Weibull	ANOVA	ANOVA	ANOVA	ANOVA
	C ₁	39.2	42.3	6.54	5.33	5.07	5.75
	C ₂	11.6	15.1	4.81	6.87	5.00	5.16
	No. Specimens	15		15		12	
	No. Batches	3		3		3	
Data Class	Interim		Interim		Screening		
E ₂ ^c (Msi)	Mean	3.37	3.66	3.89	4.18	3.23	3.49
	Minimum	2.94	3.13	3.38	3.63	2.82	2.98
	Maximum	3.61	3.93	4.17	4.55	3.54	3.83
	C.V.(%)	6.04	6.70	5.79	5.84	7.64	7.23
	No. Specimens	15		15		12	
No. Batches	3		3		3		
Data Class	Interim		Interim		Screening		
v ₂₁ ^c	Mean						
	No. Specimens						
	No. Batches						
	Data Class						
ε ₂ ^{cu} (µε)	Mean		11900		16800		8650
	Minimum		9020		13400		6550
	Maximum		17800		20800		12400
	C.V.(%)		20.1		11.8		19.5
	B-value		(1)		(1)		(1)
	Distribution		Weibull		ANOVA		Weibull
	C ₁		12900		5.06		9340
	C ₂		5.04		2200		5.42
	No. Specimens		15		15		12
	No. Batches		3		3		3
Data Class		Interim		Interim		Screening	

(1) Basis values are presented only for A and B data classes.

* ALL DOCUMENTATION PRESENTLY REQUIRED WERE NOT SUPPLIED FOR THIS MATERIAL.

MATERIAL:		E-Glass 7781/EA 9396 8-harness satin weave fabric				Table 6.2.4(f) EGI/Ep 295-8HS E-7781/EA 9396 Compression, 2-axis [0]₁₆ -65/W, 72/W, 200/W Interim, Screening	
RESIN CONTENT:	27.6-30.4 wt%	COMP: DENSITY:	1.89-1.93 g/cm ³				
FIBER VOLUME:	51.2-53.8 %	VOID CONTENT:	4.0-5.0 %				
PLY THICKNESS:	0.0083-0.0085 in.						
TEST METHOD:	ASTM D 3410B-87		MODULUS CALCULATION:		Chord between 1000 and 3000µε		
NORMALIZED BY:	Specimen thickness and batch fiber areal weight to 50% fiber volume (0.0085 in. CPT)						
Temperature (°F)	-65		72		200		
Moisture Content (%)	1.48-2.33		1.48-2.33		1.48-2.33		
Equilibrium at T, RH	(1)		(1)		(1)		
Source Code	30		30		30		
	Normalized	Measured	Normalized	Measured	Normalized	Measured	
Mean	43.5	46.5	22.0	23.6	13.4	14.2	
Minimum	36.4	38.6	16.8	18.9	11.3	11.8	
Maximum	52.5	56.1	26.4	27.7	17.2	18.3	
C.V.(%)	9.58	10.0	13.3	12.8	14.8	14.8	
F_2^{cu}	(2)	(2)	(2)	(2)	1.88	1.84	
Distribution	Weibull	Weibull	ANOVA	ANOVA	ANOVA	ANOVA	
(ksi) C ₁	45.4	48.6	3.50	15.3	2.36	4.95	
C ₂	9.65	10.9	1.39	3.56	4.31	2.49	
No. Specimens	15		10		18		
No. Batches	3		2		3		
Data Class	Interim		Screening		Interim		
Mean	3.81	4.07	3.11	3.34	2.91	3.08	
Minimum	3.32	3.41	2.96	3.23	2.25	2.32	
Maximum	4.16	4.46	3.25	3.49	3.73	3.92	
C.V.(%)	6.22	6.76	3.40	2.40	13.6	13.8	
E_2^c	15		9		18		
(Msi) No. Specimens	3		2		3		
No. Batches	Interim		Screening		Interim		
Data Class							
v_{21}^c							
Mean	12400		7800		4540		
Minimum	9890		4570		2880		
Maximum	15700		9310		6890		
C.V.(%)	13.3		18.8		22.9		
ϵ_2^{cu}	(2)		(2)		(2)		
Distribution	Weibull		Weibull		Weibull		
(µε) C ₁	13100		8330		4950		
C ₂	8.42		7.91		4.68		
No. Specimens	15		10		18		
No. Batches	3		2		3		
Data Class	Interim		Screening		Interim		

(1) Specimens conditioned at 140°F, 95-100% RH for 68-180 days.

(2) Basis values are presented only for A and B data classes.

* ALL DOCUMENTATION PRESENTLY REQUIRED WERE NOT SUPPLIED FOR THIS MATERIAL.

MATERIAL:	E-Glass 7781/EA 9396 8-harness satin weave fabric			Table 6.2.4(g) EGI/Ep 295-8HS E-7781/EA 9396 Shear, 12-plane [+/-45]_s 72/A, -65/A, 200/A, -65/W, 72/W, 200/W Interim		
RESIN CONTENT:	25.0-27.7 wt%	COMP: DENSITY:	1.92 g/cm ³			
FIBER VOLUME:	54.2-56.9 %	VOID CONTENT:	3.6-5.7 %			
PLY THICKNESS:	0.0083-0.0085 in.					
TEST METHOD:	ASTM D 3518-76			MODULUS CALCULATION:		
NORMALIZED BY:	Not normalized					

Temperature (°F)	72	-65	200	-65	72	200	
Moisture Content (%)	Ambient	Ambient	Ambient	1.52-2.32	1.52-2.32	1.52-2.32	
Equilibrium at T, RH				(1)	(1)	(1)	
Source Code	30	30	30	30	30	30	
F_{12}^{su} (ksi)	Mean	11.5	16.9	7.11	8.52	5.49	
	Minimum	9.45	13.1	4.59	6.74	4.16	
	Maximum	13.5	20.3	9.56	10.7	6.44	
	C.V.(%)	9.20	14.1	15.8	13.3	11.9	
	B-value	(2)	(2)	(2)	(2)	(2)	
	Distribution	Weibull	Weibull	Weibull	Weibull	Weibull	
	C ₁	12.0	17.9	7.59	9.01	5.76	
	C ₂	11.8	8.15	6.77	8.08	11.0	
	No. Specimens	23	18	19	18	18	
	No. Batches	3	3	3	3	3	
Data Class	Interim	Interim	Interim	Interim	Interim		
G_{12}^s (Msi)	Mean	0.758	1.03	0.458	0.860	0.490	
	Minimum	0.625	0.901	0.289	0.624	0.336	
	Maximum	0.928	1.29	0.549	0.976	0.666	
	C.V.(%)	11.3	10.5	12.9	11.6	16.7	
	No. Specimens	22	18	19	16	18	
	No. Batches	3	3	3	3	3	
	Data Class	Interim	Interim	Interim	Interim	Interim	
	γ_{12}^s (µε)	Mean					
		No. Specimens					
		No. Batches					
Data Class							

- (1) Specimens conditioned at 140°F, 95-100% RH for 111-117 days.
- (2) Basis values are presented only for A and B data classes.

This section is reserved for future use.

6.3 GLASS - POLYESTER COMPOSITES

6.4 GLASS - BISMALIMIDE COMPOSITES

6.5 GLASS - POLYIMIDE COMPOSITES

6.6 GLASS - PHENOLIC COMPOSITES

6.7 GLASS - SILICONE COMPOSITES

6.8 GLASS - POLYBENZIMIDAZOLE COMPOSITES

6.9 GLASS - PEEK COMPOSITES