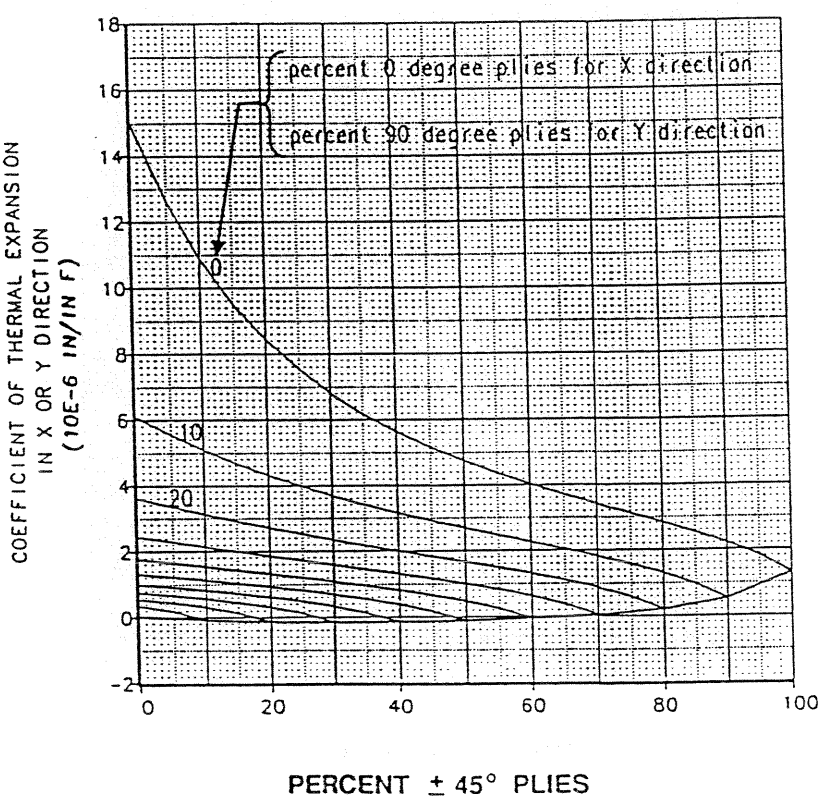
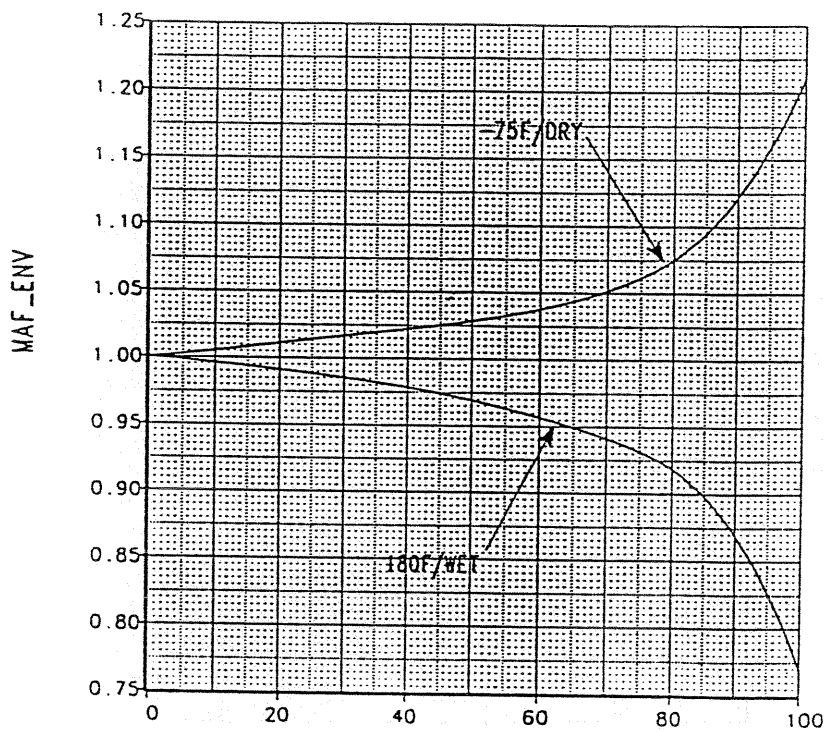
Prepreg Material Specification:	BMS 8-212, TYPE II, CLASS 1 or 3, GRADE 145 or 190
Resin Content:	35 (% WT)
Process Specification:	BAC 5317-1
70° F/DRY ENVIRONMENT, (0/±45/90) LAMINATES	



DG-100-527

Figure 2.2.1-4 Nominal α_x Coefficient of Thermal Expansion

Prepreg Material Specification:	BMS 8-212, TYPE II, CLASS 1 or 3, GRADE 145 or 190
Resin Content:	35 (% WT)
Process Specification:	BAC 5317-1
(0/±45/90) LAMINATES	

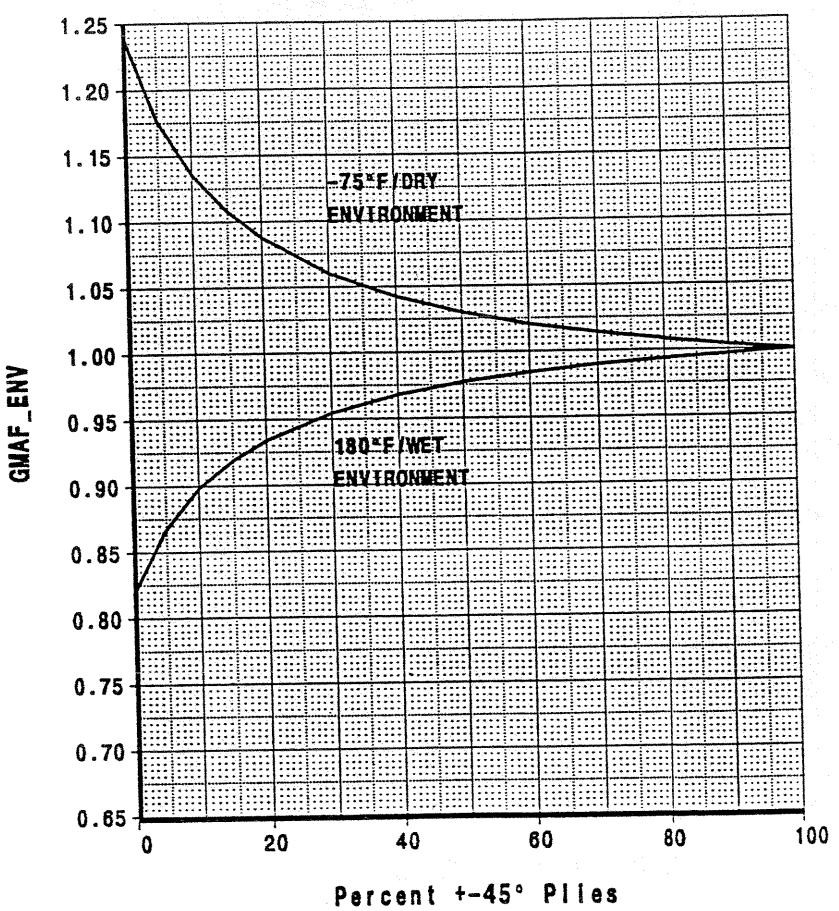


$E_{x\ ENVIRONMENT} = E_{x\ NOMINAL} \times MAF\_ENV$

DG-100-528

Figure 2.2.1-5 E_x Environmental Adjustment Factor

Prepreg Material Specification:	BMS 8-212, TYPE II, CLASS 1 or 3, GRADE 145 or 190
Resin Content:	35 (% WT)
Process Specification:	BAC 5317-1
(0/±45/90) LAMINATES	

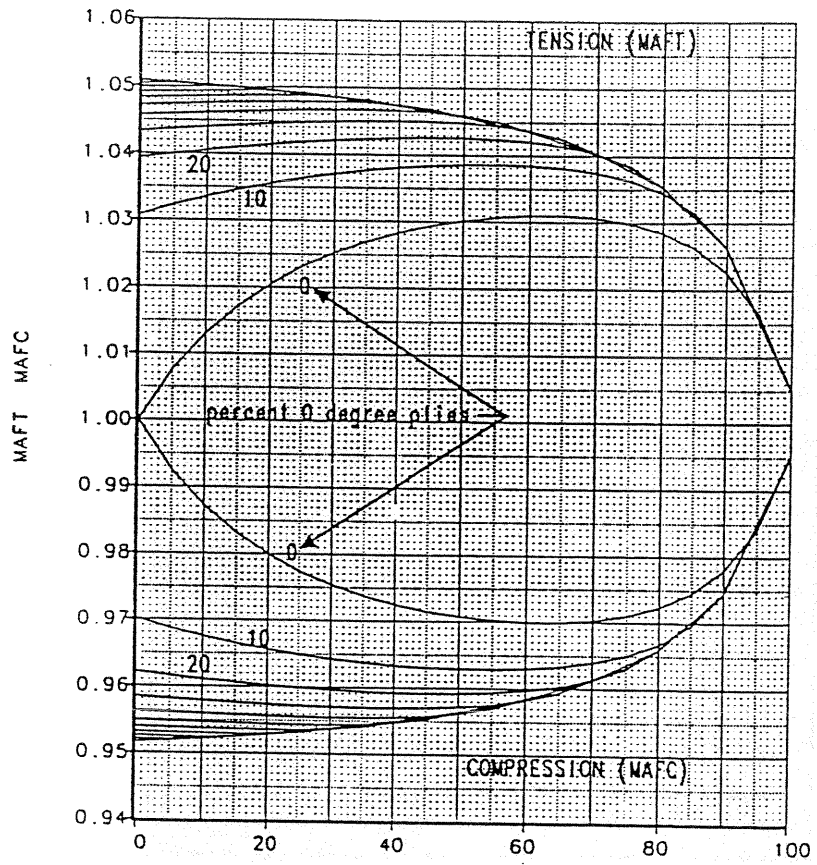


$$G_{XY_{ENVIRONMENT}} = G_{XY_{NOMINAL}} \times GMAF\_ENV$$

DG-100-529

Figure 2.2.1-6 G_{xy} Environmental Adjustment Factors

Prepreg Material Specification:	BMS 8-212, TYPE II, CLASS 1 or 3, GRADE 145 or 190
Resin Content:	35 (% WT)
Process Specification:	BAC 5317-1
70° F/DRY ENVIRONMENT, (0/±45/90) LAMINATES	



$E_{x\ TENSION} = E_{x\ NOMINAL} \times MAFT$

$E_{x\ COMPRESSION} = E_{x\ NOMINAL} \times MAFC$

DG-100-530

Figure 2.2.1-7 E_x Tension/Compression Adjustment Factors

2.2.2 BMS 8-212, Type III, Class 1 or 3, Grade 145 or 190

This specification applies to 350°F cure epoxy resin impregnated BMS 9-8 Type I carbon fiber (average modulus range 32 to 35 msi) unidirectional tape.

Type III: 37 percent by weight resin content.
Class 1: Unidirectional tape for manual layup.
Class 3: Unidirectional tape for use with automated tape laying equipment or manual layup.

Contents:

Table 2.2.2-1 Ply Properties

TABLE: 2.2.2-1		PLY PROPERTIES						
Prepreg Material Specicification:		BMS 8-212, TYPE III CLASS 1 or 3, GRADE 145 or 190						
Resin Content:		37 (% WT)						
Cured Ply Thickness:		0.0059 (in) - GRADE 145		0.0080 (in) - GRADE 190				
Density:		0.056 lb/in^3						
Process Specification:		BAC 5317-1						
PROPERTY		UNIT	ENVIRONMENTAL CONDITION					
			-75° F		70° F		180° F ⑤	
			DRY	WET	DRY	WET	DRY	WET
MODULUS ②	E_1 ①	Msi	← 17.1 →					
	E_2	Msi			1.28			
	G_{12}	Msi	0.82		0.66			0.54
	G_{13}	Msi	0.82		0.66			0.54
	G_{23}	Msi	0.82		0.66			0.54
POISSON'S RATIO	ν_{12}	----	← 0.34 →					
COEFFICIENTS OF LINEAR THERMAL EXPANSION ③	α_1	in/in ° F	$.02 \times 10^{-6}$				$.02 \times 10^{-6}$	
	α_2	in/in ° F	15×10^{-6}				15×10^{-6}	
COEFFECIENTS OF LINEAR MOISTURE EXPANSION ④	β_1	in/in %M						
	β_2	in/in %M						
THERMAL CONDUCTIVITY	κ_1	BTU/(hr ft °F)						
	κ_2	BTU/(hr ft °F)						
	κ_3	BTU/(hr ft °F)						

① E_1 is the average of tension and compression moduli. For special analyses use tension/compression modulus adjustment factors to determine tension or compression E_1.

② Modulus values are secant values at a strain level of 4000 μ in/in. For special analysis use modulus versus strain curves to determine secant values at the desired strain level.

③ Values are for expansion between -75° F and 70° F, and 70° F and 180° F.

④ %M = Percent absorbed moisture by weight.

⑤ 180°F values are to be used for 160°F environment.

DG-100-531

Prepreg Material Specification:	BMS 8-212, TYPE III, CLASS 1 or 3, GRADE 145 or 190
Resin Content:	37 (% WT)
Process Specification:	BAC 5317-1
70° F/DRY ENVIRONMENT, (0/±45/90) LAMINATES	

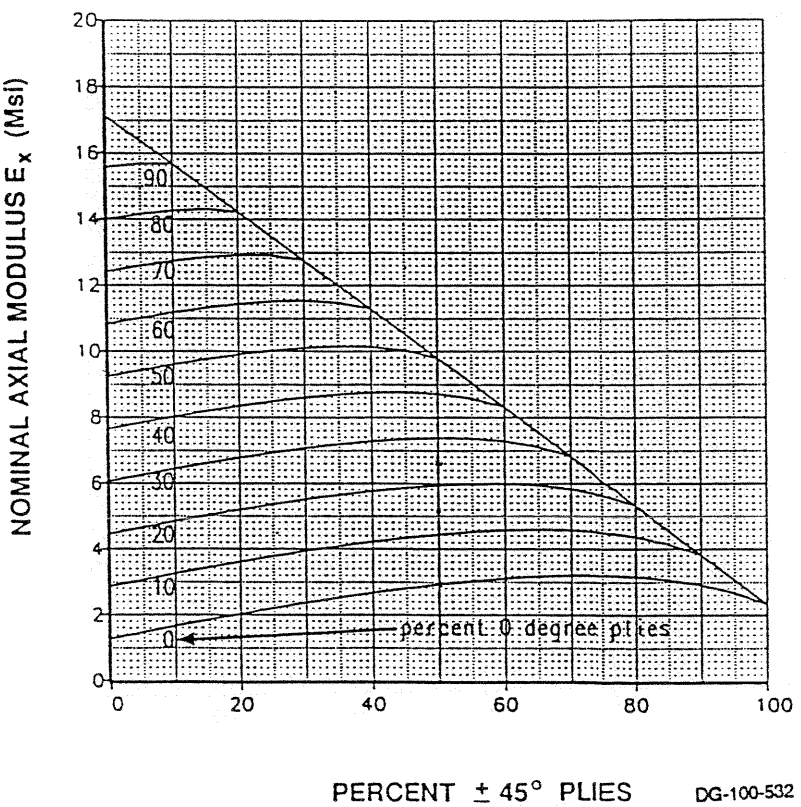


Figure 2.2.2-1 Nominal E_x Modulus

Prepreg Material Specification:	BMS 8-212, TYPE III, CLASS 1 or 3, GRADE 145 or 190
Resin Content:	37 (% WT)
Process Specification:	BAC 5317-1
70° F/DRY ENVIRONMENT, (0/±45/90) LAMINATES	

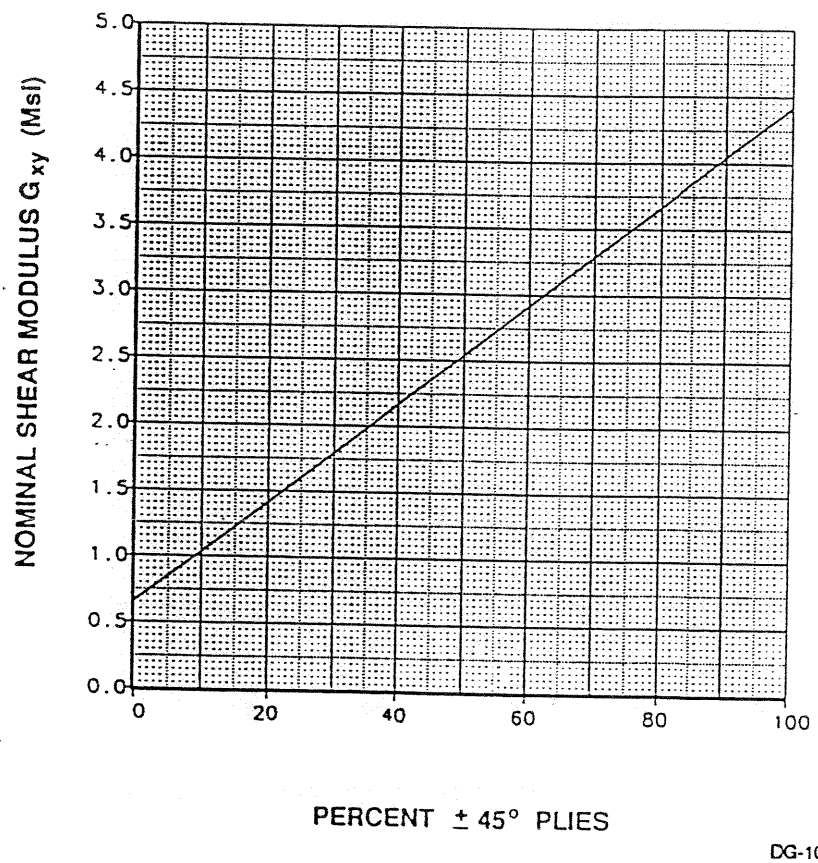


Figure 2.2.2-2 Nominal G_{xy} Modulus

Prepreg Material Specification:	BMS 8-212, TYPE III, CLASS 1 or 3, GRADE 145 or 190
Resin Content:	37 (% WT)
Process Specification:	BAC 5317-1
70° F/DRY ENVIRONMENT, (0/±45/90) LAMINATES	

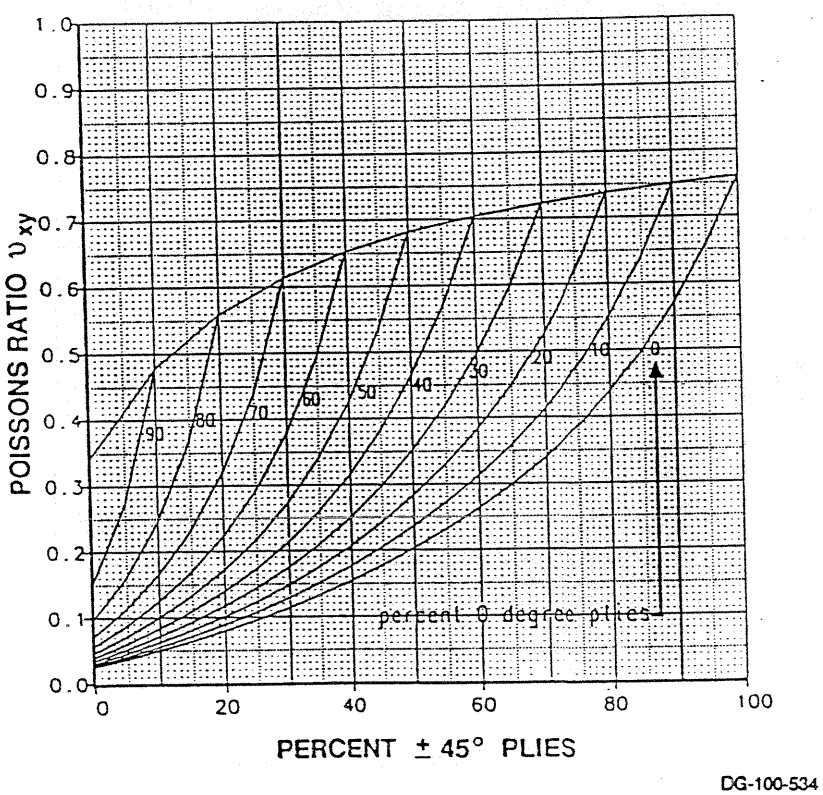


Figure 2.2.2-3 Nominal ν_{xy} Poisson's Ratio

Prepreg Material Specification:	BMS 8-212, TYPE III, CLASS 1 or 3, GRADE 145 or 190
Resin Content:	37 (% WT)
Process Specification:	BAC 5317-1
70° F/DRY ENVIRONMENT, (0/±45/90) LAMINATES	

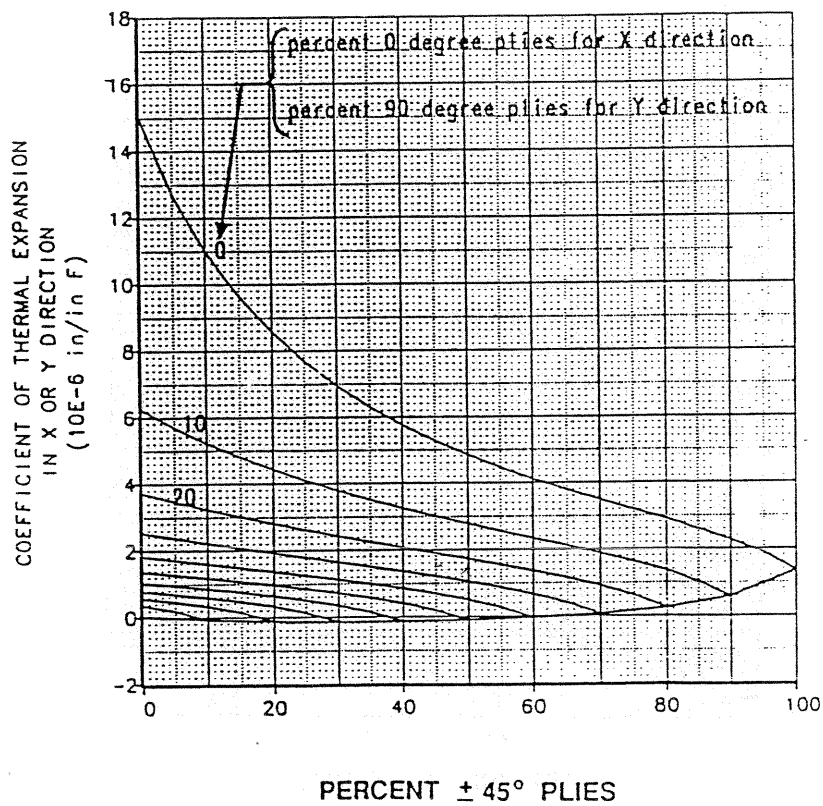
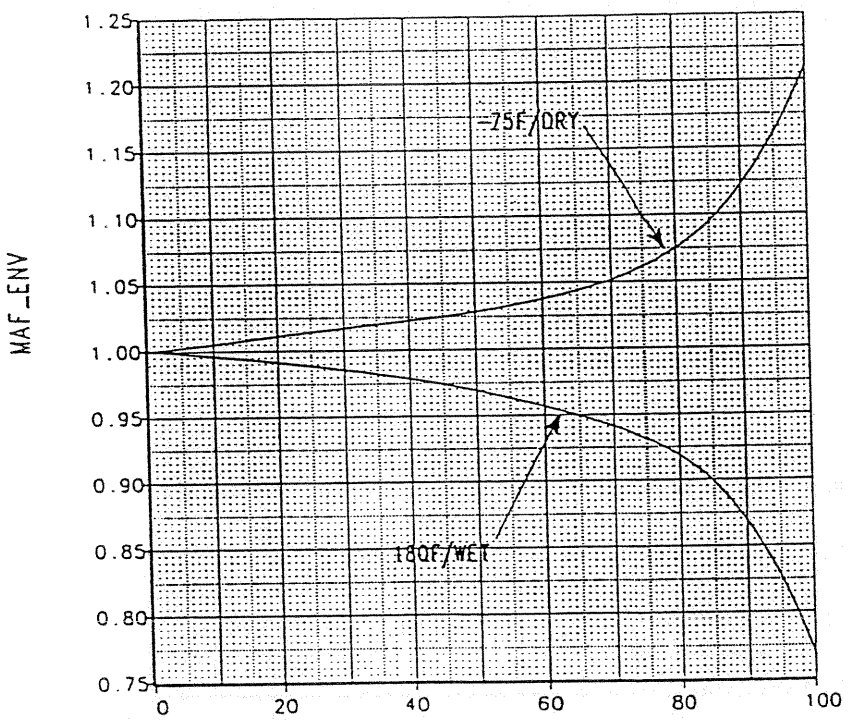


Figure 2.2.2-4 Nominal α_x Coefficient of Thermal Expansion

Prepreg Material Specification:	BMS 8-212, TYPE III, CLASS 1 or 3, GRADE 145 or 190
Resin Content:	37 (% WT)
Process Specification:	BAC 5317-1
(0/±45/90) LAMINATES	

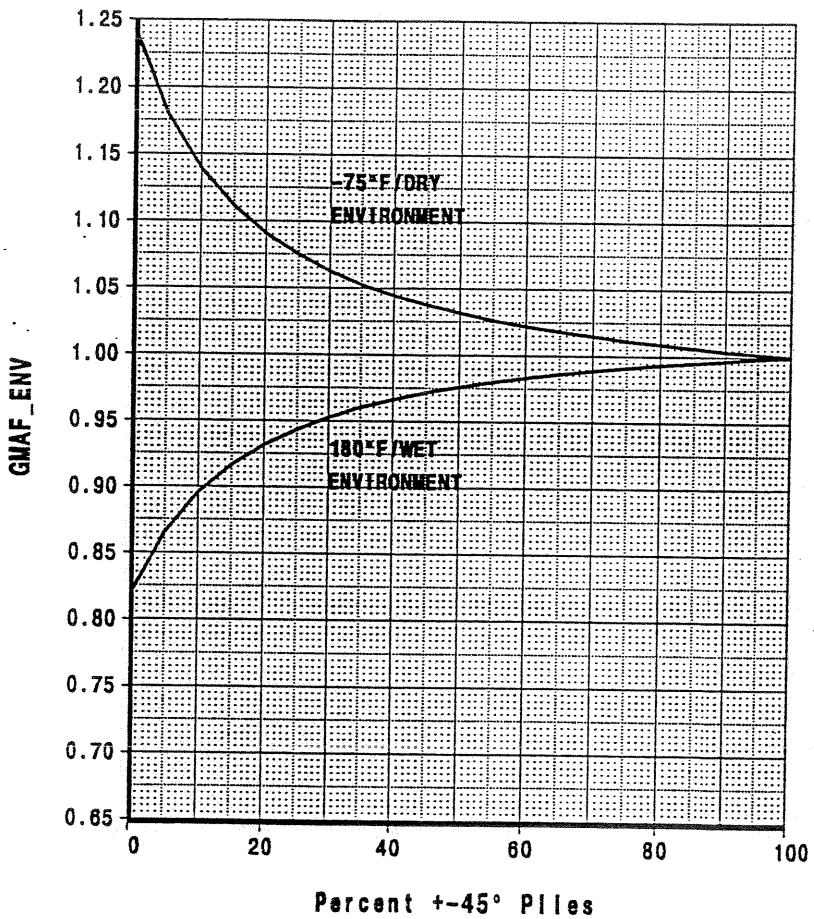


$E_{x\ ENVIRONMENT} = E_{x\ NOMINAL} \times MAF\_ENV$

DG-100-536

Figure 2.2.2-5 E_x Environmental Adjustment Factors

Prepreg Material Specification:	BMS 8-212, TYPE III, CLASS 1 or 3, GRADE 145 or 190
Resin Content:	37 (% WT)
Process Specification:	BAC 5317-1
(0/±45/90) LAMINATES	

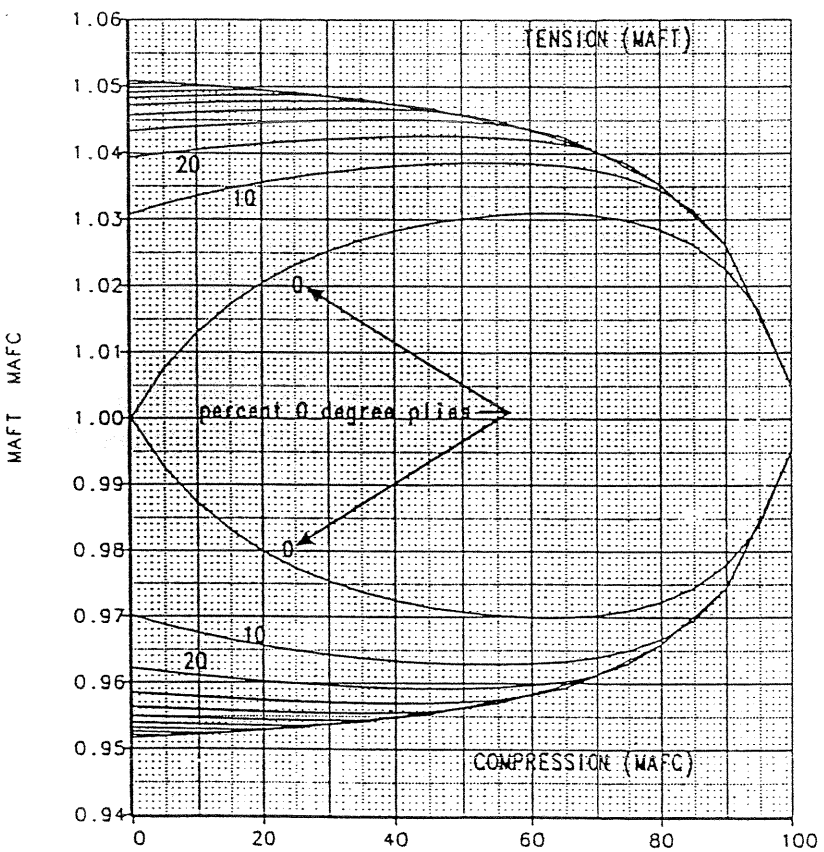


$$G_{XY_{ENVIRONMENT}} = G_{XY_{NOMINAL}} \times GMAF\_ENV$$

DG-100-537

Figure 2.2.2-6 G_{xy} Environmental Adjustment Factors

Prepreg Material Specification:	BMS 8-212, TYPE III, CLASS 1 or 3, GRADE 145 or 190
Resin Content:	37 (% WT)
Process Specification:	BAC 5317-1
70° F/DRY ENVIRONMENT, (0/±45/90) LAMINATES	



PERCENT ± 45° PLIES

$E_{x\ TENSION} = E_{x\ NOMINAL} \times MAFT$

$E_{x\ COMPRESSION} = E_{x\ NOMINAL} \times MAFC$

DG-100-538

Figure 2.2.2-7 E_x Tension/Compression Adjustment Factors

2.2.3 BMS 8-212, Type IV, Class 2, Style 3K-70-PW

This specification applies to 350°F cure epoxy resin impregnated BMS 9-8 Type I carbon fiber (average modulus range 32 to 35 msi) woven fabric.

Type IV: 40 percent by weight resin content.
Class 2: Woven Fabric Prepreg.

Contents:

Table 2.2.3-1 Ply Properties

TABLE: 2.2.3-1		PLY PROPERTIES						
Prepreg Material Specicification:		BMS 8-212, TYPE IV, CLASS 2, STYLE 3K-70-PW						
Resin Content:		40 (% WT)						
Cured Ply Thickness:		0.0083 (in)						
Density:		0.055 lb/in ^{3}						
Process Specification:		BAC 5317-1						
PROPERTY		UNIT	ENVIRONMENTAL CONDITION					
			-75° F		70° F		180° F ⑤	
			DRY	WET	DRY	WET	DRY	WET
MODULUS ②	E_1 ①	Msi	8.30					
	E_2	Msi	8.30					
	G_{12}	Msi	0.87		0.70			0.45
	G_{13}	Msi	0.87		0.70			0.45
	G_{23}	Msi	0.87		0.70			0.45
POISSON'S RATIO	ν_{12}	----	0.06					
COEFFICIENTS OF LINEAR THERMAL EXPANSION ③	α_1	in/in ° F	1.6×10^{-6}				1.6×10^{-6}	
	α_2	in/in ° F	1.6×10^{-6}				1.6×10^{-6}	
COEFFECIENTS OF LINEAR MOISTURE EXPANSION ④	β_1	in/in %M						
	β_2	in/in %M						
THERMAL CONDUCTIVITY	κ_1	BTU/(hr ft °F)						
	κ_2	BTU/(hr ft °F)						
	κ_3	BTU/(hr ft °F)						

① E_1 is the average of tension and compression moduli. For special analyses use tension/compression modulus adjustment factors to determine tension or compression E_1.

② Modulus values are secant values at a strain level of 4000 μ in/in. For special analysis use modulus versus strain curves to determine secant values at the desired strain level.

③ Values are for expansion between -75° F and 70° F, and 70° F and 180° F.

④ %M = Percent absorbed moisture by weight.

⑤ 180°F values are to be used for 160°F environment.

DG-100-539

Prepreg Material Specification:	BMS 8-212, TYPE IV, CLASS 2, STYLE 3K-70-PW
Resin Content:	40 (% WT)
Process Specification:	BAC 5317-1
70° F/DRY ENVIRONMENT, (0/±45/90) LAMINATES	

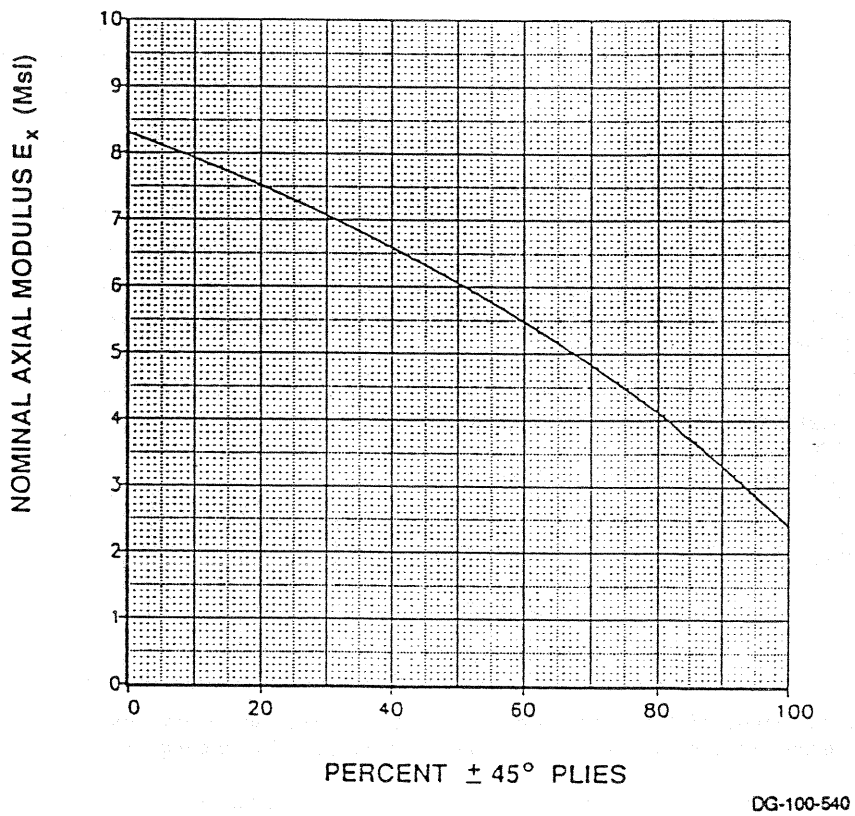


Figure 2.2.3-1 Nominal E_x Modulus

Prepreg Material Specification:	BMS 8-212, TYPE IV, CLASS 2, STYLE 3K-70-PW
Resin Content:	40 (% WT)
Process Specification:	BAC 5317-1
70° F/DRY ENVIRONMENT, (0/±45/90) LAMINATES	

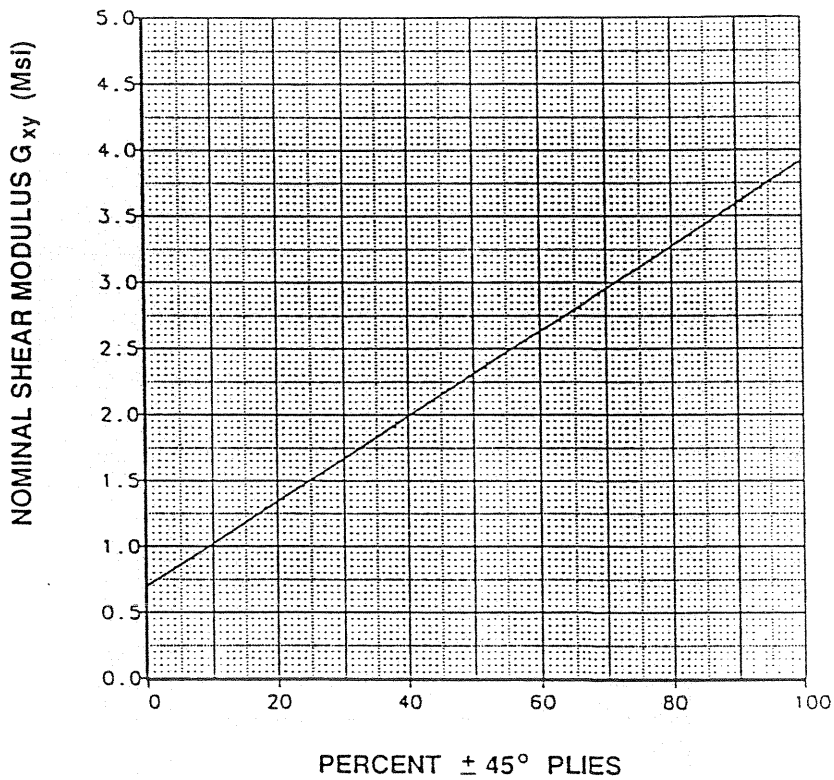


Figure 2.2.3-2 Nominal G_{xy} Modulus

Prepreg Material Specification:	BMS 8-212, TYPE IV, CLASS 2, STYLE 3K-70-PW
Resin Content:	40 (% WT)
Process Specification:	BAC 5317-1
70° F/DRY ENVIRONMENT, (0/±45/90) LAMINATES	

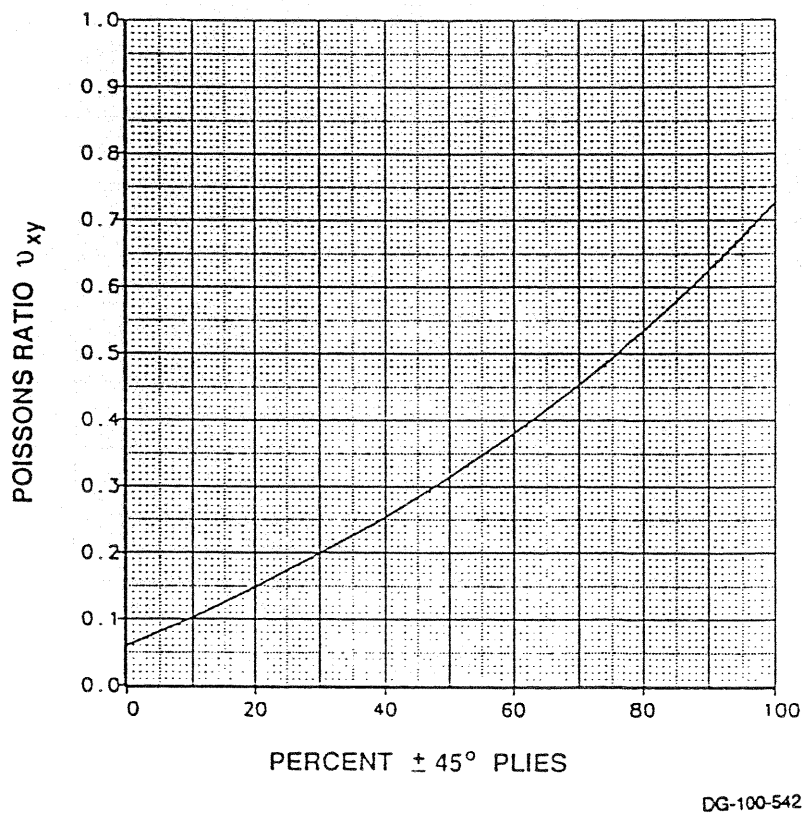


Figure 2.2.3-3 Nominal ν_{xy} Poisson's Ratio

Prepreg Material Specification:	BMS 8-212, TYPE IV, CLASS 2, STYLE 3K-70-PW
Resin Content:	40 (% WT)
Process Specification:	BAC 5317-1
70° F/DRY ENVIRONMENT, (0/±45/90) LAMINATES	

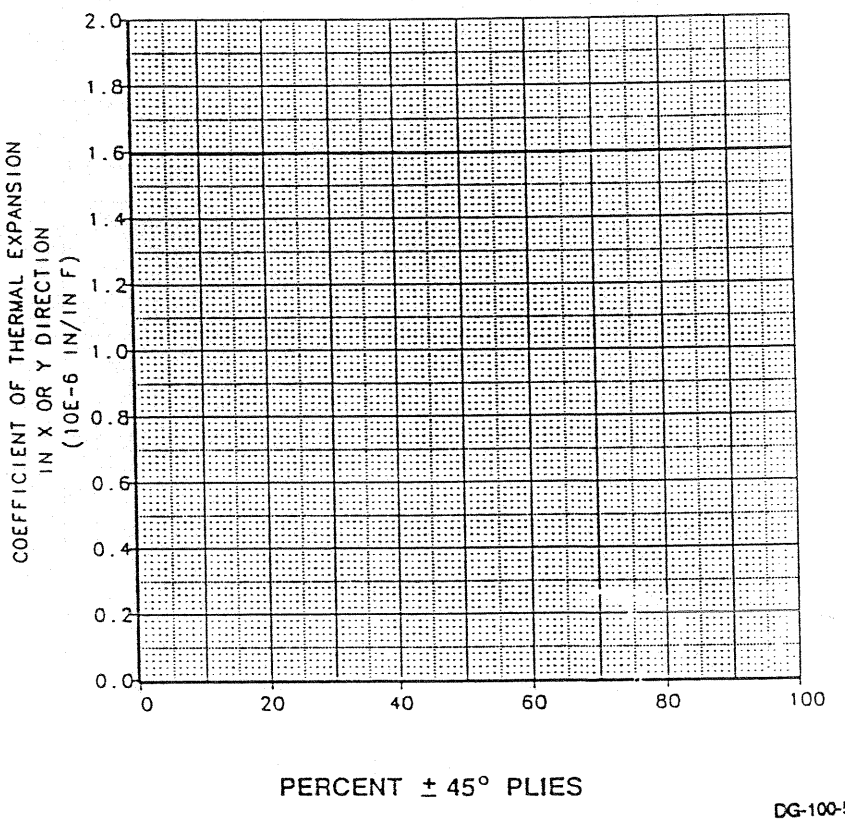
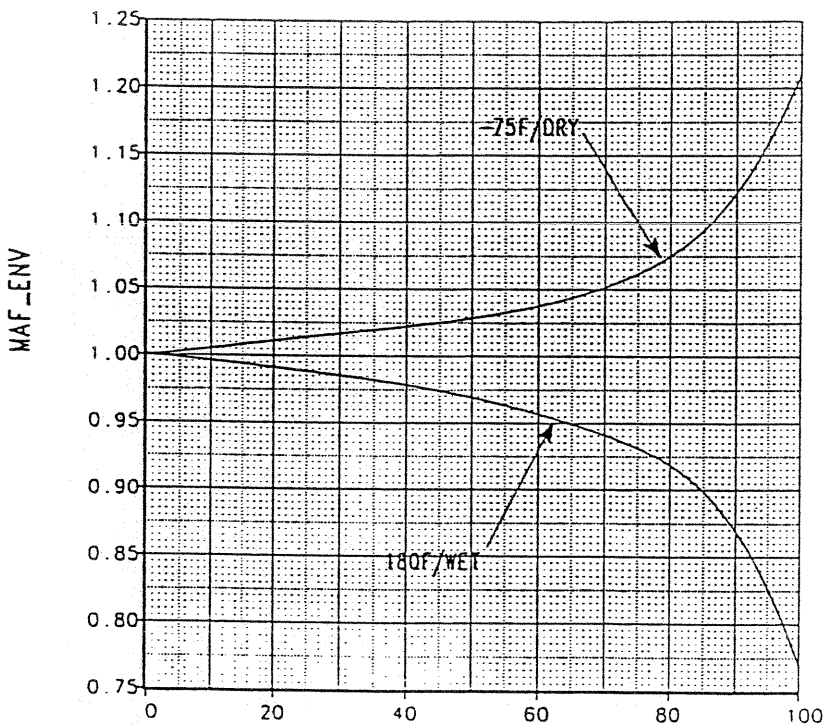


Figure 2.2.3-4 Nominal α_x Coefficient of Thermal Expansion

Prepreg Material Specification:	BMS 8-212, TYPE IV, CLASS 2, STYLE 3K-70-PW
Resin Content:	40 (% WT)
Process Specification:	BAC 5317-1
(0/±45/90) LAMINATES	

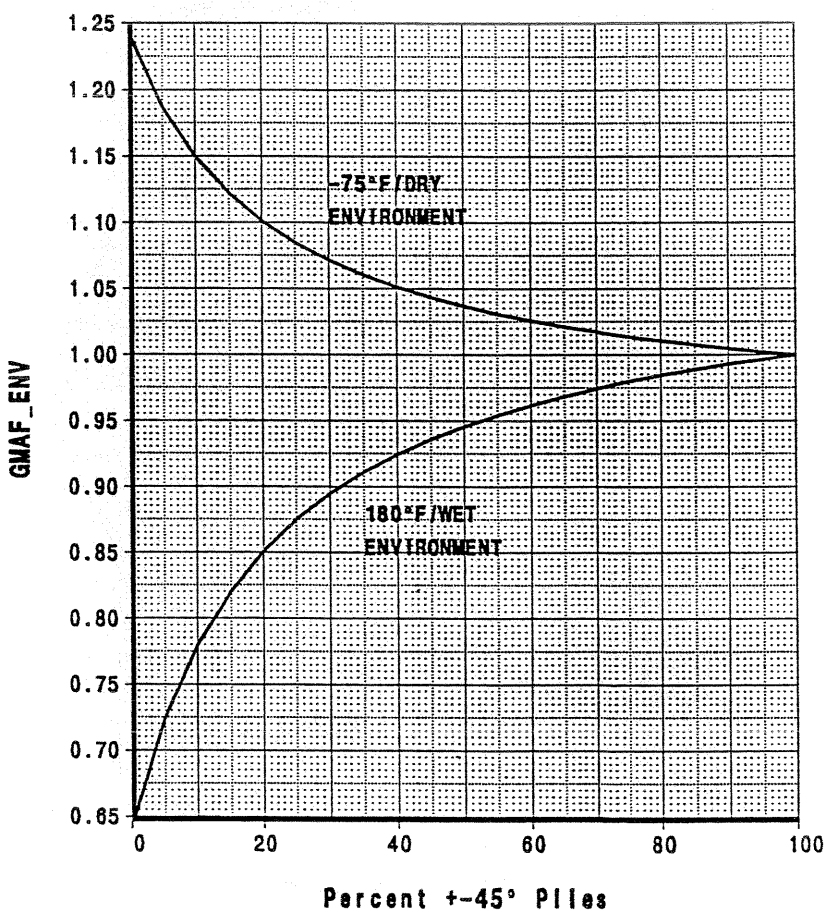


$E_{x\ ENVIRONMENT} = E_{x\ NOMINAL} \times MAF\_ENV$

DG-100-544

Figure 2.2.3-5 E_x Environmental Adjustment Factors

Prepreg Material Specification:	BMS 8-212, TYPE IV, CLASS 2, STYLE 3K-70-PW
Resin Content:	40 (% WT)
Process Specification:	BAC 5317-1
(0/±45/90) LAMINATES	

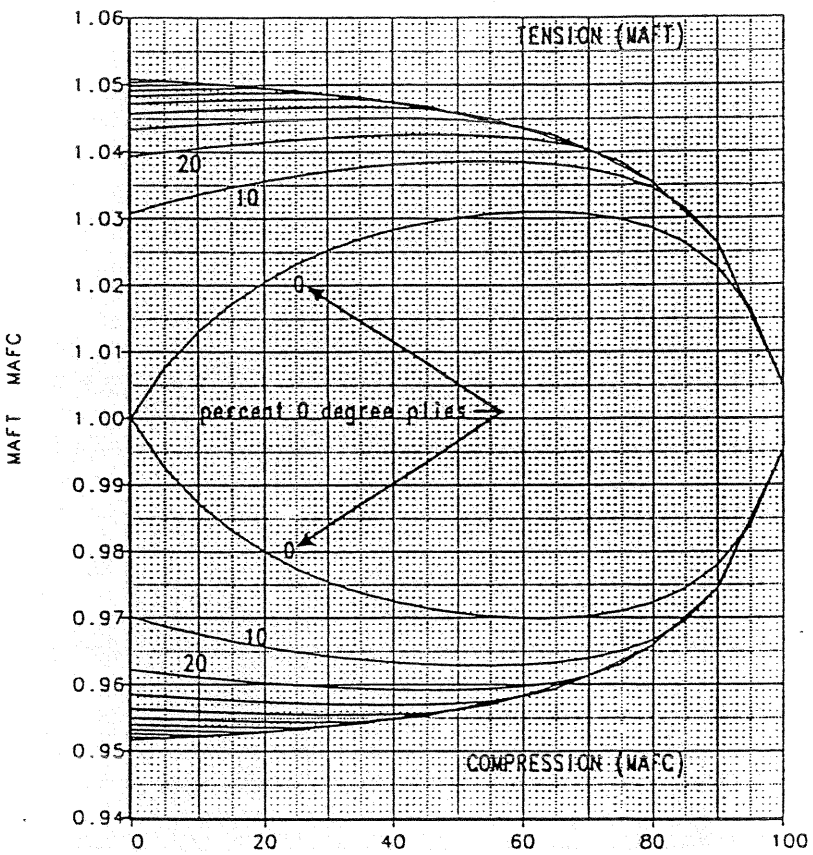


$$G_{XY_{ENVIRONMENT}} = G_{XY_{NOMINAL}} \times GMAF\_ENV$$

DG-100-545

Figure 2.2.3-6 G_{xy} Environmental Adjustment Factors

Prepreg Material Specification:	BMS 8-212, TYPE IV, CLASS 2, STYLE 3K-70-PW
Resin Content:	40 (% WT)
Process Specification:	BAC 5317-1
70° F/DRY ENVIRONMENT, (0/±45/90) LAMINATES	



$E_{x\ TENSION} = E_{x\ NOMINAL} \times MAFT$

$E_{x\ COMPRESSION} = E_{x\ NOMINAL} \times MAFC$

DG-100-546

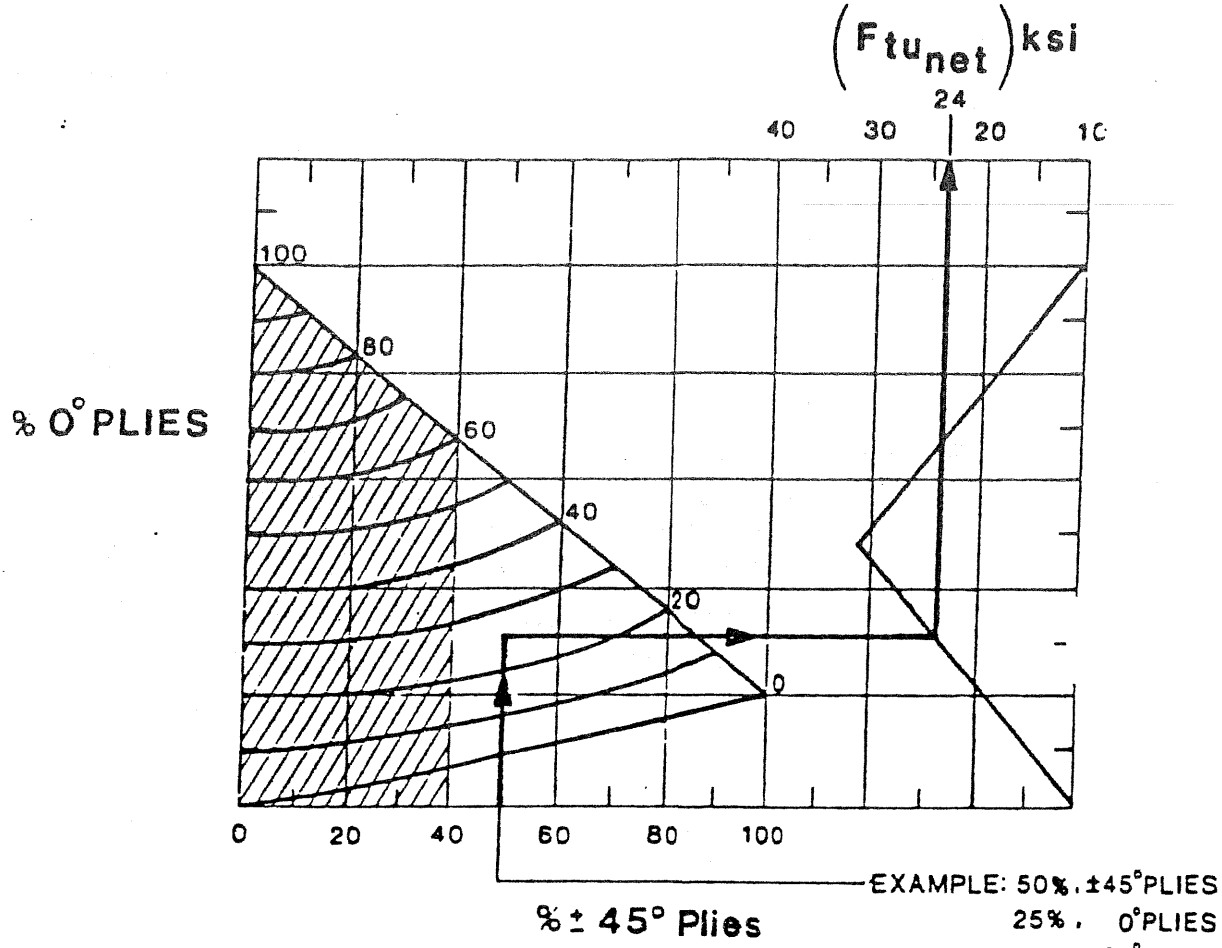
Figure 2.2.3-7 E_x Tension/Compression Adjustment Factors

BOLTED JOINT TENSION STRENGTH

TAPE & FABRIC

Graphite/Epoxy BMS 8-212 Class 1&2 per BAC 5562

CAUTION: DATA MAY NOT BE VALID FOR LAMINATES WITH BUTT SPLICES NEAR FASTENER(s)



Room Temperature

D/t 1.0 → 3.0

S/D 4.0 → 8.0

See Figure 4.3.3-2 For Restriction On Minimum Percentage Of ± 45° Plies For Bearing Strength

From Reference 1, Page 4.1 and Reference 3 and Boeing Data

FIGURE 4.3.3-1

POISSON'S RATIO

TAPE
GRAPHITE/EPOXY, BMS 8-212 Type II CLASS 1, PER BAC 5562

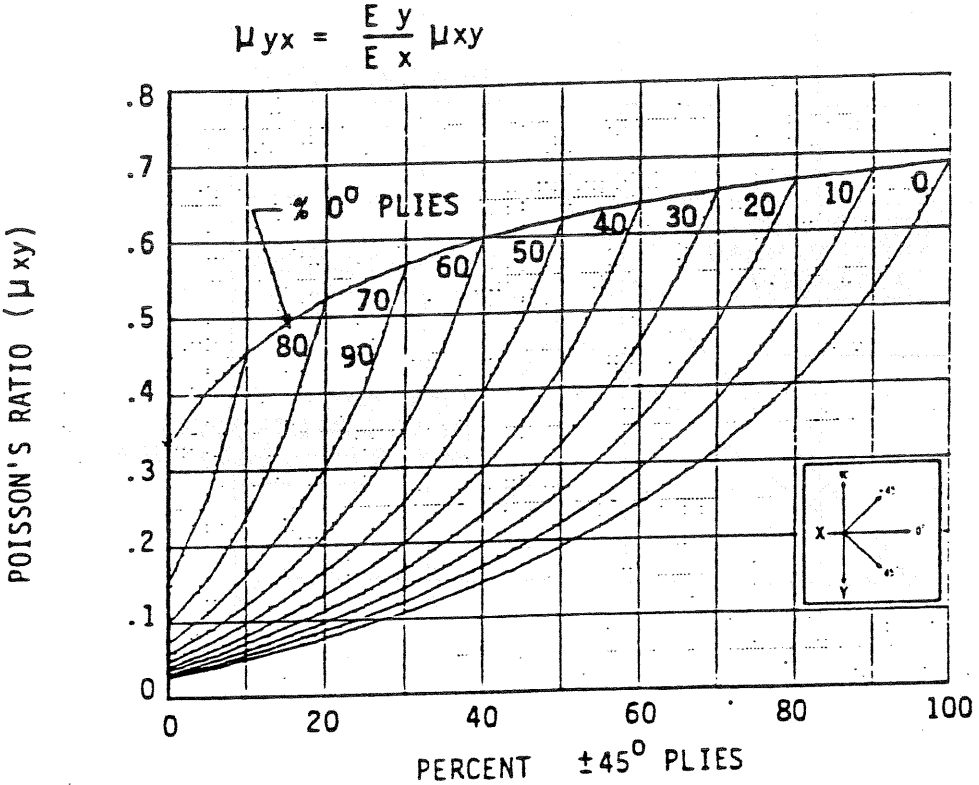
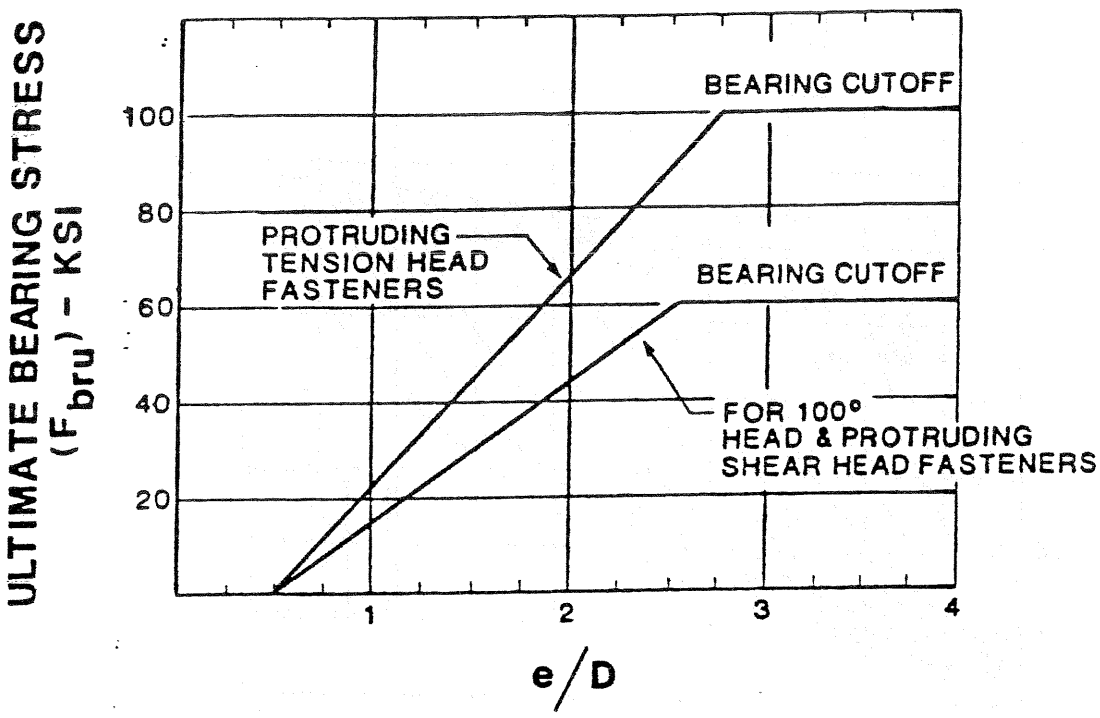


FIGURE 4.3.5-1

BOLTED JOINT BEARING STRENGTH

TAPE AND FABRIC

Graphite/Epoxy BMS 8-212 Class 1&2 per BAC 5562



ROOM TEMPERATURE

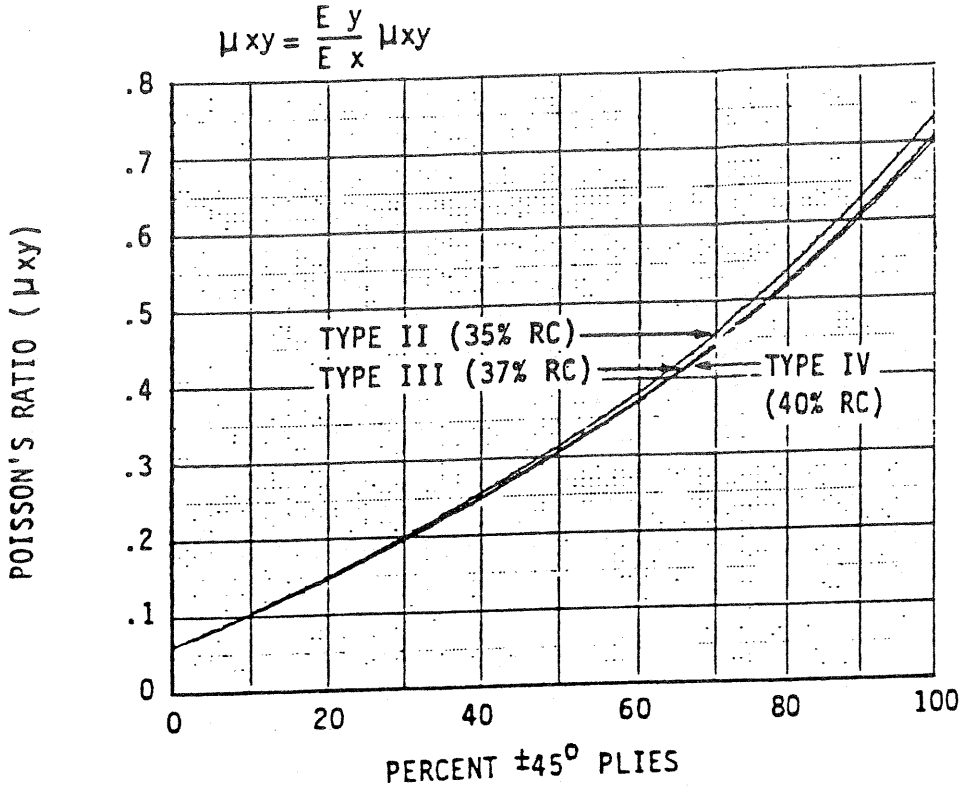
THIS DATA IS VALID FOR LAMINATES CONTAINING A MINIMUM OF 40% ±45% PLIES, AND FOR A COUNTERSINK DEPTH LESS THAN 2/3 THE LAMINATE THICKNESS.

From Reference 1, Page 4.2, Reference 2, and Boeing Data

Figure 4.3.3 - 2

POISSON'S RATIO

FABRIC
GRAPHITE/EPOXY 5 8-212 CLASS 2, PER BAC 5562



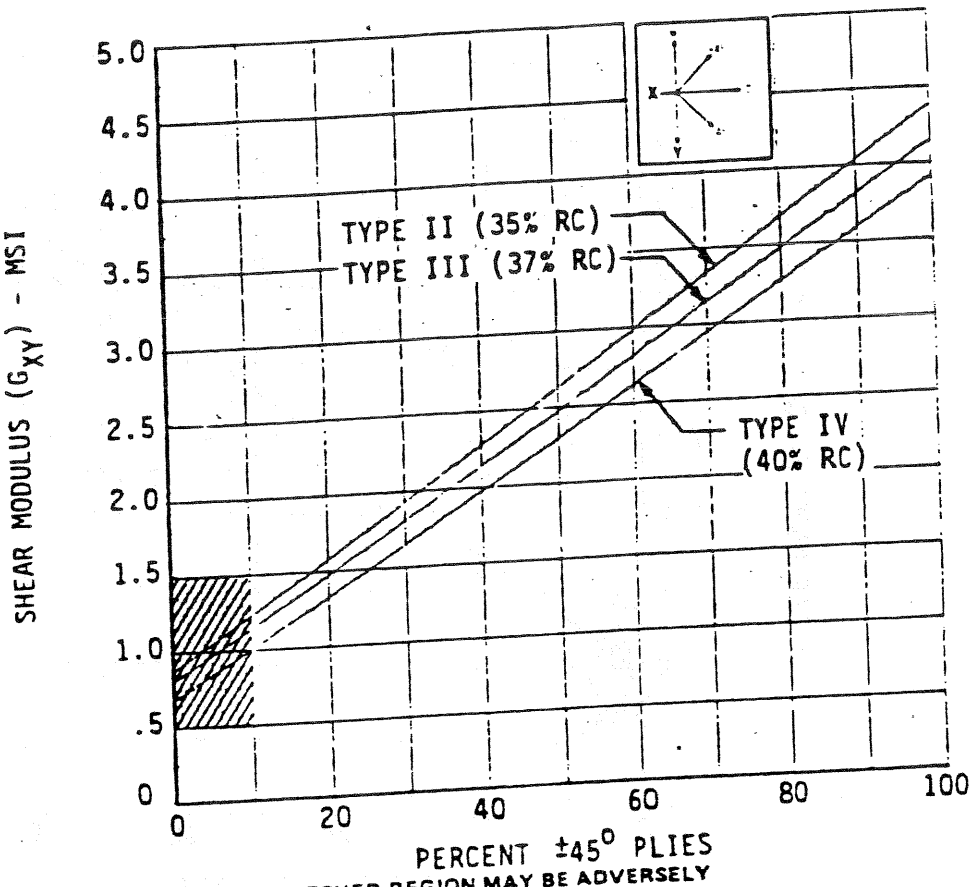
RC=NOMINAL RESIN CONTENT PER BMS 8-212

FIGURE 4.3.5-3

IN-PLANE SHEAR MODULUS AND ALLOWABLE STRAINS

FABRIC

GRAPHITE/EPOXY, BMS 8-212 CLASS 2, PER BAC 5562



CAUTION : PROPERTIES IN THE CROSS-HATCHED REGION MAY BE ADVERSELY AFFECTED BY TEMPERATURE AND HUMIDITY.

RC= NOMINAL RESIN CONTENT PER BMS 8-212

LIMIT & ULTIMATE STRAIN (IN/IN)	LIMIT STRAIN	ULTIMATE STRAIN	
		"A" BASIS	"B" BASIS
LAMINATE SHEAR ϵ_{xy}	.0053	.0108	.0117
SANDWICH SHEAR ϵ_{xy}	①	.0070	.0076

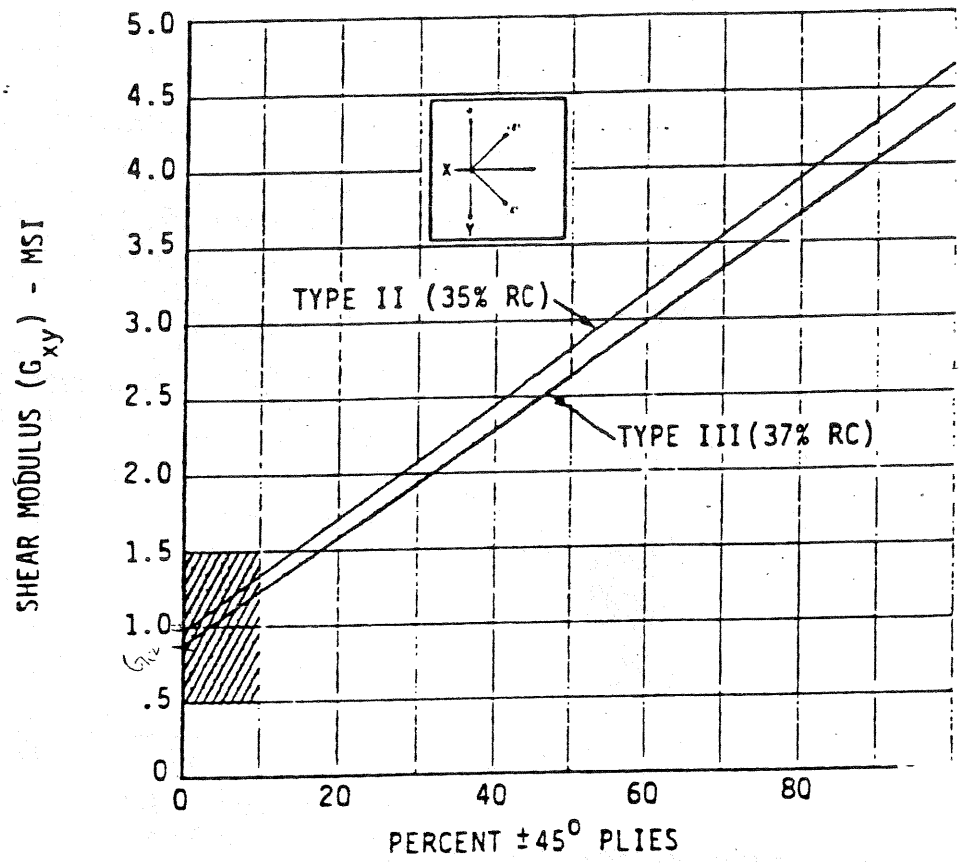
① ULTIMATE STRAIN ÷1.5

FIGURE 4.3.1-5

IN-PLANE SHEAR MODULUS AND ALLOWABLE STRAINS

TAPE

GRAPHITE/EPOXY, BMS 8-212 CLASS 1, PER BAC 5562



LIMIT & ULTIMATE STRAIN (IN/IN)

	LIMIT STRAIN	ULTIMATE STRAIN "A" BASIS	ULTIMATE STRAIN "B" BASIS
SHEAR ε_{xy}	.0053	.0133	.0144

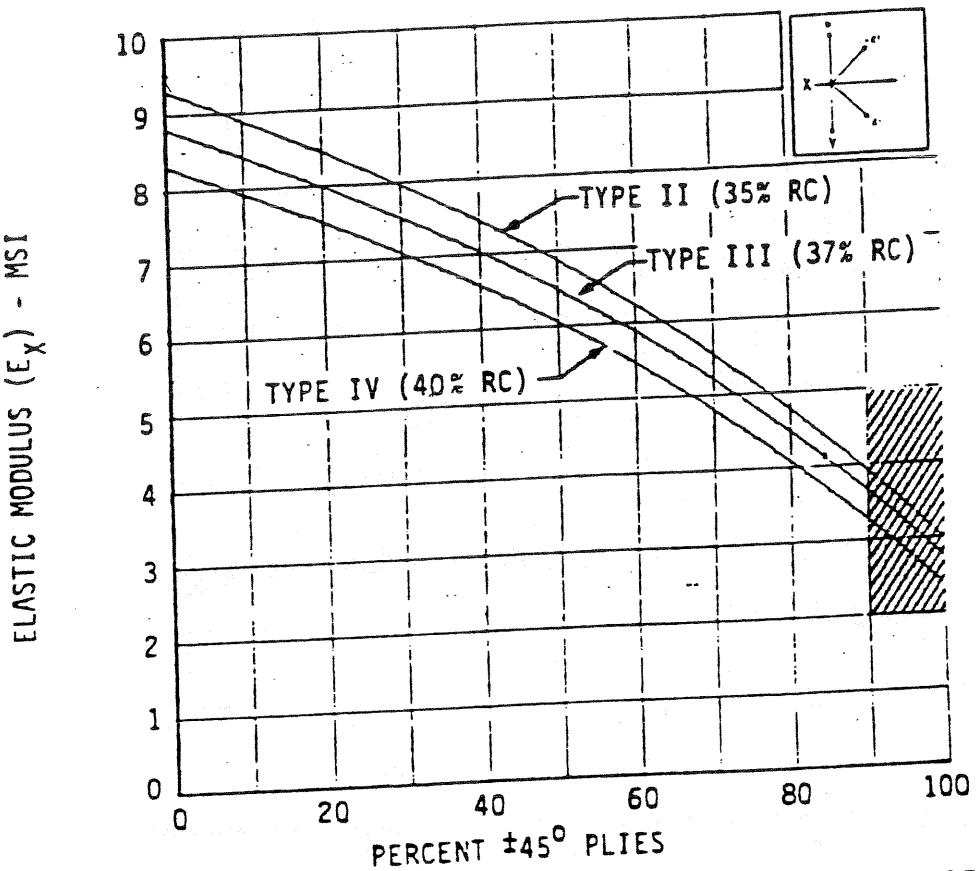
CAUTION : PROPERTIES IN THE CROSS-HATCHED REGION MAY BE ADVERSELY AFFECTED BY TEMPERATURE AND HUMIDITY.

FIGURE 4.3.1-4

ELASTIC MODULUS AND ALLOWABLE STRAINS

FABRIC

GRAPHITE/EPOXY, BMS 8-212 CLASS 2, PER BAC 5562



CAUTION : PROPERTIES IN THE CROSS-HATCHED REGION MAY BE ADVERSELY AFFECTED BY TEMPERATURE HUMIDITY.

RC-NOM RESIN CONTENT PER BMS 8-212

LIMIT & ULTIMATE STRAIN IN/IN)	LIMIT STRAIN	ULTIMATE STRAIN "A" BASIS	ULTIMATE STRAIN "B" BASIS
LAMINATE TENSION ε_t	.0035	.0059	.0064
LAMINATE COMPRESSION ε_c	.0027	.0054	.0059
SANDWICH TENSION ε_t	①	.0043	.0046
SANDWICH COMPRESSION ε_c	①	.0035	.0038

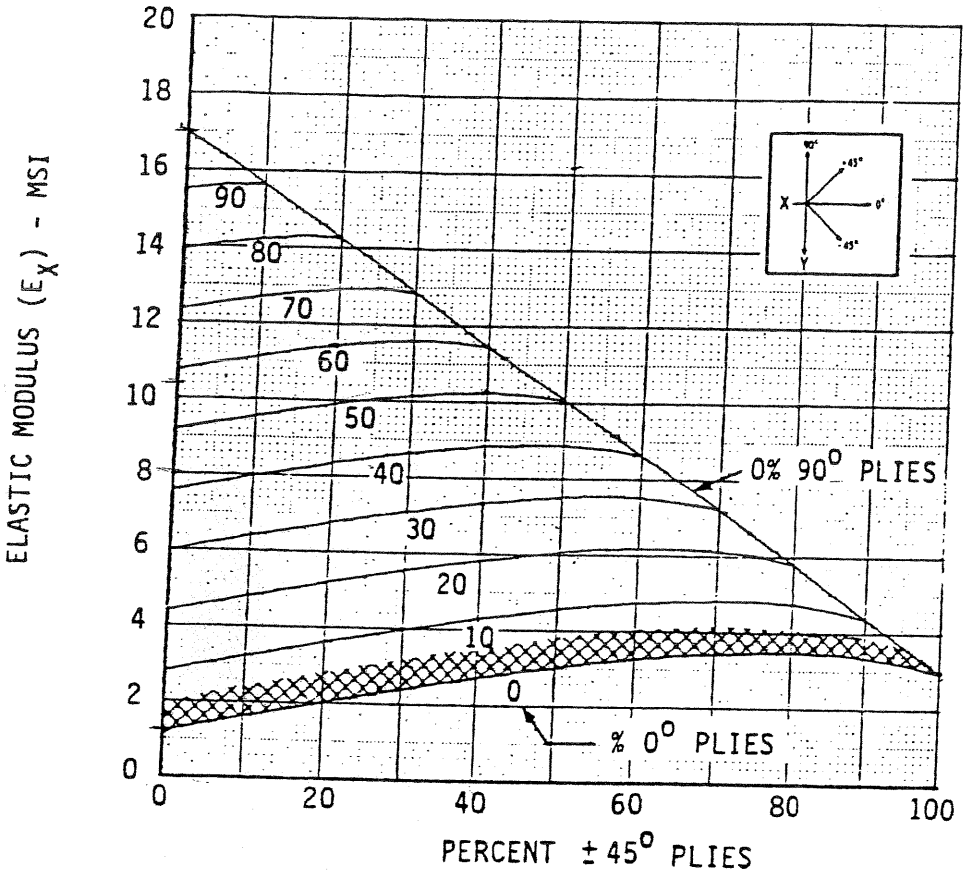
① ULTIMATE STRAIN ÷ 1.5

FIGURE 4.3.1-3

ELASTIC MODULUS AND ALLOWABLE STRAINS

TAPE

GRAPHITE/EPOXY, BMS 8-212 TYPE III CLASS 1, PER BAC 5562



CAUTION : PROPERTIES IN THE CROSS - HATCHED REGION MAY BE ADVERSELY AFFECTED BY TEMPERATURE AND HUMIDITY.

LIMIT & ULTIMATE STRAIN (IN/IN)

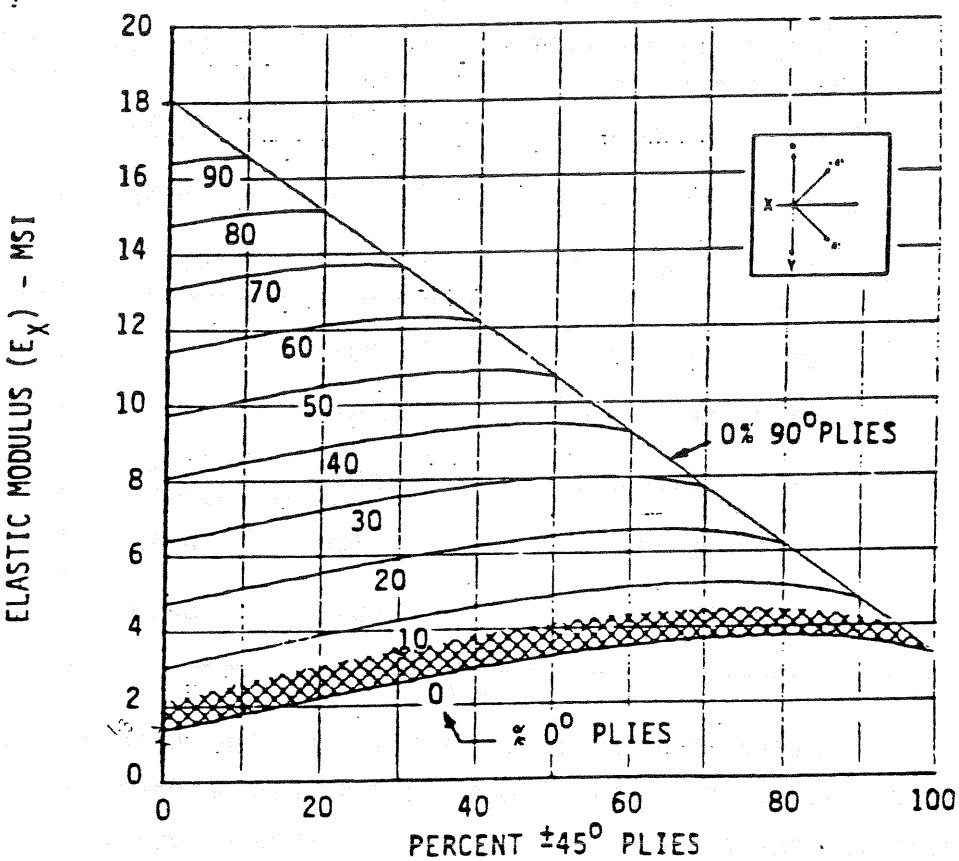
	LIMIT STRAIN	ULTIMATE STRAIN "A" BASIS	ULTIMATE STRAIN "B" BASIS
TENSION ϵ_t	.0035	.0082	.0090
COMPRESSION ϵ_c	.0027	.0067	.0072

FIGURE 4.3.1-2

ELASTIC MODULUS AND ALLOWABLE STRAINS

TAPE

GRAPHITE/EPOXY, BMS 8-212 TYPE II CLASS 1, PER BAC 5562



CAUTION : PROPERTIES IN THE CROSS - HATCHED REGION MAY BE ADVERSELY AFFECTED BY TEMPERATURE AND HUMIDITY.

LIMIT & ULTIMATE STRAIN (IN/IN)

		ULTIMATE STRAIN	
	LIMIT STRAIN	"A" BASIS	"B" BASIS
TENSION ϵ_t	.0035	.0082	.0090
COMPRESSION ϵ_c	.0027	.0067	.0072

FIGURE 4.3.1-1

4.3 Mechanical Properties (con't)

All properties presented are based on laminate thickness less than .30 inches. No change in these properties is anticipated when tests are completed on laminate thicknesses greater than .30 inch. Laminate thickness should be calculated using ply thickness values shown below. Adjustments for variations in measured fiber volume or part thickness should not be made.

CURED THICKNESS TABLE (BMS 8-212)

FORM	BMS 8-212 DESIGNATION	NOMINAL CURED THICKNESS-INCHES* TYPE II	TYPE III	TYPE IV
Tape	Class 1 Grade 95	.0037	.0039	-
	Class 1 Grade 145	.0056	.0059	-
	Class 1 Grade 190	.0074	.0078	-
Fabric	Class 2 3K-70-P	.0075	-	-
	Class 2 3K-70-PW	.0075	-	.0083
	Class 2 3K-70-CSW	.0073	.0075	-
	Class 2 3K-135-8H	.0144	.0150	-
	Class 2 1K-50-5H	.0048	.0050	-

TABLE 4.3-1

Because Type I material properties are not included in this section, the thickness values for Type II materials should be used when making stress calculations for Type I materials. Although Type I materials have different thicknesses than Type II materials after cure, they contain the same amount of graphite fiber per ply resulting in the same allowable per ply. Therefore, by using Type II allowables and unit thickneses for stress calculations when using Type I material, the proper allowable stress and margin of safety will be obtained.

s Analysis. (See Table 4.2-1 for preliminary weight
ı data).