## THE BOEING COMPANY

2.6 BMS 8-168

2.6.1 BMS 8-168, Type II, Class 1, Grade 145 or 190

This specification applies to a 250°F cure epoxy resin impregnated BMS 9-8 Type I carbon fiber unidirectional tape.

Type II:

Self Adhesive Resin System

Class 1:

Unidirectional prepreg tape.

Reference: Coordination Sheet BY1HU-SHW-C92-007, "BMS 8-168 Analysis Methods and Design Values for 777 Program", 1/20/1992.

## Contents:

Table 2.6.1-1	Ply Properties
Table 2.6.1-2	Design Values
Table 2.6.1-3	Environment Adjustment Factors

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# Table 2.6.1-1 Ply Properties

TABLE 2.6.1-1 PLY PROPERTIES

PREPREG MATERIAL SPECIFICATION: BMS 8-168, TYPE II, CLASS 1, GRADE 145 OR 190

**RESIN CONTENT:** 

40 (% WT)

**CURED PLY THICKNESS:** 

.0062 (in) - Grade 145

.0082 (In) - Grade 190

PROCESS SPECIFICATION: BAC 5317-5

			ENVIRONMENTAL CONDITION					
PROPERTY		UNIT	-75	۰F .	70° F		160° F	130° F
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1			DRY	WET	DRY	WET	DRY	WET
MODULUS <sup>②</sup>	E1 1	msi	16.2					
al what	E 2	msi	1.1	(1.1)	1.1	(1.1)	1.0	1.0
	G <sub>12</sub>	msi	0.68	(0.68)	0.68	(0.63)	0.53	0.53
	G <sub>13</sub>	msi	0.68	(0.68)	0.68	(0.63)	0.53	0.53
	G 23	msi	0.68	(0.68)	0.68	(0.63)	0.53	0.53
POISSON'S RATIO	V <sub>12</sub>	क छ के ब	-34				-	
COEFFICIENTS OF	α1	In/In ° F	.02 x	10 -6			.02 x	10 <sup>-6</sup>
LINEAR THERMAL EXPANSION 3	α 2	in/in ° F	15 x 1	10 -6			15 x 10 <sup>-6</sup>	
COEFFECIENTS OF	β 1	in/in %M			0	.0		
LINEAR MOISTURE EXPANSION ④	β 2	in/in %M	2400 x 10 <sup>-6</sup>					
THERMAL CONDUCTIVITY	κ <sub>1</sub>	BTU/(hr ft °F)						
	κ2	BTU/(hr ft °F)						
	к <sub>з</sub>	BTU/(hr ft °F)						

- ① E<sub>1</sub> is the average of tension and compression moduli. For stability analysis use E<sub>1</sub>, compression = 15.4 Msi.
- 2 Modulus values are secant values at a strain level of 4000  $\mu$  ln/ln. For special analyses use modulus versus strain curves to determine secant values at the desired strain level.
- 3 CLTE values are for expansion between -75° F and 70° F, and 70° F and 180° F.
- 4 %M = Percent absorbed moisture by weight.
- 5 Values in ( ) are estimates.

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Enclosure to: B-Y1NU-HB-C94-027

# Guidelines for Usage of Moduli and Strength Design Values

Ply Properties - Table 2.6.1-1.

The room temperature (70°F) / dry condition values shown in this table are referred to as nominal moduli values. These values are to be used for almost all laminate analyses, including the calculation of strain design values from test data. The exceptions are:

- 1. buckling analyses, where compression moduli values at the appropriate environment are used,
- 2. test correlation analyses where it is desired to predict actual strain gage response.

The values for the other environments are used for the two cases listed above.

## Unnotched Tension, Compression and Shear Strains - Table 2.6.1-2

These strain values are based on unnotched, undamaged coupon test results. The values may be used for test correlation analyses. The margin of safety analysis procedure in Section 5.6 should be used with the unnotched strain values.

For notched laminate strain values for use with bolted joint analyses or to account for impact damage, refer to Section 11.4.3. The notched strain values may be used with the margin of safety analysis procedures of section 5.6 for laminate checks away from bolted joint areas.

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# Table 2.6.1-2 Design Values

Prepreg Material Specification: BMS 8-168, TYPE II, CLASS 1, GRADE 145 OR 190

Resin Content:

42 (% WT)

Process Specification:

BAC 5317-5

70°F/DRY ENVIRONMENT, (0/±45/90) LAMINATES

(Do not use Typical Values for Ultimate Strength analyses. They may be used for Damage

Tolerance or	test correlation analyses).		Baseline Fiber Direction Strain		Lamina Shear
Typical La	mina (Ply) Strain				Strain
		RT/a	mbient	RT/amb	RT/amb
		Laminate		2	
		t > 0.14 in.	Sandwich	All	All
BMS 8-168	Unnotched Tension	0.01000	0.00600	0.01000	
Tape	Unnotched Compression ***	0.01000	0.00500	0.01000	
	Unnotched Shear	*****		*****	0.01500

		Baseline F Direction S		Tape Transverse Direction	Lamina Shear Strain
		RT/a	mbient	RT/amb	RT/amb
		Laminate			
		t > 0.14 in.	Sandwich	All	All
BMS 8-168	Unnotched Tension	0.00800	0.00480	0.01000	****
Tape	Unnotched Compression ***	0.00800	0.00415	0.01000	******
	Unnotched Shear	*****			0.01500

\*\*\* Minimum 10% 45 and -45 degree plies

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Table 2.4.1-3 Environment Adjustment Factors

Prepreg Material Specification: BMS 8-168, TYPE II, CLASS 1, GRADE 145 OR 190

Resin Content:

42 (% WT)

Process Specification:

BAC 5317-5

70°F/DRY ENVIRONMENT, (0/±45/90) LAMINATES

		Environme	ent Correction	on Factors
Г		Tension	Comprs.	Lamina
	Environment	(Ct,env)	(Cc,env)	Shear
BMS 8-168	-65F/ambient	0.90	1.00	1.00
Tape	RT/ambient	1.00	1.00	1.00
1.45	RT/wet	0.97	0.94	0.94
	130F/dry	0.93	0.88	0.88
	130F/wet	0.90	0.82	0.82
	160F/dry	0.90	0.82	0.82

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# 2.6.2 BMS 8-168, Type II, Class 2, Style 3K-70-PW

This specification applies to a 250°F cure epoxy resin impregnated BMS 9-8 Type I carbon fiber woven fabric.

Type II:

Self Adhesive Resin System

Class 2:

Woven Fabric Prepreg.

Reference: Coordination Sheet BY1HU-SHW-C92-007, "BMS 8-168 Analysis Methods and Design Values for 777 Program," 1/20/1992.

#### Contents:

Table 2.6.2-1	Ply Properties
Table 2.6.2-2	Design Values
Table 2.6.2-3	Environment Adjustment Factors

## THE BOEING COMPANY

# Table 2.6.2-1 Ply Properties

TABLE 2.6.2-1		PLY PROPERTIES						
PREPREG MATERIAL	SPECIFICAT	10N: BMS 8-1	68, TYPE	II, CLAS	S 2, STY	LE 3K-70-	PW	
RESIN CONTENT:		42 (% W	m) -					
CURED PLY THICKNES	SS:	.0086 (I	ר)					
PROCESS SPECIFICAT	TION:	BAC 531	7-5					
CONTRACTOR OF THE PROPERTY OF	and the state of t			ENVI	RONMENT	AL COND	TION	
PROPERTY		UNIT	-75	۰F	70	۰F	160° F	130° F
			DRY	WET	DRY	WET	DRY	WET
MODULUS <sup>②</sup>	E1 1	msi	7.8					
	· E 2	msi			7.	8		
	G <sub>12</sub>	msl	0.56	(0.56)	0.56	(0.52	0.45	0.45
	G <sub>13</sub>	msi	0.56	(0.56)	0.56	(0.52)	0.45	0.45
	G 23	msi	0.56	(0.56)	0.56	(0.52)	0.45	0.45
POISSON'S RATIO	V 12		4		.0	6		
COEFFICIENTS OF	α1	In/In°F	1.6 x 1	<sub>0</sub> -6		$\overline{\hspace{1em}}$	. 1.6 x	10 <sup>-6</sup>
LINEAR THERMAL EXPANSION ③	α2	in/in ° F	1.6 x 1	0 -6			1.6x	10 -6
COEFFECIENTS OF	β 1	in/in %M			220 x	10 <b>-</b> 6 ·		
LINEAR MOISTURE EXPANSION (4)	β 2	in/in %M	220 x 10 <sup>-6</sup>					
THERMAL CONDUCTIVITY	κ <sub>1</sub>	BTU/(hr ft °F)						
	κ2	BTU/(hr ft °F)						
	κз	BTU/(hr ft °F)						

- ① E<sub>1</sub> & E<sub>2</sub> are the average of tension and compression moduli. For stability analysis use E<sub>1</sub>, compression = E<sub>2</sub>, compression = 7.4 Msi.
- 3 CLTE values are for expansion between -75° F and 70° F, and 70° F and 180° F.
- 4 %M = Percent absorbed moisture by weight.
- ⑤ Values in ( ) are estimates.

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#### THE BOEING COMPANY

Enclosure to: B-Y1NU-HB-C94-027

# Guidelines for Usage of Moduli and Strength Design Values

Ply Properties - Table 2.6.2-1.

The room temperature (70°F) / dry condition values shown in this table are referred to as nominal moduli values. These values are to be used for almost all laminate analyses, including the calculation of strain design values from test data. The exceptions are:

- 1. buckling analyses, where compression moduli values at the appropriate environment are used,
- 2. test correlation analyses where it is desired to predict actual strain gage response.

The values for the other environments are used for the two cases listed above.

# Unnotched Tension, Compression and Shear Strains - Table 2.6.2-2

These strain values are based on unnotched, undamaged coupon test results. The values may be used for test correlation analyses. The margin of safety analysis procedure in Section 5.6 should be used with the unnotched strain values.

For notched laminate strain values for use with bolted joint analyses or to account for impact damage, refer to Section 11.4.3. The notched strain values may be used with the margin of safety analysis procedures of section 5.6 for laminate checks away from bolted joint areas.

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# Table 2.6.2-2 Design Values

Prepreg Material Specification: BMS 8-168, TYPE II, CLASS 2, STYLE 3K-70-PW

Baseline Fiber

**Resin Content:** 

42 (% WT)

Process Specification:

**BAC 5317-5** 

70°F/DRY ENVIRONMENT, (0/±45/90) LAMINATES

(Do not use Typical Values for Ultimate Strength analyses. They may be used for Damage Tolerance or test correlation analyses).

**Unnotched Tension** 

**Unnotched Shear** 

Unnotched Compression \*\*\*

# Typical Lamina (Ply) Strain

BMS 8-168

Fabric

1	Dascinio I	4	Transverse	Shear
ı	Direction S	train	Hansverse	
ı			Direction	Strain
١	RT/a	mbient	RT/amb	RT/amb
	Laminate	-		
	t > 0.14 in.	Sandwich	All	All
	0.01000	0.00600		
	0.01000	0.00500		
				0.01500

Tape

Estimated B-Basis Lamina (Ply) Strain	Baseline Fi Direction S		Tape Transverse Direction	Lamina Shear Strain
	RT/a	mbient	RT/amb	RT/amb
	Laminate t > 0.14 in.	Sandwich	All	All
BMS 8-168 Unnotched Tension	0.00800	0.00480	#######	a 10 10 10 10 10 10 10 10 10 10 10 10 10
Fabric Unnotched Compression ***	0.00800	0.00415		***
Unnotched Shear				0.01500

\*\*\* Minimum 10% 45 and -45 degree plies

DG-100-584

Lamina

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# Table 2.6.2-3 Environment Adjustment Factors

Prepreg Material Specification: BMS 8-168, TYPE II, CLASS 2, STYLE 3K-70-PW

**Resin Content:** 

42 (% WT)

Process Specification:

BAC 5317-5

70°F/DRY ENVIRONMENT, (0/±45/90) LAMINATES

		Environme	ent Correcti	on Factors
		Tension	Comprs.	Lamina
	Environment	(Ct,env)	(Cc,env)	Shear
BMS 8-168	-65F/ambient	0.90	1.00	1.00
Fabric	RT/ambient	1.00	1.00	1.00
	RT/wet	0.97	0.94	0.94
V.	130F/dry	0.93	0.88	0.88
	130F/wet	0.90	0.82	0.82
	160F/dry	0.90	0.82	0.82

