

Series Specifications 110FW.E3 (Series 110FW)  
 Rev 3.0C, Feb-19-2009

**Table 110FW.E3.1A  
 (Series 110FW)  
 Mechanical Specifications**

Series	110FW
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Temp (F)	Pipe Strengths (psi)					Pipe Moduli (psi)				
	Axial Tensile	Hoop Tensile	Axial Flex.	Hoop Flex.	Axial Comp.	Axial Tensile	Hoop Tensile	Axial Flex.	Hoop Flex.	Axial Comp.
Ambient	8,400	26,400	16,800	N/A	18,000	1,400,000	2,200,000	1,400,000	2,200,000	1,500,000
150	8,400	26,400	16,800	N/A	18,000	1,400,000	2,200,000	1,400,000	2,200,000	1,500,000
175	8,190	25,740	16,380	N/A	17,550	1,365,000	2,145,000	1,365,000	2,145,000	1,462,500
200	7,980	25,080	15,960	N/A	17,100	1,330,000	2,090,000	1,330,000	2,090,000	1,425,000
225	7,770	24,420	15,540	N/A	16,650	1,295,000	2,035,000	1,295,000	2,035,000	1,387,500
250	7,560	23,760	15,120	N/A	16,200	1,260,000	1,980,000	1,260,000	1,980,000	1,350,000

**ASTM D4024 / D5421 Flange Codes**

2" - 6" Flanges, 150psi	RTR-111C-334; CM-B4IF-66
8" Flanges, 150psi	RTR-111C-335; CM-B4IF-66
10" - 12" Flanges, 150psi	RTR-111C-336; CM-B4IF-66
14" - 24" Flanges, 150psi	RTR-111C-337; CM-B4IF-66

All materials are contact molded (closest definition to filament wound in D4024), epoxy vinyl ester resin, integrally molded flange.  
 The grade epoxy is interpreted to include epoxy vinyl esters.

**ASTM D2310 / D2996 Pipe Codes**

2" - 3" Pipe	RTRP-11FT1-1112
4" Pipe	RTRP-11FT1-1113
6" Pipe	RTRP-11FT1-1114
8" and larger Pipe	RTRP-11FT1-1116

All materials are filament wound, epoxy vinyl ester resin, reinforced liner, HDB of > 5,000psi for joints, > 10,000psi for pipe (axial loads included).  
 Short term hoop strength > 10,000psi; long. tensile strength > 8,000psi;  
 Long. tensile modulus > 1,000,000psi; stiffness factor varies with pipe size.  
 The grade epoxy is interpreted to include epoxy vinyl esters.  
 Replace 'T' with 'Q' for the HDB rating of joints.

**ASTM F1173 / ISO15840 Codes**

Type I, Resin 2, Class B, Rating Method 1

**Other Properties**

Density (lb/cu in.)	0.06
Shear Modulus (psi)	1,400,000
Thermal Expansion Coefficient (in./in./F)	0.00001
Thermal Conductivity (BTU-in./ft^2-hr-F)	1.3
Minor Poisson's Ratio, $\nu_{min} = \nu_{ha}$	0.55
Major Poisson's Ratio, $E_a/E_h * \nu_{ha} = \nu_{ah}$	0.35
Hazen Williams Coefficient	150
Specific Roughness (in.)	0.0002

**ASTM D5685 Fittings Codes**

2" - 24" Fittings, 150psi	RTRF 52E4D
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Contact molded fittings, epoxy vinyl ester resin, reinforced liner,  
 butt & strap joint, 150psig rating

Notes:  
 1. Axial flexural is also termed bending; hoop flexural is also termed circumferential.  
 2. Blank areas are Not Recommended.

Series Specifications 110FW.E3 (Series 110FW)  
 Rev 3.0C, Feb-19-2009

**Table 110FW.E3M.1A (Metric)  
 (Series 110FW)  
 Mechanical Specifications**

Series 110FW

Temp (C)	Pipe Strengths (MPa)					Pipe Moduli (GPa)				
	Axial Tensile	Hoop Tensile	Axial Flex.	Hoop Flex.	Axial Comp.	Axial Tensile	Hoop Tensile	Axial Flex.	Hoop Flex.	Axial Comp.
Ambient	57.9	182.0	115.8	N/A	124.1	9.7	15.2	9.7	15.2	10.3
65.6	57.9	182.0	115.8	N/A	124.1	9.7	15.2	9.7	15.2	10.3
79.4	56.5	177.5	112.9	N/A	121.0	9.4	14.8	9.4	14.8	10.1
93.3	55.0	172.9	110.0	N/A	117.9	9.2	14.4	9.2	14.4	9.8
107.2	53.6	168.4	107.1	N/A	114.8	8.9	14.0	8.9	14.0	9.6
121.1	52.1	163.8	104.3	N/A	111.7	8.7	13.7	8.7	13.7	9.3

**ASTM D4024 / D5421 Flange Codes**

2" - 6" Flanges, 150psi RTR-111C-334; CM-B4IF-66  
 8" Flanges, 150psi RTR-111C-335; CM-B4IF-66  
 10" - 12" Flanges, 150psi RTR-111C-336; CM-B4IF-66  
 14" - 24" Flanges, 150psi RTR-111C-337; CM-B4IF-66

All materials are contact molded (closest definition to filament wound in D4024), epoxy vinyl ester resin, integrally molded flange.  
 The grade epoxy is interpreted to include epoxy vinyl esters.

**ASTM D2310 / D2996 Pipe Codes**

2" - 3" Pipe RTRP-11FT1-1112  
 4" Pipe RTRP-11FT1-1113  
 6" Pipe RTRP-11FT1-1114  
 8" and larger Pipe RTRP-11FT1-1116

All materials are filament wound, epoxy vinyl ester resin, reinforced liner, HDB of > 5,000psi for joints, > 10,000psi for pipe (axial loads included). Short term hoop strength > 10,000psi; long. tensile strength > 8,000psi; Long. tensile modulus > 1,000,000psi; stiffness factor varies with pipe size. The grade epoxy is interpreted to include epoxy vinyl esters. Replace 'T' with 'Q' for the HDB rating of joints.

**ASTM F1173 / ISO15840 Codes**

Type I, Resin 2, Class B, Rating Method 1

**Other Properties**

Density (g/cu cm)	1.7
Shear Modulus (GPa)	9.7
Thermal Expansion Coefficient (mm/mm/C)	0.000018
Thermal Conductivity (W-cm/cm <sup>2</sup> -C)	0.0019
Minor Poisson's Ratio, $\nu_{min} = \nu_{ha}$	0.55
Major Poisson's Ratio, $E_a/E_h * \nu_{ha} = \nu_{ah}$	0.35
Hazen Williams Coefficient	150
Specific Roughness (cm)	0.0005

**ASTM D5685 Fittings Codes**

2" - 24" Fittings, 150psi RTRF 52E4D  
 Contact molded fittings, epoxy vinyl ester resin, reinforced liner, butt & strap joint, 150psig rating

Notes:

1. Axial flexural is also termed bending; hoop flexural is also termed circumferential.
2. Blank areas are Not Recommended.

Design Envelope Data  
 Rev 3.0B, May-01-2007

**Table 110FW.E3.2A  
 (Series 110FW)  
 Design Envelope Data**

Series	110FW
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**ASTM D2992-96 Data**

Identification	Not Available
Procedure	
End Closure	
Test Environment	
LTHS (psi)	
r	
Slope of Regression Line	
HDB (psi)	

**ASME B31.3 Data**

HDB (psi)	10,000
HDS (psi)	5,000

**ISO14692 Data**

	Pipe	Fittings	Joints
<b>NPRman (psi) (f2=0.67)</b>	(f3=0.7)	(f3=1.0)	(f3=1.0)
2"	449	364	308
6"	250	255	216
12"	241	224	190
<b>Pq = LCL = f1*LTHP (psi)</b>			
2"	958	543	460
6"	533	381	322
12"	513	334	283

**Recommended Design Data**

	Sustained (f2=0.67)	Sust+Temp (f2=0.83)	Occasional (f2=0.89)
<b>Allowable Hoop Stress (psi)</b>	5,732	7,101	7,614
<b>Allowable Axial Stress (psi)</b>	1,824	2,259	2,423
<b>Allowable Bending Stress (psi)</b>	3,283	4,067	4,361
<b>Allowable Shear Stress (Cross-laminar) (psi)</b>	2,606	3,228	3,461
<b>Allowable "Secondary Bond" Shear Stress (psi)</b>	100		

**Notes:**

1. For recommended design data, axial and bending stresses may have to be considered simultaneously. In this case, the combined axial and bending stresses must not exceed the allowable bending stress, which is the larger of these values.

**Design Envelope Data**  
 Rev 3.0B, May-01-2007

**Table 110FW.E3M.2A**  
**(Series 110FW)**  
**Design Envelope Data (SI)**

Series	110FW
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**ASTM D2992-96 Data**

Identification	Not Available
Procedure	
End Closure	
Test Environment	
LTHS (MPa)	
r	
Slope of Regression Line	
HDB (MPa)	

**ASME B31.3 Data**

HDB (MPa)	69.0
HDS (MPa)	34.5

**ISO14692 Data**

	Pipe	Fittings	Joints
<b>NPRman (MPa) (f2=0.67)</b>	(f3=0.7)	(f3=1.0)	(f3=1.0)
2"	3.1	2.5	2.1
6"	1.7	1.8	1.5
12"	1.7	1.5	1.3
<b>Pq = LCL = f1*LTHP (MPa)</b>			
2"	6.6	3.7	3.2
6"	3.7	2.6	2.2
12"	3.5	2.3	2.0

**Recommended Design Data**

	Sustained (f2=0.67)	Sust+Temp (f2=0.83)	Occasional (f2=0.89)
<b>Allowable Hoop Stress (MPa)</b>	39.5	49.0	52.5
<b>Allowable Axial Stress (MPa)</b>	12.6	15.6	16.7
<b>Allowable Bending Stress (MPa)</b>	22.6	28.0	30.1
<b>Allowable Shear Stress (Cross-laminar) (MPa)</b>	18.0	22.3	23.9
<b>Allowable "Secondary Bond" Shear Stress (MPa)</b>	0.7		

**Notes:**

1. For recommended design data, axial and bending stresses may have to be considered simultaneously. In this case, the combined axial and bending stresses must not exceed the allowable bending stress, which is the larger of these values.

**Design Envelope Data**  
 Rev 3.0C, Apr-24-2008

**Table 110FW.E3.4A**  
**(110FW)**

**ISO 14692 Part 3 - Annex D Calculations**

Stress Intensification Factors (SIFs), Flexibility Factors (Kappa), Pressure Stress Multipliers (PSMs)  
 (BS7159, Type 2 Laminate, 0.0015 design strain)

Size  (in.)	Series 110FW, 110FW-C									
	Flexibility Factor	Elbows			Tees					
		Axial bending SIF		Hoop bending SIF		SIF	PSM			
	In-plane	Out-of-plane	In-plane	Out-of-plane						
2	1.3	1.1	1.2	1.9	1.7	1.1	1.0			
3	1.9	1.5	1.6	2.5	2.2	1.3	1.0			
4	2.0	1.5	1.6	2.5	2.3	1.5	1.0			
6	2.5	1.7	1.8	2.5	2.5	1.7	1.0			
8	2.8	1.9	2.0	2.5	2.5	1.7	1.0			
10	3.0	2.0	2.1	2.5	2.5	1.8	1.0			
12	3.0	2.0	2.2	2.5	2.5	1.7	1.0			
14	3.0	2.1	2.2	2.5	2.5	2.0	1.0			
16	3.0	2.1	2.3	2.5	2.5	1.9	1.0			
18	3.0	2.2	2.3	2.5	2.5	2.0	1.0			
20	3.0	2.1	2.3	2.5	2.5	2.1	1.0			
24	3.0	2.2	2.3	2.5	2.5	2.1	1.0			
30	3.0	2.5	2.5	2.5	2.5	2.3	1.0			
36	3.0	2.5	2.5	2.5	2.5	2.3	1.0			
42	3.0	2.5	2.5	2.5	2.5	2.3	1.0			
48	3.0	2.5	2.5	2.5	2.5	2.3	1.0			

Note: Tees that are qualified according to ISO14692 have a PSM of 1.0. Tees that are not qualified will typically have PSMs ranging from 1.8 to 3.0. Reducing tees will have slightly different SIFs than tees; however, it is acceptable to use the same values as the same-size tees. e.g., a 6"x2" reducing tee or olet would have the same SIF as a 6" tee.

Figure 110FW.E3.C1 Rev 3.0A, Feb-15-2005  
ISO 14692 Design Envelope - FIBERBOND® Pipe  
f1\*LTHP=533psi; f1\*LTHS=8556psi; STHP=1645psi; STHS=26400psi  
Short Term Axial Strength=8400psi; Est'd Long Term Axial Strength=2722psi; r=0.64

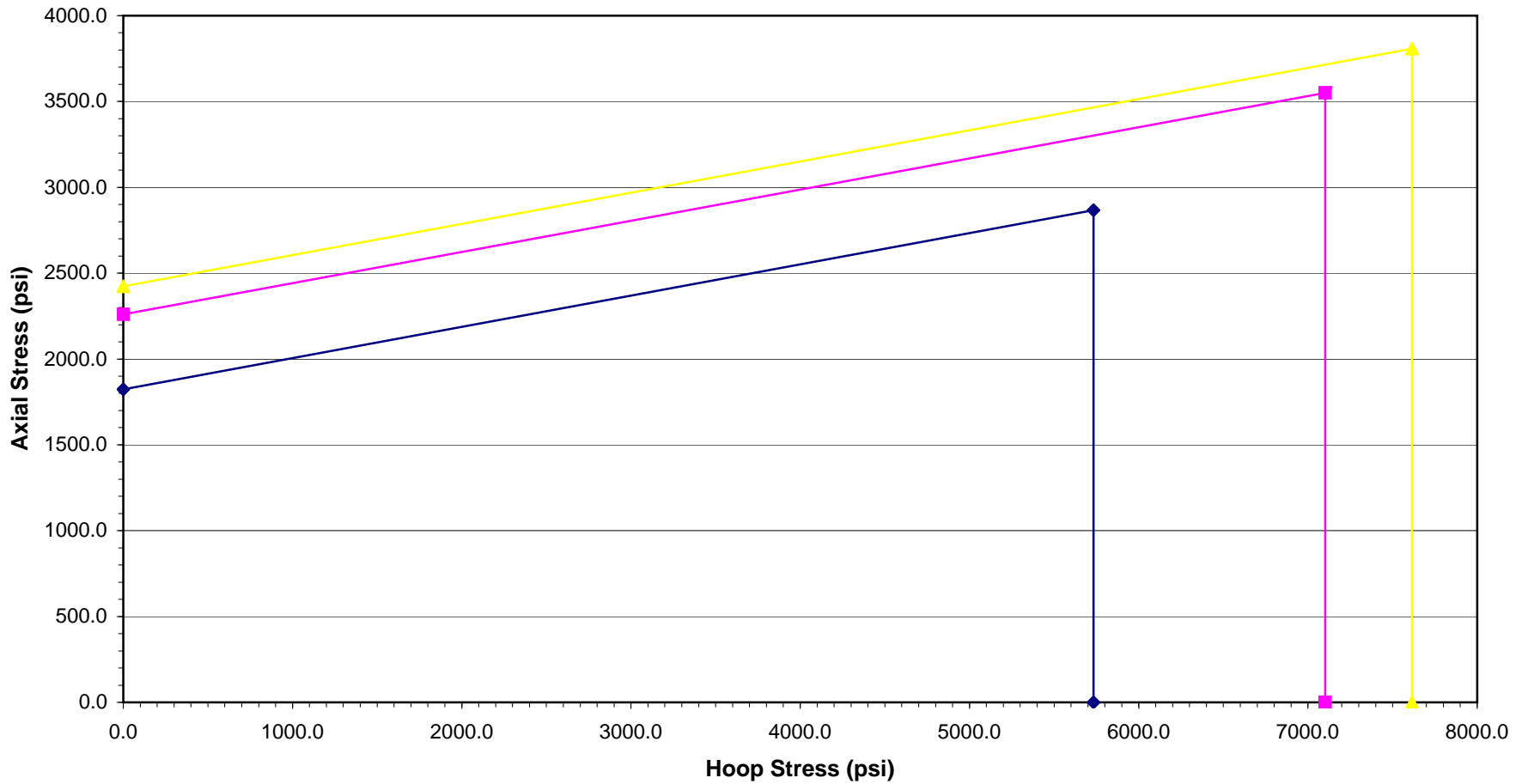


Figure 110FW.E3.C2 Rev 3.0A, Feb-15-2005  
ISO 14692 Design Envelope - FIBERBOND(R) Fittings  
f1\*LTHP=381psi; f1\*LTHS=4851psi; STHP=1021psi; STHS=13000psi  
Short Term Axial Strength = 12200psi; Est'd Long Term Axial Strength = 4552psi; r=1.9

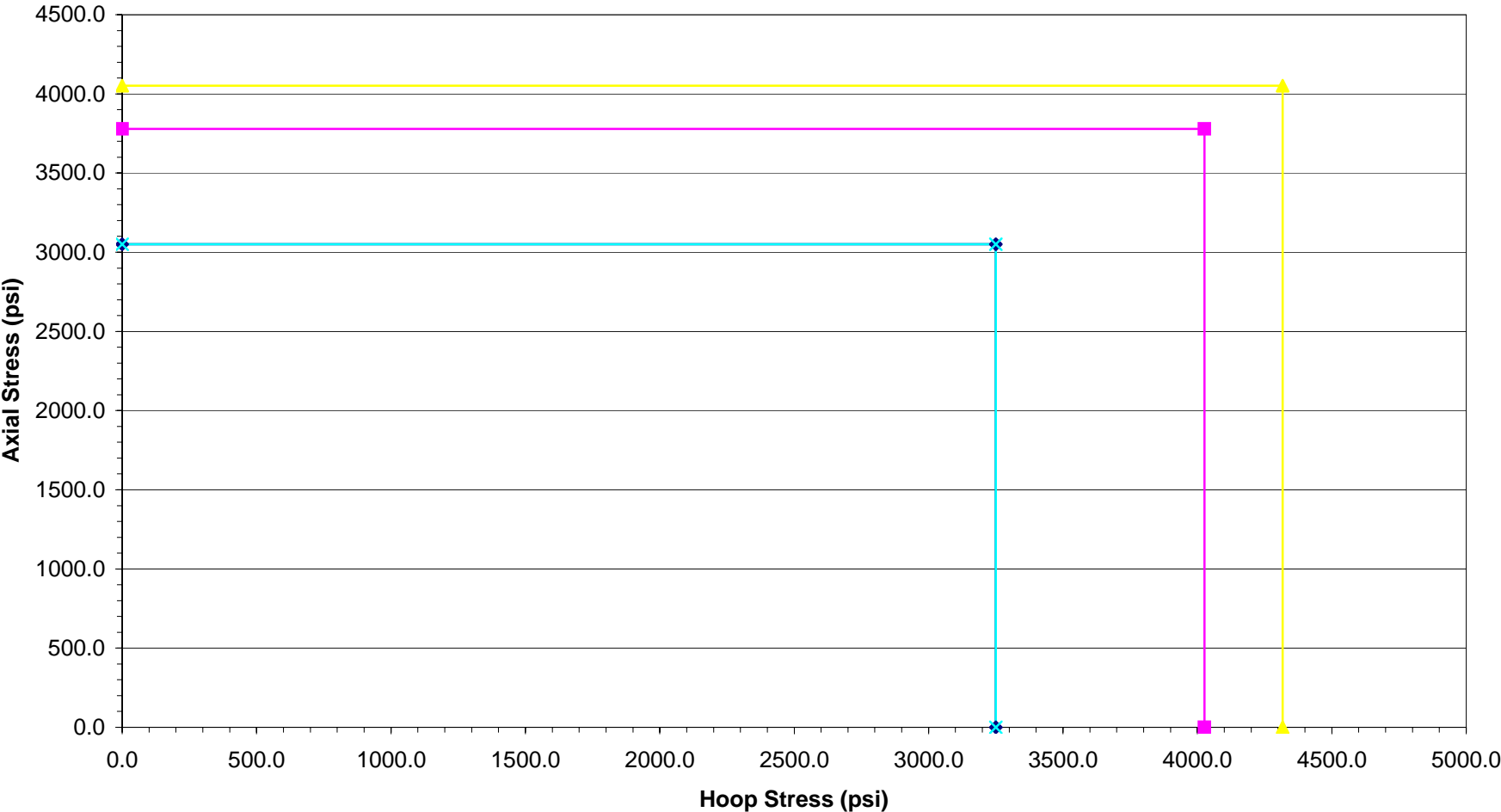


Figure 110FW.E3.C3 Rev 3.0A, Feb-15-2005  
ISO 14692 Design Envelope - FIBERBOND® Butt Weld Joints  
f1\*LTHP=322psi; f1\*LTHS=4104psi; STHP=864psi; STHS=11000psi  
Short Term Axial Strength = 11000psi; Est'd Long Term Axial Strength = 4104psi; r=2.0

