

Series Specifications 20C.E3 (Series 20C)
 Rev 3.0C, Feb-19-2009

**Table 20C.E3.1A
 (Series 20C)
 Mechanical Specifications**

Series 20C

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	6,780	20,400	13,560	N/A	20,400	1,130,000	1,700,000	1,130,000	1,700,000	1,700,000
150	6,780	20,400	13,560	N/A	20,400	1,130,000	1,700,000	1,130,000	1,700,000	1,700,000
175	5,085	15,300	10,170	N/A	15,300	847,500	1,275,000	847,500	1,275,000	1,275,000
200										
225										
250										

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" - 18" Flanges, 150psi	RTR-111C-337; CM-B4IF-66
20" - 24" Flanges, 100psi	RTR-111B-227; CM-B4ID-44

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-11FT1-1012
4" Pipe	RTRP-11FT1-1013
6" Pipe	RTRP-11FT1-1014
8" and larger Pipe	RTRP-11FT1-1016

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 > 6,780psi;
 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)	1,150,000
Thermal Expansion Coefficient (in./in./F)	0.00001
Thermal Conductivity (BTU-in./ft ² -hr-F)	1.3
Minor Poisson's Ratio, $\nu_{min} = \nu_{ha}$	0.53
Major Poisson's Ratio, $E_a/E_h \cdot \nu_{ha} = \nu_{ah}$	0.35
Hazen Williams Coefficient	150
Specific Roughness (in.)	0.0002

ASTM D5685 Fittings Codes

2" - 18" Fittings, 150psi	RTRF 52E4D
Contact molded fittings, epoxy vinyl ester resin, reinforced liner, butt & strap joint, 150psig rating	
20" - 24" Fittings, 100psi	RTRF 52E4C
Contact molded fittings, epoxy vinyl ester resin, reinforced liner, butt & strap joint, 100psig rating	

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

Series Specifications 20C.E3 (Series 20C)
 Rev 3.0C, Feb-19-2009

**Table 20C.E3M.1A (Metric)
 (Series 20C)
 Mechanical Specifications**

Series 20C

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	46.7	140.7	93.5	N/A	140.7	7.8	11.7	7.8	11.7	11.7
65.6	46.7	140.7	93.5	N/A	140.7	7.8	11.7	7.8	11.7	11.7
79.4	35.1	105.5	70.1	N/A	105.5	5.8	8.8	5.8	8.8	8.8
93.3										
107.2										
121.1										

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" - 18" Flanges, 150psi	RTR-111C-337; CM-B4IF-66
20" - 24" Flanges, 100psi	RTR-111B-227; CM-B4ID-44

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-11FT1-1012
4" Pipe	RTRP-11FT1-1013
6" Pipe	RTRP-11FT1-1014
8" and larger Pipe	RTRP-11FT1-1016

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 > 6,780psi;
 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)	7.9
Thermal Expansion Coefficient (mm/mm/C)	0.00018
Thermal Conductivity (W-cm/cm ² -C)	0.0019
Minor Poisson's Ratio, ν_{mh}	0.53
Major Poisson's Ratio, $E_a/E_h \cdot \nu_{mh} = \nu_{ah}$	0.35
Hazen Williams Coefficient	150
Specific Roughness (cm)	0.0005

ASTM D5685 Fittings Codes

2" - 18" Fittings, 150psi	RTRF 52E4D
Contact molded fittings, epoxy vinyl ester resin, reinforced liner, butt & strap joint, 150psig rating	
20" - 24" Fittings, 100psi	RTRF 52E4C
Contact molded fittings, epoxy vinyl ester resin, reinforced liner, butt & strap joint, 100psig 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 20C.E3.2A
 (Series 20C)
 Design Envelope Data

Series	20C
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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
NPRman (psi) (f2=0.67)	(f3=0.7)	(f3=1.0)	(f3=1.0)
2"	571	478	449
6"	219	184	173
12"	170	169	158
Pq = LCL = f1*LTHP (psi)			
2"	1,216	714	670
6"	468	275	258
12"	363	252	236

Recommended Design Data

	Sustained (f2=0.67)	Sust+Temp (f2=0.83)	Occasional (f2=0.89)
Allowable Hoop Stress (psi)	4,429	5,487	5,884
Allowable Axial Stress (psi)	1,472	1,824	1,956
Allowable Bending Stress (psi)	2,650	3,283	3,520
Allowable Shear Stress (Cross-laminar) (psi)	2,606	3,228	3,461
Allowable "Secondary Bond" Shear Stress (psi)	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 20C.E3M.2A
 (Series 20C)
 Design Envelope Data (SI)**

Series	20C
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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
NPRman (MPa) (f2=0.67)	(f3=0.7)	(f3=1.0)	(f3=1.0)
2"	3.9	3.3	3.1
6"	1.5	1.3	1.2
12"	1.2	1.2	1.1
Pq = LCL = f1*LTHP (MPa)			
2"	8.4	4.9	4.6
6"	3.2	1.9	1.8
12"	2.5	1.7	1.6

Recommended Design Data

	Sustained (f2=0.67)	Sust+Temp (f2=0.83)	Occasional (f2=0.89)
Allowable Hoop Stress (MPa)	30.5	37.8	40.6
Allowable Axial Stress (MPa)	10.2	12.6	13.5
Allowable Bending Stress (MPa)	18.3	22.6	24.3
Allowable Shear Stress (Cross-laminar) (MPa)	18.0	22.3	23.9
Allowable "Secondary Bond" Shear Stress (MPa)	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 20C.E3.4A
(20C)

ISO 14692 Part 3 - Annex D Calculations

Stress Intensification Factors (SIFs), Flexibility Factors (Kappa), Pressure Stress Multipliers (PSMs)
 (BS7159, Type 2 Laminate, 0.0012 design strain)

Size (in.)	Series 20C									
	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	2.5	1.7	1.8	2.5	2.5	1.5	1.0			
6	2.9	1.9	2.1	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	2.9	1.9	2.1	2.5	2.5	1.7	1.0			
14	3.0	2.2	2.4	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	2.3	2.4	2.5	2.5	2.0	1.0			
20	3.0	2.3	2.4	2.5	2.5	2.1	1.0			
24	3.0	2.3	2.5	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 20C.E3.C1 Rev 3.0A, Feb-15-2005
ISO 14692 Design Envelope - FIBERBOND® Pipe
f1*LTHP=468psi; f1*LTHS=6611psi; STHP=1444psi; STHS=20400psi
Short Term Axial Strength=6780psi; Est'd Long Term Axial Strength=2197psi; r=0.66

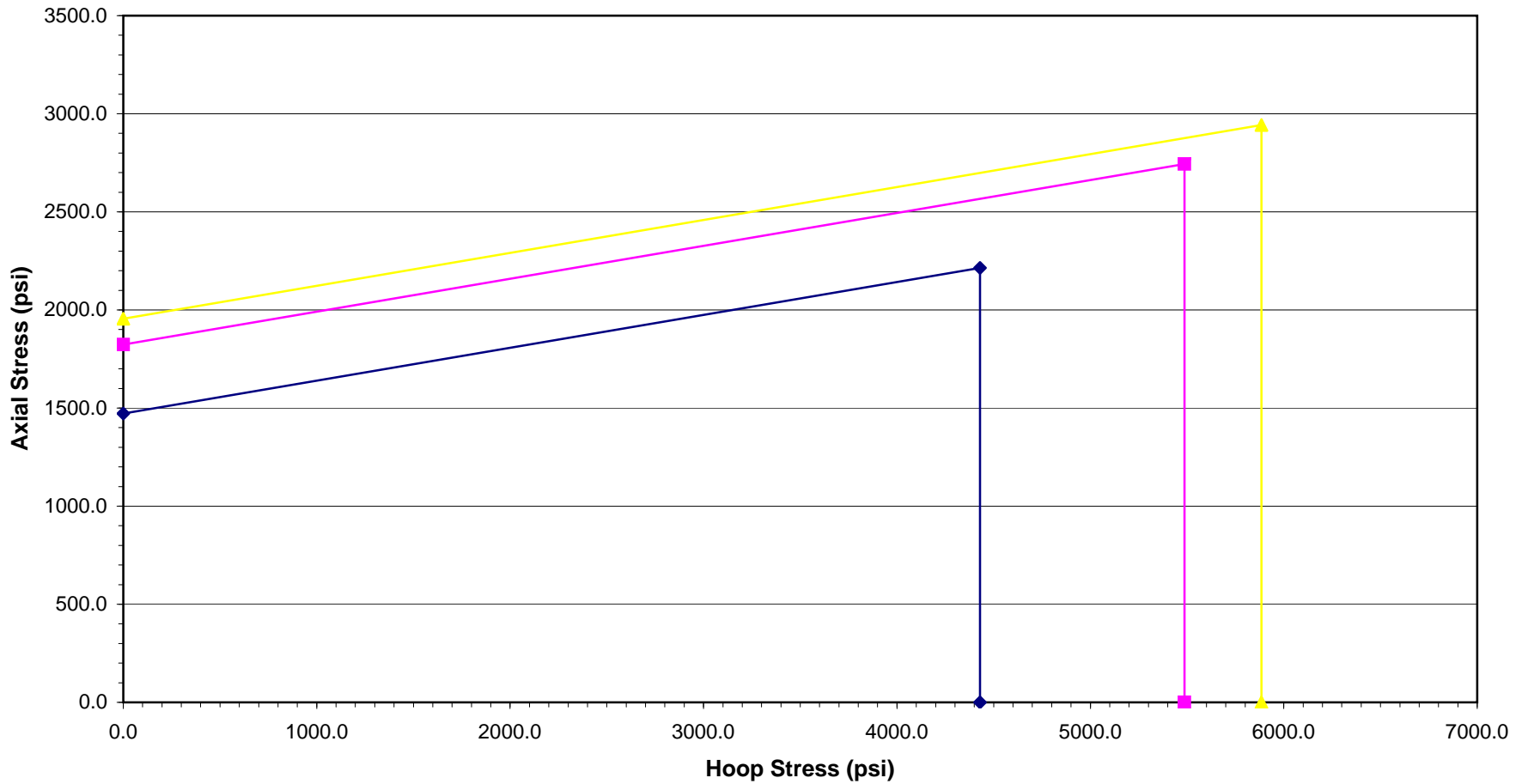


Figure 20C.E3.C2 Rev 3.0A, Feb-15-2005
ISO 14692 Design Envelope - FIBERBOND(R) Fittings
f1*LTHP=275psi; f1*LTHS=3881psi; STHP=736psi; STHS=10400psi
Short Term Axial Strength = 10400psi; Est'd Long Term Axial Strength = 3881psi; r=2.0

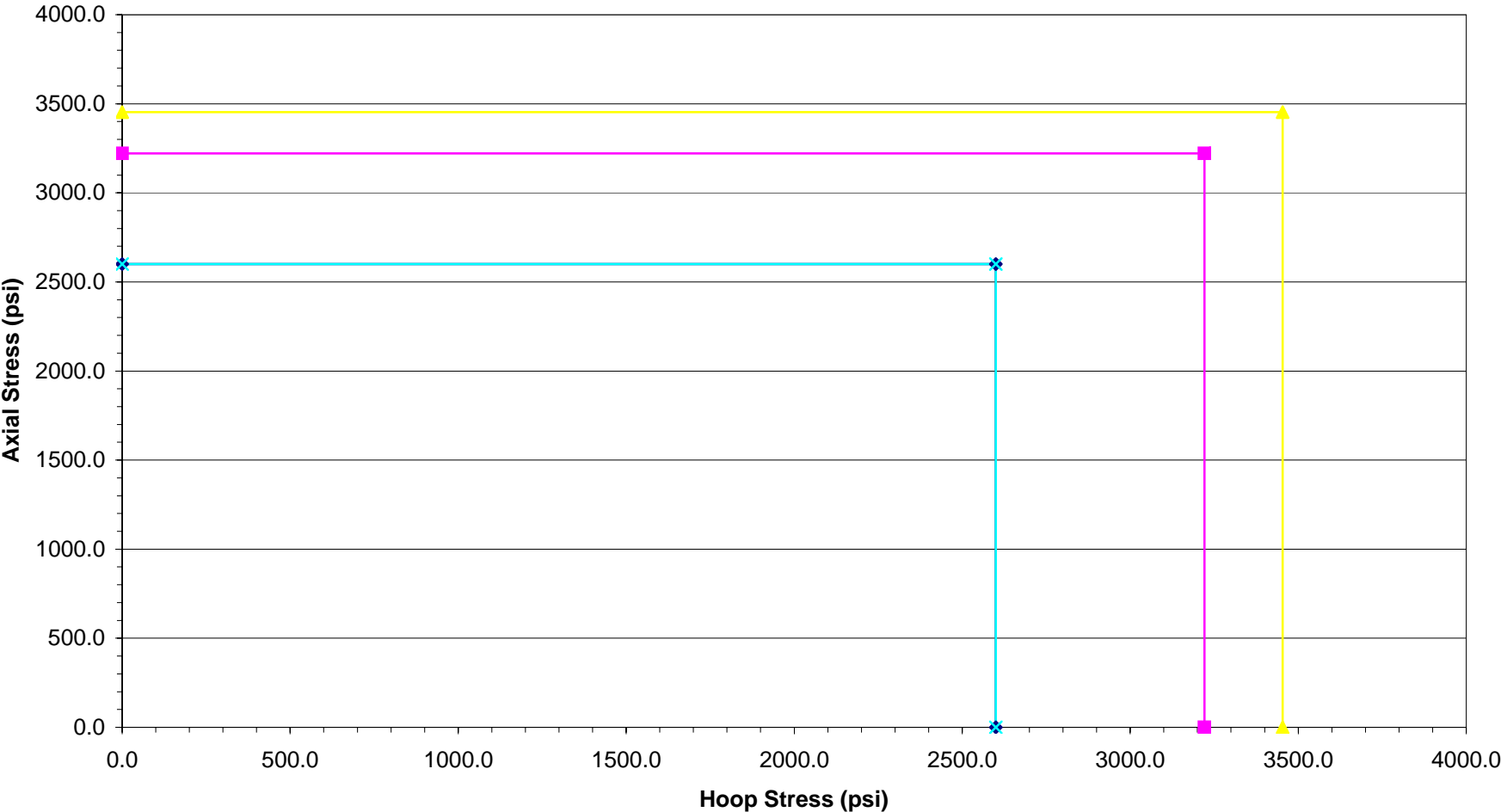


Figure 20C.E3.C3 Rev 3.0A, Feb-15-2005
ISO 14692 Design Envelope - FIBERBOND® Butt Weld Joints
f1*LTHP=258psi; f1*LTHS=3642psi; STHP=691psi; STHS=9760psi
Short Term Axial Strength = 9760psi; Est'd Long Term Axial Strength = 3642psi; r=2.0

