

# GREEN THREAD® PIPING SYSTEMS



**NOV Fiber Glass Systems** is the combination of the **Star® Fiberglass** product line and the **Smith Fibercast®** product lines bringing over 60 years of “Time-Tested” composite pipe experience to the Oilfield, Chemical/Industrial, Petroleum Marketing, Marine and Offshore markets.

## PRODUCT

**Green Thread** pipe is a filament wound product using amine-cured epoxy resins and fiberglass and a resin-rich liner reinforced with surfacing veil for superior corrosion resistance. It is recommended for dilute acids and caustics.

Pipe and fittings are available in **1” through 16”** diameters with pressure ratings up to 450 psig static at a maximum operating temperature of **225°F**, 18”-24” are available on request. The **1” through 6”** pipe diameters are available in 20 foot random lengths and the **8” through 24”** diameters are in 19 or 39 foot random lengths.

**Green Thread Performance Plus™** is available in **4” through 24”** sizes with a 450 psig static pressure rating. Refer to A1325.

## FITTINGS

Compatible epoxy fittings are manufactured with the same **chemical/temperature** capabilities as the pipe. Depending on the particular part and size, fittings will be compression molded, contact molded, hand fabricated or filament wound.

- Fittings Literature:  
*A1350-Standard 1”-16”*

## JOINING METHODS

**Green Thread** pipe and fittings are joined using the matched tapered connection. Pipe is supplied with one end belled (integral bell or factory-bonded coupling) and one end tapered.

Epoxy adhesive is used to secure the joints. When properly installed, the entire system will operate at the maximum pressure rating of the pipe.

## FIELD TAPERING & JOINING

Pipe can be cut and easily retapered for installation in the field using NOV Fiber Glass Systems tapering tools. Power or manual tools are available for smaller diameter pipe. Both manual and power operated tools are available for larger diameter pipe. Power-driven tools are recommended for larger pipe sizes and where many tapers are required. See **Manual No. F6000, Pipe Installation Handbook for Matched Tapered Bell & Spigot**

**Joints**, for installation instructions and recommendations on the proper tool for your particular application.

## RECOMMENDED SERVICES

**Green Thread** pipe is the product of choice for many services requiring the additional chemical resistance provided by a resin-rich corrosion barrier. Refer to E5615 “**Chemical Resistance Guide**” for proper application.

## BENEFITS

**Green Thread** pipe is light weight when compared to steel, black iron, copper, and stainless steel. When considering total installed cost, **Green Thread** piping provides significant savings due to its light weight and ease of installation. No heavy handling equipment is required and the load **Green Thread** pipe adds to a structure is minimal compared to other materials. For example, 4” **Green Thread** pipe weighs only 1.2 lbs. per foot compared to 5.6 lbs. for Schedule 10 stainless.

## DISTRIBUTION

NOV Fiber Glass Systems has a network of stocking distributors across the U.S. as well as representatives and distributors in many other parts of the world. These distributors are supported by a staff of experienced technical personnel at the home office and by highly trained, strategically located field personnel.



## PRODUCT DATA

### Nominal Dimensional Data

Pipe Size (In)	I.D.		O.D.		Wall Thickness		Liner Thickness		Weight		Capacity	
	(In)	(mm)	(In)	(mm)	(In)	(mm)	(In)	(mm)	(Lbs/Ft)	(kg/m)	(Gal/Ft)	(Ft <sup>3</sup> /Ft)
1	1.193	30	1.370	35	0.090	2.29	0.015	0.38	0.3	0.45	0.06	0.008
1½	1.760	45	1.960	50	0.100	2.54	0.015	0.38	0.5	0.74	0.13	0.017
2	2.152	55	2.390	61	0.119	3.02	0.025	0.64	0.7	1.04	0.19	0.025
3	3.279	83	3.516	89	0.119	3.05	0.025	0.64	1.0	1.49	0.44	0.059
4	4.281	109	4.521	115	0.120	3.05	0.030	0.76	1.3	1.93	0.75	0.100
6	6.351	161	6.645	169	0.147	3.73	0.030	0.76	2.4	3.57	1.65	0.220
8	8.361	212	8.717	221	0.178	4.52	0.030	0.76	3.9	5.80	2.85	0.382
10	10.363	263	10.795	274	0.216	5.49	0.030	0.76	5.9	8.78	4.38	0.586
12	12.286	312	12.758	324	0.236	5.99	0.030	0.76	7.7	11.50	6.16	0.823
14	14.038	357	14.548	370	0.255	6.48	0.030	0.76	9.5	14.10	8.04	1.075
16	16.040	407	16.610	422	0.285	7.24	0.030	0.76	12.2	18.20	10.50	1.403

Tolerances or maximum/minimum limits can be obtained from NOV Fiber Glass Systems.

#### ASTM D2996 Designation Codes

1"-1½"	RTRP-11FY1-3111
2"-8"	RTRP-11FY1-3112
10"	RTRP-11FY1-3114
12"-16"	RTRP-11FY1-3116

#### Pipe Lengths Available

Size (In)	Random Length (Ft)
1-6	20
8-16	19 or 39

#### Pressure Ratings<sup>(1)</sup>

Size (In)	Maximum Internal Static Pressure (psig)		Maximum External Pressure (psig) <sup>(1)</sup>	
	225°F		75°F	225°F
1	450		360	292
1½	450		187	150
2	450		289	241
3	450		123	69
4	225		77	56
6	225		33	21
8	225		18	15
10	225		18	15
12	225		18	15
14	225		15	10
16	225		15	10

<sup>(1)</sup>Vacuum Service: A full vacuum within the pipe is equivalent to 14.7 psig external pressure at sea level. External pressure ratings are based on test data obtained using ASTM D2924. Contact NOV Fiber Glass Systems if higher external pressure designs are required.

## Average Physical Properties

Property	75°F psi	24°C MPa	225°F psi	107°C MPa
<b>Axial Tensile - ASTM D2105</b>				
Ultimate Stress	10,550	71	7,160	49.4
Modulus of Elasticity	1.75 x 10 <sup>6</sup>	12,100	1.03 x 10 <sup>6</sup>	7,102
<b>Poisson's Ratio <math>V_{a/h}</math> (<math>V_{h/a}</math>)</b>				
	0.35 (0.72)			
<b>Axial Compression - ASTM D695</b>				
Ultimate Stress	33,300	230	17,800	122.7
Modulus of Elasticity	1.26 x 10 <sup>6</sup>	8,687	0.54 x 10 <sup>6</sup>	3,723
<b>Beam Bending - ASTM D2925</b>				
Ultimate Stress	23,000	158.6	16,000	110
Modulus of Elasticity (Long Term)	2.18 x 10 <sup>6</sup>	15,031	1.11 x 10 <sup>6</sup>	7,653
<b>Hydrostatic Burst - ASTM D1599</b>				
Ultimate Hoop Tensile Stress	46,300	319.2	49,540	342
<b>Ring Tensile - ASTM D2290</b>				
	<u>Sizes</u>			
Minimum Hoop Tensile Stress	1"-1½"	9,018	62.4	-
	2"-16"	27,280	188	-
<b>Hydrostatic Design - ASTM D2992,</b>				
<b>Procedure B - Hoop Tensile Stress</b> Static 20 Year Life (* 200°F/93.3°C data)	LTHS	27,715	191.1	16,945*
	LCL	22,400	154.4	14,654*
*1)Beam bending design stress is 1/8 of ultimate to allow for additional stresses.				

<b>Thermal Expansion Coefficient - ASTM D696</b>	1.26 x 10 <sup>-5</sup> in/in/°F	2.27 x 10 <sup>-5</sup> mm/mm/°C
<b>Thermal Conductivity</b>	0.23 BTU/hr-ft-°F	0.4 W/m-°C
<b>Specific Gravity - ASTM D792</b>	1.8	
<b>Hazen-Williams Coefficient</b>	150	
<b>Absolute Surface Roughness</b>	0.00021 Inch	0.0053 mm
<b>Manning's Roughness Coefficient, N</b>	0.009	

## Properties of Pipe Sections Based on Minimum Reinforced Walls

Size (In)	Reinforcement End Area(In <sup>2</sup> )	Reinforcement Moment of Inertia (In <sup>4</sup> )	Reinforcement Section Modulus (In <sup>3</sup> )	Nominal Wall End Area (In <sup>2</sup> )
1	0.23	0.06	0.07	0.36
1½	0.37	0.16	0.16	0.58
2	0.57	0.37	0.31	0.85
3	0.85	1.24	0.70	1.27
4	1.06	2.59	1.15	1.66
6	2.20	11.71	3.52	3.00
8	3.66	33.50	7.69	4.78
10	5.70	79.90	14.80	7.18
12	7.46	146.60	22.98	9.28
14	9.30	238.00	32.72	11.45
16	12.04	402.00	48.40	14.62

## Recommended Operating Ratings

Size (In)	Axial Tensile Loads Max. (Lbs)		Axial Compressive Loads Max. (Lbs) <sup>(1)</sup>		Bending Radius Min. (Ft) Entire Temp. Range	Torque Max. (Ft Lbs) Entire Temp. Range	Parallel Plate Loading <sup>(2)</sup> ASTM D2412		
	Temperature 75°F	Temperature 225°F	Temperature 75°F	Temperature 225°F			Stiffness Factor (In <sup>3</sup> / Lbs/In <sup>2</sup> )	Pipe Stiffness (psi)	Hoop Modulus x10 <sup>6</sup> (psi)
1	580	410	1,880	1,010	40	25	40	1,170	1.26
1½	960	660	3,090	1,650	60	60	70	640	1.50
2	1,480	1,030	4,770	2,550	80	180	200	910	1.58
3	2,190	1,520	7,090	3,790	110	230	240	330	1.89
4	2,740	1,900	8,840	4,730	140	380	230	140	1.81
6	5,680	3,950	18,350	9,810	210	1,070	540	100	2.13
8	9,430	6,550	30,470	16,290	270	2,490	730	60	2.24
10	14,690	10,200	47,450	25,370	340	4,510	1,620	70	2.95
12	19,210	13,350	62,110	33,200	400	7,000	2,800	80	3.27
14	23,950	16,650	77,420	41,390	460	9,970	3,600	60	2.46
16	31,000	21,550	100,230	53,580	530	14,700	6,500	60	3.20

<sup>(1)</sup>Compressive loads are for short columns only.

## SUPPORTS

Proper pipe support spacing depends on the temperature and weight of the fluid in the pipe. The support spacing table is based on unrestrained continuous beam theory using the pipe bending modulus derived from long-term beam bending tests. The maximum spans lengths were developed to ensure a design that limits mid-span deflection to 1/2 inch and dead weight bending to 1/8 of the ultimate bending stress. Any additional loads on the piping system such as insulation, wind, seismic, etc. requires further consideration. Restrained (anchored) piping systems operating at elevated temperatures may result in guide spacing requirements that are shorter than unrestrained piping systems. In this case, the maximum guide spacing governs the support span requirements for the system. Pipe spans near elbows require special attention. Both supported and unsupported elbows are considered in the following tables and must be followed to properly design the piping system.

There are seven basic rules to follow when designing piping system supports:

1. Do not exceed the recommended support span.
2. Support heavy valves and in-line equipment independently.
3. Protect pipe from external abrasion at supports.
4. Avoid point contact loads.
5. Avoid excessive bending. This applies to handling, transporting, initial layout, and final installed position.

6. Avoid excessive vertical loading to minimize bending stresses on pipe and fittings.
7. Provide adequate axial and lateral restraint to ensure line stability during rapid changes in flow.

### Maximum Support Spacing for Uninsulated Pipe<sup>(1)</sup>

Pipe Size (In.)	Continuous Spans of Pipe (Ft.) <sup>(2)</sup>			
	75°F	150°F	225°F	Gas 75°F
1	10.9	10.2	9.2	13.9
1½	12.6	11.8	10.7	16.9
2	14.1	13.2	11.9	19.0
3	15.9	14.8	13.4	23.2
4	17.0	15.8	14.3	26.2
6	20.5	19.1	17.3	32.8
8	23.3	21.7	19.7	38.0
10	26.0	24.2	22.0	42.6
12	27.9	26.0	23.5	46.3
14	29.5	27.5	24.9	49.6
16	31.4	29.3	26.6	53.1

<sup>(1)</sup>Consult factory for insulated pipe support spacing.

<sup>(2)</sup>Max. mid span deflection 1/2" with specific gravity 1.0.

## Support Spacing vs. Specific Gravity

<b>Specific Gravity</b>	2.00	1.50	1.25	1.00	0.75
<b>Multiplier</b>	0.86	0.92	0.96	1.00	1.07

Example: 6" pipe @ 150°F with 1.5 specific gravity fluid, maximum support spacing = 19.1 x 0.92 = 17.6 ft.

### Adjustment Factors for Various Spans With Unsupported Fitting at Change in Direction

Span Type	Factor
a Continuous interior or fixed end spans	1.00
b Second span from supported end or unsupported fitting	0.80
c+d Sum of unsupported spans at fitting	≤0.75*
e Simple supported end span	0.67

\*For example: If continuous support is 10 ft., c+d must not exceed 7.5 ft. (c=3 ft. and d=4.5 ft.) would satisfy this condition.

### Adjustment Factors for Various Spans With Supported Fitting at Change in Direction

Span Type	Factor
a Continuous interior or fixed end spans	1.00
b Second span from simple supported end or unsupported fitting	0.80
e Simple supported end span	0.67

## THERMAL EXPANSION

The effects of thermal gradients on piping systems may be significant and should be considered in every piping system stress analysis. Pipe line movements due to thermal expansion or contraction may cause high stresses or even buckle a pipe line if improperly restrained. Several piping system designs are used to manage thermal expansion and contraction in above ground piping systems. They are listed below according to economic preference:

1. Use of inherent flexibility in directional changes
2. Restraining axial movements and guiding to prevent buckling
3. Use expansion loops to absorb thermal movements
4. Use mechanical expansion joints to absorb thermal movements

To perform a thermal analysis the following information is required:

1. Isometric layout of piping system
2. Physical and material properties of pipe
3. Design temperatures

4. Installation temperature (Final tie in temperature)
5. Terminal equipment load limits
6. Support movements

A comprehensive review of temperature effects on fiberglass pipe may be found in NOV Fiber Glass Systems' "Engineering and Piping Design Guide", Manual No. E5000, Section 3.

Change in Temperature °F	Pipe Change in Length (In/100 Ft)
25	0.4
50	0.8
75	1.1
100	1.5
125	1.9
150	2.3

## Restrained Thermal End Loads and Guide Spacing

Operating Temperature °F (Based on installation temperature of 75°F)

Size (In)	125		150		175		200		225	
	Guide Spacing (Ft)	Thermal End Load (Lbs)	Guide Spacing (Ft)	Thermal End Load (Lbs)	Guide Spacing (Ft)	Thermal End Load (Lbs)	Guide Spacing (Ft)	Thermal End Load (Lbs)	Guide Spacing (Ft)	Thermal End Loads (Lbs)
1	6.3	145	5.2	190	4.6	220	4.2	235	3.9	230
1½	9.2	240	7.6	315	6.6	365	6.1	385	5.7	380
2	11.3	370	9.3	490	8.2	565	7.4	595	7.0	585
3	16.8	550	13.9	720	12.2	835	11.1	885	10.4	870
4	21.8	680	18.0	908	15.8	1,040	14.4	1,100	13.5	1,080
6	32.1	1,420	26.5	1,870	23.3	2,170	21.2	2,190	19.9	2,250
8	42.2	2,350	34.8	3,110	30.6	3,600	27.9	3,800	26.1	3,740
10	52.2	3,660	43.1	4,850	37.9	5,600	34.5	5,930	32.3	5,820
12	61.8	4,790	51.0	6,340	44.8	7,330	40.9	7,750	38.3	7,610
14	70.5	5,980	58.2	7,910	51.2	9,140	46.6	9,670	43.7	9,490
16	80.6	7,740	66.5	10,240	58.4	11,830	53.3	12,520	49.9	12,290

## OTHER CONSIDERATIONS

### Testing:

The recommended field test procedure for **Green Thread** pipe is to conduct the following cyclic pressure test. The piping system should be pressurized to 1½ times the operating design pressure, ten times. The tenth pressurization should be maintained for 1-8 hours and the line inspected for leaks.

Field test pressures are limited to 1½ times the maximum cyclic rating of the lowest rated component in the system. The maximum test pressure should not exceed 450 psig for any system without consulting NOV Fiber Glass Systems.

Pipelines operating at low pressures subjected to severe thermal cycling should be tested at 1½ times the piping system pressure rating.

**Do not field test until all supports, anchors and guides are properly installed.**

### Water Hammer:

Care should be taken when designing an FRP piping system to eliminate sudden surges. Soft start pumps and slow actuating valves should be considered.

## APPROVALS



## **SALES OFFICES**

### **North America**

2700 West 65th Street  
Little Rock, AR 72209  
Phone: 501 568 4010  
Fax: 501 568 4465

25 S. Main Street  
Sand Springs, OK 74063  
Phone: 918 245 6651  
Fax: 918-245 7566

### **Canada**

30 Strathlea Crescent SW  
Calgary, Alberta Canada T3H 5A8  
Phone: 403 660 4131  
Fax: 403 246 7850

### **Latin America (North Zone)**

2425 SW 36th Street  
San Antonio, Texas 78237  
Phone: 210 896 4438  
Fax: 210 434 7543

### **Latin Amrtica (Mercosul)**

Albano de Carvalho #400  
Officina 301  
Recreio dos Bandeirantes  
Rio de Janeiro 22795-380  
Phone: 55 21 88619170

### **Central Asia / Russia**

Microdistrict-13, Bldg-23, Apt. 4  
Mangistau Region  
Aktau, Kazakhstan  
Phone: 7 701 5141087  
Fax: 7 7292 436176

### **Middle East**

PO Box 61335  
Jafza View 18, Office 0506  
Jebel Ali Free Zone  
Dubai, United Arab Emirates  
Phone: 9714 886 5660  
Fax: 9714 886 5670

### **Pacific Rim**

10 Ubi Crescent  
#02-93 Ubi Techpark (Lobby E)  
Singapore 408564  
Phone: 65 6842 2293  
Fax: 65 6741 2293

### **China**

6 Ning Bo Road, Haping Road  
Centralized, Industrial Park,  
Harbin Development Zone  
Harbin China 150060  
Phone: 86 451 8709 1718  
Fax: 86 451 8709 1719

Litanghe Road  
Xiangcheng Economic Development  
Zone  
Suzhou, China 215131  
Phone: 86 512 8518 0099  
Fax: 86 512 8512 0101

### **Europe**

Dlhá 27  
Nesvady 94651  
Slovakia  
Phone: 42 191 836 0122

### **West Africa**

P.O. Box 14148  
Chioma Loveday Flats,  
Chief Ogbonda's Compound, #105  
Woji Road  
Woji, Port Harcourt, RV 500001  
Nigeria  
Phone: 234 803 338 2623  
Fax: 215 252 5140

## **MANUFACTURING FACILITIES**

San Antonio, Texas USA

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## **Supply Chain Solutions**

## **Tubular and Corrosion Control Solutions**

## **Well Service and Completion Solutions**

## **Headquarters**

2425 SW 36th Street  
San Antonio, Texas 78237 USA  
Phone: 210 434 5043  
Fax: 210 434 7543

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 **Fiber Glass Systems**

**One Company . . . Unlimited Solutions**

[fgspipe@nov.com](mailto:fgspipe@nov.com)

[www.fgspipe.com](http://www.fgspipe.com)