Green Thread™ HP 16

(Product Data)

Applications

- Chemical Processing Liquids
- Food Processing Liquids
- Potable Water
- Cooling Water
- Condensate Return
- Industrial Wastewater
- Mildly Corrosive Liquids
- Crude Oil & Gas
- Produced Water
- Saltwater
- CO_2

Materials and Construction

Pipe is manufactured by filament winding process using amine-cured epoxy thermosetting resin to impregnate strands of continuous glass filaments. The pipe wall includes an internal resin-rich corrosion barrier.

Green Thread HP 16 products are available in sizes 1”-42” (25-1,050 mm) diameters with a static pressure rating of 232 psig (16 bar). The pipe is designed for continuous operation at 200°F (93°C) serviceable up to 230°F (110°C) by applying a derating factor of 0.76 to all component ratings. Sizes 1”-6” (25-150 mm) are available in 20’ (6 m) lengths and sizes 8”-42” (150-1,050 mm) are available in 19’ or 39’ (6 or 12 m) lengths.

NSF Standard 61 certification for Green Thread HP 16 pipe and fittings is for potable water service.

ASTM D-2996 Classification: RTRP-11FW1-3110 for static design basis.

Fittings

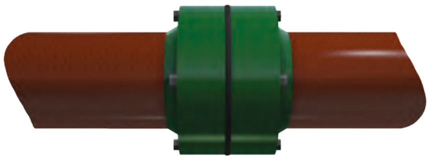
Fittings are manufactured with the same chemical and temperature capabilities as the pipe. Depending on the configurations and size, the fitting construction method will be compression molded, contact molded, fabricated or filament wound. Fitting details are in two documents. Use CI1350 for sizes 1”-16” (25-400 mm)and CI1351 for 18”-42” (450-1050 mm). All fittings may not have the same pressure rating as the pipe. A piping system design pressure rating is governed by the lowest rated component used in the system.

Joining System

- **Bell & Spigot** - Matched-taper joint secured with epoxy adhesive. Self-locking feature resists movement, facilitating joining runs of pipe without waiting for adhesive to cure.
- **Flanged** - Available for all piping systems and diameters; factory assembled or shipped loose for assembly in the field.

View of Joint Illustrations

Bell & Spigot



Flanged

Nominal Dimensional Data

Pipe Size		Inside Diameter		Outside Diameter		Minimum Reinforced Wall Thickness		Liner Thickness		Weight [2]	
in	mm	in	mm	in	mm	in	mm	in	mm	lbs/ft	kg/m
1[1]	25	1.19	30.2	1.34	34.0	0.057	1.45	0.015	0.38	0.2	0.4
1½[1]	40	1.76	44.7	1.91	48.5	0.062	1.57	0.015	0.38	0.4	0.6
2[1]	50	2.15	54.6	2.34	59.4	0.075	1.91	0.020	0.51	0.6	0.8
3[1]	80	3.28	83.3	3.47	88.1	0.075	1.91	0.020	0.51	0.8	1.2
4[1]	100	4.28	108.7	4.47	113.5	0.075	1.91	0.020	0.51	1.1	1.6
6[1]	150	6.35	161.3	6.60	167.6	0.105	2.67	0.020	0.51	2.1	3.2
8	200	8.36	212.3	8.66	220.0	0.127	3.23	0.020	0.51	3.3	4.9
10	250	10.36	263.1	10.72	272.3	0.156	3.96	0.020	0.51	4.9	7.3
12	300	12.29	312.2	12.70	322.6	0.185	4.70	0.020	0.51	7.1	10.6
14	350	14.04	356.6	14.49	368.0	0.204	5.18	0.020	0.51	8.9	13.2
16	400	16.04	407.4	16.55	420.4	0.234	5.94	0.020	0.51	11.6	17.3
18	450	17.82	452.6	18.37	466.6	0.257	6.53	0.020	0.51	14.1	21.0
20	500	19.83	503.7	20.42	518.7	0.273	6.93	0.020	0.51	16.5	24.6
24	600	23.83	605.3	24.53	623.1	0.328	8.33	0.020	0.51	23.7	35.3
30	750	30.03	762.8	30.93	785.6	0.430	10.90	0.020	0.51	38.7	57.6
36	900	36.03	915.2	37.09	942.0	0.510	13.00	0.020	0.51	54.7	81.4
42	1050	42.03	1067.6	43.27	1099.0	0.600	15.20	0.020	0.51	74.8	111.3

(1) Minimum reinforced wall thickness exceeds the requirement for the 232 psi standard rating for HP16. The 1" thru 3" pipe sizes are rated to 435 psig and the 4" and 6" sizes to 300 psig.

2) Based on the minimum wall.

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 following tables were developed to ensure a design that limits beam mid-span deflection to ½ inch to ensure good appearance and adequate drainage. 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.

Support Spacing vs. Specific Gravity

Specific Gravity	2.00	1.50	1.25	1.00	0.75
Multiplier	0.86	0.92	0.96	1.00	1.07

Example: 6" pipe @ 70°F (21.1°C) with 1.5 specific gravity fluid, maximum support spacing = 20.5 ft. X 0.92 = 18.8 ft.

Maximum Support Spacing for Uninsulated Pipe[1]

Size		Continuous Spans of Pipe[2]			
		feet		meters	
in	mm	70°F	200°F	21.1°C	93.3°C
1	25	11.3	10.0	3.44	3.07
1 ½	40	12.8	11.4	3.92	3.50
2	50	14.1	12.6	4.32	3.86
3	80	15.9	14.2	4.85	4.33
4	100	17.1	15.2	5.21	4.64
6	150	20.5	18.3	6.27	5.60
8	200	23.0	19.9	7.00	6.29
10	250	25.7	22.9	7.83	6.99
12	300	27.7	24.1	8.44	7.34
14	350	29.1	25.3	8.88	7.72
16	400	31.1	27.1	9.51	8.27
18	450	32.7	28.4	9.97	8.67
20	500	33.8	29.3	10.3	8.96
24	600	37.0	32.2	11.3	9.82
30	800	43.1	38.5	13.1	11.7
36	900	46.1	40.1	14.1	12.2
42	1050	51.0	45.5	15.5	13.9

(1) For Sg=1.0, consult manufacturer for heavier insulated pipe support spans. Span recommendations include no provision for weight of (fittings, valves, etc.) or thrusts at branches and turns. Heavy valves and other appurtenances must be supported separately.

(2) Calculated spans are based on ½" mid-span deflections to ensure good appearance and adequate drainage. Total system stresses should always be taken into account by the system design engineer when determining support spans.

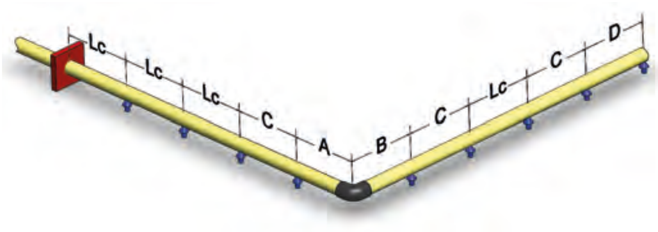
There are seven basic guidelines to follow when designing an above ground piping system:

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 run loading. Vertical loads should be supported sufficiently to minimize bending stresses on pipe and fittings.
7. Provide adequate axial and lateral restraint to ensure line stability during rapid changes in flow (water hammer).

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

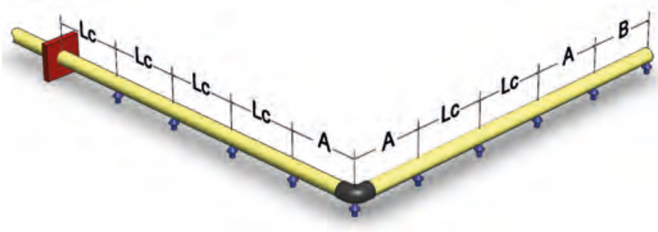
	Span Type	Factor
Lc	Continuous interior or fixed end spans	1.00
C	Second span from supported end or unsupported fitting	0.80
A+B	Sum of unsupported spans at fitting	≤0.75*
D	Simple supported end span	0.67

*For example: If continuous support is 10 ft. (3.04 m), A+B must not exceed 7.5 ft.(2.28 m) (A=3 ft. (0.91 m) and B=4.5 ft. (1.37 m)) would satisfy this condition.



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

	Span Type	Factor
Lc	Continuous interior or fixed end spans	1.00
A	Second span from simple supported end or unsupported fitting	0.80
B	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, Section 3.

Temperature Change		Pipe Length Change	
°F	°C	in/100 ft	cm/100 m
25	13.9	0.36	3.0
50	27.8	0.72	6.0
75	41.7	1.08	9.0
100	55.6	1.44	12.0

Testing

Hydrostatic testing is recommended to evaluate the integrity of all new piping installations. For systems operating below the system rating, a test pressure of 1.5 times the system operating pressure is recommended; however, the maximum test pressure must not exceed 1.3 times the lowest pressure rated fiberglass component in the piping system.

The hydro test pressure should be repeated up to ten cycles from 0 psig to the test pressure to provide a high degree of confidence in the piping system. The final pressurization cycle should be allowed to stabilize for 15-30 minutes, then inspected for leaks. Do not attempt to repair leaks while system is pressurized. The hydro test should be repeated after any re-work is performed.

When hydro testing, open high-point vents (if used) to prevent entrapment of air in the lines as the system is slowly filled with water, then close the vents and slowly pressurize to the test pressure. Upon completion of hydro test, relieve the pressure on the system slowly, open vents and any drains to allow for complete drainage of the system.

Water Hammer

Piping systems may be damaged by pressure surges due to water hammer. The use of soft start pumps and slow actuating valves will reduce the magnitude of surge pressures during operation and are highly recommended.

Typical Mechanical Properties

Pipe Property		70°F	21°C	150°F	65°C	200°F	93°C	Method
		psi	MPa	psi	MPa	psi	MPa	
Hydrostatic Design Basis	(LTHS)	23,400[1]	161[1]	23,400	161	17,500	121	ASTM D2992,
	(LCL)	20,900[1]	144[1]	20,900	144	15,800	109	Proc. B (20 yrs)
Ultimate Hoop Stress at Weeping		36,000	248	45,000	313	48,400	334	ASTM D1599
Circumfererntial								
Hoop Tensile Modulus		3.84×10^6	26,500	2.86×10^6	19,700	2.25×10^6	15,500	NOV FGS
Poisson's Ratio v_{ha}		0.61		0.73		0.8		NOV FGS
Longitudinal								
Axial Tensile Strength		11,600	80	10,100	70	9,200	63.4	ASTM D2105
Axial Modulus		2.24×10^6	15,000	1.53×10^6	11,200	1.24×10^6	8,550	ASTM D2105
Poisson's Ratio v_{ah}		0.35		0.39		0.42		ASTM D2105
Axial Bending Strength		12,300	85	-	-	-	-	NOV FGS
Axial Bending Modulus		2.25×10^6	15,000	1.75×10^6	12,100	1.43×10^6	9,900	ASTM D2925
Shear Modulus		1.76×10^6	12,100	1.65×10^6	11,400	1.58×10^6	10,900	NOV FGS

Typical Physical Properties

Pipe Property	Value	Value	Method
Thermal Conductivity Pipe Wall	0.19 BTU/hr•ft•°F	0.33 W/m°C	NOV FGS
Thermal Expansion	12.0×10^{-6} in/in•°F	21.6×10^{-6} mm/mm•°C	ASTM D696
Flow Coefficient, Hazen Williams	150		-
Absolute Roughness	1.7×10^{-5} ft	5.3×10^{-6} m	-
Density	121 lbs/ft³	1940 kg/m³	ASTM D792

[1] Value obtained at 150°F

[2] The differential pressure between internal and external pressure which causes collapse.

[3] A 0.67 design factor is recommended for short duration vacuum service. A full vacuum is equal to 14.7 psig (0.101 MPa) differential pressure at sea level.

[4] A 0.33 design factor is recommended for sustained (long-term) differential collapse pressure design and operation.

Ultimate Collapse Pressure

Size		Collapse Pressure[2,3,4]			
		psig		MPa	
in	mm	75°F	200°F	24°C	93°C
1	25	550	430	3.79	2.96
1½	40	340	260	2.34	1.79
2	50	330	250	2.28	1.72
3	80	120	90	0.827	0.621
4	100	49	36	0.338	0.241
6	150	40	28	0.269	0.193
8	200	27	19	0.179	0.131
10	250	27	19	0.179	0.131
12	300	27	19	0.179	0.131
14	350	23	16	0.172	0.117
16	400	23	16	0.159	0.110
18	450	22	15	0.152	0.103
20	550	18	12	0.117	0.083
24	600	18	12	0.117	0.083
30	750	21	15	0.138	0.097
36	900	21	15	0.138	0.097
42	1050	21	15	0.138	0.097

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