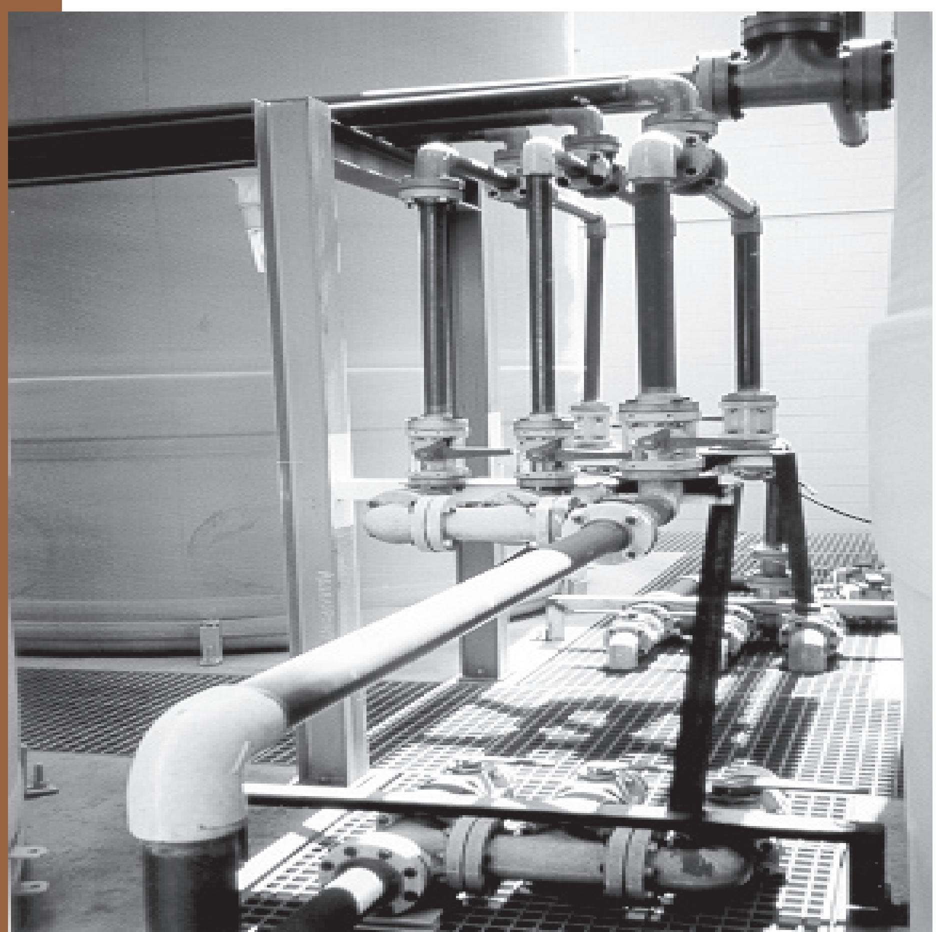
Bulletin No. A1280
September 15, 2007

Fiber Glass Systems
CENTRICAST® RB-1520 Piping Systems



CENTRICAST RB-1520 Pipe

PRODUCT

CENTRICAST RB-1520 pipe is manufactured with high strength glass fabrics and our highly resilient formulation of aromatic amine cured epoxy resin. A 50 mil integral corrosion barrier of pure resin provides excellent corrosion resistance. It is recommended for most caustics, salts, solvents, many acids and chemical process solutions up to 225°F. CENTRICAST RB-1520 proprietary resin formulation also provides the toughness for many corrosive types of slurry. Pipe and fittings are available in 1¹/₂"-14" with static pressure ratings up to 150 psig, with higher pressure ratings in smaller sizes. CENTRICAST RB-1520 comes in 20' nominal or exact lengths.

EXTERNAL BARRIER

A 10 mil resin-rich reinforced external corrosion barrier provides excellent corrosion resistance and protection from ultraviolent (UV) radiation. Fiber Glass Systems warrants CENTRICAST RB-1520 pipe and fittings against UV degradation of physical properties and chemical resistance for 15 years.

FITTINGS

Compatible epoxy fittings are manufactured with the same chemical/temperature capabilities as the pipe. The fabrication process is dependent on the fitting type and size. Fittings are manufactured by compression molding, contact molding or filament winding.

JOINING METHODS

An adhesive bonded socket connection with positive stops in the fittings is standard. The use of positive stops in the fittings is standard. The use of positive stops simplifies close tolerance piping installation. This joining system is easy to install and no special tools are required for field assembly. The joint is prepared for bonding by lightly sanding the pipe O.D. and the mating fitting's socket. A high strength adhesive with the same chemical resistance and temperature capabilities is used to bind the pipe and fittings. See Manual No. F6080 "pipe Installation Handbook" for detailed installation instructions and fabrication techniques.

RECOMMENDED SERVICES

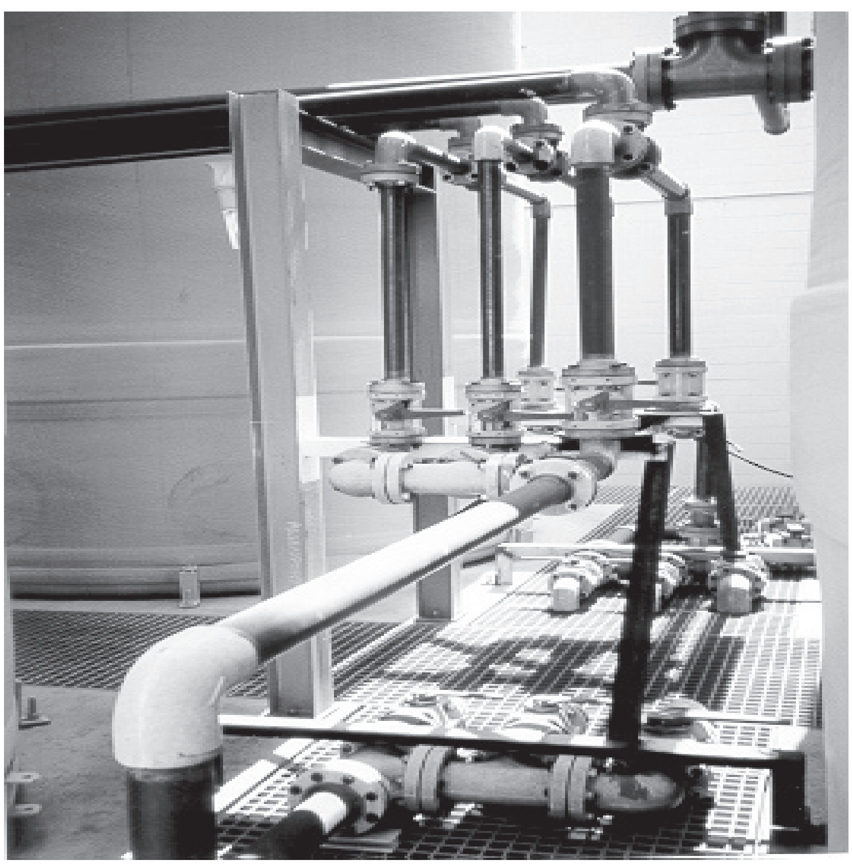
CENTRICAST RB-1520 epoxy resin pipe is excellent for many chemical and slurry applications including caustics, acids, salts, solvents and process solutions that corrode traditional metal pipe. Refer to Manual No. E5615 "*Chemical Resistance Guide*" for proper application.

BENEFITS

The excellent chemical resistance of the RB-1520 piping system provides longer service life than traditional piping materials. RB-1520 pipe performance conveying chemical mixtures and hot caustics is particularly exceptional resulting in a reduction in maintenance and replacement costs.

DISTRIBUTION

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 field, strategically located field personnel.



PIPE PROPERTIES

General Specifications and Dimensional Data*

Nominal Pipe Size (In)	Nominal I.D.		Nominal O.D.		Nominal Wall Thickness		Reinforcement Thickness		Nominal Weight		Capacity	
	(In)	(mm)	(In)	(mm)	(In)	(mm)	(In)	(mm)	(Lbs/Ft)	(kg/m)	(Gal/Ft)	(CuFt/Ft)
1 1/2	1.55	39.4	1.90	48.3	0.18	4.4	0.12	2.9	0.58	0.86	0.10	0.013
2	2.06	52.2	2.38	60.3	0.16	4.1	0.10	2.5	0.68	1.01	0.17	0.023
3	3.18	80.8	3.50	88.9	0.16	4.1	0.10	2.5	1.03	1.53	0.41	0.055
4	4.18	106.2	4.50	114.0	0.16	4.1	0.10	2.5	1.34	1.99	0.71	0.095
6	6.27	159.0	6.63	168.0	0.18	4.6	0.12	3.0	2.23	3.32	1.60	0.214
8	8.23	209.0	8.63	219.0	0.20	5.1	0.14	3.6	3.24	4.82	2.76	0.369
10	10.30	262.0	10.75	273.0	0.22	5.6	0.16	4.1	4.45	6.63	4.34	0.580
12	12.30	312.0	12.75	324.0	0.24	6.1	0.18	4.6	5.77	8.59	6.14	0.821
14	13.50	343.0	14.00	356.0	0.24	6.1	0.18	4.6	6.35	9.45	7.46	0.997

*All values are nominal. Tolerances or maximum/minimum limits can be obtained from Fiber Glass Systems.

ASTM D2997 Designation Codes*:

1 1/2"-4"	RTRP-21CW-4556
6"	RTRP-21CW-4555
8"	RTRP-21CW-4554
10"-12"	RTRP-21CW-4553
14"	RTRP-21CW-4552

*Mechanical properties cell classifications shown are minimum. Actual classifications may be higher for some sizes.

Pipe Lengths Available

Size (In)	Random Length (Ft)
1 1/2"-14"	20*

*Pipe is offered in random or exact lengths. Random lengths are from 18.0 to 20.4 feet long.

Pressure Ratings for Uninsulated Piping Systems (1) (2)

Nom. Pipe Size (In)	Maximum Internal Pressure @ 225ºF (psig)			Maximum External Pressure(6)		
	Socket Pressure Fittings(3)	Flanged Pressure Fittings(4)	Other Pressure Fittings(5)	75ºF	150ºF	225ºF
1 1/2	300	150	NA	920	753	649
2	300	150	125	290	231	199
3	275	150	125	103	104	90
4	150	150	100	47	37	32
6	150	150	100	22	18	16
8	150	150	100	19	12	11
10	150	150	75	12	10	8
12	150	150	75	7	6	5
14	125	150	-	7	6	5

(1) Static pressure ratings, typically created with use of a gear pump, turbine pump, centrifugal pump, or multiplex pump having 4 or more pistons or elevation head.
(2) For insulated and/or heat traced piping systems, use 100% of the uninsulated piping recommendations up to 200ºF and reduce these ratings 50% for 200ºF to 225ºF operating temperatures. CENTRICAST RB-1520 pipe and epoxy fittings can be used in drainage and vent systems up to 250ºF operating temperatures. For compressible gasses consult the factory for pressure ratings. Heat cured adhesive joints are highly recommended for all piping systems carrying fluids at temperatures above 120ºF.
(3) Socket elbows, tees, reducers, couplings, flanges and nipples joined with WELDFAST ZC275 adhesive.
(4) Flanged elbows, tees, reducers, couplings and nipples assembled at factory.
(5) Laterals, crosses, and saddles.
(6) Ratings shown are 50% of ultimate; 14.7 psi external pressure is equal to full vacuum.

CENTRICAST RB-1520 Pipe

Average Physical Properties[1]

Property	75ºF psi	24ºC MPa	200ºF psi	99ºC MPa	225ºF psi	107ºC MPa
Axial Tensile - ASTM D2105						
Ultimate Stress	30,000	210	26,000	180	25,000	170
Design Stress	7,500	52	6,500	45	6,250	43
Modulus of Elasticity	2.5E+06	17,200	2.2E+06	15,200	2.1E+06	14,500
Poisson's Ratio V	0.15		0.15		0.15	
Axial Compression - ASTM D695						
Ultimate Stress	35,000	240	28,000	190	17,000	110
Design Stress	8,750	60	7,000	48	4,250	29
Modulus of Elasticity	3.2E+06	22,000	2.8E+06	19,300	2.7E+06	18,600
Beam Bending - ASTM D2925						
Ultimate Stress	40,000	280	35,000	240	33,000	230
Design Stress[1]	5,000	34	4,375	30	4,125	28
Modulus of Elasticity (Long Term)	3.7E+06	26,000	3.2E+06	22,000	3.1E+06	21,000
Hydrostatic Burst - ASTM D1599						
Ultimate Hoop Tensile Stress	30,000	210	26,000	180	25,000	170
Hoop Tensile Modulus of Elasticity	2.4E+06	17,000	2.1E+06	14,500	2.0E+06	13,800
Hydrostatic Design - ASTM D2992, Procedure B - Hoop Tensile Stress Static 50 Year @ 75ºF	19,270	130	-	-	-	-

Coefficient of Linear Thermal Expansion - ASTM D696	Non-Insulated Pipe: 9.6 x 10^{-6} in/in/ºF • 17.4 x 10^{-6} mm/mm/ºC Insulated Pipe: 13,.0 x 10^{-6} in/in/ºF • 23.5 x 10^{-6} mm/mm/ºC
Thermal Conductivity	0.07 BTU/(ft)(hr)(ºF) • 0.04 W/(m)(ºC)
Specific Gravity - ASTM D792	1.41 (0.053 Lb/in³ • (1.47 g/cm³)
Flow Factor - SF / Hazen-Williams Coefficient	C-150
Surface Roughness	1.7 x 10^{-5} Feet
Manning's "n"	0.009

(1) Stress and modulus values can be interpolated between temperatures shown.

Properties of Pipe Sections Based on Minimum Reinforced Walls

Size (In)	Reinforcement End Area(In^2)	Reinforcement Moment of Inertia (In^4)	Reinforcement Section Modulus (In^3)	Nominal Wall End Area (In^2)
1 1/2	0.64	0.26	0.27	0.95
2	0.71	0.46	0.39	1.11
3	1.07	1.54	0.88	1.68
4	1.38	3.35	1.49	2.18
6	2.45	13.00	3.92	3.64
8	3.73	33.60	7.79	5.29
10	5.32	74.60	13.90	7.28
12	7.11	140.00	22.00	9.43
14	7.82	187.00	26.70	10.40

Recommended Operating Ratings

Size (In)	Axial Tensile Loads Max. (Lbs) @ 75ºF	Axial Tensile Loads Max. (Lbs) @ 225ºF	Axial Compressive Loads Max. (Lbs)(1)(2) @ 75ºF	Axial Compressive Loads Max. (Lbs)(1)(2) @ 225ºF	Bending Radius Min. (Ft) Entire Temp. Range	Torque Max. (Ft Lbs) Entire Temp. Range	Parallel Plate Loading(2) 5% Deflection & 75ºF ASTM D2412: Stiffness Factor In^3 Lbs/In^2	Pipe Stiffness (psi)	Hoop Modulus $x10^6$ (psi)
1$^1/_2$	4,800	4,000	5,600	2,700	59	113	279	2,632	2.2
2	5,400	4,500	6.300	3,000	73	163	317	1,444	3.8
3	8,000	6,700	9,300	4,500	108	368	317	433	3.8
4	10,400	8,600	12,100	5,900	139	620	317	200	3.8
6	18,400	15,300	21,500	10,400	204	1,632	547	107	3.8
8	28,000	23,300	32,700	15,900	266	3,246	709	62	3.1
10	39,900	33,300	46,600	22,600	331	5,786	1,195	54	3.5
12	53,300	44,400	62,200	30,200	393	9,178	1,701	46	3.5
14	58,600	48,800	68,400	33,200	432	11,108	1,701	35	3.5

(1) Compressive loads are for short columns only. Buckling loads must be calculated when applicable.

(2) Burial calculations must be based on 5% deflection as shown in table above.

SUPPORTS

The following engineering analysis must be performed to determine the maximum support spacing for the piping system. Proper pipe support spacing depends on the temperature and weight of the fluid carried in the pipe. The support spacing is calculated using continuous beam equations and 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 $^1/_2$ inch and bending stresses to less than or equal to $^1/_8$ of the ultimate bending stress. Any additional weight on the piping system such as insulation or heat tracing requires further consideration. Restrained (anchored) piping systems operating at elevated temperatures often result in guide spacing requirements that are more stringent than simple unrestrained piping systems. In this case, the maximum guide spacing will dictate the support/guide spacing requirements for the system. Pipe support spans at changes in direction require special attention. Supported and unsupported fittings at changes in direction 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, anchors, and guides:

1 Do not exceed the recommended support span.
2 Support valves and heavy in-line equipment independently . This applies to both vertical and horizontal piping.
3 Protect pipe from external abrasion.
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 at outlets or changes in direction.
7. Provide adequate axial and lateral restraint to ensure line stability during rapid changes in flow.

Nom. Pipe Size (In.)	Continuous Spans of Pipe (Ft.) Deflection=$^1/_2$” Specific Gravity=1.0 75ºF	150ºF	225ºF
1$^1/_2$	16.6	16.0	15.9
2	17.3	16.7	16.6
3	19.4	18.7	18.6
4	20.9	20.1	20.0
6	24.2	23.3	23.2
8	26.9	26.0	25.8
10	29.5	28.4	28.2
12	31.7	30.6	30.4
14	32.5	31.4	31.1

*Consult factory for insulated pipe support spacing.

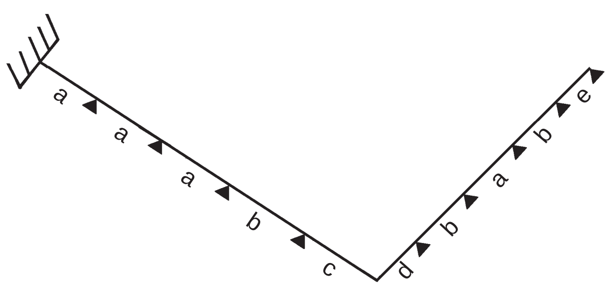
Support Spacing vs. Specific Gravity

Specific Gravity	3.00	2.00	1.50	1.25	1.00	0.75	Gas/Air
Multiplier	0.76	0.84	0.90	0.95	1.00	1.07	1.40

Example: 6” pipe @ 150°F with 1.5 specific gravity fluid,
maximum support spacing = 27.9 x 0.90 = 19.5 ft.

Piping Span Adjustment Factors With Unsupported Fitting at Change in Direction

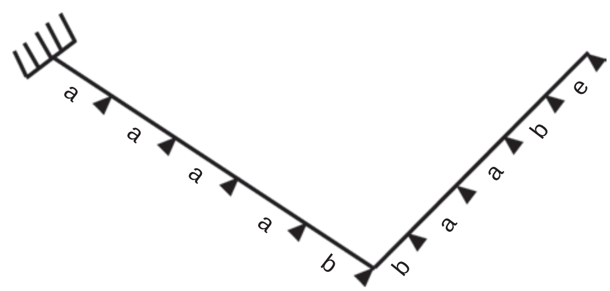
	Span Type	Factor
a	Continuous interior or fixed end spans	1.00
b	Second span from simple supported end or unsupported fitting	0.80
c + d	Sum of unsupported spans at fitting	≤ 0.75*
e	Simple supported end span	0.67



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

Piping Span Adjustment Factors With Supported Fitting at Change in Direction

	Span Type	Factor
a	Continuous interior or fixed end spans	1.00
b	Span at supported fitting or span adjacent to a simple supported end	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 Fiber Glass Systems’ “Engineering and Piping Design Guide”, Manual No. E5000, Section 3.

Unrestrained Thermal Expansion Uninsulated Pipe (1)

Change in Temperature ºF	Pipe Change In Length (In/100 Ft)
25	0.29
50	0.58
75	0.86
100	1.15
125	1.44
150	1.73
175	2.02
200	2.30
225	2.59

Restrained Thermal Expansion Pipe Compressive End Loads Uninsulated Pipe (1)

Nominal Pipe Size (In)	End Loads (Lbs/ºF
1 1/2	19.8
2	22.0
3	32.8
4	42.5
6	75.3
8	114.6
10	163.5
12	218.4
14	240.1

Allowable Bending Moment 90º Elbow

Nominal Pipe Size (In)	Allowable Moment (Ft•Lbs)
1 1/2	150
2	225
3	475
4	650
6	1,650
8	2,850
10	4,500
12	6,500
14	10,000

(1) Consult the factory for thermal expansion and compressive end loads of insulated pipe.

Restrained Thermal End Loads and Guide Spacing

Size (In)	Operating Temperature ºF (Based on installation temperature of 75ºF)									
	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 1/2	7.4	990	6.1	1,485	5.3	1,980	4.7	2,475	4.3	2,970
2	9.5	1,100	7.7	1,650	6.7	2,200	6.0	2,750	5.5	3,300
3	14.1	1,640	11.5	2,460	10.0	2,460	8.9	4,100	8.2	4,920
4	18.3	2,125	14.9	3,188	12.9	4,250	11.6	5,313	10.6	6,375
6	27.1	3,765	22.1	5,648	19.1	7,530	17.1	9,413	15.6	11,295
8	35.3	5,730	28.8	8,595	25.0	11,460	22.3	14,325	20.4	17,190
10	44.0	8,175	36.0	12,263	31.1	16,350	27.9	20,438	25.4	24,525
12	52.3	10,920	42.7	16,380	37.0	21,840	33.1	27,300	30.2	32,760
14	57.5	12,005	46.9	18,008	40.6	24,010	36.3	30,013	33.2	36,015

Expansion Loop Design Minimum Leg Length (Feet)

Size (In)	Change in Length (Inches)										
	1/2	1	2	3	4	5	6	7	8	9	10
1 1/2	2.7	3.8	5.4	6.6	7.7	8.6	9.4	10.1	10.8	11.5	12.1
2	3.0	4.3	6.1	7.4	8.6	9.6	10.5	11.3	12.1	12.8	13.5
3	3.7	5.2	7.3	9.0	10.4	11.6	12.7	13.7	14.7	15.6	16.4
4	4.2	5.9	8.3	10.2	11.8	13.2	14.4	15.6	16.7	17.7	18.6
6	5.1	7.1	10.1	12.4	14.3	16.0	17.5	18.9	20.2	21.4	22.6
8	6.2	8.7	12.3	15.1	17.4	19.5	21.3	23.0	24.6	26.1	27.5
10	7.3	10.3	14.6	17.9	20.6	23.1	25.3	27.3	29.2	31.0	32.6
12	8.3	11.8	16.7	20.4	23.6	26.3	28.9	31.2	33.3	35.3	37.3
14	7.7	10.9	15.5	19.0	21.9	24.5	26.8	29.0	31.0	32.8	34.6

Note: Multiply expansion loop minimum leg length by 1.414 for directional change cantilever leg length.

TESTING

See Section 3 of Fiber Glass Systems' Manual No. F6080, Pipe Installation Handbook: Hydrostatic Testing and System Startup.

When possible, Fiber Glass Systems' piping systems should be hydrostatically tested prior to beginning service. Care should be taken when testing, as in actual installation, to avoid water hammer. *All anchors, guides and supports must be in place prior to testing the line.*

Test pressure should not be more than 1 1/2 times the working pressure of the piping system and never exceed 1 1/2 times the rated operating pressure of the lowest rated component in the system.

OTHER CONSIDERATIONS

Water (Fluid) Hammer

A pressure surge will occur when fluid flow in a piping system is abruptly changed during events such as rapid pump startup or a quick closing valve. This surge can be significantly reduced by controlling pump startup and valve closure rates.

The maximum pressure surge in psi caused by water hammer can be calculated by multiplying the fluid velocity in ft/sec times the constant listed in the "Fluid (Water) Hammer Constants" Table. The peak pressure for the system will equal the water hammer surge plus the operating pressure at the time the water hammer occurred.

Fluid (Water) Hammer Constants[1]

Pipe Size (In.)	Fluid (Water) Hammer Constants[1]
1 1/2	38.8
2	33.6
3	28.5
4	25.5
6	23.2
8	22.0
10	21.1
12	20.6
14	19.7

[1] Constants are valid for water at 75ºF.

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LITTLE ROCK, AR
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FIBER GLASS SYSTEMS

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