Bulletin A2000
December 15, 2008

Fiber Glass Systems
Silver Streak®
Piping Systems

NOV Fiber Glass Systems™

SILVER STREAK® Abrasion Resistant Pipe

PRODUCT

Available in 2" through 24" diameter sizes, SILVER STREAK piping is designed especially for abrasive and corrosive services found in flue gas desulfurization (FGD) scrubber applications such as limestone, gypsum and ammonium sulfate slurries.

SILVER STREAK pipe is filament wound using epoxy resin and fiberglass reinforcement. Manufactured with a proprietary blend of abrasion-resistant additives, it is offered with a standard 80 mil nominal liner. Custom liner thicknesses are available on special order.

SILVER STREAK epoxy piping up to 24" is ideal for yard piping and is designed to operate at temperatures up to 225°F and pressures up to 225 psig. SILVER STREAK LD is available 30" through 48", is ideal for recirculating piping, and operates at temperatures up to 200°F and pressures up to 150 psig.

FITTINGS

A complete line of standard fittings, including long radius elbows, is available. Fittings are constructed with the same abrasion-resistant additives as the pipe. All fittings, except compression molded, have a minimum corrosion/abrasion barrier of 100 mils. See Bulletin No. A2050 for standard fitting dimensions.

JOINING METHODS

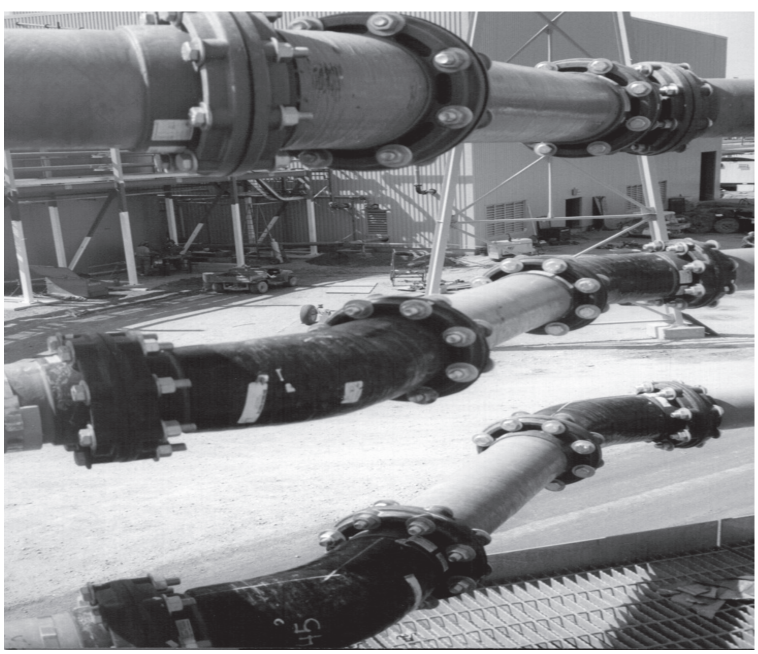
The standard joining system for SILVER STREAK piping is the **matched tapered bell and spigot.** It is available in 2" through 24" diameter sizes. The tapered joints are made using 8000 series adhesive. Piping can also be joined with flanges.

FIELD INSTALLATION

SILVER STREAK pipe can be cut and tapered in the field using tools from Fiber Glass Systems. For detailed information, refer to Manual No. F6000, Matched Tapered Bell & Spigot Joint Pipe Installation Handbook, and to individual tool and adhesive sheets for SILVER STREAK products.

FEATURES & BENEFITS

- Entire 80 mil nominal liner contains 80 percent resin/abrasion-resistant additives and 20% reinforcement.
- Available with 2"-24" diameters standard.
- Designed to operate at temperatures up to 225°F and pressures up to 225 psig.
- Rated for full vacuum service at 175°F.
- Complete line of standard fittings, including long radius elbows, available—constructed with the same abrasion-resistant additives as the pipe.
- Pipe comes spigot x spigot in 2" through 12" sizes and spigot x spigot or bell x spigot in 14" through 24" sizes.
- Custom-fabricated assemblies are available upon request.
- Suggested specification guides for SILVER STREAK are available in Bulletin No. A2001.



PRODUCT DATA

General Specifications and Dimensional Data

Nominal Liner Thickness - 0.080”/1.8 mm

Nominal Pipe Size	Nominal I.D.		Nominal O.D.		Nominal Wall Thickness		Nominal Weight		Max. Support Spacing(1) @ 150°F	
(In.)	(In.)	(mm.)	(In.)	(mm.)	(In.)	(mm.)	(lbs./ft.)	(kg./m.)	(ft.)	(m.)
2	2.00	51	2.40	61	.200	5.1	1.1	1.6	14.0	4.2
3	3.28	83	3.65	93	.186	4.7	1.6	2.4	15.7	4.8
4	4.28	109	4.66	118	.190	4.8	2.1	3.1	17.0	5.2
6	6.35	161	6.75	171	.197	5.0	3.1	4.6	19.2	5.9
8	8.36	212	8.82	224	.227	5.7	4.8	7.1	21.7	6.6
10	10.36	263	10.82	275	.230	5.8	6.1	9.1	23.1	7.0
12	12.29	312	12.77	324	.240	6.1	7.5	11.2	24.5	7.5
14	14.04	357	14.60	371	.278	7.1	10.1	15.0	26.6	8.1
16	16.04	407	16.66	423	.309	7.8	12.8	19.1	28.5	8.7
18	17.83	453	18.48	469	.326	8.3	15.1	22.5	29.8	9.1
20	19.83	504	20.54	522	.354	9.0	18.3	27.5	31.4	9.6
24	23.83	605	24.64	626	.404	10.3	25.2	37.4	34.3	10.4

ASTM D2996 Designation Codes

2”-24”	RTRP-11FX1-3110

Pipe Lengths Available

Size (In)	Random Length (Ft)
2-6	30
8-24	40

SILVER STREAK® Abrasion Resistant Pipe

TYPICAL PHYSICAL PROPERTIES

ASTM D2996 Designation RTRP-11FF-3110

Property	Value (psi)		Value (MPa)	
	@75°F	@225°F	@24°C	@107°C
Axial Tensile - ASTM D2105				
Ultimate Stress	10,550	7,160	72.7	49.4
Design Stress	2,637	1,790	18.2	12.3
Modulus of Elasticity	1.75×10^6	1.03×10^6	12,093	7,102
Poisson's Ratio $V_{a/h}$ ($V_{h/a}$)	0.35 (0.56)			
Axial Compression - ASTM D694				
Ultimate Stress	33,300	17,800	229.6	122.7
Design Stress	8,325	4,450	57.4	30.7
Modulus of Elasticity	1.26×10^6	0.54×10^6	8,687.4	3,723
Beam Bending - ASTM D2925				
Ultimate Stress	23,000	16,000	158.6	110.3
Design Stress	2,900	2,000	20.0	13.8
Modulus of Elasticity (Long Term)	2.18×10^6	1.11×10^6	15,030	7,653
Hydrostatic Burst - ASTM D1599				
Ultimate Hoop Tensile Stress	46,300	49,500	319.2	341.3
Ring Tensile - ASTM D2990				
Minimum Hoop Tensile Stress	27,280	-	188.1	-
Hydrostatic Hoop Design Stress ASTM D2992 - Procedure B 20 Year Static Life at 200°F (LCL)	22,400	14,654	154.4	101.0
Coefficient of Linear Thermal Expansion ASTM D696	1.26×10^{-5} in./in./°F		2.27×10^{-5} mm/mm/°C	
Thermal Conductivity	0.23 BTU/(ft.)(hr.)(°F)		0.4 W/(m)(°C)	
Specific Gravity - ASTM D792	1.8			
Hazen-Williams Flow Factor, C	150			

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)
2	0.80	0.51	0.42	1.38
3	1.12	1.74	0.95	2.03
4	1.49	3.81	1.63	2.67
6	2.31	12.56	3.72	4.05
8	3.73	34.8	7.89	6.12
10	4.70	66.5	12.29	7.65
12	5.89	116.5	18.25	9.45
14	8.19	211.0	28.9	12.50
16	10.77	361.0	43.3	10.9
18	12.80	530.0	57.4	18.6
20	15.80	805.0	78.4	22.5
24	22.2	1637.0	132.9	30.8

Recommended Operating Ratings

Size (In)	Axial Tensile Loads Max. (Lbs) 75ºF	Axial Tensile Loads Max. (Lbs) Max Rated Temp.	Axial Compressive Loads Max. (Lbs)[1] 75ºF	Axial Compressive Loads Max. (Lbs)[1] Max Rated Temp.	Bending Radius Min. (Ft) Entire Temp. Range	Torque Max. (Ft Lbs) Entire Temp. Range	Parallel Plate Loading[2] 5% Deflection ASTM D2412 Stiffness Factor In^3 Lbs/In^2	Pipe Stiffness (psi)	Hoop Modulus $x10^6$ (psi)
2	2,107	1,430	6,652	3,556	76	130	n/a	n/a	n/a
3	2,961	2,010	9,349	4,997	115	280	n/a	n/a	n/a
4	3,921	2,662	12,379	6,617	147	480	n/a	n/a	n/a
6	6,078	4,126	19,189	10,257	213	1,130	n/a	n/a	n/a
8	9,836	6,667	31,052	16,599	279	2,420	n/a	n/a	n/a
10	12,394	8,413	39,128	20,915	342	3,650	n/a	n/a	n/a
12	15,532	10,543	49,034	26,211	403	5,570	n/a	n/a	n/a
14	21,597	14,660	68,182	36,446	461	9,010	n/a	n/a	n/a
16	28,400	19,278	89,660	47,927	526	13,400	n/a	n/a	n/a
18	33,754	22,912	106,560	56,960	584	15,000	n/a	n/a	n/a
20	41,665	28,282	131,535	70,310	649	24,400	n/a	n/a	n/a
24	58,541	39,738	184,815	98,790	778	41,500	n/a	n/a	n/a

(1)Compressive loads are for short columns only. Buckling loads must be considered for long slender columns.

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 independenly. 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.

Maximum Support Spacing for Uninsulated Pipe*

Nom. Pipe Size (In.)	Continuous Spans of Pipe (Ft.) Deflection=1/2" Specific Gravity=1.0 75ºF	150F	200F	Gas[1] 75ºF
2	15.0	14.0	13.1	18.3
3	16.8	15.7	14.8	22.7
4	18.2	17.0	16.0	25.7
6	20.6	19.2	18.1	31.5
8	23.3	21.7	20.4	36.4
10	24.8	23.1	21.8	40.3
12	26.3	24.6	23.1	44.0
14	28.5	26.6	25.0	47.5
16	30.6	28.5	26.8	51.1
18	32.0	29.8	28.0	54.0
20	33.7	31.4	29.5	57.1
24	36.7	34.3	32.2	63.0

*Consult factory for insulated pipe. 1. Consider stability issues when used.

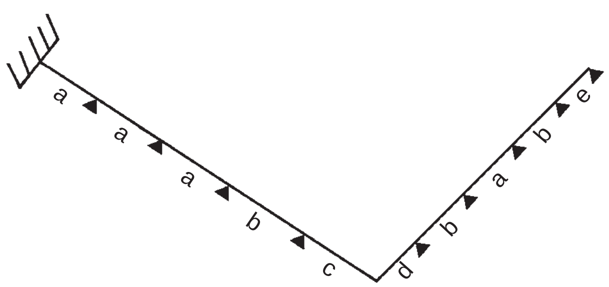
Support Spacing vs. Specific Gravity

Specific Gravity	2.00	1.50	1.25	1.00	0.75
Multiplier	0.86	0.91	0.95	1.00	1.05

Example: 6” pipe @ 150°F with 1.5 specific gravity fluid, maximum support spacing = 19.2 x 0.91 = 17.4 ft.

Piping Span Adjustment Factors With Unsupported Fitting at Change in Direction

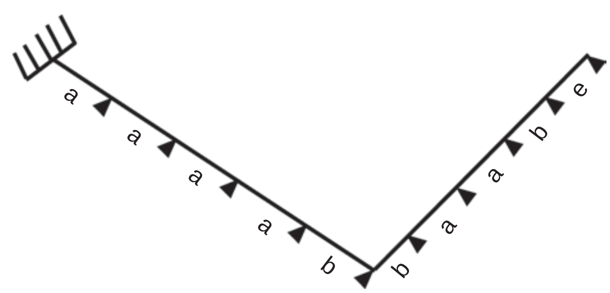
	Span Type	Factor
a	Continuous interior or fixed end spans	1.00
b	Second span from simple supported end or unsupported fitting	0.80
c + d	Sum of unsupported spans at fitting	≤ 0.75*
e	Simple supported end span	0.67



* 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.

Change in Temperature ºF	Pipe Change in Length (In/100 Ft)
25	0.38
50	0.76
75	1.13
100	1.51
125	1.89
150	2.27
175	2.65

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)
2	11.1	513	9.2	679	8.1	785	7.4	830	6.9	815
3	17.4	721	14.4	955	12.6	1,103	11.5	1,167	10.8	1,146
4	22.3	955	18.5	1,264	16.2	1,461	14.8	1,545	13.8	1,517
6	32.6	1,481	26.9	1,960	23.6	2,265	21.5	2,396	20.2	2,352
8	42.6	2,396	35.2	3,172	30.9	3,665	28.2	3,877	26.4	3,806
10	52.5	3,020	43.4	3,997	38.1	4,619	34.7	4,885	32.5	4,796
12	62.1	3,784	51.3	5,009	45.0	5,788	41.0	6,122	38.4	6,011
14	70.9	5,262	58.5	6,965	51.4	8,049	46.8	8,513	43.8	8,358
16	80.8	6,920	66.8	9,159	58.6	10,584	53.4	11,195	50.0	10,991
18	89.8	8,225	74.2	10,886	65.2	12,579	59.4	13,305	55.6	13,063
20	99.7	10,153	82.3	13,437	72.3	15,528	65.8	16,424	61.6	16,125
24	119.9	14,265	99.0	18,881	87.0	21,818	79.2	23,076	74.1	22,657

*Basic pipe support spacing requirements must be followed.

Expansion Loop Design Minimum Leg Length (Feet)

Size (In)	Change in Length (Inches)								
	1/2	1	2	3	4	5	6	8	10
2	4.2	5.5	7.3	8.6	9.8	10.8	11.8	13.4	14.9
3	5.2	6.8	9.0	10.7	12.1	13.4	14.6	16.6	18.4
4	6.0	7.8	10.3	12.2	13.8	15.3	16.6	18.9	20.9
6	7.4	9.5	12.6	14.9	16.8	18.6	20.1	22.9	25.3
8	9.1	11.5	15.0	17.6	19.9	21.8	23.6	26.8	29.6
10	10.0	12.7	16.5	19.4	21.9	24.1	26.1	29.6	32.7
12	11.1	14.0	18.2	21.4	24.1	26.5	28.6	32.4	35.8
14	12.0	15.1	19.6	23.0	25.9	28.4	30.7	34.8	38.4
16	13.1	16.5	21.2	24.9	27.9	30.7	33.1	37.4	41.3
18	13.6	17.1	22.1	25.9	29.2	32.0	34.6	39.2	43.2
20	14.0	17.7	23.0	27.1	30.5	33.5	36.2	41.0	45.3
24	14.9	18.9	24.7	29.2	32.9	36.2	39.2	44.5	49.1

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

TESTING

See Fiber Glass Systems Manual No. F6000, Pipe Installation Handbook for Matched Tapered Bell & Spigot Joints:

The normal recommended test procedure for RED THREAD II pipe is to conduct a cyclic pressure test. A cyclic pressure test subjects the piping system to 10 pressurization cycles at 1$^1/_2$ times the anticipated or design operating pressure. The tenth pressurization is maintained on the line for 1-8 hours while the line is inspected for leaks. Lines that can be subjected to severe temperature cycles, such as steam condensate lines, hot water lines, and cold water lines, should be tested using the cyclic test procedure at 1$^1/_2$ times the system pressure rating, even if the system is to operate at relatively low pressure.

No field test pressure should exceed 1$^1/_2$ times the maximum rated cyclic pressure rating of the lowest rated element in the system. Under no circumstances should a field pressure test exceed 450 psig without consulting Fiber Glass Systems.

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)
2	35
3	28
4	25
6	22
8	21
10	19
12	19
14	19
16	19
18	19
20	19
24	19

(1) Valid for ambient temperature water.

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