Conley Composites
an ANDRONACO INDUSTRIES company

ENDURANCE™ 60
CONTINUOUS CAST PIPE
VINYL ESTER FRP

Quantum Leap Manufacturing Process
Conley Composites has developed break-through proprietary technology in the manufacture of vinyl ester fiberglass reinforced thermoset we call "Continuous Cast Pipe" that produces a machine-made resin rich pipe to exact inside and outside diameter dimensions continuously. The process not only results in an extremely consistent product but also allows for pipe lengths up to 50 feet.

Superior to Competitors FRP Pipe
Conley Endurance 60 "Continuous Cast Pipe" manufac-turing strategically places continuous glass reinforce-ment directly in the axis of stress loading, axial and hoop, providing outstanding strength in each axis.

The machine-positioned directional glass placement yields much greater stiffness offering higher axial tensile and beam bending capabilities for greater unsupported span situations and lower thermal expansion/ contraction, while maintaining excellent pressure safety factor for hoop strength.

MADE IN USA

Resin Rich Nexus® 50 - 60 Mil Corrosion Barrier
Endurance 50 internal corrosion barrier consists of 6 layers of Nexus® veil, each saturated with vinyl ester resin. The resin rich Nexus veil reinforcement provides increased strength and ductility that isn't easily cracked or fractured like "Fragile, non reinforced pure resin" is known to do with competitor's pipe. Endurance pipe has been proven to provide over 2 times the impact resistance over competitor pipes as well.

Pressure and Temperature
Endurance 50 pipe is rated to 300 psi from -40°F to 200°F. Conley fittings also maintain the same pressure/ temperature rating as Endurance pipe.

External Resin Rich Nexus® Corrosion Barrier
Endurance 50 pipe also incorporates a 10 mil resin rich Nexus external corrosion barrier on the O.D. which provides an excellent barrier to environment and airborne corrosives. Endurance pipe also contains a UV inhibitor to aid against ultraviolet radiation from sunlight.

ENDURANCE™ 60
PRODUCT SCOPE

Materials and Construction
Endurance 50 is manufactured with two distinct layers; the 50 - 60 mil Nexus reinforced vinyl ester corrosion barrier with a heavy duty glass reinforcement saturated with Vinyl Ester resin.

The 50 - 60 mil internal corrosion barrier (inner liner) consists of a minimum of six layers of Nexus veil saturated with Vinyl Ester resin. The Nexus veil adds reinforcement to increase strength and ductility of the resin rich corrosion barrier.

The glass reinforcement, or cage, is manufactured with glass fiber bundles, pressure saturated with a highly chemical resistant formulation of premium vinyl ester resin to provide maximum exterior corrosion resistance. The unique pressure saturating process eliminates voids between fibers and resin. The fiberglass bundles are oriented in strict axial and hoop directions, which provide outstanding, stiffness and pressure capabilities.

The unique manufacturing process used to produce Endurance 50 allows for lengths of straight spools to be manufactured up to 50 ft. allowing the end user to reduce the number of socket or flanged joints in the field.

Fittings
Conley fittings are filament wound, and have a minimum double Nexus veil reinforced Vinyl Ester internal corrosion resistant barrier (50 - 60 mils), filament wound glass reinforced structural cage, and a Nexus veil external corrosion barrier.

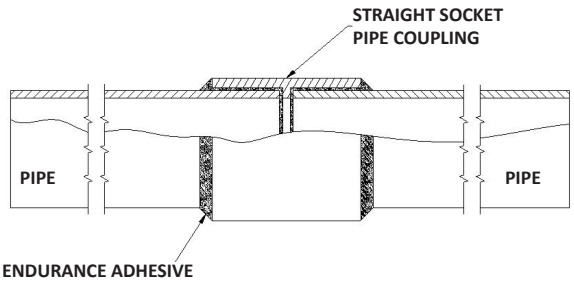
Connections - Straight Socket Joints
Straight Adhesive Socket Joints are used with both pipe to fitting connections as well as pipe to pipe connections using couplings.

Flange connections are used to join the fiberglass pipe and fittings to other equipment. Flanges are designed for the operating pressure per the system requirements as a minimum. Flange dimensions conform to ANSI/ASME B16.5 150 lb drilling. Rotatable flanges (available on pipe spools only) exhibit enough strength to be connected to raised face surfaces (equipment connections, valves, etc.) and do not require a spacer ring to maintain a flat surface to the O.D of the flange. Where rotatable spool flanges are connected to any frp fittings, a full face gasket is required.

Gaskets and Hardware
Flat washers shall be used between bolt heads or nuts and the back side of flanges.

Recommended gasket materials are a minimum of 1/8 inch in thickness with a suitable chemical resistance to the service. Gaskets shall have a Shore A hardness of 50 to 70.

PTFE envelope gaskets are not recommended. See the Conley Installation & Fabrication Manual for bolt torque requirements.



This type of joint shall be the only means of joining pipe and fittings. No tapering of pipe end shall be allowed.

Flanges
Flanges are to be attached to a pipe section only with straight socket adhesive joints. Flanges through 8” diameter shall be serrated for improved gasket sealing. Full face gaskets are required at any flanged connection to fittings. Ring gaskets are optional between rotating spool flanges and raised face connections.

Quality Assurance and Inspection
Conley’s Quality Assurance program is certified to ISO 9001-2015. All pipe is dimensionally inspected and measured as per Conley specifications. Fittings are inspected at each stage of manufacture for liner, reinforcement and external corrosion barrier thickness.

ENDURANCE™ 60
PROPERTIES

Nominal Dimensional Data

Nominal Pipe Size in	O.D.		I.D.		Total Wall Thickness		Reinforcement Thickness		Weight	Capacity	Internal Pressure at 75°F	Internal Pressure at 200°F	Vacuum Rating at 200°F
	in	mm	in	mm	in	mm	in	mm	lb/ft	gal/ft	psi	psi	psi
1	1.32	33.5	1.05	26.6	0.14	3.6	0.08	2.0	0.38	0.04	300	180	Full
1 1/2	1.88	47.8	1.60	40.6	0.14	3.6	0.08	2.0	0.55	0.11	300	180	Full
2	2.38	60.5	2.06	52.3	0.16	4.1	0.10	2.5	0.82	0.17	250	150	Full
3	3.50	88.9	3.07	78.0	0.22	5.5	0.16	3.9	1.65	0.38	250	150	Full
4	4.50	114.3	4.03	102.3	0.24	6.0	0.18	4.5	2.63	0.66	150	90	Full
6	6.63	168.3	6.07	154.1	0.28	7.1	0.22	5.6	4.23	1.50	150	90	Full
8	8.63	219.1	7.98	202.7	0.32	8.2	0.26	6.7	6.25	2.60	150	90	Full

Properties of Pipe

Nominal Pipe Size in	Reinforcement End Area in^2	Nominal Wall End Area in^2	Reinforcement Moment of Inertia in^4	Reinforcement Section Modulus in^3
1	0.30	0.50	0.06	0.09
1 1/2	0.43	0.74	0.17	0.18
2	0.72	1.12	0.47	0.39
3	1.63	2.22	2.28	1.30
4	2.40	3.17	5.62	2.50
6	4.43	5.58	22.73	6.86
8	6.88	8.4	60.24	13.97

Typical Properties

Thermal Expansion Coefficient ASTM D696	4.5 x 10^{-6} in/in/°F
Thermal Conductivity	0.31 BTU/hr-ft-°F
Specific Gravity - ASTM D792	1.71
Density - ASTM D792	0.062 lb/in^3
Haze-Williams Coefficient	150
Manning's Roughness Coefficient, n	0.009
Absolute Surface Roughness	0.0002
Cantilevered Bending	40,000 psi

Average Physical Properties

Property	75°F	24°C	175°F	80°C	200°F	93°C
	psi	MPa	psi	MPa	psi	MPa
Axial Tensile - ASTM D638						
Ultimate Stress	66,000	460	46,200	320	39,600	270
Design Stress	16,500	115	11,550	80	9,900	68
Modulus of Elasticity	4.5 x 10^6	31,000	3.1 x 10^6	21,400	2.7 x 10^6	18,600
Poisson's Ratio ν	0.39					
Axial Compression - ASTM D695						
Ultimate Stress	58,300	400	40,810	280	35,000	240
Design Stress	14,575	100	10,203	70	8,750	60
Modulus of Elasticity	5.1 x 10^6	35,160	4.9 x 10^6	33,780	4.8 x 10^6	33,090
Hydrostatic Burst - ASTM D1599						
Ultimate Hoop Tensile Stress	13,000	90	9,100	63	7,800	54
Design Stress	3,250	23	2,275	16	1,950	13
Hoop Tensile Modulus of Elasticity	2.5 x 10^6	17,240	1.8 x 10^6	12,410	15 x 10^6	10,340
Beam Bending						
Ultimate Stress	48,000	330	33,600	230	28,800	200
Design Stress	6,000	41	4,200	29	3,600	25
Modulus of Elasticity	4.0 x 10^6	27,580	2.8 x 10^6	19,310	2.4 x 10^6	16,550

ENDURANCE COMPOSITE PIPE WITH COMPOSITE VALVE

Supports

Piping must be properly supported to prevent excessive deflection and loading. Piping support spans depend on total pipe weight, i.e. liquid full weight dependent on fluid density, and operating temperatures. Elevated operating temperatures affects the bending modulus of the piping material. The established maximum support spans ensure a mid-span deflection limited to 0.5" with an 8:1 safety factor for ultimate bending stress. Support conditions are defined as Type I, II, III and IV. Type II conditions are the most common, in which the pipe is analyzed as a continuous beam spanning two or more supports. Types I, III, and IV conditions refer to uniform distributed loads with single-span, four-spans, and fixed end supports respectively. Any additional external loads applied to the piping system such as insulation, wind or seismic loading require further analysis.

There are six key principals to properly support FRP Pipe:

1. Avoid Point Loading
2. Do not exceed recommended minimum support spans
3. Protect pipe from abrasion at support locations
4. Support heavy valves and equipment independently
5. Avoid excessive bending during handling and installation
6. Properly support vertical runs to avoid excessive loading and cantilever loads

Unsupported Spans (ft)(*)

Size	Support Type			
in	Type I	Type II	Type III	Type IV
1	9.1	10.6	10.8	13.6
1.5	10.2	11.9	12.1	15.2
2	11.6	13.6	13.8	17.4
3	14.3	16.7	17.0	21.4
4	15.7	18.4	18.7	23.5
6	18.6	21.8	22.2	27.9
8	20.9	24.5	24.9	31.3

*For fluids with specific gravity of 1.0 and max mid-span deflection of 0.5"

Temperature Correction Factors

75°F	150°F	175°F	200°F
1.00	0.91	0.89	0.88

Specific Gravity Correction Factors

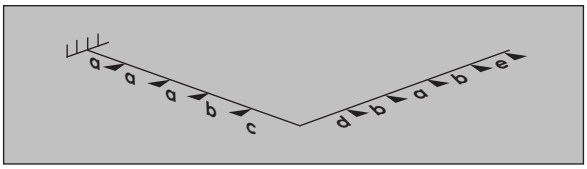
Specific Gravity	3.00	2.00	1.50	1.25	1.00	0.75	GAS/ AIR
Multiplier	0.76	0.84	0.90	0.95	1.00	1.07	1.40

Example:
4" simply supported pipe @ 150°F with a 1.25 specific gravity fluid,
Maximum support spacing = 18.4 x 0.91 x 0.95 = 15.9 ft

Adjustment Factors For Various Spans with Unsupported Fittings at Changes 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

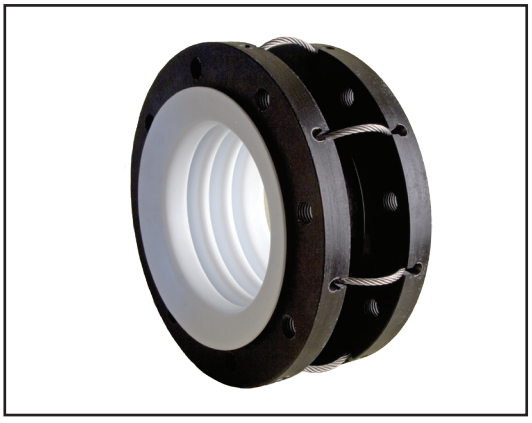
*Example: If continuous support is 10 ft., c + d must not exceed 7.5 ft. (c = 3 ft. and d = 4.5 ft.) would satisfy this condition.



Thermal Expansion

Proper thermal expansion review and appropriate design of supports and guides for FRP piping systems is an important consideration. Thermal expansion can induce high stresses in an FRP piping system and even cause buckling if improperly supported or not designed to address thermal growth. Various methods can be used to manage stresses caused by thermal expansion in above ground installations. These methods are listed below in order of economic preference:

1. Designing enough flexibility into the piping system with direction changes
2. Anchoring and guiding to restrain axial movement and prevent buckling
3. Additions of expansion loops to absorb thermal growth
4. Use of mechanical PTFE expansion joints to absorb thermal growth



ETHYLENE™ PTFE EXPANSION JOINT WITH DURCOR® STRUCTURAL COMPOSITE FLANGES

Thermal Expansion cont.

Proper thermal analysis of a piping system requires the following information:

1. Isometric layout of the entire piping system
2. Material properties of the pipe
3. Design temperature
4. Ambient installation temperature
5. Equipment allowable loads (i.e. nozzle loads)
6. Support movements

Elbow Strength

Recommended Allowable Bending Moments for 90° Elbows			
Nominal Pipe size	Allowable Moment	Nominal Pipe size	Allowable Moment
in	lb-ft	in	lb-ft
1	50	4	700
1 1/2	150	6	1,700
2	250	8	2,900
3	500		

Thermal Growth

Change in Temperature °F	Change in Length in/100 Ft
25	0.14
50	0.27
75	0.41
100	0.54
125	0.68
150	0.81
175	0.95
200	1.08

The coefficient of thermal expansion for Endurance™ pipe is 4.5 x 10^{-6} in/in/°F. Expansion and contraction from changes in temperature in pipe runs can be determined by interpolation from the above data.

Distance from Expansion Joint and Expansion Loop to Primary and Secondary Guides

Nominal Pipe Size in	Primary Guide in	Secondary Guide in
1	4	14
1 1/2	6	21
2	8	28
3	12	42
4	16	56
6	24	84
8	32	112

Primary and secondary guides are recommended adjacent to expansion joints and expansion loops to direct the movement of the piping and minimize axial misalignment.

Restrained Thermal End Loads and Guide Spacing

	Operating Temperature °F(1)									
	100°F		125°F		150°F		175°F		200°F	
Size	Guide Spacing	Thermal End Load	Guide Spacing	Thermal End Load	Guide Spacing	Thermal End Load	Guide Spacing	Thermal End Load	Guide Spacing	Thermal End Load
in	ft	lbs	ft	lbs	ft	lbs	ft	lbs	ft	lbs
1	12.0	169	7.9	332	6.2	493	5.1	651	4.3	797
1 1/2	18.1	244	11.9	478	9.3	711	7.7	938	6.5	1,148
2	21.5	411	14.1	806	11.1	1,197	9.2	1,579	7.7	1,934
3	29.7	935	19.6	1,832	15.3	2,721	12.7	3,592	10.6	4,398
4	37.9	1,379	25.0	2,704	19.6	4,016	16.2	5,301	13.5	6,490
6	55.1	2,540	36.3	4,980	28.4	7,396	23.5	9,761	19.7	11,952
8	70.9	3,949	46.7	7,744	36.6	11,500	30.3	15,178	25.3	18,586

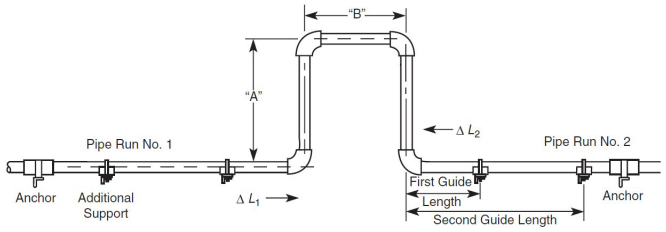
(1) Based on an installation temperature of 75°F

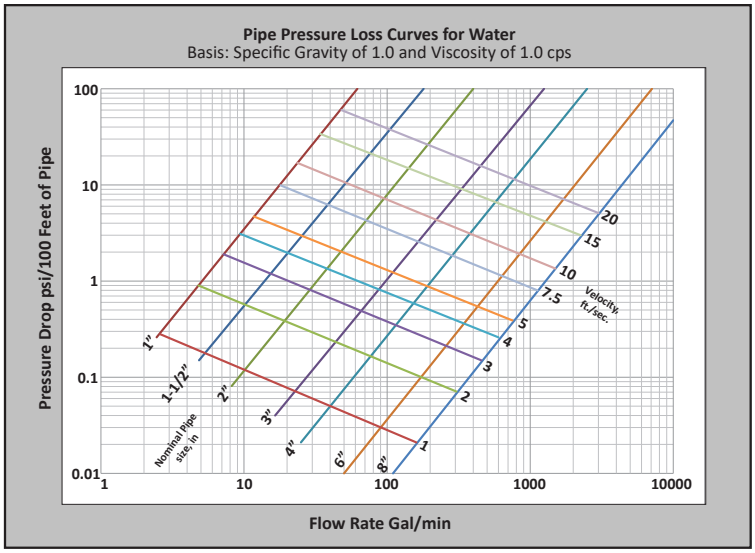
Expansion Loop Leg Sizing

Expansion loops are used to accommodate thermal expansion in piping systems that otherwise do not have enough inherent flexibility in the system design. See below table for minimum leg lengths for various amounts of expected expansion in 1” increments up to 10”. Two guides placed on each side of expansion loops control the direction of thermal growth into the expansion loop and ensure proper alignment.

Nominal Pipe Size in	Minimum “A” Leg Length (ft) for Total Thermal Expansion (in)									
	1”	2”	3”	4”	5”	6”	7”	8”	9”	10”
1	2.9	4	4.9	5.7	6.4	7	7.5	8	8.5	9
1.5	2.9	4.1	5	5.7	6.4	7	7.5	8.1	8.6	9
2	3.6	5.1	6.3	7.2	8.1	8.9	9.6	10.2	10.8	11.4
3	5.7	8	9.8	11.3	12.6	13.8	14.9	16	16.9	17.9
4	7.5	10.6	13	15	16.8	18.3	19.8	21.2	22.5	23.7
6	9.7	13.7	16.7	19.3	21.6	23.7	25.5	27.3	29	30.5
8	12.1	17	20.9	24.1	26.9	29.5	31.8	34	36.1	38

(1) Total Thermal Growth is ΔL1+ΔL2 as shown below
(2) “B” leg length is typically 1/2 “A” leg length





Equivalent Feet of Head Loss Through Fittings

Size in	90° Elbow	45° Elbow	Tee Thru Run	Tee Thru Branch
1	2	0.8	1.5	5
1 1/2	3.7	1.9	2.7	8.5
2	5	2.4	3.3	11
3	7.5	3.9	4.7	16
4	10.5	5	6.5	21
6	15.5	8.3	10.25	33
8	19.5	11	14	43

Pressure Rating for Fittings up to 200 °F(1)

Nominal Pipe Size in	Flanged and Socket Fittings psi
1	300
1 1/2	300
2	300
3	300
4	300
6	250
8	250

(1) Static Pressure Ratings

Raw Materials Standard Test Method

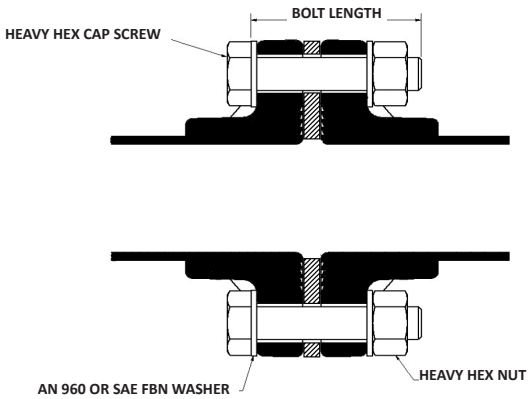
ASTM D543	Test for Resistance of Plastics to Chemical Reagents
ASTM D638	Test for Tensile Properties of Plastics
ASTM D648	Test for Deflection Temperature of Plastics under Load
ASTM D695	Test for Compressive Properties of Rigid Plastics
ASMT D696	Test for Coefficient of Linear Thermal Expansion
ASTM D790	Test for Flexural Properties of Plastics

Finished Product Standard Test Methods

ASTM D1599	Test for Short-Time Rupture Strength of Plastic Pipe, Tubing and Fittings
ASTM D2105	Test for Longitudinal Tensile Properties of Reinforced Thermosetting Plastic Pipe and Tube
ASTM D2412	External Loading Properties of Plastic Pipe by Parallel Plate Loading
ASTM D2925	Test for Beam Deflection of Fiberglass Pipe

Fastener Specifications

The below fastener recommendations are for use with flanged connections. Recommended fastener materials are ASTM A193 B7 studs with ASTM A194 Gr 2H heavy hex nuts. Washer must be dimensional equivalent to AN960 or SAE FBN. All nuts, fasteners and washers shall be of materials suitable for use in the operating environment and for operating conditions.



Pipe Size	Fastener Size	HHCS Length	Stud Length
1”	1/2”-13	2-1/2”	3-3/4”
1-1/2”	1/2”-13	2-1/2”	3-3/4”
2”	5/8”-11	3”	3-3/4”
3”	5/8”-11	3-1/2”	4-1/2”
4”	5/8”-11	3-1/2”	5-1/4”
6”	3/4”-10	3-3/4”	5-1/4”
8”	3/4”-10	4”	5-1/2”

See the Conley Installation & Fabrication Manual for bolt torque requirements and procedure.

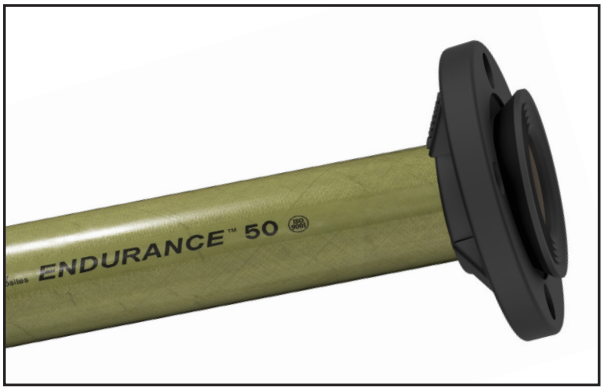
Maximum Recommended Loading

Size	Axial Tensile Loads Max. lbs Temperature		Axial Compressive Loads Max. lbs[1] Temperature		Parallel Plate Loading ASTM D2412[2]		
					Stiffness Factor	Pipe Stiffness	Hoop Modulus
in	75°F	200°F	75°F	200°F	in^3lb/in^2	psi	$x10^6$ psi
1	4,800	2,900	4,300	2,500	130	2,115	2.10
1 1/2	7,000	4,200	6,100	3,700	221	1,475	2.26
2	11,800	7,000	10,400	6,200	221	1,060	2.26
3	26,800	16,100	23,700	14,200	856	1,050	2.76
4	39,600	23,700	35,000	21,000	1,508	1,040	3.26
6	73,000	43,800	64,500	38,700	2,370	497	2.67
8	113,500	68,100	100,300	60,200	3,450	315	2.30

(1) Compressive loads are for short columns only

(2) Values listed for 5% diameter reduction

ENDURANCE™ 60
ACCESSORIES



ENDURANCE™ 50 SPOOL
ROTATABLE FLANGE OPTION

The rotating structural composite Durcor flange eliminates problems with "2-holing" bolt holes making fabrication and installation much easier.

Composite Flanged PTFE
Expansion Joints
Size Range 1" - 42"

Composite
Butterfly Valves
Size Range 2" - 48"

Composite Flanged, Wafer Swing Check Valves
& Ball Check Valves
Size Range 1"- 30"

Composite
Ball Valves
Size Range 1" - 10"

Composite
Floor Drains
Size Range 3" - 12"

Composite
In-line & Y Strainers
Size Range 1-1/2" - 30"

Composite Flanged
360° View Sight Gages
Size Range 1" - 12"

Composite
Diaphragm Valves
Size Range 1-1/2" - 6"

END-517

Conley Composites
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