

Bondstrand® LPA Series

Bondstrand Fiberglass Piping Systems for Oilfield Service

Introduction

NOV Fiber Glass Systems is a leading manufacturer of technically advanced fiberglass piping systems. Fiberglass pipe, commonly referred to as Fiberglass Reinforced Plastic (FRP) or Glass Reinforced Epoxy (GRE), is the material of choice for demanding oilfield applications.

NOV Fiber Glass Systems Bondstrand LPA Series Oilfield line-pipe is available in diameters of 2-inch to 12-inch (50 mm to 300 mm) and in pressure classes of 300 psig to 3000 psig (20 barg to 206 barg). Pipe sections are assembled using the Taper/Taper adhesive joint. As the piping system weighs about a quarter to one-eighth of the equivalent steel pipeline, it requires substantially smaller lifting equipment and a typical installation crew of three to six, depending on diameter.

Uses and Applications

- Crude oil transmission lines
- Gas transmission lines
- Oilfield re-injection lines
- Brine, saltwater and seawater lines
- Potable water transport lines
- Brackish water transport lines
- Wastewater and sewage systems
- Drainage lines
- General industrial service for mildly corrosive liquids

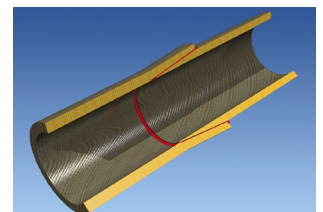
Performance

NOV Fiber Glass Systems pipe laminate meets the requirement of API specification API 15LR and API 15HR. Pipe wall design uses a hydrostatic design basis of 121.2 N/mm² at 93°C, in accordance with ASTM D2992 (Procedure B). Pipe and fittings have a liner thickness of 0.25mm. Pipe with no liner is available upon request. The laminate has a minimum safety factor of 3.0 for short term burst, in accordance with ASTM D1599. The joint is designed to provide a minimum safety factor of 3:1 in accordance with ASTM D1599. The pipe wall thickness established in this catalogue is based on design temperature of 93°C. Consult NOV Fiber Glass Systems for higher application temperatures.

Maximum operating Temperature: 93 °C

Joining System

Taper/Taper integral filament-wound male and female adhesive-bonded joint, 2 - 12 inch.



Taper/Taper adhesive-bonded joint

Product Description

Pipe diameter: 2" – 12" (50 – 300 mm)

Pipe system design for pressure rating up to 206 bar(3000 psi)

Pipe

Filament-wound fiberglass reinforced epoxy with taper male and taper female adhesive-bonded joint.

Fittings

Standard filament-wound fittings are couplings, 22.5°, 45° and 90° elbows, tees and reducing tees, concentric reducers, flanges and nipples. Special fittings are available upon request. Flanges are available in ANSI B 16.5, DIN, ISO and JIS. Other drilling patterns are available upon request. Tees for high pressure rating are in coated steel material. O-ring type van stone stub end with coated steel ring is used for high pressure systems.

Reinforcement

Roving with a yield of 450 yd/lb or TEX of 1100 g/km is used as the reinforcing glass fiber. These roving are continuous filaments. They consist of multiple filaments of E-glass sized with an epoxy compatible, proprietary, silane-based sizing designed for reinforcement of epoxy resins cured with amines.

A combination of unique processing and the proprietary sizing system provides rapid and complete wet-out required at high filament winding speed. These roving meet the requirements of MIL-R-60346C for Type I, Class1, for filaments other than "G" type. NOV Fiber Glass Systems conducted extensive R&D to match the resin system with glass roving with proprietary sizing.

Resin System

NOV Fiber Glass Systems uses DGEBA epoxy resin. This is a medium viscosity liquid epoxy resin. It contains no diluent and provides good fiber wetting and a high level of mechanical and chemical resistance properties in the cured state.

Curing Agent System

MDA-based aromatic amine is used as the curing agent.

Aromatic amine is best suited for use as an epoxy curing agent in forced cure applications. This aromatic multifunctional curing agent can be used to produce high strength, chemically resistant, elevated temperature tolerant epoxy parts.

Epoxy systems cured with MDA-based aromatic amine offer superior resistance to water, acid, alkalis, and hydrocarbon solvents.

Quality standards

NOV Fiber Glass Systems is a leader in high-pressure fiberglass piping technology. All pipes are manufactured using state-of-the-art, computer-controlled filament winding machines to meet API (American Petroleum Institute) 15LR and 15HR Specifications. In order to meet industries ever more exacting needs for quality products and services, NOV Fiber Glass Systems's quality system is certified to API Specification Q1 and ISO 9001.

Durable and corrosion resistant - Bondstrand piping is inert to internal corrosion from crude oil components, residues, injection water or bacteria. Similarly, it resists exterior corrosion even in aggressive environments. It is designed for a service life is based from ASTM D2992 static design with free ends.

Advantages

Resin-Rich Liner

Bondstrand LPA Series fiberglass pipes are manufactured with a 0.25mm internal resin-rich liner to improve chemical, erosion and temperature resistance.

Reduced Maintenance Costs

The absence of electrolytic corrosion combined with the resistance to chemical and bacteriological corrosion, eliminate the need for cathodic protection or chemical additives. No external coating is required for either buried or above-ground pipe lines. Bondstrand® piping is both weather and UV-resistant.

Cost-Effective Alternative

Automated manufacturing process, reduced installation time, minimal maintenance cost and long service life are just some of the advantages of the Bondstrand fiberglass piping technology. It is the cost effective alternative to coated steel.

Designed to Carry Crude Oil

The smooth internal surface of Bondstrand piping significantly reduces head loss. Properly installed and pressure tested, Bondstrand® piping is leak-free and, as such, constitutes a long-term environmentally acceptable solution.

NOV Fiber Glass Systems Experience

Many long-distance Bondstrand crude oil and water injection pipelines have been installed in all types of conditions to meet customers' requirements. Project reference list is able to provide upon request.

Typical pipe length

From 50 –200 mm (2" to 8"): 9.0 m random length

Size mm	Size Inch	Random Length (m)
50	2	9.0
80	3	9.0
100	4	9.0
135	6*	9.0
150	6	9.0
200	8	11.89
250	10	11.89
300	12	11.89

Note: * 6-inch pipe with 135.0 mm inside diameter

Typical Pipe Dimensions

Typical Pipe Dimensions for Buried Pipelines - 20 year design life

Size		I.D.		Minimum Total Wall Thickness (including 0.25 mm liner)				
Inch	mm	mm	LPA300	LPA500	LPA600	LPA800	LPA1000	
2	50	53.2	1.8	1.8	1.9	2.4	3.0	
3	80	81.8	2.0	2.3	2.7	3.6	4.4	
4	100	105.2	2.0	2.9	3.4	4.5	5.6	
6*	135	135.0	2.3	3.6	4.3	5.7	7.1	
6	150	159.0	2.6	4.2	5.0	6.7	8.3	
8	200	208.8	3.3	5.4	6.5	8.6	10.8	
10	250	262.9	4.2	6.8	8.1	10.8	13.6	
12	300	313.7	4.9	8.1	9.6	12.9	16.1	

Size		I.D.		Minimum Total Wall Thickness (including 0.25 mm liner)				
Inch	mm	mm	LPA1250	LPA1500	LPA2000	LPA2500	LPA3000	
2	50	53.2	3.7	4.5	6.0	7.6	9.5	
3	80	81.8	5.5	6.7	9.0	11.5	-	
4	100	105.2	7.0	8.5	11.5	14.7	-	
6*	135	135.0	8.9	10.8	14.6	18.7	-	
6	150	159.0	10.5	12.6	17.2	22.0	-	
8	200	208.8	13.6	16.5	-	-	-	
10	250	262.9	17.1	20.7	-	-	-	
12	300	313.7	20.4	-	-	-	-	

Pipe series designation:

- First three alpha-characters indicate product series
- Last three or four digits indicate rated pressure in psig.

External Pressure Performance

Size		Ultimate Collapse (bar) at 21°C				
Inch	mm	LPA300	LPA500	LPA600	LPA800	LPA1000
2	50	13.3	13.3	14.4	35.1	70.6
3	80	5.3	8.1	14.3	34.8	70.0
4	100	2.5	8.1	14.2	34.6	69.9
6*	135	1.7	8.1	14.1	34.5	69.6
6	150	1.7	4.9	14.1	34.5	69.3
8	200	1.6	3.5	14.0	34.4	69.3
10	250	1.7	4.0	14.3	34.8	69.9
12	300	1.7	4.8	14.3	34.7	69.7

Size		Ultimate Collapse (bar) at 21°C				
Inch	mm	LPA1250	LPA1500	LPA2000	LPA2500	LPA3000
2	50	143.6	258.4	661.3	1396.5	2822.9
3	80	142.9	255.2	654.8	1383.7	-
4	100	142.1	254.1	652.2	1377.6	-
6*	135	141.2	253.6	649.2	1373.0	-
6	150	141.0	252.6	647.9	1372.1	-
8	200	140.6	252.4	-	-	-
10	250	141.8	253.6	-	-	-
12	300	141.3	-	-	-	-

Note: * 6-inch pipe with 135.0 mm inside diameter

Pipe Weight

Size		Minimum Weight of Empty Pipe (kg/m)				
Inch	mm	LPA300	LPA500	LPA600	LPA800	LPA1000
2	50	0.6	0.6	0.6	0.8	1.0
3	80	1.0	1.1	1.4	1.8	2.3
4	100	1.3	1.9	2.2	3.0	3.8
6*	135	1.9	3.0	3.6	4.9	6.2
6	150	2.2	4.3	5.0	6.8	8.6
8	200	3.3	7.1	8.6	11.6	14.7
10	250	5.4	11.3	13.6	18.3	23.3
12	300	8.1	16.0	19.3	26.0	33.0

Size		Minimum Weight of Empty Pipe (kg/m)				
Inch	mm	LPA1250	LPA1500	LPA2000	LPA2500	LPA3000
2	50	1.3	1.5	2.1	2.8	3.7
3	80	2.9	3.6	5.0	6.6	-
4	100	4.8	5.9	8.3	10.9	-
6*	135	7.9	9.7	13.5	17.8	-
6	150	10.9	13.4	18.7	24.7	-
8	200	18.7	23.0	-	-	-
10	250	29.7	36.4	-	-	-
12	300	42.2	-	-	-	-

Initial Stiffness

Size		Specific Tangential Initial Stiffness (STIS) in N/m ² at 21°C				
Inch	mm	LPA300	LPA500	LPA600	LPA800	LPA1000
2	50	47650	47650	51322	121435	236633
3	80	19297	29392	51031	120326	234765
4	100	9200	29463	50653	119645	234224
6*	135	6342	29296	50410	119481	233539
6	150	6326	29252	50320	119481	232507
8	200	6267	29123	50123	118987	232386
10	250	6510	29629	50993	120269	234479
12	300	6461	29541	50915	120086	233638

Size		Specific Tangential Initial Stiffness (STIS) in N/m ² at 21°C				
Inch	mm	LPA1250	LPA1500	LPA2000	LPA2500	LPA3000
2	50	462794	801073	1894224	3689111	6786477
3	80	460671	791909	1877306	3659324	-
4	100	458398	788624	1870744	3645213	-
6*	135	455529	787130	1862770	3634480	-
6	150	454996	784492	1859451	3632416	-
8	200	453825	783821	-	-	-
10	250	457356	787312	-	-	-
12	300	455942	-	-	-	-

Stiffness Factor

Size		Stiffness Factor (SF) per ASTM D-2412 in lbs.in at 21°C				
Inch	mm	LPA300	LPA500	LPA600	LPA800	LPA1000
2	50	69	69	75	182	366
3	80	100	153	270	656	1319
4	100	100	327	570	1387	2798
6*	135	144	686	1198	2927	5896
6	150	235	1120	1954	4781	9588
8	200	527	2524	4408	10782	21700
10	250	1094	5128	8956	21762	43726
12	300	1845	8685	15192	36914	74007

Note: * 6-inch pipe with 135.0 mm inside diameter

Stiffness Factor C'tnd

Size		Stiffness Factor (SF) per ASTM D-2412 in lbs.in at 21°C				
Inch	mm	LPA1250	LPA1500	LPA2000	LPA2500	LPA3000
2	50	743	1338	3424	7230	14615
3	80	2689	4804	12323	26042	-
4	100	5691	10173	26112	55151	-
6*	135	11946	21454	54921	116159	-
6	150	19492	34924	89551	189654	-
8	200	44022	79019	-	-	-
10	250	88601	158485	-	-	-
12	300	150029	-	-	-	-

Pipe Stiffness

Size		Pipe Stiffness (PS) per ASTM D-2412 psi at 21°C				
Inch	mm	LPA300	LPA500	LPA600	LPA800	LPA1000
2	50	371	371	400	946	1843
3	80	150	229	397	937	1828
4	100	72	229	394	932	1824
6*	135	49	228	393	930	1819
6	150	49	228	392	930	1810
8	200	49	227	390	927	1810
10	250	51	231	397	937	1826
12	300	50	230	396	935	1819

Size		Pipe Stiffness (PS) per ASTM D-2412 psi at 21°C				
Inch	mm	LPA1250	LPA1500	LPA2000	LPA2500	LPA3000
2	50	3604	6238	14750	28726	52845
3	80	3587	6166	14618	28494	-
4	100	3569	6141	14567	28384	-
6*	135	3547	6129	14505	28301	-
6	150	3543	6109	14479	28285	-
8	200	3534	6103	-	-	-
10	250	3561	6131	-	-	-
12	300	3550	-	-	-	-

Pipe Bending Radius

Size		I.D.	Maximum Allowable Bending Radius (M)				
Inch	mm	mm	LPA300	LPA500	LPA600	LPA800	LPA1000
2	50	53	25	26	39	46	52
3	80	81	29	67	73	84	92
4	100	105	55	95	104	118	128
6*	135	135	107	134	146	162	175
6	150	159	135	167	180	199	215
8	200	208	200	240	256	278	296
10	250	262	256	309	327	356	377
12	300	313	325	385	405	437	464

Size		I.D.	Maximum Allowable Bending Radius (M)				
Inch	mm	mm	LPA1250	LPA1500	LPA2000	LPA2500	LPA3000
2	50	53	57	62	72	80	94
3	80	81	100	109	122	134	-
4	100	105	138	148	164	180	-
6*	135	135	188	199	220	238	-
6	150	159	228	242	264	285	-
8	200	208	313	328	-	-	-
10	250	262	397	418	-	-	-
12	300	313	486	-	-	-	-

Do not bend pipe until adhesive has cured. At rated pressure sharper bends may create excessive stress concentrations.

Note: * 6-inch pipe with 135.0 mm inside diameter

System Short-Term Burst	Size		I.D. mm	Minimum System Short-Term Burst or Weep Pressure (Psi)				
	Inch	mm		LPA300	LPA500	LPA600	LPA800	LPA1000
	2	50	53.2	900	1500	1800	2400	3000
	3	80	81.8	900	1500	1800	2400	3000
	4	100	105.2	900	1500	1800	2400	3000
	6*	135	135.0	900	1500	1800	2400	3000
	6	150	159.0	900	1500	1800	2400	3000
	8	200	208.8	900	1500	1800	2400	3000
	10	250	262.9	900	1500	1800	2400	3000
	12	300	313.7	900	1500	1800	2400	3000

Size	I.D.		Minimum System Short-Term Burst or Weep Pressure (Psi)				
	in	mm	LPA1250	LPA1500	LPA2000	LPA2500	LPA3000
2	50	53.2	3750	4500	6000	7500	9000
3	80	81.8	3750	4500	6000	7500	-
4	100	105.2	3750	4500	6000	7500	-
6*	135	135.0	3750	4500	6000	7500	-
6	150	159.0	3750	4500	6000	7500	-
8	200	208.8	3750	4500	-	-	-
10	250	262.9	3750	4500	-	-	-
12	300	313.7	3750	-	-	-	-

Above 3:1 STB hydrostatic test conducted as per ASTM D-1599

Field Testing

Pipe system is designed for field-testing with water at up to 150% of rated pressure.

Surge Pressure

Maximum allowable surge is 125% of rated pressure.

Typical Physical Properties

Pipe Property	Unit	Value	Method
Thermal conductivity			
Pipe Wall	Btu.in/(hr.ft ² .°F)	2.3	NOV FGS
	W/m.°C	0.33	
Thermal expansion			
Linear	10 ⁻⁶ in/in/°F	10	NOV FGS
	10 ⁻⁶ mm/mm/°C	18	
Flow coefficient	Hazen-Williams	150	-
Absolute roughness	10 ⁻⁶ ft	17.4	-
	10 ⁻⁶ m	5.3	
Specific gravity	-	1.8	-
Density	lb/in ³	0.065	-
	Kg/m ³	1800	

Note: * 6-inch pipe with 135.0 mm inside diameter

Typical Mechanical Properties	Pipe Property	Unit	70°F (21°C)	200°F (93°C)	Method
	Circumferential				
	Tensile stress at weeping	10 ³ psi	34.8		ASTM D1599
		MPa	240		
	Tensile modulus	10 ⁶ psi	3.65	3.20	NOV FGS
		GPa	25.2	22.1	
	Poisson's ratio axial/hoop		0.65	0.81	NOV FGS
	Longitudinal				
	Tensile strength	10 ³ psi	11.60	9.40	ASTM D2105
		MPa	80.0	65.0	
	Tensile modulus	10 ⁶ psi	1.81	1.40	ASTM D2105
		GPa	15.2	9.70	
	Poisson's ratio hoop/axial		0.40	0.44	ASTM D2105
	Beam apparent				
	Elastic modulus	10 ⁶ psi	1.81	1.16	ASTM D2925
		GPa	12.5	8.0	
	Hydrostatic design basis	10 ³ psi	19.15	-	ASTM D2992
	Static (200°F, 93°C)	MPa	126.1	-	

National Oilwell Varco has produced this brochure for general information only, and it is not intended for design purposes. Although every effort has been made to maintain the accuracy and reliability of its contents, National Oilwell Varco in no way assumes responsibility for liability for any loss, damage or injury resulting from the use of information and data herein nor is any warranty expressed or implied. Always cross-reference the bulletin date with the most current version listed at the website noted in this literature.

North America
2425 SW 36th Street
San Antonio, TX 78237 USA
Phone: +1 210 434 5043

South America
Estrada de Acesso à Zona
Industrial Portuária de Suape, s/no.
Recife, PE, Brazil 55.590-000
Phone: +55 81 3501 0023

Europe
PO. Box 6, 4190 CA
Geldermalsen, The Netherlands
Phone: +31 345 587 587

Asia Pacific
No. 7A, Tuas Avenue 3
Jurong, Singapore 639407
Phone: +65 6861 6118

Middle East
PO. Box 17324
Dubai, UAE
Phone: +971 4881 3566

www.fgspipe.com • fgspipe@nov.com

 **Fiber Glass Systems**

© 2012 National Oilwell Varco. All rights reserved.
OG1010 supersedes FP1035 November 2012