

# Bondstrand™ 2400LD-ECP Series

Product Data - Glass Fiber Reinforced Epoxy (GRE) pipe systems for Marine and Offshore services



## Applications

- Sea Water Cooling
- Caisson
- Water Ballast
- Drain

## Approvals

ISO 14692 is an international standard intended for offshore applications on both fixed and floating topsides facilities. It is used as guidance for the specification, manufacture, testing and installation of GRE (Glassfiber Reinforced Epoxy) piping systems. The United Kingdom Offshore Operators Association (UKOOA) Document Suite, issued in 1994, formed the basis of the ISO 14692 standard.

Bondstrand pipe series that are used in the marine and offshore industry are designed in accordance with the above standard including meeting IMO requirements and are type- approved by major certifying bodies listed below.

- American Bureau of shipping (U.S.) (1)
- Lloyd's Register of Shipping (U.K.)
- Bureau Veritas (France)
- DnV - GL

## Materials and Characteristics

Filament wound Glass fiber Reinforced epoxy (GRE) plain ended pipe with butt & wrap joint.

- Laminate meets requirements of API Specification 15LR and ISO 14692,
- Pipe wall design based on hydrostatic design basis (Procedure B) with a 0.5 service factor,
- Pipe sizes: 1100, 1200, 1300, 1400 & 1500 mm (44", 48", 52", 56" & 60"),
- Standard pressure rating up to 16 bar (232 psi) and temperature up to 93°C.
- ASTM D-2310 classification: RTRP-11AW for conductive pipe and RTRP-11FW for non-conductive pipe.
- Pipe and fittings are designed to have an external collapse pressure maximum up to 4 bar with safety factor of 3.

## Joining System

**Pipes** - The pipes have good chemical resistance properties & the inner liner plays the most important role here. Special chemical resistance C glass & the resin matrix form the inner liner. Liner thickness of 0.5 mm is used for the standard non-conductive product; thicker liners are available on request. Our conductive pipe systems have been developed to prevent accumulation of potentially dangerous levels of static electrical charges. Pipe,

fittings and flanges contain high strength conductive filaments. Together with a conductive adhesive this provides a continuous electrically conductive system

**Fittings** - The mitered fittings (elbows, tees and reducers) are available for 44", 48", 52", 56" & 60" (1100, 1200, 1300, 1400 & 1500 mm) sizes. The lamination of the mitered fittings is carried out by laying Chop Strand Mat and Woven Roving in a pre-defined sequence impregnating with resin. The end configuration of the fittings may be plain or flanged end, as per customer's requirement. Common available fitting configurations are listed below.

- 90° and 45° elbows, Reducers, Tees and reducing tees, Grounding Saddles

**Flanges** - Flanges are made on a standard pipe by hand lay-up process with flat gaskets or O-ring seal as required by customer. The flange laminate is built up using Chop Strand Mat and Woven Roving combination. Bondstrand marine flanges are flat face produced with ANSI B16.1CL125 drilling for easy connection to piping systems, other drilling patterns are available upon request.

**Butt-Wrap Lamination** - The joints are made by connecting two ends of pipe or fitting and then laminating Chop Strand Mat and Woven Roving in pre-defined sequence with resin. The width and thickness of the Butt & Wrap joints are calculated based on pressure class to suit the customer's requirement.

View of Joint Illustrations



Butt & Wrap

## Performance

Bondstrand series 2400LD-ECP pipes are filament wound with epoxy resin for superior strength and manufactured with precision to Fiber Glass Systems high quality standards. Epoxy resins form a durable bond to fibers that are designed to withstand its rated pressure in both pipes and fittings. These piping systems are capable of withstanding aggressive environments including chemical and seawater applications.

Bondstrand series 2400LD-ECP pipes have two pipe offerings, conductive and non-conductive series. Non-Conductive series will have standard liner besides structural wall thickness, while the conductive series will be an unlined product. Conductive LD pipe, fittings and flanges incorporate high strength conductive filaments to prevent accumulation of potentially dangerous levels of electric static charges by the flow of liquids. LD piping systems uses butt & wrap joints which are made electrically conductive by using special conductive liners and coatings. Accumulated charges are harmlessly drained from the fiberglass pipe system into the metallic structure of the ship by means of stainless steel cables embedded in fiberglass grounding saddles. The saddles are adhesive bonded to the external wall of the pipe.

Pipe and fittings are available for continuous operating pressures of up to 232 psi (16 bar) and 200°F (93°C). The standard size range offerings are 44", 48", 52", 56" & 60" (1100, 1200, 1300, 1400 & 1500 mm). The pipes and fittings are offered for various External Collapse Pressure (ECP) rating from 1 bar to 4 bar with factor of safety 3 enabling it to withstand full vacuum conditions.

## Structural Wall Thickness\*

Pipe Size		External Collapse Pressure (ECP)							
		1 bar (ECP01)		2 bar (ECP02)		3 bar (ECP03)		4 bar (ECP04)	
in	mm	in	mm	in	mm	in	mm	in	mm
44 <sup>(a)</sup>	1100	0.78	19.9	0.99	25.1	1.14	28.9	1.26	31.9
48	1200	0.85	21.7	1.08	27.4	1.24	31.5	1.37	34.8
52	1300	0.93	23.5	1.15	29.3	1.34	34.1	1.48	37.7
56 <sup>(a)</sup>	1400	1.00	25.3	1.26	32.0	1.44	36.7	1.60	40.6
60	1500	1.07	27.1	1.35	34.3	1.55	39.4	1.71	43.4

\* Standard liner thickness of 0.5mm is not included in structural wall thickness.

<sup>(a)</sup> Currently, mandrels are not available for these sizes. Consult NOV Fiber Glass Systems for information on sizes not mentioned in the above table.

## Pipe Weight

Pressure range: up to 16 bar; Temperature: up to 93°C

Pipe Size		External Collapse Pressure (ECP)							
		1 bar (ECP01)		2 bar (ECP02)		3 bar (ECP03)		4 bar (ECP04)	
in	mm	kg/m	lb/ft	kg/m	lb/ft	kg/m	lb/ft	kg/m	lb/ft
44 <sup>(a)</sup>	1100	92.4	137.5	116.9	173.9	134.3	199.9	148.4	220.9
48	1200	109.7	163.2	138.8	206.6	159.7	237.6	176.4	262.5
52	1300	128.5	191.2	162.7	242.1	187.1	278.4	206.8	307.7
56 <sup>(a)</sup>	1400	148.8	221.4	188.5	280.5	216.8	322.6	239.6	356.5
60	1500	170.6	253.9	216.1	321.6	248.6	369.9	274.7	408.8

<sup>(a)</sup> Currently, mandrels are not available for these sizes. Consult NOV Fiber Glass Systems for information on sizes not mentioned in the above table.

## Pipe Length

Bondstrand marine pipes are produced in standard lengths as per below table. Pipes can be cut to specified lengths at the factory. Consult your Fiber Glass Systems representative

Nominal Pipe Size		Length	
in	mm	ft	m
44	1100	37	11.4
48	1200	37	11.4
52	1300	37	11.4
56	1400	37	11.4
60	1500	37	11.4

## Bondstrand Guide Specification

### Pipe construction

The structural wall of fiberglass pipe 44, 48, 52, 56 & 60-inch sizes shall have continuous glass fibers wound at a 54¾ helical angle in a matrix of cured epoxy resin.

Pipe 44, 48, 52, 56 & 60-inch sizes shall be rated up to 232 psig & 200°F and shall have a minimum full vacuum capability with a safety factor of 3:1.

### Fittings construction

Fittings 44 to 60-inch sizes shall be mitered using Bondstrand series 2400LD-ECP pipe with internal & external hand lay-up lamination.

### Testing

Samples of pipe shall be tested at random, based on standard quality control practices to determine conformance of the materials to American Society for Testing and Materials guidelines for testing fiberglass pipe products: ASTM D1599, ASTM D2105.

All fittings with suitable end configuration (example Flanged ends) shall be 100% hydro-tested prior to shipping.

### Technical Support

Consult Fiber Glass Systems for further recommendations concerning the shipboard or offshore use of Bondstrand pipe system. For particular questions regarding the installation and use of Bondstrand series 2400LD-ECP anti-static pipe and fittings, refer to the Fiber Glass Systems Marine Engineering Manual.

### Conversions

1 psi = 6895 Pa = 0.07031 kg/cm <sup>2</sup>	1 lb•in = 0.113 N•m
1 bar = 10 <sup>5</sup> Pa = 14.5 psi = 1.02 kg/cm <sup>2</sup>	1 in <sup>4</sup> = 4.162 x 10 <sup>-7</sup> m <sup>4</sup>
1 MPa = 1 N/mm <sup>2</sup> = 145 psi = 10.2 kg/cm <sup>2</sup>	1 ft/sec = 0.304 m/sec
1 GPa = 10 <sup>9</sup> Pa = 145,000 psi = 10,200 kg/cm <sup>2</sup>	1 gpm = 6.31 x 10 <sup>-7</sup> m <sup>3</sup> /sec
1 in = 25.4 mm	°C = 5/9 (°F - 32)
1 ft = 0.3048 m	

## Engineering Design & Installation

### Services

Consult the following literature for recommendations about design, installation and use of Bondstrand pipe, fittings and flanges:

- Marketing Bulletin Engineering and Design Support Services
- Bondstrand Corrosion Guide
- Fiberglass Pipe and Tubing
- Bondstrand Marine Design Manual

Please consult Fiber Glass Systems for the current version of the above literature.

### Field Testing

Bondstrand pipe systems are designed for hydrostatic testing with water at 150% of rated pressure.

## Typical Mechanical Properties

Pipe Property	70°F	21°C	200°F	93°C	Method
	psi	N/mm <sup>2</sup>	psi	N/mm <sup>2</sup>	
<b>Hydrostatic Design Basis</b>	23,351	161 <sup>(1)</sup>	17,549	121	ASTM D2992, Proc. B (20 ans)
<b>Ultimate Hoop Stress at Weeping</b>	40,610	280	48,442	334	ASTM D1599
<b>Circumferential</b>					
Hoop Tensile Modulus	3.87 x 10 <sup>6</sup>	26,700	2.36 x 10 <sup>6</sup>	16,300	ASTM D2290
Poisson's Ratio $v_{ha}$ <sup>(2)</sup>	0.61		0.80		NOV FGS
<b>Longitudinal</b>					
Axial Tensile Strength	11,603	80	9,427	65	ASTM D2105
Axial Strength Modulus	2.24 x 10 <sup>6</sup>	15,500	1.24 x 10 <sup>6</sup>	8,550	ASTM D2105
Poisson's Ratio, $v_{ah}$ <sup>(3)</sup>	0.35		0.42		ASTM D2105
Axial Bending Strength	12,328	85	-	-	NOV FGS
Axial Bending Modulus	2.24 x 10 <sup>6</sup>	15,500	1.43 x 10 <sup>6</sup>	9,900	ASTM D2925
Shear Modulus	1.75 x 10 <sup>6</sup>	12,100	1.66 x 10 <sup>6</sup>	11,500	NOV FGS

## Typical Physical Properties

Pipe Property	Value	Value	Method
<b>Thermal Conductivity Pipe Wall</b>	0.19 BTU/hr·ft·°F	0.33 W/m°C	NOV FGS
<b>Thermal Expansion</b>	12.0 x 10 <sup>-6</sup> in/in °F	21.6 x 10 <sup>-6</sup> mm/mm °C	ASTM D696
<b>Flow Efficient, Hazen Williams</b>	150		-
<b>Absolute Roughness</b>	17.0 x 10 <sup>-6</sup> ft	5.3 x 10 <sup>-6</sup> m	-
<b>Density</b>	112.4 lb/ft <sup>3</sup>	1800 kg/m <sup>3</sup>	-
<b>Specific Gravity</b>	1.8		ASTM D792
<b>Specific Heat</b>	0.22 BTU/lb °F	910 J/kg °C	-
<b>Grounding Resistance @ 500 Volt-Pipe</b>	<0.3 x 10 <sup>-6</sup> Ohm.ft	<1 x 10 <sup>-6</sup> Ohm/m	ASTM D257
<b>Grounding Resistance @ 500 Volt-Ftg.</b>	<1 x 10 <sup>-6</sup> Ohm/pc	<1 x 10 <sup>-6</sup> Ohm/pc	ASTM D257
<b>Shielding Capability</b>	100 Volt		-

<sup>(1)</sup> value obtained at 65°C

<sup>(2)</sup>  $v_{ha}$  = The ratio of axial strain to hoop strain resulting from stress in the hoop direction.

<sup>(3)</sup>  $v_{ah}$  = The ratio of hoop strain to axial strain resulting from stress in the axial direction.

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