Waves of Innovation:
Bondstrand is the Marine Industry

Fiber Glass Systems | NOV

PIPESPAIN
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Fiber Glass Systems | NOV

Agenda

Overview of NOV Fiber Glass Systems

Why use composites in the Maritime Industry?

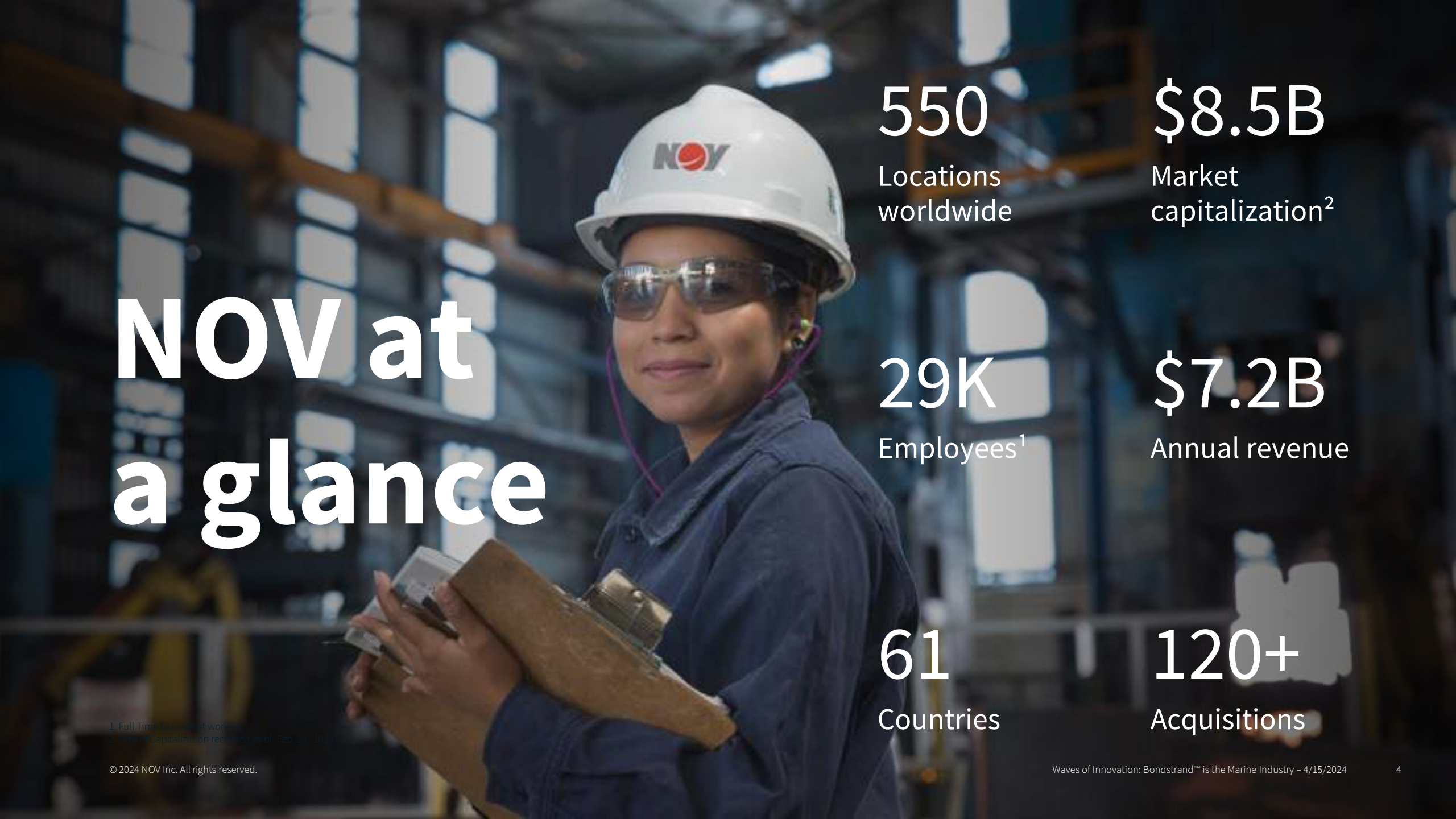
Benefits / Features

Marine Applications

- GRE Piping
- FRP Structures
- FRP Tanks

Approvals and Certifications

Regulations and Standards



NOV at a glance

550
Locations worldwide

$8.5B
Market capitalization[2]

29K
Employees[1]

$7.2B
Annual revenue

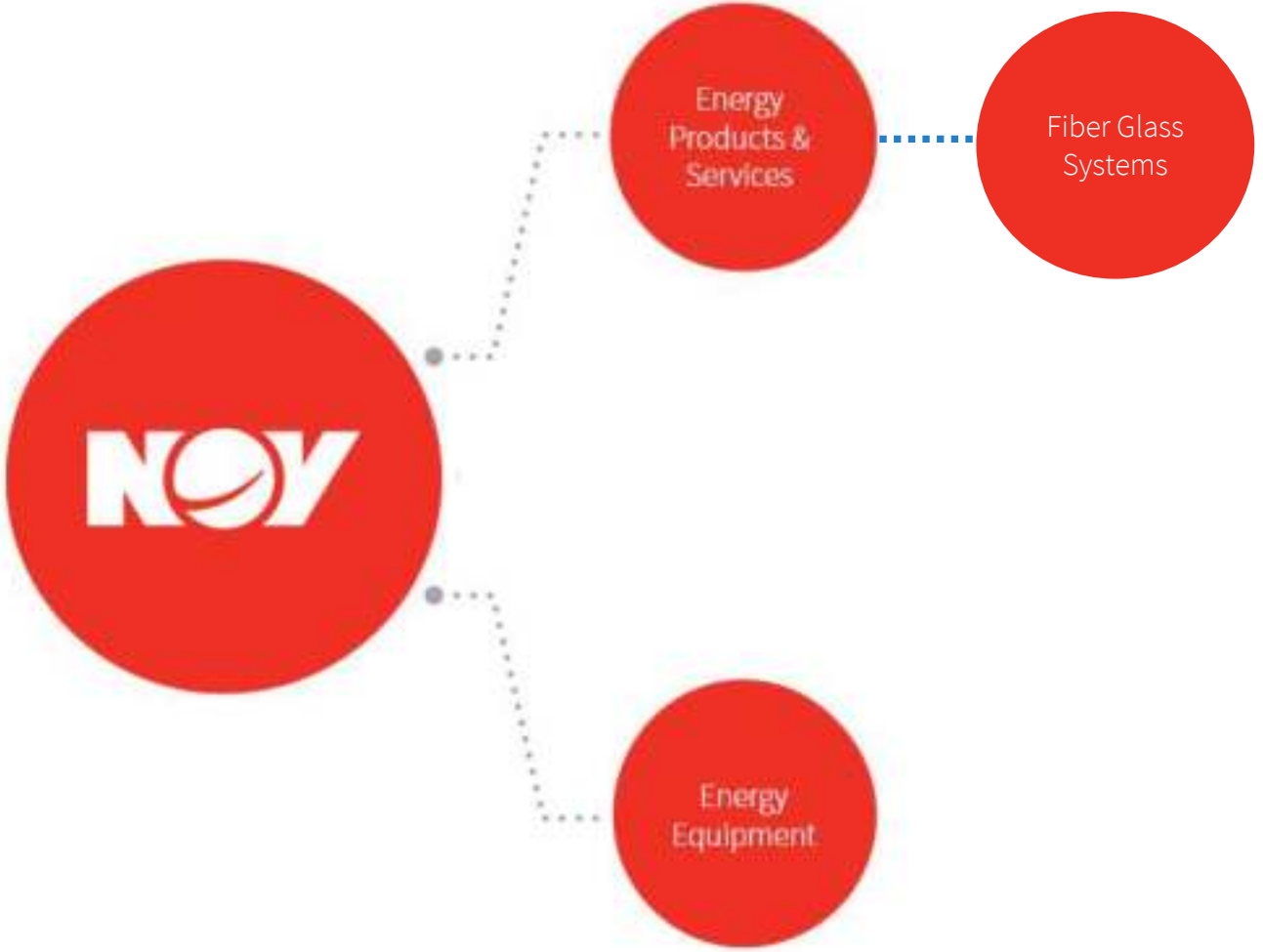
61
Countries

120+
Acquisitions

1. Full Time Equivalent workers
2. Market capitalization recorded as of Feb. 21, 2024

NOV Energy Products & Services

Fiber Glass Systems

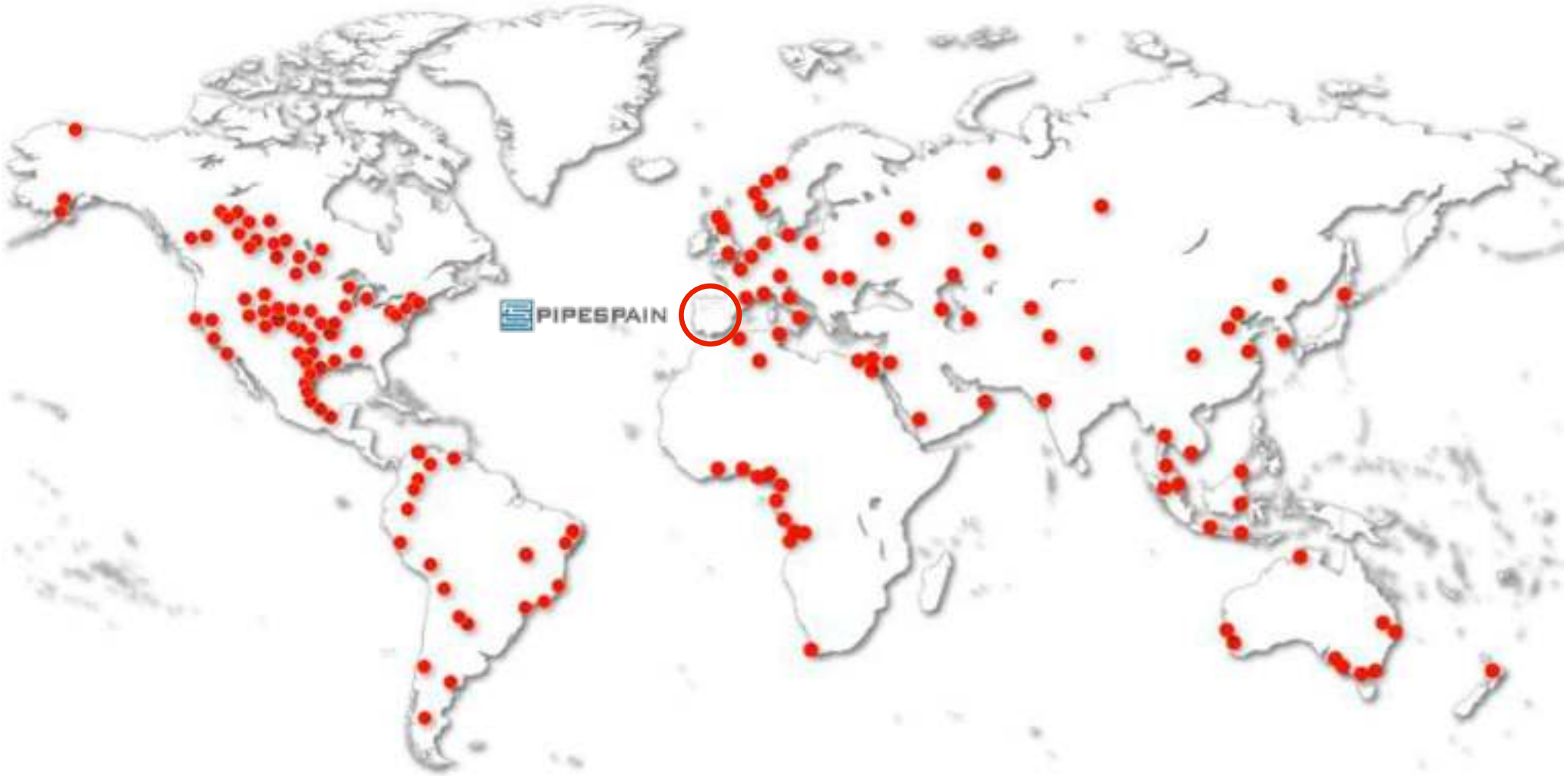


FGS Manufacturing Facilities

Plant Locations

Overview

Global Presence



PIPESPAIN

Fiber Glass Systems Global Service Network

FABRICATION

SUPPLY

DETAIL ENGINEERING

TECHNICAL SURVEY & INSPECTION

TESTING

INSTALLATION & FIELD SERVICE

PIPESPAIN

Bondstrand at the forefront in Marine, Offshore & Subsea

Our solutions

- GRE Piping Systems
- FRP Structural Products
- GRP Tanks

Our services

- Advanced Design Advanced Manufacture
- Engineering Consultancy, Globally
- Specialist Field Service Technical Support
- Global Service Network

Advantages

- Increased Safety
- Reduce weight
- Eliminate corrosion
- Lower CO_2e
- Decrease total cost of ownership
- 40+ years in-service experience

Why use composites in maritime?

Increased safety
- No corrosion failures from hidden degradation
- Improved efficiency

Reduced weight - 1/3 (structures) 1/6 (piping) that of steel
- 66% weight saving
- Lower weight = CaPex & OpEx savings
- Less mechanical handling, faster install

Lower lifetime costs
- Reduced maintenance
- Significant OpEx, TotEx savings
- Predictability

Lower retrofit costs
- Replacing original corroded products often cheaper than steel
- No hot works
- Reduce PoB

Main benefits of composite materials

Lower total cost of ownership

Highly corrosion resistant

Lightweight
1/3 to 1/6 weight of steel

Offsite build
For fast-track site installation

Low conductivity & electromagnetic transparency

Marine Growth

Good fire performance & UV resistance

Durable/long service life

Qualified & Approved
Extensively used in industry for decades

Unlimited applications
From wastewater to warships

Erosion and corrosion

Reduce CO_2e

GRE Piping Applications

Current piping applications

- Sea Water Systems
- Firewater Systems
- Cooling Water
- Produced Water
- Sanitary Systems
- Drain Lines
- Column Piping
- Potable Water
- Ballast Piping
- Sounding Tubes
- Vent Lines
- Scrubbers
- Sodium Hypochlorite
- Caissons
- Grey Water
- Accommodation Piping

Bondstrand Product Series

Series 2000M

- Diameter: 2-40 inch
- Pressure Class: 16 bar
- Quick-Lock adhesive bonded joint – 2” to 6”
- Taper-Taper adhesive bonded joint > 6”
- Standard with 0,5mm liner
- Maximum design temperature 93 ^{0}C
- Wall thickness in according to IMO external pressure requirement

Series 7000M

- Pressure Class: 16 bar
- Quick-Lock adhesive-bonded joint – 2” to 6”
- Taper-Taper adhesive joint > 6”
- Standard unlined. Conductive liner available
- Maximum design temperature 93 ^{0}C
- Conductive filaments in pipe wall
- Conductive adhesive
- Wall thickness in according to IMO external pressure requirement

Series 2400M

- Diameter: 2-40 inch
- Pressure Class: up to 75 bar
- Taper-Taper adhesive joint
- Available as lined or unlined pipe
- Available as conductive or nonconductive pipe
- Maximum design temperature 93°C

2400 LD

- Size: 44”, 48”, 52”, 56” & 60”
- 1100, 1200, 1300, 1400, 1500 mm
- Available up to internal pressure 225 psi (16 bar)
- Available with external collapse pressure up to 58 psi (4 bar)
- Laminated joints

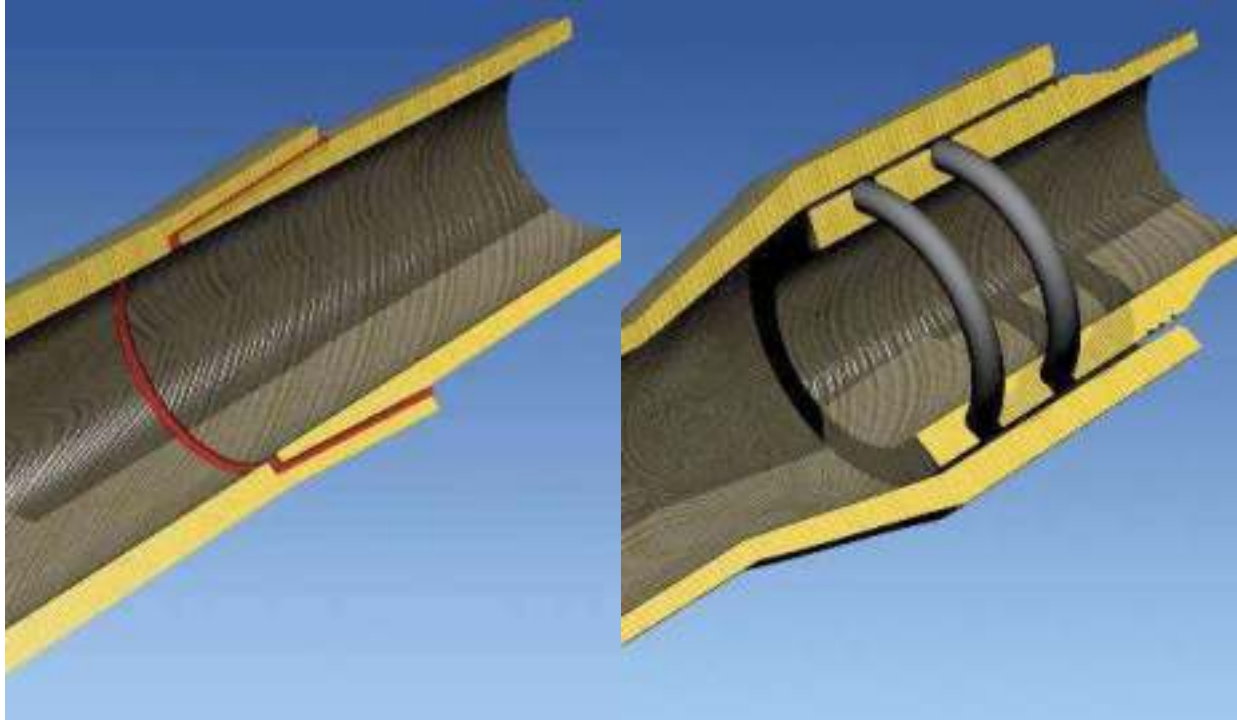
FP

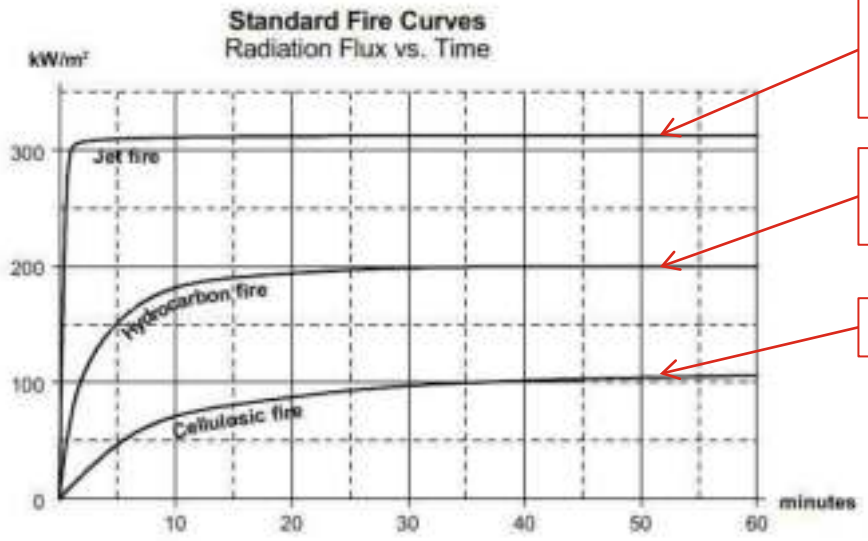
- All Bondstrand Series meet IMO L3 Fire Endurance requirements
- Bondstrand FP (i.e. with intumescent coating) Series for all fire endurance requirements available:
  - IMO L1
  - IMO L2
  - IMO L3 WD
  - JF 120
  - JF 60
  - JF 30

Bondstrand

Product Series

- General Purpose – All Marine Water Services
- Diameter Range 25 mm – 1500 mm
- Pressure Rating from 10 bar to 75 bar for specific Applications
- Min temp – 45 deg ^{0}C Max temp + 93 (121) deg ^{0}C
- Qualified to ISO, NORSOK, ASME B31.3, TOTAL PVV 178, Shell Dep, etc.
- IMO L1, IMO L2, IMO L3, IMO L3 WD, JF 30, JF 60
- Engineering Support e.g. - Pipe supports centres, GRE 24“ dia @ 20 bar spans 12.4 m whereas CuNi 24“ dia @ Sch 20 spans around 9.0 m.





Jet Fire Conditions:
JF 30, JF 60 (30 & 60 minute respectively)
330 kW/m^2 @ 1100 ^{0}C

Fire Endurance (IMO) Levels: L1 & L 2 @ 200 kW/m^2 @ 1100 ^{0}C

All bare Bondstrand Piping meet IMO L3

Life Cycle of a 20-Year Project

Examining CO_2 emissions

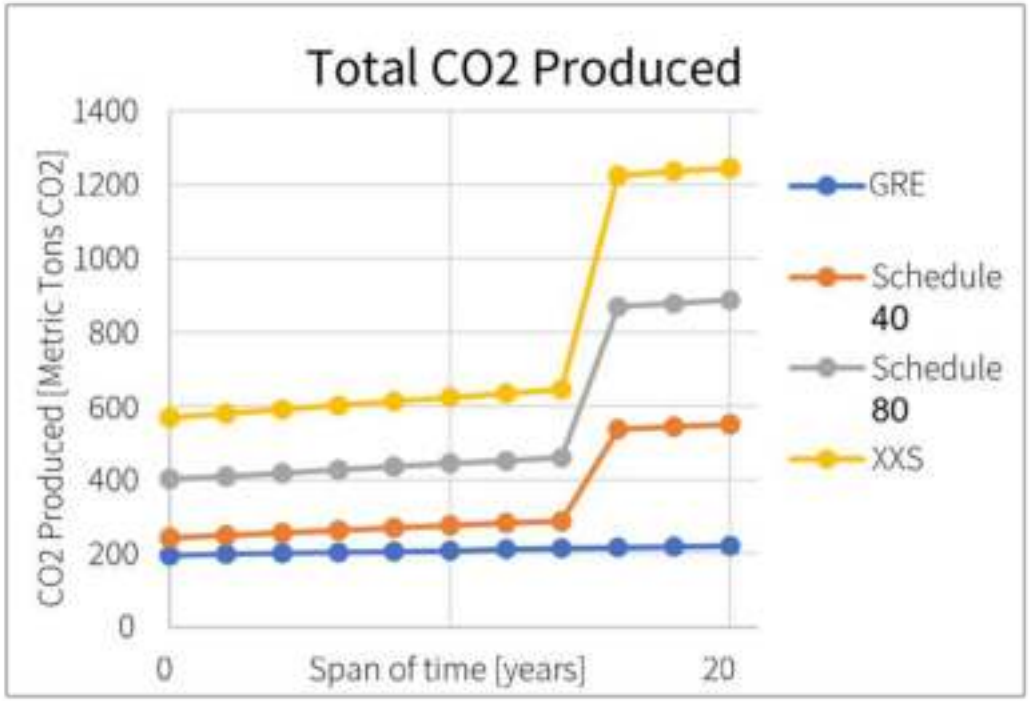
20-year water transmission pipeline life-cycle analysis

- GRE results in 60% less emissions
- CS pipe systems will need replacing at least once – higher operating expenditures and replacement costs
- GRE requires a smaller amount of fossil energy and is beneficial for applications requiring long service life

GRE results in

60%

Less CO_2 emissions



Value Story: Egina FPSO - Length 330 m x Width 61 m, Storage 2.3 million barrels, Production: 200,000 bpd

- 12 Systems in Bondstrand™
- 35.5k Meters of pipe
- 55.3k Pieces of fittings
- 13k Spools delivered to yard
- 72” Diameter Caisson Piping

Queen Elizabeth Class (QEC) Aircraft Carriers

UK Ministry Of Defence

Over 2000 No. Bondstrand® GRE pipe spools were supplied per ship for:

- Chilled water, waste heat water
- Ballast water
- Seawater cooling systems

Over 5,300 metres of pipe systems supplied per vessel. FGS provided detailed design & fabrication drawings. Installation and field service team based on-site for 6 years. Innovative bulkhead penetration trims provided to maintain water integrity and fire resistance.

Combined weight saving of over 390 tonnes with innovative composite materials

FRP Structural Applications

Gratings, Handrails and Structures

Duragrid® Phenolic FRP Grating

- Provides resilient surface to dynamic loads such as wheels and impact
- Lightweight, 1/3 that of steel grating
- Meets ASTM F3059 Wheel and Impact load requirements

MARRS® Offshore FRP Handrail – Offshore

- Circa 11kg per metre (3 rail configuration)
- 1.5kN/m load capability
- Minimal deflection (< 30mm at 0.74kN load)
- Proven 25 year phenolic FRP technology
- Excellent fire reaction and fire integrity

For Fire Integrity Applications

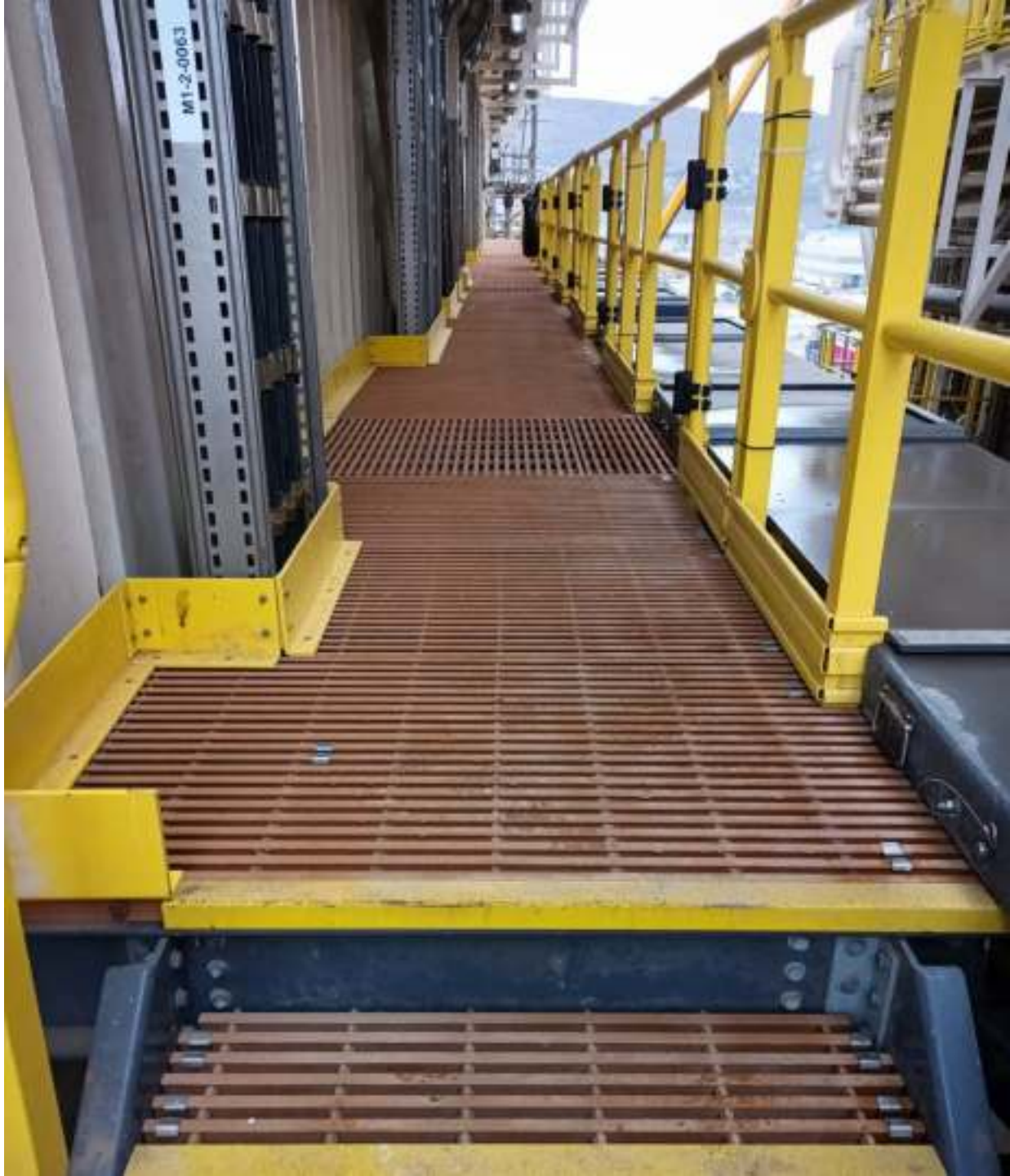
FRP Profiles for Tertiary Structures – Offshore

- Robust, with solid rung profile
- Proven 25 year phenolic FRP technology
- Excellent fire performance and integrity
- Minimal maintenance

FRP Grating - Topside

Pultruded FRP Grating

- Assembled from “pultruded” profiles, uni-directional
- 60 – 70 % reinforcement content
- High strength to weight ratio, lower deflection
- Resilient bearing bar surface
- Excellent “Fire Reaction” properties
- Self extinguishing, low combustibility
- Low smoke, low toxicity (IMO regs)
- ASTM F3059 fully compliant
- Approved by ABS, DNV, Lloyds, BV, etc.
- Proven over 25 years offshore



MARRS® Offshore FRP Handrail

Low weight
- Circa 15kg per metre (3 rail configuration)

Structural
- 1.5kN/m load capability
- NORSOK compliant
- Minimal deflection (< 30mm at 0.74kN load)
- Robust

Materials
- Proven 25 year phenolic FRP technology
- Excellent fire reaction and fire integrity
- Minimal maintenance

Versatile
- New build or retrofit
- Horizontal or sloped for stairs 2 or 3 mid rail

Post Connection Options

FRP Structural Access

Many more…

FRP Ladders

FRP Hop Ups

FRP Mud Troughs

FRP Wind Walls

FRP Safety Gates

FRP (Fiber Reinforced Polymer)
Marine & Offshore Tertiary Structural Systems

Product	Service and Locations	Qualifications and Approval			Type Approval
Phenolic Grating	Open Deck or semi enclosed areas Platforms, Catwalks & Access Areas Other fire critical applications, such as means of escape Access for firefighting Emergency operation or rescue	USCG PFM 2-98 (1998) ✓	ASTM F-3059 2017 ✓	NORSOK ✓	ABS, BV, DNV-GL, Lloyds, etc ✓
Phenolic Handrail	Open Deck or semi enclosed areas Platforms, Catwalks & Access Areas Other fire critical applications, such as means of escape Access for firefighting Emergency operation or rescue	ISO BS EN 14122-3 ✓	OSHA 1910.23 ✓	NORSOK C-002 and N-003 ✓	ABS ✓
Phenolic Ladders	Project by project based on risk-based approach	Designed from first principles, as steel equivalent			N/A
Phenolic Stairs	Project by project based on risk-based approach	Designed from first principles, as steel equivalent			N/A
Access Platforms	Project by project based on risk-based approach	Designed from first principles, as steel equivalent			N/A

Certificates and Approvals

- Alberta Boilers Safety Associates (ABSA)
- **American Bureau of Shipping (ABS)**
- American National Standards Institute (ANSI)
- American Petroleum Institute (API)
- American Society of Mechanical Engineers (ASME)
- American Water Works Association (AWWA)
- ASTM International
- British Standard – European Standard ISO (BS EN)
- **Bureau Veritas (BV)**
- Det Norske Veritas Germanischer Lloyd (DNV GL)
- Factory Mutual (FM)
- **Lloyd's Register (LR)**
- NSF International
- Technical Standards & Safety Authority (TSSA)
- Underwriters Laboratories (UL/ULC)
- United Kingdom Ministry of Defence (UK MoD)
- **United States Coast Guard (USCG)**
- United States Department of Defense (Military Specifications)
- United States Department of Transportation (DOT)
- United States Food & Drugs Administration (FDA)

FRP Tank Products

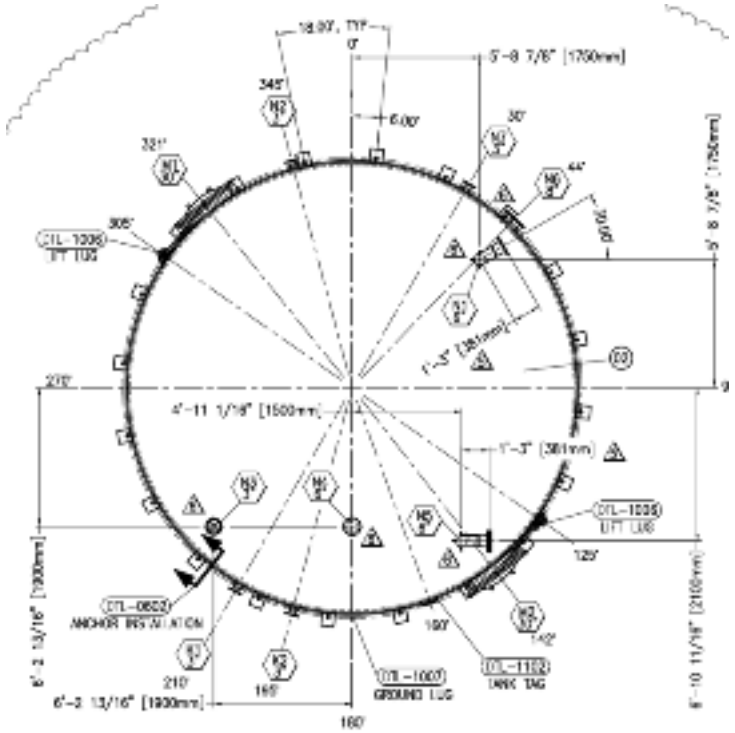
GRP Tanks and Vessels

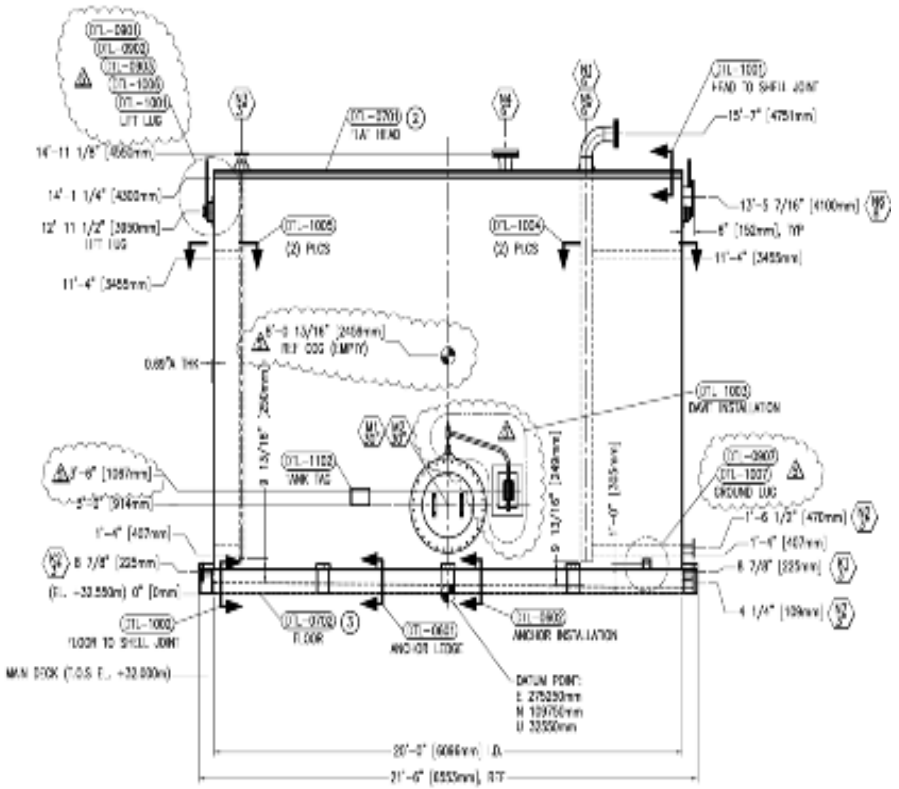
- High Chloride Environments
- Wet Acid Environments
- Water & Wastewater Environments
- Caustic (Alkali) Environments
- Abrasive & Corrosive Environments
- Systems with Significant pH Swings
- Numerous other Chemical Services & Combinations
  - Resin selected for specific chemical and design temperatures

GRVE Service Water Tank T-24301

Final Design 6 M x 4.3 M Flat Top with Self Drain Slope

- Capacity :125.5M^3
- Weight : 8.5 Tons
- Design Temperature : 80^{0}C





Finished Goods

Key Success Factors for Composite Implementation

- **Product**
  - Manufacturing Processes
  - Quality Assurance
  - Delivery
- **Engineering**
  - Stress and Surge Analysis
  - Spool Design
  - Piping Support Design
  - Structural and FEA Analysis
  - Structures design
  - Clash checks and integration
- **Installation**
  - Project Management
  - Site supervision
  - Qualified and trained bonders
  - Certification
  - Testing of systems
- **Warranty**
- **Aftermarket**
  - Adequate Global Service Coverage
  - Trained and qualified technical personnel

Key to ensure a reliable operational system

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