BHGE Deepwater Technology
Reducing Flexible Pipe Diameter and Weight

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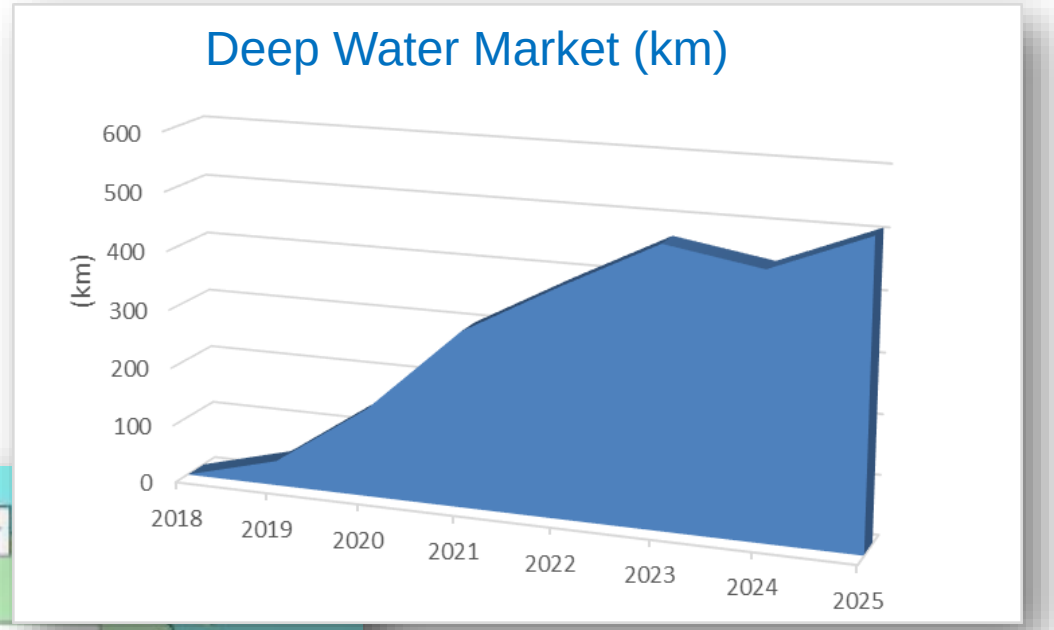
Deepwater Market Outlook

Flexible pipes are key to the development of deep and ultra-deep water fields

Key Challenges:

- Weight of pipe
- Hydrostatic pressure
- Reservoir pressure
- Pipe Collapse
- Limit on pipe ID
- Sour fluids
- Manufacturing cost
- Buoyancy control
- Installation cost



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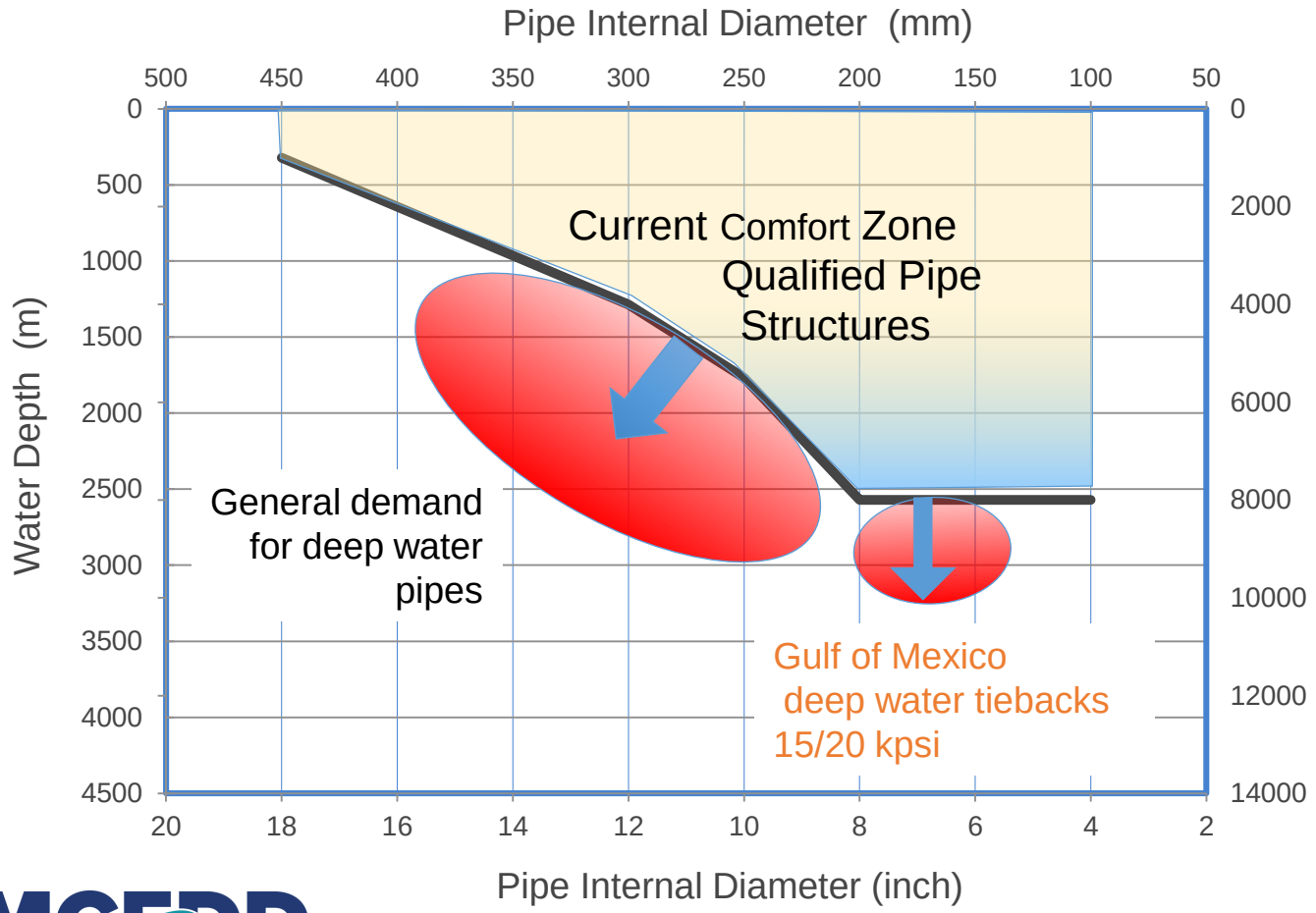
Current Capabilities

Throughput demands larger diameter pipes



Additional tensile armour layers required to take load

Maximum pressure is limited by the size and strength of pressure armour

Maximum water depth is limited by carcass collapse capacity

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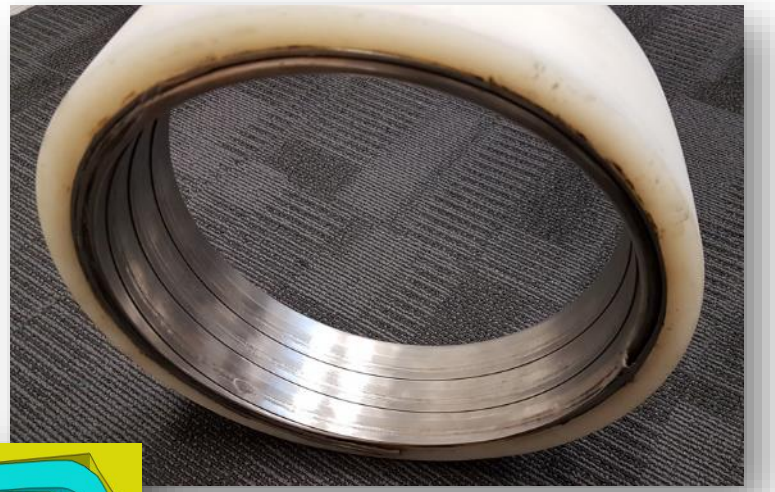
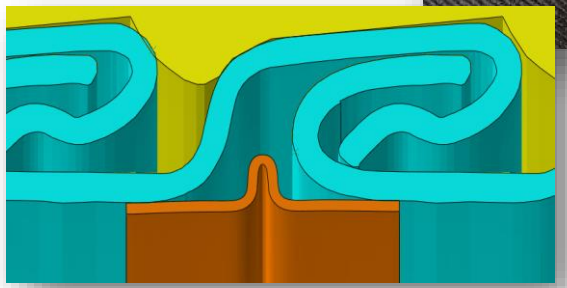
Reducing pressure losses and FIP

Carcass is made of metal flat strip formed to a profiled spiral tube

- Deepwater pipes require thicker (stronger) carcass
- Thicker carcass have larger inner spiral cavity which create flow induced pulsations (FIP) that will limits dry gas flow rates

Flexinsert significantly improves FIP performance





Dry natural gas velocity can be increase from approximately 2 m/s to 20 m/s without inducing FIP

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BHGE Flexinsert Technology

- Allows larger carcass sizes to be used without compromising flow
- Developed ‘T’ shaped profile in welded and non welded construction
- Currently non-welded Flexinsert qualified (DNV-GL) for static service
- Qualification of welded Flexinsert for dynamic service by 2Q
- Available in same material grades as carcass profiles
- Pipe diameter range 6 to 16inch ID
- Negligible weight penalty

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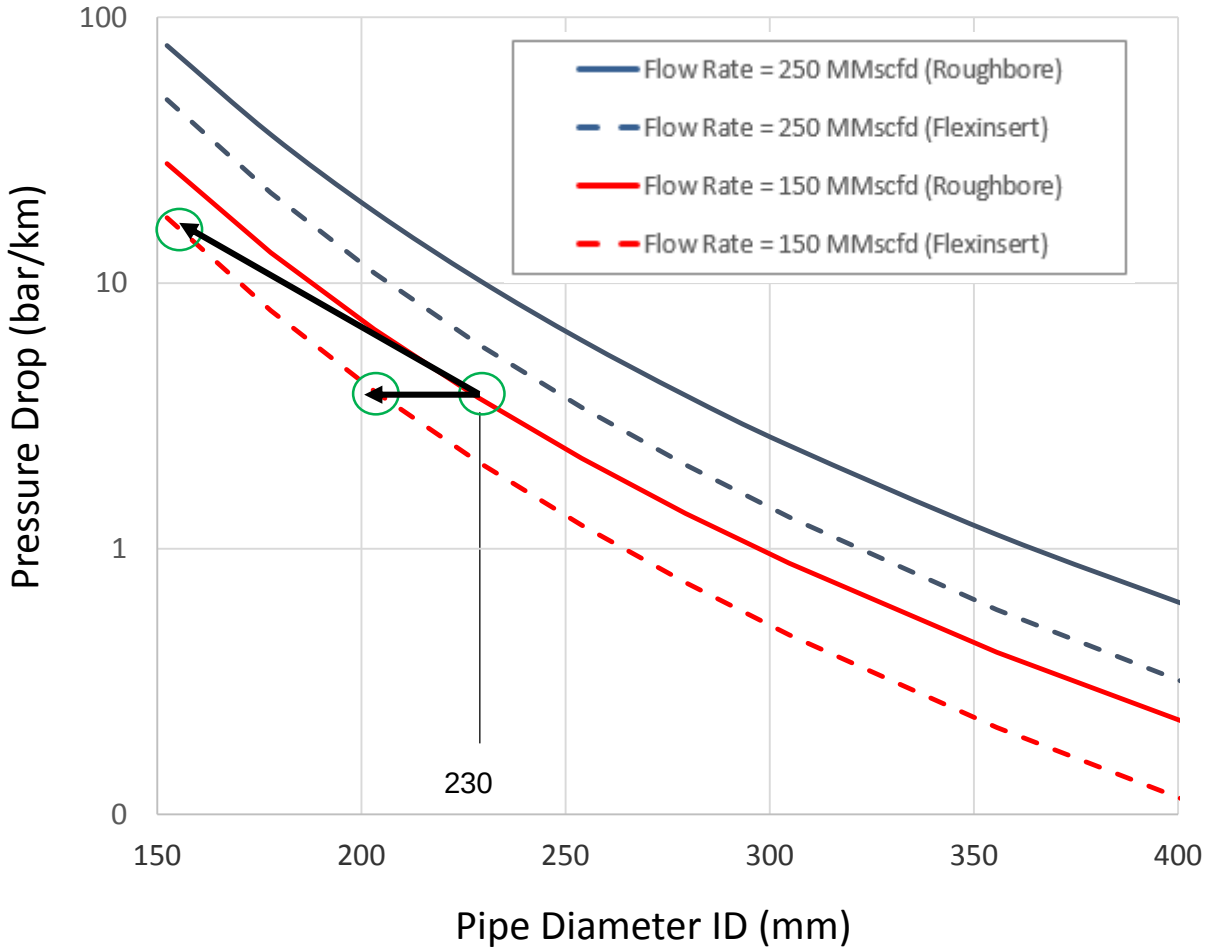
Flow Improvement due to Flexinsert

Reduced pressure drop due to Flexinsert



With same pressure drop pipe diameter can be reduced by approximately 13% (30% velocity increase)

Flow velocity can be increased up to 10 m/s based on FIP analysis … bringing the diameter down 35%

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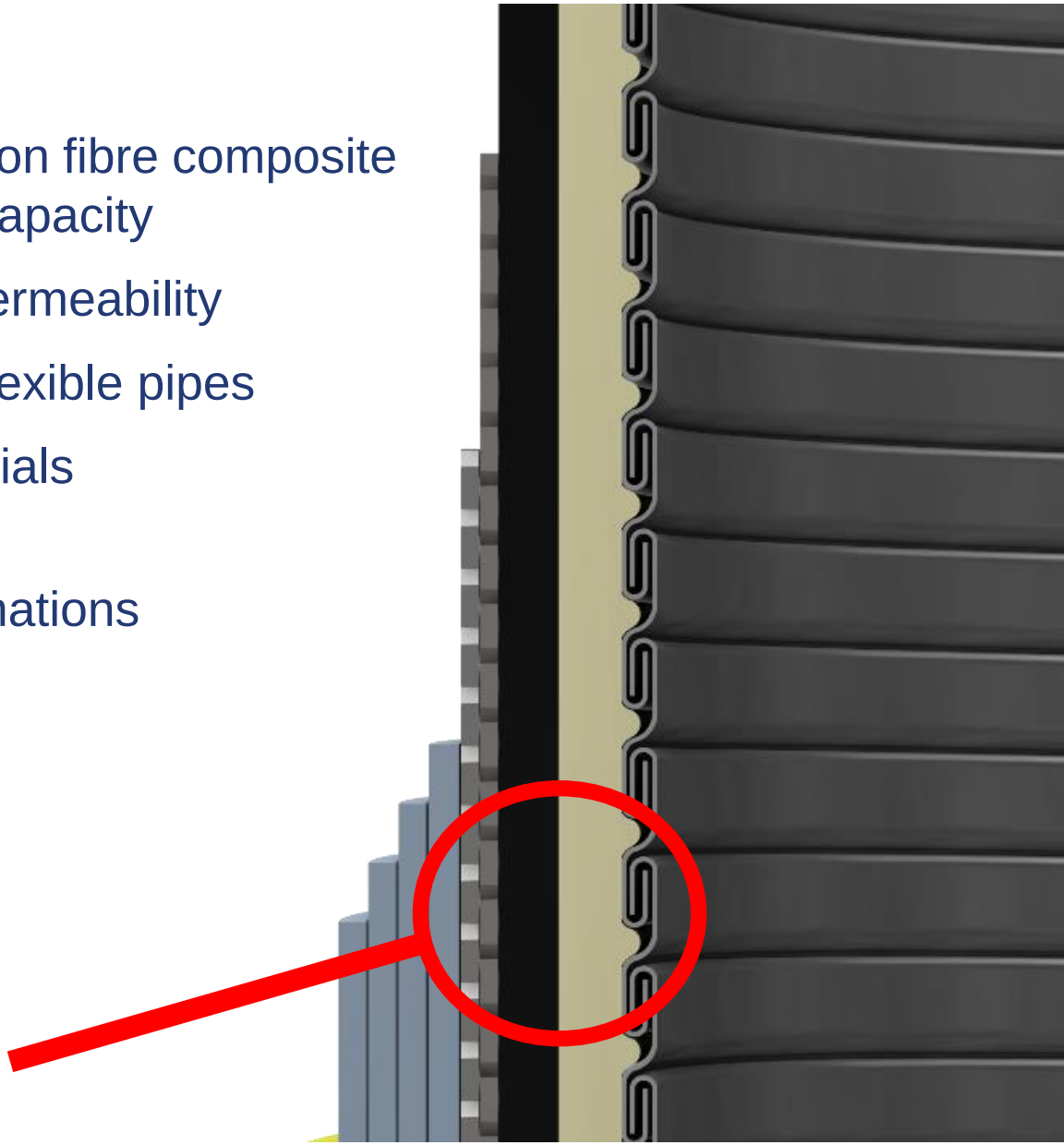
BHGE Bonded Composite Technology

- High strength/low weight carbon fibre composite layer for increased pressure capacity
- Strongly reduces CO2/H2S permeability
- Same MBR as conventional flexible pipes
- Well known and trusted materials (aerospace/automotive)
- Mature and proven end terminations
- State of the art manufacturing
- Simplified design
- Optimised material usage



Pressure Sheath with Bonded Composite

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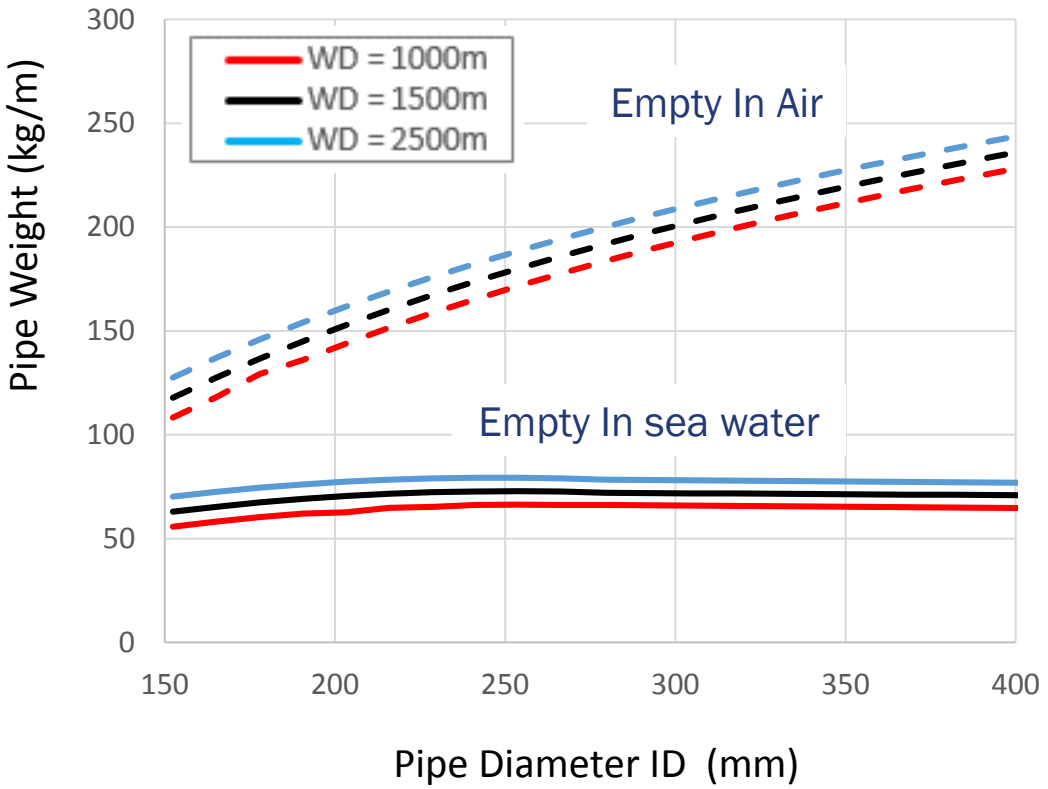
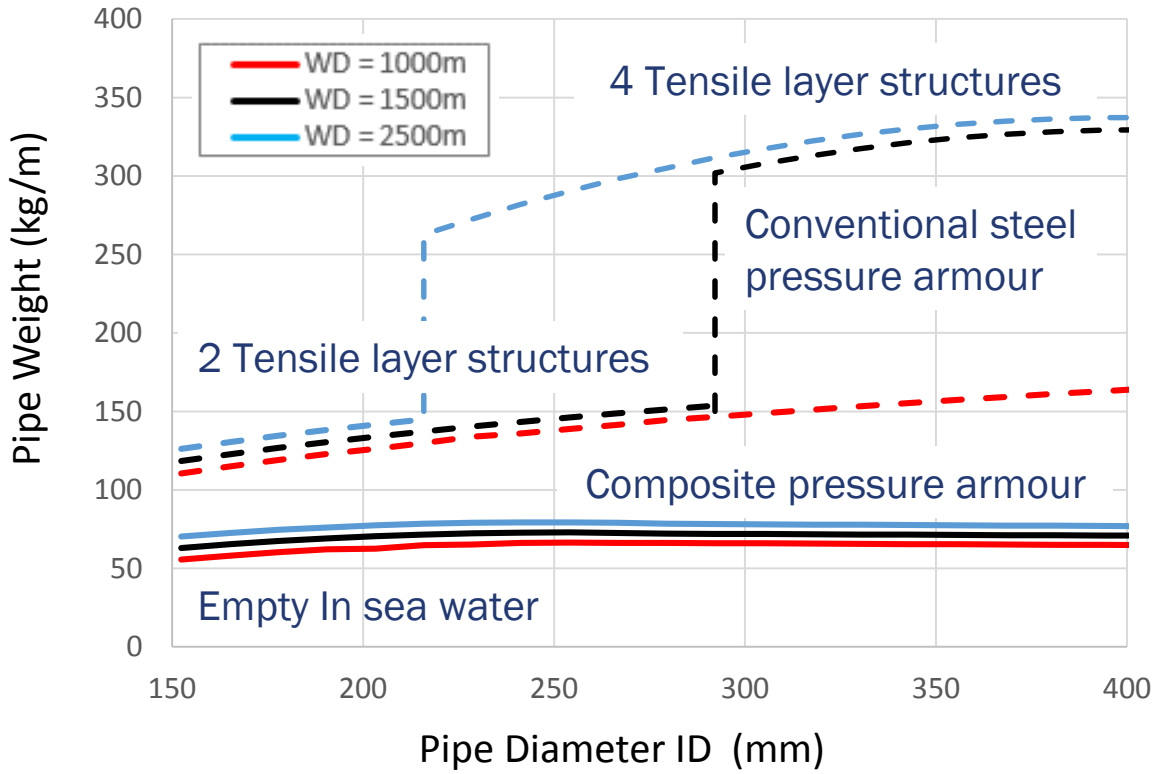
Reducing Pipe Weight Using Composite Pressure Armor

Composite Pressure Armour Pipe



Comparison of Composite and Conventional



40% weight reduction – small ID pipes at shallow water depth
80% Weight Reduction - large ID Pipes at greater Water Depth

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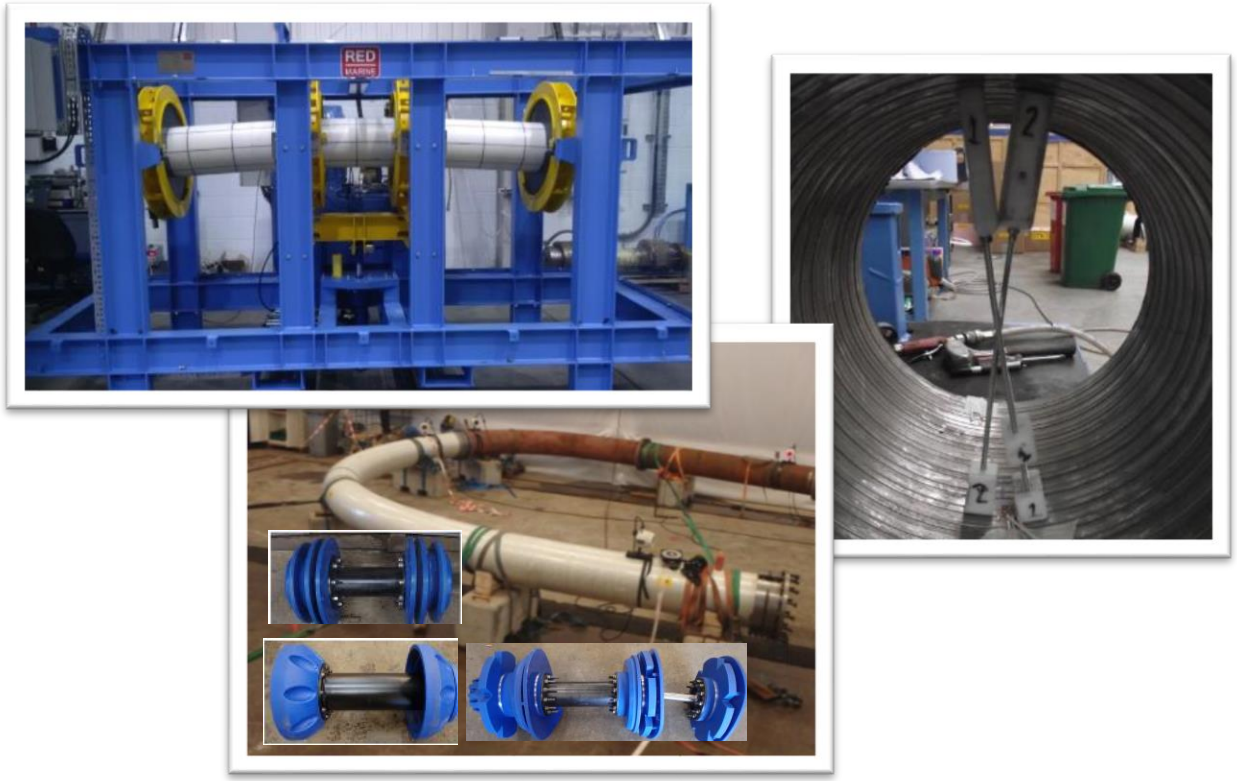
BHGE Qualification Program Status

Composite Pipe

- Prototype Pipes Manufactured
- Full-scale DTR Complete
- DNV-GL Qualification Program Endorsement
- Deep Water Collapse Testing Ongoing
- Dynamic Qualification by 1Q 2019

Flexinsert

- Prototype Pipes Manufactured
- Static Qualification Completed
- Dynamic Cycling and Wear Testing
- Dynamic Qualification by 2Q 2018



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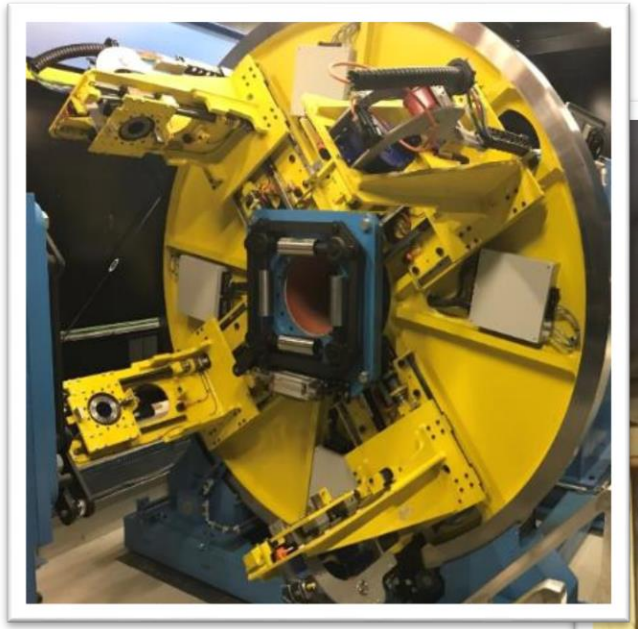
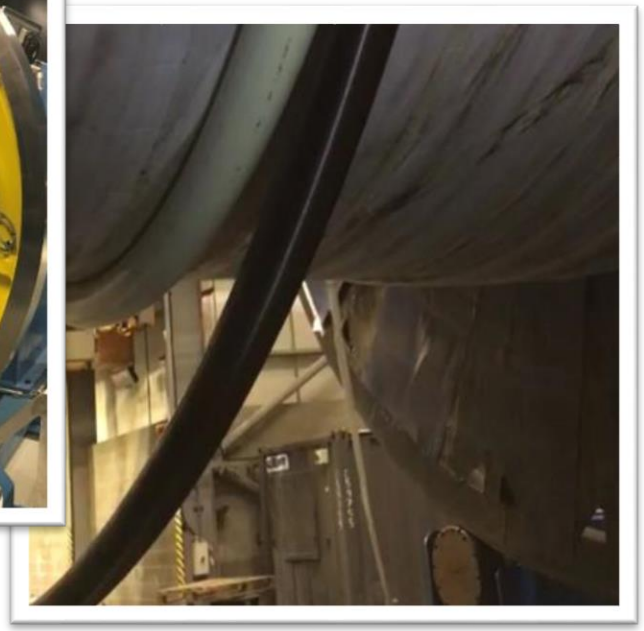
BHGE Manufacturing Industrialization

Composite Pipe

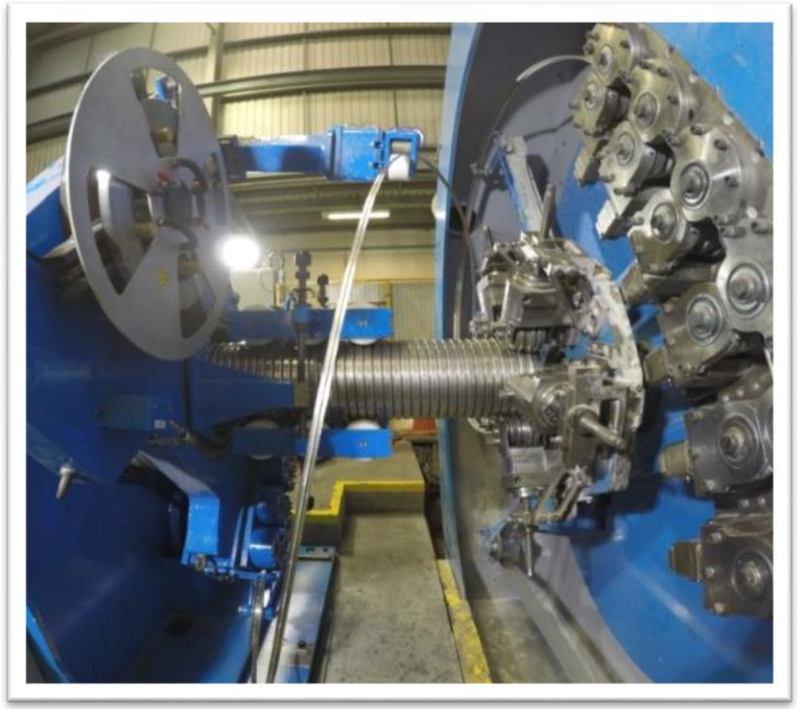
- State of the Art Laser Consolidation Solution
- Stage 1 Production Line In Place and Operating
- High-capacity Production Line to be Completed by 2020





Flexinsert

- Industrialized Manufacturing Facility Completed
- Integrated Welding Process
- Capable of Full Range of Pipe Diameters



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BHGE Deep Water Flexible Pipe Comparison (Hypothetical Field)

Same performance with same gas flow rate, design pressure, design temperature and water depth

Pipe Specification

- Gas Export Riser
- 1800m Water Depth
- Pipe ID – 9 1/8 inch
- Flow Rate – 150 MMscfd
- Design Pressure 5000 psi

	Conventional	BHGE Pipe	**Saving**
Tensile Armour Layers	4	2	**50%**
Carcass Thickness (mm)	14	12	**14%**
Pipe ID (")	9.125	8	**12%**
Pipe OD (mm)	401	345	**14%**
Pipe Weight in Water (kg/m)	225	66	**71%**
Pipe Length (m)	2340	1980	**15%**
Shipped Product Weight (te)	829	285	**66%**
Shipping Via	Carousel	35ft reel	
Configuration	Lazy wave with buoyancy	Free hanging	

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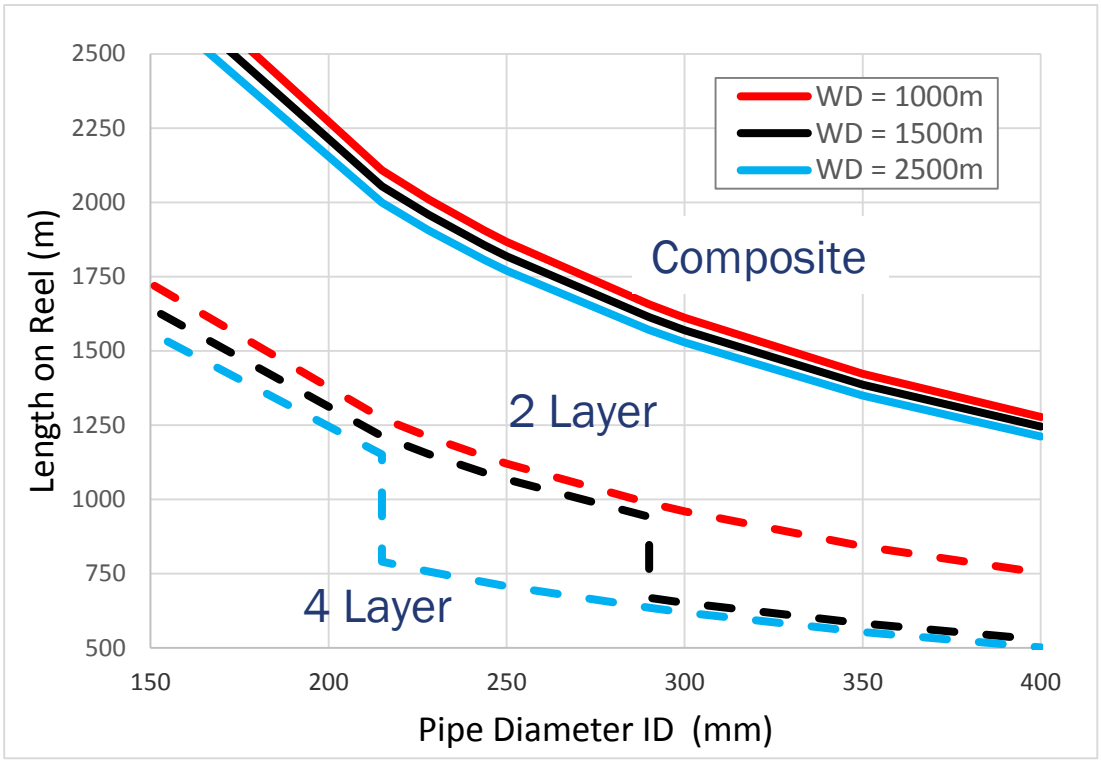
BHGE Deep Water Pipe (Composite and Flexinsert)

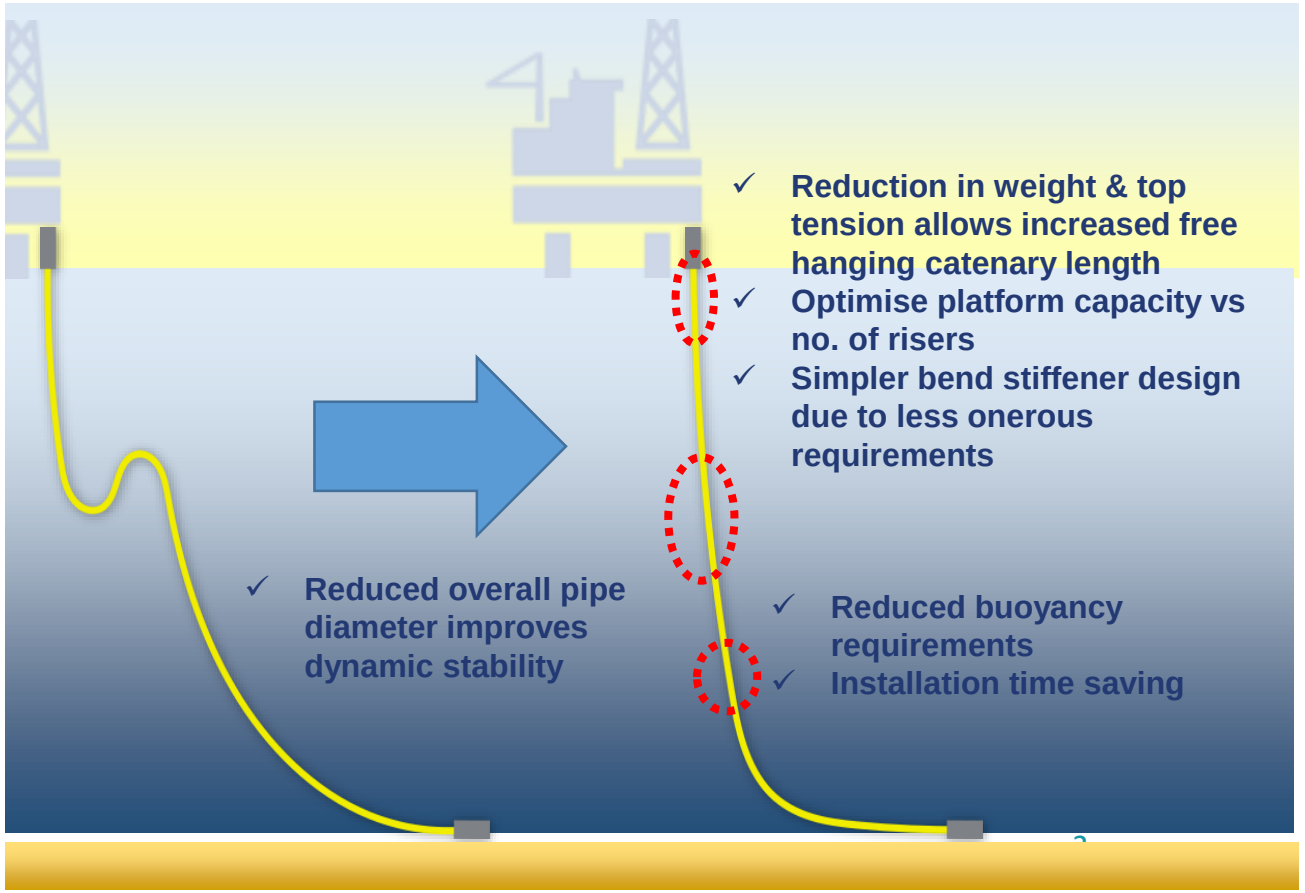
System Optimisation

Packaging Advantage (35ft Reel)



9 1/8” Pipe 1800m WD from 3 Reels to 1 Reel

Configuration Optimization



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CONVENTIONAL

30% INCREASE IN REEL CAPACITY | REDUCED MOBILISATION COST & TIME | REDUCED SHIPPING COST | REDUCED INSTALLATION TIME & ANCILLARIES | PLATFORM OPTIMISATION & FHC

COMPOSITE

20% reduction in total installed cost

WHEN MOVING FROM LAZY WAVE CONFIGURATION TO FREE-HANGING CATENARY

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Additional Technologies and Conclusion

- New buoyancy control techniques
- Multi-segment pipe configurations
- Single layer barrier sheath with controlled profiles
- Smart manufacturing facility with modern monitoring/control equipment
- Outer sheath breach detection - early warning system
- Pipe integrity monitoring using MAPS

BHGE Have Capability for Deep Water Larger Diameter Pipes

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