DEEPWATER PIPELINE INSPECTION
A TOOLBOX APPROACH

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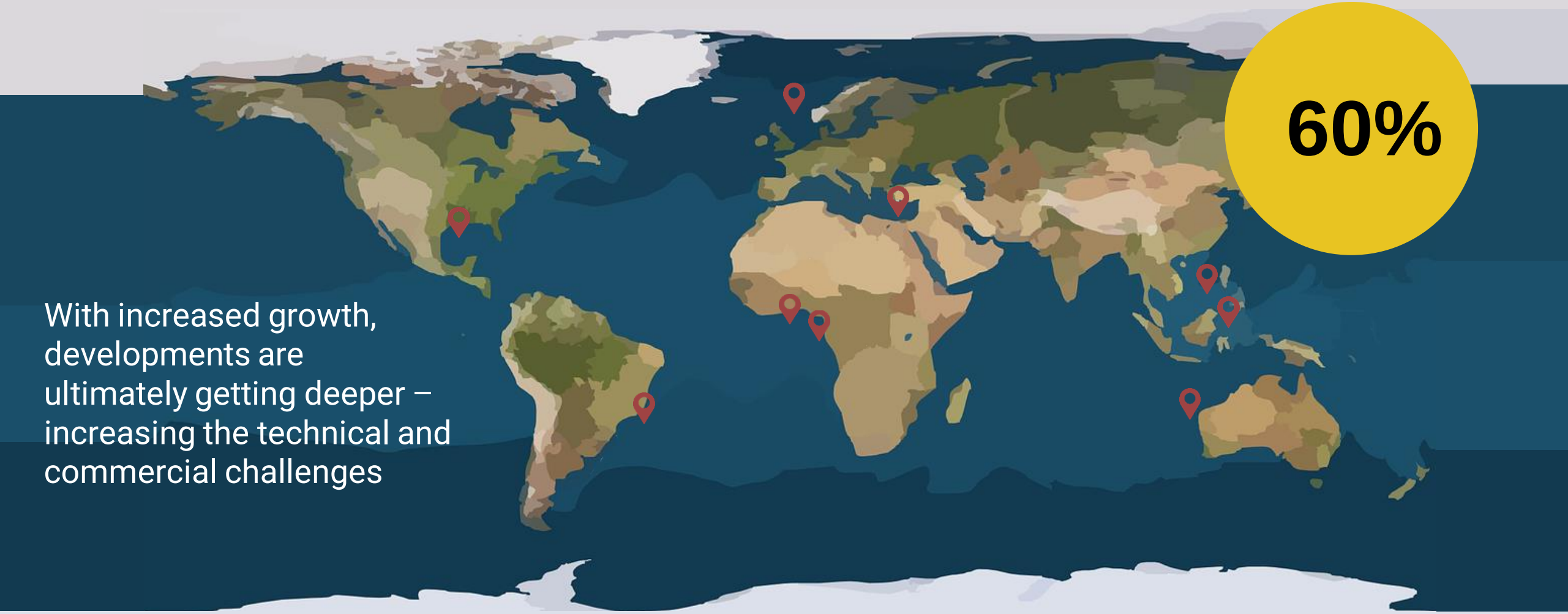
The Future of Deepwater Pipelines

Global Deepwater production is expected to increase 60% by 2030, reaching 17 million bbl/day – Wood Mackenzie OGJ Nov. 29, 2022



With increased growth, developments are ultimately getting deeper – increasing the technical and commercial challenges

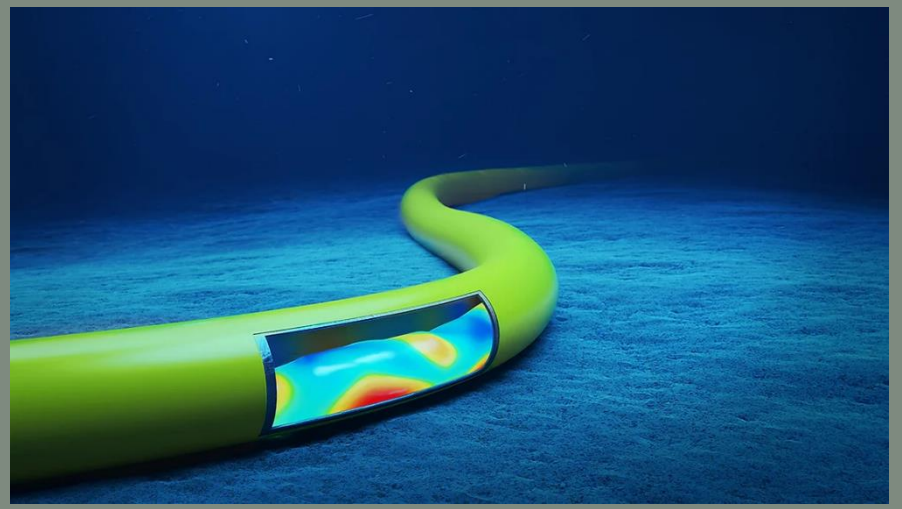

ENVIRONMENT
MECHANICAL DESIGN
THE
CHALLENGE
OPERATION

ENVIRONMENT

Maslin, E. (2020) *Fully Remote diverless pipeline (MIG) welding equipment. From PRSI Pool.* Available at: https://www.pedigital.com/news/482657-the-pipeline-repair-busters-being-ready-for-the-worst-case (Accessed 7th November 2023)

- Complex and costly repairs
- Impracticable dig verification
- High logistics costs
- Remote subsea intervention

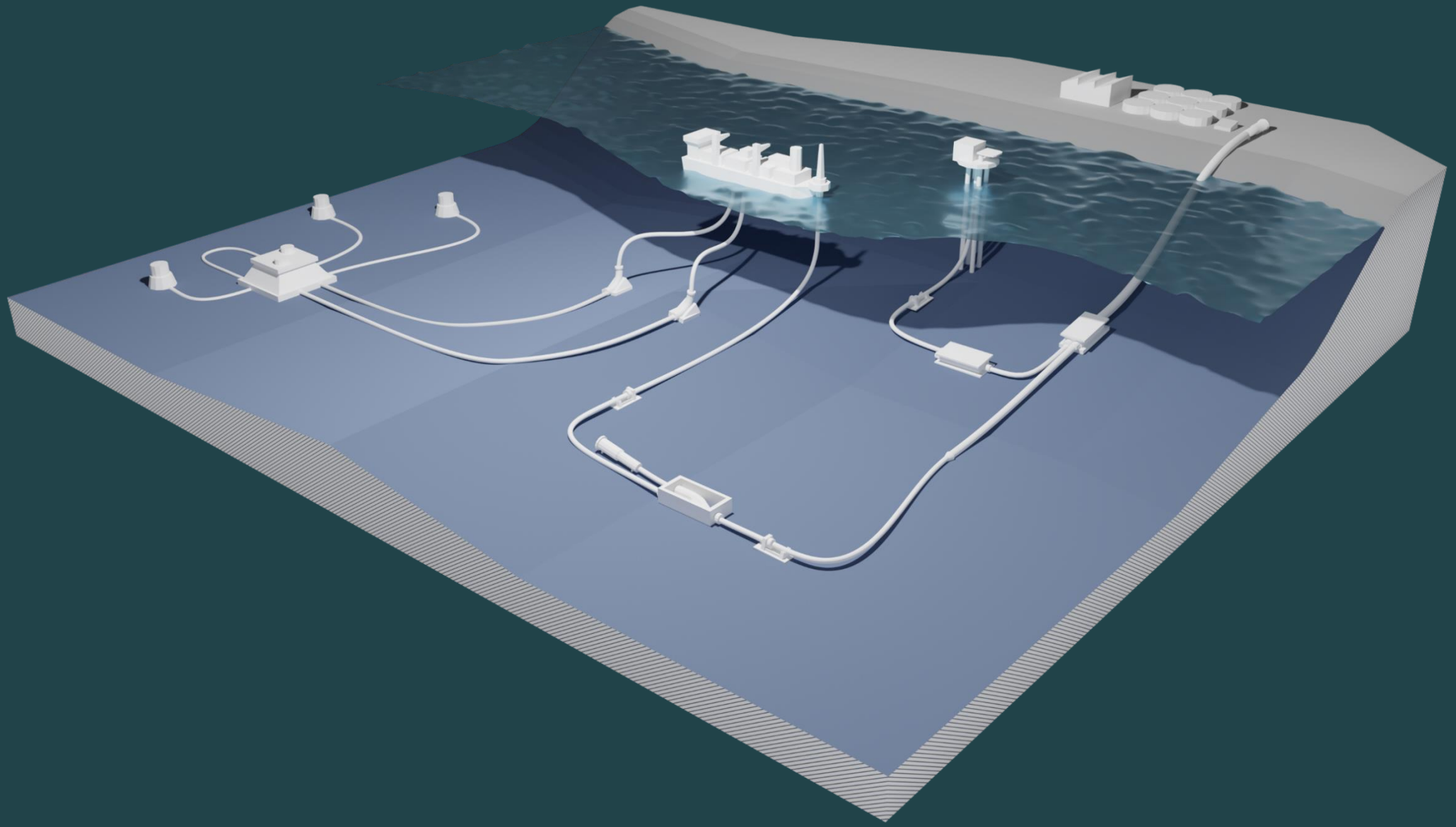
- High Pressure
- Elevated Temperatures
- Debris, wax & hydrate management
- High flow
  - Minimized deferment
  - Tie-ins & side flow
- Predominantly internal corrosion

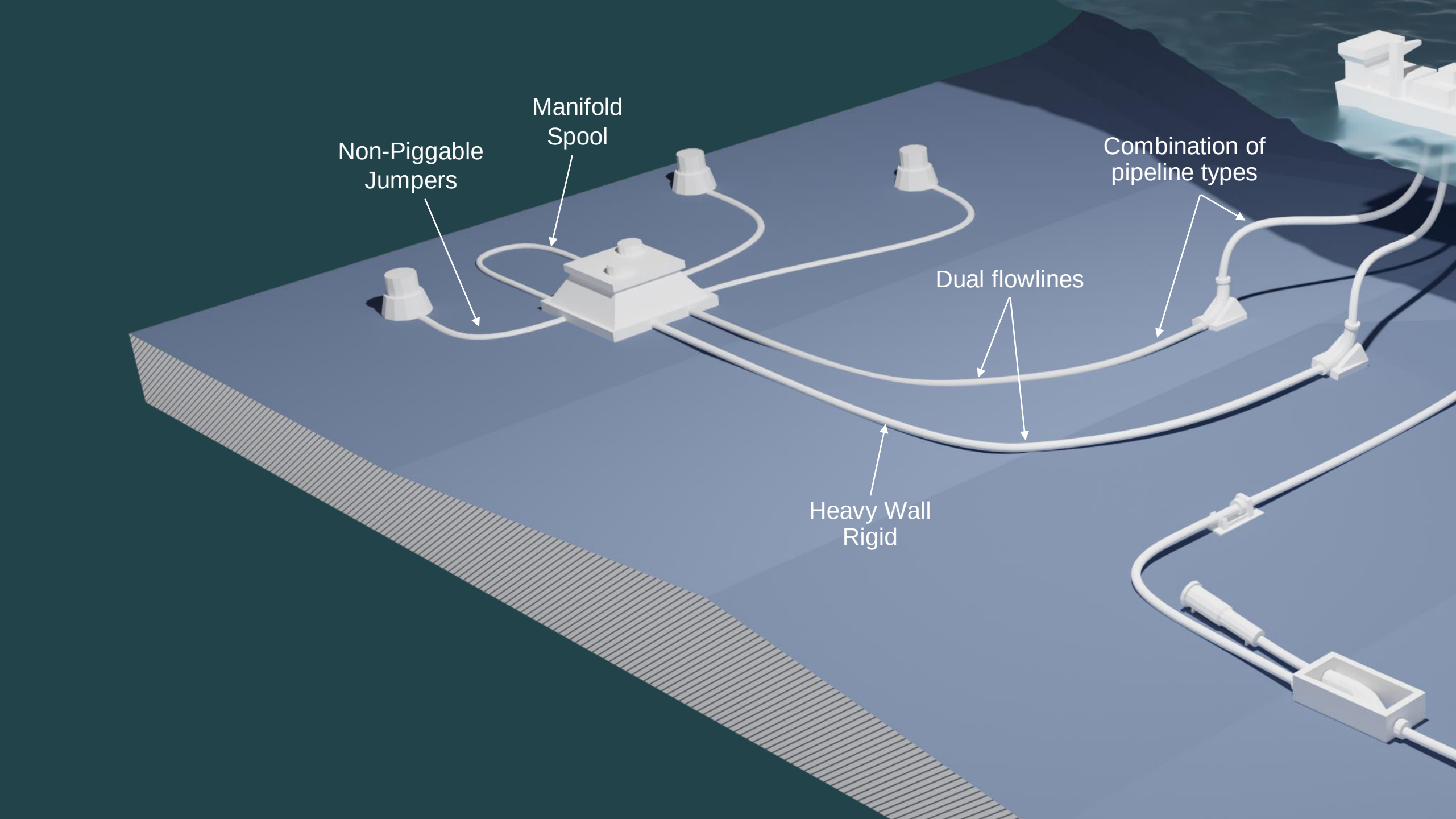


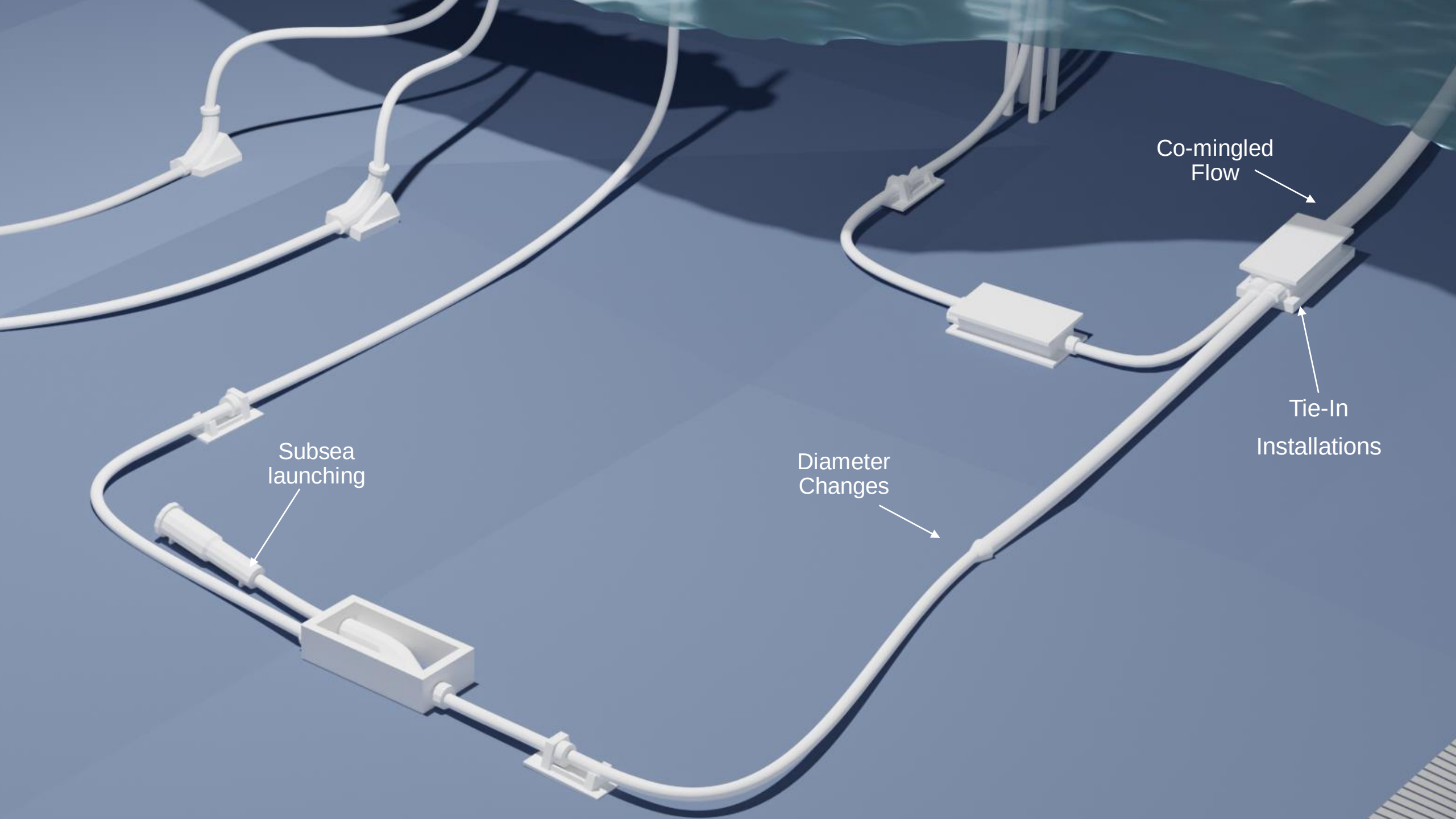
Meechan.G. (2210) *Blog:What does a Flow Assurance Engineer do?* Available at: https://www.crondall-energy.com/post/blog-what-does-a-flow-assurance-engineer-do (Accessed 7th November 2023)

OPERATION

MECHANICAL DESIGN




Manifold
Spool
Non-Piggable
Jumpers
Combination of
pipeline types
Dual flowlines
Heavy Wall
Rigid


Co-mingled
Flow
Tie-In
Installations
Diameter
Changes
Subsea
launching

DEEPWATER PIPELINES
ASSOCIATED PIGGING CHALLENGES

ACCESS

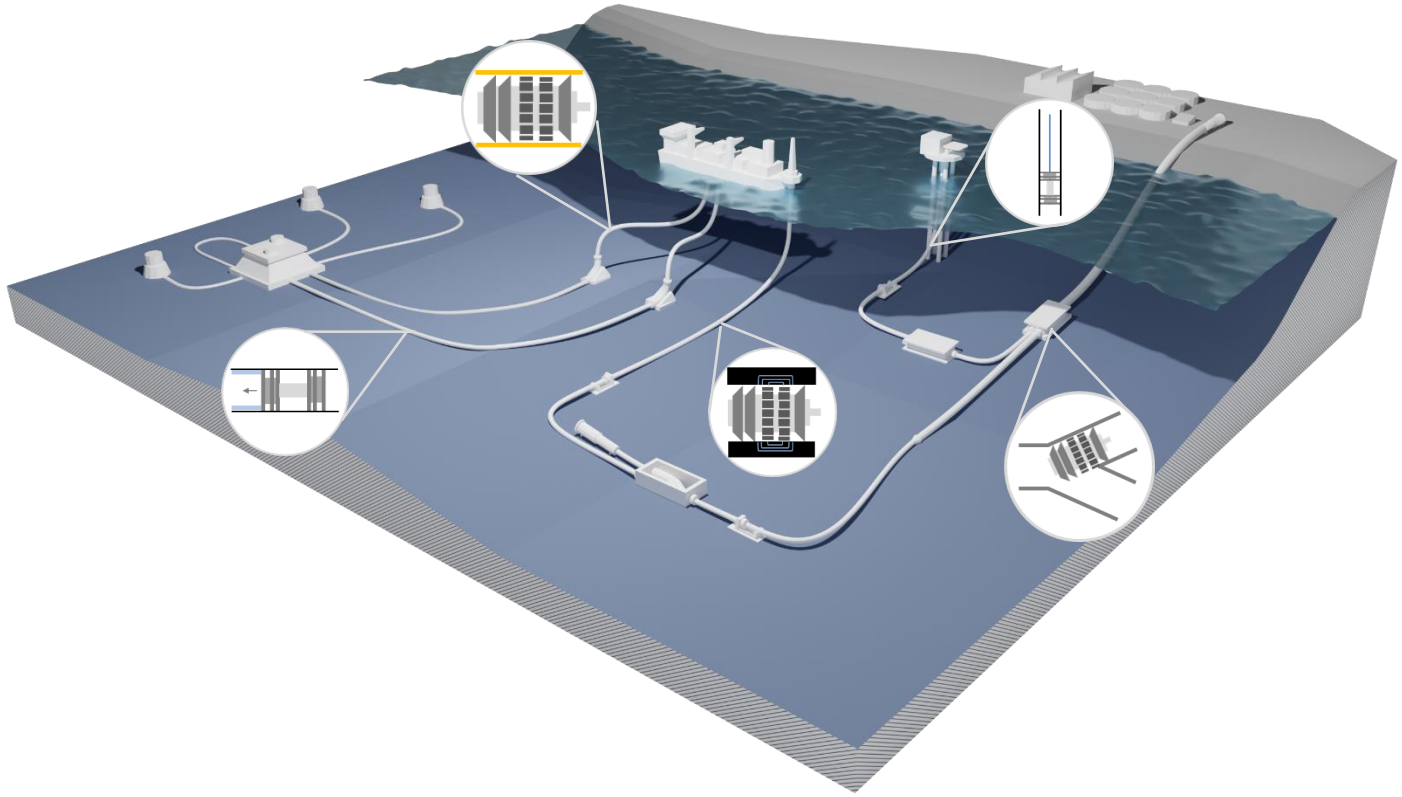
- Constrained launch and receive facilities
- Subsea operations

OPERATION

- High velocities and side flow
- High Temp and pressures
- Liquid management

PASSAGE

- Large ID changes
- Long sealing tools for wye and tee passage
- Debris removal
- Heavy wall



SAFE FLEXIBLE PASSAGE

THE CHALLENGE

- Pig design to mitigate the impact on flexible carcass:
  - Tools supported by PU and/or nylon wheels
  - Non-aggressive cleaning tools, composed of plastic cleaning elements only
  - Wheeled magnetizers for MFL technology

Bigger Picture

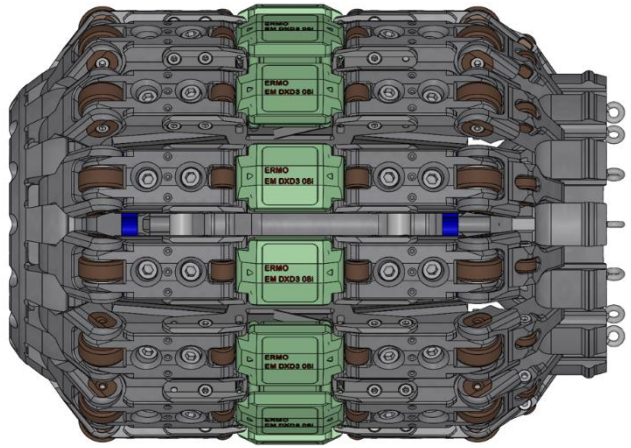
DEEPWATER CHALLENGES

- Gas systems
- Heavy Wall Rigid Pipe
- Long pipeline Lengths

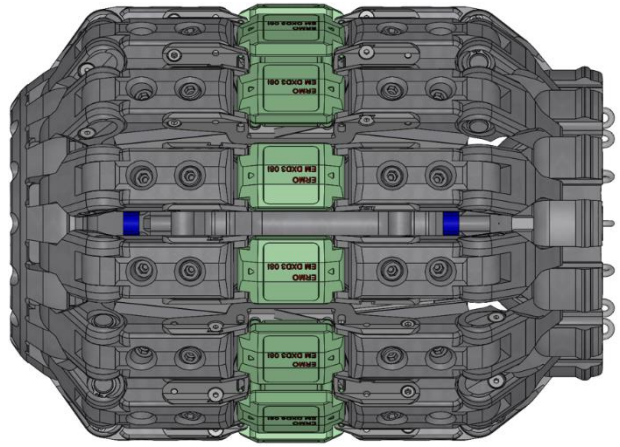
CASE STUDY 1
WHEELS OR NO WHEELS?

“IS A WHEELED MAGNETIZER THE BEST SOLUTION?... OR IS IT LIMITING THE INSPECTION POTENTIAL”

	With Wheels	without
Low Friction		
Low Contact forces		
High Magnetisation		
Debris Tolerance		
ID Optimization		
Speed effect tolerant		

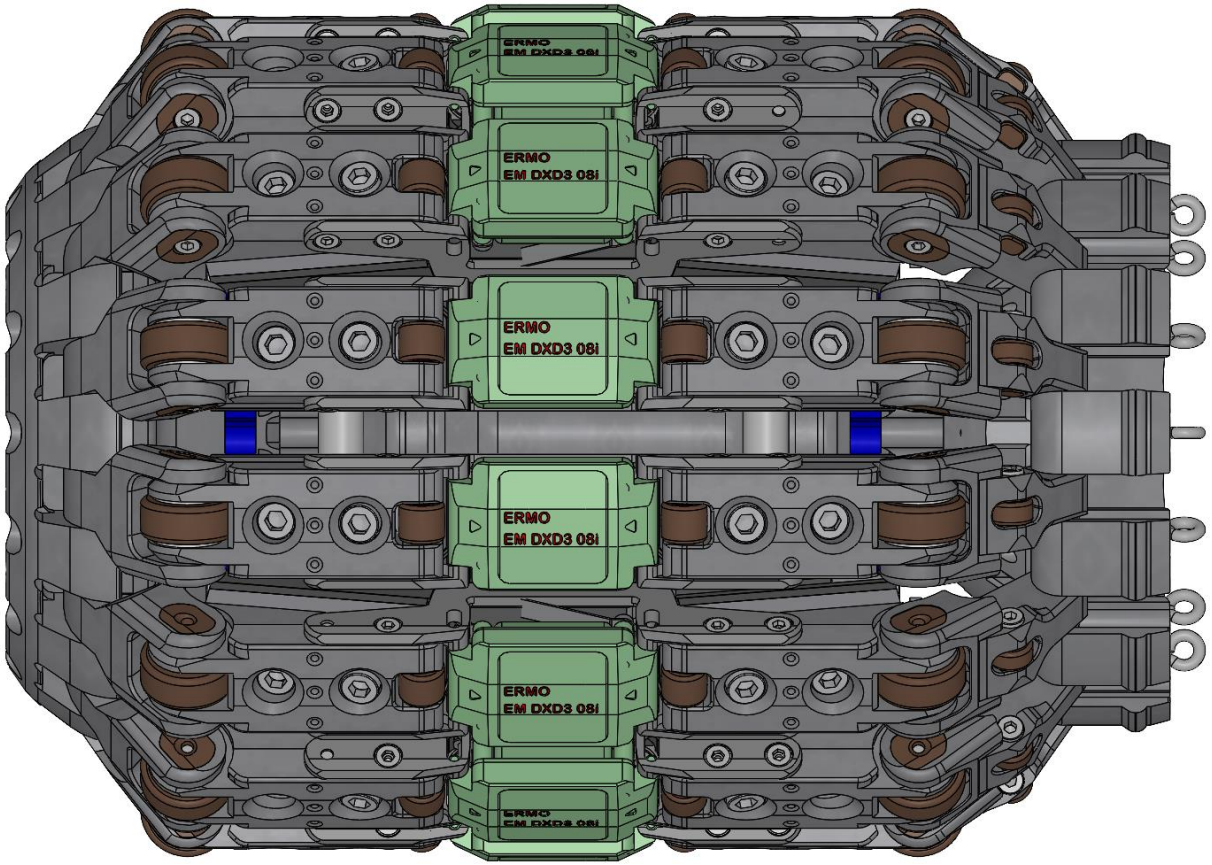


Wheel supported brush



Wear-resistant steel brush

CASE STUDY 1
WEAR-RESISTANT STEEL BRUSHES WITH WHEELS

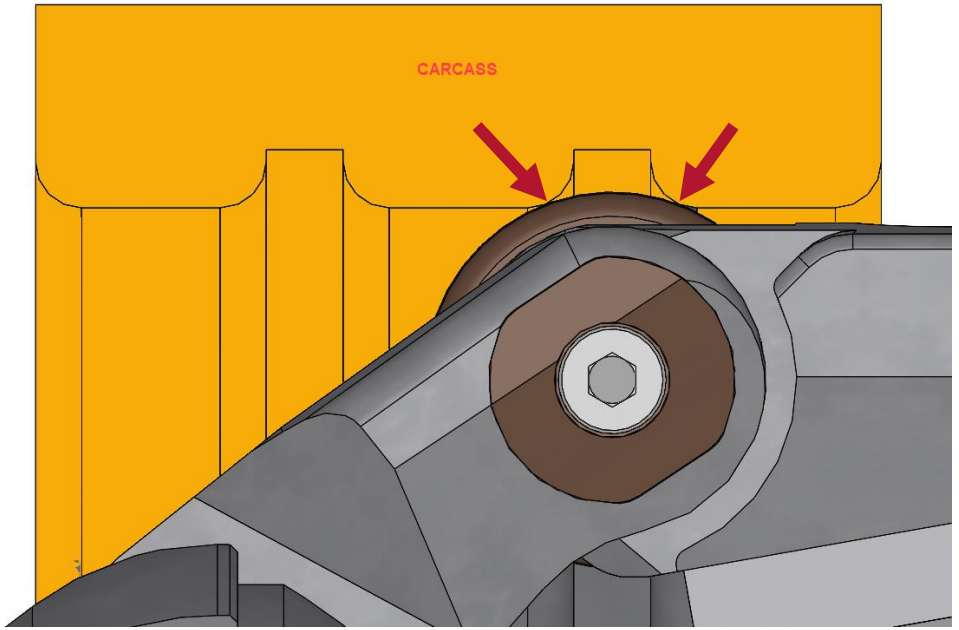


Wear-resistant steel brush with wheels

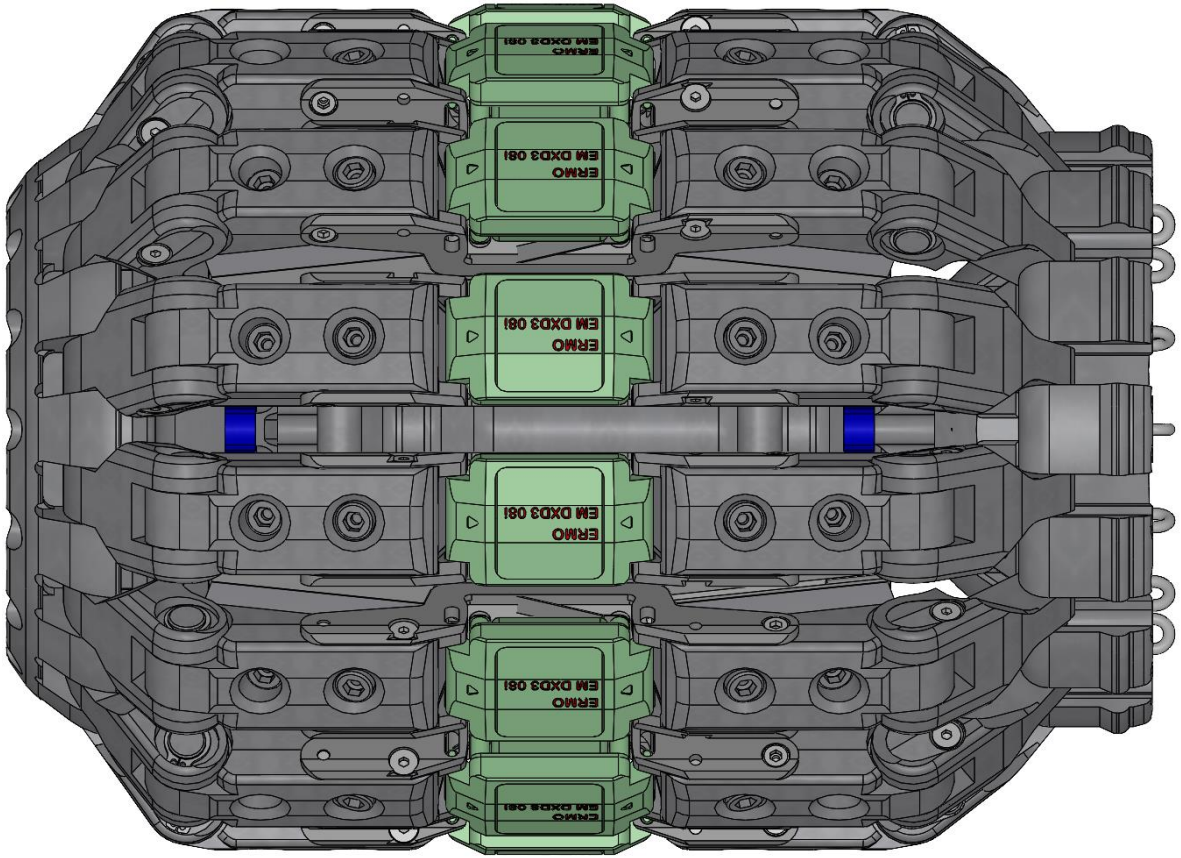
Low friction

Lower magnetization due to lift-off

Local surface **pressure** (wheels)

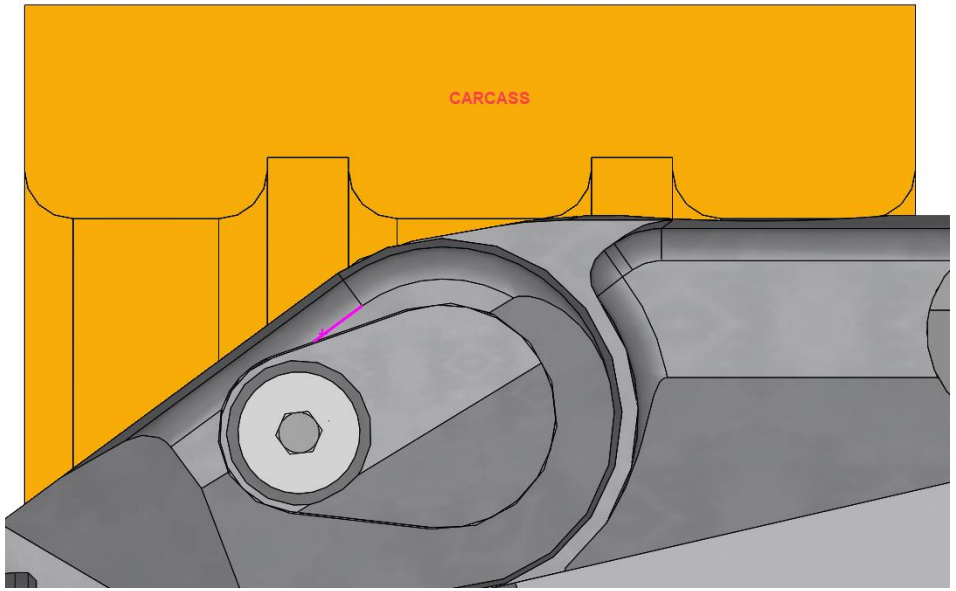


CASE STUDY 1
WEAR-RESISTANT STEEL BRUSHES



Wear-resistant steel brush

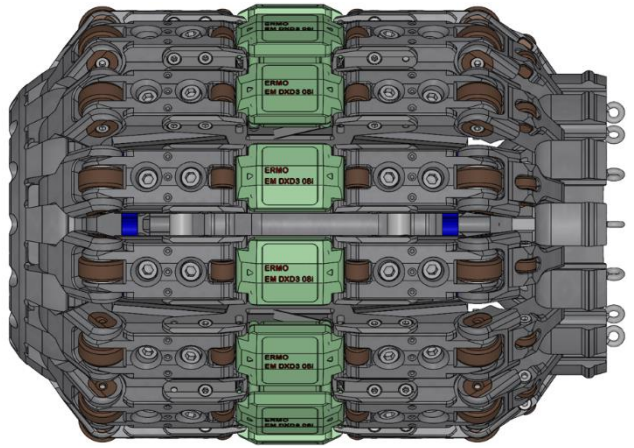
- **High** magnetization
- **Equally distributed** surface pressure
- Brush curvature **optimized** to ID



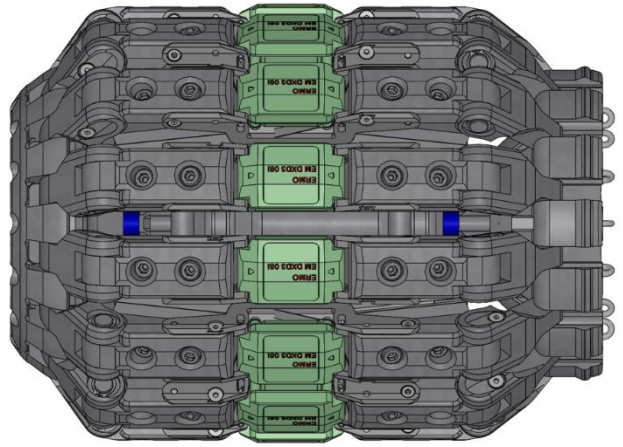
CASE STUDY 1
WHEELS OR NO WHEELS?

“IS A WHEELED MAGNETIZER THE BEST SOLUTION?... OR IS IT LIMITING THE INSPECTION POTENTIAL”

	With Wheels	without
Low Friction	✓	
Low Contact forces		✓
High Magnetisation		✓
Debris Tolerance		✓
ID Optimization		✓
Speed effect tolerant		✓

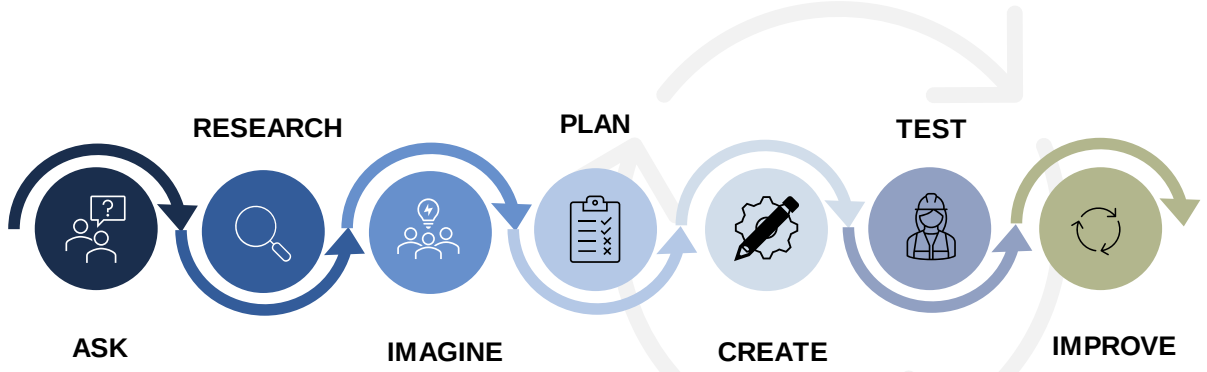


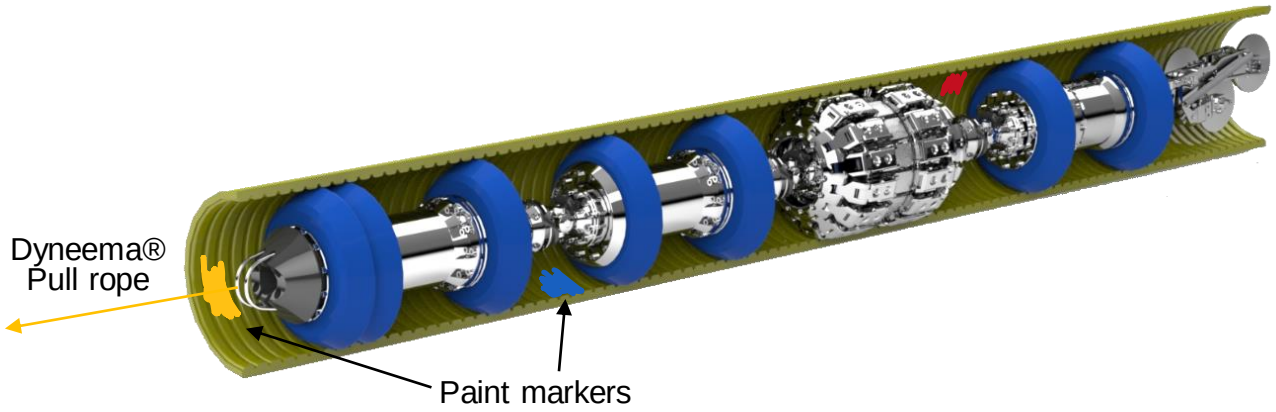
Wheel supported brush



Wear-resistant steel brush

CASE STUDY 1
PROVING THE CONCEPT





1. Do brushes without wheels damage a flexible?
2. Review of MFL Design and calculations
3. Optimisation of brushes & tool setup
4. Brush manufacture and test setup
5. Pull testing
6. Results & Review

CASE STUDY 1
RESULTS & REVIEW

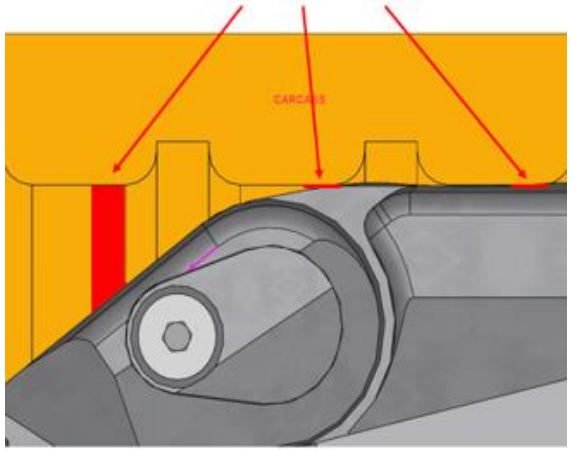
1. The MFL tool without wheels passed through the flexible safely without inducing damage

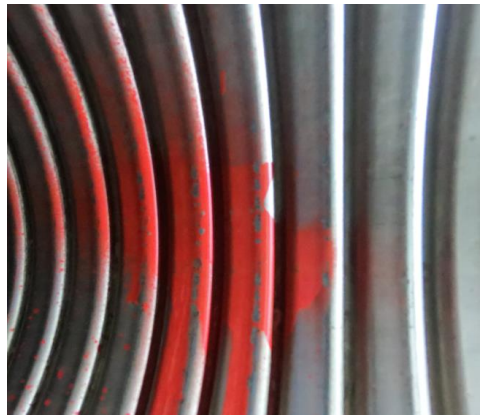
2. The PU only test had the same effect to the paint as the magnetiser

3. Testing provides greater flexibility of tool setups and inspection options

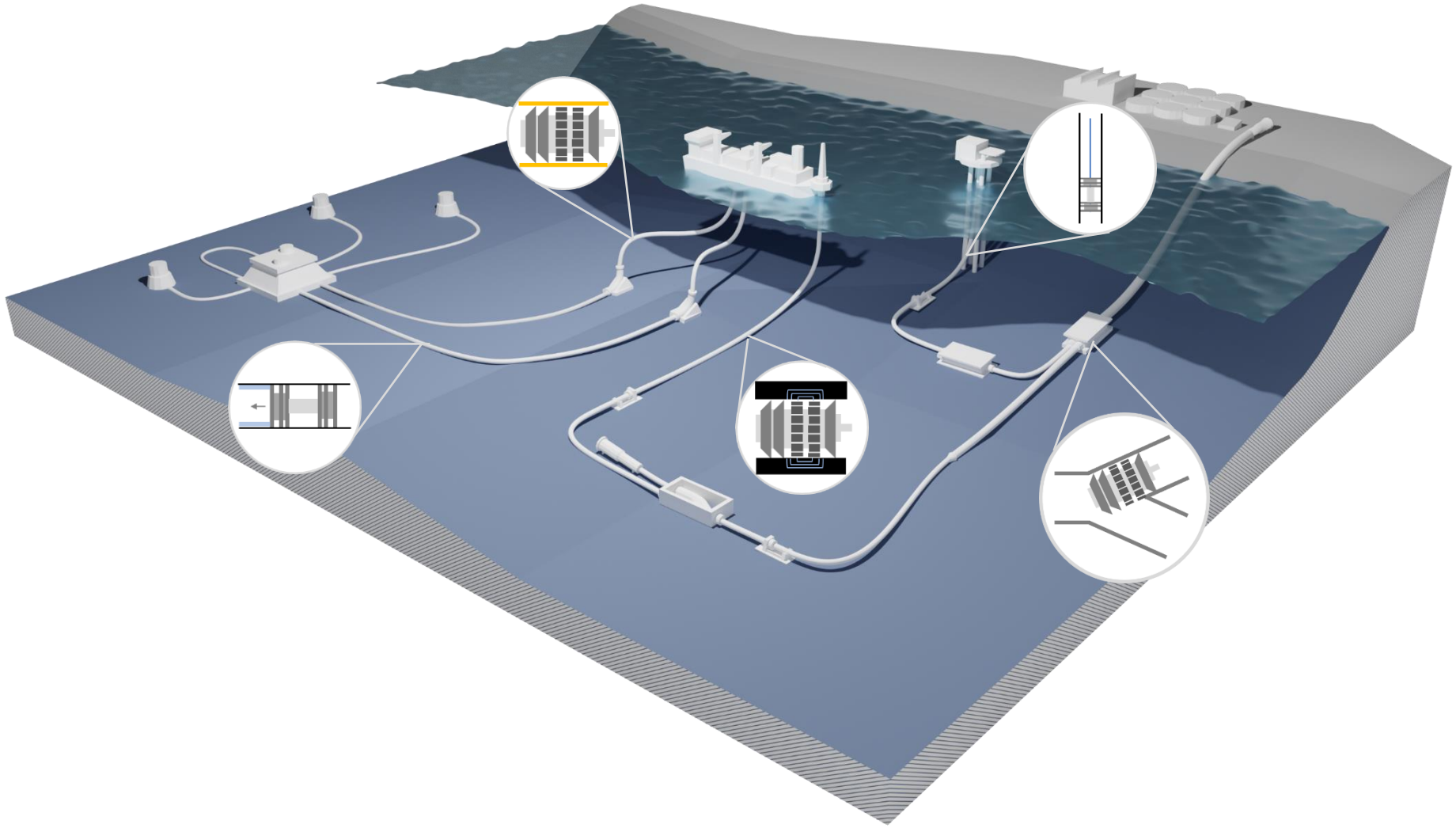
4. Every pipeline system is different – the exact tool setup should be reviewed on a case-by-case to provide the optimum solution

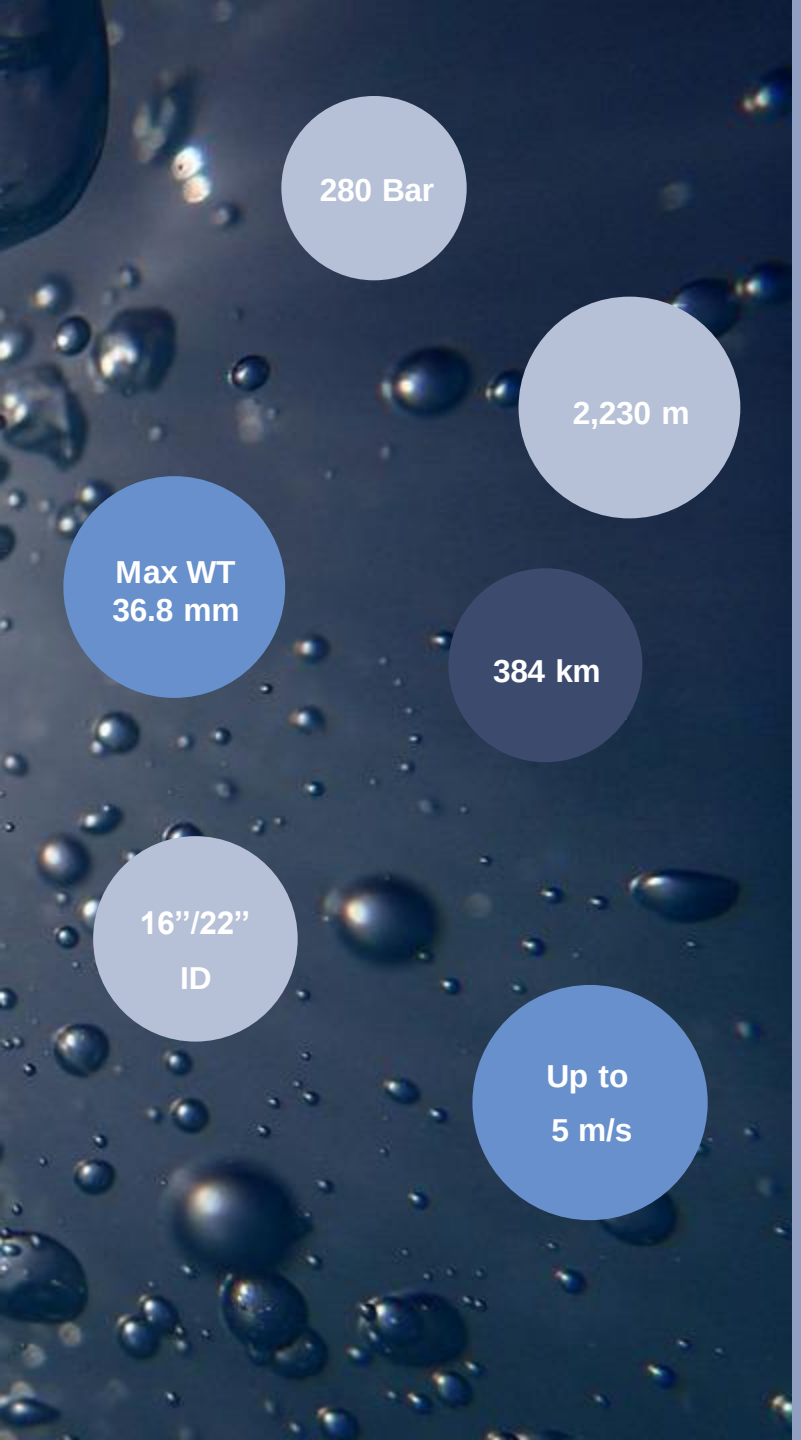
Main Contact Areas





DEEPWATER PIPELINES
ASSOCIATED PIGGING CHALLENGES





DEEPWATER MULTI-DIAMETER GAS PIPELINE

THE CHALLENGE

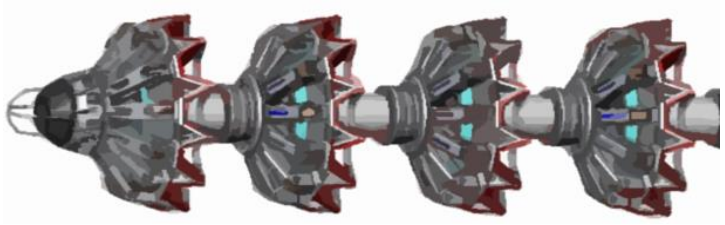
- Multi-diameter 16”/22”
- Cleaning and gauging requirement
- Critical Installations: Y-pieces, T-pieces, valves
- Passage through flexibles and flow coating
- High operating pressure
- Heavy Wall Thickness
- Long pipeline Length

Bigger Picture

DEEPWATER CHALLENGES

- No product deferment
- High Gas velocity

CASE STUDY 2
CONCEPT & DESIGN



16”/22” Multi-Diameter Pull unit

- Wide Operating range (340 – 610 mm)
- Modular design
- Long sealing length for Y passage
- Stabilization of sealing elements
- Integrated battery packs
- high pressure transmitter

Cleaning/Gauge Tool

- Spring loaded brushes
- Nylon brushes for flow coating
- Cleaning effect from pull unit
- Combined cleaning and gauging reducing runs

IEC Tool

- Combined geometry and corrosion inspection
- Compact low-friction design
- High accuracy of detection and sizing of internal features which is the main integrity concern

CASE STUDY 2
TESTING & IMPROVE

- Bypass test under low and high differential pressures
- 6 pump tests
- 30 pull tests in 5 different diameters (16”/18”/20”/22”/24”) to verify tool specifications
- Pressure vessel testing

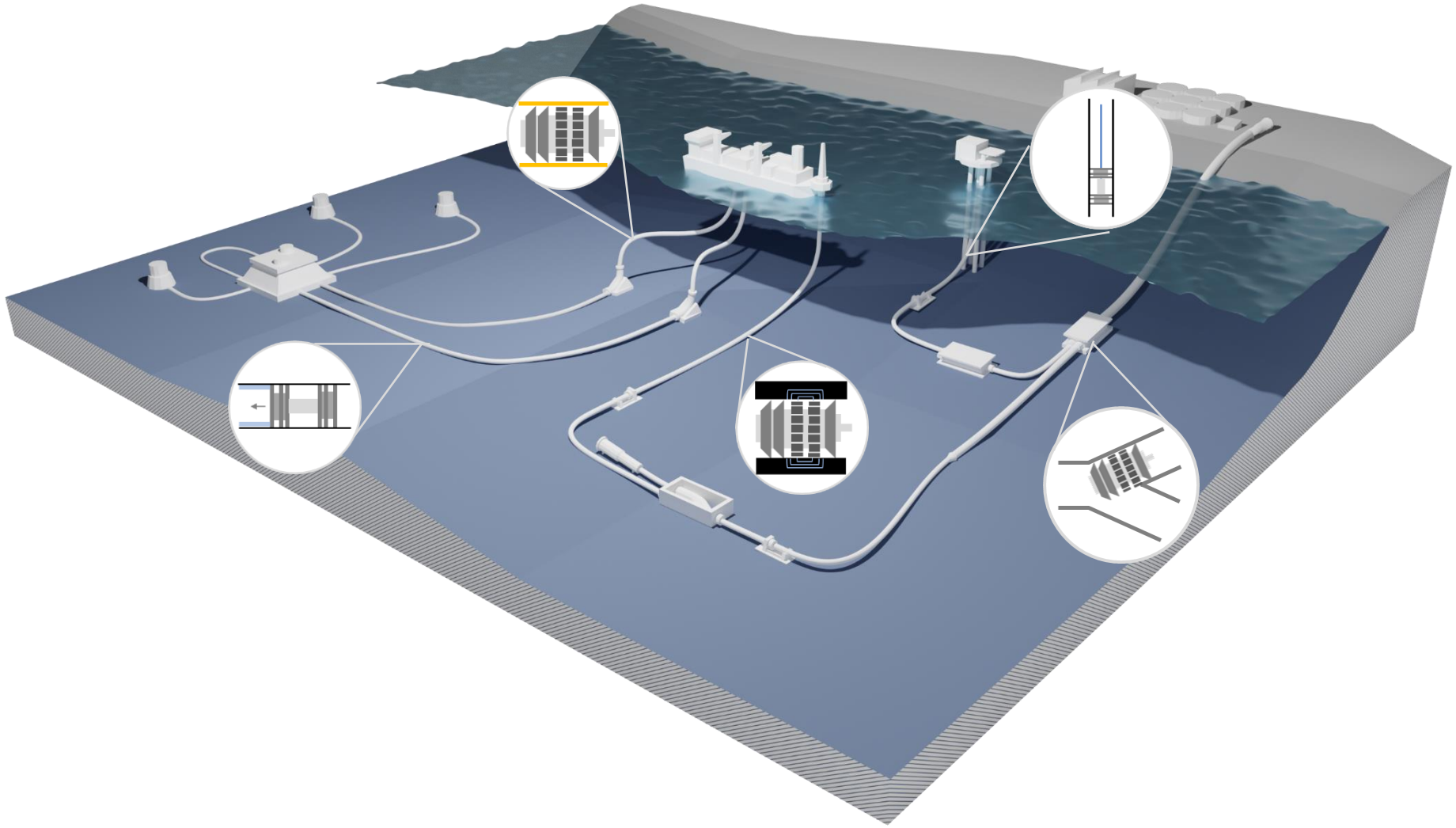
Test Loop

- 51 elements
  - Full ID range, bends
  - T-Pieces
  - Original Y-Piece
  - Stop/start in all features/sections

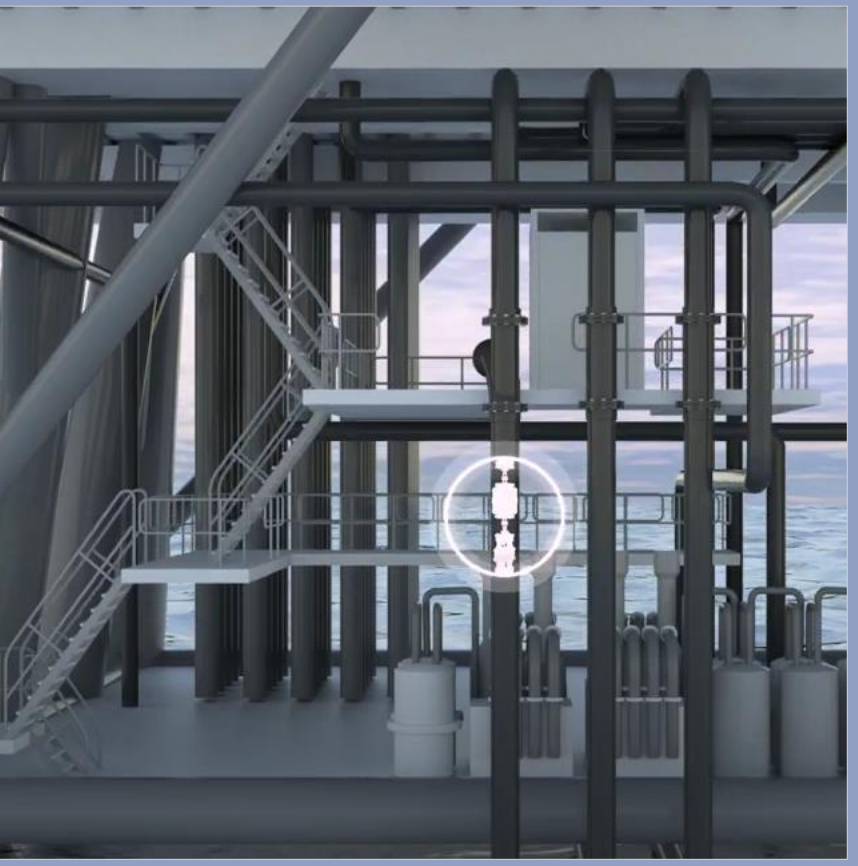
DEEPWATER MULTI-DIAMETER GAS PIPELINE
RESULTS & REVIEW

- Substantial cost saving for the client due to early ROSEN involvement at pipeline design phase
- Staged approach to design and testing
- Onerously test tool
- ILI run was successful:
  - Delivered Ontime
  - Quality geometry, metal loss & XYZ data
  - 100% internal coverage
- High repeatability of IEC data to allow for accurate corrosion growth estimates

DEEPWATER PIPELINES
ASSOCIATED PIGGING CHALLENGES



SELF-PROPELLED TETHERED TOOLS



THE CHALLENGE

- Line cannot be looped or is risky to loop due to malfunctioning valves
- Conventional Bi-Di pigging is not possible because flow cannot be reverse

BENEFIT

- Capable to measure geometry, wall thickness, corrosion, cracks
- Utilizes TOFD for girth weld inspection
- Can be used to grind girth welds
- Data recorded in and out in real-time
- Capability in 6” and larger
- Up to 12km inspected previously, longer length possible (up to 24 km)

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Precise Data Collection from 10” Pipeline

Girth Weld Integrity & Crack-Like Defects

THANK YOU FOR JOINING THIS PRESENTATION.

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