

Technologies Developed for Long Length Cost Effective Tieback Umbilicals

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Cost Effective Long Length Tieback Umbilicals

Subsea Umbilical

Hydraulic

- Power to actuate valves
- Chemical Injection
- Coolant
- Gas Injection
- Annulus Bleed Lines

Electric Control

- Control of Valves
- Power to Wellhead Controls

Power Transfer

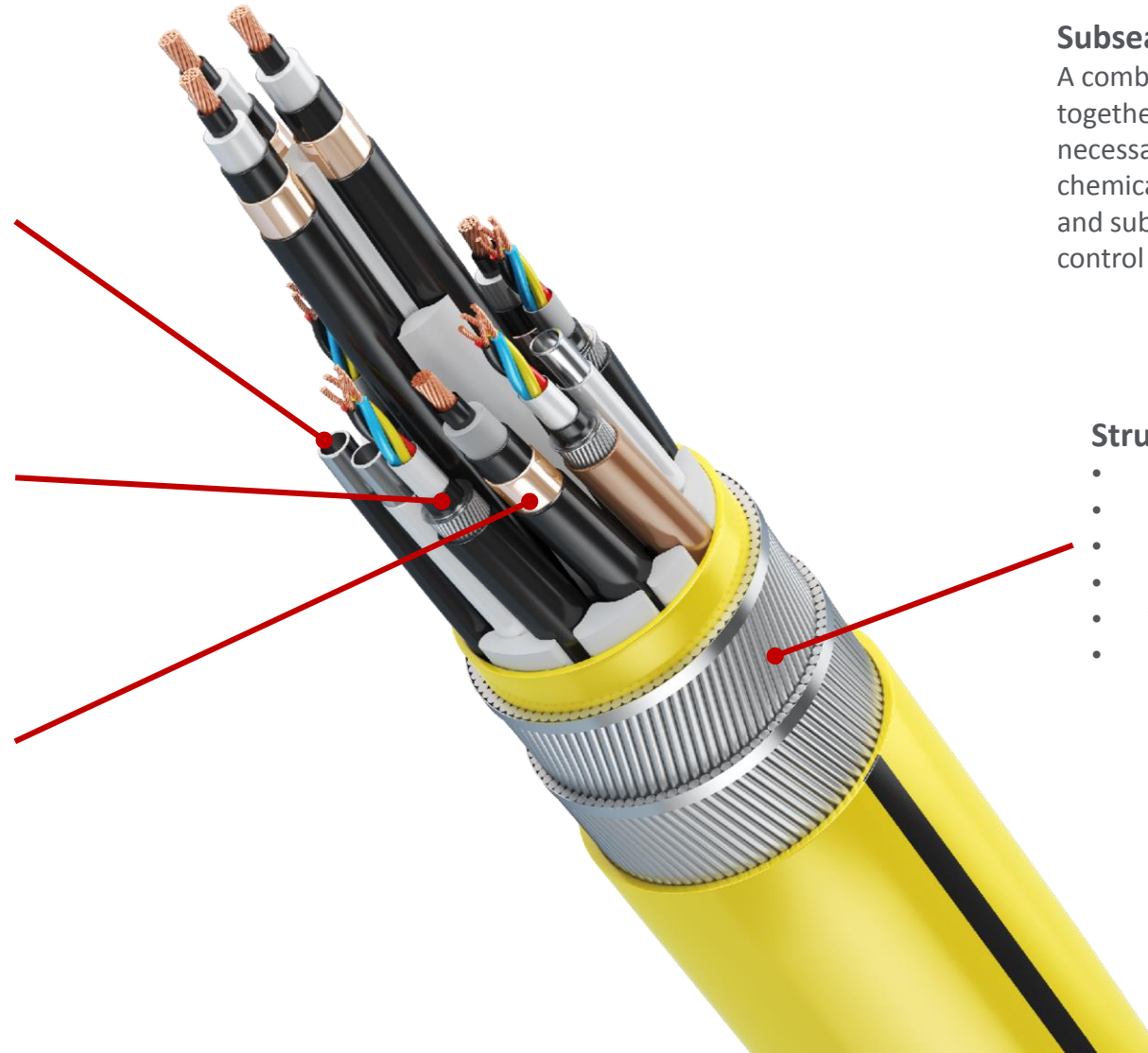
- Power to Subsea Pumps
- Power Supply to facilities
- Heated Pipelines

Subsea Umbilical

A combination of components bundled together and designed to supply necessary control, energy and chemicals to subsea wells, manifolds and subsea systems requiring remote control

Structural Integrity

- Axial Strength
- Impact Resistance
- Abrasion Resistance
- Ballast
- Torsional Balance
- Fatigue Resistance



Cost Effective Long Length Tieback Umbilicals

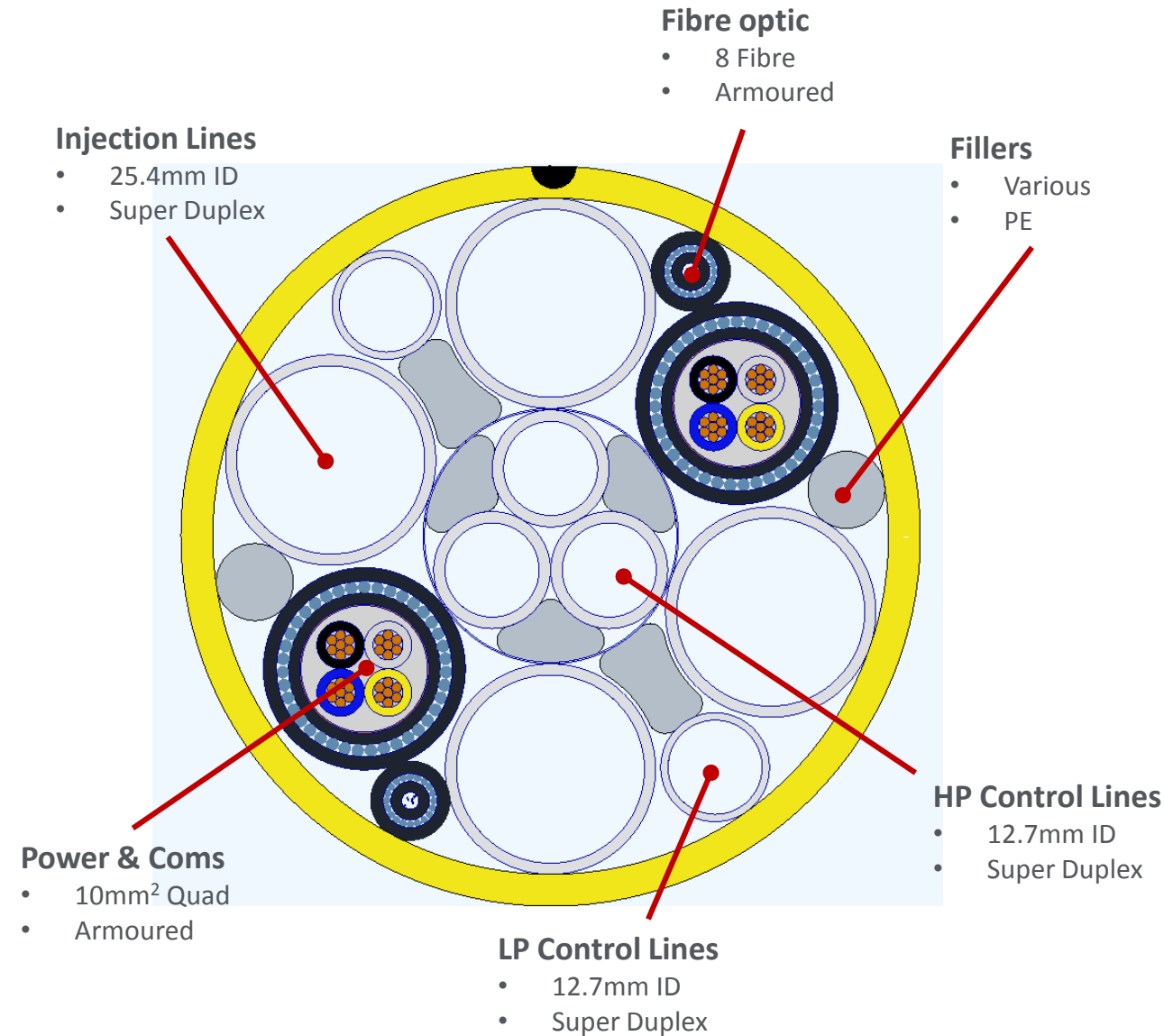
Challenges

Challenge

- ▶ Reduce installed cost of umbilical system whilst maintaining functionality
 - ▶ Minimise dry weight, outer diameter & umbilical complexity
 - ▶ Challenge existing industry conservatism and identify cost savings with minimal risk
 - ▶ Optimize installation capacity, submerged weight, structural integrity

The 'Standard Umbilical'

- ▶ Design philosophy based upon industry requirements
- ▶ Long length, typically 80km+



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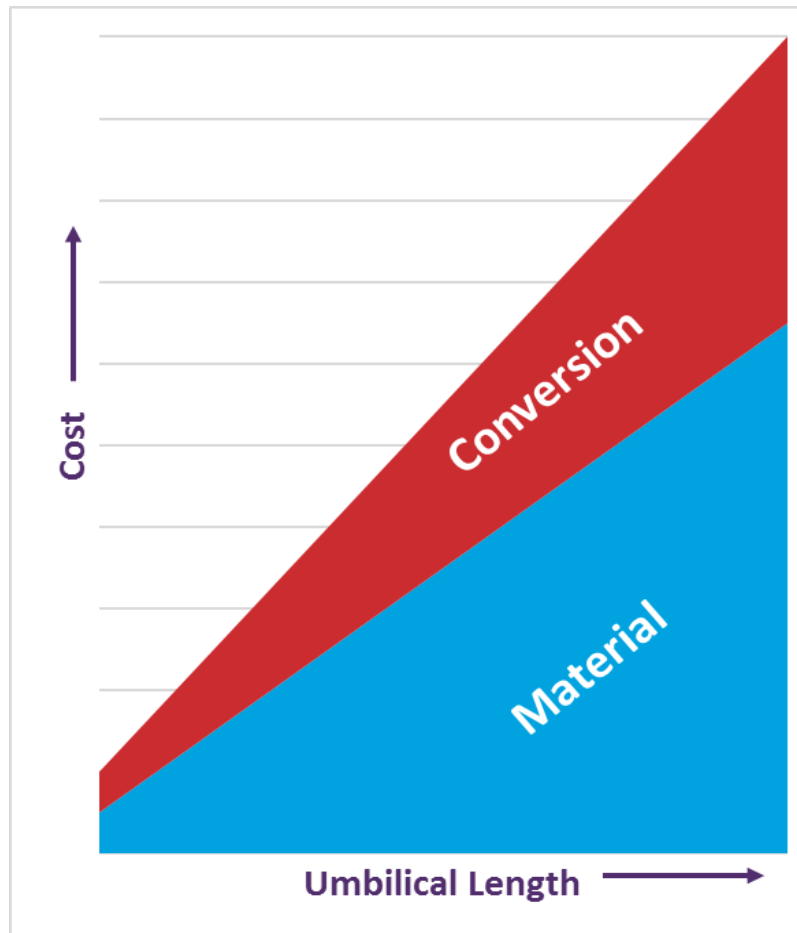
Cost of the System

Cost Challenges

- ▶ Material cost is dominant
- ▶ Cost and length approximately proportional

Installation

- ▶ Light weight required for long length
- ▶ Long weather windows required
- ▶ Cost v risk value balance



- ▶ Cross section design
- ▶ Control system integration
- ▶ Manufacturing efficiency

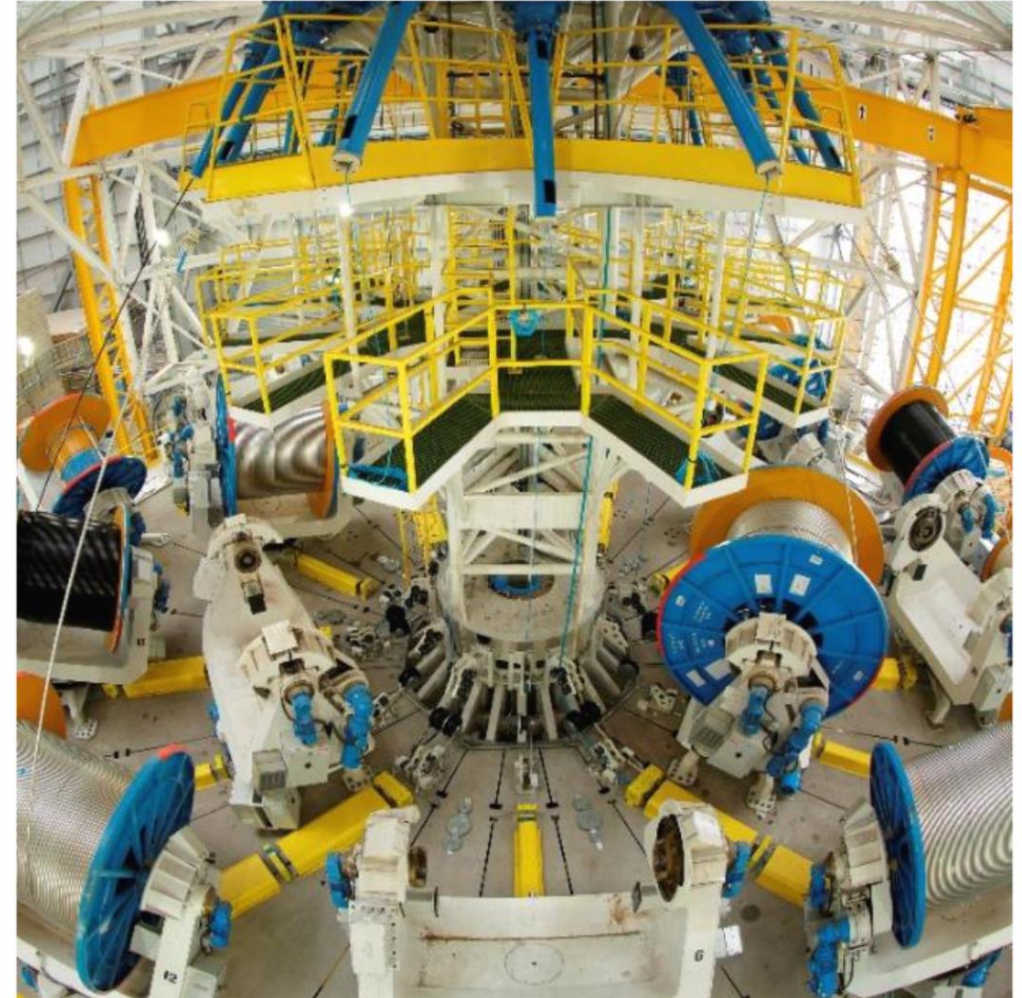
- ▶ Functional component design
- ▶ Specification review
- ▶ Material choice
- ▶ Manufacturing options

Cost Effective Long Length Tieback Umbilicals

Conversion Cost Optimization

Cost Effective Conversion

- ▶ Maximise manufacturing through-put through effective use of assets & design
 - ▶ Minimize use of non-functional materials
 - ▶ Exploit full capacity of manufacturing assets
 - ▶ Cross section designed around efficiency of manufacturing process
 - ▶ Quality driven design for ease of manufacture; using experience to avoid manufacturing quality issues



Cost Effective Long Length Tieback Umbilicals

Material Cost Optimization



Cost Effective Cable Design

- ▶ Remove conservatism creep developed over the past 30 years & optimise against ISO standard
- ▶ Component cost, umbilical OD and umbilical weight reduction

Move towards Electric Control

- ▶ DC/AC transmission cable optimised for step out distance
- ▶ Integration of control & umbilical system design



Cost Effective Hydraulic Design

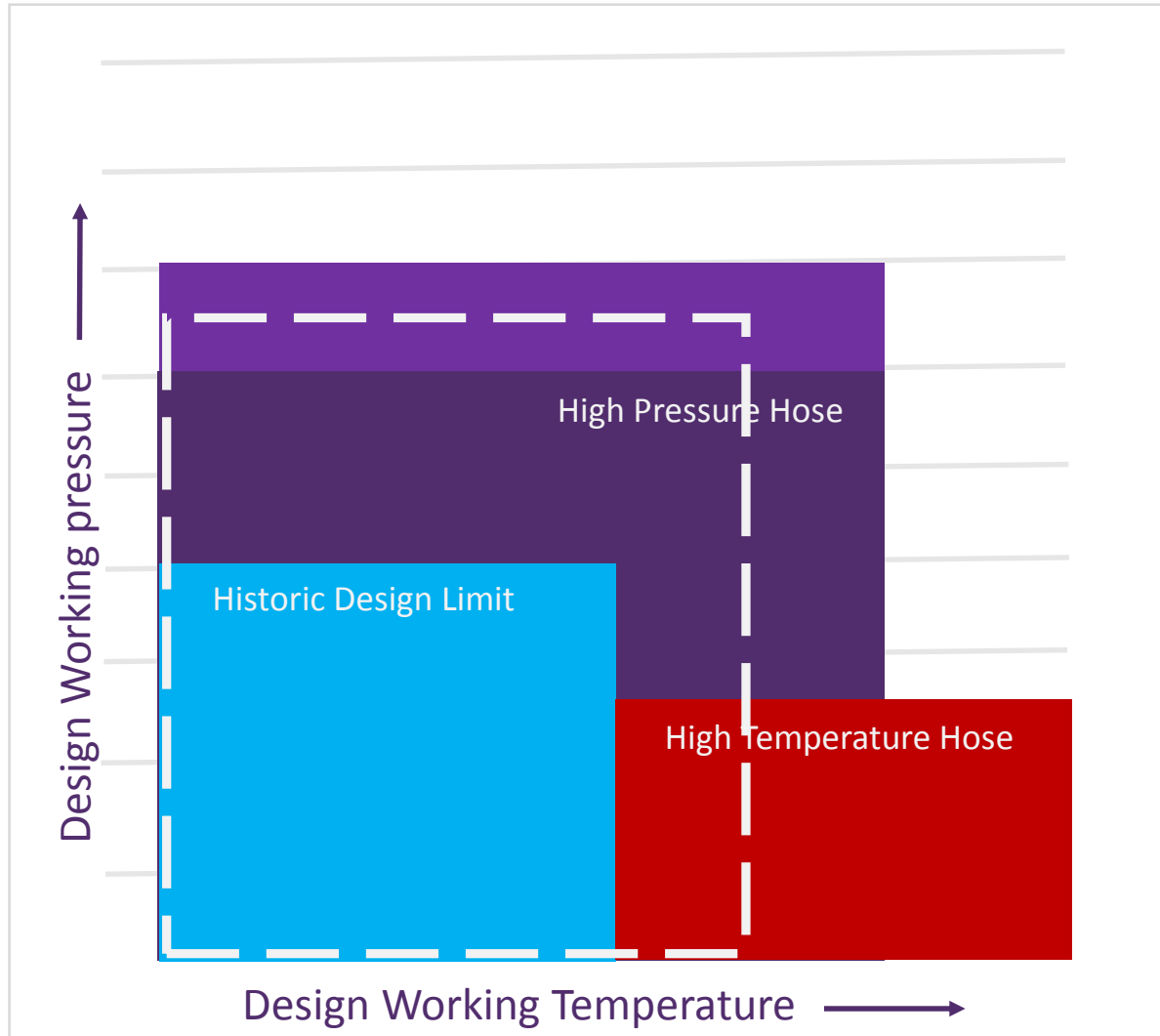
- ▶ Optimise manufacture & design of steel tubes for actual function
- ▶ Optimise materials used
- ▶ Challenge conservative assumption on operation

High Integrity Thermoplastic Materials

- ▶ New materials enable thermoplastic hose to compete directly with steel tube

Cost Effective Long Length Tieback Umbilicals

Material Cost Optimization

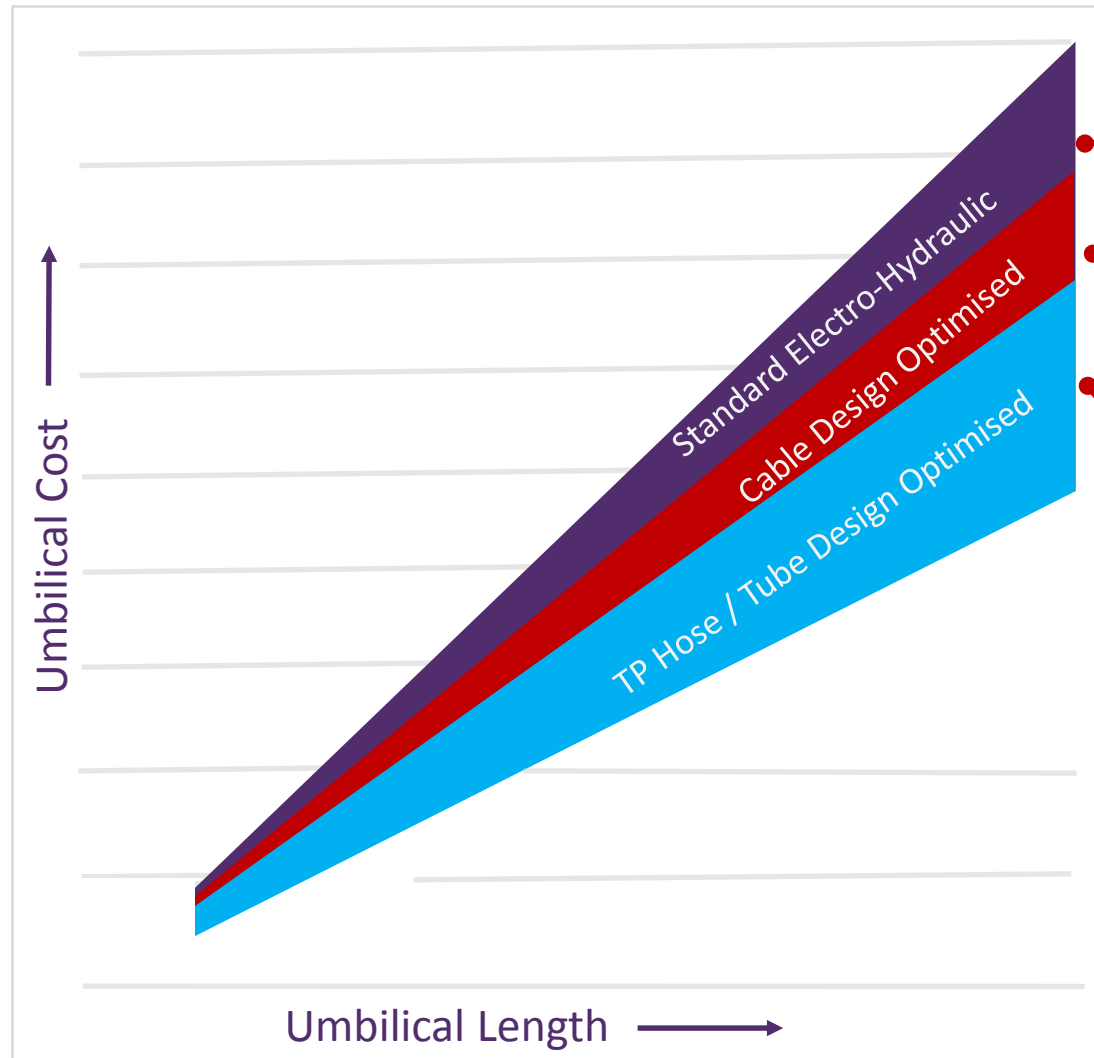


High Integrity Thermoplastic Materials

- ▶ High temperature and high pressure hose currently available
- ▶ Standard hose material cost reduction in line with optimised tube
- ▶ High temperature hose significantly more cost effective than equivalent high temperature tube design
- ▶ Significant cost reduction of thermoplastic v steel tube umbilical

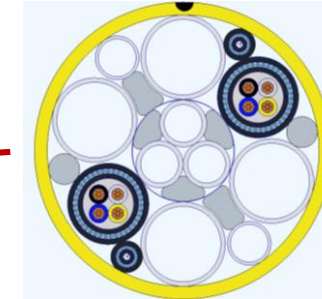
Cost Effective Long Length Tieback Umbilicals

Material Cost Optimization



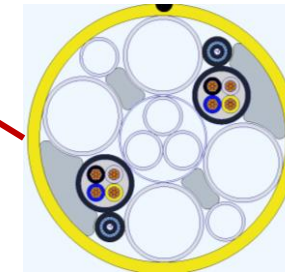
Standard

- ISO 13628-5 compliant
- Seamless super duplex



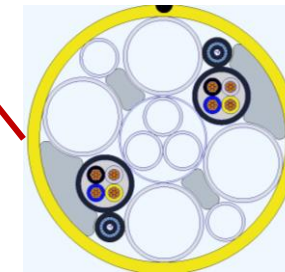
Cable Design

- Cable design optimised
- Material optimised



Tube Design / Thermoplastic Hose

- Tube design optimised
- 10% reduction in wt
- Material optimised

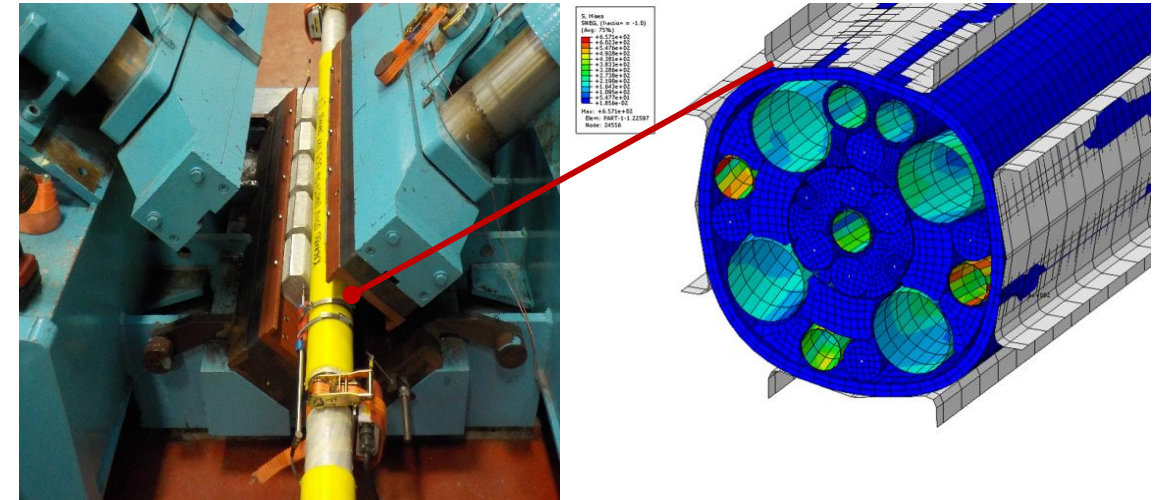


Cost Effective Long Length Tieback Umbilicals

Installation & Service Optimization

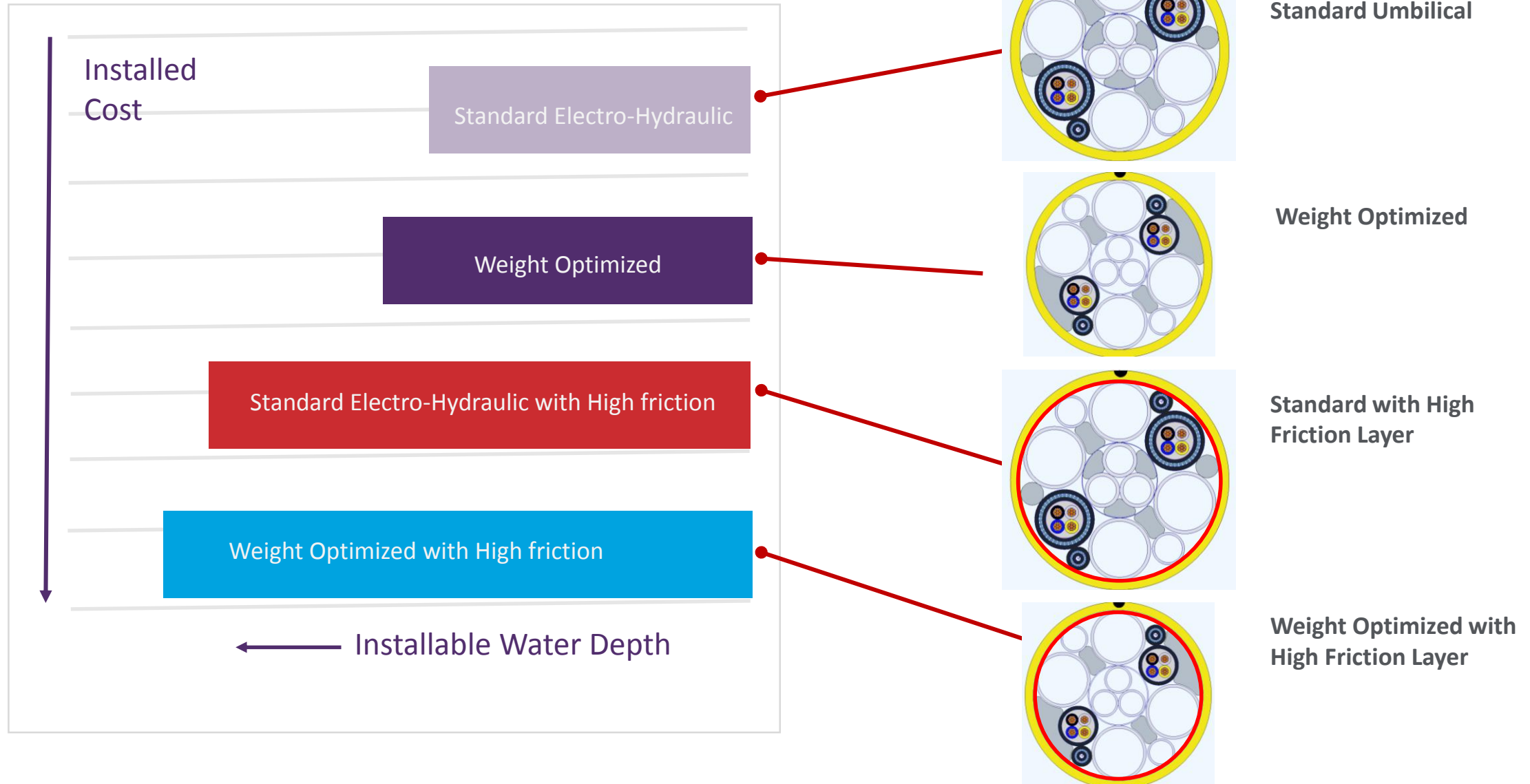
Optimize Installation Efficiency in Deep Water

- ▶ Too much material optimisation can result in structural deficiencies
- ▶ High friction aid – Patented CompressiGrip added to bundle to reduce required squeeze loads in tensioners
- ▶ Understand operational limits and balance cost saving with risk whilst using new technologies to enable higher performance



Cost Effective Long Length Tieback Umbilicals

Installation Load Optimization

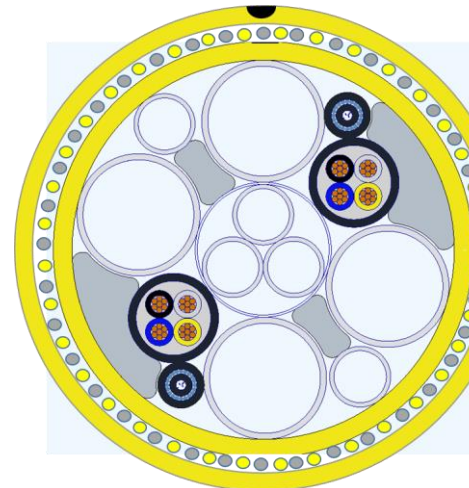
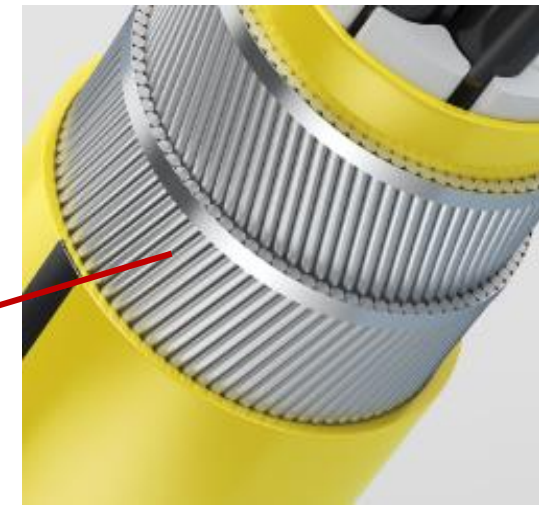
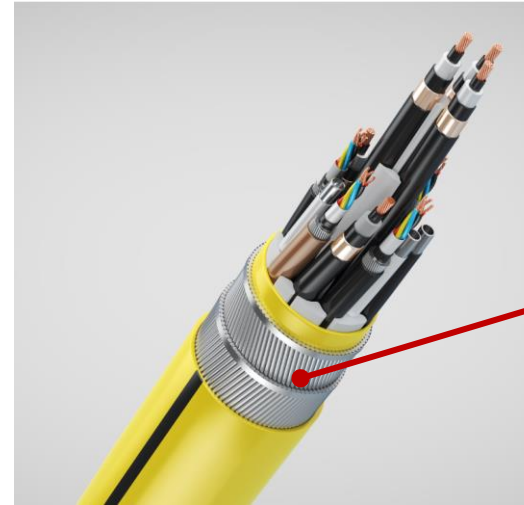


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Installation & Service Optimization

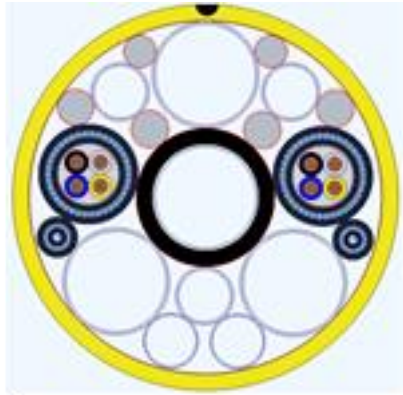
Optimized installability and on-bottom stability in Shallow Water

- ▶ Material optimization or simplification can result in in-place stability deficiencies or reduce the durability of the system
- ▶ Optimized armoring added to bundle as ballast to ensure the umbilical is stable and to protect the structure from abrasion
 - ▶ Conventional metallic armor adds weight and toughness in particular to thermoplastic umbilicals
 - ▶ Patented composite armor provides strength and resilience without taxing weight

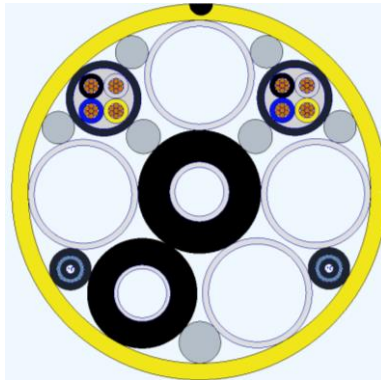


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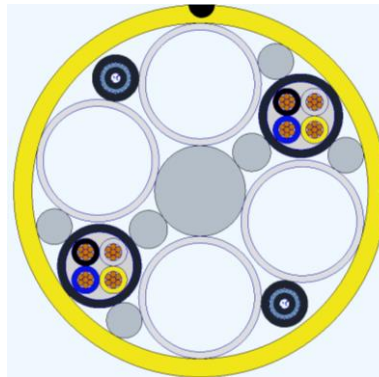
Move Towards Electric Control



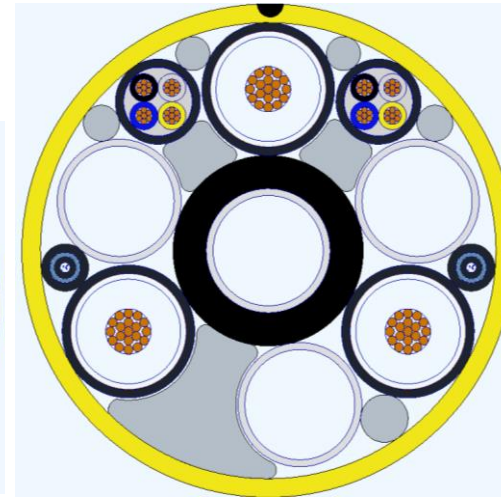
Standard Design



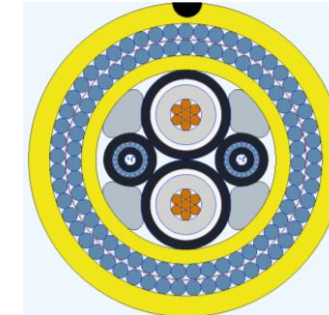
EII Electric Tree



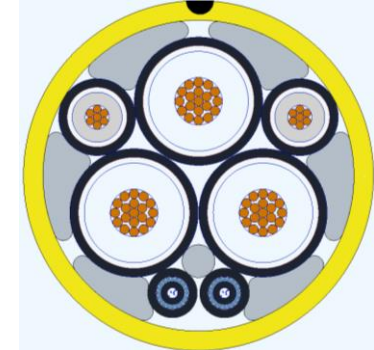
All Electric Control



All Electric IPCU



DC All Electric

All Electric IPCU with
subsea Chemical
Storage

Electric Power & Control

- ▶ Cost reduction through reduced complexity & implementation of full electric control system
- ▶ Fully integrated system with optimised transmission and control architecture

Electric System Optimization

- ▶ Smart power management systems, optimised cable sizes
- ▶ DC System for ultra-long length step out
- ▶ Bundling control and power system for efficient installation

Cost effective Long Length Tieback Umbilicals

Summary

Challenges of long length tieback umbilicals

- ▶ Minimise dry weight, outer diameter & umbilical complexity
- ▶ Challenge existing conservatism and identify cost savings with minimal risk
- ▶ Optimise installation capacity, submerged weight, structural integrity

Technologies Developed

- ▶ Low cost cables – TRL 5
- ▶ Optimized tube design & Next Generation TP hose – TRL 5
- ▶ Composite amours – TRL 7
- ▶ High friction installation aid – TRL 5
- ▶ AC / DC electric control systems – TRL 7

