What Does FLNG Mean for the Pipeline Industry?

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Agenda

- Introduction
- Some facts and figures
- Field layout and pipeline design
- What can history tell us (FPSO analogy)
- Flow Assurance
- Conclusions

Is FLNG the end of the pipeline industry?

With the advent of FLNG, the need for new large onshore infrastructure and therefore long large diameter trunklines to connect to them has changed.

This has lead many in the subsea world to declare that the local pipeline industry is now longer needed.

Whilst the demand for large diameter pipelines may change, the number and complexity of the future infield flow lines for FLNG will increase.

FLNG Technology

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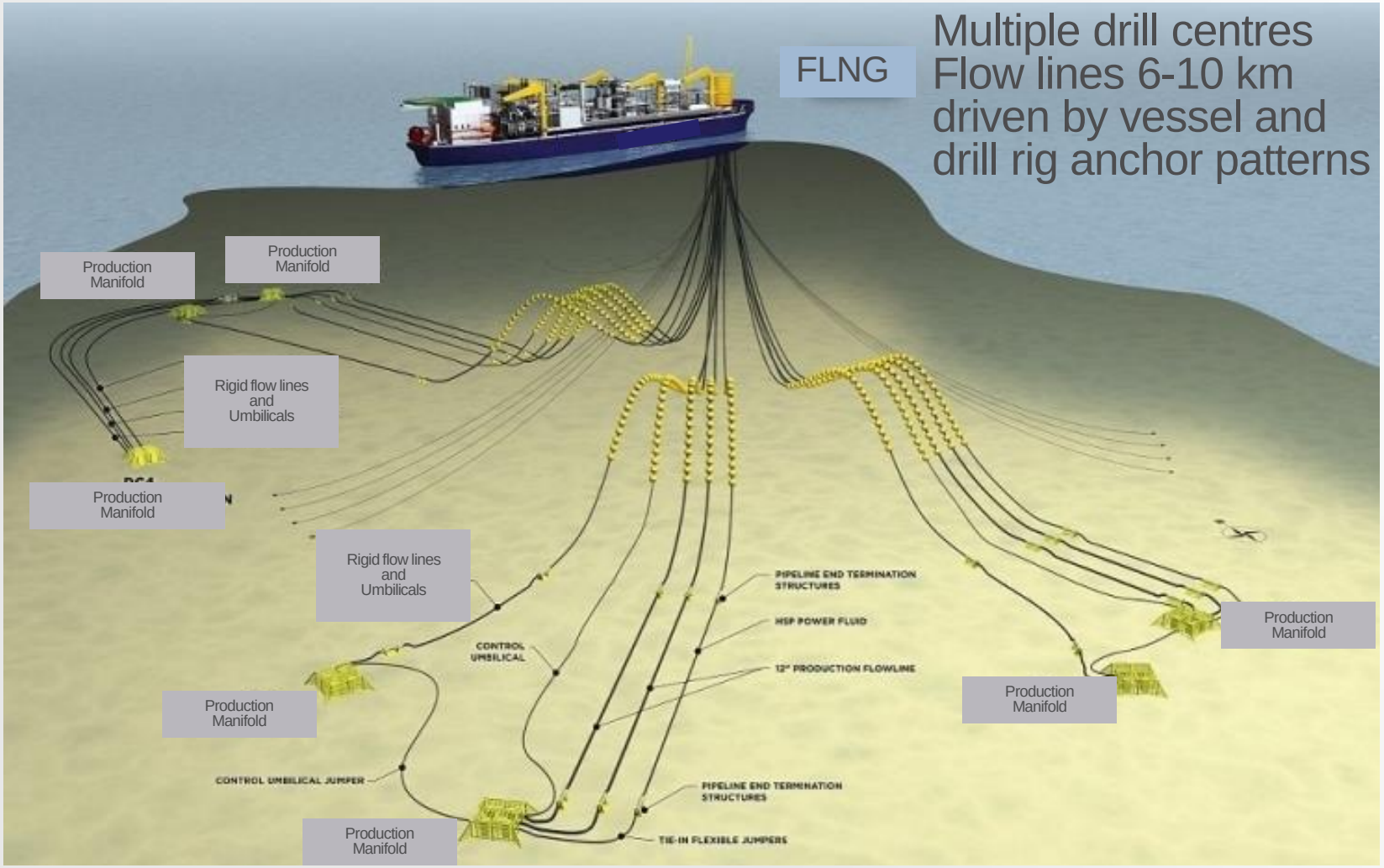
Pipeline Design

Gas reservoir parameters offshore WA:

- Temperature: 100^0C - 160^0C
- Pressure: 230 - 300 Bar *
- Water depth: 100 – 1500m
- Medium to high CO_2 levels
- Low H_2S
- Waxy condensates
- Design Life 25-40 years

* Design Pressure may be as much as 690 Bar driven by MEG (mono-ethylene glycol) injection pressures.

Possible Subsea Layout



Potential Design Issues

Issue	Flow assurance	Material selection	Buckling / Walking	Installation
High temp		Material de-rating	Larger driving force More Transients	
Short flow lines			Walking sweet spot	
High pressure		Thicker Pipe		
Corrosive		CRA lined pipe		CRA Welding
Waxy				
Single train LNG	Reliability		More shutdown/ start-ups	

Short, hot, high pressure flow lines with medium to high CO_2 levels and waxy condensates!

Risers

Current Flexible Riser Technology:

- Temp 130^{0}C < max temp
- Pressure, ID dependent

Project Name	Operator	Field Location	FPSO Mooring	Riser Concept
Girrasol	Total	WoA	spread	Bundle Tower Riser
Kizomba	ExxonMobil	WoA	spread	FSHR
Bonga	Shell	WoA	spread	SCR
Erha	ExxonMobil	WoA	spread	SCR
AKPO	Total	WoA	spread	SCR
				ower Riser
Ba	Petrobras	Brazil	spread	Flexible Riser
Caratinga	Petrobras	Brazil	spread	Flexible Riser
Marlim Sul	Petrobras	Brazil	Turret	Flexible Riser
Cascade & Chinook	Petrobras America	GoM	Turret	FSHR
BC 10	Shell	Brazil	Turret	Lazy Wave SCR
Gendalo & Gehem	Chevron	Offshore Indonesia	spread	SCR
Leviathan	Noble	Offshore Israel	spread	SCR

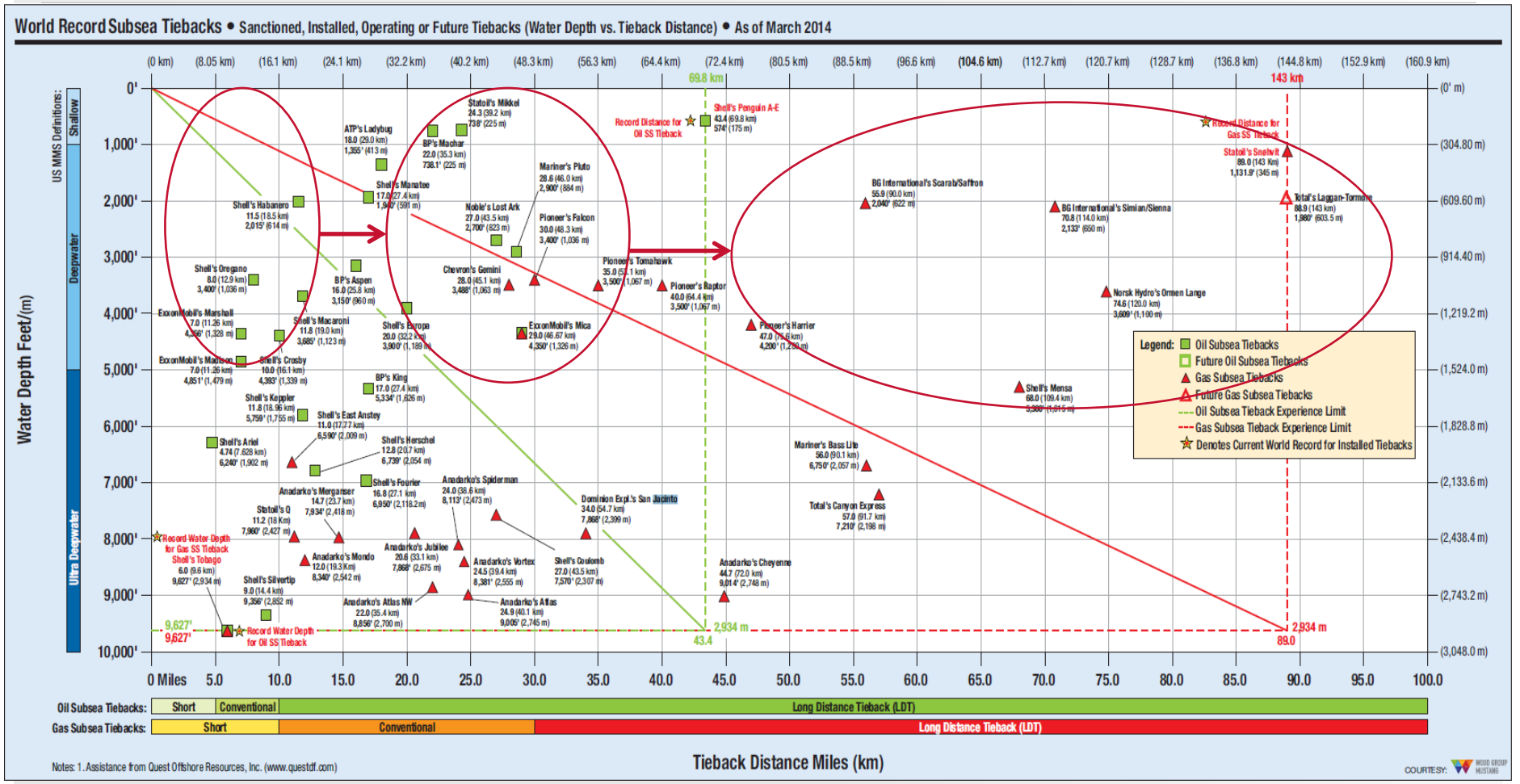
Could SCR's be added to the pipeline mix ?

What Can History Tell Us (FPSO analogy)?

- First FPSO installed in 1985 in 50 m water depth, 10-15 wells
- Currently we have over 200 FPSO's in up to 2000+m water depth, 40-50 wells
- Initially fields designed with short step out distances i.e. 5-10 km
- Current tieback distances are now 20-40+ km

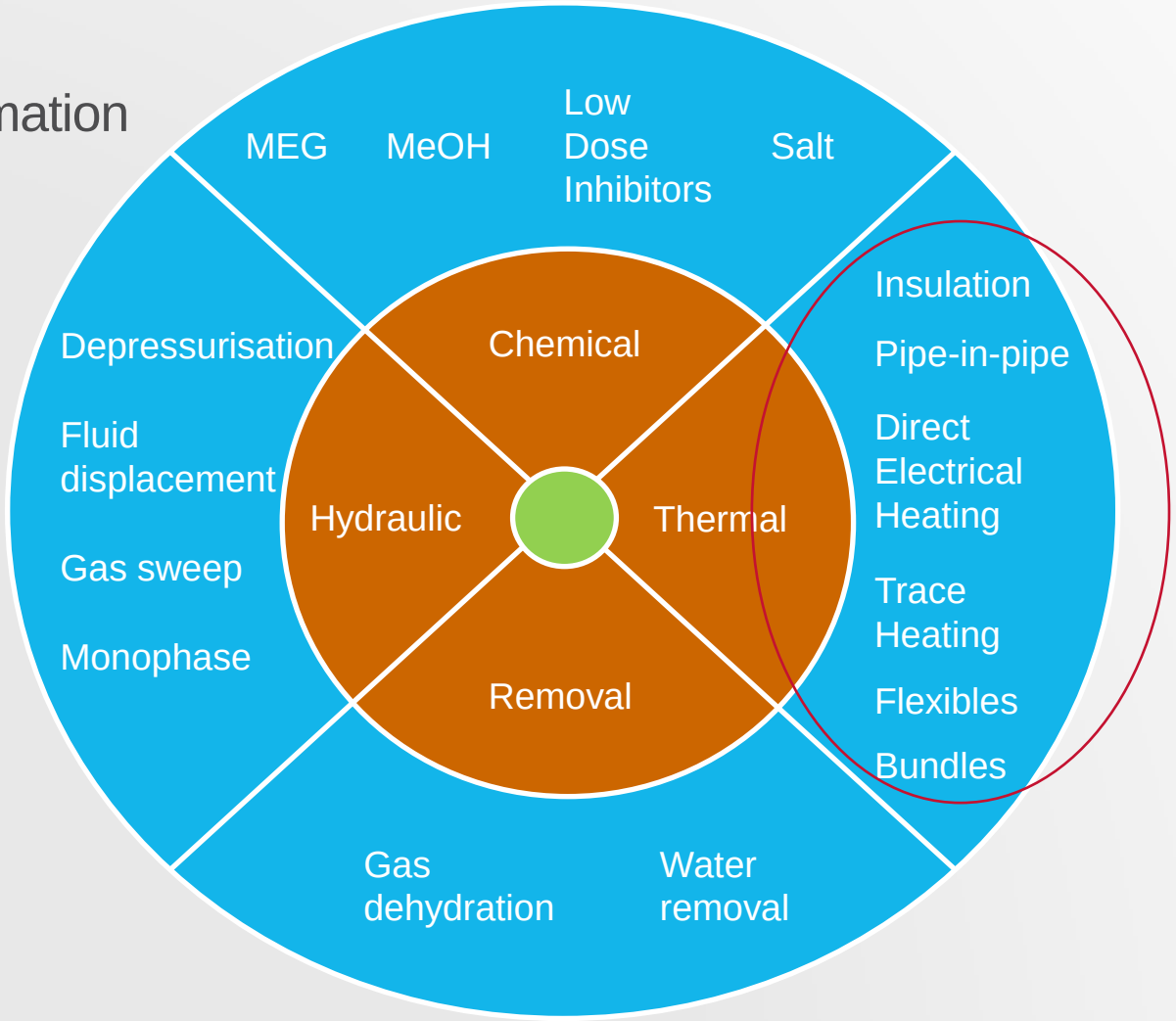
Will FLNG head the same way?

Subsea Tieback lengths

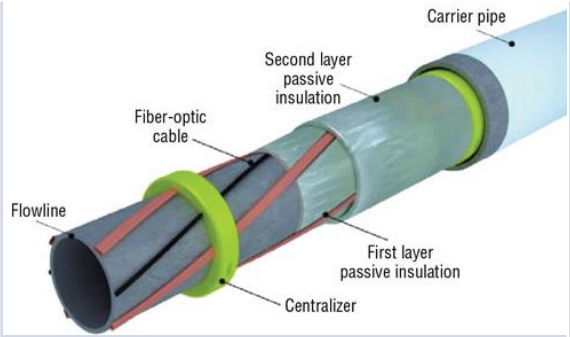


Flow Assurance Issues & Available Mitigation Techniques

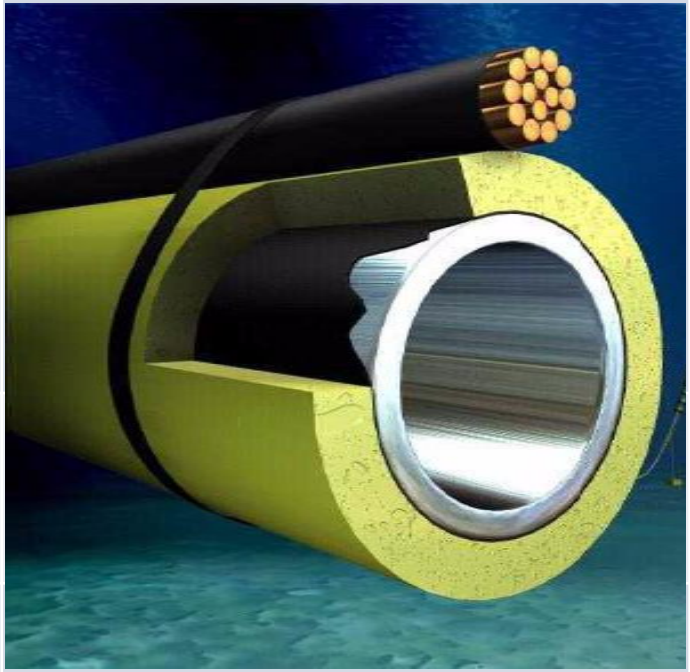
- Hydrate formation
- Waxing



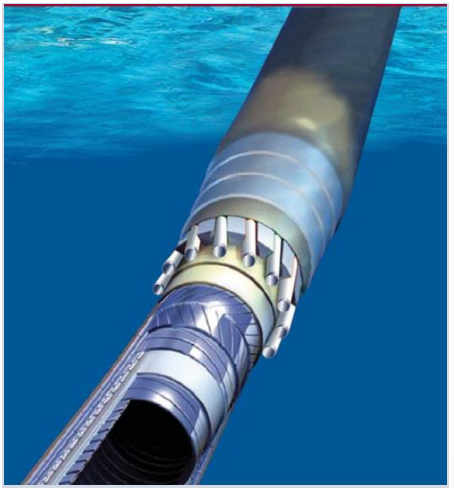
Active Flowline Heating (AFH) Technologies



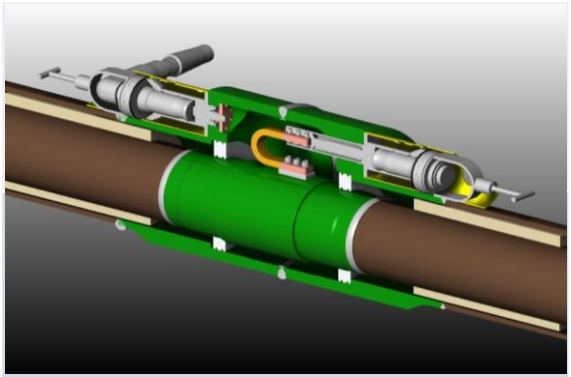
Electrically Trace Heated Pipe-in-Pipe (ETH PiP)



Open Direct Electrical Heating (Open DEH)



Integrated Production Bundle (IPB)



Direct Electrical Heating Pipe-in-Pipe (DEH PiP)

Rigid Pipe Bundle

Closing Comments

Pipelines servicing FLNG facilities will have various design challenges due to the nature of the product, the field layouts, design life and location.

As FLNG facilities are deployed the subsea pipeline industry will have to develop and evolve to continue to support these field developments.

FLNG is not the end of the subsea pipeline industry but a new era which will require innovative thinking and new technologies to solve the potential design issues.

Questions ??