What Does FLNG Mean for the Pipeline Industry?

Alan Gillen
Principal Pipeline Engineer & Pipeline TA

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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

Production rates:
• 3.9 Mtpa of LNG
• 22,0000 bpd condensate

Total Liquid Storage:
• 437,500 m$^3$ or 125 Olympic swimming pools
Gas reservoir parameters offshore WA:

- Temperature: 100°C - 160°C
- Pressure: 230 - 300 Bar *
- Water depth: 100 – 1500m
- Medium to high CO₂ levels
- Low H₂S
- 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

Multiple drill centres
Flow lines 6-10 km
driven by vessel and
drill rig anchor patterns
## Potential Design Issues

<table>
<thead>
<tr>
<th>Issue</th>
<th>Flow assurance</th>
<th>Material selection</th>
<th>Buckling / Walking</th>
<th>Installation</th>
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<tbody>
<tr>
<td>High temp</td>
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<td>Material de-rating</td>
<td>Larger driving force More Transients</td>
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<td>Short flow lines</td>
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<td>Walking sweet spot</td>
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<td>High pressure</td>
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<td>Thicker Pipe</td>
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<td>CRA Welding</td>
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<td>Corrosive</td>
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<td>CRA lined pipe</td>
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<td>Waxy</td>
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<td>Single train LNG</td>
<td>Reliability</td>
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<td>More shutdown/ start-ups</td>
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Short, hot, high pressure flow lines with medium to high CO₂ levels and waxy condensates!
Risers

**Current Flexible Riser Technology:**
- Temp 130°C < max temp
- Pressure, ID dependent

<table>
<thead>
<tr>
<th>Project Name</th>
<th>Operator</th>
<th>Field Location</th>
<th>FPSO Mooring</th>
<th>Riser Concept</th>
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<td>WoA</td>
<td>spread</td>
<td>Bundle Tower Riser</td>
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<td>Kizomba</td>
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<td>Barrauda</td>
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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

- Chemical
  - MEG
  - MeOH
  - Low Dose Inhibitors
  - Salt

- Thermal
  - Insulation
  - Pipe-in-pipe
  - Direct Electrical Heating
  - Trace Heating
  - Flexibles
  - Bundles

- Hydraulic
  - Depressurisation
  - Fluid displacement
  - Gas sweep
  - Monophase

- Removal
  - Gas dehydration
  - Water removal
Active Flowline Heating (AFH) Technologies

- Electrically Trace Heated Pipe-in-Pipe (ETH PiP)
- Direct Electrical Heating Pipe-in-Pipe (DEH PiP)
- Open Direct Electrical Heating (Open DEH)
- Integrated Production Bundle (IPB)
- Rigid Pipe Bundle
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  ??