NEW APPROACHES for subsea installations

“*The information within this document is confidential and intended solely for the use of the individual or entity to whom they are addressed and may contain privileged information or otherwise protected by work-product immunity or other legal rules. You may not copy or disclose its contents to anyone other than set forth under the agreed confidentiality agreement. In case you have doubts about the nature of the information, you should contact us in advance.*"
Introduction

Using a converted drilling rig to lay mechanically connected pipe

Drill-Lay

CompRiser®

Hybrid riser tower with composite risers and a structural steel core pipe

“The information within this document is confidential and intended solely for the use of the individual or entity to whom they are addressed and may contain privileged information or otherwise protected by work-product immunity or other legal rules. You may not copy or disclose its contents to anyone other than set forth under the agreed confidentiality agreement. In case you have doubts about the nature of the information, you should contact us in advance.”
Using a converted-drilling rig to lay mechanically connected pipe

01

Drill-Lay

Hybrid riser tower with composite risers and a structural steel core pipe

“\textit{The information within this document is confidential and intended solely for the use of the individual or entity to whom they are addressed and may contain privileged information or otherwise protected by work-product immunity or other legal rules. You may not copy or disclose its contents to anyone other than set forth under the agreed confidentiality agreement. In case you have doubts about the nature of the information, you should contact us in advance.”}
What were the drivers for the innovation?

- Steel risers gain space in the Brazilian market
- Vessel availability for steel riser installation (ex: Reel lay, J-lay) – Scarce resource x tight schedule
- Different market cycle
- How to compete with a fit for purpose vessel?
- What are the required modifications, and will they change the drilling rig configuration?
- What are the constrains of the drilling rig and how can it be overcome?
1.2 Drill - Lay Enabler

GMC Mechanical Connector

Oil States Merlin Connector

“The information within this document is confidential and intended solely for the use of the individual or entity to whom they are addressed and may contain privileged information or otherwise protected by work-product immunity or other legal rules. You may not copy or disclose its contents to anyone other than set forth under the agreed confidentiality agreement. In case you have doubts about the nature of the information, you should contact us in advance.”
Method Overview

- Deck handling similar to marine riser
- 12m line pipe welded to double joints onshore;
- Mechanical connectors welded onshore;
- Double joints transferred to rig offshore
- Pipe lay using stinger

Required modification to rig

- Stinger; A&R winch; A&R sheave; Friction clamp (optional)
- Connector clamping system

"The information within this document is confidential and intended solely for the use of the individual or entity to whom they are addressed and may contain privileged information or otherwise protected by work-product immunity or other legal rules. You may not copy or disclose its contents to anyone other than set forth under the agreed confidentiality agreement. In case you have doubts about the nature of the information, you should contact us in advance."
Drill - Lay Overview

Limitations

- No welding – use of mechanical connector
  - No track record for permanent production risers
  - Track record for dynamic applications (TLP legs, caissons)
- Not possible to install traditional buoyancy modules (for SLWR)

Advantages

- Vessel availability in Brazil
- Good vessel motion (semi sub)
- Reversible connection

Next steps

- Basic engineering for pipelay equipment – ongoing
- Mechanical connector qualification between suppliers and Oil Companies - ongoing
- Seal Test philosophy – jointly performed with the mechanical connector qualification
- Solution for FJC – ongoing

“Confidential information within this document is confidential and intended solely for the use of the individual or entity to whom they are addressed and may contain privileged information or otherwise protected by work-product immunity or other legal rules. You may not copy or disclose its contents to anyone other than set forth under the agreed confidentiality agreement. In case you have doubts about the nature of the information, you should contact us in advance.”
Using a converted drilling rig to lay mechanically connected pipe

Hybrid riser tower with composite risers and a structural steel core pipe

"The information within this document is confidential and intended solely for the use of the individual or entity to whom they are addressed and may contain privileged information or otherwise protected by work-product immunity or other legal rules. You may not copy or disclose its contents to anyone other than set forth under the agreed confidentiality agreement. In case you have doubts about the nature of the information, you should contact us in advance."
Using a converted-drilling rig to lay mechanically connected pipe

CompRiser®

Hybrid riser tower with composite risers and a structural steel core pipe

"The information within this document is confidential and intended solely for the use of the individual or entity to whom they are addressed and may contain privileged information or otherwise protected by work-product immunity or other legal rules. You may not copy or disclose its contents to anyone other than set forth under the agreed confidentiality agreement. In case you have doubts about the nature of the information, you should contact us in advance."
What is a Riser Tower?

What changes with CompRiser®?

- TCP risers
- No bundle buoyancy
- Bundle weight: 3300mT → 1500mT
- Guide frame greatly simplified
- Termination assemblies
- Steel core pipe, suction pile, buoyancy tank are the same

INFO

- Conceptual design finalized in 2018 - Q1 (DEL)
Riser Load decrease at the FPU

<table>
<thead>
<tr>
<th></th>
<th>Flexible</th>
<th>SLWR</th>
<th>Decoupled</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>3300</td>
<td>3000</td>
<td>200</td>
</tr>
<tr>
<td>Diff.</td>
<td>3100</td>
<td>2800</td>
<td>-</td>
</tr>
<tr>
<td>incl Moor</td>
<td>3255</td>
<td>2940</td>
<td>-</td>
</tr>
<tr>
<td>incl stru</td>
<td>3655</td>
<td>3340</td>
<td>-</td>
</tr>
<tr>
<td>Winch</td>
<td>600</td>
<td>500</td>
<td>50</td>
</tr>
</tbody>
</table>

Nominal Loads on FPSO balcony
(4PO + 4WAG = 1 Decoupled System)

The load reduction on a FPSO with more than 16 risers is greater than 7,000 tons
LRTA for HRT (as bid in 2012)

LRTA for CompRiser® (patent pending)
- Less 2 Connectors per riser
- Less 1 PLET per riser
- Less 1 spool
- 500mT → 60mT

“*The information within this document is confidential and intended solely for the use of the individual or entity to whom they are addressed and may contain privileged information or otherwise protected by work-product immunity or other legal rules. You may not copy or disclose its contents to anyone other than set forth under the agreed confidentiality agreement. In case you have doubts about the nature of the information, you should contact us in advance.”*
CompRiser® Assembly (patent pending)

- BrasFELS – ideal spot (sheltered water, proximity to Santos Basin, among others)
- TCP delivered in reels
- Assembly – 20 days
- Yard area: 300,000 sqm → 30,000 sqm
“The information within this document is confidential and intended solely for the use of the individual or entity to whom they are addressed and may contain privileged information or otherwise protected by work-product immunity or other legal rules. You may not copy or disclose its contents to anyone other than set forth under the agreed confidentiality agreement. In case you have doubts about the nature of the information, you should contact us in advance.”
Tow Main Characteristics

- Vessels: 2 x 250 t AHTS
- WD: 100 to 200 meters
- Typical Speed: 3 knots
- Fatigue during tow: Improved due to reduction of termination size and overall weight

“The information within this document is confidential and intended solely for the use of the individual or entity to whom they are addressed and may contain privileged information or otherwise protected by work-product immunity or other legal rules. You may not copy or disclose its contents to anyone other than set forth under the agreed confidentiality agreement. In case you have doubts about the nature of the information, you should contact us in advance.”
The information within this document is confidential and intended solely for the use of the individual or entity to whom they are addressed and may contain privileged information or otherwise protected by work-product immunity or other legal rules. You may not copy or disclose its contents to anyone other than set forth under the agreed confidentiality agreement. In case you have doubts about the nature of the information, you should contact us in advance.
Main Principles

- Partnership signed in November 2018
- Horizontal structure to develop, commercialize and build the CompRiser®
- Exclusivity for decoupled systems
- 70% of the CompRiser® material cost (i.e. excl. services) within JV
- Early commercial and technical engagement among partners & possible suppliers

Project management, SCM, E&C
TCP (m-pipe)
Fabrication & Assembly yard
Pros

- Robust concept
- Reduced loads on FPSO → ENABLER
- Versatile → flexible / steel flowlines
- Re-deployment
- Decommissioning (reverse operation)
- Standardization potential
- High local content potential

Cons

- Limited track record (m-pipe)
- Riser replacement not feasible

Next Steps

- System FMECA with DnV (ongoing)
- m-pipe qualification (ongoing)
Thank you
Rio de Janeiro, 2019