Flowline Launch - Analysis and Reality
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SUT China
October 2018
Flowline Launch
Analysis and Reality

September 2018
Kok Ann, Lim
2H Offshore

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Agenda

- Introduction
- Subsea Flowline
  - General Layout
  - Jetty Layout
  - Flowline Bundle
  - Flowline Termination Assembly
  - Ramp Profile
  - Launch Gallery
- Flowline Launch Analysis
  - Model
  - Load Case
  - Design Criteria
  - Launch Stages
  - Challenges

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Introduction

- Subsea bundle flowline launch into water (from jetty)
- Analysis: Design of ramp profile for flowline launch
- Equipment:
  - Trolley
  - Roller
  - Sandbag
  - Centralizer

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Subsea Flowline
General Layout

- **WELL**
- **Internal Flowline Bundle (24" x 564 m)**
- **Flexible Jumpers** 3 x 3" + 3 x 4"
- **FTA Flange connection**
- **Umbilicals 3 off**
- **External Riser Bundle (20" x 60 m)**
- **Dynamic risers 6 off (105 m)**
- **Riser Gravity Base**
- **Buoyancy Tank**
- **FPSO**
- **Mooring 8 legs**
- **WD 90 m**
- **Seabed**

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Subsea Flowline
Jetty Layout

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Subsea Flowline
Flowline Bundle

- Bundle flowline consists of
  - 3 off 6-5/8” production pipes
  - 3 off 3-1/2” gas injection pipes
- 564m long (47 joints at 12m each)
- Empty annulus
- 2 x FTA

<table>
<thead>
<tr>
<th>Description</th>
<th>24”</th>
<th>6-5/8”</th>
<th>3-1/2”</th>
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<tbody>
<tr>
<td>Number of Pipe</td>
<td>1</td>
<td>3</td>
<td>3</td>
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<tr>
<td>Pipe Outer Diameter (mm)</td>
<td>609.6</td>
<td>168.3</td>
<td>88.9</td>
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<tr>
<td>Pipe Wall Thickness (mm)</td>
<td>9.525</td>
<td>12.7</td>
<td>11.13</td>
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<tr>
<td>Weight in Air (kg/m)</td>
<td>141</td>
<td>48.7</td>
<td>21.3</td>
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<tr>
<td>Application</td>
<td>Carrier</td>
<td>Production</td>
<td>Gas Injection</td>
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</table>
Subsea Flowline
Flowline Termination Assembly

- Structure base 3.6m x 6.2m
- Pre-installed jumpers
- Towing pad-eye, mudmat
- Weight in air = 5MT

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Subsea Flowline
Ramp Profile

- 1 set of launch guide and 3 sets of roller guides
- Roller guides positioned V-shape at 120°
- Sandbag placed below roller guides to adjust elevations

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Subsea Flowline Launch Gallery

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Flowline Launch Analysis Model

- Analysis – To design ramp profile for flowline launch
- Software – Flexcom-3D nonlinear time domain FEA
- FE Models – Flowline, flowline termination assembly (FTA), jumpers, buoyancy modules
- Contact – Trolley, launch guide, roller guides

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14 stages of flowline launch

Stage 1 to 6 assessed for static analysis (current loading)

Stage 7 to 14 assessed for dynamic analysis (current and wave loadings)

<table>
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<tr>
<th>Stage</th>
<th>Distance from Shoreline (m)</th>
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<tr>
<td>1</td>
<td>30</td>
</tr>
<tr>
<td>2</td>
<td>40</td>
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<td>3</td>
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<td>13</td>
<td>570</td>
</tr>
<tr>
<td>14</td>
<td>584</td>
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Flowline Launch Analysis
Design Criteria

- Maximum flowline von Mises/yield stress < 0.8
- Sufficient clearance from seabed
- Reaction force at all guides within the design limit
- Reaction force at centralizer within the design limit
- Crane reach distance < 70m from shoreline

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Flowline Launch Analysis
Stage 1

Launching Analysis - Von Mises Stress/Yield of Flowline
12m Interval Support - 30m
No current - No wave - No Pull Force - 13 Tonnes Crane Load

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Flowline Launch Analysis
Stage 2

Launching Analysis - Von Mises Stress/Yield of Flowline
12m Interval Support - 40m
No current - No wave - No Pull Force - 13 Tonnes Crane Load
Flowline Launch Analysis
Stage 3

Launching Analysis - Von Mises Stress/Yield of Flowline
12m Interval Support - 50m
No current - No wave - No Pull Force - 13 Tonnes Crane Load

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Flowline Launch Analysis
Stage 4

Launching Analysis - Von Mises Stress/Yield of Flowline
12m Interval Support - 60m
No current - No wave - No Pull Force - 13 Tonnes Crane Load

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Flowline Launch Analysis
Stage 5

Launching Analysis - Von Mises Stress/Yield of Flowline
12m Interval Support - 70m
No current - No wave - No Pull Force - 13 Tonnes Crane Load

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Flowline Launch Analysis
Stage 6

Launching Analysis - Von Mises Stress/Yield of Flowline
12m Interval Support - 80m
No current - No wave - No Pull Force - No Crane Load

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Flowline Launch Analysis
Stage 7

Launching Analysis - Von Mises Stress/Yield of Flowline
12m Interval Support - 90m
No current - No wave - No Pull Force - No Crane Load

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Flowline Launch Analysis
Stage 8

Launching Analysis - Von Mises Stress/Yield of Flowline
12m Interval Support - 150m
No current - No wave - No Pull Force - No Crane Load

Elevation from Mudline (m)

0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
-5
15
35
55
75
95
11
12
13
14

Horizontal Length from Shoreline (m)

Von Mises Stress/Yield

Flowline
Seabed Profile
FTA
MSL
Shoreline
VM
Flowline Launch Analysis
Stage 9

Launching Analysis - Von Mises Stress/Yield of Flowline
12m Interval Support - 250m
No current - No wave - No Pull Force - No Crane Load

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Flowline Launch Analysis
Stage 10

Launching Analysis - Von Mises Stress/Yield of Flowline
12m Interval Support - 350m
No current - No wave - No Pull Force - No Crane Load

Elevation from Mudline (m)

Horizontal Length from Shoreline (m)

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Flowline Launch Analysis
Stage 11

Launching Analysis - Von Mises Stress/Yield of Flowline
12m Interval Support - 450m
No current - No wave - No Pull Force - No Crane Load

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Flowline Launch Analysis
Stage 12

Launching Analysis - Von Mises Stress/Yield of Flowline
12m Interval Support - 550m
No current - No wave - No Pull Force - No Crane Load

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Flowline Launch Analysis
Stage 14

Launching Analysis - Von Mises Stress/Yield of Flowline
12m Interval Support - 583.6m
No current - No wave - No Pull Force
0.5m FTA-W Lift from First Roller

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Flowline Launch Analysis
Challenges

- Numerous trial and error iterations to obtain the optimum ramp profile for flowline launch

- Large Flexcom finite element model:
  - Mesh size
  - Long analysis computational time

- Contact between flowline and guides – convergence issue

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Questions?

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Thank you

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