An Overview of Advances in Flexible Riser and Flowline Technology

H. Ha

Offshore Convention Myanmar
Riser & Conductor Engineering

Houston | Rio de Janeiro | Aberdeen | London | Kuala Lumpur | Perth | Beijing

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An Overview of Advances in Flexible Riser and Flowline Technology

Presented by Hanh Ha
4th OC Myanmar
January 2016

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Overview

- A little about 2H
- Introduction to Un-Bonded Flexible Pipe
- Developments in Flexible Pipe Technology
- How can this be applied to Myanmar?
- Summary

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About 2H Offshore
Riser & Conductor Engineering

- Founded in 1993
- 250+ highly qualified engineers
- Global standardised procedures for seamless operation
- Extensive experience in all riser types
- Practical understanding of hardware and installation
- Leaders in marine structure dynamics
- An independent, technology driven company
- Part of the ACTEON group

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2H - Global Integrated Team

London

Houston

Rio de Janeiro

Aberdeen

Kuala Lumpur

Perth

Beijing

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2H Areas of Expertise

Drilling, Completion & Workover

- Marine drilling risers
- Jack-up risers
- Subsea well conductors
- Completion & workover risers

Production & Export

- Surface BOP drilling risers
- FPS dry tree production risers
- Fixed platform well conductors
- Jack-up production risers
- Steel catenary risers
- Freestanding hybrid risers
- Flexible risers
- Umbilicals

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Services

Concept Design & FEED
- Riser feasibility assessment and concept evaluation
- Riser sizing, vessel and field layout
- Preliminary analysis and engineering

Detailed Engineering
- Detailed design of the complete system and individual components
- Material selection, coating and corrosion protection design
- Equipment specifications and qualification, Interface management
- Gulf of Mexico CVA

Procurement management
- Vendor qualification and preparation of bid packages
- Issue RFQs, technical and commercial bid evaluation
- PO management and expediting
- QA/QC - witnessing and inspection

Fabrication & Installation Support
- Fracture mechanics analysis (ECA)
- Fatigue qualification and testing
- Fabrication management
- T&I engineering and analysis
- Gulf of Mexico CVA

Integrity Management & Monitoring
- Inspection planning
- Monitoring system design
- Dynamic data processing

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Introduction to Un-Bonded Flexible Pipe

Annulus – Space between the two extruded polymer fluid barriers
Protects the Carbon Steel Wires which are not Corrosion Resistant

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Flexible Riser Configurations

FREE HANGING

LAZY WAVE

STEEP WAVE

TETHERED LAZY WAVE

STEEP S

LAZY S

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Flexible Pipe - Statistics

- > 3,300 flexible pipes in service
- > 39,000 flexible pipe operational years
- 58% of flexible pipes installed are risers
- 76% of all flexible pipe have design pressure below 345 bar (5,000 psi)
- 90% of all flexible pipe is below 10-inch (ID)
- 70% pipes are used for design temperature less than 80° C (176° F)
- 70% of all flexible risers in water depths less than 1,000 m WD

Source: Subsea UK

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Categories of Failure Modes

• Progressing from inside
  – Carcass fatigue
  – Carcass collapse
  – Erosion
  – Temperature cycling fatigue
  – Ageing
    • Chemicals
    • Temperature
    • Water
  – $\text{H}_2\text{S} / \text{CO}_2$ diffusion $\rightarrow$ acid annulus
  – Armour fatigue
  – Vent system malfunction
    (external sheath breach)

• Progressing from outside
  – Wear from interfacing structures (arch, GT, bend stiffener)
  – Wear of fabric tape
  – Dropped objects
  – Interference with structures
  – Entanglement with other lines
  – External sheath breach
  – Aging
  – Corrosion
  – Hydrogen Induced Stress Cracking (HISC)

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Developments in Flexible Pipe Technology

New advances in flexible pipe technology ready for use now:

- New Carcass Options
- New Pressure Sheath Polymers
- Increased Sour Service
- Composite pipe

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New Carcass Designs

- Why do we need new designs?
  - Greater Collapse Resistance – Hydrostatic force
  - Greater Crushing Resistance – Installability
  - FLIP – Flow Induced Pulsations

Material Selection
- Traditionally 316L – New options – 2205, 2304, 2507
- Offer greater corrosion and higher strength – greater collapse resistance

Carcass Geometry
- Modification to Carcass Profile
- Improve prediction capability
- Requires modelling work hardening
- Elimination of flow induced vibration

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New Polymer Pressure Sheath

- Why do we need new Polymers?
  - Greater Temperature Resistance – High temperature (150°C) and low temperature blow down (-30°C)
  - Improved Creep Resistance
  - Improved Notch Resistance

Material Selection
- Traditionally options – PA11, PVDF
- New options
  - TP35 – PE derivative = 345Bar at 90°C
  - HPPA – High Temperature Polyamide = 70°C operating temperature at pH4
  - Coflon XD – Extra Ductile derivative of PVDF = -30°C to 150°C Operating temperature; fatigue life improved by factor of 10; single layer extrusion

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Mono layer Vs Bi-Layer Pressure Sheath – Blowdown

- What happens when you depressurise too quickly?
  - Collapse of the polymer pressure sheath
  - Blistering

- A bi-layer design has a **LOW** instantaneous depressurisation rate limit – Typically 200Bara per hour

- A mono layer design has a **HIGH** instantaneous depressurisation rate – Significantly greater than 400Bara per hour. This is required for blowdown operations.

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Greater Sour Service

- Flexible pipes have a volume called an annulus
- \( \text{H}_2\text{S} \) can diffuse into the annulus
- \( \text{H}_2\text{S} \) absorption layer – Reduce corrosion and SCC for armour wires

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Spoolable Composite Pipe

- Why do we need composite pipe?
  - High Temperature and Pressure Resistance
  - No annulus – no corrosion issues
  - Light weight for deep water applications
  - Certain options can be significantly cheaper

Who’s making it?
- Magma m-pipe – carbon fibre with peek matrix
- Airborne reinforced thermoplastic pipe – E-glass with Polyamide matrix
- NOV – glass epoxy with PU liner

Disadvantages?
- Magma m-pipe – Expensive, particularly for larger bore sizes
- Airborne and NOV – Shallow water only (150m water depth max)

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How can this be applied to Myanmar?

Case Studies

Learn more at www.2hoffshore.com
Wellstream
Dai Hung Flexible Global Analysis

- Detailed Global Analysis
- Offshore Vietnam
- 110m water depth
- Floating Production Unit
- Lazy-S Configuration
- Additional detailed analysis for the Catenary Anchor leg Mooring Buoy (CALM)

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Statoil Peregrino WAW Re-Analysis Study

- Re-Analysis and verification
- Offshore Brazil
- 95m-135m water depth
- External Turret Moored FPSOs
- 6 Weight Aided Wave Risers
- 4 Lazy Wave Power Umbilicals
OGX – OSX2 and OSX3

- From Conceptual to Detailed Subsea Engineering
- Tubarão Azul (OSX-2)
  Tubarão Martelo (OSX-3)
- Offshore Brazil
- 135m, 105m water depth
- Turret Moored (FPSOs)
- Lazy-S, Pliant Wave, Weight Aided Wave (WAW) Configurations
- 26 Flexible Risers
  (Gas Injection/ Lift/Export, Water Injection and Production)

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Conductor Supported Modular Offshore Structure

- Small platform or platform extension to support surface (dry) trees
- Alternative to a jacket
- Low cost
- Small structures, local fabrication
- Short installation, using a jack-up
- Fast schedule – 6-9 months delivery

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Low Cost Shallow Water WHP Solution – CoSMOS
CoSMOS WHP – Designed & Built in Malaysia for $12m USD

The unmanned TBDP-A CoSMOS WHP comprises of stabilization frame and topsides with three (3) different level which are:

1. Upper Deck
2. Mezzanine Deck
3. Lower Deck & Stabilization Frame

A subsea stabilization frame is **installed prior to topside installation** in order to commence the drilling activity via jack-up rig. **Topside is installed after drilling and completion.**

**Designed and fabricated locally in Malaysia in 10months for $12m USD**

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Tullow Oil TEN

- Detailed Design
- Tweneboa, Enyenra, Ntomme fields in Offshore Ghana
- 1425m water depth
- Turret Moored FPSO
- Lazy Wave Flexible Risers
  - 3 Stages Campaigns
  - P50 – 11 risers, 4 umbilicals
  - P10 – 4 risers, 1 Umbilical
  - Future – 2 risers, 2 Power Cables

Learn more at www.2hoffshore.com
Tullow Oil TEN

Learn more at www.2hoffshore.com
Feasibility assessment of the system to transfer the production oil and water from the Tension Leg Wellhead Platform (TLWP) to an FPSO located 1500m away
9 FSHR Pre-FEED, FEED and Detailed Design
• Global analysis
• Systems engineering
• Package engineering
• Procurement and Fabrication support
• Installation support

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Total/HMC Kaombo FSHR Detailed Design

Project Overview:
- 2 FPSOs, 18 STTRs (6 PIP) offshore Angola
- HMC / Technip consortium
- 2H part of integrated team with HMC

2H Scope:
- Buoyancy Tank package engineering and design
- STTR Systems Engineering
- Global analysis
- Detailed FEA (for URA / LRA)

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Petrobras
BSR – Guara and Lula

Learn more at www.2hoffshore.com
Dis-connectable Turret

Dis-connectable Turret Analysis

Learn more at www.2hoffshore.com
Summary

- Exciting new **qualified** flexible riser pipe technology.
- Flexible pipe ready for **Shallow** and **Deep water** applications.
- A number of development options solutions for both shallow water and deep water developments already exist.
- Hybrid riser solutions for **Ultra Deep Water** is an industry enabler.

Learn more at [www.2hoffshore.com](http://www.2hoffshore.com)
## 2H Offshore Experience (I)

### Concept Design and FEED

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<td>Su Tu Nau Flexible Riser Feasibility Study</td>
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### Detailed Engineering

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<td>Total</td>
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<td>Duco</td>
<td>CLOV Umbilical Analysis</td>
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<td>Subsea7</td>
<td>BSR Flexible jumpers, risers and lazy-wave flexibles, for Petrobras Sapinhoá &amp; Lula-NE</td>
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### Procurement and Fabrication Management

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<td>Petrobras</td>
<td>Flexible Risers on P-34 Pilot System for Barracuda/Caratinga Development</td>
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## 2H Offshore Experience (II)

### MONITORING

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<td>Kikeh IM for Spar TTRs Offshore Malaysia</td>
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<td><strong>Chevron</strong></td>
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### INSTALLATION ENGINEERING

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<td>P-26 Semi-Sub and P-34 FPSO Flexible Risers Pull-in Analysis</td>
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<td><strong>McDermott</strong></td>
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### VERIFICATION SERVICES

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<td><strong>ATP Oil &amp; Gas</strong></td>
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Questions?

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Thank you

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