Re-usable Riser and Flowline System for Deep Water Application

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Flexible Pipe Technology

Deep Water Challenges for Riser, Flowline and Umbilical Systems

Efficient Riser Configuration

Recovery and Re-use of Riser, Flowline and Umbilical Systems

Flexible Pipe Integrity Management
Flexible Pipe: Enabling Technology for Floating Production

HISTORY

- Move from large fixed structures to floating structures.
  - Cheaper in shallow water
  - Enabling for deep water

- First flexible risers in Brazil in 1976 on the Garoupa field
- 1000 m barrier broken in 1994
- Deepest Flex pipe today 1940 m (GOM).
Flexible Pipe – Design/Technology

- From 2” to 20” ID
- Static flowline or dynamic risers

Layer by layer description
- Interlocked carcass
- Pressure sheath
- Pressure vault (interlocked)
- Anti wear tapes
- Cross wound tensile armour layers
- High strength tapes
- External / intermediate sheath

Other function can then be added:
- Thermal Insulation
- Active heating
- Gas Lift

Flexible pipe is a tailor made product optimised to meet Project specific requirements

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Flexible Pipe – Design/Technology

END FITTINGS

Main functions:

1. Withstand & transfer loads from flexible pipe (P, T, BM, Shear)
2. Armour anchoring: Tensile loads
3. Front crimping: Sealing integrity
4. Rear crimping: External sealing integrity
Flexible Pipe – Design/Technology

Bend Stiffeners

Bend Restrictors

Buoyancy Module

Hold back clamp
Flexible Pipe Capabilities

- Design Life
  - Up to 30 years

- Track record today (installed projects):
  - 7.5”ID in 1940 m WD
  - 9” ID in 1800m WD
  - 11”ID in 1300 m WD

- Qualification successfully performed for 9”ID in 2100 m WD

- Designs available for 11”ID in 2000 m WD

- Development work ongoing for WD up to 3000 m
Flexible Pipe Manufacturing – ASIAFLEX PRODUCTS

▸ Primary focus on Asia-Pacific, including India and Pakistan markets

▸ Annual capacity of 200 Km of 8” normalised flexible pipes - Complete range of products up to 14” ID

▸ Site surface of 20 ha with deep water quay

▸ 300 Tons Crane Facility

▸ Start-up mid 2010
Flexible Pipe Technology

Deep Water Challenges for Riser, Flowline and Umbilical Systems

Efficient Riser Configuration

Recovery and Re-use of Riser, Flowline and Umbilical Systems

Flexible Pipe Integrity Management
Main challenges for UDW

- Collapse Resistance,
- Thermal Insulation,
- Weight Reduction.

- Hydrostatic pressure:
- Thermal losses:
- Suspended weight
Flexible Pipe – UDW Challenges

- Better resistance to collapse can be obtained by:
  - Using high tensile carcass material
  - New pressure vault wire

- Better tensile resistance can be achieved by:
  - Using new armour material
  - New pressure vault material (above)

- Better flow assurance performance can be obtained by:
  - Increasing insulation material thickness
  - Integrating active heating (Integrated Production Bundle)
Umbilical – UDW Challenges

- Deep Water Challenges for umbilicals relate to
  - Increasing Installation and in-service loads
    - Higher tensile loads during dynamic service (riser umbilicals)
    - Higher tensile and crushing loads during installation
  - Increasing trend for subsea pumping, compression etc.
    - Higher Power cable content increases the umbilical weight
**Umbilical Technology**

- **New technology**
  - Calibrated and Certified set of design tools
    - to assess crushing load on components (within the bundle)
    - to offer better protection of “fragile” components such as fibre optic cables
  - Availability of new materials and components
    - Allow to extend umbilical capabilities
  - Sensing and monitoring possibilities

![Diagram of umbilical technology](image)
Flexible Pipe Technology

Deep Water Challenges for Riser, Flowline and Umbilical Systems

Efficient Riser Configuration

Recovery and Re-use of Riser, Flowline and Umbilical Systems

Flexible Pipe Integrity Management
Flexible Dynamic Riser Configuration

Selection of the Final Riser Configuration Depends on:
- Field Layout, Water Depth,
- Environmental Conditions,
- Floater Hull Shape,
- Mooring Arrangement,
- Acceptable Riser Payload,
- Requirement for Quick Disconnection of the FPSO,
- etc
Flexible Dynamic Riser Configuration

Typical Riser Configuration for Deep Water Application

**Free Hanging:**
- Simple configuration
- Suitable for Deep Water
- Good for moderate environmental conditions
- Good for set-ups with small heave motions

**Deep Lazy Wave:**
- Good for moderate environmental conditions
- Good for set-ups with limited motions
- Minimize quantity of buoyancy
- Good dynamic response.

**Shallow Lazy Wave:**
- Good for harsh environmental conditions
- Minimize riser pay load on FPSO
- Very good dynamic response.
Flexible Dynamic Riser Configuration

BHPB Stybarrow

**Key Requirements:**

Acceptable riser payload = 550 Te

**Water Depth** = 830m approx

Approx total weight/m all bare risers would have been 630 Te for free hanging catenary (static, excluding appurtenances)

**Solution:** Shallow Lazy Wave

- Approx 400 Tonnes Net buoyancy added to risers
- Riser configuration designed to ensure sag bend doesn’t impact seabed after buoy disconnect
Flexible Dynamic Riser Configuration

Solution: Free Hanging (2 sections)

• Total Riser length: 1775m
  - Top : 875m
  - Bottom : 900m
• Intermediate connection at 850 m below see level

Key Requirements:

Water Depth = 1400m approx

Maximum length of risers for storage on Reel : 950m
Flexible Dynamic Riser Configuration
Flexible Pipe Technology

Deep Water Challenges for Riser, Flowline and Umbilical Systems

Efficient Riser Configuration

Recovery and Re-use of Riser, Flowline and Umbilical Systems

Flexible Pipe Integrity Management

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One Concept

- Ability for an operator to recover, re-install and re-use a product at its own discretion, providing operating conditions remain within specified design basis.
  - Cost effective solution for several consecutive short-life developments
  - Can offer some flexibility for production amongst several fields

THREE NOTIONS

- Recoverability
- Wet Storage
- Re-usability

Different Requirements
Re-use of Riser, Flowline and Umbilical Systems

- **Recoverability**

  - One of the inherent characteristic of flexible pipes
    - Flexible product allowing unlimited number of spooling operations
    - Low Minimum Bending Radius
    - Excellent Fatigue Resistance
    - Installation and recovery from / to Reels or Carousels

  - Generally compatible with most Umbilical design
    - Same than above,
    - Need to be assessed on a case by case basis for some specific umbilical designs (large power cable, large Metallic tube, UTA, SUTA)

  - Flexible pipe and Umbilical line recovery shall **ALWAYS** be considered during Installation engineering Phase as a contingency scenario.
    - Design / Fabrication of recovery tools when required
    - Subsea Connectors design
Re-use of Riser, Flowline and Umbilical Systems

Subsea Recovery

- Subsea recovery aids and lifting tools shall be designed to enable recovery of subsea static umbilicals or flowlines.
  - Diverless subsea connection of recovery/lifting tool to end-fitting or connector
  - Capable to take full catenary load

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Re-use of Riser, Flowline and Umbilical Systems

- Wet Storage
  - Possible with most Flexible pipe design
    - Pipe to be abandoned on seabed filled with treated water
    - Ancillary equipments shall have sufficient CP provided
    - Pulling Heads to be designed to allow recovery
  - Commonly used in Brazil
  - Less commonly used for Umbilical System
    - Need to be assessed on a case by case basis
Re-use of Riser, Flowline and Umbilical Systems

- **Re-usability**
  
  "Operating conditions must remain within specified design basis" "

- **Common requirements for all products**
  - Overall service life
  - Maximum water depth

- **Flexible Pipe**
  - Operating conditions (Temperature, pressure)
  - Fluid composition (H₂S, CO₂ etc),

- **Umbilicals**
  - Number of function
    - Hydraulic lines (LP, HP), Chemical lines
    - Electrical cables (power, signal) - Fibre optic cable

- **Riser Configuration**
Re-use of Riser, Flowline and Umbilical Systems

CONCLUSION

- Flexible pipe and umbilical system can be designed for re-use.
  - Cost effective solution for several consecutive short-life developments
  - Can offer some flexibility for production amongst several fields

- Limits
  - Shall be considered / specified at an early stage
  - Evolution of design standards / rules
    • A design valid 15 years ago might not be acceptable anymore
  - Operating conditions more severe than anticipated
    • Might have lead to an un-anticipated ageing of the product
  - Cost: *Taylor made vs Standardization*
    • Needs to be assessed on a case by case basis
Flexible Pipe Technology

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Recovery and Re-use of Riser, Flowline and Umbilical Systems

Flexible Pipe Integrity Management
Flexible Pipeline Integrity Management

New Technology enables improved Integrity Management of Flexible Pipes

- **Real-time Monitoring of actual service condition**
  - Temperature monitoring
  - Curvature sensor
  - Water detection in annulus

- **Annulus Control**
  - Drainage
  - Gas flow or Vacuum Drying
QUESTIONS

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