Threaded Risers & Flowlines

2H have developed the designs and conducted the qualification testing for highly cost effective deepwater riser and flowline systems using threaded couplings. A range of designs are available to meet specific project requirements including free standing (COR™) and SLOR™ and free hanging (SCR). Solutions are developed using externally coated and insulated pipe and are also pipe in pipe systems offering riser base gas lift, active heating and highly efficient thermal insulation.

Critical to the commercial and technical success of this technology is the use of non welded threaded and coupled connections that are widely used in drilling and downhole applications. Such connections have now been qualified, as part of the 2H TRF JIP, for high load and fatigue critical riser and flowline service. Fatigue performance in excess of a high quality welded connection is achieved giving improved performance over a welded construction. Furthermore, threaded and coupled connections can be assembled 10 times quicker than a weld and allow the use of high strength non-weldable steels that reduce riser weight.

Procedures have been developed for installation of risers and flowlines from a range of vessels including third generation MODU and DSV. This allows increased project flexibility compared to using conventional deepwater pipe lay vessels and significant cost savings. A conventional derrick can be skidded onto a DSV and by using pipe cages lay speeds equivalent to a reel vessel can be achieved.

The design, schedule and cost benefits offered by this technology are significant when compared to conventional approaches that often require extensive weld qualification testing, high cost vessel mobilisation, high day rates and long lay durations or transit times to real bases.

TRF - The Deepwater Solution

- Free standing and free hanging configurations
- High integrity sealing and structural performance
- Process flow friendly (insulation, gas lift and heating)
- Cost effective hardware
- High strength steels to reduce weight/payload
- MODU and DSV installation
- Fast and flexible installation and commissioning

2H Offshore Engineering Limited
177 Cherry Street, Whalley
Burnley, BB10 3EX, UK
Tel: +44 7577 20227
Email: info@2h-offshore.com
A UNO Company

2H Offshore Inc.
1518 Broadway, Suite 473, Houston,
TX 77010 USA
Tel: +1 713 465 6670
Fax: +1 210 830 0948
Email: info@2h-offshoreinc.com

2H Offshore Engenharia Limitada
R. Marginal do Póvoa, 4330-106
Rio de Janeiro - RJ Brazil
Tel: 00 55 (21) 2522 6545
Fax: 00 55 (21) 2252 6345
Email: info@2h-offshore.com
The Concentric Offset Riser (COR™) and Single Line Offset Riser (SLOR™) are 2H riser designs. They are of a free-standing arrangement using a single or pipe-in-pipe configuration. Designs are available for deep water applications up to 3000m. The designs are suited to both mild and harsh environments and a range of production facilities including FPSO.

The COR™ and SLOR™ designs have been developed with full consideration to dynamic response, thermal and process capability, hardware selection, installation, and field development flexibility.

A key feature of COR™ and SLOR™ is the ability to install them quickly from any deep water drilling vessel using standard rig equipment and procedures. The riser is assembled using non-welded threaded connections and high strength steel pipe. Alternatively a welded construction is possible.

The riser is supported by a combination of air caps and syntactic buoyancy material. Short flexible jumpers are used to connect between the top of the riser and vessel. At the base the riser is connected to a jetted conductor pile.

The COR™ design uses a thermally efficient, concentric pipe-in-pipe arrangement. The annular space is filled with low pressure nitrogen or hydrocarbon gas for riser base gas lift; the latter being a requirement for many deep water developments. The annulus also provides the capability for active heating by circulation of hot water to allow hydrate/wax removal or increase production at low temperatures.

The designs are modular using a number of standard building blocks to minimise re-engineering, simplify procurement and reduce cost and schedule.

- Installation Using Drill Rig
- Standard Procedures and Tooling
- Proven Hardware
- Modular Component Design
- Thermally Efficient
- Riser Base Gas Lift
- Dual Pressure Barrier
- Maximum Development Flexibility
- Pre-Installation Capability
- Low Business Risk
- Cost Effective
**storm™ Subsea Tree - Offset riser - Manifold**

**storm™** is a unique field development solution for deepwater that has a focus on the important issues of well systems and risers. The solution provides all the advantages associated with both dry trees and subsea developments without the disadvantages. The number and criticality of the risers are greatly reduced and their interface with the vessel simplified compared to a dry tree system.

**storm™** uses horizontal trees located on modular manifolds below a floating vessel. This may be either a barge, semi or spar. The wells are drilled in the same manner as a dry tree system using a surface BOP however they are completed with a subsea tree. The arrangement provides efficient drilling and vertical access for workover operations.

Each manifold supports up to 5 wellheads and is connected by a short spool to the base of a Single Line Offset Riser (SLOR™) or Concentric Offset Riser (COR™). These provide the flowpath to the production vessel. The risers are not so sensitive to vessel motions allowing barge and semi-submersible vessels to be used.

Compared to a dry tree system, such as a spar, the **storm™** arrangement has many advantages:

**storm™ Advantages**

**Technical Advantages**
- Vertical well access
- Surface BOP
- No offshore deck mating
- Simplified riser/vessel interface
- Reduced vessel motion criticality

**Improved Safety**
- Eliminates HP risers
- Subsea isolation
- Separates drilling & production

**Reduced Cost**
- Lower cost vessel
- Lower cost risers

**Increased Flexibility**
- Short development schedule
- Ability to expand well count
- Padrill & complete wells
- Pre-install risers
- Install risers from production vessel
FLEXIBLE PIPELINES

Below is a general description of a flexible pipe given by NKT Flexibles [1]:

1. **Carcass**
   An interlocking structure manufactured from a metallic strip. The carcass prevents collapse of the inner liner and provides mechanical protection against pigging tools and abrasive particles.

2. An extruded polymer layer providing internal fluid integrity.

3. A number of structural layers consisting of helically wound C-shaped metallic wires and/or metallic strips. The pressure armour layers provide resistance to radial loads.

4. A number of structural layers consisting of helically wound flat metallic wires. The layers are counter wound in pairs. The tensile armour layers provide resistance to axial tension loads.

5. An extruded polymer layer. The function is to shield the pipe's structural elements from the outer environment and to give mechanical protection.

6. **Anti-wear layers (not shown)**
   Non-metallic layers are incorporated in order to prevent wear and tear between the structural elements.

7. **Insulation (not shown)**
   Additional layers of material with low thermal conductivity can be applied in order to obtain specific thermal insulation properties of the pipe.
Marginal Field Development

FPSO Ocean Producer

Flexibility can make all the difference in getting a marginal field development project off the ground. Flexibility that comes from:

- Accelerated schedules
- Effective risk control
- Lower front-end costs

Flexibility of this sort is provided by leasing a Mobile Offshore Production System (MOPS) from a qualified production contractor committed to delivering value— a contractor like Oceaneering Production Systems.

The FPSO Ocean Producer, a MOPS unit based on a 77,000 dwt tanker, is designed with the flexibility requirements of marginal field development in mind. With oil production capacity of 15,000 to 25,000 barrels per day, depending on crude characteristics, and storage for 500,000 barrels, the Ocean Producer is sized and equipped to develop small or marginal fields over broad ranges of production profiles, environmental conditions and water depths. Adaptable by design, the Ocean Producer can make the difference between a development dead-end and a profitable project.

Of course, it’s not only the vessel that makes the difference. It’s also a contractor with a commitment to performance, results and value. At Oceaneering, we are committed to meeting the challenges of marginal field production with MOPS units that lower costs without lowering quality. We are also committed to managing MOPS projects on aggressive conversion and mobilization schedules that accelerate cash flow and enhance development economics. And we are committed to seeking incentive-based commercial terms that help our Customers manage the risks of marginal field projects.

Flexibility and commitment, the right vessel and the right contractor. Oceaneering can make the difference in your next development project.

Production and Field Development
Contracting
Leased
Mobile Offshore Production Systems
Conversion & Deployment

Ocean Engineering was awarded its first major MOPS contract in December 1990 to provide an FPSO tanker for production of Gombe Beta field offshore Gabon. Ocean Engineering purchased the tramp tanker *Balitmore Sea* in February 1991 and converted it under in-house management to the FPSO *Ocean Producer*. The conversion was completed in nine months at a cost of $27 million, including purchase of the vessel with no loss-time accidents and without a single change order.

The *Ocean Producer* was mobilized from the U.S. Gulf to West Africa and began production for Amoco December 10, 1991. The vessel remained at Gombe Beta in continuous operation for 23 months, demobilizing at the end of October 1993 to take up its second assignment. After drydocking for inspections and field-specific modifications, the *Ocean Producer* began producing oil January 6, 1994, for Sonangol at Kako field in Block 4 offshore Angola, receiving raw crude oil from two subsea wells. Subsequent modifications made in the field brought two more wells onstream and added gas lift capability.

**Vessel Data**

<table>
<thead>
<tr>
<th>Classification</th>
<th>ABS A1 Offshore Installation FPSO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length overall (LOA)</td>
<td>789 ft</td>
</tr>
<tr>
<td>Breadth molded</td>
<td>136 ft</td>
</tr>
<tr>
<td>Depth molded</td>
<td>58 ft</td>
</tr>
<tr>
<td>Maximum draft</td>
<td>41 ft</td>
</tr>
<tr>
<td>Deadweight tonnage</td>
<td>77,290 lb</td>
</tr>
<tr>
<td>Dock area</td>
<td>59,200 sq ft</td>
</tr>
<tr>
<td>Production capacity</td>
<td>15,250 bopd</td>
</tr>
<tr>
<td>Water treating</td>
<td>12,500 bopd</td>
</tr>
<tr>
<td>Gas lift capacity</td>
<td>1.7 MMstd</td>
</tr>
<tr>
<td>Red vapor pressure</td>
<td>&lt;13 psi</td>
</tr>
<tr>
<td>BSWW content</td>
<td>&lt;1%</td>
</tr>
<tr>
<td>Discharge water</td>
<td>&lt;50 ppm</td>
</tr>
<tr>
<td>Biree capacity</td>
<td>6 MMBbl</td>
</tr>
<tr>
<td>Inlet manifold pressure</td>
<td>1,440 psig</td>
</tr>
<tr>
<td>Offloading capacity</td>
<td>3 x 3,900 gpm</td>
</tr>
<tr>
<td>Oil storage</td>
<td>515,000 bbl</td>
</tr>
<tr>
<td>Gas-fired boiler</td>
<td>35,000 lb/hr steam</td>
</tr>
<tr>
<td>Main propulsion</td>
<td>18,400 BHP</td>
</tr>
<tr>
<td>Crane capacity</td>
<td>15 ton</td>
</tr>
<tr>
<td>Electrical generators</td>
<td></td>
</tr>
<tr>
<td>Diesel</td>
<td>3 x 560 kW</td>
</tr>
<tr>
<td>Emergency</td>
<td>1 x 350 kW</td>
</tr>
<tr>
<td>Gas-fired</td>
<td>1 x 1,125 kW</td>
</tr>
<tr>
<td>Mooring system</td>
<td>6-point spread, disconnectable</td>
</tr>
<tr>
<td>Cargo tanks</td>
<td>8 tanks, segregated, by double valves</td>
</tr>
<tr>
<td>Inert gas system</td>
<td>Yes</td>
</tr>
<tr>
<td>Segregated ballast tank</td>
<td>Yes</td>
</tr>
<tr>
<td>Crude oil washing system</td>
<td>Yes</td>
</tr>
</tbody>
</table>

*A record of safe, reliable, responsible performance.*
<table>
<thead>
<tr>
<th>Component</th>
<th>Cost</th>
<th>Number</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oceanographic mapping vessel</td>
<td>$30,000.00</td>
<td>60 days</td>
<td>$1,800,000.00</td>
</tr>
<tr>
<td>side scan sonar</td>
<td>$125,000.00</td>
<td>1</td>
<td>$125,000.00</td>
</tr>
<tr>
<td>sub bottom profile</td>
<td>$100,000.00</td>
<td>1</td>
<td>$100,000.00</td>
</tr>
<tr>
<td>ROV support vessel</td>
<td>$30,000.00</td>
<td>60 days</td>
<td>$1,800,000.00</td>
</tr>
<tr>
<td>ROV</td>
<td>$1,000,000.00</td>
<td>1</td>
<td>$1,000,000.00</td>
</tr>
<tr>
<td>tooling sleds</td>
<td>$100,000.00</td>
<td>1</td>
<td>$100,000.00</td>
</tr>
<tr>
<td>Cutting tool sled</td>
<td>$2,454.00</td>
<td>1</td>
<td>$2,454.00</td>
</tr>
<tr>
<td>Welding tool sled</td>
<td>$2,359.00</td>
<td>1</td>
<td>$2,359.00</td>
</tr>
<tr>
<td>Christmas tree</td>
<td>$2,786,000.00</td>
<td>1</td>
<td>$2,786,000.00</td>
</tr>
<tr>
<td>Flexible piping</td>
<td>$18,800.00</td>
<td>30</td>
<td>$564,000.00</td>
</tr>
<tr>
<td>pipeline support ROV tooling</td>
<td>$46,000.00</td>
<td>1</td>
<td>$46,000.00</td>
</tr>
<tr>
<td>pipe mating tooling sled</td>
<td>$60,000.00</td>
<td>1</td>
<td>$60,000.00</td>
</tr>
<tr>
<td>valve turning tooling</td>
<td>$27,000.00</td>
<td>1</td>
<td>$27,000.00</td>
</tr>
<tr>
<td>pipeline repair tooling</td>
<td>$43,000.00</td>
<td>1</td>
<td>$43,000.00</td>
</tr>
<tr>
<td>Riser and submerged buoy</td>
<td>$2,400,000.00</td>
<td>1</td>
<td>$2,400,000.00</td>
</tr>
<tr>
<td>MOPS</td>
<td>$550,000.00</td>
<td>1</td>
<td>$550,000.00</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td>$11,405,813.00</td>
</tr>
</tbody>
</table>
CONCLUSION

With the current state of underwater technology it is now possible to prevent ecological and environmental damage from the catastrophic loss of a fully laden oil tanker in the ocean. When oil is released in large quantities near a shoreline from the continued leakage of a sunken tanker wreck, a huge economic impact is placed upon the indigenous population along that shoreline. The very livelihood of people who depend upon the sea for their jobs and their food is threatened. The two most noticeable aspects of this are the losses incurred by the fishing industry and the tourism industry in this region. This can lead to tremendous lawsuits as the affected countries attempt to recoup their losses from the cleanup of this oil spill.

Advances in the technology used to extract oil and gas from beneath the seafloor at water depths that seemed unreachable just ten years ago have presented a unique opportunity. For the first time, it is now possible to construct an oil pipeline capable of reaching oil at a depth of 3000m below the surface of the ocean. And as technology improves, this depth will increase. Underwater robots in the form of a Remotely Operated Vehicle (ROV) are able to perform the necessary cutting, welding, assembly, and repair of these pipelines to the surface at depths where human intervention was previously unheard of.

Instead of connecting this underwater riser pipeline to a subsea wellhead which extracts the oil from beneath the seafloor, an alternate path is undertaken where the pipeline is instead connected to valves into the oil tanks on the wreck that have been installed by the ROV. Then by pumping seawater into the tanks, the oil is displaced, and pushed back up the riser pipeline to the waiting surface recovery ship. In this manner, the tanks are emptied of their environmentally hazardous cargo, thus preventing further environmental harm.

While the financial costs of undertaking such a project may seem large at first glance when the street value of the oil contained in the wreck is considered, the cost of ignoring the problem is much higher. Cleanup fees and lawsuits can bring the true cost of the wreck into the billions of dollars. Additionally, if the responsible oil company ignores the problem, the economic impact due to negative public relations can have long-term effects on profits. In comparison, the cost of this operation while seeming expensive in the short term, is a bargain compared to the long term economic impact on company profits.
REFERENCES CONSULTED

NKT Flexibles Inc. http://www.nktflexibles.com

2H Offshore Engineering http://www.2hoffshore.com

“Flexible Riser Outer Sheath Repair by ROV” by Donald Faulds Perry Slingsby Systems Ltd.
   Ings Lane Kirkbymoorside, N Yorks, United Kingdom  YO62 6EZ

GeoAcoustics Ltd. www.geoacoustics.co.uk

Broco Underwater Systems www.broco.com/underwater

Klein Associates Inc. www.l-3klein.com

Anson Oilfield Equipment http://www.anson.co.uk

Oceaneering http://www.oceaneering.com

Subsea 7 http://www.subsea7.com

Scripps Oceanographic Institute http://www.scripps.edu


University-National Oceanographic Laboratory System http://www.unols.org