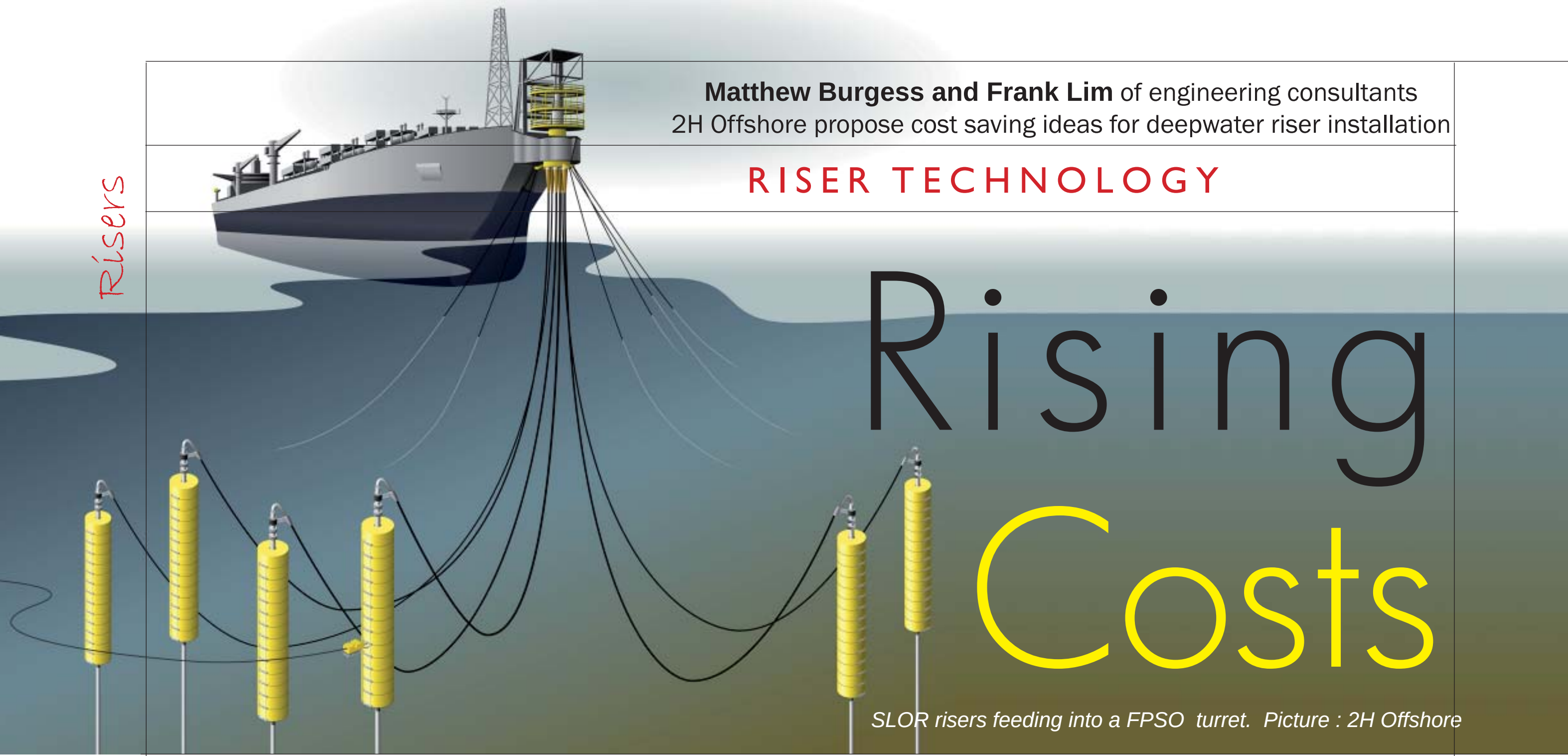
Matthew Burgess and Frank Lim of engineering consultants 2H Offshore propose cost saving ideas for deepwater riser installation

RISER TECHNOLOGY

Rising Costs



SLOR risers feeding into a FPSO turret. Picture : 2H Offshore

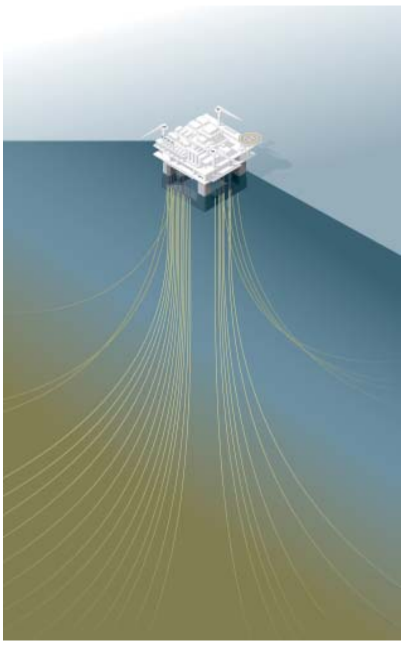
Deep water developments represent one of the most demanding challenges to the offshore industry. One of the components common to most developments are deepwater risers. Intelligent design of these, however, may offer a way of reducing project costs.

Over the years, the industry has progressively devised a number of different riser designs. Flexible Catenary Risers consist of independent spiral laid steel and thermo-plastic layers, allowing high curvature and ease of installation while easily accommodating dynamic motions. As the external hydrostatic pressure increases with water depth, the maximum riser diameter is essentially limited by the practicality of strengthening the flexible pipe structure to resist this external pressure.

Its flexibility allows the flexible pipes to be spooled continuously on to a reel for efficient and quick transportation and installation, allowing speeds averaging up to 500m/hr. A large number of reel-lay vessels are currently available, although for larger pipe diameter/deeper waters applications, there are fewer capable vessels. The installation weather window is mainly determined by the vessel response to environmental loading.

In recent years, Steel Catenary Risers – steel pipe strings hanging free from the vessel to form a simple catenery – have emerged as a major alternative to flexibles, especially in the mild/moderate deepwater environments, such as West Africa, Brazil and Indonesia. Their main advantage stems from steel being cheaper than flexible pipe. They are typically used with tension leg platforms or spars, where heave motions are small, or with semi-submersibles or FPSOs where the environment is mild.

Several installation methods are possible. In J-Lay, risers may be assembled in units of up to 6 joints (hex-joints), reducing the welds required during offshore installation. The number of vessels capable of deeper water J-lay installation is limited. The current maximum tension limit is around 1000t for high-end installation vessels, with several more havine capacities of over 500t.



Catenary risers on Petrobras P55
Picture : 2H Offshore

In S-Lay, the risers are handled in a horizontal attitude. The technique is generally not suited to deepwater, due to the very high back tensions required to prevent over stressing of the sag bend and overbend.

The Single Line Offset Risers (SLOR) employs a vertical steel riser section linked to the host vessel via a flexible pipe jumper. Although relatively new, the design has been proven on projects including Kizomba A and B, and Petrobras P52. The key advantage of this hybrid arrangement is that the vertical riser response is decoupled from the vessel motions and hence, becomes less susceptible to fatigue damage.

The vertical riser section is tensioned by a steel buoyancy can positioned at a distance below the water surface to minimise wave and current loading. The SLOR can be used with any floating vessels and is suitable for deepwater and ultra-deepwater applications in all environments.

Bundled hybrid risers consist of a number of small diameter steel pipe strings and umbilicals grouped together around a buoyant structural core pipe and kept free standing by a buoyancy can near the surface, where the vertical riser pipes are linked to the vessel by multiple flexible pipe jumpers.

Due to the complexity of assembling and testing bundled hybrid risers, onshore fabrication facilities must be used. This may be considered a positive fabrication method when contracts specify that a large percentage of local content is required for the project.

Top Tensioned Risers (TTRs) run directly from the subsea wells to the vessel deck where the surface trees are located. Tension is applied to the riser by either buoyancy cans or deck mounted hydro-pneumatic tensioners.

For spars, the installation of buoyancy cans is a complex, costly and time-consuming process. Long, multi-chamber buoyancy cans are typically used so that fewer connections need to be made during installation. However, due to their length, installation usually takes place before the topsides and derrick. The resulting approach depends on many factors including the schedule for offshore commissioning, the extent of pre-drilling and the preferred handling equipment and derrick design.

Alternative Approach to Installation

A large proportion of deepwater risers are currently based on a welded pipe construction. One of the main reasons this remains the 'default' method is that historically, lines were installed by S-lay using low strength, readily weldable steel. This is still a cost effective method for shallow water.

However, this practice continued as the industry moved into deeper waters, with contractors developing more sophisticated welding techniques and building higher specification vessels to meet the demands of deep water. This gave the operator less choice on the installation method.

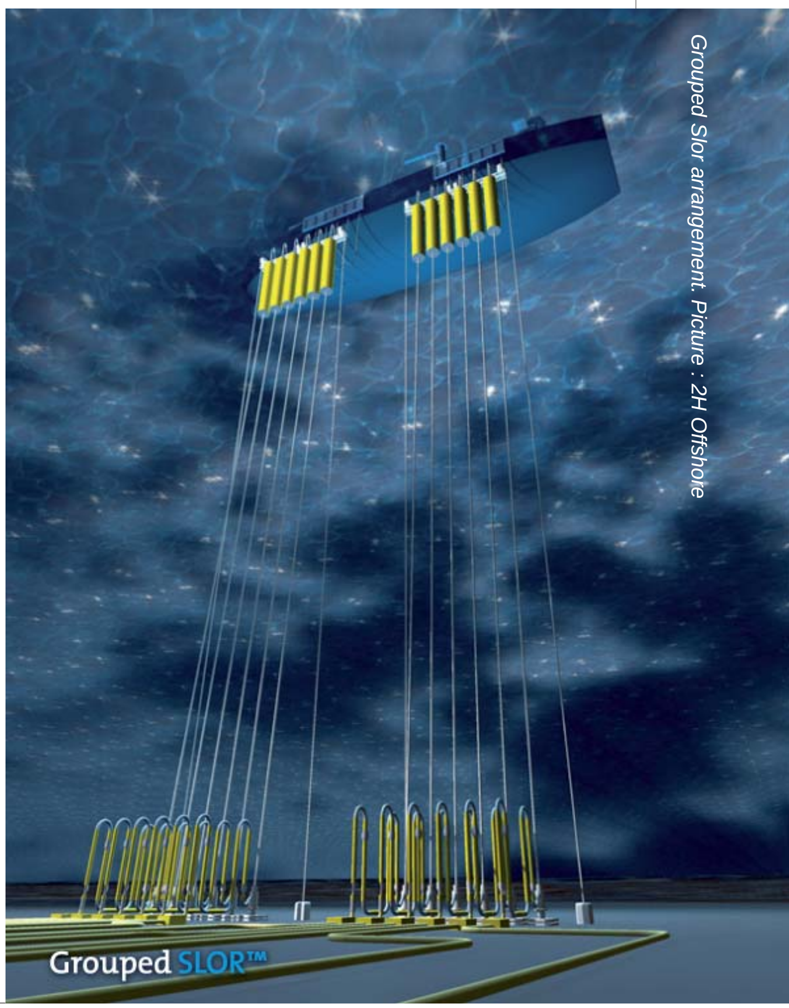
Riser steel weight increases proportionally with water depth. This has a significant effect on the costs of the riser pipe, buoyancy cans and tensioning system. Payload limitations on the production facility also becomes an issue, along with the tension limits of the installation vessel.

An alternative to welded risers would be premium mechanical connections in the form of threaded and coupled (T&C) connections. The use of these in well casing strings is ubiquitous and the industry has decades of experience and confidence in this system. A large number of threaded connector designs are available on the market, and thier use for riser and flowline solutions can provide significant benefits:

- Faster make-up speed compared to welding – 2 to 5 minutes compared to 30 to 50 minutes for a typical offshore welding and inspection procedure for a fatigue sensitive application.
- Non-welded construction allows the use of high strength steel (110ksi). This reduces riser weight, buoyancy requirements or payload on the vessel.
- Improved fatigue performance – qualification testing of threaded couplings shows that the fatigue performance is comparable to or even better than what can be achieved with a good quality single sided weld.
- The cost of pipe machined with threaded and coupled connections is greater than that of plain ended pipe, however, the steel cost is a small proportion of the total system.

One of the key benefits of using T&C connections is the ability to improve the installation procedure, particularly for SLORs and SCRs. To date, the use of T&C connections have been for applications which involve installation from a drilling derrick specifically designed to efficiently handle and install threaded pipe joints such as down hole casing.
Although mobile offshore drilling units (MODUs) are not generally used for either flowline, SCR or SLOR installation, the facilities available on these vessels are well suited for J-lay mode. The available handling equipment such as spiders and torque tongs are tailored for the use of threaded connections. The derrick capacity is variable, but is usually greater than the majority of J-lay installation barges.

The MODU is often already mobilised in the field to drill development wells on long-term charter. Its motion characteristics are superior to those of a pipelay barge. Furthermore, lay barges tend to be more sensitive to vessel heading and must be orientated during installation



Grouped Slor arrangement. Picture : 2H Offshore towards the waves, which can lead to difficulties during lay operations. It is conservatively estimated that completion of each 80ft double joint can be done in a total of 15 minutes. Unlike welded construction, the lay rate of threaded pipe is not sensitive to variations in pipe diameter or wall thickness.

Threaded SLOR Installation

The SLOR also lends itself to installation using a drilling derrick, with the riser joints connected at the drill floor. The handling and connection of the buoyancy can to the riser may be the most challenging aspect of the installation; this can be achieved by keel hauling the buoyancy can underneath the MODU, hanging it from the drilling riser tensioner chains and running the riser string through the buoyancy can.

After running through the buoyancy can, the riser string is landed on the top of the buoyancy can where a fixed connection is made. The buoyancy can is then released from the drilling riser tensioner chains and the entire riser assembly lowered using the riser running string.

The bottom of the riser is landed and locked to the foundation pile using an ROV. The can is de-watered and the riser allowed to free-stand. The flexible jumper is then installed independently by a flexible pipe lay vessel in a standard installation procedure.

Threaded SCR Installation

The drilling derrick is specifically designed for pipe make up in the vertical orientation while SCR's require a small top angle to ensure stability of the catenary. For threaded connections, however, make up angles of more than a few degrees are unacceptable and make stabbing and supporting of the riser impractical.

In order to provide the catenary with the necessary stability during installation from a MODU, the riser must be held vertically at the drill floor and deflected off the vertical below it. This requires a vertical stinger to be fitted below the drill floor to control catenary curvature.

Contract Approach

The main challenge in implementing a T&C riser system is the absence of a clear contracting approach. The riser package is currently awarded to a contractor within the subsea umbilical, riser and flowline (SURF) package.

Typically, only 15-20% of the total SURF package cost is due to the risers. SURF packages are therefore awarded to large pipeline installation contractors who have confidence and pre-investment in welded technology. This contract strategy currently suits the operators, who prefer to work within a single lump sum contractual framework and have resisted contract strategies that divest responsibility and risk away from the contractors.

In order for T&C connections and the resulting installation approach to be applied, the risers should be included as an optional element in the SURF package, and offered as a stand-alone package to be bid by specialist riser installation contractors or drilling contractors, thus widening the competition. Both T&C connections and welded riser development options should be considered as viable solutions from initial scheme.

This approach implemented from day one of a project will allow operators to benefit from the improved installation approach which T&C connections offer for deepwater risers.

Tahiti Riser Monitoring

A comprehensive riser and flowline monitoring (RFM) contract was awarded to 2H Offshore for Chevron's Tahiti Project. The RFM system design life requirement of ten years is an industry first and all the subsea sensors, electronics systems and communication cables are configured with double redundancy.

2H will provide riser monitoring instrumentation for production riser hang-off and touchdown regions and strain and motion measurements. The flowline monitoring system will measure flowline buckling shape and local temperature and hoop and axial strain.

'Breaking down an involved system into simple manageable blocks ensures integration of an RFM system with complex offshore project development,' said Metin Karayaka, Chevron RFM Project Coordinator. 'Close co-operation with Tahiti's integrated project team enabled us to optimise the RFM system for robustness and reliability'.

The 2H contract involves system design, equipment supply, integration and deployment and is he latest generation of on-line riser monitoring systems. The riser monitoring system has been configured for analytically predicted riser response and data processing. Transducers specification and location were preceded by detailed 2H studies to ensure that the monitoring objectives were met. These objectives include capturing riser vortex induced vibration (VIV) response, wave and current response and information on riser- to-seabed interaction.

The high tech on-line steel catenary risers (SCR), monitoring system is gathering riser response information at 10 Hz frequency, processing it in real-time and providing feedback to the Tahiti controls systems. The RFM system is fully integrated with Tahiti's data network,which allows data monitoring from shore. The 2H monitoring system provides critical information on riser response, confirming riser structural integrity and facilitating riser integrity management.

Data gathered by the system will also be very valuable for general understanding of riser behaviour and development of design practices.

The system architecture maximizes the use of 2H's field-proven INTEGRI.pod technology coupled with a successful long-term component track record; and utilizes existing Tahiti project infrastructure in its communications. The design of the system emphasizes data reliability and ensures that single-point failure does not result in the loss of system functionality and collection of the required data.