Slim riser an alternate method for deepwater drilling

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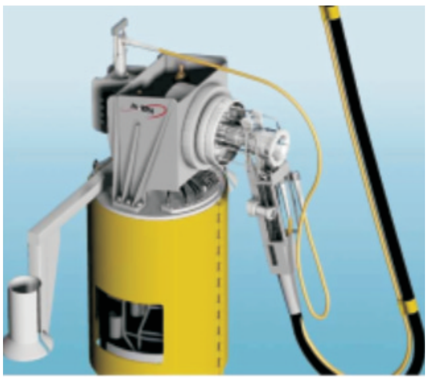
IN DECEMBER 2003 the industry drilled in 10,011 ft. water depth. The current drill and completion record is 7,209 ft. A well was drilled in October 2002 with a taut mooring system in 8,717 ft. A DP Semi drilled a Surface BOP (SBOP) well in 9,472 ft offshore Brazil in April 2003.

In 2002 a conventional spread mooring system was deployed offshore Malaysia in a record water depth of 6,152 ft with a rig rated to 7,000 ft. All the latter records and a vast majority of the wells drilled in ultra deepwater (over 5,000 ft) were drilled and/or completed with highly capable 5th Generation MODUs that are expensive to construct, contract and operate.

One of the challenges for the industry after achieving these remarkable technical accomplishments is to go forward with concepts that are more cost effective and that may be used on a routine, day in and day out basis.



EH Control System Pod Module atop a Koomey 42 line pod with flying Leads and FITA electrical (top) and hydraulic (right side) shown plugged into EH Pod Module.

One of the new concepts used over the last few years is SBOP. It has proven to be very cost effective under the right conditions, i.e. normal pressure, two or three total casing strings, expendable well, large quantity of wells to share the rig conversion, CAPEX, 2nd or 3rd Generation MODU, and calm to moderate metocean.

The concept of SBOP is to have the BOPs at the ocean surface on a floating MODU thus eliminating running and pulling the BOP and riser as a planned or unplanned event. In addition, elimination of the subsea wellhead and using slim hole drilling technology reduces costs via less mud, smaller casing, fewer bits and less equipment.

However, if well control concerns require a Subsea Shut In Device (SSID) or Subsea Disconnect System (SDS) at the ocean floor, significant MODU upgrades, more casing strings, expected abnormal pressure, desire to retain the well for future use or development, and/or mild to severe metocean, the attractiveness from a "cost effective" standpoint diminishes.

After three years of planning and engineering, an old concept of using a 16-in. OD riser has been upgraded technically and introduced to the industry for ultra deepwater 3rd and 4th generation semi MODU water depth extension.

The Slim Riser concept uses 16-in. riser in place of 21-in. riser, but still retains the 18-¾ in. BOP stack as is, 21-in. slipjoint and diverter assemblies as is, slim wellhead design for two or three casing hangers that is also compatible with horizontal trees, simple reentry system, and a patented Electro-Hydraulic (EH) Control System. The MODU with the Slim Riser kit may readily switch back and forth between conventional 21-in. riser and Slim Riser.

By using a 16-in. riser the weight, deck space and riser tension are reduced compared to a 21-in. riser system. An ABB Vetco Gray bare MR-4D (API 1.5 million lb coupling rating) 16-in. riser air weight is 16,186 lbs (1/2 in. wall tube and 3-¾ in. ID, 10K WP kill/choke lines) and with 40-in. OD buoyancy is 23,320 lbs per 75 ft joint.

A comparable 21-in. ABB Vetco Gray bare flange HMF riser is 22,060 lbs (5/8 inch wall tube required to complement required API Grade F stronger coupling and 3 ¾-in.with 48 ½ in. OD buoyancy (60 ½-in. rotary and diverter required) is 38,990 lbs per 75 ft joint. The latter translates from a Variable Deck Load (VDL) standpoint of being able to carry, depending on bare and buoyed riser make of the riser string, approximately 8,360 ft of 16-in. riser vs. 5,000 ft of 21-in. riser. You will note that the 16-in. riser uses 10K WP kill and choke lines. With fewer casing strings 10K WP pressure is very unlikely. Another advantage of the 16-in. riser is riser cleaning and solids transport up the riser annulus while drilling. No auxiliary mud circulating line is necessary as is required on a 21-in. riser, which is another weight savings. In addition the smaller 16-in. OD buoyancy provides more clearance through the rotary and diverter resulting in less buoyancy damage.

Operators and drilling contractors constantly worry about VDL but often neglect the required space to carry the rated VDL. Based on the latter riser joint data, 7,500 ft of 16-in. riser takes up the same volume as 5,000 ft of 21-in. riser.

Deck arrangement, stanchions and storage of other deck items will probably alter this ratio. It is probable that more 16-in. riser can be stored because of being able to stack the joints higher via allowable deck loading (16-in. versus 21-in. weight) and overhead crane height (less height per joint).

Mud pit volume is always of concern with water depth upgrades. In the event the riser must be pulled as a planned or unplanned maintenance event, there should be enough vacant pit volume to store the volume in the riser. Assuming the MODU has enough vacant mud pit volume to store 5,000 ft of 21-in. (5/8-inch wall), the same volume could hold 9,440 ft of 16-in. (1/2-inch wall).

SBOP due to using casing (usually P-110 grade) as riser straight into the ocean bottom, and thus no flex joint to relieve bending stress, must maintain a very tight and restrictive watch circle over the wellbore. This is generally thought to be less than 2% of water depth. For Slim Riser that uses a flex joint at the ocean floor on top of the BOP stack, the watch circle can be extended to 6% or more.

This allows the possibility of using a self-contained spread mooring system versus SBOP requirement to have a taut or semi-taut preset mooring system. Taut and semi-taut mooring systems are very expensive from a capital and deployment standpoint. A taut or semi-

Metocean in Mediterranean off Egypt		
	1-year Return	10-year Return
Waves Hs (ft)	18	33
Wave Period (sec)	12	12.25
Surface Current (sec)	1.0	1.0
Mud Line Current (sec)	0	0
Wind (mph)	46	65

"Atwood Eagle" Equipment/Condition	
Item	Capability/Condition
Wirerope	10,000 ft, 8 lines, 3-1/2 inch
Wirerope Break Strength	1,515,000 lbs
Chain	3,300 ft, 3-1/4 inch, RQ3
Chain Break Strength	1,460,000 lbs
Riser Tension	1,600,000 lbs
16" Riser Make Up	6,600 ft Buoyed, 225 ft top and 600 ft bottom bare

Metocean and mooring and riser particulars for Slim Riser analysis on Atwood Eagle semi MODU in 7,500 ft water depth offshore Egypt.

taut system may still be required for Slim Riser, but some semisubmersibles will have the capacity to conventionally spread moor.

As an example MODU for Slim Riser application, Atwood Oceanics conducted a mooring and riser study for 7,500 ft.water depth offshore Egypt. The table above lists the metocean and physical capabilities of the Atwood Eagle, an upgraded 4th generation semisubmersible rated for 5,000 ft of water.

Confirmed by a third party engineering company and again by a major operator, the mooring and riser system meets all API mooring (RP 2SK) requirements for operating, standby, survival, and damaged conditions and riser (RP 16Q) operating, survival, hang-off and landing of the BOP requirements.

For the 15 ppg mud case, only 750 kips plus disconnect tension is required out of a total tension available of 1.6 million lbs. With 950 kips, allowable mooring offsets range is –3.0% to + 1.75% in conjunction with acceptable low riser angles.

Since ultra deepwater reentry for the BOP stack and LMRP will be guidelineless, a technique used for subsea Christmas trees will be used. A single large funnel on one of the guide corners will be used in conjunction with a taller guidepost of the four posts will be used along with ROV assistance. This is a very common technique used in completion work.

Of significant importance is the slim-hole wellhead system. In the 1960's, single 13 ⅝-in. BOP stack systems were used routinely with two or three hanger systems. To meet today's requirement for metal-to-metal seals and API (Spec 17D) compliance, a number of manufacturers have designed and manufacture various slim-hole casing systems with the ability to land 2 or 3 strings of casing plus placement of a spool or horizontal tree on the 18 ¾-in. housing.

The concept for Slim Riser is to use standard drive pipe sizes (30-in.) with a standard 18-¾-in. housing (20 or 16-in. casing) bushed or machined down to a 14 ¾-in. ID to land various size hangers with seal assemblies. Common casing sizes landed in the 18 ¾-in. housing would be 11 ¾, 10 ¾, 9 5/8, 7 5/8, and 7-in., thus allowing the ability to use 5-½-in. and possibly larger tubing for completion. Depending on the casing and required hole size, bi-center bits and other proven hole enlargement techniques are available, if required.

The key innovation of the Atwood Slim Riser system is the BOP Control System. Piloted All-Hydraulic Control Systems (PHS), even with pressure bias enhancements, generally develop actuation times too slow for critical functions (rams and annulars) in over 5,000 ft of water depth and umbilical/pilot hose lengths of approximately 5,500 ft and over.

Since the vast majority of 3rd and 4th generation semisubmersibles are outfitted with PHS, they need to be upgraded to faster BOP control systems for use with the ultra deepwater Slim Riser concept. Unfortunately, multiplex control systems (MPX), which are used exclusively for ultra deep MODUs, are very expensive, time consuming to retrofit, and have a number of operational disadvantages.

A new patented hybrid Electro-Hydraulic (EH) Control System has been developed that is readily and very economically retrofitable to PHS. The concept is to use direct electrical on/off signals that have security guards for the critical functions and piloted hydraulic for the non-critical systems. The EH Control System uses a majority of the existing PHS such as the existing driller's and toolpusher's panels, HPU, UPS, most of the rig's electrical wiring, existing topside hydraulic umbilicals, both subsea pods, pod retrieving frames, and the existing BOP/LMRP stack as is. Only the pod reels, umbilicals (24 electric wires in the center with ³⁄16-in. pilot lines), banana sheaves and EH module, which is placed on top of the existing pods, will be new. Critical function reaction times will be the same as MPX times, while non-critical functions such as kill and choke valves, wellhead connectors, pressure read backs, regulator settings, etc., will be controlled by pilot hydraulic pressure.

The EH Control System has been designed as a kit and may be installed on a long move or a short two or three week non-shipyard stop. The interface between existing and new components is very clean in that the surface hydraulic umbilicals are plugged into the new EH Control System panels.

The cost of the EH Control System is a fraction of a full MPX Control System not including the BOP stack conversion that is also required with a MPX. Of significant advantage is that the EH Control System pods can be readily retrieved or rerun on guidelines or if guidelineless, which is not the case with most MPX Control Systems. The EH Control System can be installed, maintained and troubleshot by a competent rig electrician thus not requiring a specially trained technician.

The status of the Slim Riser concept is that all engineering has been completed, prototype testing on critical components for the EH Control System are nearly complete and final equipment selection and interface are being done. Lead-time is 7-9 months as controlled by equipment delivery.

A competent 3rd or 4th Generation Semi rated for 5,000 ft water depth can be readily extended to 7,500-8,000 ft with this concept.

The incentive for using the Slim Riser concept is reduced rig day rate (approximately half, depending on market conditions), less and smaller well expendable equipment, without compromising the ability to drill a secure well that can be used in the development and completion phase. ■