Riser system is designed for 3,000 m water depths

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A NUMBER OF FACTORS played a role in the selection of a riser system and configuration capable of operating in 3,000-m water depths.

These factors relate to the drilling program, the arrangement on board the vessel and the type of riser connector.

As part of the drilling program we were looking for a 21-in., 10,000 psi system capable of operating in 10,000 ft of water with a mud specific gravity of 1.6.

The initial contract in West Africa required 6,000 ft water depth capability with a mud specific gravity of 1.8.

Our first evaluation showed that this was possible with the storage and top tension that could be provided on our unit based on operating 1-year return conditions for West Africa, Brazil and Gulf of Mexico, and survival hang off from rotary based on 10-year return conditions for the same areas.

In view of the large freeboard provided by our drillship design , we chose to store the riser in an open hold located in the forward part of the vessel and handle it with a simple gantry crane (backed up by deck crane for redundancy) and horizontal skid system.

The storage in hold tends to minimize the dynamic loading and allows the motion characteristics of the vessel to be kept close to the optimum.

In view of the size and weight to be handled, we selected 70 ft long joints.

CONNECTOR, BUOYANCY

We considered various type of connectors available on the market and came to the conclusion that the "Clip Connector" designed by **Institut Francais du Petrole** (IFP) long ago offered the fastest makeup/breakout time.

It also was the safest because no prestress is required to achieve nominal capacity.

Riser buoyancy selection is based on foam modules of various density with hexagonal section and rounded angles with an outside diameter of 50 in. This shape provides a sufficient clearance in the rotary and helps storage on board.

CLIP RISER TECHNOLOGY

The main advantages of the "Clip 10-21" connectors used in the construction of both systems are the rapidity, ease of operation and reliability of the connection. It consists of a "quick" type connector with a revolving ring that, after insertion, rotates 1/8 of a revolution.

This equipment has good resistance to traction (certified at 1,134 ton and 1,588 ton, tested at 3,000 ton without rupture) and working pressure (490 bars).

This technology was developed in the 1980's by IFP and **Framatome** on the basis of a concept developed for the national project "Drilling in Deep Seas."

Clip connector developed by IFP (pin side is shown) offers faster, safer makeup/breakout.

An 1,800 m riser prototype was then built by **Creusot-Loire** and used in 1982-83 for two drilling operations in the Mediterranean (GLP1, record water depth at the time of 1,714 m, and GLP2).

FOR 10,000-FT WATER DEPTH

The characteristics of the design allow for extending operations to water depths up to 10,000 ft (3,048 m).

The basic riser configuration achieved is as follows from top to bottom:

- Telescopic joint;
- 5 non buoyant joints (3/4 in. thickness);
- 30 buoyant joints (24.6 lbs/cu ft buoyancy and 11/16 in. thickness);
- 43 buoyant joints (31.9 lbs/cu ft buoyancy and 5/8 in. thickness);
- 34 buoyant joints (33.1 lbs/cu ft buoyancy and 5/8 in. thickness);
- 29 non buoyant joints (3/4 in. thickness);
- LMRP.

In these conditions, the total weight of the riser is 2,200 ton. This requires an apparent weight of 270 ton to maintain an acceptable dynamic stability ratio of 0.12 compatible with the accelerations considered in a hang off situation.

The limit of tension at the top is 800 ton which is compatible with the installed tensioning capacity, the riser being full of mud density 1.6 (maximum density specified). And it is still compatible with the qualification of the Clip Riser and the riser tension capability installed on board our vessels.

PRESENT CONFIGURATION

The present configuration for 6,000 ft water depth is composed from top to bottom of:

- Telescopic joint;
- 5 non buoyant joints (3/4 in. thickness);
- 30 buoyant joints (24.6 lbs/cu ft buoyancy and 11/16 in. thickness);
- 26 buoyant joints (31.9 lbs/cu ft buoyancy and 5/8 in. thickness);
- 22 non buoyant joints (3/4 in. thickness);
- LMRP.

The apparent weight of the riser is 180 ton for a total weight of 1,200 ton. The apparent weight/weight ratio is 0.15, sufficient considering the weather-oceanographic conditions.

We also note that the limit of tension that should be applied at the top of this riser is 640 ton for a mud density of 1.8.

This is more than compatible with the

tensioning capacity taken on board our vessel (16 x 160,000 lb units).

Finally, the structural efficiency factor indicates that 45% of the weight of the riser contributes to the axial resistance. The rest of the weight (buoyancy modules, peripheral lines) acts like very penalizing mass for the dynamic behavior of the riser in a hang off situation.

RISER FOR GULF OF MEXICO

Drilling conditions have been reviewed for typical Gulf of Mexico 10,000 ft water depth operations in order to evaluate the effects on the riser design.

A main difference is the maximum density of the mud likely to be contained in the riser (2.04 instead of 1.6). Also the diameter and service pressure of the "kill and choke" lines are 4 ½ in. x 15,000 psi, instead of 4 in. x 10,000 psi. The increase in stress resulting from these increased specifications results in a 40% increase in the weight of the riser to 3,100 ton. The apparent weight increases to 345 ton to maintain sufficient dynamic stability. Also, structural efficiency drops to 35%.

Finally, required top tension reaches up to 1,170 ton, exceeding the proven resistance capacities of Clip 10 connectors as well as the tensioning capacity available on the vessel.

PROPOSED IMPROVEMENTS

Several approaches can deal with these difficulties.

Increasing the dimensional characteristics may cause new problems to arise. Other more subtle approaches consist of introducing new technological concepts in the riser system without upsetting the architecture.

Lightening the peripheral lines using hybrid steel-composite tubes will reduce the total weight of a 3,000 m riser by about 500 ton.

Hyperstatic integration of peripheral lines will increase the structural efficiency of the riser by almost 70%.

Reducing the volume of the mud contained in the riser in the small diameter drilling phase by the installation of an inner sheathing will reduce the top tension by over 200 ton.

Finally, active air floats can be controlled from the surface at the lower part of the riser in order to adapt the state of the riser system to the operational and environmental conditions encountered.

Work on these different topics is in progress. The goal is to design, develop and qualify the technologies needed to operate in 10,000 ft water depths with high mud density and pressure rating.

CONCLUSION

Pride Africa and Pride Angola will be able to operate in up to 1,800 m of water as equipped, and later in 10,000 ft water depths with addition of riser joints.

To comply with more stringent specifications, a technological evolution of the riser system is necessary and the new concepts listed above are being studied. These will be tested in full scale operation on our vessels for validation. ■