Rig design philosophy key for harsh-environment drilling in Barents Sea, Haltenbanken area

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HIGHER RIG RATES have led to an impressive newbuild program of semisubmersible drilling units. Will these new rigs be built for operational safety and efficiency in a harsh environment? Year-around offshore drilling operations in the north of Norway on the Haltenbanken and the Barents Sea area is a challenge against forces of nature in an extremely harsh environment with the following special environmental characteristics:

Barents Sea

- Polar low pressures.
- Low temperatures.
- Ice and snow.
- Drifting ice.

Haltenbanken

- Atlantic Ocean hurricanes.
- Strong current.
- Long wave periods.

A rig design philosophy with the main focus on the required operations is key to success in these waters.

The majority of the 4th-generation rigs operating on the Norwegian continental shelf today were built in the '80s and hence designed for exploration drilling operations. Today Statoil is performing a substantial amount of advanced and challenging production drilling, completion and workover operations on the Haltenbanken and in the Barents Sea area. Statoil hopes that some of the new multi-purpose 6th-generation semisubmersible drilling units will be built with the objective to improve the unit performance considerably and fully meet the challenging present and future operations and area conditions.

Statoil is generally concerned for some of the new rig construction projects with regards to lack of operational personnel involved in the early project planning phase.

RIG DESIGN FACTORS

Rig design philosophy is key for operational safety while performing operations in a harsh environment on the Haltenbanken and the Barents Sea area.

The following rig design factors should be established as basis for a rig design made for these conditions:

- Rig motion characteristic.
- Natural heave period.
- Large deck area and storage capacities to ensure efficient logistics.
- High air gap in operation condition and in survival.
- Arctic design.
- Environmental care.

A medium-capacity drilling facility, 4,500 to 5,000 tonnes variable deck load, with a large deck area, should be sufficient because the majority of offshore drilling operations north on the Norwegian continental shelf will be performed in water depths varying from 150 m to 450 m.

Drilling-related expenditure is a main contributor to overall field development costs in a harsh environment. Indirect operational drilling cost is affected by concept design factors such as:

- Waiting on weather.
- Back-loading and requirements for temporary boat storage.
- Weather window required for positioning the rig over the well location.
- Uptime/reliability of equipment/rig in cold weather conditions.
- Working environment.
- Environmental care.

MOTION CHARACTERISTICS

The wave conditions experienced on Haltenbanken are special. Very long

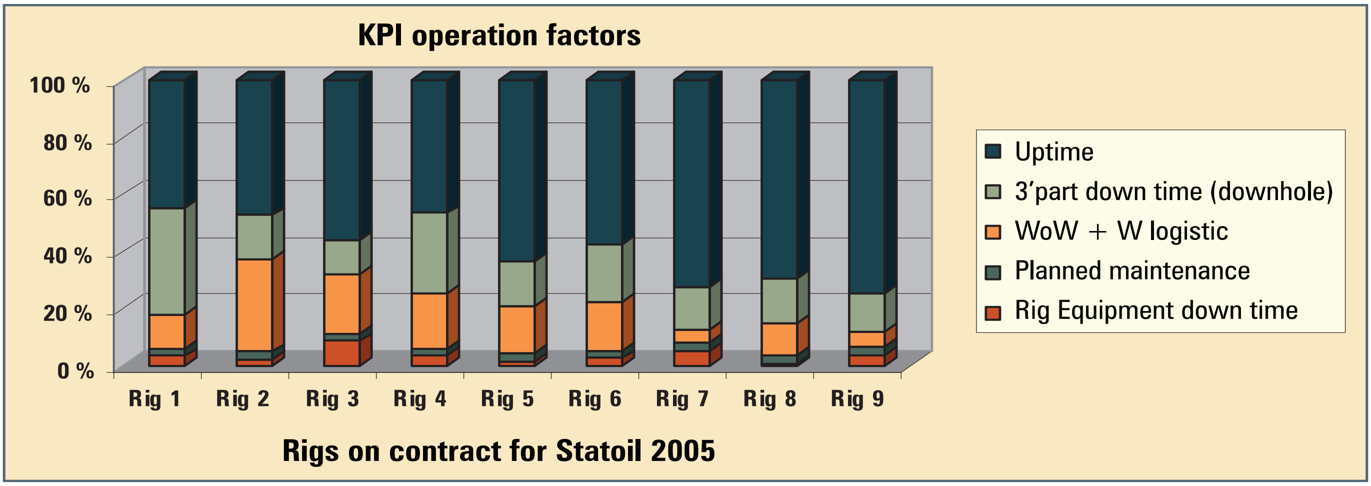
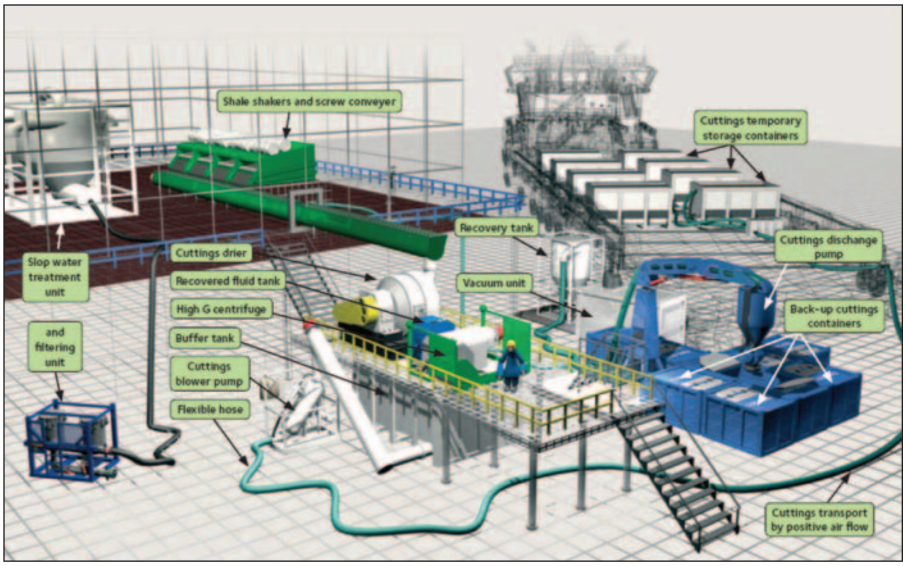


Figure 1 shows that statistical uptime for the rigs on contract for Statoil in 2005 was improved along with improved rig motion characteristic and good logistic facilities.



Noroff Instituttet Stavanger

This illustration shows the seamless product line for drilling waste minimization and the safe, efficient transport of drill cuttings onto the deck of a service vessel. The environment must be considered in rig design for the Barents Sea area in particular.

period waves (over 21-sec period and 6 -7 m high) are experienced at a yearly basis during periods with relatively moderate weather conditions when the rigs can be in full operation. The special conditions are a result of past distant Atlantic storms adding to the local conditions. This type of wave occurs as one among normal period waves, and drilling units with lower natural heave response period will suddenly heave 6-7 m.

Safety: Natural heave period exceeding 21 seconds is an important design criteria for a drilling rig performing efficient conventional completion or workover operations in the Haltenbanken area, in order to avoid a possible compensator stroke out, or a surface flow tree colliding into the drill floor when the completion riser is attached to the well head.

Cost: The magnitude of nonproductive time is affected by the rig's motion characteristic while operating in relatively moderate sea state conditions.

Efficient rigs with low wait-on-weather score is usually achieved with rigs having good rigs motion characteristic in low amplitude sea state conditions.

An efficient rig for a harsh environment is usually achieved by large displacement, large spacing between columns having relatively small total water plan area, and wide pontoons with the top of the pontoons positioned relatively deep under the water table.

Figure 1 shows that statistical uptime for the rigs on contract for Statoil in 2005 was improved along with improved rig motion characteristic and good logistic facilities.

Other factors affecting the rig's KPI performance typically are:

• Location and season of the year.

• Type of operation and third-party downhole equipment used.

6TH-GEN RIG CONCERNS

There is a possible conflict between increased drilling facility capacity for ultra-deepwater and the rigs motion characteristic required for completion and workover operations in the Haltenbanken area. There is a considerable cost impact for the substructure to maintain the rig's motion characteristic required for the Haltenbanken area as the top side drilling capacities are scaled up to meet the requirement for ultra-deep drilling.

The hull structure made for a typical ultra-deep drilling rig planned to be operating in relatively moderate sea conditions will typically focus on gaining high variable deck load (VDL) at the lowest possible cost. The most cost-efficient way of increased VDL is usually achieved by increasing the column diameter or to add blisters on the column in order to gain higher stability restoring moment, and hence increase the variable deck load capacity of the rig.

A unit designed for both the ultra-deep and harsh environment drilling needs to have both the large capacities and optimal motion characteristics. The optimization relative to variable deck load capacity, equipment capacities, unit geometry and motion characteristics have to be considered from the unit concept phase.

Additional cost issues are:

• Additional column height to fulfil air gap requirements.

• Additional spacing between columns in order to gain restoring stability moment.

• Breadth and depth under the water table of the pontoons in order to get damping effect to fulfil natural heave period and motion characteristic requirements.

ENVIRONMENTAL CARE

The Barents Sea area in particular is an important breeding area for fish vulnerable to potential pollution from any drilling operation. Environmental issues in the Barents Sea area has gained an increasingly political focus in Norway, requiring drilling operations to go hand in hand with the fishing industry.

In order to fulfil Statoil's ambitions with regards to environmental care, focus should be on the following design factors for the new rig projects:

• 2nd barrier philosophy with dedicated slope tanks and drain water cleaning system designed to clean emulsified oil in water, in order to minimize transport of slope to shore. As a minimum, the following drain/tanks should be included:

1. Drain from non-hazardous clean areas.

2. Drain from non-hazardous polluted areas.

3. Drain from hazardous polluted areas.

• Low NOX-emission from diesel generators.

• Transport of all water-based cuttings to shore after installing the BOP.

• Primary cutting transport system should be based on allocate tanks, pneumatic cuttings transport, and offloading system for cuttings treatment equipment and logistic to boat.

• Secondary cutting transport system should be based on pneumatic or vacuum cuttings transport and logistic to boat by using skips handled by the rig cranes.

ARCTIC DESIGN

The design temperatures in the Barents Sea area vary, with the lowest temperatures northeast with the Russian border. The water depths vary from 150 m to 400 m, with some areas with low satellite coverage.

In order to fulfil Statoil's ambitions with regards to arctic operation, focus should be on the following design factors:

• The rig's exposed areas, such as the derrick, drill floor, muster stations, pipe and riser deck, etc, should be fully sheltered or enclosed in order to fulfil Statoil's ambitions for the working environment while operating under cold conditions.

• All critical equipment, escape ways and muster stations should be heat traced.

• Utility systems should be placed in enclosed heated voids under deck in order to avoid environmental and mechanical damage.

• Safety systems such as well control equipment, positioning systems, firefighting and escape systems should be designed for -25°C minimum design temperature (standby mode).

• Redundant Automatic Truster Assist (ATA) positioning system in order to fulfil Statoil's requirements for shallow water depths and low satellite coverage in the Barents Sea area.

STATOIL NEW MODUS EXPERIENCE

Statoil is generally concerned for some of the new rig construction projects with regards to lack of operational personnel involved in the early project planning phase. Focus on early involvement of operational personnel in the project can reduce the number of variation orders at a later stage in the project phase. The following operational issues should be addressed at an early stage of a new rig building project:

• Safe and efficient logistic design (internal on the rig and external to supply boats).

• Third-party equipment such as logging unit, cement unit, test plant, workover/completion equipment.

• Working environment, including noise exposure and sheltering of working areas.

• Late introduction of arctic design issues.

Further, it is considered important with an early establishment of an extensive and realistic operational QA/QC- and commissioning program including the following:

• Selection of a construction yard with good QA/QC systems, dry dock capacity and top side drilling equipment assembly experience.

• Change management to focus on weight control and associated prioritizing of VDL capacity against motion characteristic).

• Commissioning of electrical systems, PLS, IT, ESD and fire and gas detection systems.

• Integrated sea trail testing of complex mooring ATA and DP3 positioning systems, all motion compensating systems.

This article is based on a presentation made at IADC World Drilling 2006, 21-22 June, Prague, Czech Republic.