Rig Integration of a dual gradient drilling system

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THE OVER-ARCHING GOALS of the SubSea MudLift Drilling Joint Industry Project (SMD JIP) were to prove the concept of dual gradient drilling and deliver a tested system. The SMD JIP Project Advisory Group (PAG) and the project team agreed that this goal was best accomplished by conducting a full-scale test of the system and associated procedures by drilling an offshore well.

Ideally, this well would have been a deepwater well using a deepwater drilling unit, but the cost of such an approach was prohibitive. Alternatively, most of the field test objectives could be answered in shallower water at a fraction of the cost of a deepwater test.

Diamond Offshore's semisubmersible Ocean New Era, a second-generation unit capable of drilling in 1,500 ft of water, was chosen to be the test rig. The rig was warm-stacked at the dock in Galveston, which proved to be of tremendous benefit during this first-time integration of a dual gradient drilling system on an existing rig.

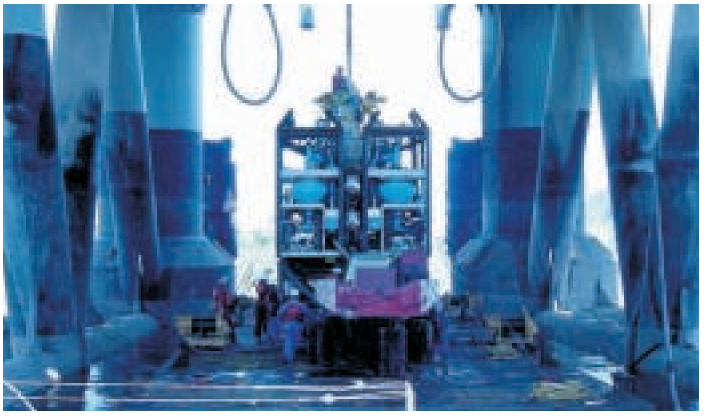
RIG INTEGRATION CHALLENGES

Integration of the SMD system with the existing Ocean New Era systems presented many challenges. Besides the new equipment items required for SubSea MudLift Drilling, it was necessary to augment existing Ocean New Era capabilities with several additional equipment items. The rig's riser had to be modified to be compatible with SMD. Temporary living and working space had to be provided for the SMD test team and JIP member company observers who would witness the test. Additional electrical generating capability was added. The rig integration team's challenge was to incorporate all of this additional equipment and personnel on the rig without impairing the rig's functionality as a drilling unit.

The Rig Integration Team established a work scope as follows for the rig modifications required for installing the SMD equipment on the Ocean New Era:

- •Cellar deck modifications/strengthening
- •BOP bridge crane modifications
- •Riser modifications
- •Surface piping
- •Mud return line
- •Seawater supply line to seawater filtration skid
- •Seawater power line
- •Valve control panel
- •Dual trip tanks
- •Riser fill-up (seawater side)
- •Rig trip tank system (drilling fluid side)
- •Additional cabins for the SMD team and observers
- •Seawater filtration skid
- •PZ-7 seawater power fluid pumps
- •Generator for clean power to drive MLP electronics

The first rig integration challenge related to the weight and dimensions of the SMD subsea MudLift Pump (MLP) package. The dimensions of the subsea MLP and manifold package were determined by the size of the Ocean New Era's moonpool (14 ft, 6-in. x 18 ft-4-in.). The MLP package was sized to allow 1-1/2-in. to 3-in. clearance through the moonpool, resulting in final MLP package dimensions of 14 ft, 2in. x 18 ft-0-in.



The SubSea MudLift drilling package is being lifted from the barge to the Ocean New Era in preparation for the first application of the new technology.

The weight of the MLP package had immediate implications in the moonpool area. The MLP package, as configured for the test well, weighed 185,000 lbs. The MLP was to land atop the LMRP and be run with the LMRP on the rig's existing riser as a unit. The total assembled weight of the MLP/LMRP assembly was 272,000 lbs, requiring strengthening of the Cellar Deck and the BOP bridge crane used in handling the BOPs.

Cellar Deck modifications consisted of local strengthening in the Cellar Deck area. A temporary "build stump" was installed forward of the moonpool to allow location of the MLP package where it was easily accessible to the rig cranes. The BOP bridge crane was strengthened through localized reinforcement, consisting of flange thickening and gusset placement along two beams not tied into the rig floor's substructure. New 70-ton hook load traveling blocks were fabricated.

Temporary riser modifications were made to the Ocean New Era's existing riser. Two external 5-in. O.D. lines were attached to the riser. One line furnished seawater power fluid to the MLP while the other returned drilling fluid from the sea floor to the rig. Each line was supported at surface by a tensioner, backed-up by a top clamp assembly. Both 5-in. lines passed through guide funnels installed along the length of the riser. Each line terminated at a base connector fitted to the flex joint, which was connected to the MLP by means of two Coflexip hoses.

The MLPs are powered by seawater pumped from the drilling rig. Two ESPs pulled seawater from the ocean and delivered it to the seawater filtration skid, which removed impurities The seawater power fluid pumps, consisting of a pair of PZ-7 mud pumps, pumped the filtered seawater to the MLPs via the seawater manifold and trip tank skid and the second 5-in.O.D. line attached to the riser. Space had to be provided for all of these additional skids.

From the well, the other 5-in. O.D. temporary riser line, the mud return line, had to be tied into the rig's existing flowline to pump drilling mud and cuttings returns back to the rig via that line.

Dual gradient drilling differs from conventional drilling operations in many ways, one of the more notable being the need to manage two separate hole volumes during trips, riser volume and mud volume. This requires separate circulating systems and two trip tanks. The Ocean New Era had an existing mud trip tank, but it was necessary to provide a second trip tank to account for riser volumes. This trip tank was included as part of the seawater manifold and trip tank skid.

Surface piping and manifolding required a great deal of planning and fabrication. The two temporary 5-in. riser lines and all of the SMD surface skids had to be tied-in to existing rig systems. A valve control panel was provided to allow remote control of the additional valves incorporated within the mud return and seawater power lines. Surface piping was one of the biggest integration tasks, and a great deal of effort was put into keeping this task out of the critical path.

The SubSea MudLift drilling system was brought through the Ocean New Era's moonpool with literally inches to spare.

INTEGRATING ELECTRICAL POWER

Rig integration issues were not only related to fluid handling. Electrical "piping" was a major challenge. Several SMD components, such as the ESPs, MLPs, control and office cabins and various centrifugal pumps on various SMD skids required electric power. The MLP system receives electrical power and computer control by way of a control reel and umbilical. The total load of these components is approximately 445KW. The Ocean New Era was capable of providing the additional power, but the power supplied by the rig may have had cycle or voltage variation due to start-up and shut-down of other rig systems. Since this was a temporary field test, the decision was taken to add a separate generator skid to provide "clean" power to the SMD equipment, rather than make the modifications necessary to utilize rig power.

LOADING AND INSTALLING EQUIMENT

All of the SMD skids, cabins, piping and riser modifications were pre-fabricated and positioned at dockside in the order they would be lifted onto the rig and installed. A rig-up plan was prepared to optimize bringing the skids and equipment aboard the rig. A "Load Master" was appointed to oversee all lifts and crane usage during the rig-up. A total of 128 pallets of material were prioritized in order of shipment so that equipment would not be received too early or too late, minimizing "double-handling". The coordinated effort of a team of 40 welders installed the skids and piping as quickly and efficiently as possible. A "Welding Master" coordinated the welding aboard the rig and at dockside.

The MLP package was not the key critical path item; it was piping. As a result, transportation of the MLP package to Galveston and subsequent positioning on the rig was delayed a few days to allow critical path activities to take priority the first few days at dockside. The MLP package was transported by barge to Galveston in one piece, as a complete unit. Once in Galveston, the barge was positioned beneath the Ocean New Era and the MLP package was lifted onto the rig through the moonpool. This operation saved a considerable amount of time, since disassembly for transport and reassembly at the rig was avoided.

Ultimately, the rig integration was performed in 23 days. This included some unplanned time, such as 99.5 hours spent repairing a piece of SMD equipment that failed during a test. Thirty hours were lost waiting on weather due to Tropical Storm Chantal. And 14 hours were lost at the sea buoy, waiting on daylight so the rig could be towed into Galveston. Without the unplanned downtime, the rig integration could have been completed in 17 days.

SUCCESSFUL RIG INTEGRATION

SMD rig integration was a great success. Several conclusions can be drawn from the rig integration:

•The SMD system fit comfortably on a relatively small second-generation semi. Integration with a newer, larger floating drilling unit should be easier.

•Rig integration times of three weeks or less are achievable.

•The Ocean New Era rig-up represented the most comprehensive rig-up scenario, since many of the rigs chosen for future application of SMD will already possess features that will eliminate the need for some of the skids used during the field test.

•Pre-planning and front-end Loading is critical.

•Pre-fabrication can drastically reduce rig-up time.

•Most of the rig-up can be done out of critical path.

•Field integration is feasible.

•Hoisting the MLP package aboard the rig as a single unit is achievable.

•Riser modifications will probably require the most lead-time. ■