On-Board Vessel/Riser Drift-Off Simulation for Dynamically Positioned Drillships

Reduces risk and waiting-on-weather time

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Background

As more dynamically positioned (DP) vessels are becoming available on the market after finishing their initial long term commitments, they are being put to work in increasingly difficult locations due to the current nature of the market for such vessels.

The characteristics of these locations are varying from harsh environments such as the Great Australian Bight, ultradeep water locations in the Gulf of Mexico and in relatively shallow water offshore Mauritania. These locations are in addition to normal deep water areas of the world such as West Africa and Brazil where DP vessels have been operating for many years.

For a well to be a viable proposition there must be commercial upsides for both the operator and the drilling contractor. This essentially equates to maximizing the vessel’s weather related operating window whilst at the same time providing low risk and exposure.

DP drilling operations have been conducted for about 30 years now, with significant advances in equipment and controls resulting in low failure rates for the latest generation of DP vessels. Even with these advances the major concerns with DP vessels are associated with the possible consequences in the event of loss of station keeping. Unless the proper planning is performed and both the operator and drilling contractor agree to well specific operating criteria (WSOC) that are put in place prior to the well being drilled, the consequences of loss of station keeping could be high.

When taking DP vessels into these even more challenging locations, a realistic basis for the WSOC becomes very critical to successful drilling and completions operations. It is in these situations that realistic numerical modelling of the well drilling system becomes important to ensure low risk and low waiting on weather time.

Until recently modelling the complete well drilling system which includes the vessel, riser, BOP/LMRP, conductor and soils model using a fully-coupled time-domain solution was an extremely time consuming exercise. Performing such an
analysis prior to each well was not feasible. This type of analytical solution is now becoming routine and essential to the DP operation. DP alert offsets can now be calculated onboard based upon the prevailing or forecasted environment and drilling rig operating condition.

**Drift-Off Simulator**

To meet this need GlobalSantaFe and MCS have developed an on-board vessel/riser drift-off simulator designed for use with DP drillships called **DeepDrift**.

**DeepDrift** provides a fully-coupled riser and vessel analysis capability that simultaneously determines the drift-off path of the vessel and the riser drift-off response. This approach eliminates the requirement for separate vessel drift-off and riser drift-off simulators and the associated iterative simulation procedure, thereby significantly reducing the simulation times and increasing the solution accuracy. **DeepDrift** predicts the vessel drift-off path after power failure and determines the location of the alert offsets for initiating riser disconnect, based on allowable limits of the riser (such as upper and lower flex joint angles, telescopic joint stroke, riser and conductor stress).

**DeepDrift** does not communicate directly with vessel and/or riser monitoring equipment. The simulator has been designed to be easy and simple to use, so as to minimise the chances of input errors and ensure correct alert offset predictions. The following input parameters are required for each simulation:

- Wind speed, current profile and wave height
- Vessel position (heading, offset from wellhead) and heave motion
- Riser operational condition (initial TJ stroke, mud weight and top tension)

These parameters were selected so that user estimates and inputs are kept to a minimum. For example, the user can either specify the sea state or allow the program to infer it based on the heave period and motion measured by the DP system.
The graphical operator interface is straightforward and intuitive and is used to specify the inputs discussed earlier and to display the drift-off limits and alert offsets. An example of the operator interface is shown below in Figure 2.

**Figure 2. DeepDrift Operators Interface**

**DeepDrift in Operation**

Figure 3 is a process flow diagram showing how to get from the initial site information to predicting the alert offsets offshore. This section goes on to describe this process in more detail.
Prior to moving to any location, site-specific data is provided by the operator to generate the riser stack-up. For each location a fully-coupled time-domain drift-off analysis is performed onshore for drilling and non-drilling scenarios, using the MCS DeepRiser engineering tool. In these simulations the metocean conditions are considered co-linear and the initial vessel position is assumed directly over the well. Under realistic offshore conditions this is rarely the case. As a result these design calculations are typically conservative estimates of the alert offsets.

Once the design calculations have been performed, the results provide the basis for the DP alert offsets that are used in the WSOC. After agreement with the operator and operations team these alert offsets are considered the minimum allowable to be used for the well.

A riser, vessel and conductor model, developed onshore using DeepRiser, is provided to the drift-off simulator so that it can predict a drift-off path for the vessel. This model is built-up onshore using DeepRiser, whose analytical engine also forms the core riser analysis program for the DeepDrift simulator. When the model is built, it’s then emailed to the drilling rig and imported into DeepDrift. It should be noted that this model can only be edited on-shore using DeepRiser.
Once the model is imported into *DeepDrift* the DP Operators can start to perform drift off simulations based on prevailing or forecasted conditions and compare against the minimum alert offsets specified in the WSOC. Should a simulation provide alert offsets that are lesser than the minimum specified in the WSOC, there will be consultation with the operations team to determine the proper course of action.

The main distinction between the design alert offsets and the on-board predicted alert offsets is that the metocean conditions in the on-board simulation are typically not co-linear. This will typically lead to larger alert offsets predicted on-board.

Another key feature of the simulator is the ability to provide alert offsets when the rig is positioned up- or down-wind from the well. By having the simulator offshore, the actual conditions for the drift-off scenario can be analyzed and improved guidance provided to the DP Operators.

**Conclusion**

The main benefits of the on-board *DeepDrift* system is that it provides rig personnel with an easy-to-use simulator that gives confirmation of the alert offsets based on the prevailing metocean conditions, thus helping to maximize the operating window while also enhancing riser integrity. *DeepDrift* is scheduled for installation and commissioning on-board GlobalSantaFe’s deep-water drill ships in early Q3 2004.