PERFORMANCE REPORT

MI SWACO
A Schlumberger Company

Operator Extends Development of Mature Deepwater GOM Field and Reduces Drilling Cost

THE SITUATION

Reduce equivalent circulating density (ECD) to eliminate lost circulation and manage constant bottomhole pressure (BHP) to maintain borehole stability while drilling narrow depleted pressure margin in mature deepwater field.

THE SOLUTION

Reduce the ECD by drilling with statically underbalanced mud. Use the dynamic annular pressure control (DAPC) system and HOLD rotating control device (RCD) to control constant BHP in narrow margin between the wellbore stability and fracture gradient while drilling, tripping, and making connections.

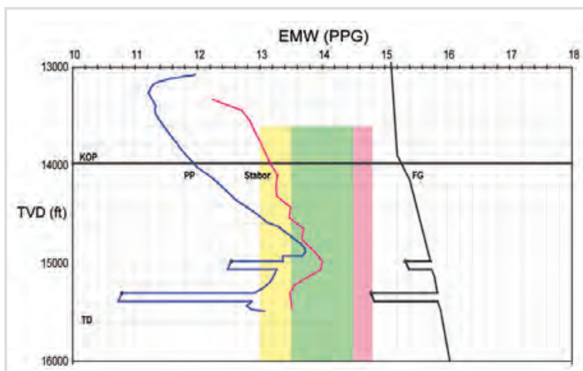
THE RESULTS

Enabled customer to drill six wells, too costly to drill conventionally, with no lost circulation or borehole instability. Controlled dynamic BHP within +/- 0.2 ppg and steady state BHP within +/- 25 psi. Minimized pump transitions to 60 to 120 seconds.

Automated MPD and constant annular pressure enables mud weight and ECD reduction and maintains wellbore stability

Eliminating lost circulation

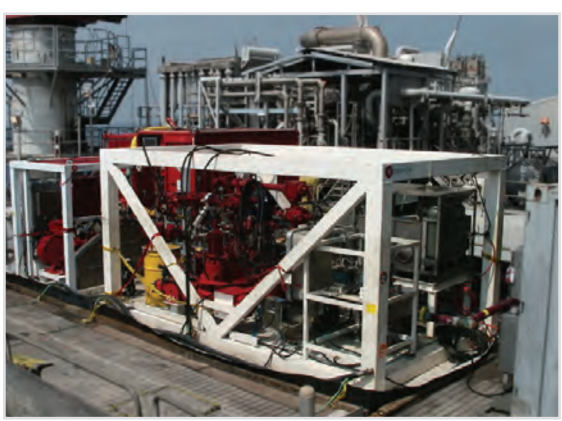
In the early phase of their redevelopment campaign in the Auger deepwater GOM field, Shell encountered unavoidable losses due to high ECD and lower than anticipated fracture gradient. Conventional efforts to drill the narrow margins were ineffective at preventing total losses. Limited in their success to 30%, Shell sought ways to drill with lower ECD, maintain wellbore stability, eliminate losses and unplanned sidetracks, and increase their success rates.



Narrow margin between fracture gradient and wellbore stability. High ECD caused by high mud weight, slim hole, and hole cleaning flow rates. Constant BHP with the DAPC system enabled Shell to reduce the mudweight and ECD, eliminate losses, and maintain stability.

Control exceeding expectations

In principle, the solution was straightforward: reduce the static mud weight below that which was needed for wellbore collapse and in so doing reduce the ECD below the fracture gradient when the rig pumps are on. However, that required an additional solution that would preserve wellbore stability by replacing the lost ECD and maintain a constant BHP when the mud pumps were turned off.



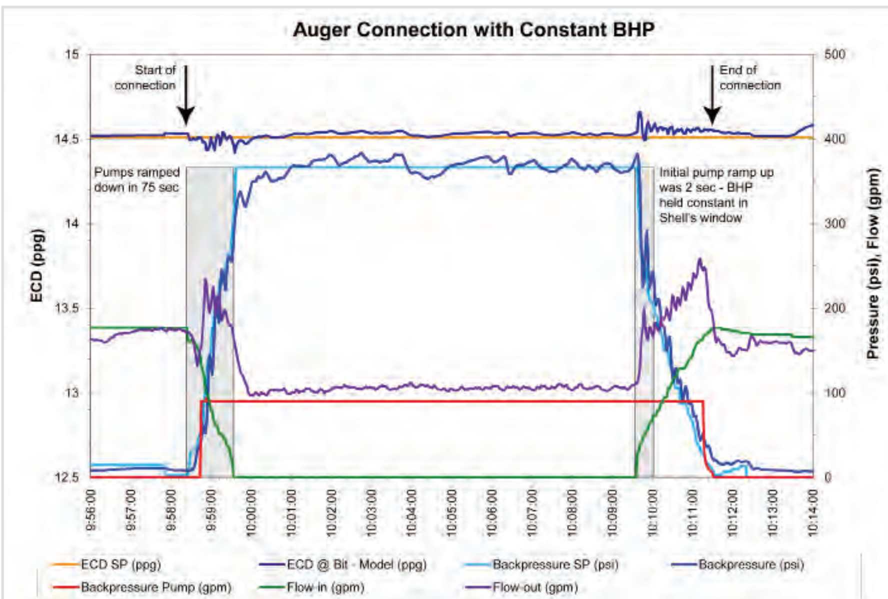
The DAPC system and HOLD RCD were key to the success of Auger redevelopment. With its fully automated, programmable control and integrated real-time hydraulics model the DAPC system achieved tighter pressure windows than expected by Shell which allowed them to extend their plans to wells with increasingly narrower margins and drill with mud that was statically under pore pressure.

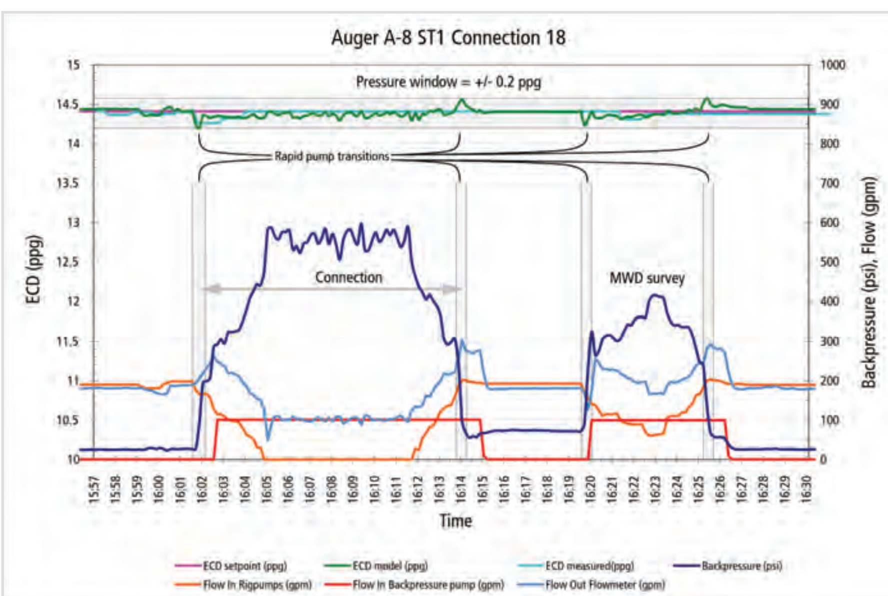
Equipped with the DAPC automated manifold backpressure pump, and pressure relief choke for ECD management, a coriolis meter for kick detection, and an HOLD RCD, the system was able to control the BHP in every operational phase – while making connections, during bit trips, and on bottom drilling.

Fast response minimizing pressure fluctuations

The connection graph shows the ability of the DAPC system to manage the BHP even during rapid changes in pump rate. During the dynamic transition at the start of connection, shown to the right, the pumps were ramped down from 180 to 0 gpm in 75 seconds and the system minimized the BHP change to -0.11 ppg. However, at the end of the connection the pumps were initially ramped up from 0 to 30 gpm in 2 seconds. Even during such a rapid transition fluctuations in the BHP were minimized to +0.13 ppg.

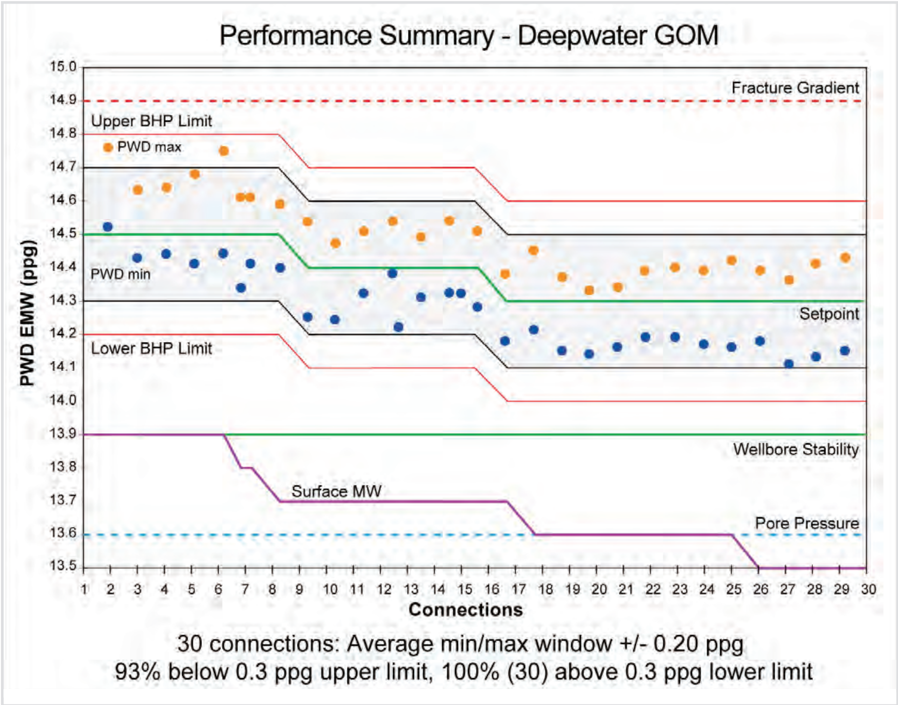
The charts below highlight multiple rapid pump transitions at the start and end of a connection and an MWD survey during which the system managed the pressure in +/- 0.2 ppg.





Maintaining constant BHP and avoiding losses

To avoid losses it was equally important to maintain constant BHP even during steady state conditions such as bit trips. The steady state graph below illustrates the system's ability to manage backpressure continuously for two hours while the bit was pulled to the casing show. During that bit trip, the BHP fluctuated no more than +/- 25 psi.



The performance summary is the record of minimum and maximum BHP that occurred during every connection managed by the system during one of the Auger wells. In this well the system managed BHP in 30 connections during which time the static MW was reduced in stages from wellbore stability to below pore pressure. The target window for the well was +/- 0.3 ppg relative to the setpoint which changed in stages along with the MW. The DAPC system achieved +/- 0.2 ppg for 93% of the connections.

Increasing production and reducing drilling costs

The DAPC system was a key solution in Auger redevelopment drilling by preventing losses in every one of the six wells drilled, all of which were impossible to drill conventionally.

By eliminating losses, the DAPC system enabled Shell to avoid the unplanned sidetracks which had cost over USD 15 million in previously unsuccessful conventional drilling efforts and reduce their overall drilling cost by over 40%.

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