Use of Riserless Mud Recovery (RMR™) to improve drilling efficiency in Block 9 shallow reservoirs

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RMR© is an innovative way to return mud and cuttings to the rig before the marine riser is run, without discharge to the seabed, there is no “Pump & Dump”

RMR© is a risk reduction system that allows you to drill a better, more stable top hole safely, quickly and with less environmental impact
RMR Benefits – Drilling Top Holes with Weighted Mud

Mitigates Geo-hazard Occurrences
Shallow Water / Gas Flow
Early kick detection
Formation Instability
Alternative to pilot hole

Allows Well Design / Construction Optimization
Reduced number of casing strings
Drill deeper open hole sections
Set the 20” deeper to get a best possible shoe or
Skip the 20” and go for a 17½” and 13 3/8” casing directly
Improved well bore quality / structural integrity

Reduces environmental impact
Saves mud & reduces logistics costs
RISERLESS MUD RECOVERY SYSTEM

‘Sub-sea’ technology
ROV friendly
Minimal rig time
Off line deployment & retrieval
Real time monitoring / communication
Well head, template, self spudding options
Proven! Over 300 wells to date
Kraken overview

- 24-well development in Block 9/02b
  - local offsets include Harding, Gryphon, Mariner
- FDP - four drill centres (DCs), each with 4-slot production and injection templates, either template within rig skidding pattern
- 370-410ft water depth across field
- Top Heimdal III reservoir 3,850 – 3,950ft TVDSS
- Slim-hole well design (originally full-hole)
Typical Kraken well plans (pre-drill stage)

DC2 Injector
Sou-I01
- 26” x 42” OH
- 20” x 36” 5jt conductor
- SW & Sweeps / vertical
- 17¼” OH / 13¾” shoe
- KCl / Polymer WBM / Deviated 14°
- Original 20” shoe depth
- Original 13¾” shoe depth

DC1 Producer
Sou-P04
- 85° Tangent
- 12¼” OH / 9¾” shoe (Producers UR to 13½”)
- Versaclean LTOBM / Horizontal (85°-90°)
- 89° Tangent
Achieving shallow build in weak, unconsolidated formations

### Use of engineered mud system
- Conductor shoe set at ±700ft
- Section TD ±2,400ft
- Conventional riserless sections with seawater & sweeps
  - Kraken 9/02b-6 appraisal – 14° achieved
  - Kraken 9/02b-7 appraisal – 18° achieved
    - field test of small batch of engineered mud
  - Other Block 9 – 6.5° by 1,900ft
  - Other Block 9 – 5.5° by 2,000ft
- Engineered mud systems
  - Gryphon and Harding achieve well in excess of 20° through
    - use of LP riser (platform)
    - Subsea wells with pre-packed wellhead and BOP in place
- Conclusion that engineered mud system with means of transporting returns to surface is critical

### Use of Riserless Mud Recovery System (RMR™)
- Enables use of engineered mud system with returns to surface
- Kraken template system – requirement to remove cuttings and cement on riserless systems from template anyway (CTS™ so RMR™ was a simple next step)
  - Use the same pump unit for both systems for simplicity
  - Return line to shaker required (hardline installed)
- Attaches to the Concrete & Cuttings Disposal System (CCDS) on the template or directly on to the Subsea Module (SMO).
Enhanced Drilling RMR™ system on Transocean Leader
Summary of results

**Surpassed expectations**

- 24 off 26” x 42” sections with CTS (batched)
- 24 off 17½” sections with RMR (batched)
- DC1 - maximum of 25° achieved
  - Held back following initial doglegs >3°
- DC2 – pushed boundary to a final survey of 41°
  - Casing run to bottom on Overdrive without issue
- 50° considered to be a technical limit
- No issues with equipment or personnel

- Pushed boundaries of pump life
  - >300 circulating hours on one subsea pump module (SPM)
- Optimised such that the SPM was left in one position & the use of two hoses meant all the slots on each template could be reached without moving the SPM.
- Aker CCDS interface used for tophole drilling and both cementing operations
- SMO used for 17½”
### DC2 - 9/02b-D1 – 17½” section 40.6° actual vs 14.6° plan

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Projection to TD
DC2 – pre-drill vs actual

- Pre-drill plan
- Actual
DC2 - longest injector (12¼” to drill Q4 2016) 775ft reduction

Previous 9¾” shoe = 8,509ft MD
New 9¾” shoe = 7,734ft MD
Saving = 775ft (½ day)