Annular Level Control

Low Riser Return System (LRRS)™

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The Principle of Annular Level Control
Low Riser Return System (LRRS)™

- The riser is only partially filled with drilling mud, while the top of the riser is evacuated
  - Single Mud Gradient Open System
- A subsea mud pump is controlling the level of mud within the riser
- Adjusting the level of mud in the riser makes it possible to change the BHP in minutes.

Simple yet effective technology
Two Versions of the LRRS

**LRRS ECD**
- Conventional mud weight
- Conventional Well control
- Minimal rig integration

**LRRS +**
- Heavy mud
- Modified well control procedures
- Pumps in series

Different solution for different application, but same principle
LRRS $^{ECD}$ for ECD Compensation
Why Use Lower Level and Heavier Mud?

Flowline level
Mean sea level

Depth
Fracture pressure
Pore pressure

Pressure
LRRS+ Matches the Drilling Window

Conventional mud pressure

LRRS mud pressure

Pore pressure

Fracture pressure

Depth

Pressure
Applicability of LRRS

The LRRS can be applied and provide benefits through the entire well.
LRRS<sup>EC</sup>D – Light-Weight System

Small footprint and weights
Subsea Mud Pump with Proven components & solutions

Pump Performance:
- 1500 gpm
- 17.5 ppg mud
- 650 ft+ head/ 600 psi+
- DNV-Drill N classified

Simple design, proven components and redundancy = RELIABILITY
ORS MPD Hardware Handling

Suspended Configuration

Docked Configuration
Technology Status LRRS

LRRS ECD Ready for pilot Q2 2012
Benefits

Improved well control
- Bigger margins
- Faster kick/loss detection

Quality improvements
- Better borehole quality
- Improved cementing

Increased production
- Effective drilling in depleted fields
- Less formation damage
- Improved completion procedures

Reduced costs
- Faster drilling
- Less NPT & consumables

The technology offers safer drilling at reduced cost