Improving Well Control Service Integrity: A Second BOP, or is There a Better Way?

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Conventional Well Control Philosophy

**Cause**
- Shallow Gas
- Well Kick
- Loss Circulation
- Gas Cut Mud

**Event / Hazard**
- Influx of Hydrocarbon
  - Hydrocarbon flow from pressurized formation

**GAP**
- Rig Control w/ Conventional systems and procedures

**Consequence**
- Blow Out
- Injury to Personnel
- Damage to Safety Critical Sys
- Environmental Damage
- H₂S Release

Operator
Bridging the Gap

**Cause**
- Shallow Gas
- Well Kick
- Loss Circulation
- Gas Cut Mud

**Event / Hazard**
- Minimize Uncertainty
- Influx of Hydrocarbon at Surface
- Hydrocarbon flow from pressurized formation

**Consequence**
- Blow Out
- Injury to Personnel
- Damage to Safety Critical Sys
- Environmental Damage
- \( \text{H}_2\text{S} \) Release

**Operator**
- Well Design (engineering, casing, fluids, etc.)
- Pore Press Identification & Mapping
- Frac Gradient Identification & Mapping
- Early Event Detection & Identification

**Control**
- Rig
- Control w/ Conventional systems and procedures
- RCD
- Automated Control of kick
- Divert Returns
Probability of Loss of Well Control – Conventional

Loss of Well Control = 1.64x10^{-4}

Or

1 in 6,100

1 in 3.7

1 in 37

1 in 3.7
Probability of Loss of Well Control – With CLD/MPD System

Loss of Well Control = $3.49 \times 10^{-7}$

Or

1 in 2,870,000

Improving by 3 orders of magnitude over conventional

Or

470 times more likely to experience loss of well control using open mud returns system
Odds in perspective

• The **odds** of being killed on a single trip in an airliner accident is 1 in 52.6 million
• Chance of dying from a car accident: 1 in 18,585
• Car accident: 1 in 16
• Odds of non-smokers dying of lung cancer: 1 in 20,000
• Odds of a smoker dying of lung cancer: 4 in 5
• **Odds of well control incident conventional**: 1:6100
• **Odds of dying from fall from ladder/scaffolding**: 1:7707
• **Odds of loss of well control with MPD = 1 : 2,870,000**
• Odds of being struck by lightning: 1 in 576,000 = 5 times more likely than loss of well control
BOP
SIL Level 1
$10^{-2} < PFD < 10^{-1}$
RCD + BOP

+ RCD
SIL Level 4
PFD better $10^{-4}$
Two essential differentiators to conventional drilling

1) The well is “secured”, i.e. closed, at all times, eliminating the primary cause of blowouts: “The crew failed to secure the well in time”
   i.e. failed to close the BOP
Two essential differentiators to conventional drilling:

2) The drilling window is determined in real time, and the drilling parameters automatically adjusted so the operation remains inside the drilling window.
Dynamic Leak Off Test (LOT)

- Stepwise increase in SBP until Flow out slightly deviates from flow in.
Dynamic Pore Pressure Test (DPPT)

Stepwise decrease in SBP until Flow out slightly increases from flow in.
Certification of Control System

- OneSync® certified by DNV under Standard D-202 up to level R0 (currently only certified control system)

- BOP control systems
Estimated Dayrate Impact of Full MPD

**Hardware & Installation Cost**

- With normal equipment write off over life of rig (like Topdrive): $2000.- for all hardware
- Depending on mode of rig modification (during operation or in shipyard): $500-750.- for all installation cost
- TOTAL Dayrate Impact non-operating: $2500-$2750/d (~1% at current dayrates)

**Operating Cost**

- No rig crew training: $10,000/d
- Rig crew trained up to operate & maintain MPD equipment: $5000/d
- Average savings observed using MPD on deepwater wells: 1/3\(^{rd}\) of well cost or ~30-35 million

- Note: *Theoretical Dayrate Impact of a single blowout like Macondo: $133 MILLION per deepwater well the operator ever drilled. (60 billion, 450 wells, estimated)*
Further Reading

135019-PA SPE Journal Paper – 2011
Jablonski, Christopher, University of Texas at Austin
Podio, Augusto L., University of Texas at Austin
„The Impact of Rotating Control Devices on the Incidence of Blowouts: A Case Study for Onshore Texas, USA“

SPE IADC 156893-MS SPE Conference Paper - 2012
Grayson, Brian, Weatherford
Gans, Anton Hubertus, Weatherford International Ltd.
„Closed Loop Circulating Systems Enhance Well Control and Efficiency With Precise Wellbore Monitoring and Management Capabilities“

Description of all blowouts on land, including historical data