HORIZONTAL DRILLING CONGRESS 2013
Using Technology to Maximize Drilling Efficiencies and Performance in the Williston Basin: Case Study

George Manthos – Statoil Principal Drilling Engineer
Bakken Integration Team
Discussion Agenda

• Introduction
• Statoil Williston Basin Performance Days and Cost

• Key Technologies
  – Modern Rig Fleet
  – Lateral Drilling Performance
  – Dewatering
  – Bi Fuel Technology

• Questions
Where we are today

**Globally**
- 37 countries and 21,000 employees
- Market Cap. USD 80 Billion
- ~ 23 billion boe resources

**North America**
- 20 billion USD investment
- 1600 employees
- NA ~30% of Statoil's discovered resources
LEVERAGING 40 YEARS EXPERIENCE
For a new energy frontier

Our DNA
• Harsh and sensitive environments
• Technology driven
• Trusted operator
• Preferred employer

Our approach
• HSE priority
• Developing value chains
• Technology emphasis
• Learning and adaptation
Statoil’s US portfolio

Commitment to growth

- **Priority One** is safe delivery of production and value for the assets
- Operatorships are key to influence and organizational clarifications

### Marcellus
- Production: ~76,000 boepd (Q4 2012)
- Reserves: 2.9 billion boe
- ~750,000 net acres
- Statoil operatorship of 70,000 net acres

### Eagle Ford
- Production: ~18,000 boepd (Q4 2012)
- Reserves: 640 million boe
- ~75,000 net acres
- Statoil transitioning to operator of Eastern acreage

### Bakken
- Production: ~47,000 boepd (Q4 2012)
- Reserves 300-500 million boe
- ~347,000 net acres
- Acquisition of Brigham O&G Q4 ‘11
- Maintain active rig count to increase production base and ensure long term growth

Midstream/downstream and regulatory matters are challenges/opportunities for all assets
Bakken/ ThreeForks Shale

Depth: 21000’ md/ 10500’ vd
~10,000ft Lateral Length
275 – 300°F, 5500 – 6000 psi
13 Active Rigs, 18-25 Days, $10.5MM D&C (40/60)
+35 Stage Frac Job (plug & perf method)

**Technology**
- Modernized Rig Fleet: Multi-well Pad, Batch Drilling
- BHA design – conventional directional pkgs
- Dewatering/ Waste Management
- Open Hole Swell Packer, +35
- Bi-Fuel – reduced energy costs and foot print
- Diesel Free alternatives

**Challenges**
- CAPEX creep
- Service Allocation
- Winter Protection
- Waste treatment/ transportation/ disposal
**Statoil Williston Basin Well Design**

- **16” Conductor** @ 120’ md
- **9 5/8” 40# J55 LTC** @ 2500’ md

**Special Drift – 6.0”**

- **Top of Lead ~ 1500ft below Surf Shoe**
- **Top of Tail ~ 600ft above top Salt**

- **TOL ~ 150ft above KOP**
- **KOP - Lodgepole**

- **7.0” 32# P110 LTC** Special Drift – 6.0” @ 11400’ md/ 10500’ vd
- **4.5” 11.6/13.5# P110 LTC** @ 21000’ md/ 10500’ vd

**300ft spacing, ~35 swell pkrs**

**Statoil Williston Basin Fluids Prgrm**

- **13.5” Hole Size**
  - WBM – 8.6 - 9.0 ppg @ 2500’ md

**Fluids Prgrm**

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- **Top of Tail ~ 600ft above top Salt**

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**300ft spacing, ~35 swell pkrs**

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- **4.5” 11.6/13.5# P110 LTC** @ 21000’ md/ 10500’ vd

**300ft spacing, ~35 swell pkrs**

**Statoil Williston Basin Lithology Profile**

**Mowry Shale**

- **Charles Salt**
- **Mission Canyon**
- **Lodgepole**

**Bakken/ Three forks**

- **8.75” Hole Size**
  - OBM – 9.5 – 9.8 ppg @ 11400’ md/ 10500’ vd

**Lithology Profile**

- **KCL Brine – 9.8 ppg** @ 21000’ md/ 10500’ vd

**TOL ~ 150ft above KOP**

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- **7.0” 32# P110 LTC** Special Drift – 6.0” @ 11400’ md/ 10500’ vd
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**Williston Basin**

- **Statoil**
- **Williston Basin**
- **Lithology Profile**
- ** fluids prgrm**
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**Statoil**

- **Williston Basin**
- **Fluids Prgrm**
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**Statoil**

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- **Fluids Prgrm**
- **Top of Lead ~ 1500ft below Surf Shoe**
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- **300ft spacing, ~35 swell pkrs**

**Statoil**

- **Williston Basin**
- **Fluids Prgrm**
- **Top of Lead ~ 1500ft below Surf Shoe**
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- **7.0” 32# P110 LTC** Special Drift – 6.0” @ 11400’ md/ 10500’ vd
- **4.5” 11.6/13.5# P110 LTC** @ 21000’ md/ 10500’ vd

- **300ft spacing, ~35 swell pkrs**
Statoil Williston Basin
Rig Type Performance

Days

- **Batch Drills (B Rigs)**
  - Move: 4.0
  - Spud-Release: 23.8
  - Release-Release: 23.4

- **Single Well Pads**
  - Spud-Release: 30.5
"Success is going from failure to failure without loss of enthusiasm"

– Winston Churchill
Modernized Rig Fleet
Statoil – Williston Basin Fleet

*Nabors B-Series Rigs*

Drawworks: Canrig AC Electric
Power: (3) Caterpillar 3512C engines – 4400 HP total
Mast: 147ft cantilever mast – 800k-lbs static hookload
Substructure: B-o-B, skid 100ft without moving backyard. Skid with full setback load of 500k-lbs
Pumps: (2) 1600HP triplex powered by AC motor
Top Drive: Canrig 1250 AC, 500 ton. Continuous TQ rating of 51kft-lbs at 118 rpms
Accessories: Canrig Automated Catwalk, Rotating Mousehole, BOP Handling system

*Other contractors used as well*
Sidewinder Footprint

Mud Pumps, Active Pit, SS Equip

Water, Trip Tank, MGS, Choke Manifold

Rig & Substructure Catwalk

Engines, Boiler, Fuel, SCR House
Power of Efficiency – 16 Rig Program

Days to drill (4) wells w/ 1 Rig and forecasted yearly well delivery for the program

Single Well Driller – Single Well Pad
(9 Move + 25 Drill)*4 Wells = 136 days or (171 wells/yr)

Single Well Driller – Multi-Well Pad
(9M + 25D) + (3M + 25D)*3 Wells = 118 days or (198 wells/yr)

Modernized Batch Driller – Multi-Well Pad
(6M + 22D) + (1M + 22D)*3 Wells = 97 days or (240 wells/yr)

- Batch set surface casing w/ smaller rig
- Efficiency through repetition
- Accelerated learning curve
- Reduction of Non-Active move time, increase in Active drilling days
Lateral drilling performance
**Background**

In-house Geosteering (Boresite)
Gamma Ray only
25ft Tgt window - Hzd above/below
Flat regional dip
Minimal Faulting/ Fracture

**Success Factors**

Experienced Drilling Crews
Local geological control
Projection Steering
Neutral BHA Tendency
Gradual directional changes
Clear fluids/ Dewatering/ Lubricants
Stabilized Lateral BHA

**Statoil**
Bakken Lateral BHA
4 ¾” Xtreme MM

**Statoil**
Bakken/ Three Forks Lateral BHA
5” Hunting MM

**Statoil**
Three Forks Lateral BHA
4 ¾” Ultra XL/LS MM

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**Stabilized Lateral BHA**

**BHI Ultra XL/LS**

**BHI X-treme**

1.5° Bend

1.5° Bend

1.5° Bend
Recognizing our Personnel

- Incentive Programs
- Mile-a-Day Club
- Top 10 Performers
- Competitive Spirit
- Motivational Tools
- Rig of the Quarter/Year

### Bakken Wells

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### Three Forks Wells

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Dewatering Process
Dewatering Process (closed loop)

The process of removing solids from a drilling mud and fluids from drill cuttings using chemical treatments followed by mechanical separation.

**Chemical – Coagulation**

- Suspended solid particles carry a negative charge, will not settle till neutralized
- Inorganic/ Organic – aluminum sulfates, gypsum, calcium nitrates, etc

**Chemical – Flocculation**

- Bridging resulting from long polymer chains of the flocculant that gather coagulated solid particles into a larger size to be removed mechanically

**Mechanical – Solids Separation**

- Big bowl Centrifuge, 3000G spin rate
Dewatering Process

WBM → Alum pH → In-Line Mixers → Mixing + Contact time → Hose A → Centrifuge

Coagulant

Flocculant

Effluent → Water reuse or discharge
Solids Disposal
Dewatering Unit

- Injection and mixing manifold
- HS-3400 Centrifuge
- Polymer mixing tanks
- Pumps
Dewatering Process (cont.)

Benefits

• Reduction of solids from drilling mud = reduced PV, increased ROP
• Reduction in dilution volumes, ~40%, difficult to quantify
• Reduction in disposal costs

Learnings

• Critical for HZ drilling performance and lubricant effectiveness
• Not all systems created equal – need to be able to handle full circ rates
• Paradigm shift in onsite use and requirements from dewatering providers
• Consistency from providers
Bi-Fuel Technology

**Purpose:** Save on diesel fuel usage by injecting produced natural gas from nearby wells to supplement rig power. EcoAFS vendor.

**Benefits:** Reduction of fuel consumption, flaring, and emissions generation. Average cost savings per rig is $5-6k/day.

- Gas injection systems automatically monitor system constraints and are programmed to engage/shut-off gas supply immediately depending on safety parameters.
- Looking into portable CNG/ LNG tanks that can eliminate the need of a gas supply via pipeline.
What is Bi-Fuel?

- “Co-firing” of standard diesel fuel and natural gas
- No engine modifications

Field application

- Natural gas can substitute 60%* of the diesel fuel required to maintain a given load

Operational advantages

- Reduced exhaust emissions
- Significant fuel cost savings

*In the Bakken
Sidewinder 103 Bi-Fuel Installation

Immediate savings realized upon installation

- $1.5MM savings per rig per year (forecasted)

Potential Future Benefits

- Installation on Service Vehicles Frac spread, Cmt Unit, Artificial lift – gas lift, etc
Questions??
There’s never been a better time for good ideas

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