

Innovative Drill string Stabilizer Enhances Drilling Performance for Operations In Middle East

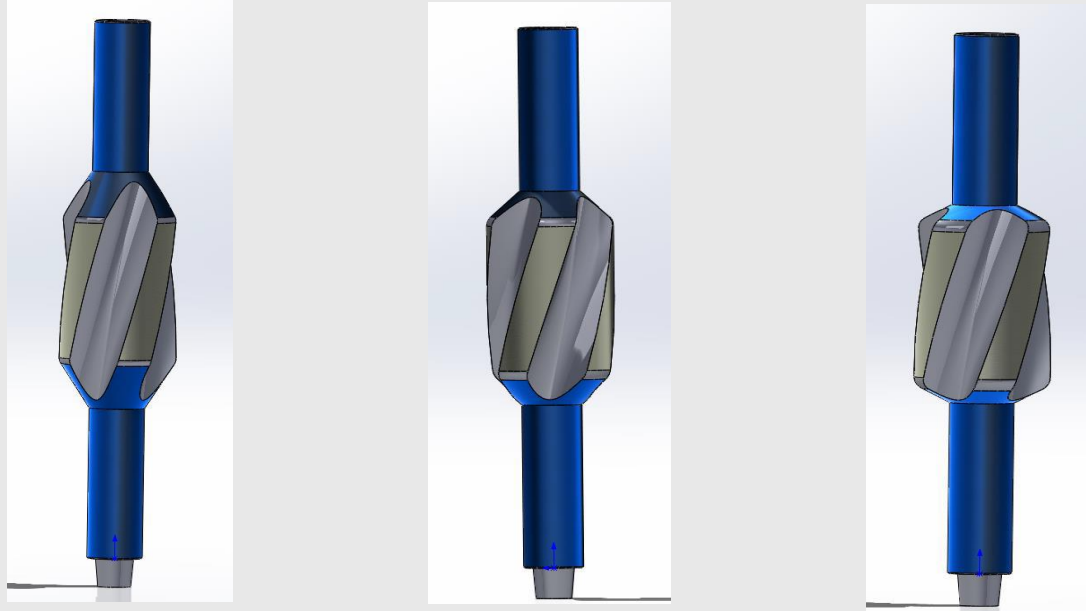
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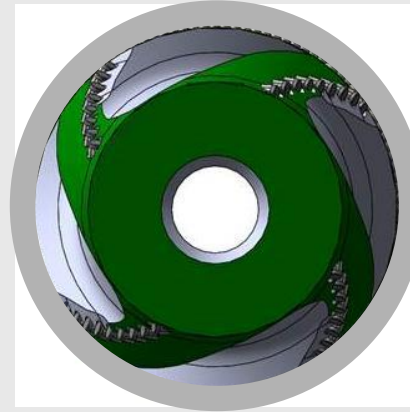
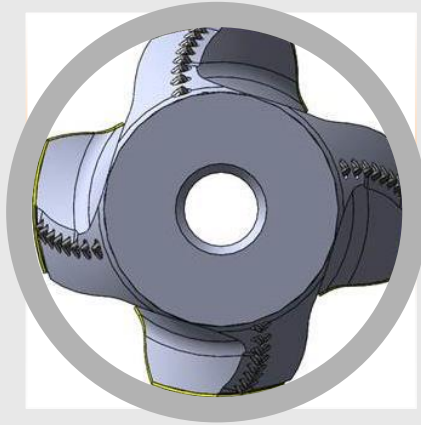
Where Are We At the Moment

Common Stabilizer shapes and Designs (Taper Angles, Shoulders and Wrap Angle)



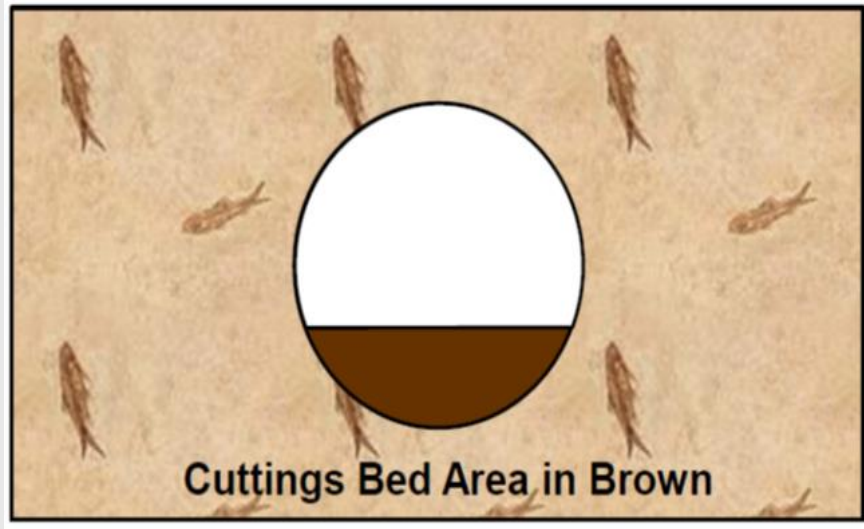
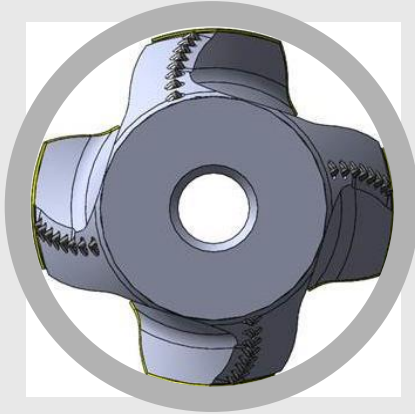
- Conventional spiral blade stabilizers which are currently in use, have numerous disadvantages
- The spiral profile and flat surface/sharp edges of the conventional stabilizer collect and trap drill cuttings when rotating, causing the stabilizer to ball up and pack off leading to increased ECD.

Design and Finish



- When drilling in sliding mode with steerable motors, increased drag causes poor weight transfer and BHA hanging up.
- The flat profile and sharp blade edges also cause considerable damage to the filter cake exposing the formation to drilling fluids which can lead to borehole instability.

Bypass Area Requirements



- When pulling out of the hole, cutting surrounding drill string formulate the “snow ploughing” action of spiral blades cause additional drag and sometimes leads to stuck pipe.
- Same action applies while drilling or running in the hole restricting the ability to drill faster.

Stabilizer Design Criteria (Features)

- End Taper Angles –smooth, no shoulders
- Wrap Angle
- Bypass Area
- Stabilizer Pad Diameter
 - Stabilizer Blade Pad to hole diameter
- Stabilizer Blade Pad Pressure
 - Pressure \leq 300 psi, based on expected side loads
- Material Specifications
 - Hard facing material: smooth, no active cutters
 - Maximum Friction Factors
 - Fabrication Methods

Stabilizer Design Theory (Over pull)

Definitions

F_{axial} = force to slide

F_{side} = stabilizer side force

μ = coefficient of friction

F_n = normal force

F_t = friction force

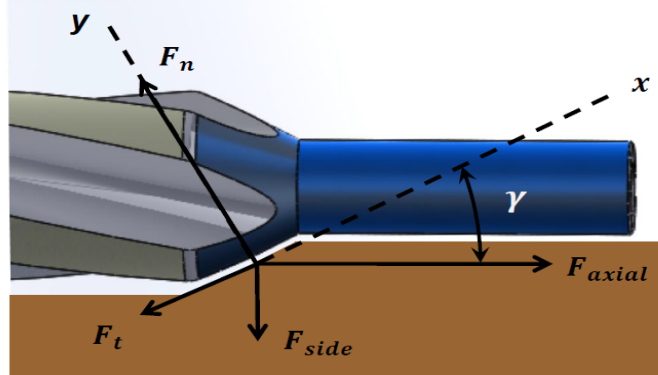
γ = stabilizer angle

1) $F_t = \mu F_n$

2) $\sum F_x = F_a \cos \gamma - F_s \sin \gamma - F_t = 0$

3) $\sum F_y = F_n - F_a \sin \gamma - F_s \cos \gamma = 0$

4) $F_n = F_a \sin \gamma + F_s \cos \gamma$



$$F_{axial} = F_{side} \left[\frac{\sin \gamma + \mu \cos \gamma}{\cos \gamma - \mu \sin \gamma} \right]$$

$$\text{for } \gamma < \tan^{-1}(1/\mu)$$

Solution was Required

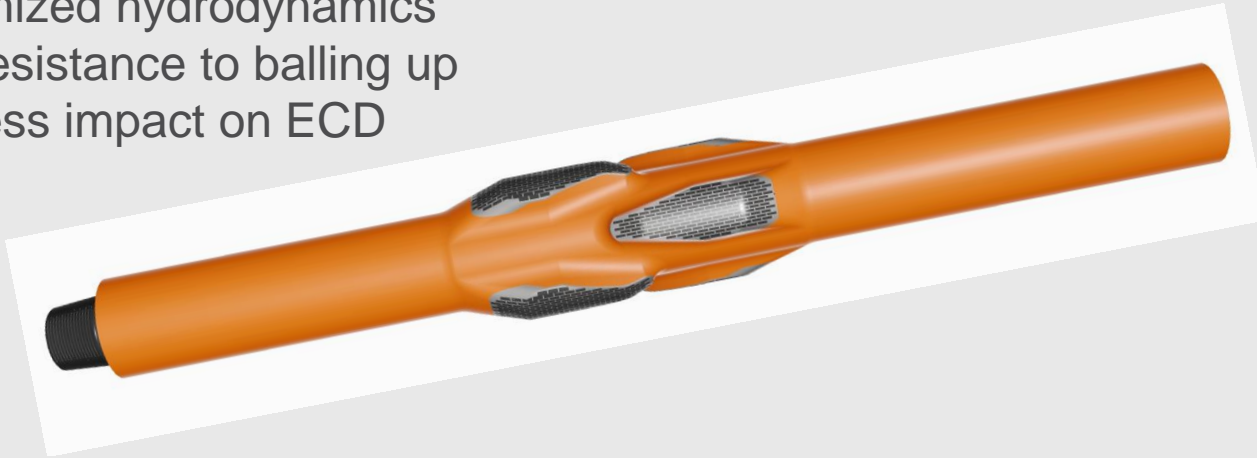
To Enhance Drilling Performance For Operator In Multi
Lateral And Extended Reach

Trial Objectives

1. Evaluate overall improvement in ROP with New stabilizer
2. Evaluate performance of New stabilizer with regard to:
 - Improved weight transfer
 - Reduced Torque
 - Reduced Motor stalls

Product Characteristics

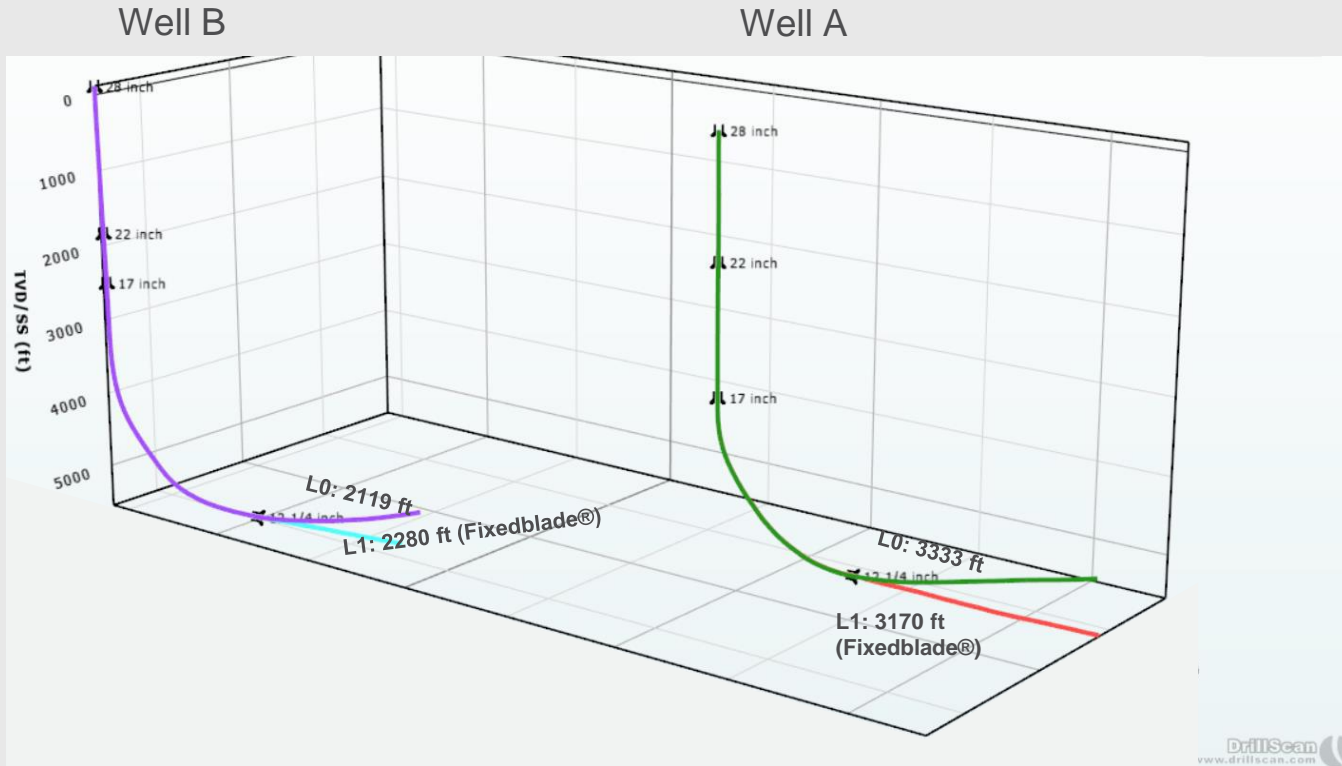
1. Reduced torque and drag
 - Improved weight and torque transfer to the bit
 - Reduced vibrations
 - Easier to trip
2. Optimized hydrodynamics
 - Resistance to balling up
 - Less impact on ECD



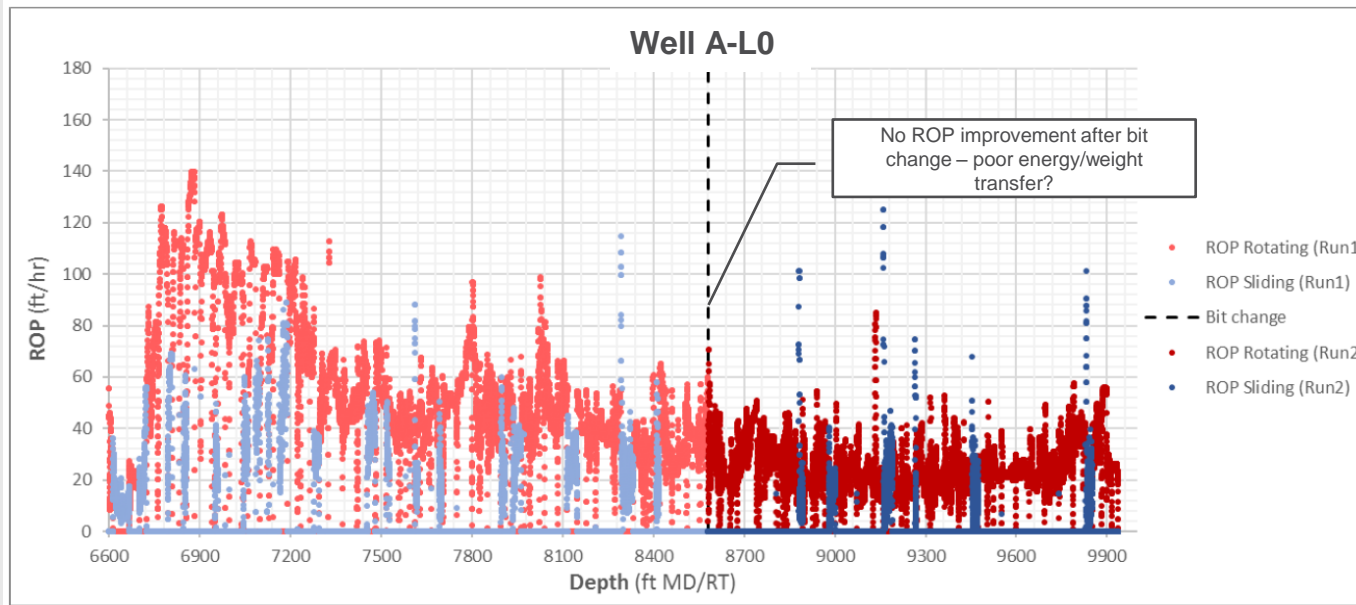
Trial Setup

1. Two dual-lateral horizontal wells with 8 1/2" sections
2. One lateral (L0) is drilled with conventional spiral blade stabilizer, another (L1) is with Fixedblade® stabilizer
3. Identical BHA provided by same Directional Drilling company

Trial Setup: Wells Schematic

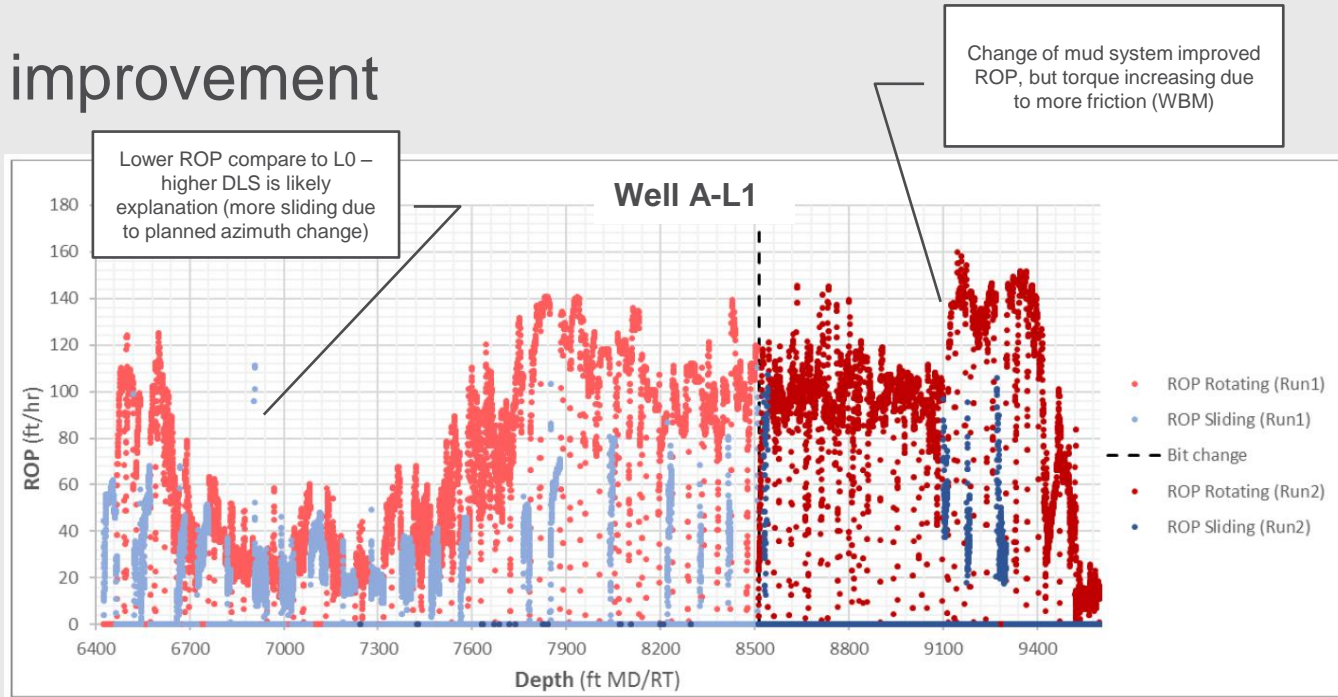


Trial Results: Well A-L0 (conventional stabilizer)



Trial Results: Well A-L1 (FixedBlade stabilizer)

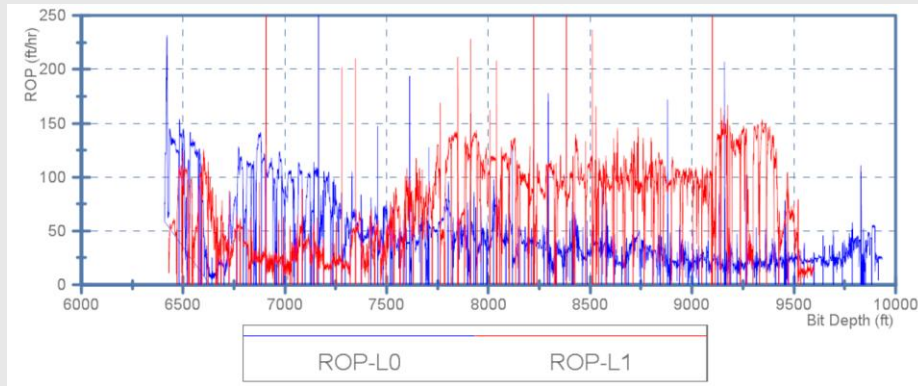
ROP improvement



Trial Results: Well A

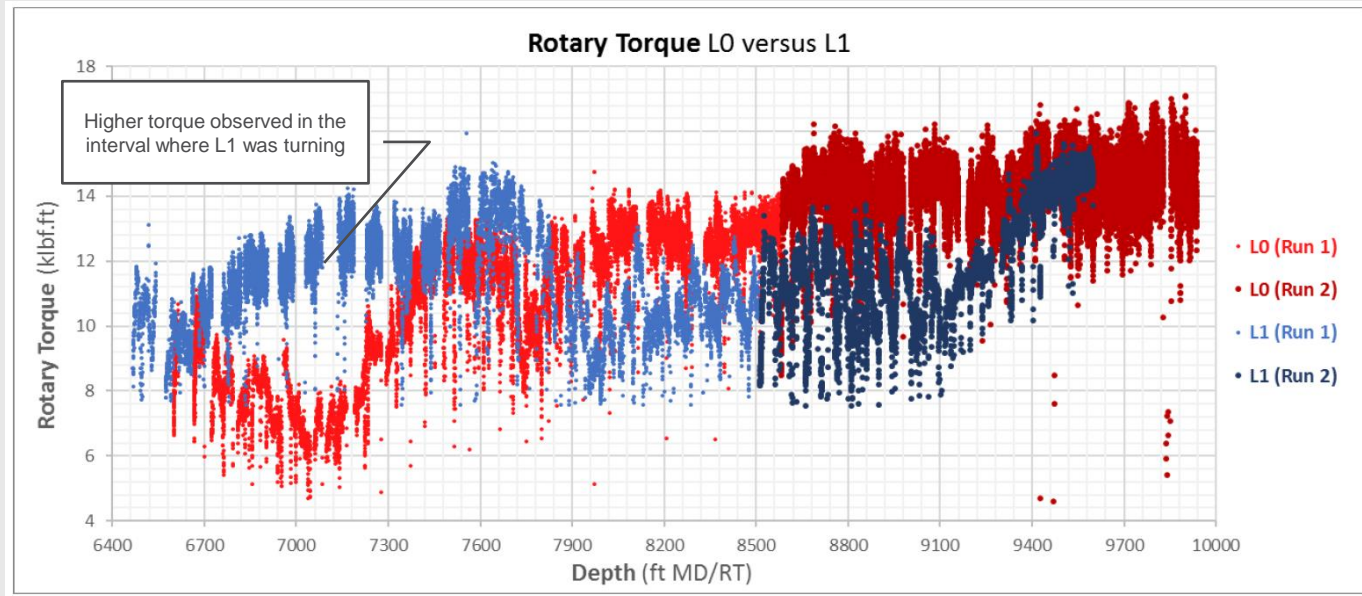
ROP improvement

	ROP, ft/hr		
	Rotating	Sliding	Sliding + Rotating
L0 Lateral (spiral blade stabilizer)	49	28	38
L1 lateral (FixedBlade®)	74	38	43
ROP improvement	+51%	+36%	+44%



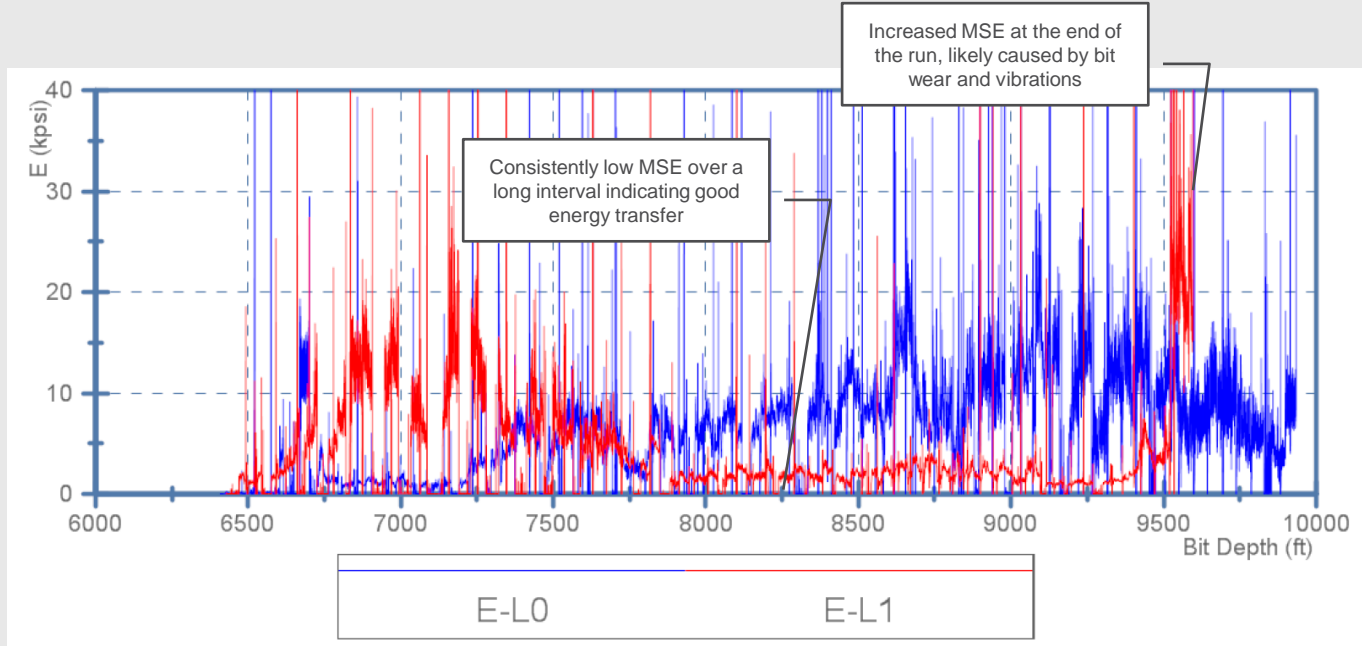
Trial Results: Well A

Torque



Trial Results: Well A

Mechanical Specific Energy (MSE)



Trial Results: Well A

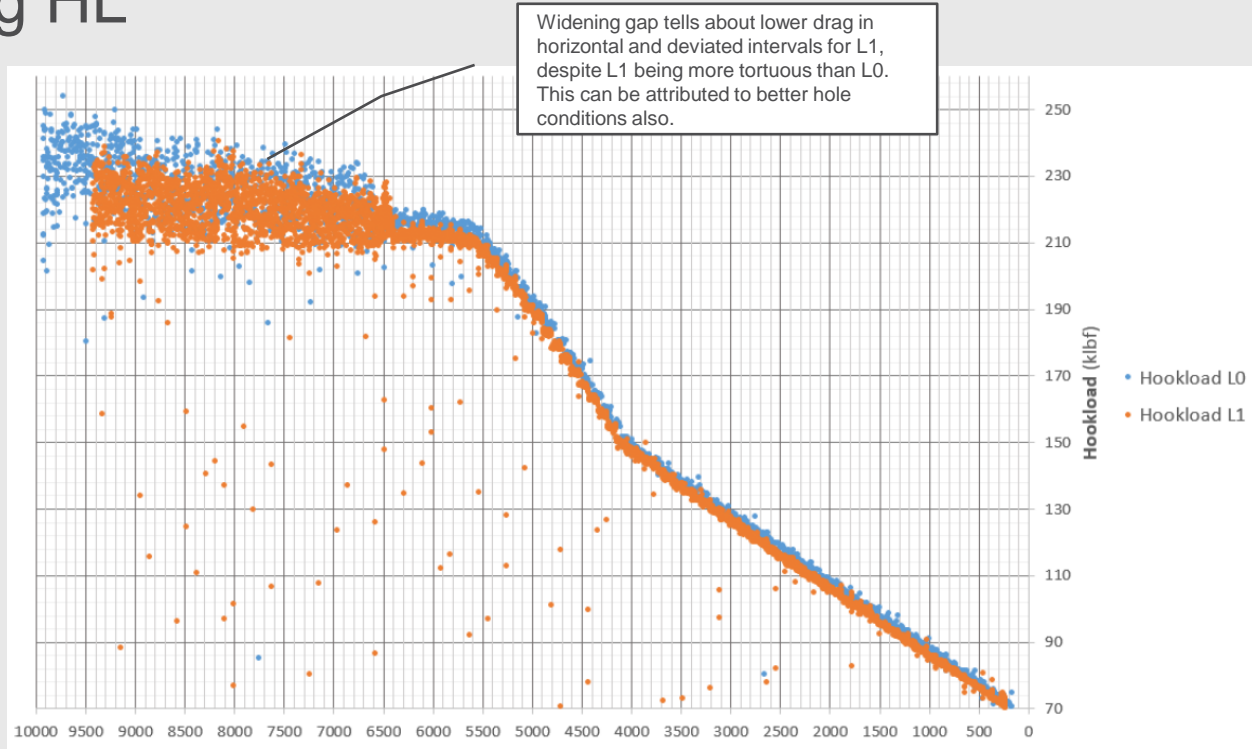
Weight Transfer

- Comparing surface WOB with downhole (or actual) WOB
- Surface WOB is the weight applied by the Driller (average value)
- Downhole WOB is estimated based on calculated friction factor
- As per data show in the table, weight transfer improved by ~3 klbf when drilling L1

	WOB Surface, klbf	WOB Downhole, klbf	WOB loss, klbf
Well-A-L0	42.38	31.15	11.23
Well-A-L1	42.72	34.80	7.92

Trial Results: Well A

Tripping HL



Trial Results: Well A

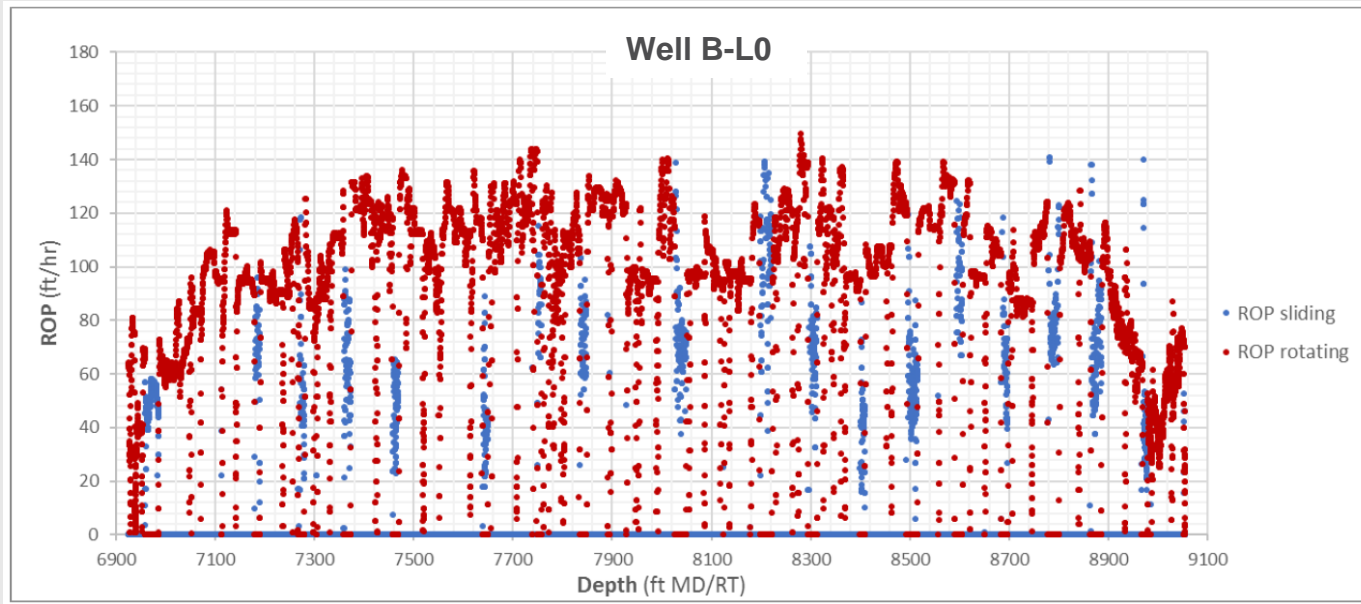
Conventional stabilizer balled up when POOH



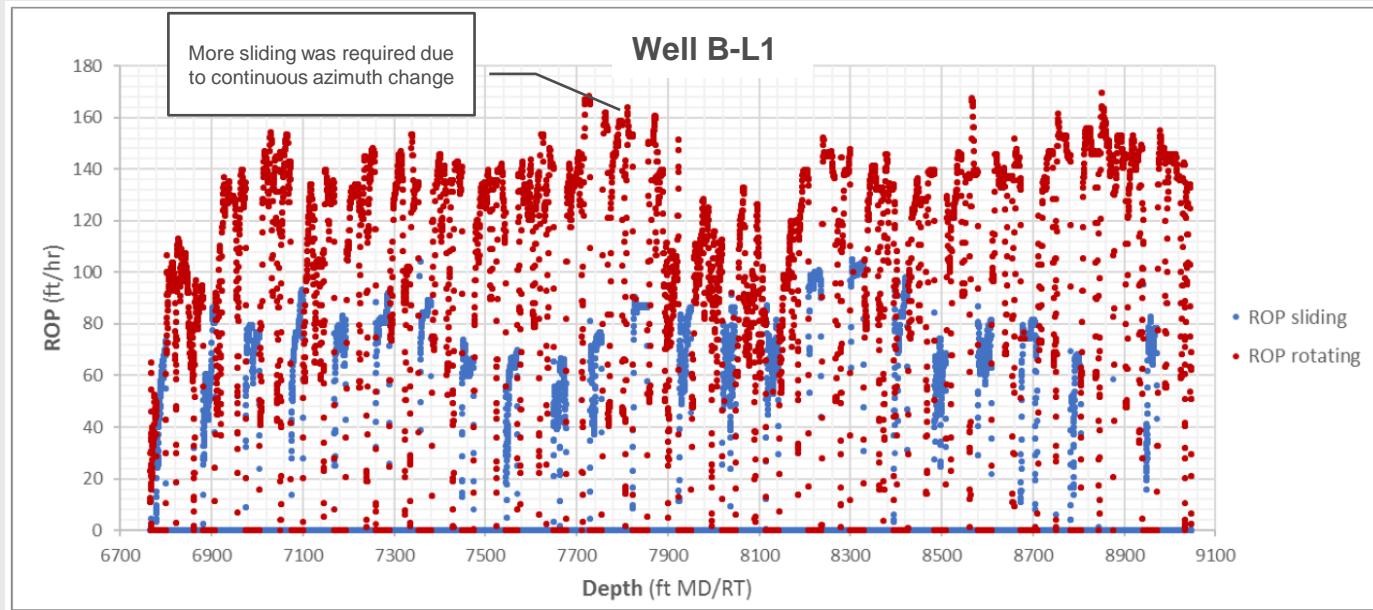
No balling up with FixedBlade



Trial Results: Well B L0 (Conventional Stabilizer)



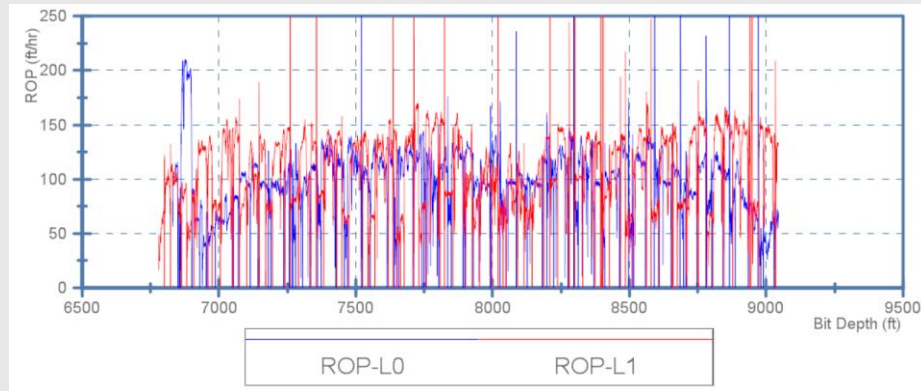
Trial Results: Well B L1 (FixedBlade Stabilizer)



Trial Results: Well B

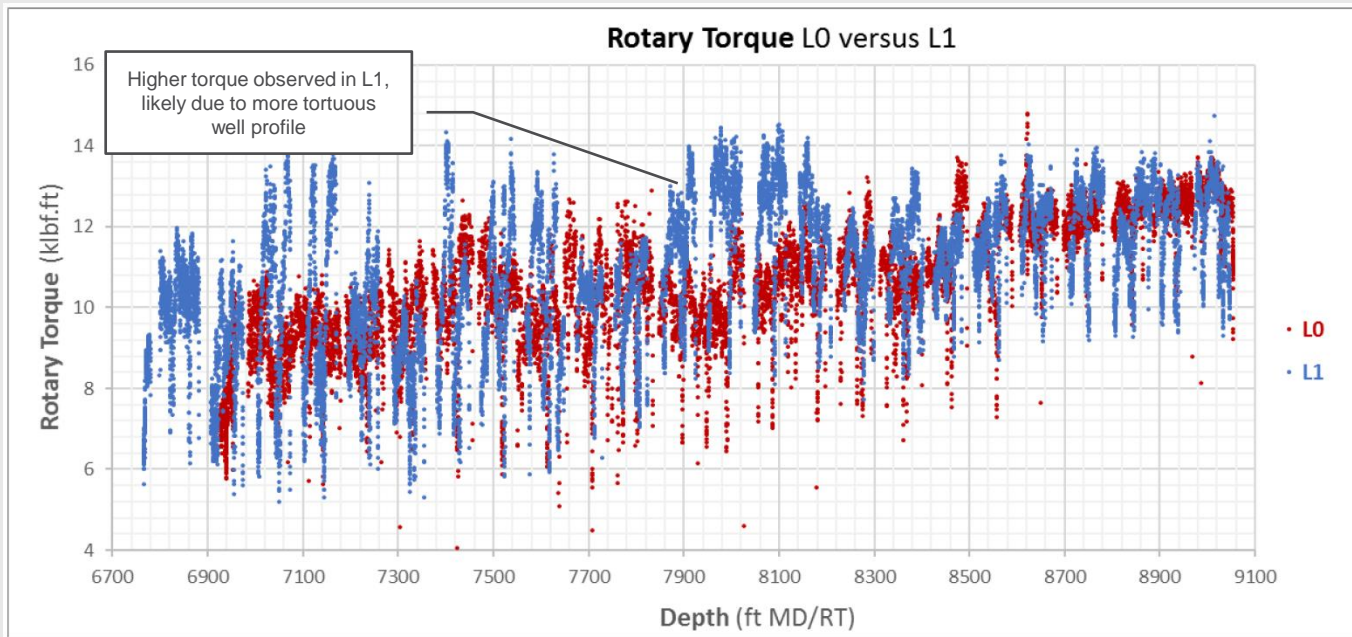
1. ROP improvement

	ROP, ft/hr		
	Rotating	Sliding	Sliding + Rotating
L0 Lateral (spiral blade stabilizer)	101	59	79
L1 Lateral (FixedBlade®)	129	74	103
ROP improvement	+28%	+25%	+30%



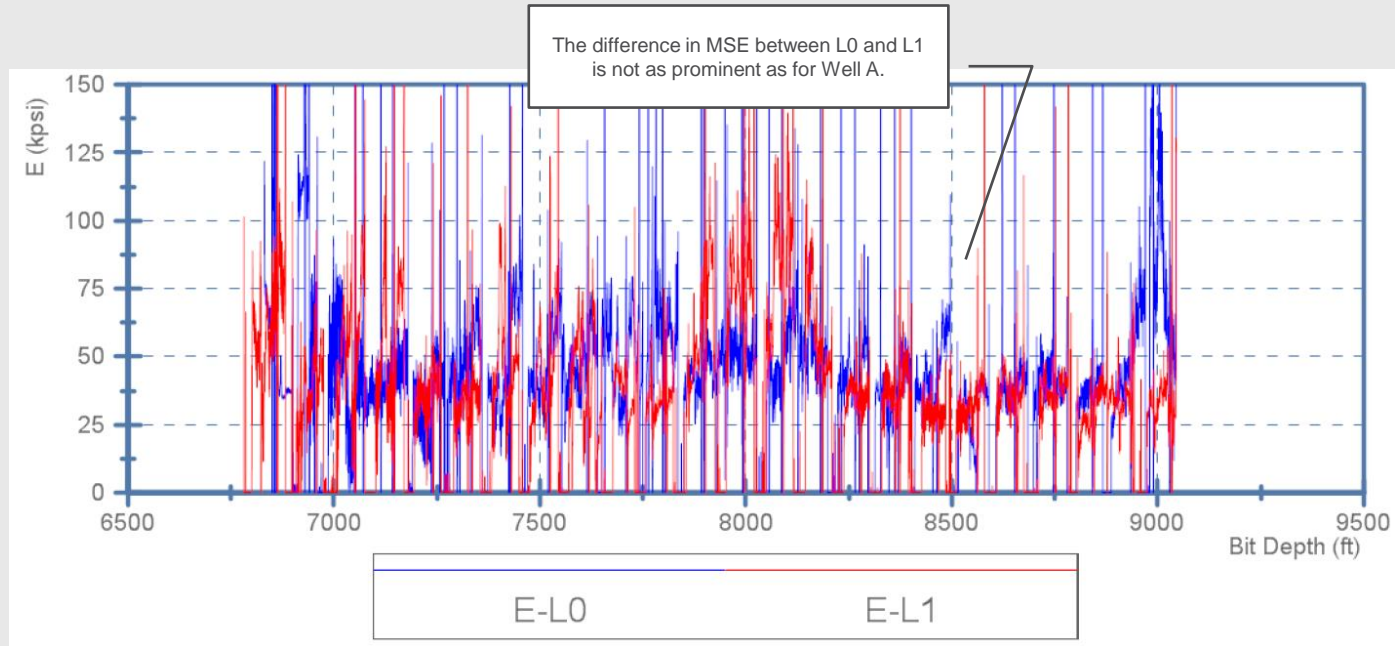
Trial Results: Well B

Torque



Trial Results: Well B

Mechanical Specific Energy (MSE)



Trial Results: Well B

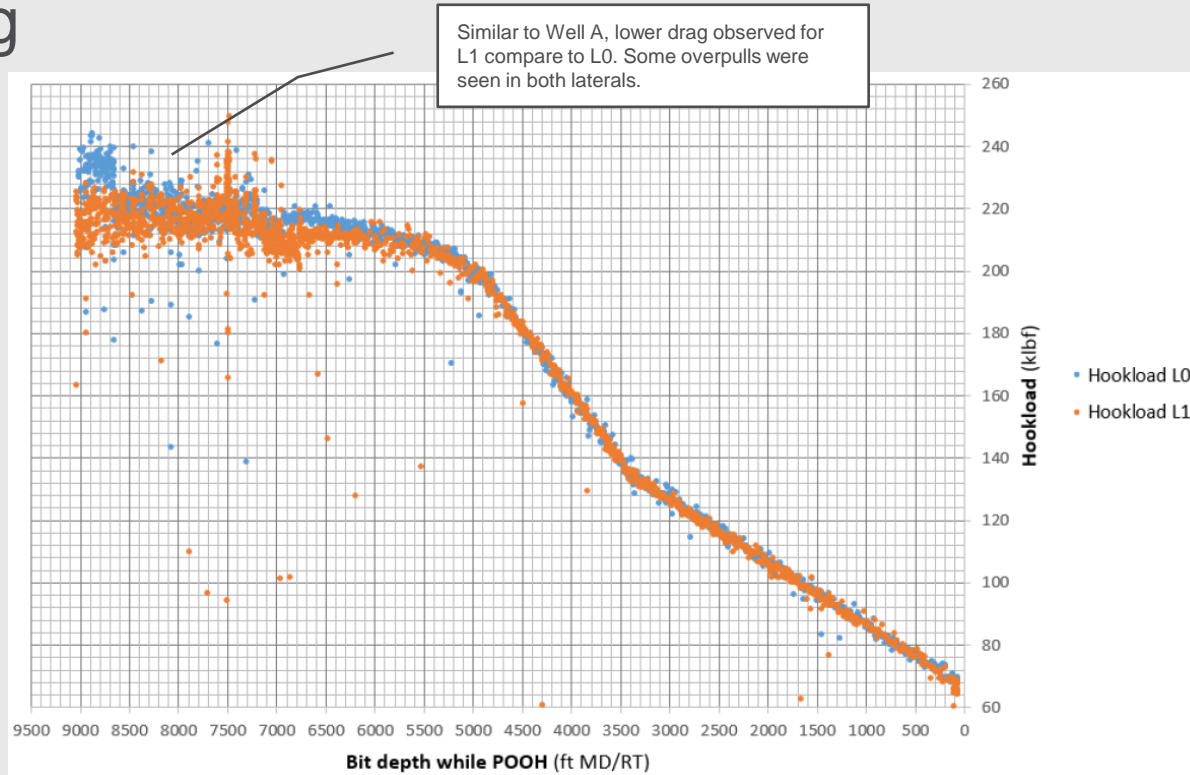
Weight Transfer

- Comparing surface WOB with downhole (or actual) WOB
- Surface WOB is the weight applied by the Driller (average value)
- Downhole WOB is estimated based on calculated friction factor
- As per data show in the table, WOB transfer improved by ~4 klbf when drilling L1.

	WOB Surface, klbf	WOB Downhole, klbf	WOB loss, klbf
Well B L0	31.07	22.53	8.54
Well B L1	38.36	33.59	4.77

Trial Results: Well B

Tripping



Conclusions

1. Average ROP increase is >30% - estimated time saving due to increased ROP is over 40 hrs for 5450 ft of total distance drilled with FixedBlade
2. Better weight transfer
3. Reduced torque
4. No motor stalls observed
5. Lower hookload when pulling out
6. No balling up was observed with FixedBlade