DEA Forum

# PDC Bit Innovations for Today's Complex Shale Wells

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Dan Scott
Senior Technical Advisor
Baker Hughes Inc.



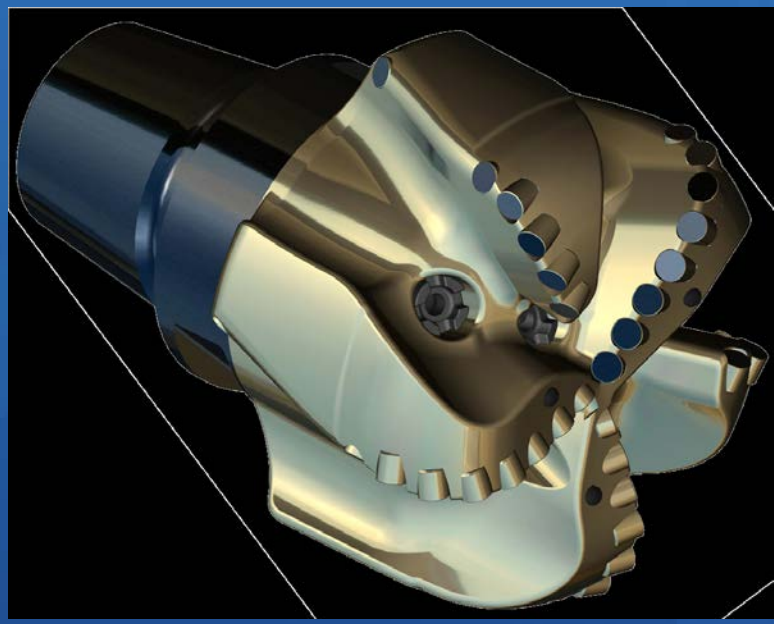
BAKER HUGHES

# Overview

- Complex well profiles require more complex BHA
  - More “jewelry” in the BHA
- Variety of new motors available
  - Higher torque
  - Longer life
- Rotary Steerable Systems
  - Bits designed for the system
- Limited HSi at the bit
  - Design and plan for it
- More demands on the cutters and bits
  - Stability improved
  - Steerability (DOC Control)
  - Durability and abrasion resistance improvements in cutters
- PDC Cutter is part of the bit, which is part of the system.

# Steerable Bit Technology Package for Unconventionals



- Unconventional shale formations
- Curve-lateral sections
- Low HSi
- Features:
  - Application specific profile
  - Polished cutters
  - Application specific cutters
  - Diverging junk slots
  - Hydrophobic coating (available on request)
  - Advanced hardfacing on tough steel body
  - Short bit body
  - DOC control to minimize torque fluctuations
    - Field adjustable  available soon
  - DART process

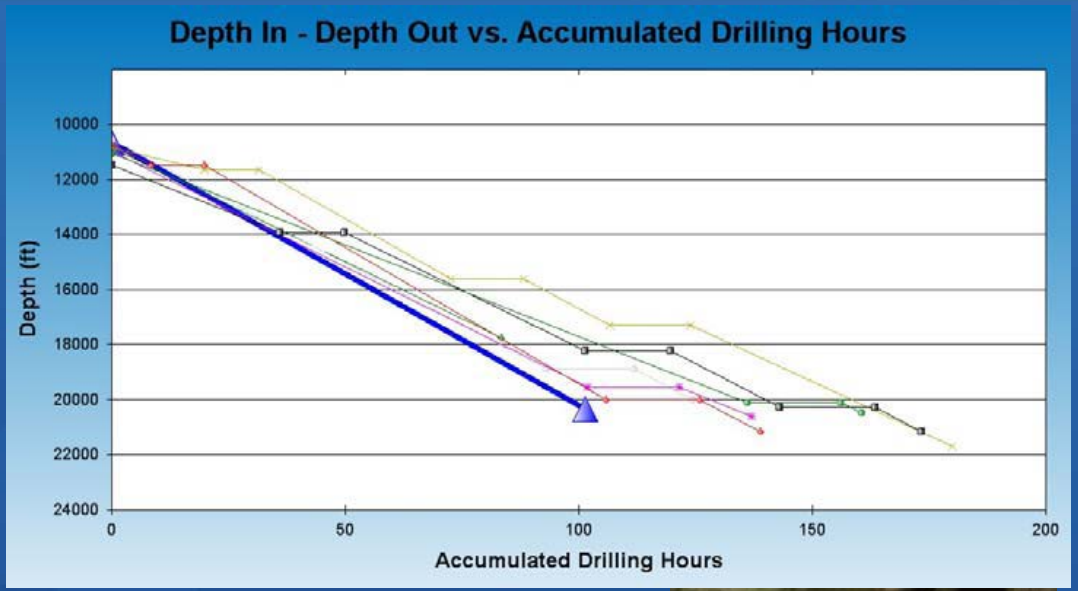
# Cutter Technology Innovations

- Improved thermal stability
- Polished finish to reduce friction
- Multidimensional contoured face runs cooler
- Enhanced chamfers to improve durability
- Higher diamond density tables
- Stronger diamond to diamond bonding
- Innovative PDC manufacturing processes
- Proprietary diamond mixes to control crack propagation
- Enhanced substrate for erosion resistance
- Rotating cutter
- Shaped cutters
- Nano - technology
- Non metallic binders, reattached, brazed, etc.

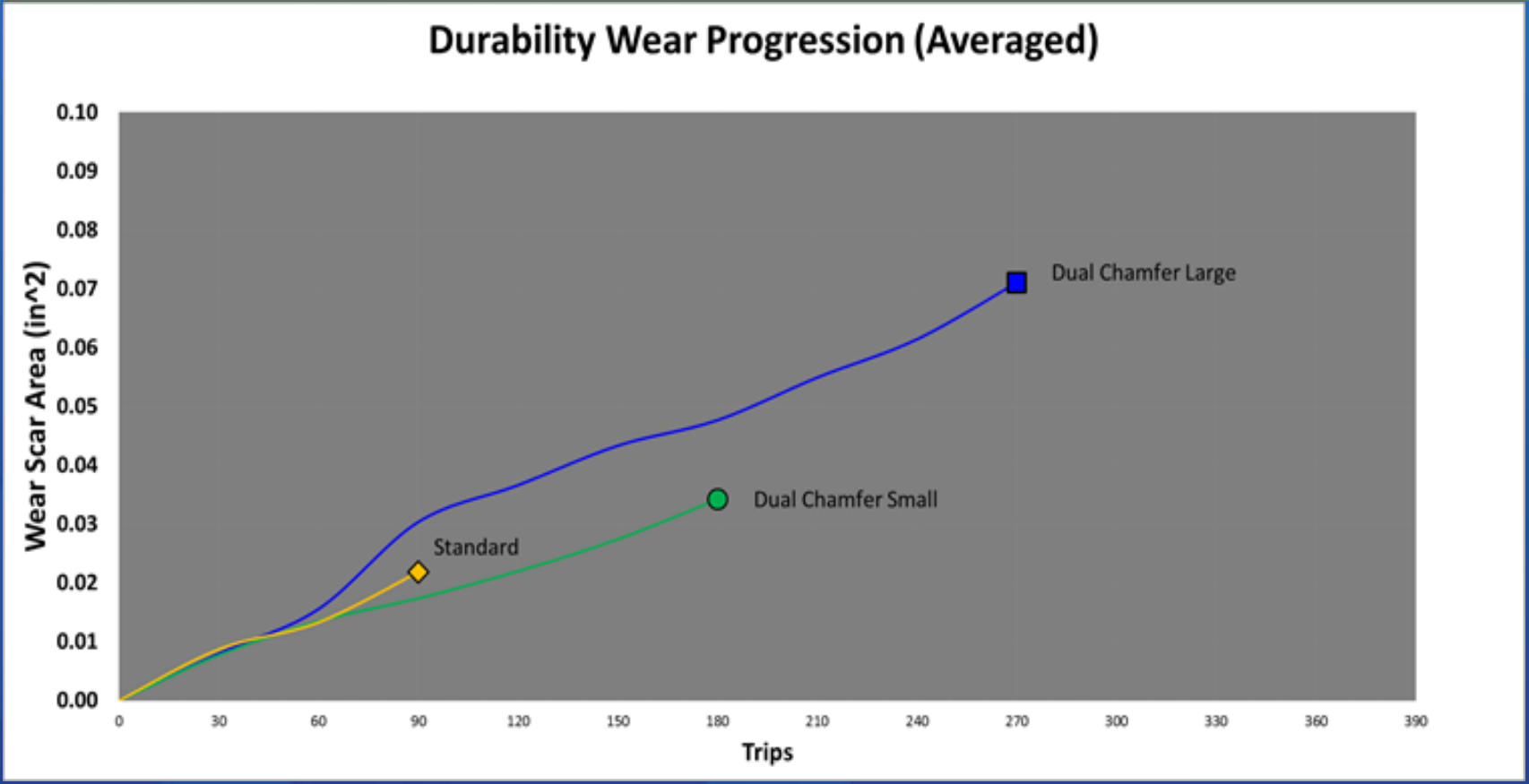
# Lateral section, Bakken, 6” 6 blades

- Features
  - Short profile
  - Longer gage length
  - Variable back-rakes
  - DOC features as required
  - Large blade standoff
  - Open hydraulically
- Results
  - Drilled the entire lateral
  - Typically requires 2-3 bits to reach a similar depth
  - Saved the customer trip time and bit cost
  - 9,685' in 101.5 hours for an average ROP of 95.4 ft/hr.
  - Reduced the section versus the closest offset by 40 hours
  - Saved the operator $133,000.



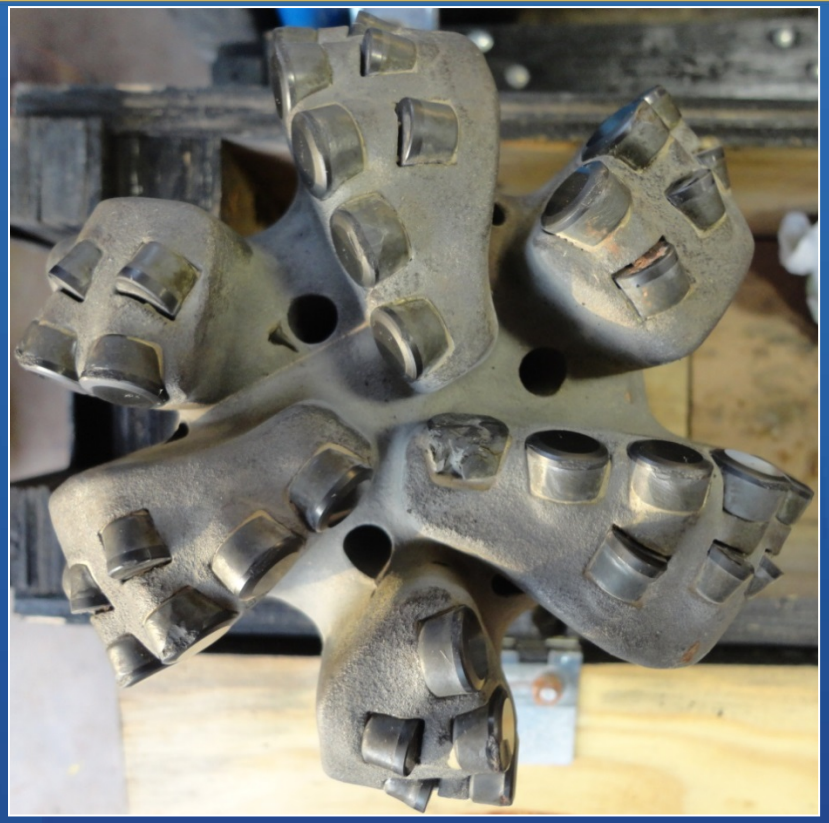
# Laboratory Test




- Dual Chamfer Geometry significantly adds cutter life
- Increase in Secondary Chamfer size increases cutter life

# 6.125”  Standard Vs Dual Chamfer Cutters

Bit #1
DPD406X
1726’ @ 46.6 ft/hr



Bit #2
DPD406X DUAL CHAMFER
2438’ @ 55.7 ft/hr

Alfalfa, Oklahoma

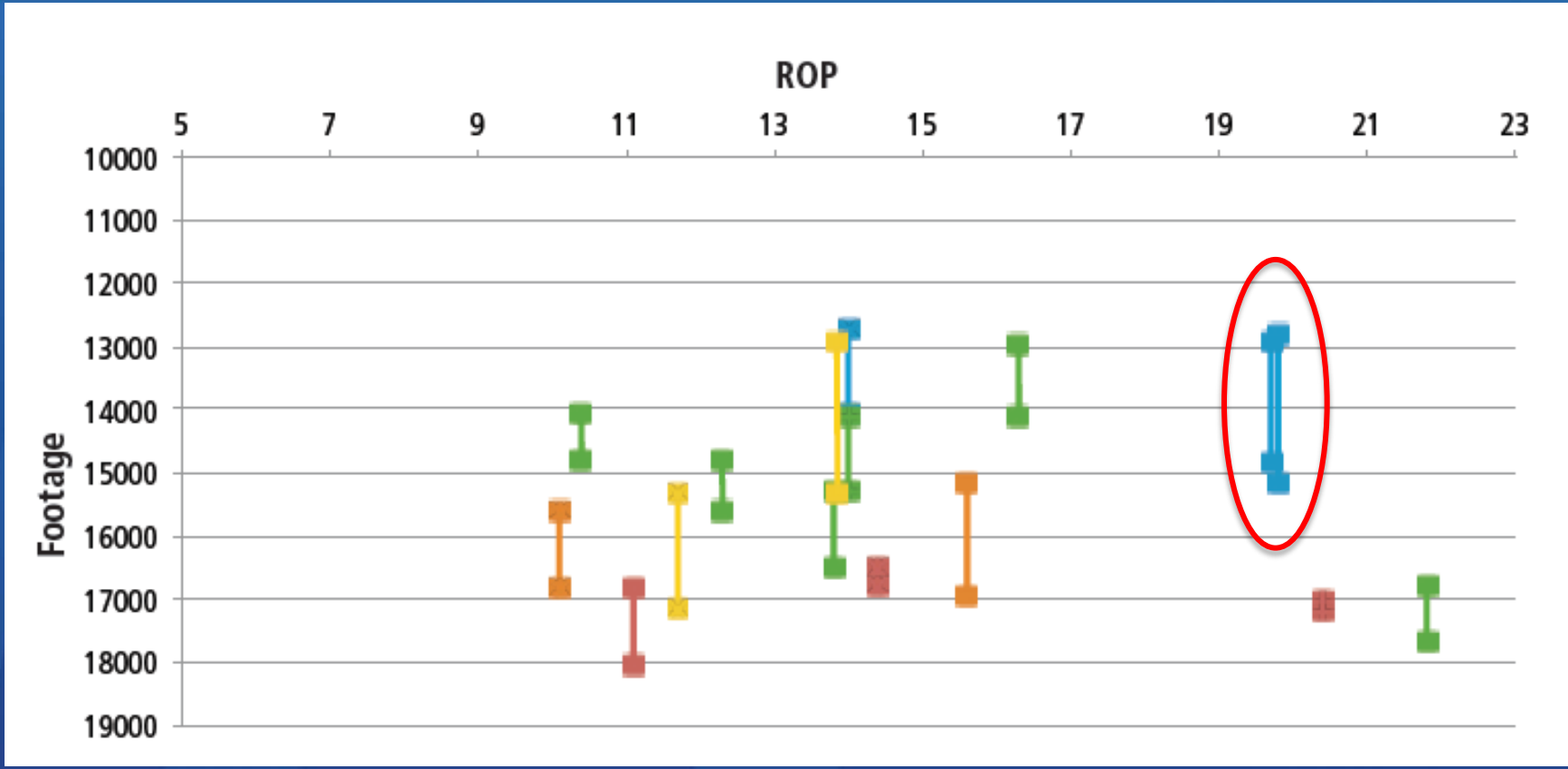
# 8.75”  Same Pad – Standard vs. Dual Chamfer

Bit #1
DPD505
3273’ @ 73.6 ft/hr

Bit #2
DPD505 Dual Chamfer
5105’ @ 74.5 ft/hr

Saginaw, Texas

# Multidimensional Contoured Face




Longer, faster, and good dull in a very hard abrasive application

# Multidimensional Contoured Face



# Permian Case Study #1 – $CO_2$ Injection Wells

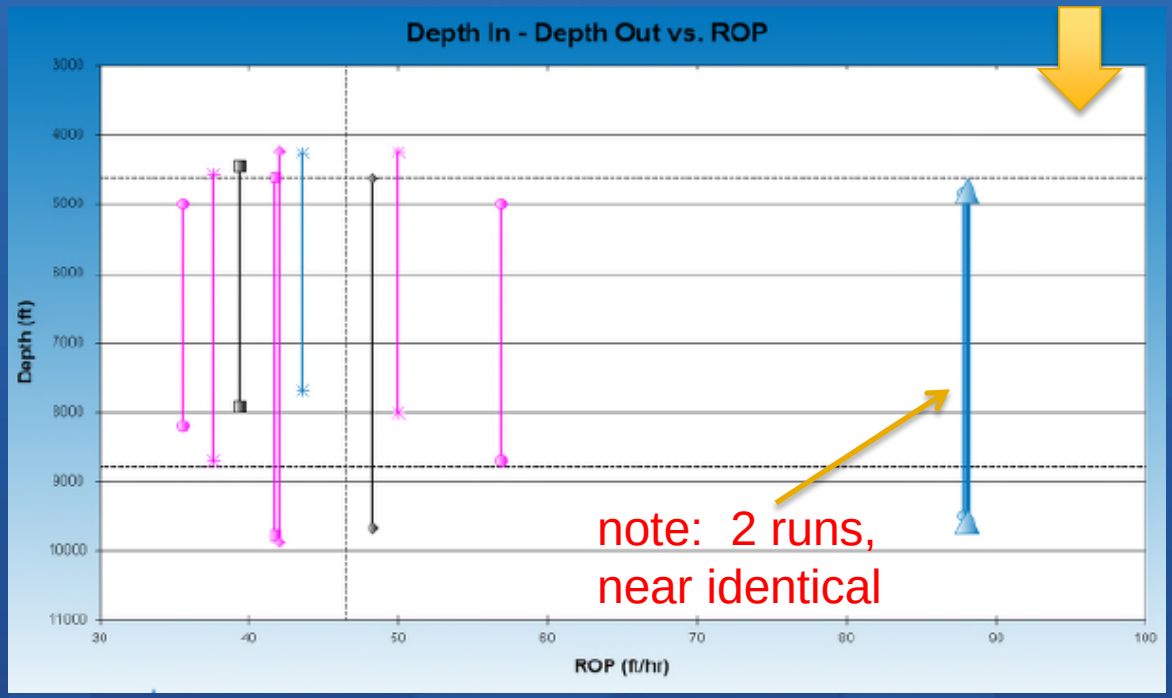
## The Challenge

- Yoakum County, TX
- San Andres Formation
  - Hard dolomites, anhydrites, and salts
- Drill curve and entire lateral with one bit


## The Solution

- State of the Art PDC Bit
  - Polished Cutters
  - Application Specific  Cutter Technology
  - Steel body with new  Hardfacing
  - Enhanced Directional Control

# The Results

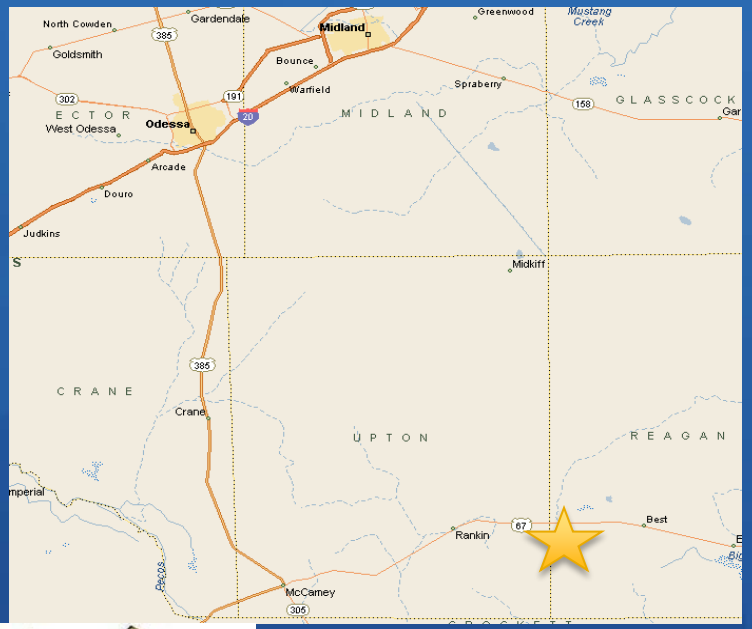



- Back to back record runs
- Exceptional tool face control
- Saved 2 days on well
- Great dull condition

# Case Study #2 – Wolfcamp B Horizontal

## The Challenge

- Reagan County, TX
- Wolfcamp B Formation
  - Shale, sandstone, chert
- Drill 9,500ft lateral with one bit
- Conventional motor assembly

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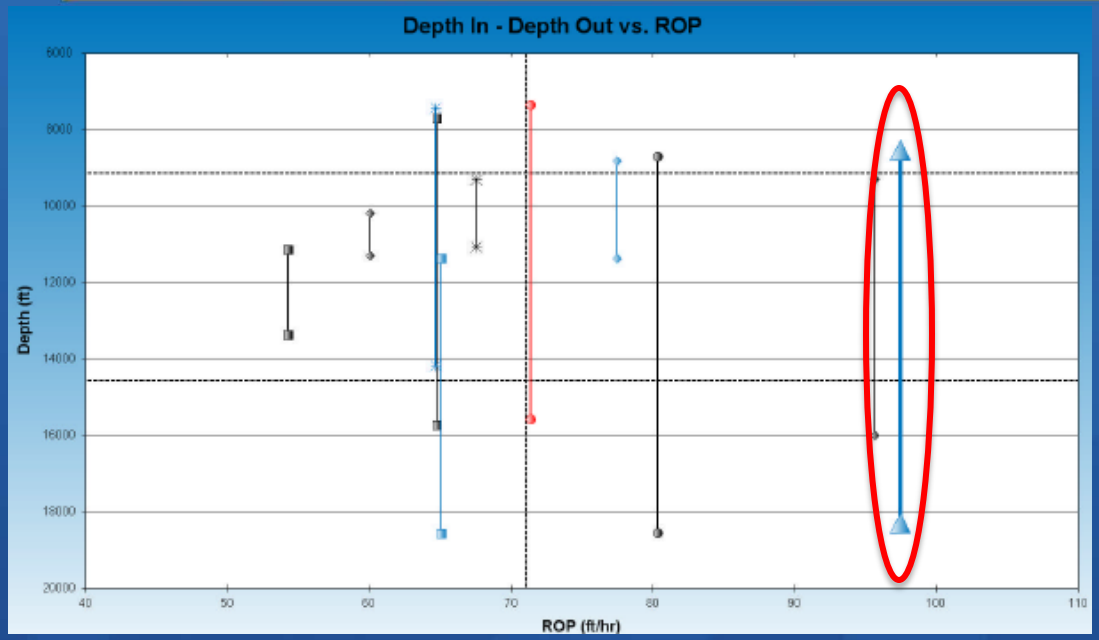
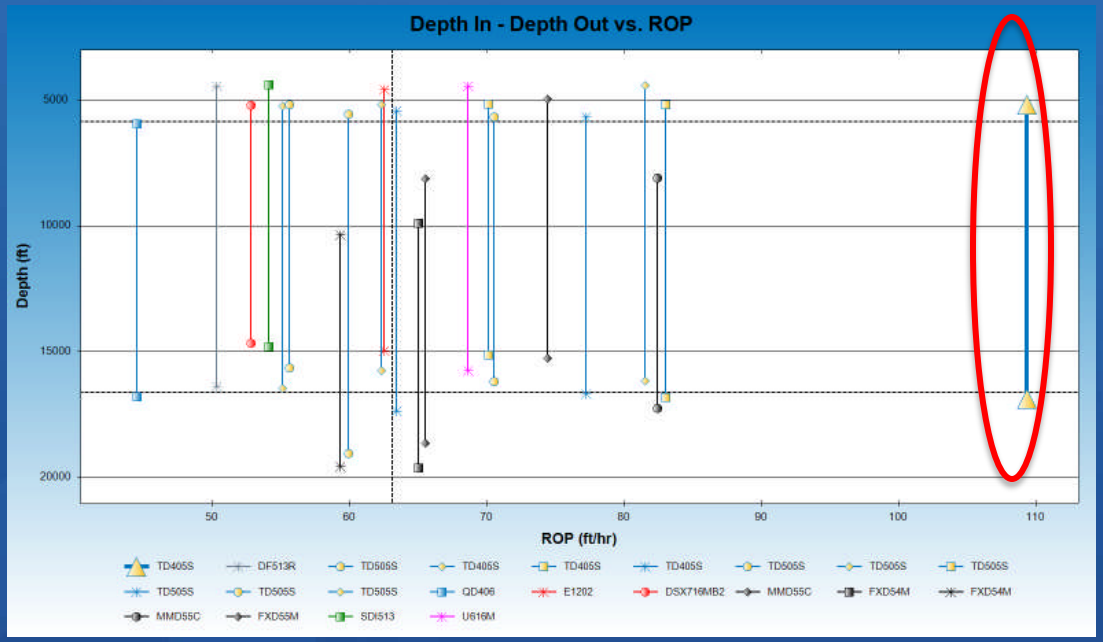



- Drill 9,500ft at 98ft/hr
  - Offsets typically drill interval with multiple bits
- Saved operator 4 days drilling time
- Excellent steerability

# Eagleford Vertical-Curve-Lateral 1 bit run

- Challenge
  - Complete V-C-L in ONE bit run
  - Drill each section with increased ROP
  - Maintain exceptional toolface control in the curve section




- **Results**
  - Went in at 5,200' and drilled to TD at 16,905' in 107 hours;
  - ROP of 109 ft/hr.
  - Saved the customer 78.7 hours compared to the offset average and approximately $139,000!
- Impact
  - 1 bit under surface to TD is not an item on your Christmas list any more but a real possibility! Work with your bit engineer to choose the right features and operating parameters.

# Eagleford Vertical-Curve-Lateral, 1 bit run

- Challenges
  - Drill the entire Vertical-Curve-Lateral with a conventional assembly from surface casing in one run with one bit and BHA
  - Drill vertical section at increased ROP
  - Maintain tool face control in the curve to achieve build rates
  - Improved tracking ability in the lateral to reduce slide time
- Results
  - Completed the Vertical-Curve-Lateral section 20 times, YTD 2014
  - There has NOT been one DBR'd bit out of the 20 completed runs
  - Dull grades typical 11TD to 12TD

# Eagleford Vertical-Curve-Lateral, 1 bit run

| RUN DATE | COUNTY | BIT SIZE | BIT TYPE | DEPTH IN | DEPTH OUT | DISTANCE | ROP (ft/hr) | DULL |
|---|---|---|---|---|---|---|---|---|
| 7/28/14 | ATASCOSA | 8.5 | | 4124 | 13693 | 9569 | 143.9 | 1-1-CT-S-X-I-WT-TD |
| 7/26/14 | GONZALES | 8.5 | | 7204 | 16815 | 9611 | 116.5 | 1-1-WT-S-X-I-NO-TD |
| 4/27/14 | MCMULLEN | 8.75 | | 5200 | 16905 | 11705 | 109.4 | 1-2-CT-A-X-I-NO-TD |
| 1/6/14 | LA SALLE | 8.5 | | 6160 | 16773 | 10613 | 108.6 | 1-1-CT-N-X-I-WT-TD |
| 6/19/14 | ZAVALA | 8.75 | | 3160 | 14583 | 11423 | 108.3 | 1-1-WT-S-X-I-NO-TD |
| 5/6/14 | MCMULLEN | 8.5 | | 4674 | 17624 | 12950 | 107.4 | 1-1-CT-S-X-I-WT-TD |
| 6/12/14 | MCMULLEN | 8.5 | | 4842 | 17511 | 12669 | 106.5 | 1-1-WT-A-X-I-NO-TD |
| 3/2/14 | MCMULLEN | 8.5 | | 6275 | 17481 | 11206 | 104.2 | 1-1-CT-S-X-I-NO-TD |
| 6/14/14 | MCMULLEN | 8.75 | | 5780 | 18250 | 12470 | 96.7 | 2-2-WT-A-X-I-CT-TD |
| 6/21/14 | ZAVALA | 8.75 | | 3160 | 14583 | 11423 | 92.5 | 1-1-WT-A-X-I-NO-TD |
| 6/26/14 | MCMULLEN | 8.75 | | 5785 | 17970 | 12185 | 85.8 | 2-2-CR-C-X-I-CT-TD |
| 5/27/14 | DE WITT | 8.75 | | 3845 | 18796 | 14951 | 85.4 | 1-1-BT-G-X-I-CT-TD |
| 4/21/14 | MCMULLEN | 8.75 | | 5200 | 16835 | 11635 | 83.1 | 1-2-LT-S-X-I-CT-TD |
| 4/10/14 | MCMULLEN | 8.75 | | 4438 | 16195 | 11757 | 81.6 | 1-2-BT-S-X-I-CT-TD |
| 2/17/14 | MCMULLEN | 8.75 | | 5700 | 16712 | 11012 | 77.3 | 1-2-BT-S-X-I-CT-TD |
| 4/8/14 | MCMULLEN | 8.5 | | 6123 | 17571 | 11448 | 76.6 | 2-2-LT-N-X-I-WT-TD |
| 6/21/14 | ZAVALA | 8.75 | | 2750 | 14001 | 11251 | 74.5 | 2-1-CR-N-X-I-WT-TD |
| 3/18/14 | LA SALLE | 8.5 | | 4425 | 17080 | 12655 | 72.2 | 1-1-CT-A-X-I-CT-TD |
| 5/25/14 | ATASCOSA | 8.75 | | 3428 | 13825 | 10397 | 63.6 | 1-2-CT-G-X-I-NO-TD |
| 1/27/14 | MCMULLEN | 8.75 | | 5587 | 19078 | 13491 | 60 | 1-2-BT-G-X-I-WT-TD |
| 3/18/14 | MCMULLEN | 8.75 | | 5190 | 15658 | 10468 | 55.7 | 1-2-CT-S-X-I-WT-TD |

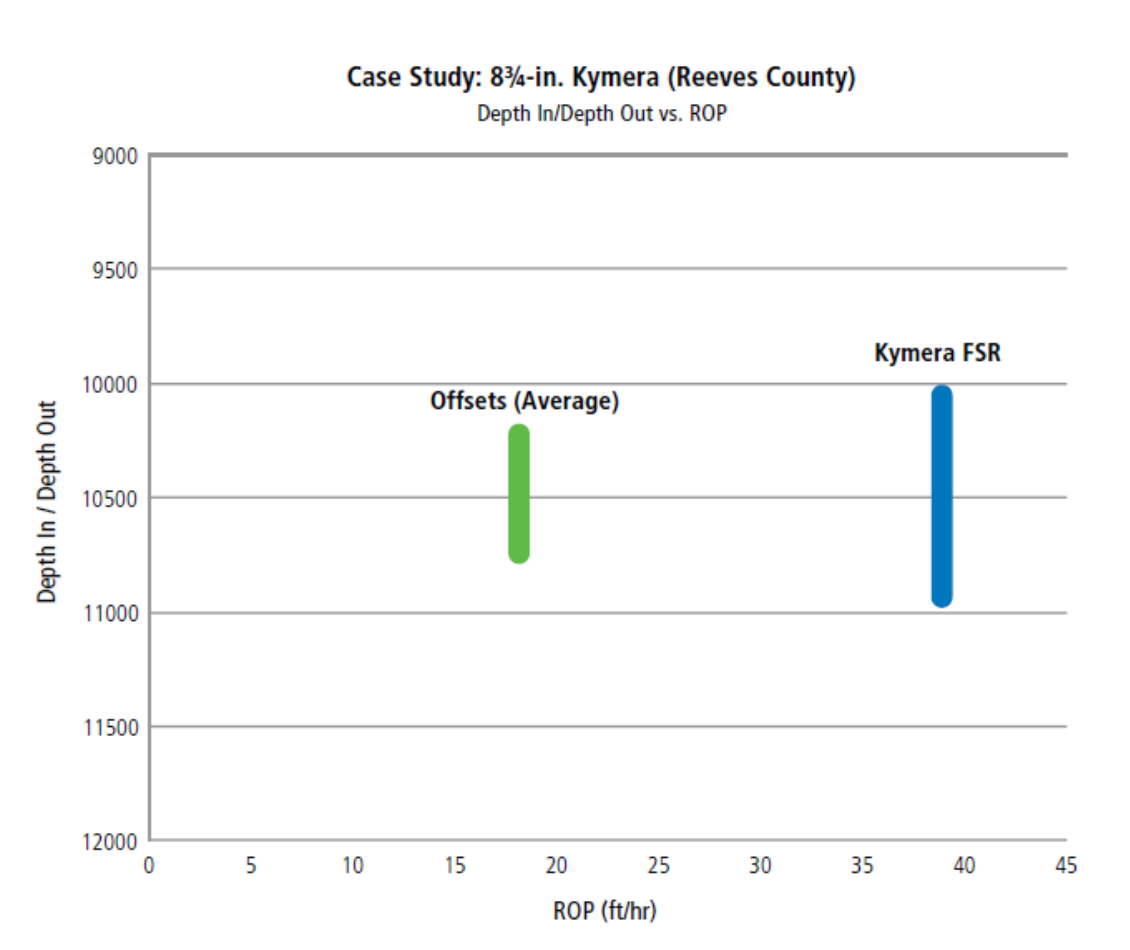
# Hybrid Bits Case Study in Unconventionals

- The Challenge: Wolfecamp curve
  - Complete curve in one run
  - Maintain or improve wear, durability, dull condition over PDC.
  - Drill through conglomerate, chert, sand

- The results
  - Beat offsets solidly
  - Run of 38.8 fph vs. 18.0 fph
  - Maintained targeted build rate of 14˚ or higher per hundred
  - One run curve in typical “2” bit section
  - 1,1 Dull
  - Saved 18 hours vs. offset average

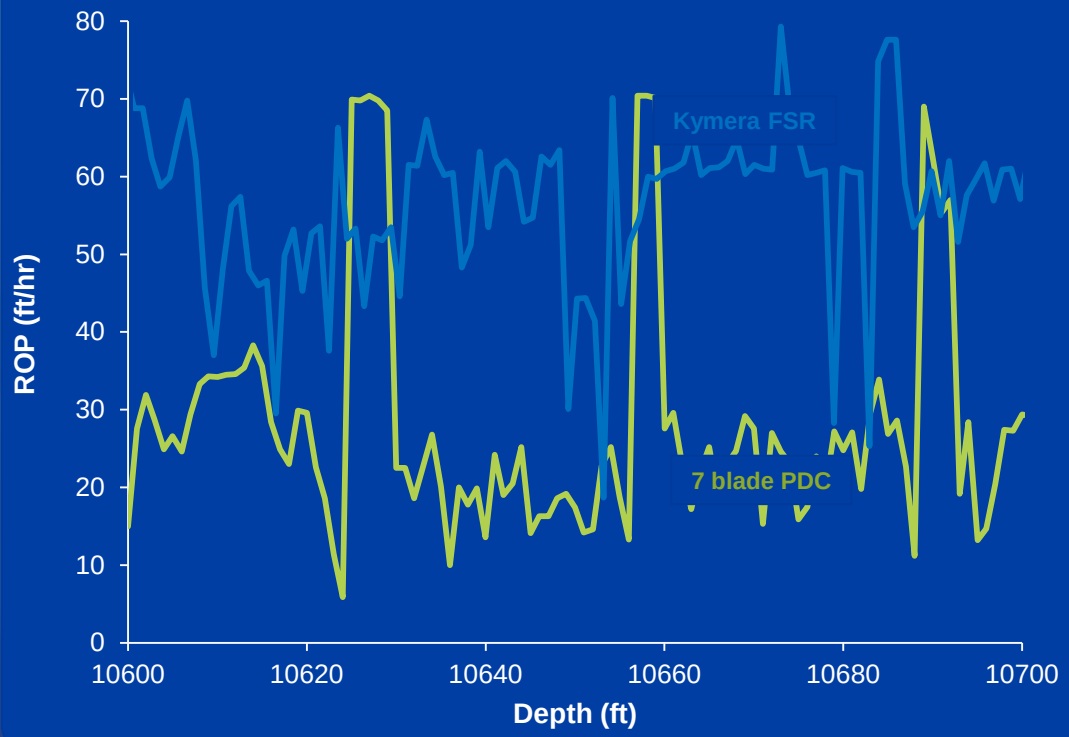
# Hybrid Performance in Curve



# Hybrid FSR vs. 7 blade

- Bone Springs, Permian





**Problem drilling curve:**

- Bone Springs Permian
- Challenging Carbonates
- Multiple bits building 12°/100ft
- Limited WOB with PDC due to reactive torque

**Solution:**

- 8-3/4” Hybrid in 1 bit
- Smooth drilling
- Increased ROP due to reduced reactive torque

**Increased ROP by up to 2x in carbonates**

https://inside.bakerhughes.com/sites/marketing/materials/Case%20Histories/41234_KymeraFSRPermianBasin_CH.pdf

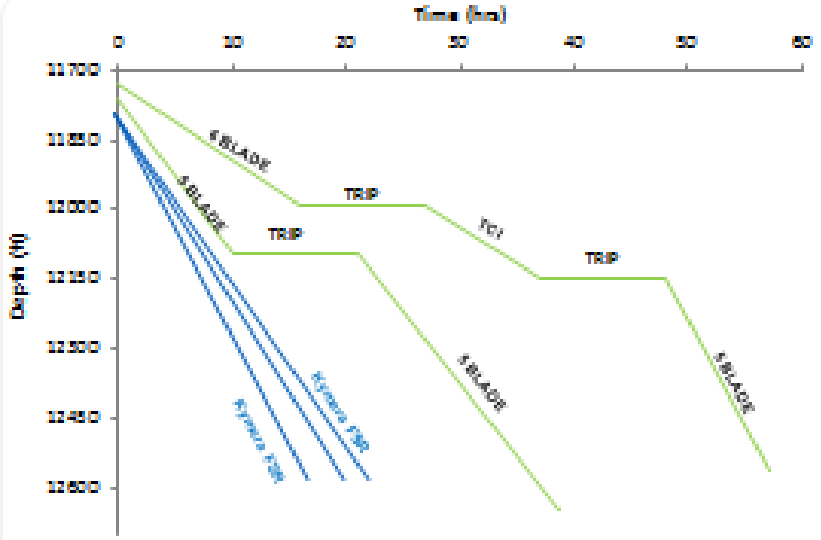
# Case Study: Hybrid Technology in South Texas

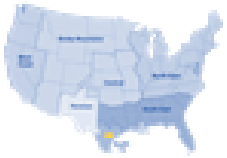
## Hybrid vs. 5 - 6 blades

- Eagle Ford , South Texas

"125 ft/hr from Hybrid is the fastest I've seen through a curve on this pad"

*Directional Driller for Eagle Ford*



Problem drilling curve:

- Karnes county, Eagle Ford
- Multiple bits curves & DTF
- Limited WOB with PDC due to reactive torque

Solution:

- Hybrid up to 125ft/hr
- Maintain steerability and allowed to maximize speed
- Set operator record for Eagle Ford

Consistency and speed, saves $510k in 3 wells

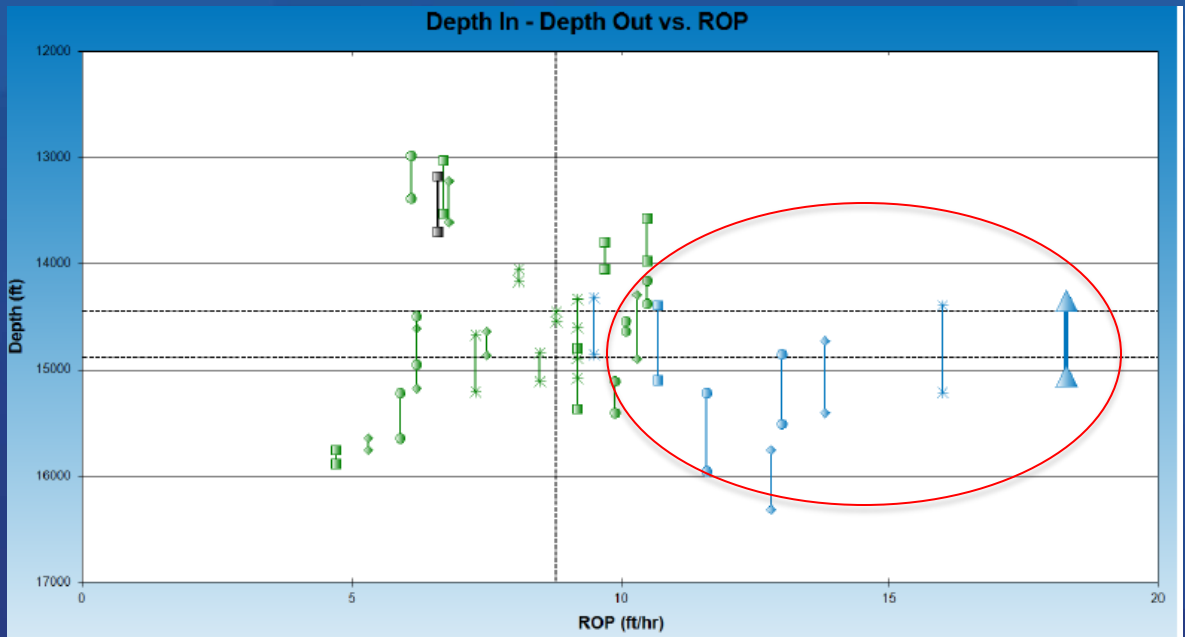
# Case Study: Hybrid curve in Mid-continent

## Challenge;

- Complete curve in 1 run
- Improve ROP, footage, customer economics
- Maintain tool face control
- Reduce number of bits and trips

## Results

- Hybrid 674’ at 13.2 fph
- PDC 356’ at 7.9 fph
- Faster, longer runs
- Less bits
- Improved economics
- Happy customer



# Summary

- Innovations in the PDC cutter and PDC bit have greatly improved economics of horizontal unconventional wells.
- One PDC bit  can generally complete the lateral.
- The focus shifted to the vertical and build sections.
- One section bit runs are becoming the norm.
- Hybrid bit technology is becoming a standard curve choice in more demanding applications.
- One bit to TD is a realistic objective in many applications. One bit V-C-L is in sight for more applications.
  - Bit specialist and drilling engineer collaboration.
- Today's PDC cutter is substantially improved over decade.
- Cutter and bit innovations have lead to field records.
- Innovation is alive and well in our industry.

# Future Possibilities (Survey of US Patents)

- Real time data from the bit
  - Module in the bit shank with monitoring and measuring capabilities
  - Optimize parameters
  - Maximum performance
- Sensors and monitors in the bit
  - Performance
  - Response
  - Formations
  - Integral part of the automated drilling system
- Bit as part of an adaptive system
- Innovative cutter shapes
- Innovative diamond tables
- Smart PDC cutters

Thank the DEA for this opportunity to share results of recent innovations.

Thank you for your attention.

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