

Hughes Christensen




QUANTEC[™]
Premium PDC Drill Bits



Hughes Christensen

- Higher ROP
- Greater Footage
- Improved Drilling Economics



Building on three decades of continuous improvement, we introduce the next generation of PDC technology: Quantec™ premium PDC.

Roller cone to PDC to Quantec PDC

In the early 1950s, operators used 250 Tricone™ bits to drill one deep gas well. By the 1970s, our patented O-ring sealed journal bearing tripled the life of the Tricone bit, leading to an 80% reduction in bits necessary to TD the well. In 1976, after we introduced the world's first PDC bit into the oilfield, operators needed just 15 bits to drill an identical well.

For example, in 2003 in the Anadarko Basin, the most durable roller cone bits were required to penetrate the tough Granite Wash at an average ROP of just 16.3 ft/hr. Previously, the formation's hard and highly abrasive sand-shale sequence would tear up the toughest PDC bits. But, everything changed in 2006.

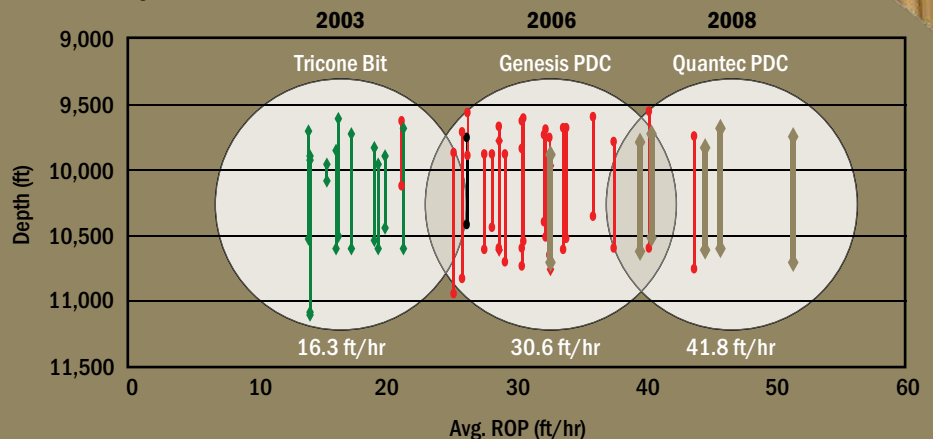
With the introduction of Quantec PDC, we continue our tradition of innovation by offering a line of bits capable of drilling further, faster through the toughest, most abrasive formations. Quantec PDC is setting footage and ROP records seemingly impossible just years ago.

With the introduction of our application-specific Genesis™ ZX™ PDC bit, tougher cutters and improved stability nearly doubled ROP through the Granite Wash at 30 ft/hr. Now, Quantec bits have pushed the performance even greater, drilling the tough formation at an average ROP of 41.8 ft/hr or 156% faster compared with the roller cone average in 2003.

Quantec PDC innovations are based on

- 129,737 work hours
- 6,000 feet of rock drilled in our drilling lab
- 4,000 hours of lab time
- 2,500 hours in simulator and rig tests
- 2,400 field runs with Quantec cutters.

Quantec PDC increases ROP 156%



Quantec PDC increases footage 153%

Bit: 7 7/8 in. Q507HX
Location: West central Oklahoma
Formation: Limestone, dolomite, shale.
Challenge: Drill through the abrasive Granite Wash in One Fast Run™, decreasing the number of bits used in this interval and reducing trip time; reduce vibration; improve stability; eliminate lost circulation.
Results: Quantec technology met all of the operator objectives, drilling through the Prue, Cherokee, Red Fork, and Atoka abrasive formations in one run and eliminating at least one trip. The robust cutting structure, designed specifically for this application with the strategic placement of cutters through diamond volume management, drilled 2,785 ft compared with 1,099 ft for the average of the offsets. Drilling hours increased 122%; ROP 8%.

CULTURE OF CONTINUOUS IMPROVEMENT

- Quantec is tougher, more stable with abrasion-resistant cutters.
- Quantec is more mechanically efficient: requires less weight and torque to drill in new condition.
- Quantec is more hydraulically efficient: resists balling and stays clean.
- Quantec is faster: bit frame and cutter layout matched to your application.



Quantec PDC

1 Diamond volume management (DVM)

Purpose: Customizes bit profile and cutter layout to your application.

Benefit: Higher ROP; greater stability; longer runs with significantly reduced cutter or BHA damage.

2 Superior impact and abrasion-resistant cutters

Purpose: Maintains abrasion and impact resistance with cutters matched to your application.

Benefit: Improved cutter life for longer runs and greater section ROP; reduced trips with fewer bit runs to complete your interval.

3 Innovative multiple cutter rows

Purpose: Drills through various lithologies without sacrificing performance.

Benefit: Higher ROP in softer intervals with excellent durability in harder intervals.

4 Optimized hydraulics

Purpose: Ensures the best balance of fluid flow, cutter cooling, and erosion resistance.

Benefit: Efficient cuttings removal for higher ROP.

5 SmoothCut™ depth-of-cut control technology

Purpose: Stabilizes the bit through hard stringers and minimizes cutter-damaging peak loads.

Benefit: Longer bit life; higher ROP.

6 Lateral Movement Mitigator™ (LMM)

Purpose: Reduces bit vibration and increases resistance to whirl.

Benefit: Longer runs; higher ROP.

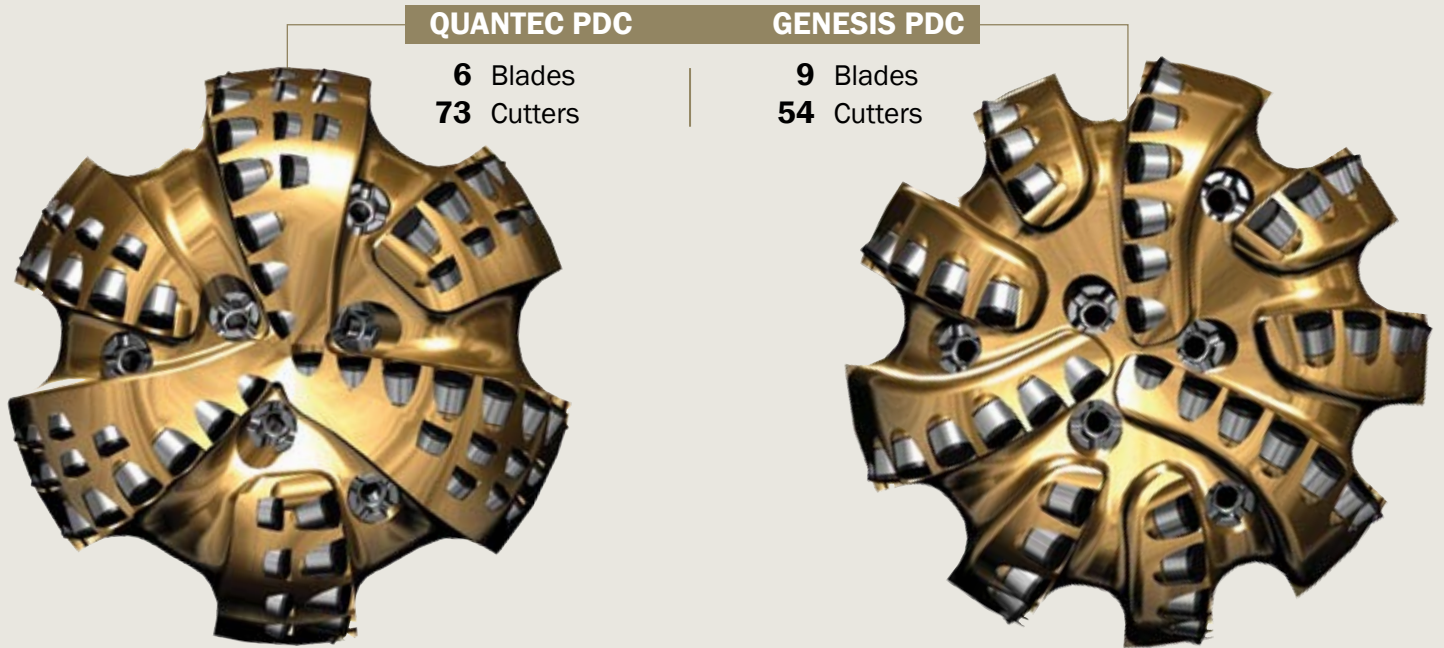
7 TSP gauge protection

Purpose: Resists wear to keep the bit in gauge even in the most abrasive intervals.

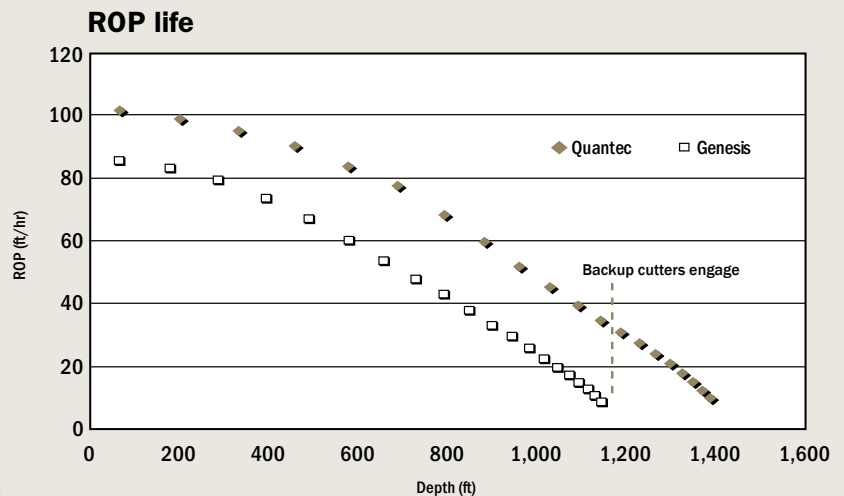
Benefit: Longer bit runs; fewer trips.

DIAMOND VOLUME MANAGEMENT: PUTTING DIAMOND WHERE NEEDED THE MOST

Quantec PDC bit designs are based on a simple, but powerful philosophy of diamond volume management. DVM adds the right amount of diamond at the right location on the bit, considering the needs of the target application. In some cases, the refined bit profiles are complemented by strategically placed single or multiple rows of backup cutters with the hydraulic and mechanical efficiency of a low blade-count PDC while retaining the durability of a high blade-count PDC. Our DVM philosophy enables Quantec designs to broaden the range of PDC drillable applications at outstanding ROP.



A hard rock application example compares a Quantec 8 3/4 in. Q506XX with our Genesis 8 3/4 in. HC 509Z to illustrate the superiority of diamond volume management. DVM produces, faster bit profiles without sacrificing durability. The Quantec PDC, has 6-blades and 9 rows of backup cutters—the equivalent of a 15-bladed bit—with 73 cutters. The Genesis PDC has 9 blades with 0 rows of backup cutters—the equivalent of a 9-bladed bit—with 54 cutters. Besides the primary, secondary, and tertiary row of Quantec cutters in this profile, the premium Quantec PDC has a 47% greater junk slot area for enhanced hydraulic efficiency.



In a computer simulation, which monitors PDC cutter wear, a new Quantec bit, utilizing DVM technology, drills faster and longer than the Genesis design.

- Abrasive Sandstone
- 150 RPM
- 25 klb



Soft formation

Hard formation

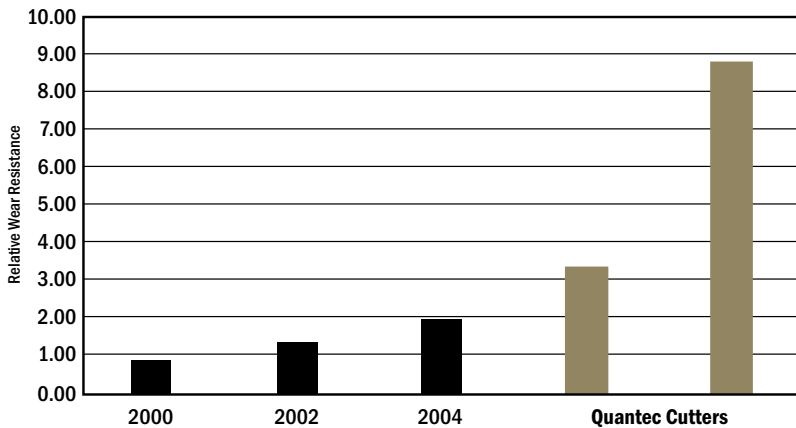
Large diameter

Quantec PDC bit profiles are customized for your specific application.

SUPERIOR IMPACT- AND ABRASION- RESISTANT CUTTERS

Since we introduced PDCs into the oil field more than 30 years ago, our engineers have worked continuously to improve the impact and abrasion resistance of our synthetic diamond cutters. Our two new Quantec cutters—Falcon and Cheetah—are up to 400% more wear resistant than early cutters, as shown in the graph below. Depending on your specific application, either the Falcon or Cheetah Quantec cutters enables you to drill faster and more efficiently.

400% greater abrasion resistance



Cutter abrasion resistance overview
Wear test analysis



Black Ice: reduced friction

All of our PDC cutters have patented polished surfaces, which reduce friction for greater cutter efficiency.

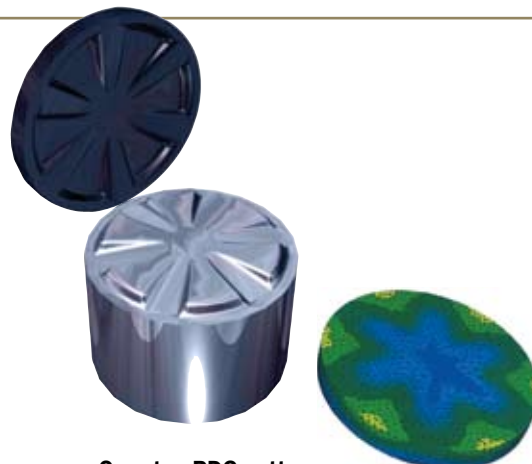
ENHANCED CUTTING MECHANICS AND DURABILITY

The new interface between the diamond and carbide surfaces is optimized for efficiency and durability. These interfaces are modeled using finite element analysis (FEA), which simulates the residual stress distributions caused by thermal loads. The Quantec cutters' innovative, single-layer diamond table technology delivers a step change in abrasion resistance with less potential for chipping or fragmenting along the boundary between the diamond layers. The single-layer diamond table also ensures greater cutter integrity.



Standard PDC cutter

Using FEA, our engineers have moved harmful residual stress away from the cutting edge, significantly increasing cutter life.



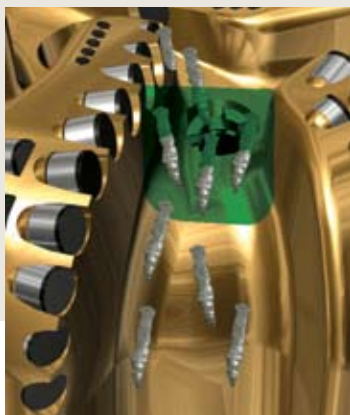
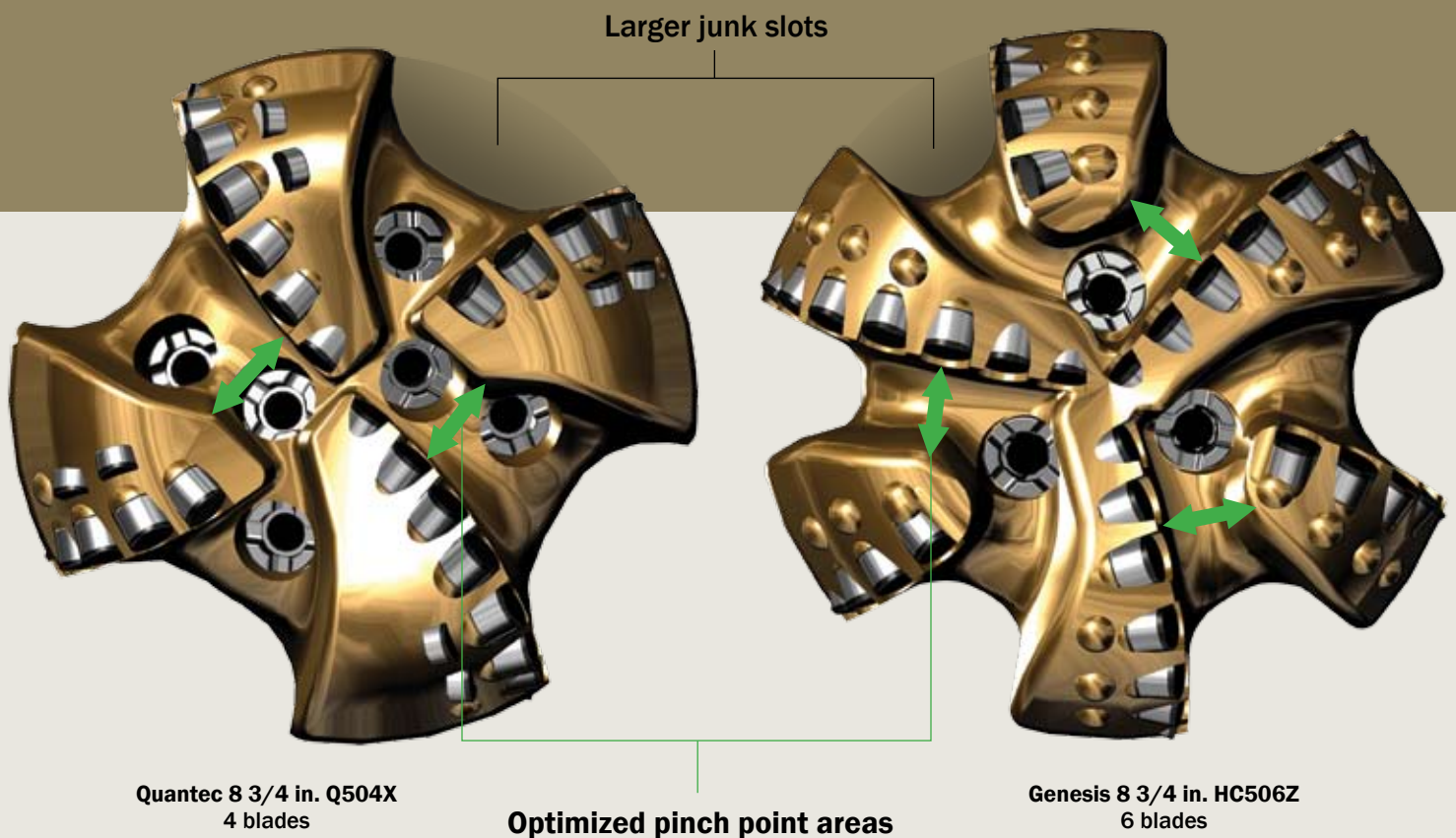
Quantec PDC cutter

A BETTER APPROACH TO HYDRAULICS

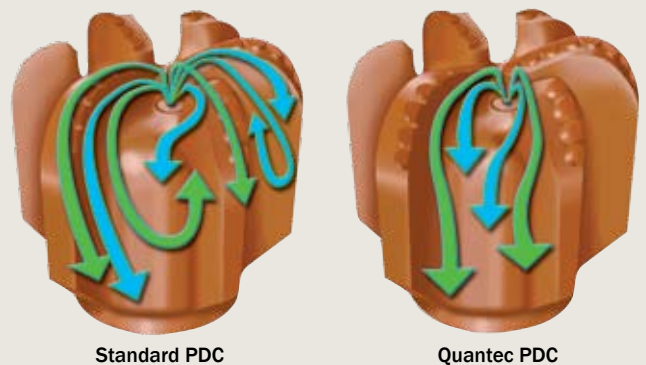
The Quantec team increases hydraulic efficiency by analyzing

- computational fluid dynamics (CFD)—optimizes nozzle location to ensure the best flow balance and cuttings transport for minimized erosion
- cuttings trajectory—optimizes the junk slot profile to evacuate cuttings away from the center of the bit
- junk-slot efficiency—increases the maximum volume of cuttings passed per blade by optimizing the relationship of generated cuttings and junk slots
- pinch point analysis—reduces balling by optimizing the areas in front of the primary blades.

Quantec PDC has larger junk slots and pinch point areas for significantly reduced balling.



Quantec bits have pinch point areas that are optimized for increased cuttings removal.



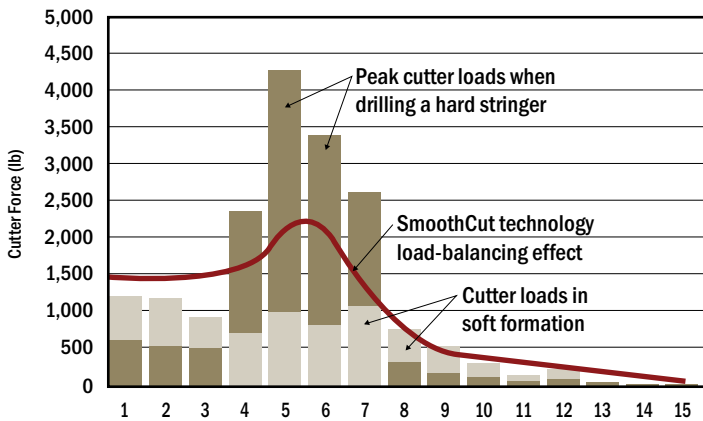
Computational fluid dynamics (CFD) balances fluid flow and cutter cooling with maximum cuttings removed.

INCREASED STABILITY AND REDUCED VIBRATION

Our engineers addressed stability issues with patented SmoothCut depth-of-cut control technology for a low-vibration, stable drill bit that reduces premature cutter wear. Bit stability increases your footage drilled and improves ROP by eliminating impact damage. Cutters retain their initial, sharp-edge geometry.

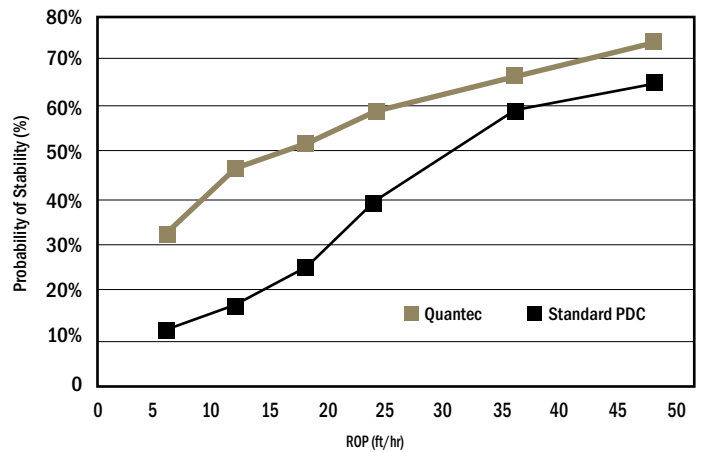
Quantec PDC bit stability also is enhanced with our patented Lateral Movement Mitigator. LMM—which reduces bit vibration and increases resistance to whirl by building up the blade and upper bit shoulder—integrates load-balancing cutting structures with chordal drop management.

Patented SmoothCut depth-of-cut control technology



Cutter-damaging peak loads—which occur when drilling hard stringers with conventional PDCs—are minimized by balancing the workload over more cutters. SmoothCut technology limits bit reactive torque response without limiting bit aggressiveness and ROP for more stable drilling.

Quantec shows improved stability in Carthage marble

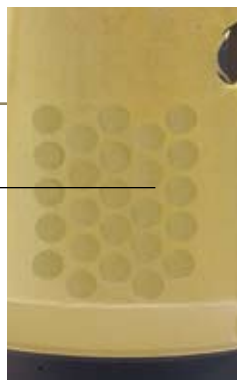


In drilling laboratory tests, Quantec designs indicate superior stability at low ROPs compared with standard PDC designs.

ENHANCED GAUGE PROTECTION



The Quantec team also reengineered the geometry, size, and spacing of the thermally stable polycrystalline (TSP) gauge inserts. The superior integrity of the newly shaped inserts—now round rather than triangular—offers the best abrasion resistance for maximum gauge-holding in the highest-stress drilling conditions.

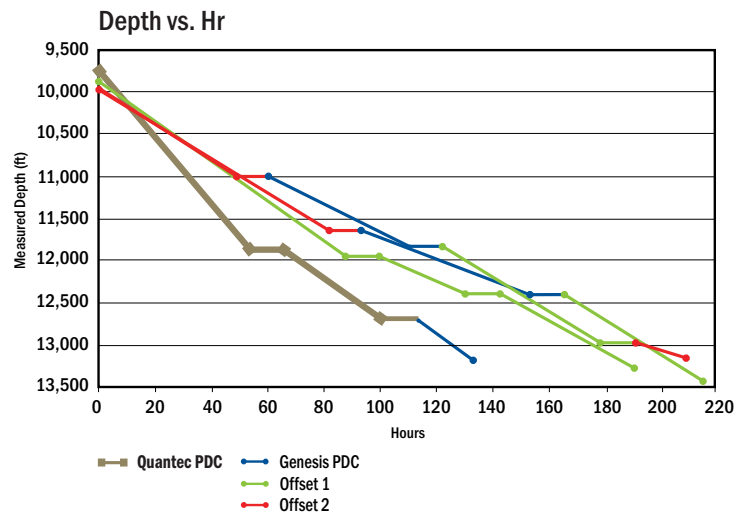


TSP gauge inserts

Wyoming

Drilling Time Reduced 35%

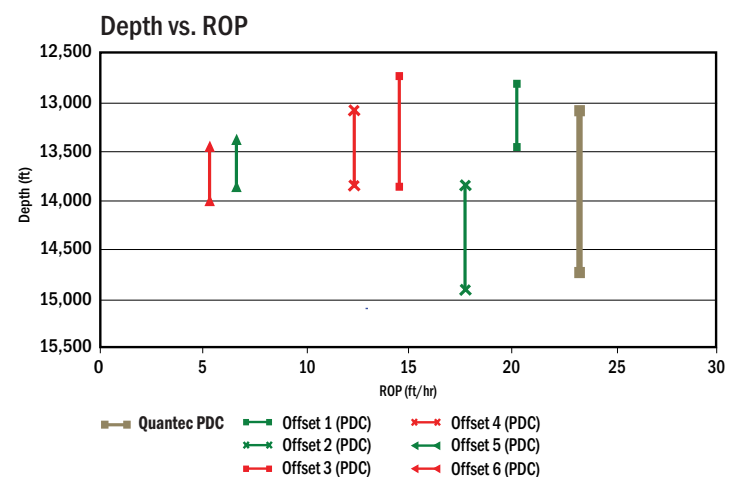
- Bits:** 6-in. Q405 and Q505
Location: Pinedale, Wyoming
Formation: Interbedded sandstones and shales.
Challenge: Very high mud weights and overburden pressures led to high confining pressures in an anticline slimhole interval. Operators have been using five-bladed PDC bits from various competitors for drilling at the bottom of S-type wells.
Results: These Quantec bits drilled the slimhole interval 72 hr faster than the average offsets. This was a 35% reduction in drilling time for a \$114,000 saving on a single well. At 1 well per month, this equals a total saving of nearly \$1.4 million over the year per rig.



Oklahoma

Operator Saves More than Three Days of Rig and Trip Time

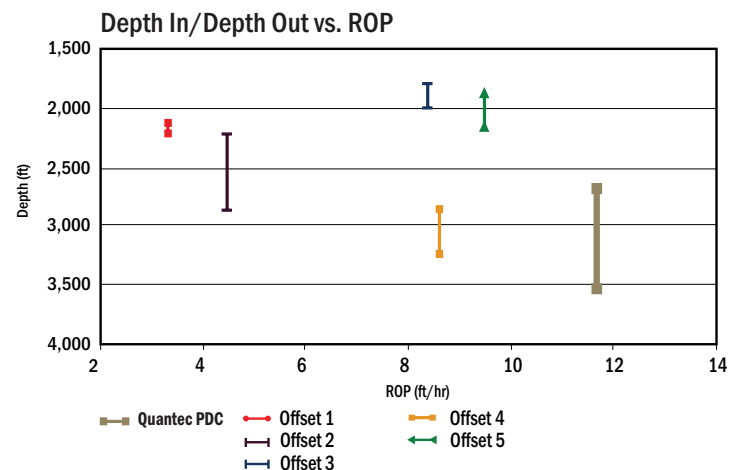
- Bit:** 9 7/8 in. Q507HX
Location: Caddo County, Oklahoma
Formation: Hard interbedded sandstones and shales.
Challenge: This tough formation requires two to three PDC and TCI bits drilling at low ROP.
Results: The operator achieved a drilling step change in this formation with Quantec technology. The Q507HX drilled the interval in 71 hr, saving 76 hr or \$76,000 per well. At 1 well per month, this equals a total saving of \$912,000 over the year per rig.



UK North Sea

Cost-Per-Meter Decreases 37% in Directional Run; Footage Increases 118%

- Bit:** 8 1/2 in. QD505XX
Location: UK North Sea
Formation: Abrasive sandstone.
Challenge: Drilling this section is difficult because of the abrasive nature of the sandstone and the extreme variability in cementation. The operator wanted to increase ROP by increasing point loading without affecting the durability of previously used Hughes Christensen bit technology and also to improve borehole quality.
Results: The Quantec PDC drilled 866 m, more than double the 398 m average distance for the offsets. ROP increased 60%: 11.7 m/hr versus 7.3 m/hr. The section was finished 9 days ahead of plan; cost-per-meter decreased 37%. All of the operator's drilling objectives were met.



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