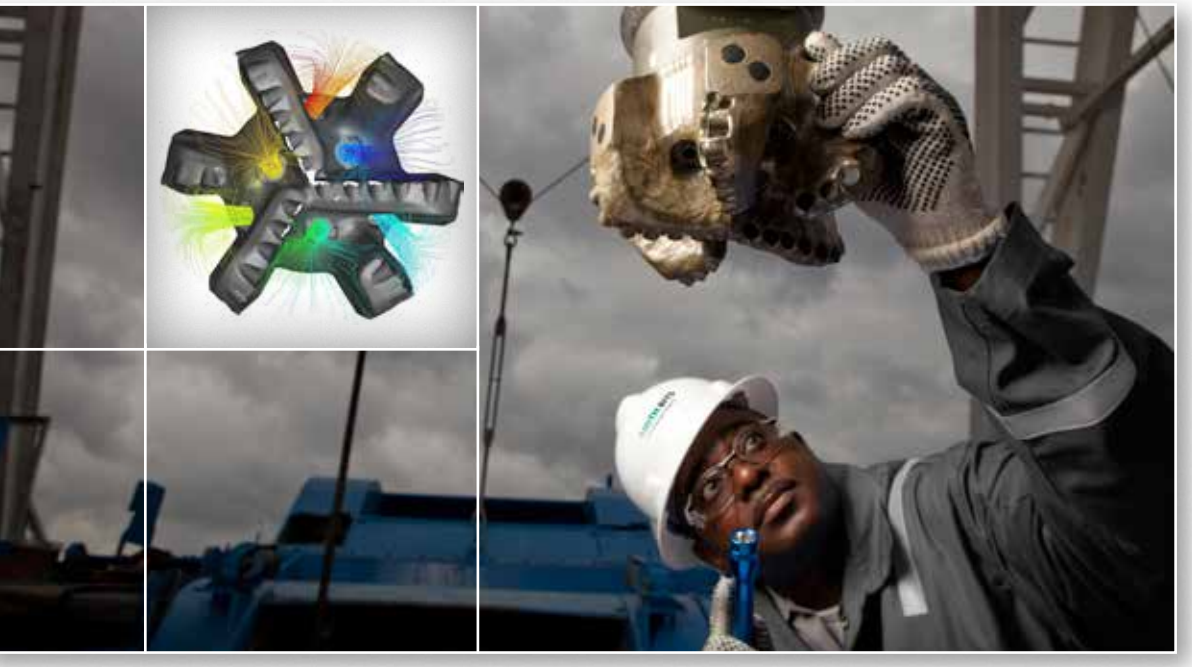
SMITH BITS
A Schlumberger Company



Spear

Next-generation shale-optimized
steel-body PDC drill bits

Applications

- Drilling curve and lateral sections in shale formations
- Operations requiring good directional control
- Formations known to cause bit balling and nozzle plugging
- Low-hydraulic energy drilling that produces deep beds of cuttings

Benefits

- Maximizes ROP in curve and lateral sections
- Combats bit balling and nozzle plugging
- Maintains drilling efficiency in low-hydraulic conditions
- Provides good directional control

Features

- Improved bullet shape promotes cuttings around bit body and into junk slots
- Improved blade geometry increases junk-slot area to evacuate cuttings from bit face
- Shale evacuation channel moves cuttings away from nozzles to inhibit plugging
- Hydraulic configuration cleans and cools cutters, maximizing ROP
- Improved cutting structure with consistent toolface control
- Steel construction reduces bit-body diameter, efficiently driving cuttings to the annulus

Design based on proven drilling performance

Introduced in 2011, the Spear* shale-optimized steel-body PDC drill bit significantly reduced bit balling and cuttings that tended to pack around the blades of matrix-body bits. Characterized by its distinctive bullet shape and smaller diameter steel body, the streamlined Spear bit put more distance between the bit body and borehole. This helped increase cuttings evacuation by minimizing blade packing and nozzle plugging, allowing the bit to drill more efficiently.

After more than 5,000 runs, the Spear bit's innovative capabilities have proven to increase drilling performance and lower drilling costs of curve- and long-lateral sections in unconventional shale plays.

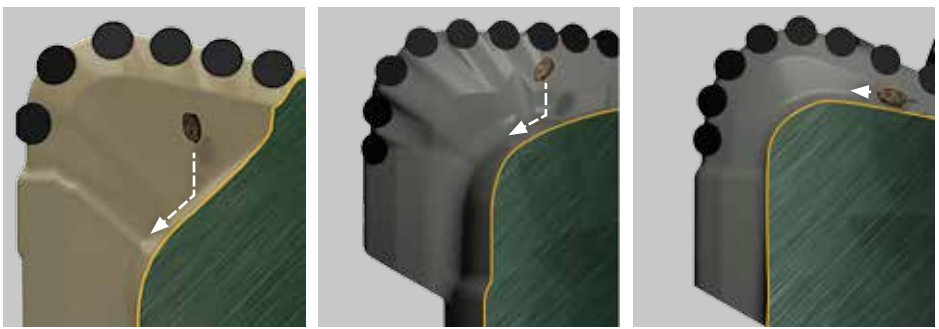
The original Spear bit was recognized among the industry's leading innovators and technological achievements at the 10th Annual World Oil Awards. Now, the next-generation Spear bit builds on this achievement to deliver significantly improved drilling performance.

Next-generation PDC bit design for shale applications

Based on Spear bit performances and a redesign program conducted by Smith Bits using IDEAS integrated drillbit design platform, the next-generation Spear shale-optimized PDC bit has demonstrated greater directional control and ROP increases as much as 40%.

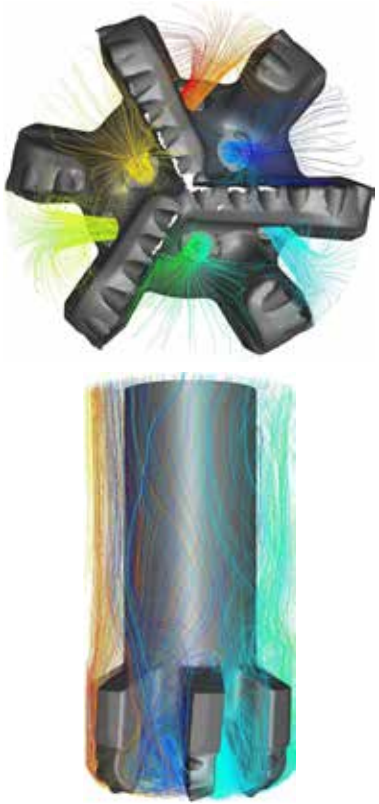
The next-generation Spear bit has been optimized to use larger 16-mm [⅝-in] cutters for improved ROP with tool face control. Improved blade geometry has given the bit an increased junk slot area to promote cuttings migration from the bit face.

The Spear bit's reduced bit body profile also improves cuttings evacuation into the annulus, which is essential in long-lateral shale sections where bit nozzles can become plugged as a result of low hydraulic energy. How well a nozzle functions under these conditions can mean the difference between pulling a bit prematurely and continuing to drill efficiently.



The next-generation Spear bit features an improved bullet-shaped profile (left). The steeper gradient provides more effective cuttings evacuation than the first-generation Spear (middle) and a standard matrix PDC bit profile (right).

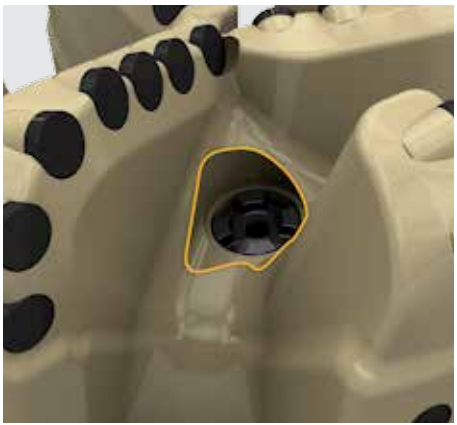
Advanced fluid modeling for improved hydraulics



The next-generation Spear bit's advanced hydraulics maximizes cutting structure cleaning and junk slot flow.

PDC bits used in unconventional shale applications are often run in a poor hydraulic environment: high mud weights, low flow rates, and large nozzle, total flow areas (TFA) produce a bit hydraulic horsepower (HSI) of less than 1.0. In such conditions, bit nozzle placement is crucial.

An extensive computational fluid dynamics (CFD) analysis was conducted on the next-generation Spear bit to optimize nozzle placement. This resulted in an improved hydraulic configuration that cleans and cools cutters more effectively, which helps prolong cutter life and maximize ROP.



A shale evacuation channel is formed on the bit body near the nozzle bores providing an unobstructed flow path for cuttings evacuation, which greatly reduces blade packing and nozzle plugging.

Curve and lateral shale sections drilled in one run

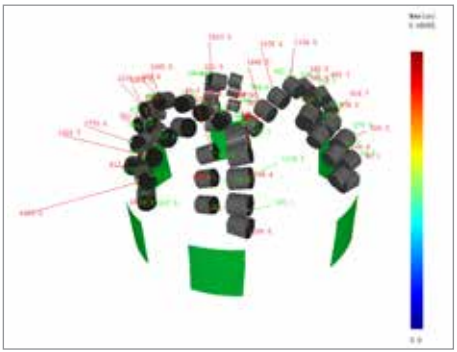
ONYX II premium PDC cutters increase cutting structure durability for longer bit life.

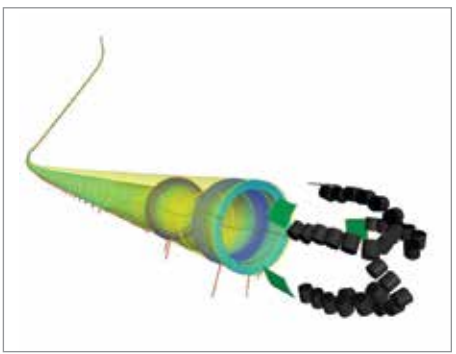
Design option pushes performance

The Spear bit can be fitted with ONYX II* PDC cutters. This range of premium cutters has greater thermal stability, impact resistance, and durability. As a result, cutters stay sharper longer to extend bit life—an essential capability for drilling a curve section through challenging interbedded formations.

IDEAS design improves ROP with excellent directional control

Beyond using IDEAS* integrated drillbit design platform to improve the bit's cutting structure and bit-body design, bit design engineers also used the IDEAS design platform to improve the next-generation Spear bit's performance in the well's curve section without compromising toolface control. When compared with the first-generation PDCs, the next-generation Spear bits have improved ROP in curve and lateral sections while providing excellent directional control for accurate wellbore placement.





The next-generation Spear bit was designed using IDEAS platform, which enables bit engineers to accelerate the workflow of new bit designs.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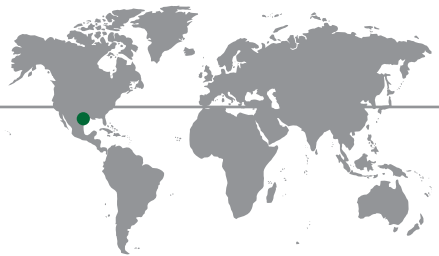
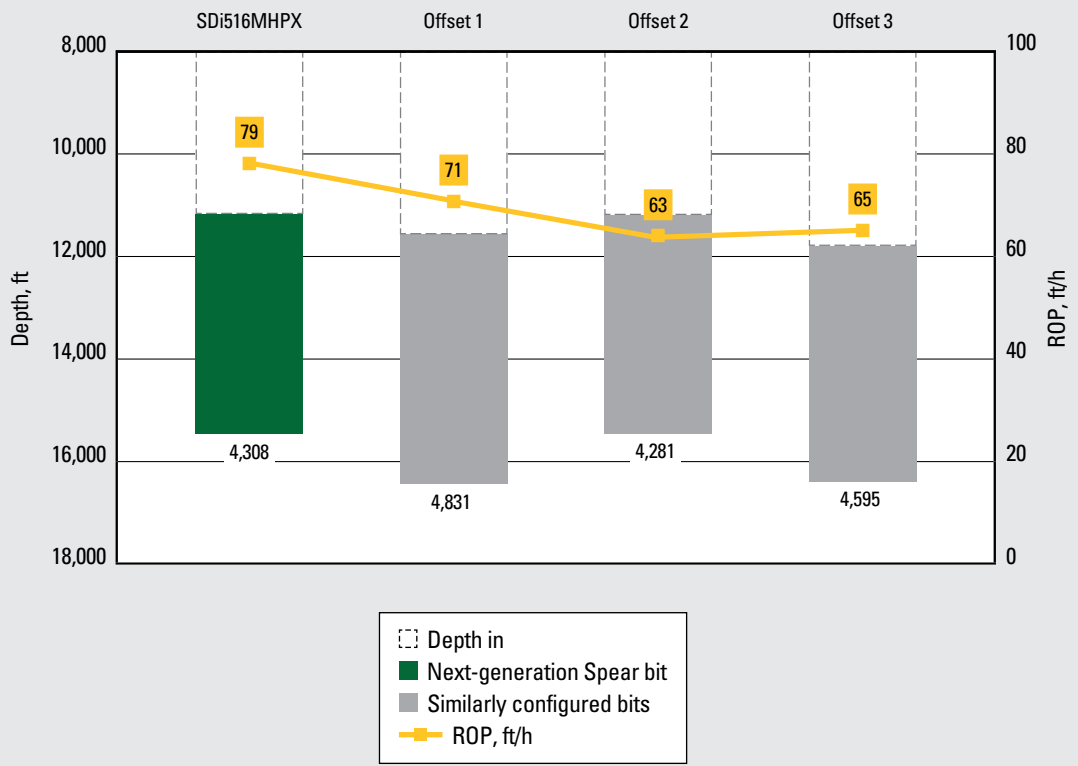


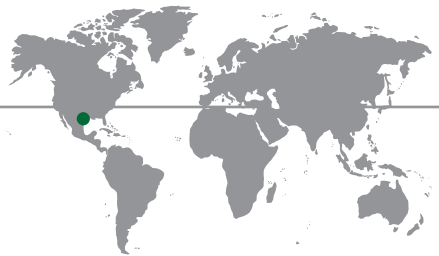
Next-generation Spear PDC bit drills Eagle Ford shale 22% faster compared with median ROP of offset wells

An operator planning to drill 8¾-in sections in the Eagle Ford shale of Karnes County, Texas, sought a bit that could drill curve and lateral sections efficiently. Drilling shale applications in the Eagle Ford is generally conducted using low-power rigs, which produce lower hydraulic pressure. Additionally, bits used in shale applications have larger nozzles that increase TFA, causing poor bit HSI. This produces a poor hydraulic environment marked by low flow rates. As a result, cuttings evacuation is impaired, resulting in poor toolface control and reduced ROP.

Smith Bits recommended the 8¾-in, SDi516 five-blade, next-generation Spear bit. It drilled the 4,308-ft, 8¾-in lateral section at an average rate of 79 ft/h with good toolface control before being pulled at TD in excellent dull condition: 0-1 with no wear on the cutting structure. Compared with the offset well median ROP of 65 ft/h recorded by similarly configured bits, the new Spear PDC bit's ROP represents an increase of 22%.



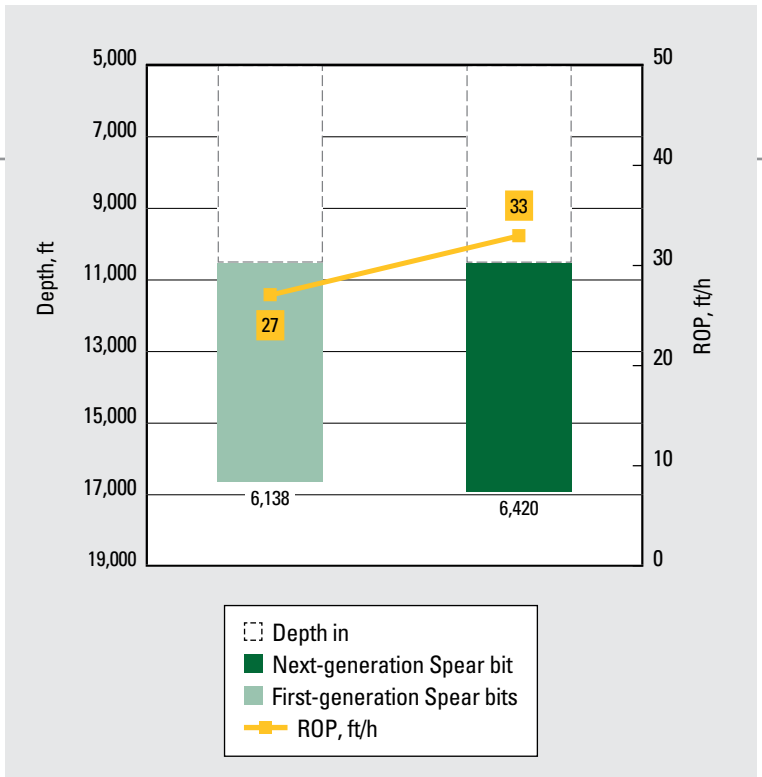
When compared with the offset drilling performances by bits from other manufacturers, the 8¾-in, SDi516 five-blade, next-generation Spear PDC bit drilled the curve and lateral sections in Eagle Ford shale with greater efficiency, increasing ROP by 22%.



Next-generation Spear PDC bit drills Haynesville shale 19% faster than previous bit design

Drilling 6¾-in curve and lateral sections in Louisiana's Haynesville shale, an operator was experiencing bit balling and nozzle plugging, resulting in bits being prematurely pulled. The operator also had to deal with other difficulties commonly associated with shale play applications. Drilling is generally conducted using low-power rigs and relatively high mud weights of 16 ppg. These factors produce a poor hydraulic environment with low flow rates. Adding to this is an inadequate hydraulic horsepower (HSI) of 0.3 to 0.8 at the bit that impairs cuttings evacuation, which results in bit balling, poor toolface control, and low ROP.

Smith Bits recommended the next-generation Spear bit drilled the 6¾-in curve and lateral sections for a total of 6,420 ft at 33 ft/h with no formation packing or nozzle plugging. The bit was pulled at TD in excellent dull condition: 0-1 with little wear on the cutting structure. When compared with 11 offset wells that were drilled an average of 6,138 ft by bits based on the first-generation Spear bit design at an ROP of 27 ft/h, the next-generation Spear bit design drilled 282 ft farther and increased ROP 19%.



The next-generation Spear PDC bit drilled the curve and lateral sections with no nozzle plugging or bit balling and provided good directional control, increasing ROP 19%.

The 6¾-in, SDi611 six-blade, next-generation Spear PDC evacuates cuttings more effectively to combat bit balling in shale applications while providing the directional control necessary to efficiently drill curve and lateral sections.

Spear

Find out more about next-generation Spear shale-optimized steel-body PDC drill bits at www.slb.com/Spear.

Case Studies

- A next-generation, five-blade, 8¾-in SDi516 Spear bit drilled a 4,308-ft section in the Eagle Ford shale at 79 ft/h. When compared with similarly configured bits, the Spear bit increased ROP 22%.
- A next-generation, six-blade, 6¾-in SDi611 Spear bit drilled 6,420 ft in the Haynesville shale at 33 ft/h, completing the tight curve and lateral sections in one run. This surpassed the performance of bits based on the original Spear bit design.

ONYX II

PDC cutters with greater wear resistance and durability to maximize ROP
www.slb.com/ONYXII

IDEAS

Integrated drillbit design platform
www.slb.com/IDEAS

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