Halliburton Shale Solutions

Unconventional resources. Unlimited potential.
The Halliburton Advantage:

Unmatched Resources for All-Inclusive Shale Solutions

The key to unlocking the potential of unconventional gas resources is knowledge that spans from initial resource assessment to initial production and beyond. Halliburton offers you that knowledge through extensive technological capabilities and unequaled experience in shale gas exploitation.

Our industry-leading product service lines provide the differentiating technologies and services you need to meet the challenges of shale gas production:

**Advanced analysis and evaluation services** that deliver vital information about well conditions, formation pressures, gas and geology, giving you confidence in determining producibility of your shale play and planning exploitation strategies.

**Comprehensive drilling and reservoir evaluation tools** that maximize reservoir contact while providing real-time geosteering and drilling optimization, so you get fast, efficient well construction.

**Innovative completion and production technologies**, integrated for your specific shale application, to optimize reservoir drainage during the production phase and beyond.

**A suite of stimulation monitoring and optimization products and services** that lets you visualize and optimize reservoir drainage in real time, maximizing production while reducing costs.
Yielding little production since drilling began in 1981, the Barnett shale in Texas became an “instant” major play in 1995, when introduction of hydraulic fracturing technology unleashed more than two million cubic feet of gas per day from each of five out of six initial wells. With current assets still exceeding an estimated 10 trillion cubic feet, the Barnett shale today produces two percent of all the gas consumed daily in the U.S.
Much of the estimated 1,000 trillion cubic feet of U.S. shale gas is found in basin-centered accumulations with production mechanisms that differ according to source rock attributes. Understanding the implications of these differences in designing exploration strategies, Halliburton provides expertise and analytical tools for identifying critical attributes of basin-centered gas accumulations to increase exploration and production-planning effectiveness.
Every gas shale play is different. From the relatively shallow, fractured Fayetteville shale of the Arkoma Basin to the deep, harsh conditions of the Haynesville shale of Louisiana, every reservoir requires a special approach. But wherever your play, you want drilling and reservoir evaluation solutions that maximize reservoir exposure while mitigating the risks of drilling unstable formations – and you need cost-efficiencies in this low-margin environment.

Halliburton’s integrated solutions bring together the tools you need:

To help mitigate risks during drilling, the ADT® drilling optimization service employs DrilSaver™ III software to detect and measure the magnitude of drilling vibrations, while geomechanics software from Landmark’s Knowledge Systems Inc. (KSI) reduces uncertainties in preplanning geomechanical and pore pressure models, so you can run optimal mud weights for well control and wellbore stability.

To improve drilling efficiencies, the GeoForce® constant wall thickness motor is matched with a Security DBS Drill Bits FullDrift® bit to deliver faster drilling and better wellbore quality, while the industry-first 3D-i™ drilling optimization package maximizes system performance. You can even monitor rig floor activity to reduce NPT using MaxActivity™, and MaxDrill™ applications providing the driller with rig floor display of optimum drilling parameters for specific bit design and rock properties.

Optimizing horizontal wellbore placement to achieve maximum drainage requires the ability to change well trajectory in real time. Halliburton's near-bit sensors provide inclination, gamma and combination measurements, while our StrataSteer® 3D geosteering package provides geological roadmapping in real time, and the Mercury™ electromagnetic telemetry system delivers faster communication that’s more reliable than mud pulse telemetry.

To reduce the risk of damaging the formation or collapsing the wellbore, Halliburton’s Pressure-While-Drilling sensor provides real-time monitoring. And in underbalance applications, GeoBalance™ managed pressure drilling system provides precise pressure control services to help protect fragile formations. Constant bottomhole pressure is maintained to overcome instability caused by formation pressure cycling, and damage to the formation is minimized without interfering with the natural fracture system.

To cut well construction costs, our advanced reservoir drainage solutions combine multilateral drilling with multistage fracturing capabilities to effectively improve reservoir exposure and drawdown with a smaller footprint.
When precise borehole positioning or geosteering cannot be accomplished by conventional methods, LaserStrat® chemostratigraphic service provides "geochemical fingerprinting" to identify stratigraphic units in near real-time at the wellsite, enhancing stratigraphic control with unprecedented resolution for precise wellbore placement. A significant advantage of the LaserStrat service is that it works well in higher silica rocks which are predominant in the best zones for fracturing in many shale plays.

Advantages of using Chemostratigraphy at Wellsite
- Enhanced wellbore placement
- Greater correlation confidence in directional wells
- While-drilling geochemical data
- While-drilling correlation to offset wells
- While-drilling correlation of chemical data
- Enhanced coring/casing point picks

While-drilling correlation to offset wells
Enhanced correlation confidence in directional wells
While-drilling geochemical data
Because of the highly variable nature of shale, each basin, well and pay zone requires completion solutions that are customized to the conditions at hand. Formation characteristics, downhole conditions, environmental constraints and the constant need for cost efficiency create special challenges in every shale reservoir.

Providing all-inclusive shale solutions for your shale play, Halliburton offers a wide range of stimulation technologies and services, including the newest, most advanced fracturing technologies, and the most comprehensive monitoring and optimization capabilities:

**CHALLENGE:**

**Optimizing Reservoir Drainage for Maximum Production**

To maximize value of stimulation services, our VeriStim™ service optimizes stimulation operations in real time, using the StimWatch® service to provide continuous temperature profiles over the length of a treatment well. Combining this data with ExactFrac® microseismic data from the fracturing process, VeriStim service enables you to visualize and optimize reservoir drainage.

To effectively stimulate horizontal openhole wells requires placing fractures with surgical precision. Using drillpipe, tubing or coiled tubing in single and multilateral horizontal completions, the patented SurgiFrac® service creates distinct individual fractures where conventional methods cannot.

To achieve the highest possible cumulative production, you need to optimize fracture placement from the start. Innovative horizontal multizonal completions options from Halliburton provide the precision and efficiency of Pinpoint stimulation for highly accurate fracture placement with little or no intervention. Using the Delta Stim® sleeve and Swelpacker® isolation system lets you selectively access a variety of pay zones in a single wellbore and provides you with the option to close off one or more zones at a future date.
To overcome unique challenges of water fracturing, you need unique solutions. Halliburton’s AquaStim® service combines specially designed additives into a custom package that improves cleanup, reduces fracture face damage and helps improve production from water fracturing treatments. OptiKleen-WF™ cleanout agent improves clean-up while GasPerm 1000™ surfactant removes water from the fracture face area to reduce damage. Compatible with all water-based fracturing fluids, including seawater, SandWedge® treatment enhances proppant pack conductivity for improved long-term production, reducing or eliminating fines migration and protecting against diagenesis.

To minimize water requirements, Halliburton has introduced OmegaFrac™ additive, the first fracturing fluid that eliminates the need to use potable water without compromising the necessary fluid qualities. While most fluids used in fracturing treatments today are blended from fresh water and natural polymers, OmegaFrac additive is based on a proprietary biopolymer and uses field-produced brine water to effectively suspend and deliver proppant into the fracture, providing easy clean-up to maximize sustained conductivity.

To overcome flow convergence issues, CobraMax® H fracturing service provides maximum near-wellbore conductivity, combining Hydra-Jet™ service-assisted fracturing with the well control capabilities and speed of coiled tubing. Used to stimulate cased and cemented horizontal wells with induced screenouts at the end of each treatment, CobraMax H service improves well performance by accurately controlling the fracture placement in horizontal sections.

To overcome limitations imposed by harsh environments, you need expertise and technology for reliable solutions, even in high-temperature, high-pressure applications. When rate, wellhead pressures and pump times require reliable high-pressure equipment, Halliburton is the recognized leader, providing Sperry Drilling Services’ Stellar® MWD/LWD suite, which includes the SOLAR® high-temperature service, delivery of exceptional performance even under the most extreme downhole conditions.
Halliburton Knows Shale

With our understanding of shale reservoirs nationwide, Halliburton meets the wide-ranging challenges of shale gas production with an all-inclusive approach to custom shale solutions.

We’ve established a national network of Halliburton technical teams who know their shale “from the ground down.” They understand the challenges presented by local geology and maintain a close collaboration with other local specialists within each of Halliburton’s product service lines. This seamless, comprehensive knowledge connection has led to optimization solutions that span from the discovery and planning phase to production enhancement, and include critical operations such as Water Management and Drilling Efficiency.

Through this extensive “eco-system” of shale gas knowledge, Halliburton alone has the power to deliver all-inclusive custom solutions for shale gas producers across the country. Because knowledge is power – and no one knows shale like Halliburton.

Due to the unique nature of shale, each basin, asset, well and pay zone requires specific treatments which can be optimized in real time for the best economic value using VeriStim™ stimulation monitoring and optimization service. This flagship workflow of Halliburton’s Digital Asset™ environment integrates a suite of products and services that enables the operator to visualize and optimize reservoir drainage in a real-time collaborative environment, maximizing reserves and reducing CAPEX.

To determine the viability and producibility of shale reservoirs, ShaleEval™ service provides expert lithology analysis through complex formation and fluid screenings, while ShaleFrac™ service offers QuikLook® reservoir modeling with advanced fracturing design capabilities for stage development and optimum wellbore placement.
The Technology Advantage

Halliburton’s success in the shale and around the country comes from decades of experience and continuous technological innovation. Our line-up of product service line companies includes some of the most recognized technical leaders in the industry: Landmark, Sperry Drilling Services. Security DBS Drill Bits. Baroid Fluid Services. We’ve been here from the start, instrumental in developing the key enabling technologies that first made shale gas production economically viable. And we’ve never stopped.

Today, Halliburton integrated shale solutions include the newest, most advanced stimulation innovations, already helping reduce production costs in shale gas plays around the county:

An improvement over existing proppants, Halliburton’s new MonoProp™ proppant achieves a partial monolayer of deformable polymer alloy particles to maintain adequate fracture width without creating flow impediments, allowing unrestricted hydrocarbon fluid flow from the formation through the fracture to the wellbore.

A new, advanced dry polymer ADF™ blender mixes Halliburton fracturing fluids from a dry-polymer base rather than a hydrocarbon-based concentrate, reducing environmental impact. And our innovative MIMIC™ proppant transport measuring device directly measures the ability of the fracturing fluid to transport the propping agent under specific downhole conditions, providing a measurement that until now could only be inferred from fluid viscosity.

We’re developing new multistage fracturing techniques and making significant strides toward balancing the global hydrocarbon/fresh water equation with water management solutions that minimize use of fresh water and reduce or eliminate produced water and the need for disposal.

Proven expertise and continuous innovation. This is the technology advantage, and it means that no other service company can supply what Halliburton does: integrated solutions backed with the science and experience necessary to adapt them to the unique challenges of shale geology.
An All-Inclusive Advantage

From rotary steerable drilling systems to chemounitigraphic guidance, leading technologies of Halliburton product service lines are combined in application-specific solutions that mean improved efficiencies in drilling shale reservoirs, maximum drainage in producing them, and greater accuracy in monitoring and optimization.

But the value of Halliburton’s contribution goes beyond that.

Because of our long experience in the challenging geology of U.S. shale basins, Halliburton is well positioned to serve shale gas operators through a robust North American infrastructure that enables us to meet a growing demand for services.

In the Bakken shale, for example, where customers have changed stimulation techniques from conventional fracturing with sand to Pinpoint stimulation techniques utilizing manmade proppant, we’ve already developed logistics solutions with suppliers that enable us to meet the growing demand for manmade proppant.

As a result of such far-reaching capabilities, you can depend on our integrated service intelligence to lower overall project costs while maximizing asset values.

Only Halliburton can combine these extensive technological capabilities with unequaled presence in shale gas exploitation to bring you the benefits of knowledge-based, all-inclusive shale solutions. That’s our advantage.

MWD for Underbalanced Drilling

Challenge

When the Appalachian Basin’s leading natural gas producer recently began an ambitious plan of dry air horizontal drilling in the Devonian shale, it faced the challenge of directionally drilling multiple underbalanced wells in a field containing soft formations imbedded with hard stringers.

Solution

For this underbalanced drilling application, Halliburton recommended capturing and transmitting survey data using the Mercury™ EM electromagnetic telemetry MWD system from Sperry Drilling Services which, unlike the mud pulse telemetry of competitor wireline systems, sends data via fluid and mechanical pulsing technology.

Results

Use of the Mercury EM system from Sperry Drilling Services noticeably reduced drilling time compared to wireline, cutting the average time of six days per well by the competition to just four days per well. At a conservative estimate of $50,000 per day, the resulting savings in drilling costs approaches $100,000 per well. With hundreds of wells planned for the field, savings to the operator could total millions of dollars.
**AquaStim® Water Frac Service**

**Challenge**

In shale formations, a water fracturing treatment can create issues even as it improves fracture communication. Using friction-reduced water as the fluid can leave behind trapped fluids and fracture face damage. One operator looked to Halliburton's AquaStim® service to overcome the choking effects of formation changes that were impeding hydrocarbon flow following conventional water frac treatments.

**Solution**

To increase production in this specific formation, the AquaStim service was used to design a total water fracturing treatment package combining specific additives that included: GasPerm 1000™ surfactant to remove water from the fracture face area, OptiKleen-WF™ cleanout agent and SandWedge® proppant coating for enhanced conductivity.

**Results**

The custom-designed AquaStim total water fracturing treatment package resulted in better clean-up, reduced fracture face damage and improved production with higher initial and ultimate recovery. What's more, the AquaStim treatment eliminated use of phenols, resulting in a better environmental profile.

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**QuadPack® Drill Bits**

**Challenge**

In the hard-to-drill Woodford shale in Hughes County, Oklahoma, Security DBS Drill Bits was challenged to provide a bit design that could increase penetration rate and reduce bit runs through the long intermediate section where the well plan called for a build to horizontal and a long lateral to TD.

**Solution**

To improve both penetration rate and footage drilled in this hard formation, Security DBS Drill Bits provided an 8-3/4-inch QHD39R roller-cone design. Part of the QuadPack® Plus line of premium bits, the QHD39R combines specific QuadPack bit longevity features and engineered hydraulics to produce optimum drilling performance over long bit life. In addition to larger bearing load capacities and greater seal dependability, the engineered hydraulics design in QuadPack Plus bits enables Security DBS Drill Bits to optimize hydraulic performance and drilling fluid efficiency to further enhance performance and longevity. In this case, the QHD39R provided excellent steerability while drilling 2,160 feet to successfully complete the build section at an average ROP of 22.7 feet per hour, then drilled 4,455 feet of lateral in just two runs, averaging 29-1/2 feet per hour, to TD the section at 11,914 feet.

**Results**

In this field record performance, the QHD39R QuadPack Plus bit from Security DBS Drill Bits successfully completed the entire build interval at an excellent ROP, as well as completing the lateral section in a record two runs while achieving a field record ROP of 30-1/2 feet per hour. As a result, over the interval from the start of the build section to TD, the customer realized savings of $177,310.
Chemosteering® Service

Challenge
Encountering a fault of undefined displacement after 400 meters of horizontal drilling, one operator chose LaserStrat® chemostratigraphy-while-drillingservice to help decide whether a sidetrack was warranted.

Solution
When the LaserStrat service data showed that drilling upward just five meters would position the wellbore back in the pay zone, the shallow gas well was successfully chemosteered to TD without a costly sidetrack or abandonment.

Results
Used in subsequent wells, the fault information revealed by LaserStrat service precisely guided wellbore placement which helped to double gas production in the third well.

ShaleLog® Service – Mancos Play, Raton Basin

Challenge
Over 18 months, one operator identified and began developing an exploration play for the Pierre member of the Mancos shale in the Raton Basin. The Cretaceous-aged laminated shale is found at depths of 4,000 to 6,000 feet, with gross overall thickness ranging from 2,200 to 2,800 feet. Completions to date have focused on the lowest of five intervals with commercial pay of 200 to 400 net feet, but had proved frustrating with confusing results. Halliburton was challenged to provide analysis that would bring consistency to the play.

Solution
By normalizing the logs, using neural networks to reconstruct missing log data and running ShaleLog® service for each well in the play. The result of this processing focused completion attempts to the brittle shale intervals.

Results
As a result of this successful effort, the operator has now identified approximately 1,200 risk-adjusted potential drilling locations in the Pierre Shale based on 80-acre well spacing. Wells will be tied into the extensive existing CBM infrastructure and drilled from both existing and new pads, utilizing the Company’s integrated well service model and benefiting from related drilling efficiencies.
Halliburton Shale Solutions

When it comes to unlocking shale gas, only Halliburton can supply it all - from reservoir characterization and imaging to assessment; horizontal drilling to stimulation and produced water handling. Throughout the exploration, development or decline stage of a play, one technology or technique doesn’t fit all. Even a slight variation in the application of tools or technologies can make all of the difference between an excellent or sub par performance. Halliburton offers custom solutions for any given shale play.

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