

# Whipstock Options for Sidetracking

**Historically, drillers have relied on openhole cement plugs or cased hole whipstocks for sidetracking wells. By incorporating an innovative downhole anchor with a whipstock assembly, drillers can set whipstocks in open holes without concern for cement plug integrity. Advances in whipstock and mill design are also significantly reducing the time required to initiate cased hole sidetracks.**

**Greg Bruton**  
*Chesapeake Operating, Inc.*  
*Oklahoma City, Oklahoma, USA*

**Jimmy Land**  
**David Moran**  
**Shantanu Swadi**  
*Houston, Texas, USA*

**Ryan Strachan**  
*Aberdeen, Scotland*

**Ketil Tørge**  
*Stavanger, Norway*

---

*Oilfield Review* Spring 2014: 26, no. 1.  
Copyright © 2014 Schlumberger.

For help in preparation of this article, thanks to Joshua Anderson, Aliaksei Koran, Scott LaBelle and Eric Wilshusen, Houston; James Bain, Paris; Kendall Decou, Broussard, Louisiana, USA; Aaron Miller, Oklahoma City, Oklahoma, USA; and Andrew Redden and David Stewart, Aberdeen.

i-DRILL, Runner, TrackMaster, TrackMaster CH, TrackMaster OH, TrackMaster OH-C, TrackMaster TT and WhipSim are marks of Schlumberger.

1. A drilling template is a metal guide used to drill multiple wells from a single surface location. It has multiple holes, or slots, that are used to direct the position and orientation of the conductor pipe or drillstring as the surface hole is being drilled. When production from a well is no longer profitable, the operator may choose to recover the slot by plugging the original well and sidetracking to create a new wellbore. Slot recovery operations usually involve removing a section of casing, followed by performing an openhole sidetrack or creating a casing exit using a whipstock and mill combination. For more on slot recovery: Abshire LW, Desai P, Mueller D, Paulsen WB, Robertson RDB and Solheim T: "Offshore Permanent Well Abandonment," *Oilfield Review* 24, no. 1 (Spring 2012): 42–50.
2. Fuller GA and Edwards J: "Key Factors to Consider for Sidetrack Success in Deepwater Operations Using Synthetic Based Muds," paper OTC 23663, presented at the Offshore Technology Conference, Houston, April 30–May 3, 2012.
3. Time drilling is a process requiring an extremely low rate of penetration—sometimes less than 1 m/h [3 ft/h].

When they can't engineer their way through a downhole problem, drillers sometimes sidetrack around it. Sidetracking—deviating from an existing wellbore—is performed for a variety of reasons. On rare occasions, it is accidental. In many more instances, operators sidetrack as an alternative to abandoning the surface hole when there is a need to detour around junk or unstable formations. Sometimes they sidetrack to reposition a well's bottomhole location after failing to intercept a prospective pay zone. Increasingly, however, operators rely on sidetracking as a part of their production strategy: They deliberately sidetrack from a central wellbore to drill multilateral wells, and in unconventional reservoirs, they sidetrack to drill horizontally for maximal wellbore exposure. For expensive offshore developments, sidetracking is used for slot recovery on drilling templates.<sup>1</sup>

Typically, a vertical pilot well is drilled and logged to determine where the reservoir lies, then a deviated wellbore is kicked off from the pilot hole. If the kickoff point (KOP) is in cased hole, the driller will need to set the whipstock, mill a window through the casing and drill a few feet of rathole to establish the sidetrack. After changing out the BHA, the driller extends the sidetrack using a directional assembly. If the KOP is in open hole, the whipstock is set in the open wellbore, and a directional drilling assembly can be used immediately to launch the sidetrack.

These sidetracking strategies are becoming especially important as operators venture into challenging environments—particularly in deepwater prospects that call for highly deviated

boreholes to reach multiple targets or prospects that can only be accessed by drilling through hard and abrasive rock formations. Such conditions highlight the need for consistent and reliable sidetracking technology.

Reliability may be an issue in some sidetracking operations. Traditionally, most openhole sidetracks are kicked off from a cement plug. These operations involve drilling a pilot hole and then setting a cement plug that extends several meters above and below the KOP. Once the cement has set, a directional BHA is used to kick off the well to begin drilling the sidetrack. The success of the sidetrack depends largely upon the integrity of the cement plug, which, in turn, depends on the formation's compressive strength, the quality of the cement pumped downhole and the amount of time allowed for curing the cement—often at least 24 hours.

Operators have discovered a variety of factors that may cause cement plug failure or degradation:

- Drilling fluid may contaminate the cement slurry.
  - Residual mud or oil film may prevent cement from bonding with the wellbore wall.
  - Cement volumes pumped downhole may be inadequate.
  - Insufficient time waiting on cement to cure may prevent the development of compressive strength needed to support the plug.
  - Improperly formulated cement may not set as expected or within the time allotted.
- Numerous other causes have been documented as well.<sup>2</sup>



Typically, cement integrity is ascertained by the drill bit when the operator attempts to kick off from the plug. Any failure of the cement requires the operator to start over: drill out the cement, trip out of the hole, acquire and mix a new batch of cement, set a new plug, allow it to cure and attempt another kickoff—all at substantial added cost.

Even a successful cement plug can be costly. Cement must be deployed to the rig site, mixed and then pumped downhole, where it is held under pressure while it sets up. Then the driller must trip into the hole with a bit to dress off the plug to the required depth of the KOP.

Dressing the plug requires low weight on bit and low rate of penetration (ROP). These precautions help the driller avoid sticking the bit during any unexpected encounters with green, or uncured, cement. Upon reaching the KOP, the driller trips out of the hole to pick up a directional BHA. To kick off the well, the driller must

*time drill* the first few meters to ease the well into its new trajectory.<sup>3</sup>

In addition to being time-consuming, establishing a KOP in high-pressure intervals or in highly deviated wellbores can be problematic. In deepwater environments, characterized by elevated temperature and pressure, cement strength is usually no greater than that of the formation; the bit drills out the material of least resistance—in this case, the cement, rather than the formation. In highly deviated wells, cement plugs can become elongated along the slant of the wellbore; sometimes the cement moves downhole along the low side of a deviated wellbore or spirals downward in vertical holes. In some cases, multiple cement plugs must be set before the operator obtains one that is sufficient for sidetracking.

To get around such problems, a new whipstock system has been developed. The TrackMaster OH openhole whipstock sidetracking system permits the operator to lock an anchor in place and estab-

lish a reliable KOP at the precise depth and orientation needed—often, in just one trip. Operators may take a similar approach for sidetracking out of cased hole using the TrackMaster CH cased hole whipstock system. Openhole and cased hole sidetrack examples from the US and North Sea demonstrate the reliability and accuracy of this integrated whipstock system.

#### **System Options**

Cased hole sidetracks have relied on whipstocks for several decades. The TrackMaster whipstock systems were developed to address the challenges of sidetracking in openhole and cased wellbores. The openhole system provides two options for setting the whipstock, which depend on whether the operator will need to access or isolate the interval beneath the KOP. The cased hole system is designed to mill a smooth window through the casing before drilling into the formation.



^ Sidetracking after pumping cement. With its anchor in place, the TrackMaster OH-C system permits drillers to sidetrack without having to wait for cement to cure.

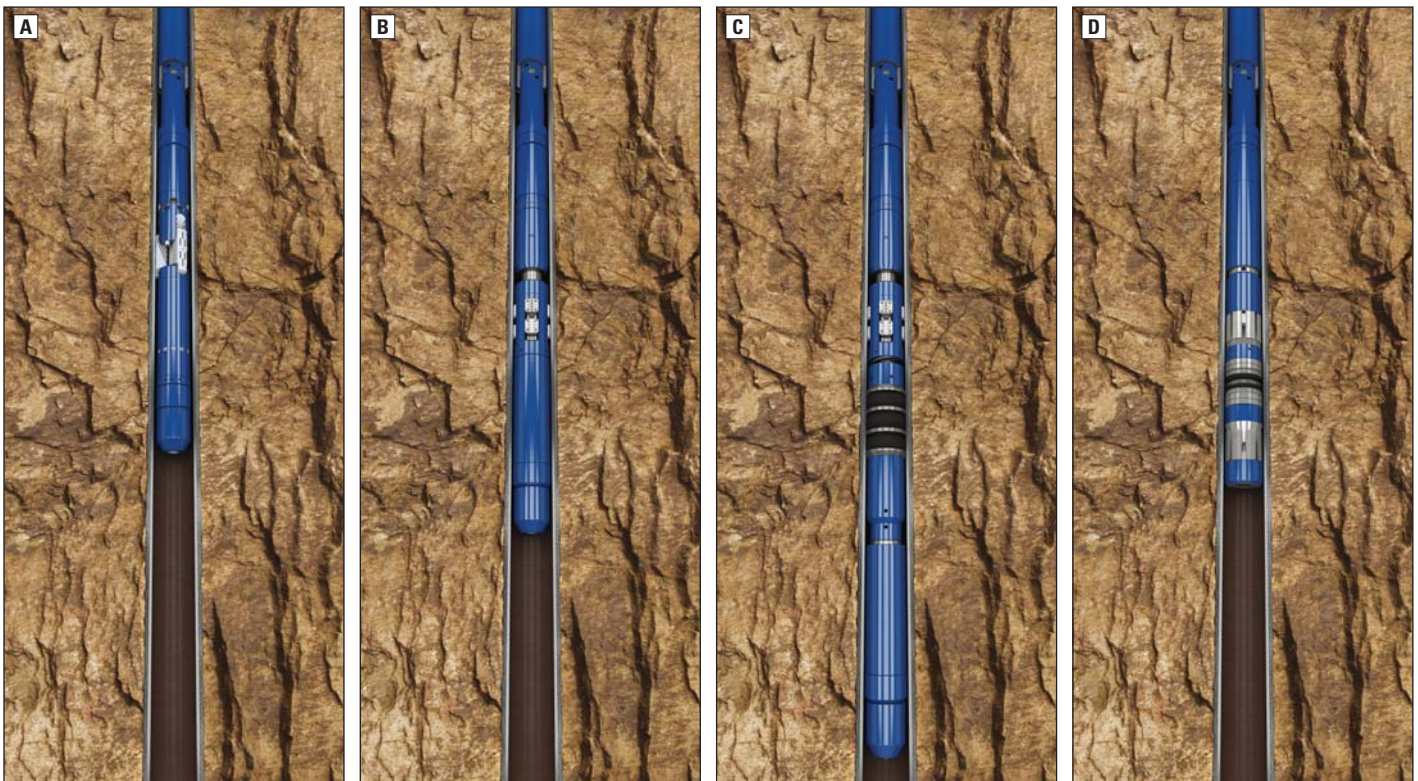
The TrackMaster OH openhole whipstock system is engineered for sidetracks in which lower-zone isolation is not required. It permits single trip sidetracking without the uncertainty associated with setting a conventional cement plug. To achieve their wellbore departure objectives, operators can

place the system anywhere in the wellbore—regardless of well profile or type of formation. This system has an internal lock to hold it in place after the anchor is set. This option provides accurate control of kickoff depth and direction while eliminating time spent waiting for the cement plug to cure.

Some openhole sidetrack applications require a cement plug to isolate the borehole beneath the KOP. In these scenarios, operators can use the TrackMaster OH-C openhole whipstock and cementing system (left). This system lets the driller set a whipstock and a cement plug beneath it in a single trip. Because the anchor holds the whipstock in place, the operator can sidetrack the well without waiting for the cement to cure.

The TrackMaster CH cased hole whipstock system is used to create full-gauge windows in high-grade steel and chrome casing (next page, left). This system can mill window exits through multiple strings of casing, then continue drilling a few meters into the formation to start the sidetrack.<sup>4</sup>

A similar system has been designed for through-tubing applications. The TrackMaster TT thru-tubing whipstock system can exit standard steel casing below the production tubing, then drill a 1- to 4.5-m [3- to 15-ft] rathole to initiate the kickoff. It is designed to pass through tubing and then anchor inside the liner to mill a window. This option can be a cost-effective alternative to pulling completion tubing from existing wells prior to sidetracking.



^ Four cased hole options for securing the whipstock. The hydraulically actuated expandable anchor (A) provides flexibility for a range of casing sizes and is used when borehole isolation with a packing element is not required. The retrievable anchor (B) is hydraulically set. The retrievable anchor with packer assembly (C) is a hydraulically set system and can be used when borehole isolation with a packing element is required. The permanent packer anchor (D) is used when an isolation barrier is required; as its name suggests, this packer is not retrievable.

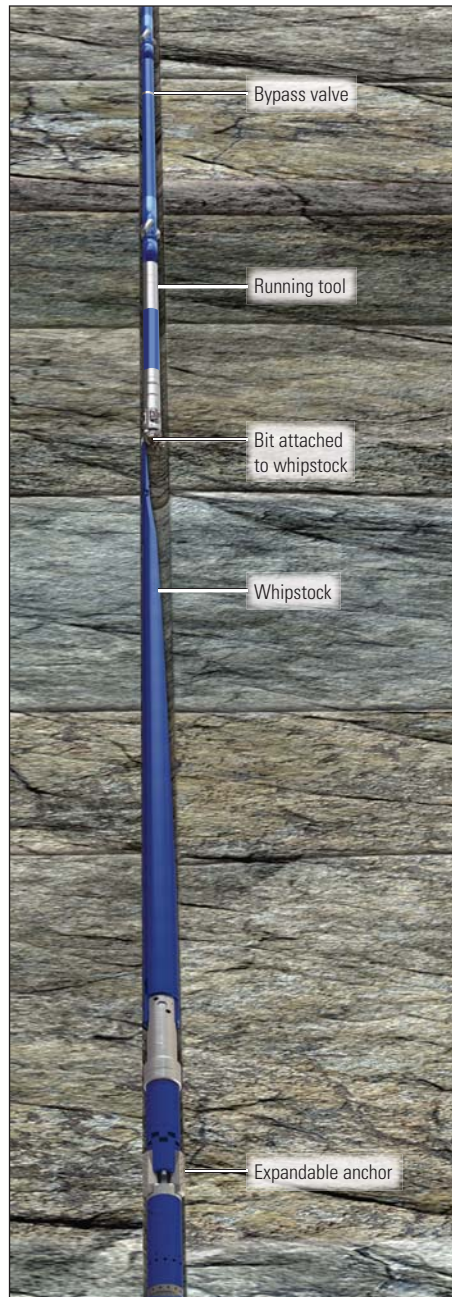


^ Milling a window. The TrackMaster CH whipstock system uses specially designed mills to create a window exit through the casing. After the last mill has passed through the casing, the mills are typically pulled, and a directional drilling assembly is run to total depth.

### Variations on a Theme

TrackMaster whipstock systems are composed of basic subassemblies with variations between openhole and cased hole models. Each subassembly is integral to the whipstock system and to the operational reliability of the sidetracking opera-

4. Typically, only a couple of meters of rathole are drilled before the mill is pulled, and a directional drilling assembly is installed to continue sidetracking operations.
5. Whipstock rotation can be caused by torque in the drillstring or by settling under gravity in response to wellbore inclination.



^ The TrackMaster OH system. This whipstock system consists of five subassemblies. These subassemblies are run in the hole as one long string, but after the anchor is set, the bit is sheared from the whipstock to enable the upper three subassemblies to act independently of the lower two.

tion. The openhole system comprises five subassemblies (above):

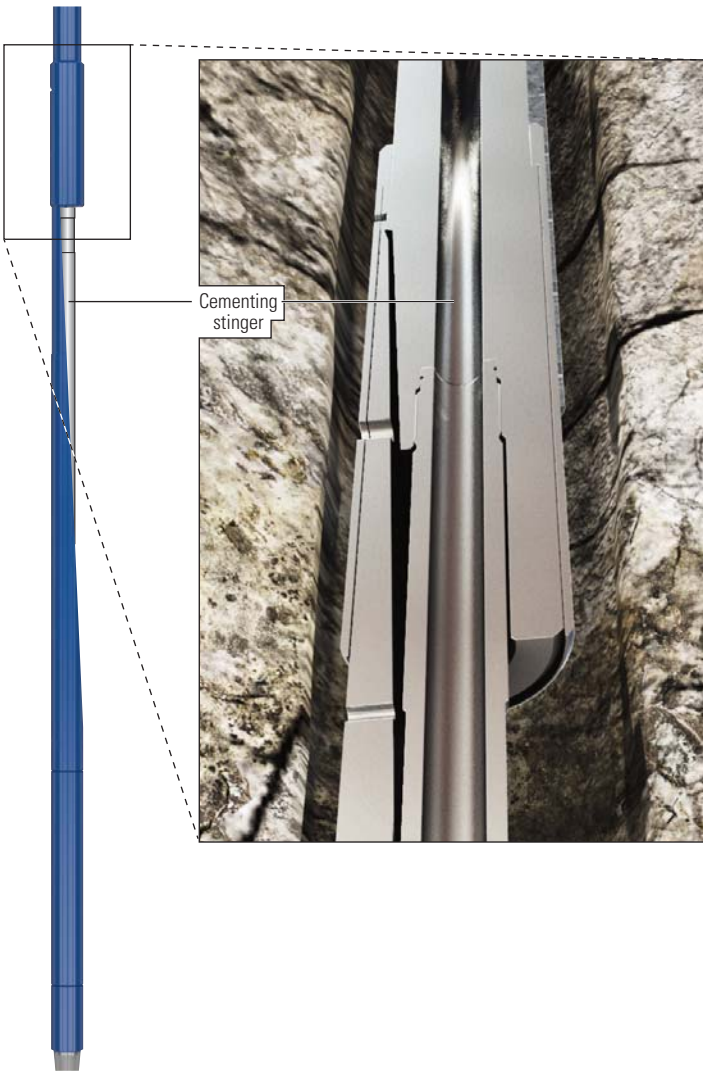
- a multicycle bypass valve to permit MWD telemetry of directional data for azimuthal orientation of the whipstock.
- a running tool to set the anchor
- a drill bit to initiate the sidetrack
- a whipstock, or steel ramp, to establish a KOP
- an anchor to hold the whipstock in place



^ Hydraulic expandable anchor. This anchor's triaxial steel slips can expand to 150% of their original outside diameter to ensure a firm hold across a range of hole sizes.

The openhole cementing system carries the above components along with a tailpipe subassembly that can be pulled out of the hole after cement is pumped. The cased hole system employs two to four mills to cut a window in casing and drill into the formation. Key features of each subassembly are discussed below.

In openhole applications, an expandable anchor secures the whipstock system in place (above). This hydraulically activated anchor, positioned below the whipstock, can be run to depth and activated in a single trip. Its three steel slips grip the borehole wall to provide centralization and resist axial load and torque.<sup>5</sup> When the anchor is activated, a mechanical locknut inside the anchor prevents unintentional retraction, which ensures maintenance of precise kickoff depth and direction. The cased hole system offers four options for securing the whipstock (previous page, bottom).

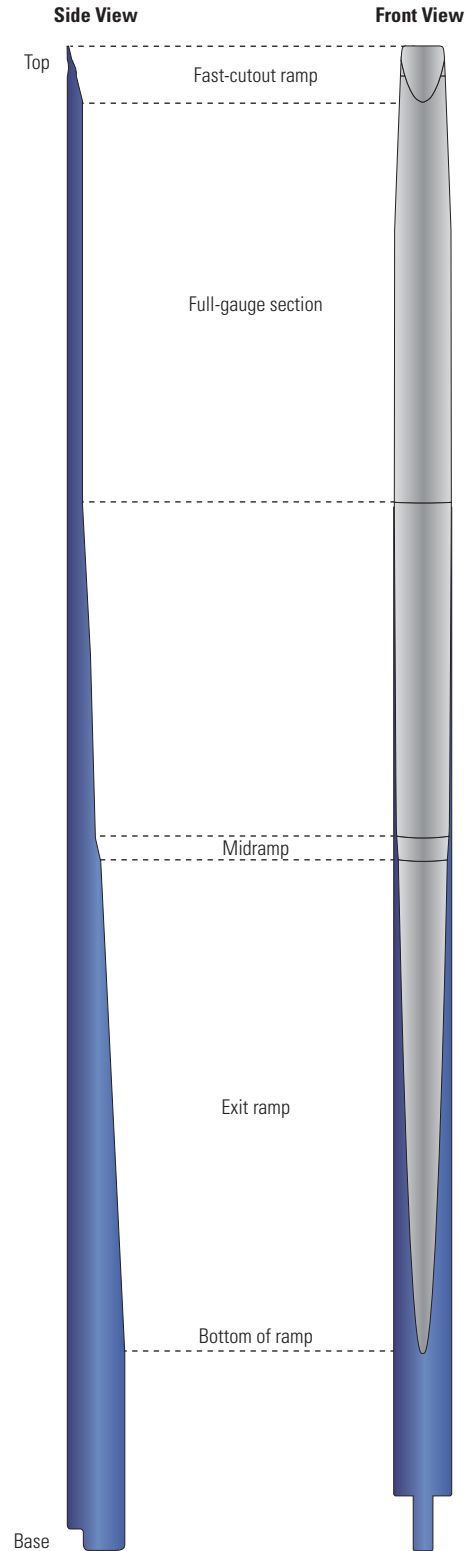


^ Whipstock with cementing conduit. The TrackMaster OH-C openhole whipstock and cementing system has a removable cementing stinger to enable pumping of cement after the whipstock anchor is set. After the cement is pumped, the stinger is pulled free of the whipstock and brought to the surface to permit further sidetracking operations.

The whipstock, a steel ramp used to deflect the bit or mill toward the wall of the wellbore, helps the driller initiate the sidetrack. As the bit or mill travels down the sloping ramp, it starts to cut against the wellbore wall. Ramp design is crucial to the performance of the bit or mill during kickoff and, ultimately, to the outcome of the sidetrack. The TrackMaster whipstock closely matches the size of the roller cone or polycrystalline diamond compact (PDC) bits to optimize bit performance during openhole kickoffs. For openhole cementing, the whipstock has a conduit to accommodate a removable cementing stinger (above). A retention collet beneath the stinger supports extended lengths of tailpipe below the anchor to enable selective placement of the

cement plug. After pumping cement, the driller pulls the stinger out of the hole and immediately trips back in the hole with a directional drilling assembly to kick off from the whipstock. In cased hole applications, the specially designed whipstock enhances cutting engagement with the casing and helps reduce dogleg severity.<sup>6</sup> This whipstock is divided into multiple segments, each defined by changes in ramp angle (right):

- The fast-cutout ramp, located at the upper portion of the whipstock, provides the deflection angle needed to initiate the casing cutout. It also cradles the mill to protect it while tripping into the hole.
- The full-gauge section of the ramp creates an elongated window, minimizing dogleg severity.



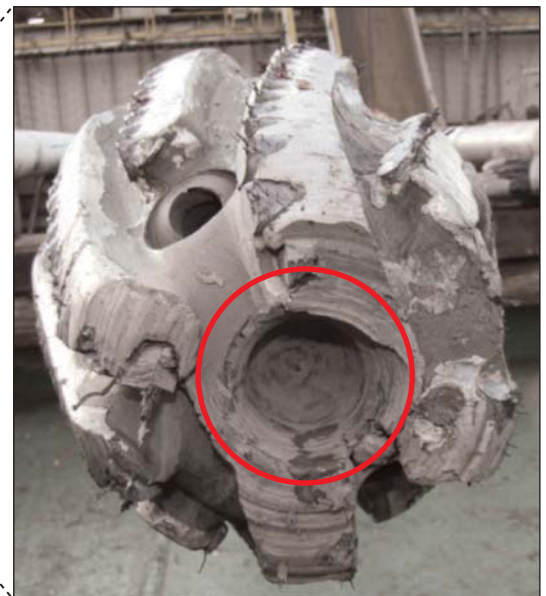
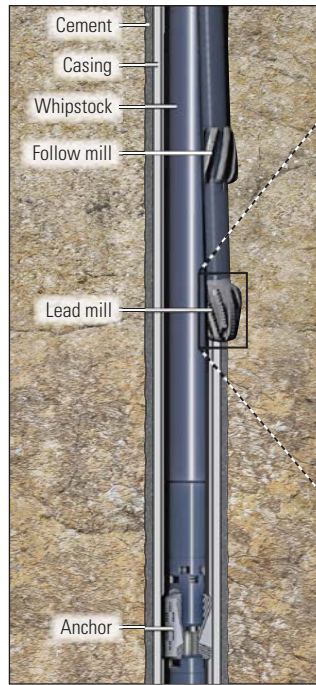
^ Whipstock ramp profile. The TrackMaster whipstock is divided into distinct segments marked by changes in ramp angle.

6. Dogleg severity, which describes deviation in a wellbore, is usually expressed in degrees per 30 m [degrees per 100 ft] of wellbore length.

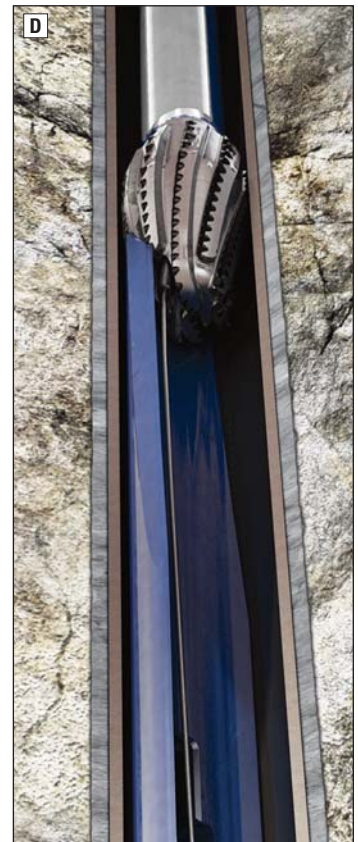
- The midramp accelerates the lateral movement of the lead mill past its center point to reduce the risk of coring the mill and to allow the mill to more fully engage the formation for facilitating completion of the window and rat-hole in one run (right).

- The exit ramp provides the necessary angle to allow the mill to reliably depart the whipstock. This section helps minimize the possibility of the mill tracking back into the original wellbore.

Drill bits or mills establish the KOP and the rat-hole beyond. The TrackMaster system can accommodate a wide range of bits and mills—from roller cone bits to PDC, tungsten carbide insert and diamond-impregnated mills (below). TrackMaster performance specialists use dynamic modeling software to help operators select the optimal bit or mill for the job. For openhole applications, the software can be used to investigate how directional assemblies such as rotary steerable systems, positive displacement motors or turbodrilling systems might affect the sidetrack.



^ Coring a mill. Mill coring occurs when the lead mill is gouged by the edge of the casing, thereby creating a hole at the center of the mill (circled, photograph). As the center of the lead mill crosses the casing wall (left), the tip of the mill can be subjected to extreme wear, which adversely affects milling efficiency.



^ Bit and mill options. The bit or mill is attached to the top of the whipstock before it is run in the hole. On an openhole assembly, the bit is attached to the whipstock by shear pins. The openhole system can accommodate PDC (A), roller cone (B) or diamond-impregnated bits (C). Cased hole mills (D) are attached to the top of the whipstock by a break bolt. After the whipstock is oriented and the anchor is set, the bit or mill is separated from the whipstock by exerting upward or downward force to shear the attachment points.

In cased hole jobs, the standard mill configuration comprises a lead, a follow and a dress mill ([below](#)). The lead mill geometry is matched to the angles on the TrackMaster whipstock to maximize cutting structure engagement with the casing while minimizing loads against the whipstock face. This arrangement directs more of the milling force into the casing than into the whipstock. Lead mills are available in a variety of cutting structures to optimize performance for a wide range of sidetracking objectives. The follow mill's function is to elongate the window. The dress mill further scours the window, ensuring that subsequent assemblies can pass through smoothly. For some jobs, the dress mill is eliminated, resulting in a bimill design.

The running tool, which is critical for positioning the whipstock, is located above the bit or mill. It consists of a fluid-filled chamber with a

floating piston to compensate for pressure changes as temperature and hydrostatic pressure increase with depth. The running tool provides clean oil or water for activating the whipstock system's hydraulic anchor or packer. Clean fluid is used to preclude contamination from cuttings, debris or mud components. These may clog the control line that supplies the hydraulic pressure essential for actuating the anchor.

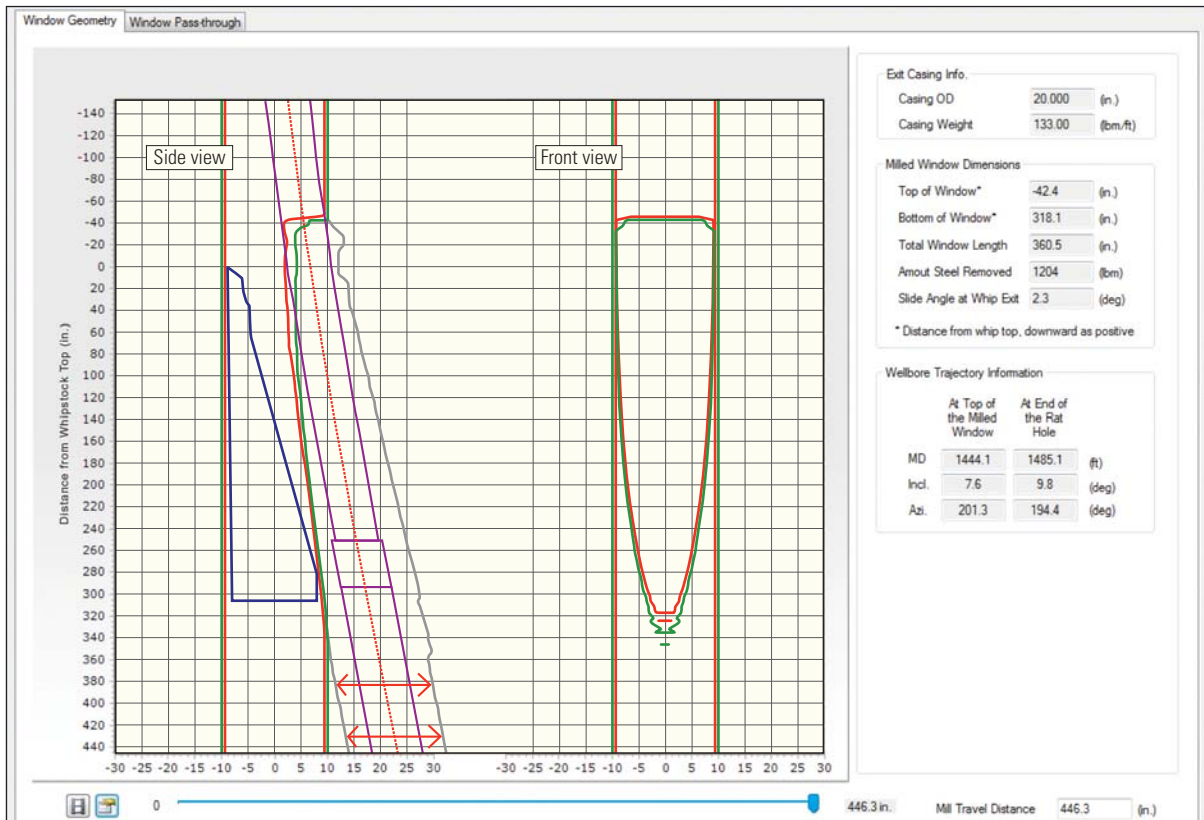
After the whipstock is run to its specified depth and oriented, surface pressure is increased to set the anchor. This pressure is transmitted across the floating piston, which travels downward as the fluid enters the anchor to drive the slips into the casing. After the anchor is set, the bit or mill is sheared off the whipstock. At that time, any clean fluid trapped between the running tool and the mill head will discharge to the

annulus, allowing the piston to bottom out. With the piston in this position, the drilling fluid can pass around it to communicate with the annulus and allow milling operations to begin.

A multicycle bypass valve permits circulation while the whipstock system trips in the hole and the whipstock is oriented. Both MWD and gyroscopic orientation operations use this valve, which allows the rig to circulate or pulse the drilling fluid before the anchor is set. Pulsing the fluid is necessary to facilitate MWD telemetry between the downhole azimuthal sensor and the surface. The valve is configured to cycle each time the pumps are turned on and permits five cycles before closing on the sixth cycle. Thus, the driller is allowed five attempts to orient the whipstock; often the whipstock is set by the second attempt. When the valve is closed, pressure is applied to set the anchor.



^ Making the grade. Every component is measured and calipered before going in the hole. Once the milling assembly is retrieved, each mill is graded for wear. The lead mill (*foreground*) is designed to initiate the cutout and mill the window as it slides down the whipstock. It also drills the rathole. The follow mill (*middle*) engages the casing and elongates the window. The dress mill (*background*) removes rough edges around the window.



^ WhipSim casing window simulation. Side and front views show casing outside diameter (green) and inside diameter (red). Multiple mills produce a window that extends 42.4 in. [108 cm] above and 318.1 in. [808 cm] below the top of the whipstock (*left*, blue) for a total opening of 360.5 in. [916 cm]. The WhipSim program models the shape of the rathole (gray) produced by the lead and follow mills and the resulting openhole diameter (red arrows). The track that the milling assembly (purple) will follow (red centerline) is also modeled. Engineers can study the progression of window and rathole development using a slider bar at the bottom (blue) to view simulation playbacks at various stages throughout the process.

### System Design and Modeling

The TrackMaster system utilizes advanced dynamic modeling for designing sidetracks to meet customer specifications. For cased hole applications, the WhipSim whipstock simulation software helps whipstock specialists model the milling operation and determine the resulting geometry of the milled window (above). It also tests the pass-through capability of directional drilling assemblies and completion strings to ensure that the size and dogleg severity of the sidetrack can accommodate the passage of production equipment.

The Runner drillstring analysis program performs prerun analysis of buckle stresses as well as torque and drag on the workstring during the wellbore departure operation. Once the job has begun, the Runner program provides real-time analysis of downhole parameters encountered for comparison with modeled parameters.

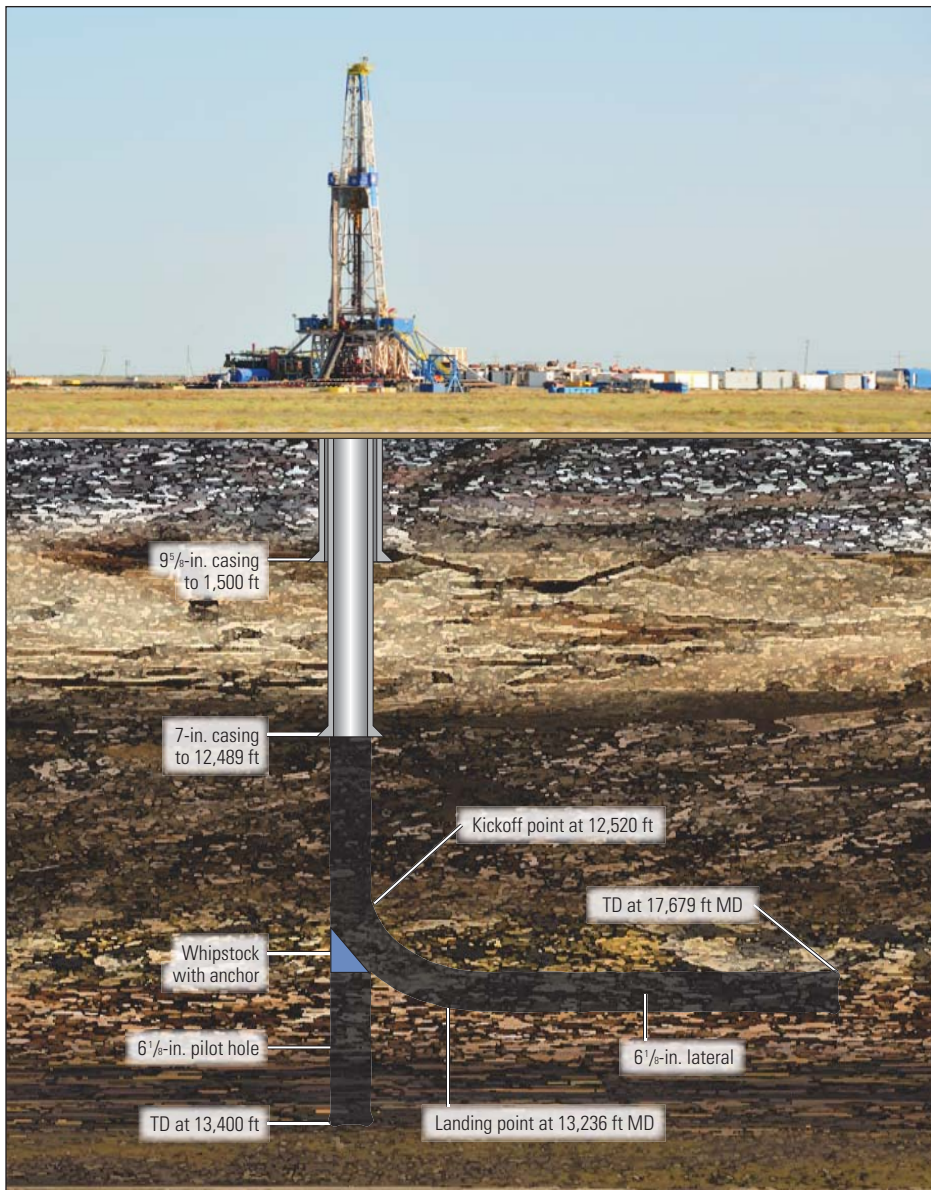
The i-DRILL engineered drilling system design process uses predictive modeling to evaluate BHA behavior. Using data from offset wells and surface and downhole measurements, the i-DRILL system creates a virtual drilling environment, allowing the specialist to evaluate the performance of various components in the BHA and then select those elements best suited to the unique conditions of each wellbore.

### Put to the Test

Among the most challenging scenarios in directional drilling is building high-angle wellbores in formations with characteristics that change quickly and erratically. The Granite Wash formation of western Oklahoma and northern Texas, USA, poses many such challenges. This formation covers nearly 500 mi<sup>2</sup> [1,300 km<sup>2</sup>] and consists of a highly variable mix of detrital sands and gravels that were derived from the ancestral Wichita-Amarillo uplift and deposited into the adjacent

basin. The formation is hard and abrasive with wide variations in mineralogy that make rock properties difficult to anticipate from one well to the next.

For decades, operators produced multiple pay zones through vertical wells; now the play is seeing an increase in the number of horizontal wells. Drilling those wells, especially while trying to build angle, can be problematic. The heterogeneous nature of this formation renders steerable drilling assembly performance unpredictable, which often forces drillers to make multiple trips to attain desired build rates. Because of the formation variability, selecting a bit on the basis of performance in adjacent wells is difficult; premature bit wear has been a common problem. The combination of poor steering performance and multiple bit trips results in unproductive time and additional equipment costs.



▲ Wellbore configuration. After drilling a pilot hole, the operator logged the well to ascertain the depth of the target horizon. A kickoff point was set at 12,520 ft [3,816 m] with a build rate of 14°/100 ft [14°/30 m] to allow the directional assembly to land at 13,236 ft [4,034 m]. (Adapted from Bruton et al, reference 7.)

Chesapeake Operating, Inc. is actively drilling in this play. For wells planned with kickoffs from pilot holes, the operator typically drilled through the desired objective and logged the well. After Chesapeake determined the target interval, the driller would set a whipstock and anchor assembly at the KOP, then pull out of the hole to run a directional drilling assembly and build the curve section to reach the landing point. Chesapeake sought to eliminate the trip required for picking up the directional assembly. The operator also wanted to establish a reliable kickoff structure and drill a curve free of additional doglegs that might hamper subsequent passage of BHAs or completion equipment.

In Beckham County, Oklahoma, Chesapeake planned to drill a 13,400-ft [4,080-m] pilot hole through the Granite Wash formation, then set a whipstock and kick off, building angle at 14°/100 ft [14°/30 m].<sup>7</sup> After landing in the targeted horizon, the operator planned to drill nearly 4,000 ft [1,220 m] to TD. The drilling program called for a single trip to set the whipstock, initiate the curve and drill as close to the landing point as possible. Upon reaching the landing point, the operator planned to pull the BHA and run a directional drilling assembly to reach TD (above). Chesapeake opted to sidetrack the well using a TrackMaster system and selected a double-bend turbodrill with

a diamond-impregnated bit to help achieve a high build rate.

After drilling the pilot hole, the drilling crew pulled out of the hole to run the whipstock system, drilling assembly and MWD tools. When the bit reached the KOP, a gyro was used to azimuthally orient the whipstock, then the driller hydraulically activated the openhole anchor. When the drilling assembly was disengaged from the whipstock, the driller kicked off the sidetrack and was able to build angle to 73° before stopping to pull the bit when ROP slowed appreciably. After drilling 600 ft [183 m], the bit had worn out—which is not unusual for sidetracking operations in the Granite Wash formation.

The driller encountered no problems while tripping out of the hole or while running back in with a new BHA. The new assembly allowed the driller to reach the planned landing point, and the well was drilled successfully to TD. The ease of tripping in and out of the hole indicated that a smooth sidetrack had been produced, relieving the operator of the need to go back and ream the hole. In addition to running the whipstock and drilling system in just one trip, Chesapeake avoided the uncertainties and associated costs of making a special trip to set a cement plug.

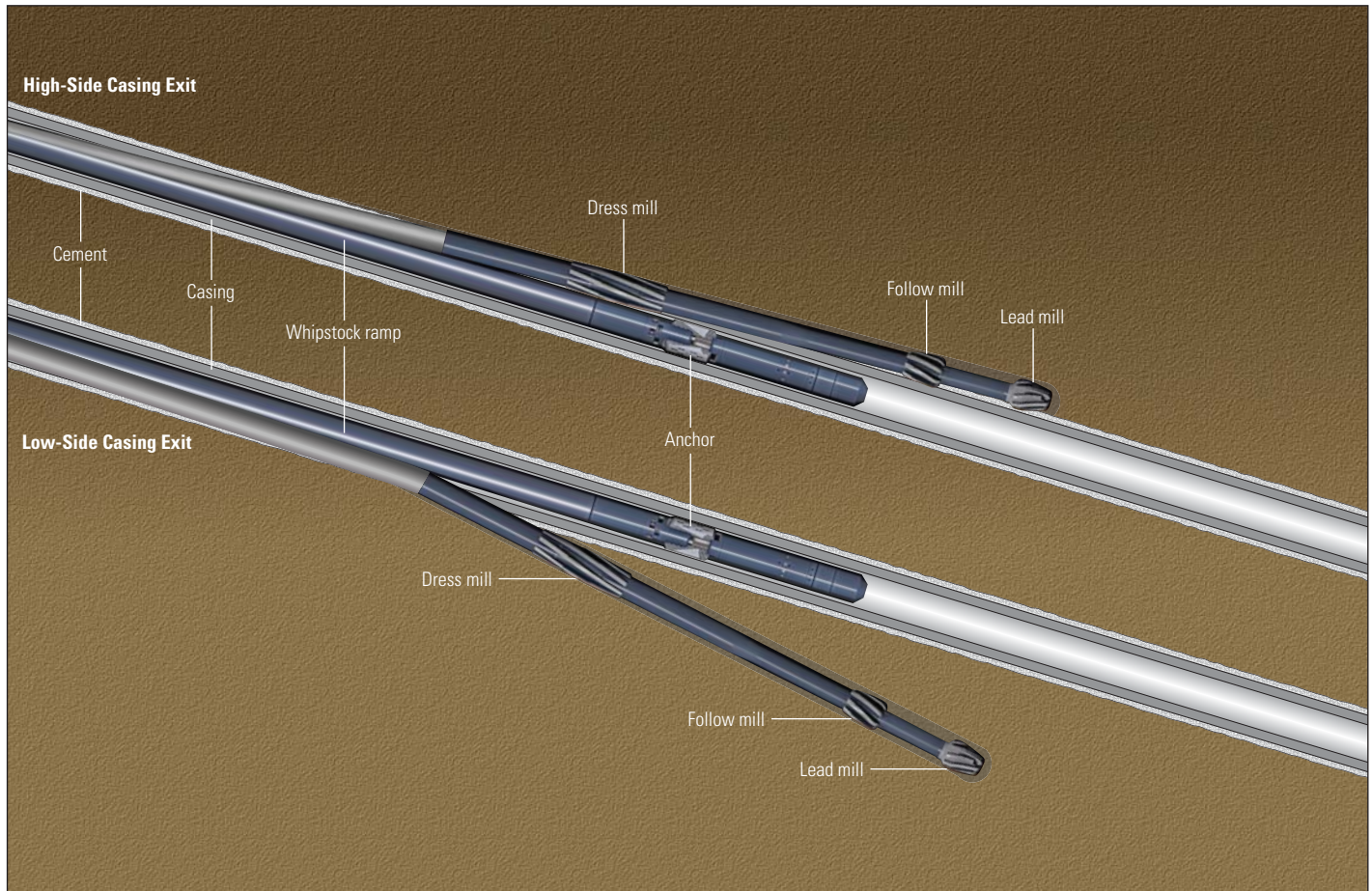
#### Sidetracks in a Mature Field

In 1970, BP discovered the Forties field, one of the largest finds in the UK North Sea. The Forties field lies about 170 km [105 mi] east of Aberdeen in 125 m [410 ft] of water. This field produces from five platforms and is estimated to contain about 397 million m<sup>3</sup> [2.5 billion bbl] of oil. When Apache Corporation acquired a majority working interest in 2003, the field was producing from 45 wells. By 2011, Apache had drilled an additional 32 wells and had mapped several new drilling targets for future development.

As the field has matured, Apache has had to pursue reserves farther from the platforms. To reach distant targets, Apache drilled high-angle wellbores sidetracked from existing wells. In the process, the operator has encountered wellbore instability challenges attributed to loss of reservoir pressure and anisotropic properties of the shale overburden.<sup>8</sup>

7. Bruton GA, Talkington J, Desai P, Swadi S and Kelley J: "Innovative Drilling System with a Built-In Kick-Off Ramp Allows Dependable Curve Building in Granite Wash Formation," paper SPE/IADC 163534, presented at the SPE/IADC Drilling Conference and Exhibition, Amsterdam, March 5–7, 2013.

8. Finlay A, Bain J, Fairweather A and Ford J: "Innovative Whipstock Technology/Procedures Successfully Complete Challenging Low-Side, Uncemented Casing Exits: UK North Sea," paper SPE 149625, presented at the SPE Deepwater Drilling and Completions Conference, Galveston, Texas, USA, June 20–21, 2012.



^ Casing exits. Wellbore angle, window orientation and formation characteristics can cause some high-side casing exits to track along the casing. Gravity works in favor of low-side exits, pulling the milling assembly away from the casing.

In the Forties field, conventional high-side casing exits were complicated by borehole instability problems outside the casing window. At the juncture between the original wellbore and the new sidetrack, drillers frequently experienced difficulties. Although many of these sidetracks showed no signs of borehole instability during the initial run to mill the casing window, during subsequent trips with a drilling assembly, the hole packed off at the window as the shale collapsed around the BHA. Efforts to free the assembly sometimes resulted in damage to the window area, forcing an additional run with a mill to dress the window. In some cases, a new sidetrack had to be drilled higher up the wellbore.

In high-inclination wellbores, high-side casing exits can pose additional problems for the driller. Often, the milling assembly will track down the existing casing, following the casing instead of the desired horizontal path (above).

This tendency gains momentum when voids in the annulus form a path of least resistance for the mill to follow.

In response to these problems, engineers proposed milling a low-side casing exit. When standard whipstock assemblies are used, even these exits can be problematic because they can close off access to the lower wellbore when the mill assembly is released from the whipstock and the whipstock drops to the low side of the wellbore. However, to offset gravitational pull, the engineers modified the assembly to exert upward force at the tip of the whipstock when the anchor is set.

The low-side casing exit mitigates the problem of the milling assembly tracking down the exterior of the casing because gravity tends to make the BHA drop angle when the lead mill drills into the formation. The low-side exit is somewhat shielded from unstable formations by the casing itself, which provides a roof over the low-side window. To date, 22 low-side windows have been milled at Forties field.

### Operator Flexibility

Recovering used drill slots, drilling multilateral wells, sidetracking around pieces of junk or drilling extended-reach wells present unique engineering challenges that can be compounded by kickoff problems. Rather than setting the whipstock only 30° right or left of the high side of a wellbore—a common practice for many whipstock services—the TrackMaster whipstock system provides the flexibility to reliably sidetrack at any orientation and at any wellbore inclination.

This capability gives operators a direct path to the target without the need to drill an oriented, high-side sidetrack. They no longer have to drill around and down to reach their target, which pays off with a reduction in drilling time. Now, instead of sidetracking around trouble, operators are sidetracking toward opportunity. —MV