

DEEP HOLE DRILLER

AN ATLAS COPCO PUBLICATION FOR THE DRILLING PROFESSIONAL — NO. 2 / 2013



Atlas Copco RD20 in North Dakota Bakken

Presetting
contractor moves
faster with RD20

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Another top hole
contractor relies
on RD20

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T4W DH works
fast and safe for
water well driller

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Atlas Copco

EDITORIAL



As 2013 concludes, Atlas Copco looks back on a successful year with a lot of changes. One of those changes has been an increased focus on the global oil and gas market. This is a market that has always been of great importance to the company, and we continue to aggressively expand our presence.

Customer interaction, training, new product development and increasing manufacturing capacity are all important factors to help us grow. We continue to improve and develop our current fleet that includes our RD20 product line as well as the newest addition to our oil and gas line: the Predator Drilling System.

Atlas Copco will be launching a CE Mark Predator in 2014, meaning it will be available across Europe. Currently, you can find Predator Drilling Systems working in the United States, Africa, and Asia. Expanding into the European market is something that we're looking forward to.

New product development is always first in mind at Atlas Copco, and it's something that we will devote great attention to in 2014. Whether it's improving our current fleet or looking into different solutions to help our customers, our engineering and marketing team has been working to better understand our target markets. They have been traveling around the world to meet our key customers and sales companies to discuss their needs and wants in the oil and gas, water well, geothermal, and exploration markets, to name a few.

There's a great opportunity to grow in the oil and gas market, and Atlas Copco will continue to offer the best products for our customers so they can meet the demands of this ever-changing market.

Matt Buttacavoli
Engineering Manager—Deep Hole

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Atlas Copco

Having what it takes

A competent workforce and reliable Atlas Copco RD20 drill rigs keep contractor competitive on the Bakken

(on the cover) Owner Craig Obermueller (left) and Joe Maguire, superintendent of Craig's Roustabout Bakken operations.

After one of Craig's bucket rigs has set steel conductor pipe (background), an RD20 moves over the hole to start the surface hole. Since this hole will be turned between three and four degrees as a collision avoidance precaution, driller Phillip Lacombe will turn operations over to a directional drilling contractor, Leam Drilling Systems, when he has finished setting things up.

Oil drilling activity in the Williston Basin has picked up where the activity of the 1970s and '80s left off. This has been made possible by advances in horizontal drilling, the evolution of enhanced oil recovery techniques and advances in equipment.

As major operators race to make up for the 30-year lull, one of the strategies they depend on involves hiring top hole contractors. These vertical drilling specialists with their truck-mounted rigs drill and case the wider, top portions of well profiles before sealing them with well heads. Conventional rigs follow behind to complete the well to total depth. This combined fleet drilling is referred to by some as the “spudder rig” method. Spudder rigs can mobilize much more quickly than conventional rigs to secure leases for the major operators.

Although work is plentiful, Craig Obermueller, owner of Craig’s Roustabout Services of Vernal, Utah, said he’s seen a few drilling contractors go home defeated. As he explained, success as a contractor in the Bakken—at least until Williston’s infrastructure catches up—seems to require self-sufficiency. “If you don’t bring what

you need with you, you won’t have it.” That means having and retaining a competent workforce and using reliable drillings machines like Craig’s six Atlas Copco RD20 III and RD20 XC rigs.

In an isolated environment

Obermueller’s company is a prime example of self-sufficiency. First, Obermueller knows what is needed because he is no stranger to the region. He lived and worked in North Dakota in the mid ‘70s during the first boom. Obermueller has returned with Craig’s Roustabout Services, which has grown since its founding in 1981 to become a provider of a wide range of services to the oil industry. They serve the intermountain region from the Dakotas west and from the northern U.S. border south to Colorado, offering services in construction, blasting, trucking, roustabout, disposal, hydro excavation services and drilling.

For surface drilling over the Bakken, Craig’s combines small bucket auger rigs to set conductor pipe with their Atlas Copco RD20 drilling rigs. Four of Craig’s RD20 rigs are range III rigs with RD20 pipe. Two are RD20 XC rigs with hydraulic elevators

for handling external upset pipe, or “bottleneck pipe.”

Three of the rigs are based out of Williston. At times Craig’s brings a fourth rig over from the Utah home office to meet surges in demand.

In the relative isolation of Williston, a 15-hour drive from the Utah office, Craig’s own technician performs almost all maintenance and repair for the rigs at the Williston headquarters located just west of the town, complete with service bays.

Since downtime sends a contractor’s clients to eager competitors, drill reliability is crucial. Obermueller said, “I just can’t say enough about these RD20s. They are that dependable.” Though he has had smaller models of other makes, he has used Atlas Copco RD20 rigs since he first expanded Craig’s drilling capabilities to bid larger, deep hole projects in 2006.

Eric Kay, general manager for Craig’s Roustabout agreed: “We’ve really had good success with them.”

Top hole efficiency

Obermueller said he is amazed at today’s well designs. “They are 20,000-foot wells—»





BIG CHANGES IN SMALL TOWN

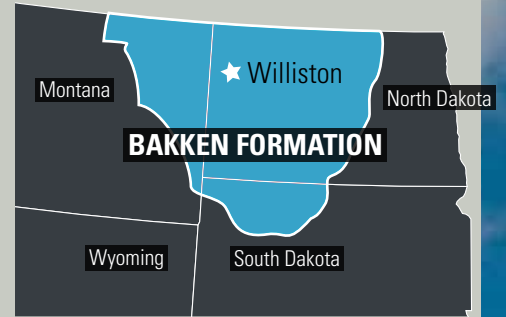
Though for the past couple years Williston, N.D., has been the talk of the U.S. oil industry, this is not actually the first boom in the Williston Basin. The 360-million-year-old Bakken and Three Forks formations below it were originally discovered in 1951. Oil produced from both is included in estimates of resources here and potential for recovery.

First developed in the 1970s, declining oil prices and the limits of recovery technology brought further development to a standstill in the early 1980s. Technological advances such as horizontal drilling, improving market prices and revised resource estimates by the U.S. Geological Survey have rekindled interest in the Bakken.

That new interest caused a flurry of activity. In 2000 Williston had a population of 12,500 and city planners worried about keeping people. Now as a bonafide boomtown, Williston is at least twice that size and growth has spilled over the state. For instance, nearby Watford City's official population is 2,500, but that doesn't include the nearly 5,000 people living in RVs and renting rooms in the city limits. More than 13,000 vehicles pass through Watford City each day between Interstate 90 and Williston.

Since the first discovery of the Williston Basin's oil potential, the U.S. Geological Survey determined that the formation extends further west and south, from Canada's southern Saskatchewan to most of western North Dakota and substantial portions of Montana and South Dakota.

Experts believe the formations here may contain around 400 billion barrels, though they do not yet agree on what percentage is recoverable. The USGS



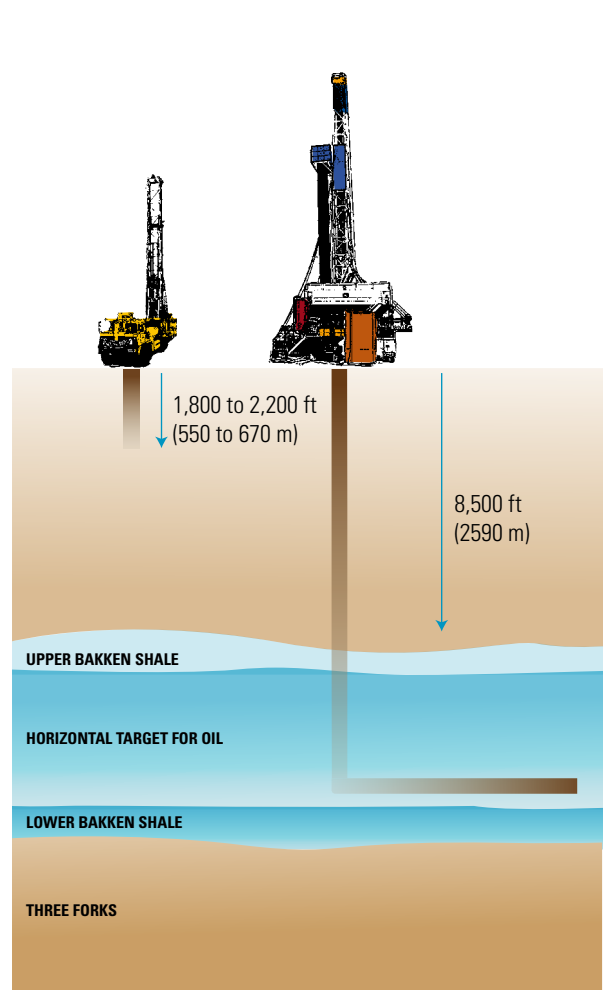
1995 estimate was only about 151 million barrels of recoverable oil. Revising its estimate five years ago due to advances in industry technology and technique, the USGS calculated that 3.0 to 4.3 billion barrels were technically recoverable—25 times more than the first estimate. In its April 10, 2008, release, the USGS wrote: "The Bakken Formation estimate is larger than all other current USGS oil assessments of the lower 48 states and is the largest 'continuous' oil accumulation ever assessed by the USGS." A continuous oil accumulation means that the oil resource is dispersed throughout a geologic formation rather than existing as discrete, localized occurrences.

In the spring of 2013 the USGS increased its estimates of the formation's technically recoverable reserve to 7.4 billion barrels, nearly 50 times more than its 1995 expectation.

Yet some geologists believe that's still too low, speculating from their own findings that the resources here may be as much as three times the current USGS estimates.



(right) Although the Atlas Copco RD20 can drill to 5,500 ft (1,675 m), it is setting up shallower holes for a conventional oil rig in the Bakken.



» and 10,000 feet of that is sideways.” Yet, Obermueller said, wells like these that used to take major operators weeks to drill might take days now.

Joe Maguire, Craig’s drilling superintendent for its Williston operations, said they’ll move pad to pad in just 13 trailer loads. That includes solids-control components, a shaker box, two 400-barrel upright fluid storage containers, a pipe trailer, their wheel loader, a skid steer and then light towers and other jobsite equipment. In North Dakota, for some of the year, that includes bumper-mounted heaters to keep them working at minus 30 degrees.

Craig’s prefers to use bucket auger rigs for preparing the rat hole and setting 14- to 20-inch conductor pipe anywhere from 60 to 80 feet deep. Then the RD20 moves in.

Straightforward drilling

Craig’s puts two crews of five on a hole working in two 12-hour shifts. One RD20 and its crews were set up on a pad to drill and case six holes 10 feet apart. Jobs in this area ranged from 1,800 to 2,220 feet. The current hole would be to 1,870 feet.

After the steel rat hole was set by the bucket auger, the RD20 moved over the hole with a bottom hole assembly that consisted of a 13 ½-inch PDC bit, short sub, 8-inch collar and 6-inch collar before the

bottleneck pipe.

Phillip La-combe, who has been with Craig’s five years now, kept rotation under 90 rpm for the first 500 feet drilled to make the straightest hole possible.

Craig’s drilling crews take great pride in just how straight their holes are. But as a precautionary measure for collision avoidance, the client specified this pad’s holes be drilled 3.5 degrees from vertical.

“We know we can drill them perfectly parallel, straight as an arrow shooting for a bulls-eye, no interference,” Kay said. “But the conventional rigs coming behind us will drill them to a kickoff at 10,000 feet. Imagine: six holes 10 feet apart for almost two miles.”

To turn this hole, though, which required a mud motor crew, Craig’s called in directional specialist Leam Drilling Systems. The Leam crew put the mud motor on with chain torque wrenches mounted on the rig.

Each hole required about 600 barrels of clear well water to drill. No additives



ERIC KAY
General Manager,
Craig’s Roustabout

were necessary. Water was reclaimed from the 480-barrel shaker box to be reused for finishing a hole. If the next pad was near enough to make transportation cost-effective and would be drilled by the same driller, the water was centrifuged and carried to the next job. If not, then the water was taken to a prepared disposal site.

Although solids retrieved from these top holes were not from the overlying layers of the landscape and not in the production zones, Craig’s was required on this property to remove cuttings to a disposal site as well.

Maguire said drilling was routine from hole to hole. Crews worked 12-hour shifts. Once they reached the bottom, they would set for an hour circulating it to flush the hole. They performed a “wiper trip” to swab the hole. Setting casing generally took one 12-hour shift. Holes on average took a day and a half to drill. Moving hole to hole took about four hours.

Craig’s Williston crews currently have steady business from their clients, and they are studying logistics that might be required to meet demand, which could include adding another rig. Whatever the future brings, Craig’s will be ready for it, having whatever it takes to endure the boom since there appears to be no bust in available work. ☉

Transcend to a higher level

Pre-setting contractor's Atlas Copco RD20 rigs do more for less cost »



The RD20 XC has a lower deck, dual breakout wrenches, slips, hydraulically actuated links and an elevator to handle oilfield pipe. The bottleneck, “externally upset” ends of oilfield pipe permit unrestricted flow of drilling fluids through joints but do not have the wrench flats of RD20 pipe.

» **D**uring a discussion of the great value that top hole specialists like Transcend Drilling of Odessa, Texas, bring to today’s major operators, Transcend’s Vice President Mark Franklin said, “Spudder services used to be the first to get cut when prices dropped, companies hoping to save money by doing it themselves. But we find that larger companies instead tend to think of the big picture. It’s about, ‘How many more barrels do I put in the tanks at the end of the day?’”

Franklin said one client could put the value in figures. “They told us we helped them develop 15 percent more wells last year—and they were able to do it at 10 percent under budget.”

Franklin believes that kind of production achievement is directly attributable to Transcend’s company philosophy and its use of Atlas Copco RD20 rigs. “We are unbeatable for our safety procedures. We are highly productive. We believe in keeping clean, reliable rigs. And I don’t think you can find a cleaner, safer, more productive rig than the Atlas Copco RD20.”

Clients trust the RD20 reputation

“We started with one RD20 III with APL (automated pipe loader),” Franklin ex-

plained. “Our client looked it over and liked it and put it to work on their leases.”

Transcend believes one of their crews may have set a drilling speed record running with the APL.

Transcend has quickly established itself as a safe, reliable top hole contractor. Last year the company set 131 wells for a total 172,000 vertical feet (52,400 m).

“Five months ago we got a second rig, planning to make it available for other customers,” Franklin said. “But our first client approached me to put it to work for them.”

Steady work for employees

Franklin said Transcend has been fortunate to find and retain employees as they have grown. “Those larger contracts for the RD20s assure our employees of steady work, which is what we’re after. We don’t want employees to worry about working one job with us, then getting stuck waiting for the next. Or about having to let them go and then trying to get them back as work comes in.”

Candidates applying to Transcend don’t have to have prior experience. In fact, Franklin said, he’s not so interested in candidates with long tenures in other types of drilling:

“I’ve been on both of our RD20s, drilling and running casing. They’re easy to operate. Anyone mechanically inclined at all can be trained to run one.”

Keith Boyd
Transcend’s Drilling Manager

“Pre-setting surface casing is different from water well and different from big rig work. It’s a whole other mindset. We’ll run round the clock if a client needs it. On the other hand, we’re not sitting on one hole for weeks and weeks at a time. We’re usually done in a day and a half and moving. We need someone who is looking ahead to



The driller keeps a steady eye on both the RD20 XC crew and pipe.

the next job even while he's finishing the job he's on."

Venture Drilling Supply's Odessa shop

Franklin has gone to Atlas Copco distributor Venture Drilling Supply to meet his supply needs for a little over four years. Venture provided Transcend with its RD20s. In 2012 Venture opened a store and service center in Odessa so that it could bring customer support directly to its West Texas customers.

Franklin said that having technical support close by has been much more convenient. The distance between the Permian Basin's headquarter cities of Odessa and Midland to the metropolitan areas of Dallas and Houston can significantly delay deliveries and service. But now what used to require overnight shipping rarely takes more than two to three hours to pick up.

Venture's Regional Manager Tyler Williams said the Odessa center provides 24/7 service and parts support that the oil fields need. Transcend is currently performing its own service and repair, looking for help only on larger projects like top drive rebuilds or rotary head work.

Daily operations

Transcend's two RD20 drill rigs are manned by four-person crews working seven days on, seven off, in 12-hour shifts. Two crews and two tool pushers per rig work 24/7, 365 days a year.

In his 30-year drilling and drill manufacturing career, Transcend's new drill-

ing manager, Keith Boyd, has worked with all sizes of drill rigs, from conventional to top-drive. He especially likes how Transcend has taken advantage of the RD20 rig's mobility. "The RD20 is easy to move and easy to maintain. Transcend mounted almost all its yard equipment on trailers, so there are fewer loads to move." Transcend has three trucks to relocate the rig in nine loads.

Boyd said, "I've been on both of our RD20s, drilling and running casing. They're easy to operate. Anyone mechanically inclined at all can be trained to run one."

Franklin described typical operations. "They can spud in one morning, drill 1,500 feet, trip out, and run casing by 9, 10 at night. If they need to work on the rig, they have until the next morning. A move takes two to three hours and then they rig up and go again, moving rigs every other day."

Rig No. 2

On this day Transcend's Rig No. 2, an Atlas Copco RD20 XC, was tripping out of a freshly drilled hole near Odessa into Rustler Formation limestone. The "XC" is a version of the RD20 designed to use externally upset pipe (also called "EU" or "bottleneck pipe") commonly found throughout the oilfields of West Texas. This was the 80th well of a 140-well contract for this client.




Such contracts assure Transcend crews of steady work.

David Rodgers, tool pusher, said the hole was drilled with an 11-inch PDC bit to 1,440 feet (427 m) using 6 1/2-inch collars on 4 1/2-inch drill pipe. Torque was steady at 2,300 with 15,000 pounds on bit turning 100 to 120 rpm. Fluid was fresh water with 10 barrels of high-viscosity sweep every third joint, Rodgers said.

The crew was drilling pre-set holes here through the sedimentary layer of West Texas red bed to the limestone at a pace of about 17 hours each. This job included 12 pads, one well on each. All holes were cased with threaded 8 5/8-inch diameter steel casing. The crew was moving to a new hole about every other day.

Preparing for anticipated demand, Franklin said Transcend has increased its workforce from just 15 people to 65 since its startup in 2011. "We are confident about the industry. We believe we'll be drilling for quite a while."

Transcend is on track to pre-set 150 wells in 2013 and hopes to top the number again in 2014. 

SAFE business, GOOD equipment

CTI's new top hole drilling division is cutting its teeth in West Texas oil fields with two Atlas Copco RD20s



Dow Bowman, general manager of CTI Energy Services' new Surface Drilling Division, said the division was established at their customers' invitation to pre-set their casing and well heads. "From the very start," he said, "our goal has been first and foremost to be a safe business founded on good people and good equipment."

That's why although CTI's surface drilling division may be new, its top management and trainers are not. They are drilling veterans like Bowman himself, who bring the experience of their long, successful careers to the startup venture. And it's also why the first rig CTI brought to the oilfields of West Texas was an Atlas Copco RD20 Range III.

Coming directly from the Marcellus Shale of Ohio, it has been retrofitted for bottleneck pipe with a partial XC conversion kit. Based on the success of that rig, when CTI added a second rig this past April it was an Atlas Copco RD20 XC.

RD20 veteran drillers among CTI's management are sharing their experience

directly with new drillers like Julian Bradley. Bowman happened to be visiting Rig 1 on Bradley's first day as driller. The CTI crew was preparing to spud in on the West Texas red bed not far from Odessa.

Bradley had served as driller's helper for several weeks but had not been in charge of the rig before. His pride in the rig was evident as he told how a CTI crew had just set a record for one of its clients. The client company hadn't had an RD20 working for them before. Bradley said, "They told us we were faster than they'd seen in their experience."

First priority, safety

Bowman said CTI's priority right now, though, is not speed. "We are willing to take more time to deal with safety. The crews are still learning. Safety is the main thing," he said. "Speed will come in time, with experience."

Bowman said, "We can't stress safety enough. All major operators insist on it. Before we pick up the first collar, we will do a pre-spud safety meeting. We will do pre-

“We are willing to take more time to deal with safety. The crews are still learning. Safety is the main thing.**”**

Dow Bowman
General Manager, CTI Energy Services

spud inspections and complete a job safety analysis."

Patience is a virtue to this general manager. "It's okay to slow down a bit in the beginning. When you have new people handling 8-inch collars and 13-inch casing, there's a lot to learn, problems to solve and personnel lessons to work on." **»**

Visiting a client's lease, CTI General Manager Dow Bowman is briefed on progress by tool pusher Carlos Lopez while the crew sets up one of CTI's Atlas Copco RD20 rigs to spud in on a top hole job.





Taking advantage of the RD20's mobility, CTI mounts all of its yard equipment and gear on trailers. A move from one pad to another takes just eight trailers and, depending on distance, can be completed in just a few hours.

» Safety is one of the main reasons they wanted Atlas Copco RD20 drill rigs. Bowman said, "They're all hydraulics. There's no rotary table, no spinning chains." Then he added, "They're also easy to move. And you can see how we keep everything trailer-mounted. We move quickly. We have our own trucks. It takes maybe eight trailer loads to move."

RD20 versatility

Bowman explained how versatile the RD20 rig was. For example, their first rig had previously been in Ohio drilling 6 1/2 inch to 7 7/8 inch-diameter primary wells for production. It was air drilling with DTH hammers, typically 4,000 to 5,000 feet deep, using RD20 pipe. "But," Bowman said, "down here in Texas, everything's bigger."

He said that although most holes the crew had drilled so far were ranging from 400 to 1,000 feet with a few deeper, they were much larger in diameter than those drilled in the Marcellus Shale. For example, one hole Bradley mentioned was 17 1/2 inches

in diameter for the full 1,600 feet. Most top hole profiles CTI has been assigned typically start with 17 1/2-inch surface holes that are drilled using tricones and mud.

For some of those holes, the rotary bit and 17-inch stabilizer are swapped for an Atlas Copco NewTech 12 1/4-inch PDC bit. Bowman said they have only just started using Atlas Copco's new PDC bits, but like them so far. The first they used was slightly too aggressive. Atlas Copco worked with CTI to reconfigure a bit specifically for CTI's use on their Permian Basin leases.

Asked about using PDC bits for larger diameter bores as well, Bowman grinned. "I don't doubt the RD20 has the power to turn a 17 1/2-inch PDC, but it would probably spin the rig around." Though there may be some technology advances coming

RD20 XC FOR OIL FIELDS

The Atlas Copco RD20 XC is specifically engineered for the oil field. It comes standard with a hydraulically actuated elevator and link kick-out system at the head.

Though both the RD20 and RD20 XC can be used for directional rotary drilling, the RD20 XC rotary head has a disk brake to assist in holding the rotary head in position while using the downhole motor to steer the bit.

The RD20 XC is rated for

120,000 pounds (54 tonnes) of pullback and can drill 2 7/8 inch to 4 1/2 inch (73 to 114 mm) OD pipe to depths of 5,500 feet (1,675 m).

The RD20 XC also has high pressure 3,000 psi mud piping and swivel.

The RD20 XC has a breakout table with two breakout wrenches for externally upset pipe. The table itself is set a foot lower to add extra clearance for handling Range III casing. And it has a slip bowl instead of a fork chuck.

in the near future that address the torque issue, CTI currently drills holes larger than 12 1/4 inches in diameter with tricones.

For making up and breaking joints, Bowman said, "The Petol chains and Scorpion Jaws are a real help."

First of many to come


On this hole, Bradley's first as driller, he would use an 11-inch diameter Atlas Copco PDC all the way to 1,700 feet. No conductor pipe was necessary at this location. In addi-

Why hire a surface hole contractor?



Venture Drilling Supply's Tyler Williams (front) visits with Julian Bradley as Bradley prepares for his first shift as RD20 operator.

tion to the PDC bit, the bottom hole assembly would consist of three 8-inch collars and two stabilizers.

The hole was to be the first of many to come for Bradley. Bowman said CTI has an aggressive five-year plan that includes adding several more RD20 drill rigs running full time. It might not be long before Bradley is himself an experienced driller, with his own understudy learning from him. In all likelihood he'll pass on the CTI legacy he learned from mentors like Bowman. Safety is first and foremost, speed is the result of experience, and mobility comes from having trailer-mounted yard equipment for a fleet of versatile, highly mobile Atlas Copco RD20 drilling rigs. 

With a career that extends from the Bakken to the Permian Basin and ranges from oil field roughneck to petroleum engineer and from PDC bit design pioneer to several highly esteemed positions in the industry, CTI co-owner Bob Iversen knows oil and gas drilling. Yet when his customers ask him about the value of hiring surface hole contractors, he doesn't ask them to take his own word for it. He lets them prove it to themselves.

Iversen provides a one-page spreadsheet whose fields the customer fills in with their own numbers. The formula is relatively simple but calculates how much annual revenue increase operators can expect from their conventional rigs with a top hole contractor pre-setting surface casing ahead of it.

Customers might believe that the additional cost of hiring CTI is more expensive, at least up front, than doing the holes with their conventional rigs. So Iversen laid out a hypothetical set of easy-to-calculate numbers to illustrate just how the revenue increase pays for the cost of a top hole contractor many times over.

For the sake of this demonstration, grant that a given conventional rig drills one well every 10 days. Grant also that two of those days are to set surface casing. When CTI drills the top hole and presets casing, it gives

the conventional rig a two-day head start on its next hole.

A conventional rig is not drilling holes every day, so for this demonstration the rig is capable of drilling 40 wells this year. When CTI partners on the 40 holes, and each well gives the conventional rig two more days to drill more holes, the rig has 80 more drilling days. With CTI presetting these holes with surface casing, the conventional now completes up to 10 additional holes for a new annual total of 50 production wells.

There is more to the formula than that, but in the first case that Iversen helped a customer calculate, an extra nine wells at the average oil price that year forecast a revenue increase of \$36 million. The cost of drilling those additional nine holes (because they still cost money to drill) combined with the cost of contracting CTI came to roughly \$6 million. That means the company's revenue increase was a net total of \$30 million per conventional rig.

Iversen said, "Depth of holes, cost of running this or that company's conventional rigs—it's all over the board down here. But I've never seen less than \$10 million in calculated revenue increase per rig per year by hiring a surface hole contractor in the Permian Basin."

Bio

Bob Iversen began his oil drilling career as a roughneck working in eastern Montana during the boom of the Williston Basin in the 1970s. He knew this was the business for him. He attended the Montana School of Mineral Science and Technology in Butte, earning a degree in petroleum engineering. Taking a job with Christensen Diamond Products, he was made product manager of the first polycrystalline diamond compact bits (PDC). A string of company acquisitions and mergers eventually led to a position with Baker Hughes as senior vice president of technology.

In 1994 Iversen accepted the challenge to revamp a U.S.-based bit design and manufacturing company. The company, Diamond Products International, and what Iversen calls "a great team of people" prospered under his direction and was eventually purchased 12 years later by National Oilwell Varco.

Three years ago Iversen partnered with Charles Thompson and Jeremy Corr to form CTI Energy Services. A rat hole drilling company initially, last spring CTI took up a client's invitation to provide surface drilling services as well.

Since Iversen believes intelligent company leadership can only come from management when managers have experienced the business at every level firsthand, he joined those who sleep with the rigs at the pad. "I'd never worked around rigs like Atlas Copco RD20s. I had to go out there, get dirty, understand the guys' dilemmas, spend a couple 12-hour shifts with the roughnecks."

Atlas Copco values the hands-on expertise. Atlas Copco engineers have welcomed Iversen's insights in their work to configure exactly the right solution for CTI and its customers in the field, both on the rig and in the hole.

Hammering out the curve

First-of-its-kind directional air drilling system cuts unconventional oil drilling time, costs in half

The quest for cost-effective directional drilling tools for unconventional oil has finally produced a reliable system for the job. It didn't require new technology, just modifications on existing, proven tools and the persistence of directional drilling experts dedicated to turning the corner with percussion.

Air drilling expert Tom Weller described the benefits of the new bottom hole assembly (BHA): "Even on our worst day, we're two times faster than rotary and saving \$100 a drill foot."

The breakthrough percussion drilling technique was developed from Atlas Copco Secoroc TD 90 hammers and jet subs, as well

Weller's interest in air began in the 1980s in the Appalachian Basin before he left on a career that took him around the world. Upon returning to the United States to work in the Marcellus Shale in the spring of 2011, he discovered that the progressive trend toward air drilling in the U.S. had stalled out. In some places where air had been introduced, companies had gone back to tricones.

Weller said, "I believe 20 percent or more of oil drilling in the U.S. should be done with air, but when I came back I was only seeing 5 to 10 percent."

He also noted that down-the-hole drilling was still vertical, in comparatively shallow holes. Weller's vision was to create a faster, better drilling technique through the use of DTH hammers capable of directional drilling. Although some companies were already successful steering rotary tools on air, Weller said, "I knew we could do much better with percussion."

Keystone Drilling sales representative Ed Teel coordinates support for drilling companies throughout the Marcellus region from Keystone's Wycoc, Pa., center. The center keeps Atlas Copco Secoroc bits and hammers on hand and has a maintenance and repair shop that provides 24/7 service.

Teel said he first met Weller on site at a drill pad. "He asked me about air applications that were beyond me. He has all this experience with air from all over the world. So I told him he should contact Jeff White."

An air motor looks the same as a mud motor. This job used a bend of 1.25 degrees.

Jeff White is an Atlas Copco down-the-hole tools specialist for oil and gas. When the two met, it was flint meeting steel. Weller said, “Jeff was a man after my own heart. I knew right here I had found an ear, and I didn’t want to use anyone else.”

Weller credited White, who has an engineering background, with working out the air hydraulics for the system. White said the answer was simple, but “it just needed a champion like Tom Weller.”

White and Weller believed pneumatic direction tools would drill holes more than twice as fast and at half the cost of rotary. Together they developed the patented solution that’s turning hammer drilling on its side.

Simple solution

White said, “I thought we could make modifications to existing Atlas Copco Secoroc technology.” The ability to turn would be provided by an air-driven motor.

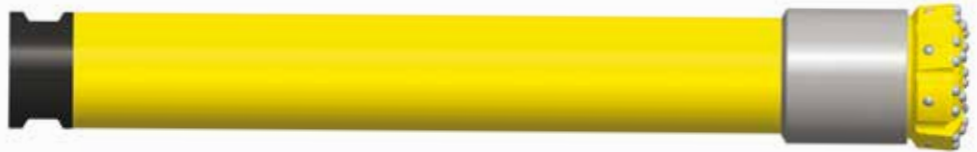
“Atlas Copco already had jet subs to handle the air. We have the Hydrocyclone to handle fluid. We have EDGE to monitor performance. All we needed were a few changes to the hammer.” White said a side benefit of using modified technology rather than inventing technology is the ability to use existing complementary products such as fluids, foams and Hydrocyclone. “We have something for every situation.”

The successful hammer candidate was an off-the-shelf 8 ½-inch Atlas Copco Secoroc TD 90 pneumatic hammer. The modified version has been renamed the TD 90 DT for “TD 90 Directional Tool.”

White said air flow issues came primarily from the need to put far more air in the hole to clear out cuttings than was necessary to run the hammer. Atlas Copco jet subs were a key component of the solution, diverting a significant portion of the 3,000 cfm airflow from the drill string before it reached the hammer, strategically spacing the subs to move cuttings up the annulus. The other part of the solution was fine-tuning the hammer’s blow-down sequence. Together the solutions provided sufficient air for evacuating cuttings without overworking the hammer.

Vibration and lateral loading were other obstacles to overcome. Weller said putting a hammer on its side raises G-forces “by about two orders of magnitude,” or 100 times greater than vertical operation.

Once the formula for the blow down sequence proved itself in the TD 90 DT, directional drilling success spread across the entire Atlas Copco Secoroc range of hammers. Deep hole version offerings include the QLX 100 DT, QL 120 DT and QL 60 HF HC.



TD 90

Other components that make directional air drilling with Atlas Copco work

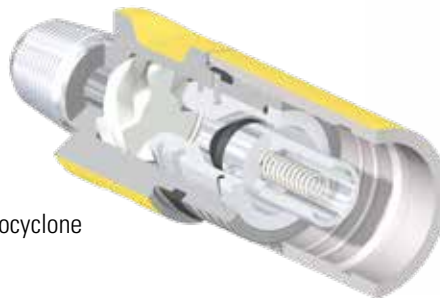
Jet sub



Edge drill monitoring system



Hydrocyclone



One of the solutions seemed at first counter-intuitive: Weller had the shock sub removed. He said it was making vibration worse and obscuring communications with monitoring systems. “The shock sub was actually causing excessive shocks,” Weller said. He added that by not having to rent it, they would realize a savings of a half million dollars a year.

To increase the radius of turns, the additional length of adding a hammer was accommodated by shortening the mud motor’s driveshaft.

Josh Marcus, Senior DTH product specialist at Atlas Copco Secoroc, said that the over-rotation of the motor when the hammer was lifted off bottom also had to be addressed. From an engineering standpoint, he

» said, the solution was quite simple. The key was to make sure the hammer used the same air while it was off bottom as it did when it was cycling on the bottom.

Once the formula for the blow down sequence proved itself in the TD 90 DT, directional drilling capability spread across the entire Atlas Copco Secoroc range of hammers. Deep hole offerings now include the QLX 100 DT, QL 120 DT and QL 60 HF HC.

Up to 15 times faster

The first wells were drilled to 7,000 feet (2,130 m), 20 feet apart, at 15 degrees for collision avoidance measures. With the modified BHA and a new Atlas Copco 8 3/4-inch bit configured especially for this application, the entire 7,000 feet of hole length to the kick off in the sandstone cap could be drilled without tripping out.

“We had been tripping out three times a hole,” Weller said, “with connections every 30 feet. It took up to 11 hours per trip.”

The new bits make a difference. “We used to use three bits per hole. We get two holes per bit now.” He said penetration rates are now up to 15 times faster.

Weller said it’s still a learning process, and changing to new personnel after the winter furlough slowed the process’s



JEFF WHITE
Atlas Copco down-the-hole tools specialist

Jeff White said the technique in some locations has been up to 15 times faster, but a reasonable expectation is anywhere from two to five times faster. Here rotary drilling had been progressing at 40 to 50 feet per hour. Percussive drilling had to be held back to 300 feet per hour out of concern the assembly would outpace the operator’s ability to keep weight on bit.

evolution. “This is not written down. Each crew has to be taught. Drilling this way is as much art and touch as it is science in development.”

Two of the things the crews have learned are to clean the hole and “don’t break stuff,” Weller said. “Drilling at a 25 to 30 degree angle in a dirty hole can be a problem.”

Weller said the rest is learning to slow down. “We’re at 26 rpm on the bit. We were at 60 rpm but were experiencing motor failure. It’s important to get the hammer, motor and jet sub working together to flush the hole and turn the corner. When we reduced pressure, we doubled the rate of drilling on this hole.”

Each hole unique

On this day Weller’s crew was building the curve near Tunkhannock, Penn. Target depth for the top drive rig was 7,400 feet. A conventional rig would complete the hole to 16,500 feet total depth.

This hole required an 8-inch, 1.25 degree fixed motor with a 12-inch hammer. Air was first supplied by three compressors and a booster, adding a fourth compressor nearer the bottom. Air was controlled by throttling the booster up or down. At 3,880 feet the flow was 2,600 cfm at 150 psi. Standpipe pressure was 425 psi. By 7,000 feet, Weller said, air flow would be 3,400 cfm.

One-third of the air was leaving the jet sub before the hammer, and a jet sub was

set in the drill string 130 feet off the bottom to help with evacuation.

The hole was angled at 5 degrees to 1,683 feet (513 m) and then turned 26 degrees to 3,400 feet (1,036). The hole was kept at 26 degrees through 6,400 feet with the oiler injecting 3.5 gph, every third joint receiving an extra half gallon to keep the inclined hammer sufficiently lubricated.

White said the technique in some locations has been up to 15 times faster, but a more reasonable expectation is anywhere from two to five times faster. In this location rotary drilling had been progressing at about 40 to 50 feet per hour. Percussive drilling in the same area had to be held back to 300 feet per hour out of concern the assembly would outpace the operator’s ability to keep weight on bit.

Weller said the number of days to drill 12,000-foot (3,658 m) holes start to finish have been cut from the upper twenties to 13 or less through the use of top hole rigs. These “spudder rigs” start the hole and build the curve out to the 7,000-foot kickoff in as little as six days. Weller estimated that directional hammer drilling is now saving the company “half the days and more than half the cost” of rotary. “Save days, dollars follow.”

For White, the directional hammer system is the fulfillment of a dream that just needed the right people to make it come to life: “Every person who’s seen it, without exception, admires it for its simplicity. Simplicity is the beauty of it.”



ED TEEL
Keystone Drilling sales representative

Drilling at the *speed* of air

Pneumatic hammer drilling faster and more economical than mud drilling

Josh Marcus, senior product specialist of Atlas Copco Secoroc down-hole tools, said pneumatic hammer drilling gives drillers an advantage in all but the most extremely soft ground conditions. And when weighted drilling fluid is not required to control the formations, hammer drilling should be the favored technique.

Tom Weller is one of the industry's leading proponents of pneumatic drilling. Not only does Weller prefer it for carrier-mounted top drive rigs doing surface work, he also takes advantage of its cost-reducing speed on conventional rigs.

"A conventional triple drill rig is great for drilling with the QL 120 hammer," Weller said. "Hydraulics give perfect control on the break. You can control it with fast reaction to weight on bit. Maintains a constant feed rate."

Weller was working as a drilling superintendent for an unconventional oil and gas development company at an Ohio pad that required 10 top holes. Using an Atlas Copco Secoroc QL 120 hammer to drill 12 1/4-inch-diameter holes, the rate of penetration exceeded 400 feet (122 m) an hour. Weller said, "We were flying along. In just over 16 hours we drilled 2,550 feet (777 m)."

Weller said the instantaneous ROP read up to 600 feet (183 m) an hour at times. »



» They would pull back for cutting management. “To drill this fast you have to know the formation.”

Pushing the hammer in an abrasive formation could cause premature failure of the bit. Here they were drilling through Onondaga limestone and then a big seam of Oriskany sandstone at 4,100 feet (1,250 m). After that they passed through hard Clinton sedimentary rock before the Queenston shale beds to the resource layers.

The well profile and casing changes were engineered to the formation. After setting 30-inch conductor casing to 100 feet, drill crews isolated the fresh water zone with a 24-inch hole to 500 feet cased with 18 ³/₈-pipe.

From there the well profile narrowed to a 17 ¹/₂-inch hole to 1,500 feet cased with 13 ³/₈ pipe, continuing the next 4,700 feet (1,432 m) to the kickoff with a 12 ¹/₄-inch hole and 5 ¹/₂-inch pipe.

The drilling crew vertical-drilled the hole all the way to its 6,200-foot (1,890 m) kickoff point solely with the QL 120. Drilling with air controlled the formation’s water, using flow rates of up to 6,700 cfm with pressures up to 440 psi.

The drill string consisted of 5-inch drill pipe, nine 6 ¹/₂-inch collars, and an Atlas Copco 12 ¹/₄-inch carbide button bit. Weight on bit was from 8,000 to 15,000 pounds. Rotation was 25 rpm.

To complete the well for production, drilling crews fluid-drilled through the oil-producing formation after the kickoff point with an 8 ¹/₂-inch PDC bit to a total depth of 14,859 feet (4,530 m) cased with 5 ¹/₂-inch pipe.

The drill was penetrating so fast it produced 20 tons of cuttings an hour more than rotary had. It took seven people to manage cuttings instead of the usual four.

Total cost of the hole was calculated to split equally, about half for the vertical and half for the lateral. In general, the longer the lateral, the more expensive the hole’s overall cost per foot.

By comparison, mud drilling would have progressed at 400 to 800 feet per day. Pneumatic hammer drilling had been averaging 2,000 feet or more per day.

The final cost analysis includes the operational cost, mostly fuel. For fluid drilling the rig consumes about 1,500 gallons of fuel per day. On air it only uses 400 gallons. Even including fuel used by eight compressors and their generators, with a combined fuel use of 3,680 gallons a day, air cut overall drilling costs in half. ⦿



TOM WELLER
Drilling expert



Drilling blind

Yet their Atlas Copco
T4W DH 'does what
they need it to' »



Tyler Williams of Venture Drilling Supply (at left) talks to THI tool pusher Richard Evans as the company's new Atlas Copco T4W DH rig spuds in to drill a water well for a client with an eight-well lease on Texas University Lands.



THI, ESCO Leasing LLC's water well division, encountered such profound voids at one of their customer's oil leases that most often circulation was completely lost after the first 300 to 400 feet. THI simply switched its new Atlas Copco T4W DH deep hole rig from rotary air to fluid drilling with clear water to complete 900-foot wells to total depth in a single shift. Carrier-mounted top head rigs like the T4W DH increase both safety and productivity for the water well contractor in the West Texas oil fields.

Seeing no sign of cuttings or fluid while steadily pumping 200 gallons a minute down the hole is sure to tighten the chest of most water well drillers. But for THI drilling crews working the void-filled sedimentary deposits above Santa Rosa sandstone on this lease, loss of circulation is routine.

One of the two drill rigs THI brought to a recent job was its Atlas Copco T4W DH rig. The T4W DH is the deep hole version of the T4W water well drill rigs. Deep hole capability is made possible by 70,000 pounds of pullback—20,000 pounds more than the standard T4W.

THI is the water well division of ESCO Leasing LLC, whose headquarters are in Bowie, Texas, with additional offices in Godley, Mineral Wells, San Angelo, Sweetwater and Palestine. THI had been contracted by their client operator to drill eight water wells, one to a pad placed roughly 1,200 feet (366 m) apart on a lease in the University Lands of West Texas.

Wes Spruiell manages the THI water well program. His career precedes today's widespread use of top head drive drill rigs. While he has an appreciation for what good kelly rig crews can do, he conceded the increased safety that comes from a top drive rig like the T4W DH. "Fewer moving parts.



Tyler Williams (right) asks Richard Evans how the holes are going with the Atlas Copco T4W DH. Evans says they will drill to 900 feet total depth and case the hole in a single shift.

Much safer rigs. Our accident rates are really low using top drive rigs.”

Safety means a lot in this industry. Spruiell said, “Major operators really look you over. They will compare your man hours to your accident record. Too many accidents, you’re out.”

Spudding in

Setting up on the pad didn’t take long. As the T4W DH rigged up, four 360-barrel water hoppers were lined up left of its pipe trailer. A mud puppy at its right side was joined by a trailer-mounted water pump.

THI tool pusher Richard Evans said they were lucky on this pad: “Most of the time there are rocks big as our truck that we have to start on, but this pad is nice and flat.”

Driller Clifton Beaty spudded in by first drilling with a 12 ¼-inch PDC bit slow and steady, to serve as the pilot hole for a 14 ¾-inch reamer. Then the four-man crew installed a 10-foot length of 14 ¼-inch conductor pipe.

Next a 12 ¼-inch well bore was drilled with a PDC bit to 900-foot total depth using a combination of air and mud. “We started the hole with air, misting maybe three gallons a minute with four to five buckets of soap to help raise cuttings,” he said. »

ABOUT THE UNIVERSITY LANDS

The current 2.3 million acres of University Lands in West Texas were formed from state land dedicated to a Permanent University Fund. The fund was established in 1876 by the Constitution of the State of Texas to generate revenue for higher education. A portion of revenue generated by leasing the land for private use is distributed to the University of Texas System and Texas A&M University System by the state’s Available University Fund (AUF).

The Lands originally generated revenue through grazing leases. Oil was discovered on the property in 1901. Since the mid-1920s the greater part of the funding has come from oil and gas leases, though some of the overall revenue is generated through sulfur and mineral leases, water royalties and other investments.

The two public universities and their associated institutions have benefitted from the AUF leases, but there is a second benefit. Drilling activity on the University Lands is highly regulated and closely monitored, which makes them a living laboratory where the safest and most ecological practices in the drilling industry can be applied, studied and perfected.



About 80 percent of the wells drilled in this part of the University Lands will lose circulation somewhere after 300 feet. THI drills with PDCs on air, misting three gallons a minute until that point. Then they will switch to 200 gallons of clear water per minute, none of which they’ll see return.

» “But then we lost circulation at 300 feet (91 m) and changed over to water, pumping 200 gallons (760 L) a minute—and we don’t get to recover any of that.”

Takes water to get water

Each of the four hoppers held four 90-barrel tanker loads of water. By the end of drilling, seven more tankers returned to add water to the hoppers. In all, the 23 tanker loads brought nearly 114,000 gallons (432,000 L) of water to complete the well to total depth.

Evans said they found that about 80 percent of the holes in this part of the University Lands must be drilled “blind.” Drillers tune drill performance without the benefit of seeing fluids or cuttings.

But, Evans said, in the horizontal beds of mudstone and siltstone overlying the sandstone here, it wasn’t too much of a problem. “We do take our time with the conductor pipe. We go slow, precision-setting that,” he said. “But then when we start drilling the well, we don’t hold back. We’ll drill a 25-foot stick in 10 minutes or so. Six sticks, or 150 feet (46 m) an hour.”

Well a week

Holes were drilled to depth so quickly with the T4W DH that they usually didn’t need to run at night. “It runs fast enough that it does what we need it to do during daylight hours,” Evans said.

THI does the complete well job, “the whole shootin’ match,” he said. The crews can finish, on average, about one well a week. This includes drilling, casing, grouting and setting the pump. For this well the crew set 21-foot (6.4 m) length of 0.020- to 0.022-inch (0.5 to 0.56 mm), pipe-based, stainless steel screen on 6 5/8-inch (168 mm) steel casing.

One of THI’s other water well rigs, an Atlas Copco TH60, joined them on this eight-well project, completing the entire job in just four weeks. ●

T4W DH

With matched integrated components on both the 50,000 lb (22,700 kg) and 70,000 lb (31,000 kg) versions of the T4W drill rig’s twin cylinder, chain feeds are rated at actual pull-back capacity. Fast and slow feed functions provide precise control of bit weight and penetration rate. The feed system optimizes performance and helps control drilling cost.

The single motor worm-gear head is rugged and compact for down-the-hole (DTH) drilling with air and foam. Its floating spindle absorbs drilling shocks and is easy on threaded connections. The powerful spur-gear head provides more torque and speed for rotary air and mud drilling, as well as DTH drilling. It is the multi-purpose workhorse for deeper or larger diameter holes. Both rotary heads feature torque limit control to pre-set the maximum torque output of the rotary head. For making up tool joints or threading casing together, the driller can torque up to the required specification every time.



The T4W and T4W DH use a conservative power factor so the drill performs at peak efficiency while maintaining an adequate power reserve. The diesel deck engine, compressor and hydraulic pumps are all mounted on a separate power pack frame. The frame is cushion-mounted directly to the main frame of the carrier, which helps maintain critical alignment of power components to assure long life.

The T4W’s efficient power pack design directly couples the compressor to the engine, assuring alignment and minimal power loss. The hydraulic pump-drive box connects to the opposite end of the engine, allowing for flexibility of power components while maintaining power efficiency.

T4W GENERAL SPECIFICATIONS		
CARRIER	FEED SYSTEM	
STANDARD CHASSIS: 6 X 4 Custom, 203" (5.2 m) wheelbase	HEAVY DUTY CHAIN	
ENGINE: CAT C-13, 380 hp (283 kW), 50-state engine	PULLDOWN: 30000 lbf (133 kN)	
OPTIONAL CHASSIS: 6 X 6 all-wheel drive	PULLBACK: 50000 lbf (122 kN)	
8 X 4 twin steer	OPTIONAL PULLBACK	
Polished aluminum wheels, air conditioning	W/ REGEN: 70000 lbf (311 kN)	
	DRILL FEED RATE: 11 fpm (3.4 m/min)	
	FAST FEED RATE: Up 110 fpm (33.5 m/min)	
	FAST FEED RATE: Down 70 fpm (21.3 m/min)	
DERRICK	ROTARY HEAD	
DIMENSIONS: 33' 3" X 46" X 33" (10.1 m X 1.2 m X 0.8 m)	STANDARD WORM GEAR:	
	Torque at 0-109 rpm 5983 lbf-ft (8.1 kNm)	
	OPTIONAL WORM GEAR:	
	Torque at 0-110 rpm 8000 lbf-ft (10.8 kNm)	
SWIVEL AND PIPING	JIB HOIST/CASING HOIST	
RATED FOR 350 psi (24 bar) OPERATION	LIFTING CAPACITY (STANDARD): 1250 lb (567 kg)	
SWIVEL I.D.: 2" (5.08 cm)	OPTIONAL: 2500 lb (1134 kg)	
PIPING I.D.: 2" (5.08 cm)	LINE SPEED: 70 fpm (21.3 m/min)	
	8000 lb CASING HOIST: 80 fpm (24.3 m/min)	
POWERPACK SELECTIONS	CUMMINS ENGINES	
COMPRESSORS	QSX-15-C: 600 hp (447 kW) at 1800 rpm	
170 cfm@350 psi (30.3 m ³ /min@24 bar)	QSK-19C: 700 hp (522 kW) at 1800 rpm	
1250 cfm@350 psi (35.4 m ³ /min@24 bar)		
OPTIONS		
Hydraulic indexing cylinder	DHD lubrication	Water tank
Collar handling package	Auxiliary fuel tank	High-torque rotary head
Deephole package w/regen	Universal pipe handling	Many more
Water injection	Extended derrick	
Mud pumps	Deck engine starting aid	

AtlasCopcoMarketplace.com PRE-OWNED DRILLS



Atlas Copco TH60/2000 sn:6561
Location: West Sacramento, CA
Tower: 38 ft. w/29,500 lb pullback
Truck Engine: 475 Hp Cat 3406E
Drill Hours: Approx. 11,800
Compressor: 825 cfm / 350 psi



Atlas Copco TH60/2001 sn:6661
Location: Milwaukee, WI
Tower: 38 ft. w/29,500 lb pullback
Truck Engine: 475 Hp Cat 3406E
Drill Hours: 15,462
Compressor: 825 cfm / 350 psi



NEW EQUIPMENT COMING SOON

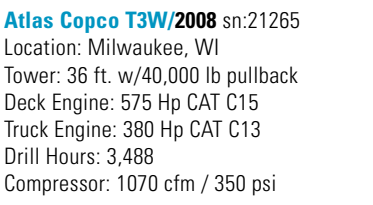


Atlas Copco RD20XC/2014 sn:21431
Location: Garland, TX
Compressor: 1250 cfm / 350 psi
Tower: Range III w/120,000 lb pullback
Deck Engine: 755 Hp Cummins QSK 19
Truck Engine: 380 Hp Cummins ISM



Atlas Copco TH60/2014 sn:21446
Location: Milwaukee, WI
Compressor: 1070 cfm / 350 psi
Tower: 36 ft w/40,000 lb pullback
Truck Engine: 600 Hp Cummins QSX

Atlas Copco TH60DH/2014 sn:21447
Location: Milwaukee, WI
Compressor: 1070 cfm / 350 psi
Tower: 36 ft w/70,000 lb pullback
Truck Engine: 600 Hp Cummins QSX



Atlas Copco T3W/2008 sn:21265
Location: Milwaukee, WI
Tower: 36 ft. w/40,000 lb pullback
Deck Engine: 575 Hp CAT C15
Truck Engine: 380 Hp CAT C13
Drill Hours: 3,488
Compressor: 1070 cfm / 350 psi



Atlas Copco T2W/2012 sn:21402
Location: Milwaukee, WI
Tower: 30,000 lb pullback/pulldown
Truck Engine: 475 Hp International MaxxForce
Drill Hours: 607
Compressor: 750 cfm / 300 psi

INCOMING TRADE

Atlas Copco TH60/2008 sn:21275
Location: Milwaukee, WI
Compressor: 900 cfm / 350 psi
Tower: 36 ft w/40,000 lb pullback
Truck Engine: 600 Hp Cummins ISX
Drill Hours: TBD

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