By Steve Fiscor, Editor-in-Chief

When a coal operator needs a shaft, the choices are limited. Two processes are currently employed by the coal industry: conventional shaft sinking, which places personnel and materials into the shaft; and mechanical excavation or shaft drilling. In today's safety conscious environment, more and more coal operators are choosing mechanical excavation by specialty contractors like Shaft Drillers International (SDI).

SDI leads the industry in mechanically excavating (blind bore) shafts using reverse circulation drilling technology (See Blind Shaft Development, Coal Age, February 2009, p. 37-40). The technique is founded on the principles of buoyancy and uses a combination of drilling fluid (water) and air to create a quick, safe and cost effective operation. No personnel enter the shaft during the process. The shaft drilling system's cutter-head remains under a column of standing water, so the technique requires no underground development within close proximity until the shaft works are completed. Once the underground mining crews reach the shaft, the bulkhead is removed and the shaft is accessed.

In the event a mine operator requires access to existing works, SDI also performs raise-boring (and down-reaming). The process minimizes disturbance to surrounding rock and limits interruptions to traffic and services.

Ultimately the mining direction dictates the ideal location for a shaft; but conditions on the surface can impact the shaft's physical location and its diameter as well. Often, poor decisions on bad ground will mandate a reduction in the diameter of the shaft. Through a series of acquisitions, SDI has advanced its ability to properly support the unconsolidated material near the surface and has recently developed new techniques to overcome poor ground conditions.

Recently, the company has achieved a few milestones working with difficult ground conditions and tight schedules.

Casing Through Poor Ground Gonditions

Similar to coal mining, each shaft project varies with site-specific conditions. "During the last 18

months, SDI has completed several interesting projects," said Tim Bruner, project manager, SDI. "Each had its minor to major challenges. Using our capabilities, personnel and large fleet of drilling rigs, we were able to successfully solve problems."

Last year, a Midwest coal operator required two large diameter 230-ft deep, steel-lined shafts. The problem this project encountered, Bruner explained, was the overburden consisted of 50 ft of unconsolidated material between the surface and the bedrock. "That's a little more than we encounter with projects in the East," Bruner said. "Ground conditions were poor and wet, and the opening was not going to stay open for very long."

The immediate task was to gain control over the unconsolidated material, get it stabilized and cased so SDI could set up its equipment and drill the remaining 180 ft from the top of the dirt-bedrock horizon down to the coal seam. They decided to use two larger diameter steel casings and "telescoped" them through the poor ground conditions. "Using standard excavation techniques, we excavated down about 20 ft," Bruner said. "A casing was set and grouted into place, which stabilized the top 20 ft. The remaining 30 ft was where we found exceptionally poor ground conditions." A slightly smaller casing was assembled on-site. Using a vibratory hammer, the shaft drillers success-fully pushed the smaller casing through the bad ground to the top of the bedrock and then proceeded with the standard blind drilling technique.

SDI owns the largest vibratory hammer (1,800 hp) in the continental U.S. With 390 tons of driving force, the equipment actually grips I-beams or casings in this situation. "We purchased it three years ago for instances just like this… to drive large diameter steel casings through bad ground," Bruner said.

The larger of the two casings (18-ft diameter) was constructed from bolt-together, corrugated steel. The smaller casing (16-ft) was constructed from welded steel sections that were welded together onsite. "The size of those casings were so large they had to be fabricated on location," said John Peters, senior vice president of engineering. "For the larger of the two, we purchased prefabricated bolt-together corrugated segments. We put those together and placed them in the ground. Rather than trying to vibrate bolted segments, we bought rolled and welded pipe segments, transported those segments onto the site and welded them together to make a 50-ft can. We set that can into the hole and vibrated it down to bedrock."

Bruner said it worked like a dream. "That's certainly something new and different for us, using two different types of pipe and telescoping them to overcome those ground conditions," Bruner

said. “The onsite fabrication took some time and we anticipated that. Once the casings were set in place, we had no leakage.”

Another notable aspect of the project was the completion times. Because the mine needed two shafts, SDI placed two complete shaft drilling rigs on location. “That ability is unique to SDI,” Bruner said. “We maintain a fleet of large-diameter drilling rigs and the associated equipment, so we could drill both shafts simultaneously rather than waiting to start the second shaft after the first shaft was finished. With our team and our equipment we are able to significantly reduce the time it would normally take to complete a multiple-shaft project.”

The entire Midwest project was completed by SDI in about nine months. “We mobilized material and equipment to that site in late December 2008 and demobilized in September 2009,” Bruner said. “From January to April, the crews assembled surface casing on location. If all we had to do was set 20 ft of surface casing and drill two shafts to 230 ft, it would have taken a lot less time. The actual drilling process was about average.”

Shafts on Demand

Another coal operator required an 8-ft diameter, 650-ft shaft and they needed it quickly. “It started as a typical project except the mine had a fairly unreasonable time frame for completion,” Bruner said.

Ordinarily, SDI crews work two shifts per day, five days per week. SDI manned that project around the clock from the first day of mobilization to the last day of demobilization. Typically a blind-bored bleeder shaft of this diameter and depth would require five months to complete. “We completed the project, which was a relatively deep shaft, in nine weeks,” Bruner said. “That was a new record for SDI.”

“We were able to do that with current company staffing levels without interrupting any of our other projects,” Peters said. “We had several other projects under way at the time.”

The project was not only completed in record time, but it was done safely, Peters explained. “The safety advantage is simple; there are no men in the shaft,” Peters said. “All of the work is conducted from the surface. This is another significant SDI advantage.”

Mines are keenly aware of a contractor's safety record and have become very selective as to what companies are allowed on-site. "SDI places a very high emphasis on safe work practices and employee safety," said Charlie Riggs, SDI member. "We've earned our reputation for excellence through commitment and professionalism; our emphasis is on maintaining a safe job site through daily safety inspections. We are not simply trying to comply with MSHA standards, but the mine's requirements as well, which are usually more stringent."

Poor Near-Surface Geology

Within the last year, SDI completed three projects in Appalachia that exhibited challenging near-surface conditions, where the first 100 ft of bedrock was fractured. "There was no way to seal it with standard pre-grout job," Bruner said. "With all three projects we over-drilled top 100 ft or so and over-cased it with a diameter slightly larger than what the mine needed. We were then able to finish the shaft development drilling inside of that and case it to the original diameter."

Based on SDI's expertise from drilling in different geology, Bruner explained, these problems were recognized at the earliest possible point. "If a shaft project gets to the shaft construction stage before the contractors realize they have a problem, the only option is to finish that shaft at a smaller diameter than originally specified," Bruner said. "By detecting the problem early, we were able to make important decisions on the fly, such as over-casing the hole, securing additional larger surface casing, finding a 100-ft string of permanent casing, and preparing a large bit for the job." SDI's expertise and the adaptability gained through in-house fabrication facilities prepared and equipped the shaft drilling crew to successfully complete the project.

Down-Reaming Offers Potential Upside

In the last year or so, SDI has contracted for five shafts that were not its typical blind drilling projects. They were either raise bored or down-reamed. Blind drilling has to be completed into a virgin coal seam ahead of mining. Sometimes for various reasons—mine plan changes, new regulations, permitting issues, etc.—a mine needs to gain access to a developed portion of the mine. The three the company has completed to date went exceptionally well, according to Bruner.

Raise boring is prevalent in coal mining, but down-reaming is rare. The difference between the two is the direction of the drilling process. Both use pilot holes. With raise boring, a cutterhead is transported underground and attached. The cutterhead is pulled to the surface allowing all of the cuttings to fall into the mine. Down reaming uses a large-diameter, blind-drilling shaft rig.

“We drill the pilot hole, retrieve those tools, put the cutterhead on at the surface, start the down-reaming process, and let the cuttings fall down the pilot hole,” Bruner said.

The diameter of the pilot hole for down reaming is a little larger than what would be typically used for blind shaft drilling, 24 vs. 17.5 inches. Mines handle the cuttings in various ways. Most transport them using scoops. “If the mines can plan far enough in advance, they can prepare cross cuts to store the material underground,” Bruner said. “Otherwise, it is usually shipped out of the mine on a conveyor system.”

The rates for down-reaming are similar to those of a standard blind-drilled shaft. “Down reaming has some advantages,” Peters said. “The surface requirements are a lot less because the technique does not require a settling pond for the cuttings. It’s a trade off really, permitting at the surface is easier, but you have to handle the material underground.”

Mine Planning Advantage

As mining engineers plan for mine development over the next three to five years, SDI’s role becomes more important. “While the engineers are planning the ventilation, escape-ways, etc., the operator is able to perform his economic planning,” Bruner said. “Working with us on the plan, they know in advance—three to five years out—what that particular shaft will likely cost.”

There are economies of scale when it comes to operations as well. “If they can plan far enough in advance, we can have the shaft available with no interruption to underground operations,” Bruner said. “The miners reach the shaft, pull the bulkhead, and they are ready to go.”

SDI has entered into long-term agreements with several leading coal companies. “The coal operators give us a six-month to two-year schedule,” Bruner said. “They tell us what they’ll need within the next two years, which allows us to properly schedule our equipment and workers. That allows us to offer additional cost savings.”

SDI continues to experience exponential growth. “We have increased manpower by more than 40%,” said Scott Kiger, SDI member. “We have a substantial fleet, well qualified engineers and seasoned field personnel. Our global presence is expanding as well.”