Walter Energy Boosts Longwall Production with Controlled Start Transmissions

Longwall Mining Case Study

Caterpillar Global Mining

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Longwall Production at Blue Creek No. 7 Mine

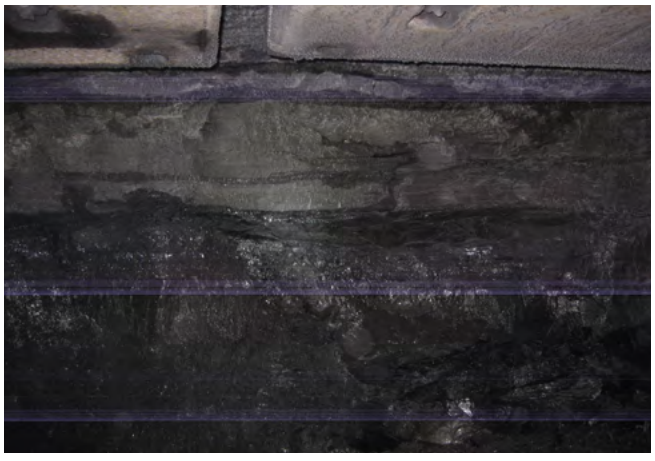
Walter Energy's metallurgical coal division, Jim Walter Resources, was successfully longwall mining in challenging conditions since the 1970s. The company operated three longwall faces at two mines in Alabama, where the crews mined high quality metallurgical coal primarily from the Blue Creek seam. In 2016, the two Blue Creek mines of Jim Walter Resources were acquired by Warrior Met Coal, Inc. — a large scale, low-cost U.S.-based producer and exporter of premium met coal that is currently operating two highly productive underground mines in Alabama.

At the Blue Creek No. 7 Mine, two longwall faces began operating in 2011. The 7 West face cut two seams — the Blue Creek situated below the Mary Lee, as well as rock interburden or "middleman" between the seams. The coal seams were deep — 1,500 to 1,800 ft (460 to 550 m) — and varying geology presented additional challenges. Typical mining height when twin-seam mining was 8 to 9 ft (2.4 to 2.7 m) with the Blue Creek seam making up about 6 ft (1.8 m) of that height and the interburden constituting 1 to 3 ft (0.3 to 0.9 m). The bottom was very hard sandstone, which limited the ability to cut the floor.

The 7 East face had 5 to 6 ft (1.5 to 1.8 m) of laminated rock interburden above the Blue Creek seam, as well as 4 to 12 in. (10 to 30 cm) of draw rock immediately above the seam. Some areas of the longwall panels had 12 to 40 ft (3.7 to 12.2 m) of sandstone above the seams, which did not always cave as desired after the longwall passes.

This sometimes caused heavy loading of the roof supports—which prompted mine managers to retrofit Cat® rock burst valves to each leg of the roof supports to provide improved stability during heavy loading.

When single-seam mining is done, the primary challenge is to maintain roof control under the middle man. A shield with high density (greater than 10 tons or 9 metric tons per square foot) is typically selected. The roof support must have high capacity at low operating heights to prevent yielding and consequently trapping the shearer.



Single-seam mining can be optimal because it eliminates the need to cut, handle and process the middle-man rock. However, the payoff depends on the thickness of the thinner Mary Lee seam. When twin-seam mining, more coal is recovered, but mining the rock interburden takes time and increases wear and tear on machinery, including the preparation plant.

Despite the geological challenges, Walter Energy typically developed panels for face widths of 1,000 ft (300 m) and panel lengths of 6,000 to 13,000 ft (1800 to 4000 m).

CSTs Deal with Heavy Conveyor Loads and Jams

In 2011, Walter Energy entered into an agreement with Caterpillar to install controlled start transmissions (CSTs) on two of their three longwall systems in northern Alabama. The CSTs were sized and configured to work with Walter's self-designed and manufactured armored face conveyors—with the objective of coping with heavy loads of rock on the conveyor, starting the conveyor when loaded heavily, protecting the conveyor from damage caused by rock jams and better controlling conveyor speed to optimize production.

Cat CST Gearboxes

The Cat CST is a planetary gearbox with an integrated, highly efficient multi-disc clutch, all governed by an intelligent control system that adjusts conveyor speed to match production. The CSTs are oil-cooled via a closed-loop system. As shown with Walter's face conveyors, Cat CSTs can be retrofitted to any armored face conveyor system—although there are major advantages to using a fully integrated Cat system.

The Cat CSTs deliver:

- soft starting of the face conveyor
- heavy-load startup
- precise load sharing of the 3 x 1200 hp face conveyor motors
- instant overload protection against rock jams and other problems

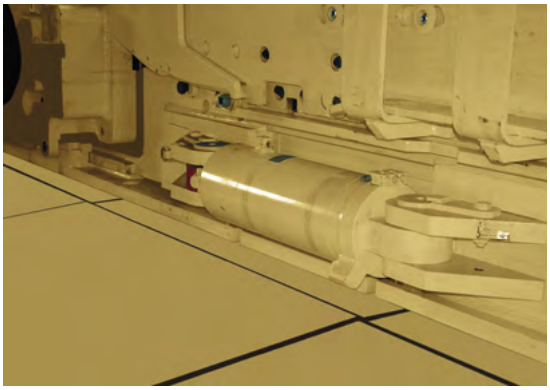
The first panel with the CSTs started in January 2013 at Mine No. 7 and finished in October of the same year. The panel, E-4 East, was 1,040 ft (320 m) wide and 13,365 ft (4070 m) long.

During mining of this panel, the mine saw a significant improvement in the mining rate — averaging 53 ft (16 m) per day retreat rate, compared to 40 ft (12 m) per day in the previous panel. Equally impressive, the mine did not have to change either face conveyor sprocket when mining the 13,365-ft (4070 m) panel, despite the highly abrasive quality of the coal and rock mined. In the adjacent panel, operating without CSTs, the same design sprockets at the head and tail were changed three times each. Much of this can be attributed to the smooth operation of the controlled start transmissions. Not only was wear reduced on the drives, but conveyor chain wrecks were diminished greatly, leading to decreased downtime and higher production.

All productive longwalls manage face conveyor chain tension carefully. Too much tension leads to high wear of chains, sprockets, flight bars, pan lines and drive ends. Too little tension leads to slack that can let the chain "tangle" when it goes over the drive sprockets. The result is a chain wreck that can cause many hours and even shifts of downtime.

The CSTs are operated in conjunction with the Cat tensionable tail drive system (CTS). The two systems work together to give the maximum control of chain tension and to maintain optimum tension in relation to the power being consumed.

Walter Energy has been installing the CTS on its faces for several years, and now with the introduction of CSTs, the mines get the full benefit of this automation. The CTS also reduces maintenance by automatically monitoring slack and adjusting the chain through 39 in. (1000 mm) of stroke in the tensioner. Manual adjustments are much less frequent, which frees up mechanics to focus on thorough preventive maintenance.



At Blue Creek No. 7, the CSTs protected the conveying system when hard blockages – such as having metal trapped under the h/g plow – would have broken the face conveyor chain. At the end of the panel, conveyor flights were still tight on the chain, and the chain could have been used on a short panel if one was available. The panel finished on schedule and on budget.

"In my mind, the CSTs paid for themselves in our first panel of use," said Darrell Loggains, longwall manager at Blue Creek No. 7. "We got much higher footages, less downtime from chain issues, and we didn't change our sprockets even once, which has never occurred since we have had these large panels in recent years."

Record Longwall Footage

In March 2014, the No. 7 East longwall team set a record for the mine of 82 ft (25 m) of retreat mining completed in a 24-hour period. The crews showed their abilities throughout the panel by increasing their average rate from 55 to 61 ft (17 to 19 m).

"The success of the longwall can be attributed to a lot of support from our team, equipment, materials, safety procedures and everyone pulling together to maintain top performance," said No. 7 East Manager Barry Kimbrell.

Loggains credited the Cat CSTs with playing a significant role in setting the record. "The CSTs help us be consistent with the load we put on the conveyor without creating extra work for people at belt transfer points," he said. "Of course, it's very important having a team in place that takes ownership of the work and safety performance." In addition to the two longwalls working in No. 7 Mine, Cat CSTs have been added to the longwall working in No. 4 Mine. The system, configured with CSTs, is operating successfully in its second panel.

Cat® Variable Frequency Drive Enhances CST Operation

Excursus:

Cat® Variable Frequency Drives for longwall systems work in conjunction with Cat CST and Cat UEL gearboxes to deliver enhanced speed control of the armored face conveyor, very accurate load sharing between gearboxes and better efficiency when operating in weak power networks. The system optimizes power usage and even returns energy into the system when motors are used to break drives.

The VFD adds a superior level of control to the proven line-up of Cat armored face conveyor (AFC) drive technology. Adjusting speed and torque by varying the frequencies of the alternating current enables precise and stepless control. In regular operation, the speed of the AFC can be adjusted steplessly to load requirements when the plow or shearer are cutting in the same or opposite direction of the AFC.

The Cat VFD will plug into existing systems. Cat VFD drive systems are housed in separate explosion-proof cabinets and, due to current source inverter technology (CSI), they can be installed as far as 2.5 miles (4 km) from motors. Compared to other systems that integrate VFD control into motors, they do not require additional space at the face ends. Also, unlike some other systems, the Cat VFD does not cause EMC effects such as over-voltages, reflection waves or other unwanted ground currents or network disturbances.

Notes

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