

A large white mining truck is shown in a dark, blue-tinted image. The truck is a dump truck with its bed raised, dumping a load of rocks. It has large, heavy-duty tires and a prominent front grille. The background is a dark, hazy landscape.

# **MACHINE CONDITION MONITORING IN THE MINING INDUSTRY**

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In the harsh, constantly changing conditions of the mining industry, downtime and even catastrophic equipment failures have come to be accepted almost as standard—leading to costly production losses, expensive equipment repairs and sometime serious or even fatal injuries. Fortunately, advances in mining machine condition monitoring are ushering in a new era of productivity, profitability and peace of mind.



**“Mobile mine equipment represents huge capital costs – it is expensive to operate, expensive to maintain and critically important to mine productivity. However, unlike stationary machinery, monitoring mobile equipment brings substantial challenges that must be addressed to insure accurate, repeatable and reliable data application.”**

- MaintWorld



# Highly Profitable Coal Mine Is Really ‘Crushing It’

Nestled in Wyoming’s Powder River Basin you’ll find a coal-mining mecca unlike any other in the world. In fact, the basin boasts 40% of the coal mining production in the United States. When you talk with the Director of Reliability at one of the most productive mines in the basin, he paints a very compelling picture of the unique challenges and rewards of mobile mine equipment monitoring.

When hired by the mine over a decade ago as their lone reliability maintenance manager, he did all of the vibration work himself. As the manager was able to prove the merits of machine condition monitoring in the mine, he hired a pit reliability analyst and plant analyst to support his efforts. Yet in spite of their proven success, the reliability team was still searching for solutions to their toughest challenges.

MINING EQUIPMENT MONITORING :: DEGREES OF DIFFICULTY	
1 <i>Electric Rope Shovels</i>	The most difficult to monitor due to the shortest cycle times—must trigger on RPM, direction and load for accurate readings.
2 <i>Draglines &amp; Haul Trucks</i>	Very difficult due to variable speeds, directions, and loads—permanently installed monitoring devices can create consistent, reliable readings.
3 <i>Conveyors &amp; Crushers</i>	Plant equipment is more predictable than pit equipment, but every bit as critical—periodic or permanent monitoring are both viable options.



## Mobile Mine Equipment Trending Can Be Tricky

Unquestionably the biggest challenge the team faced was collecting reliable, repeatable data on their mobile mining equipment in the pit. One of the trending challenges they faced with their electric rope shovels was gathering accurate readings during the relatively short cycle times of the shovels. Equally challenging were the multiple speeds, directions and variable loads of their draglines and haul trucks. They knew they needed to find a vibration-based machine condition monitoring solution that could capture sufficient data during short cycle times and allow them to set RPM ratings and load conditions.”

## The Hazards of Harsh Mining Environments

When you consider the extreme weather conditions in Wyoming, the dust and debris inherent in any surface pit mining operations and the safety concerns of manual data collection during the actual operation of mobile mining equipment, it doesn't exactly make for the easiest of working environments. Consequently the daily routine of route-based data gathering becomes burdensome for the crew. Sometimes you can even say it's the pits—literally and figuratively.

## Increased Productivity and Peace of Mind

Fortunately, the reliability team found exactly what they were looking for with MTS. After permanently installing VBOX2 and VBOX4 vibration data collectors on their draglines and electric rope

shovels, as well as using portable VBOX3 vibration monitoring on their haul trucks, the reliability team now conducts a lot of their pit mining equipment monitoring online in the comfort and safety of our office—without the need to take the machinery out of production while doing the monitoring or place their crew in harms' way. Certainly, reducing the extent of exposure the crew has with the rotating equipment by moving several of these data collection routes online contributes to the perfect safety record among the reliability department members.

On the plant side of the operation, MTS has their critical equipment monitoring covered as well—from their conveyors to their crushers. MTS collects data at a user-set samples-per-second rate and for a user-set amount of time, and then allows post-processing of the data, giving the team the ability to slice and dice the data based on a single set of readings. Essentially, MTS is machine condition monitoring on steroids.

## Keeping the Reliability Crew ‘Out of the Pits’

Today, the reliability team members are pretty much all smiles knowing that MTS' permanently installed vibration monitoring is reducing the amount of manual data collection with each new system they install—not to mention the satisfaction of knowing their reliability work with MTS plays a role in keeping their mine among the most productive coal mining operations in North America. Now that's a very pretty picture!

# Producing Under The Pressure of Intense Fire

"A long rotary kiln is the lifeline of our entire operation. Everything revolves around the kiln," says the Reliability Engineer at one of the most productive cement plants in the West.

Inside the kiln, ground limestone, silica and iron ore are heated to 2,600 degrees to form "clinker" which is then rapidly cooled and ground into a fine powder to form Portland cement, which is then packaged or shipped in bulk. Refractory bricks lining the inside of the kiln collect scale and deteriorate under the continuous and intense process heat. Partially re-bricking the kiln is a time consuming but essential maintenance activity that occurs at least annually.

## Record-Breaking Reliability Results

The Plant Reliability Engineer is fairly bold in sharing their impressive reliability results, but has no problem giving credit where credit is due: "Recently, we broke the North America record for MTBF (Mean Time Between Failure) in our kiln. Our reliability partner MTS has provided advance notice on several items that would have otherwise shut down the kiln if not addressed. There's no question that our relationship with MTS has helped reduce our downtime and increase our productivity."



Not only has MTS helped extend the intervals between kiln maintenance to record levels, MTS has also helped significantly reduce the start-up time after a kiln shutdown. Once a year a kiln shutdown requires a 3-5 week process, providing a prime window of opportunity to conduct preventative maintenance on other machinery in the plant and in the quarry. "During the past couple of years, we've been able 'hit the start button,' so to speak, almost immediately after kiln shutdown is complete. This level of predictability and productivity was virtually unthinkable prior to our partnership with MTS".

## Relationships 101

The Plant Reliability Engineer believes it's ultimately all about relationships. "I don't do business with companies. I do business with people. Without people, there's literally no need for our product." So it's no surprise that he has plenty to say about his 20-year relationship of trust and success with MTS: "Milt and his team have been true partners from the very beginning. They've always been there. They run 24-7. Our interactions are always pleasant, positive and productive." MTS has helped them keep their finger on the pulse of their equipment to better understand the mechanical health of the production machines.



### Reliability Engineer

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### A Paradigm Shift Towards Predictive Maintenance

The plant has always had an extensive control system and data, but they haven't always had the ability or mindset to fully leverage the data. MTS created a paradigm shift in their maintenance culture and mindset, helping the plant move to a true predictive maintenance model. MTS has trained their team to ask and answer key questions such as: What does this change in the data really mean? MTS monitors a long list of equipment in the plant and the quarry, including: air flow fans, bearings, cooling equipment, crushing equipment, gearboxes, motors, and more. The Plant Reliability team sometimes even spot-check their equipment using MTS vibration data collectors, which helps bridge the gap between quarterly MTS site visits.

### Grinding Out Ever-Increasing Throughput

Before 2007, the plant struggled to improve their reliability numbers above 73% in the finishing mills. Now with the help of MTS, their numbers are impressively in the 90% range. Moving forward, MTS will continue to play a critical role in helping plant production continue to accelerate under the pressure of intense fire.



# Longwall Mining For The Long Haul

"Before partnering with MTS we were 'running blind' with no machine condition monitoring of any kind," recalls Shawn, Mine Maintenance Superintendent at the one of the largest underground trona mining operations in the country. As a result, gearbox failures were running rampant throughout the mine. Repairing and replacing the longwall shears and pan line gearboxes midway through the underground longwall mining process was terribly expensive and time consuming.

## The Ripple Effects of Running Blind

Shawn can't stress enough the impact that mechanical reliability—or lack thereof—has on workforce attitude and morale: "There's nothing more frustrating to a mechanic than repair after repair after repair. Failures and outages create a 'ripple effect' in our workforce. We are forced to temporarily re-assign workers to areas in which they don't have training or daily experience. Productivity goes down and safety concerns go up." Shawn and his maintenance team knew they needed to find a reliable mining equipment monitoring solution and implement a true Predictive Maintenance program.

## A Radical Recommendation

Fortunately, MSHA (US Mine Safety & Health Administration) allows MTS portable vibration data collection devices to be placed directly on the surface of mining equipment without the need for a hot work permit. Seeing this as a solution they could immediately implement without any red tape, Shawn hired the MTS team. After meticulously monitoring the longwall shears and pan line gearboxes, MTS recommended that rather than rebuild the machines half way through the longwall mining panels, the equipment vibration levels should be monitored regularly beyond the halfway point. The goal was to eliminate the need to rebuild in the middle of the longwall mining process.

## Record-Breaking Productivity and Safety

Shawn agreed and set the plan in motion. On the first attempt, the longwall shear produced record amounts of material mined in the shortest amount of time. It also dramatically reduced the next longwall move as the shear and pan line system could be setup before the previous mining panel was complete. The money saved by this one life extension more than pays for the services to monitor all the machines for the next 10 years. Shawn sums up the bottom-line impact best: "Our longwall miner move used to last up to 23 days. Now it's down to as low as 3 days. Plus, we're saving \$300,000 to \$500,000 or more per year purely in component repairs."



**Shawn** | *Mine Maintenance Superintendent*

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Prior to partnering with MTS, the mine recorded 12 accidents in 2008. Since working with MTS, accidents were reduced to one in 2015, zero in 2016, and one to date in 2017. "MTS has helped us totally transform the culture of our mining operation. Our track record of reliability, productivity and safety has significantly helped with employee retention and positive attitudes. We've mined record tons of trona for three consecutive years—and we still can't keep up with the market demand," Shawn declares with a tone of determination that suggests their record-breaking results will continue for the foreseeable future.

Can machine condition monitoring make a meaningful difference in your mining operation? Just ask the guy who went from running blind with rampant outages less than a decade ago to delivering eye-popping reliability results year after year.