

Averting Mining Hazards Using Emerging Technologies

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INJURIES SUFFERED DURING MACHINE maintenance and repair tasks continue to plague the mining industry. From 2003 to 2012, these types of accidents accounted for the highest number of recordable incidents in stone, sand and gravel operations. The severity of these injuries can vary widely and range from cuts and broken bones to permanent disabilities and fatalities. The most severe cases often involve entanglements where workers are caught in a machine's pinch points when they attempt to perform maintenance-related tasks while the equipment is running or energized.

A review of the U.S. Mine Safety and Health Administration's mining injury statistics reveals cases in which equipment was not properly de-energized prior to machine guards being removed. This practice creates a particularly dangerous situation in which entanglements and other types of traumatic injuries can occur. Other cases involved maintenance personnel removing guards for a routine task and forgetting to replace them after the task was completed, only to have another mine worker get injured due to improperly guarded equipment. A more serious type of entanglement



accident is when a worker is very close to or on unguarded equipment that has been properly de-energized for maintenance and another worker restarts the equipment unaware that someone is in harm's way.

Over the years, the mining industry has taken positive strides to solve these types of problems and has developed programs to train employees to follow established procedures for locking out and tagging out equipment prior to maintenance and properly removing and replacing machine guards to reduce the entanglement hazards. However, these problems still occur at alarming rates. Researchers at the Office

of Mine Safety and Health Research (OMSHR) are investigating a technology-based solution designed to provide additional layers of protection against these types of accidents.

Conventional Safety Approach

Title 30 Code of Federal Regulations prescribes machine guarding requirements based on miner safety and health objectives. While mine operators use different strategies to comply with these requirements, the ultimate goal is to properly guard equipment to eliminate entanglement hazards that can result in inadvertent contact between mine personnel and equipment. While

administrative controls such as strategically placed "Caution" signs are encouraged because they are designed to alert mine workers of the inherent dangers, the hazard itself still exists. Training programs established by individual mine sites may contribute to successfully reducing these types of accidents by educating workers on performing their jobs safely, but they do not guarantee miner safety.

Despite these approaches, unsafe practices might still be present. Workers might be concerned about production time lost when properly de-energizing equipment, they might not take the time and travel the distance to properly de-energize equipment at control centers, or they might underestimate or misunderstand the dangers present in performing a specific task. Although administrative controls and training programs have had a positive impact in reducing accident likelihood, they also highlight the need and opportunity for additional protections that

can be provided through engineering controls such as automatic machine guard monitoring and detection of personnel performing potentially hazardous tasks.

Technology-Based Solutions

The OMSHR is actively investigating emerging technologies to provide additional levels of protection against traumatic injuries suffered by those performing machine maintenance and repair tasks. Researchers have applied radio frequency identification technologies to construct a wireless communications network designed to simultaneously monitor machine guards and detect the presence of workers performing maintenance and repair tasks around static haulage equipment. The wireless network is used to transport information from all over the mine to a centralized location – typically a mine's central office. OMSHR investigations have focused on the system's performance, including the accuracy and reliability of the hardware and

wireless network used to perform the monitoring tasks.

Optional Data Transmission

A review of RFID technologies led researchers to a commercially available communication and tracking system currently being used in underground coal mines. This system is designed to track mine personnel and transmit their location over a wireless network – similar to a home Wi-Fi network – to the surface. The system uses uniquely numbered beacons, each of which transmits identifying information that can be used to monitor the location of individual assets (e.g., tools, equipment or vehicles) or workers throughout the mine. The system can be easily configured to cover large areas by installing several devices that communicate with each other.

Researchers leveraged this tracking system's features to monitor machine guards and detect when they are removed before and replaced after maintenance tasks are completed.

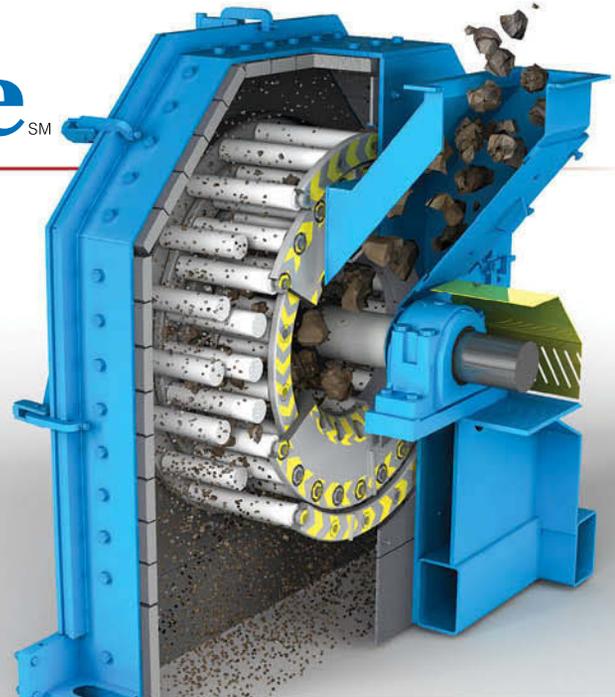
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Machine guard monitoring hardware installed on conveyor.



Example of area where technology-based personnel detection may be installed.

In addition to transmitting location, the beacons were repurposed to detect the machine guard interactions based on simple switch readings. This means that when a guard is removed, the beacon transmits information to show that a switch is open. If the guard is replaced, the beacon transmits information to show that a switch is closed. This data is transmitted over the wireless network to the centralized location, where the user interface collects and displays the information being transmitted by each of the beacons.

Machine Guard Monitoring

After applying the data transmission feature, OMSHR researchers then investigated methods to integrate the machine guard monitoring capabilities on a conveyor. Implementing this feature involved wiring mechanical and magnetic switches to individual machine guards. A separate study evaluated a number of mechanical switches and non-contact, magnetic switches that were selected based on ease of integration, cost and reliability. Ultimately, the magnetic switches were determined better choices for machine guard monitoring due to the benefits afforded. These types of switches were also less susceptible to rain and dirt and therefore were not affected in the mine environment.

In a follow-up OMSHR study, the magnetic switches were installed on a conveyor's frame and were activated

by a strong magnet installed on the machine guards. These non-contact switches were activated when the guard's magnet was pulled away from the sensing switch. The system was installed and trialed at a stone quarry in the northwest United States and deployed to monitor guards on a radial stacker conveyor in one location of the mine and a support column's guards in another location. The study involved removing and replacing guards in sequential order, followed by removing pairs of guards to ensure that the network was not overloaded and the data was accurately transmitted. The data was transmitted accurately and reliably in all cases.

Detection of Personnel

The machine guard monitoring feature is part of an integrated system that can also be used to actively detect workers in pre-defined zones. The same uniquely numbered beacons were used to develop the personnel location feature. This feature is different from existing tracking systems because the beacon system detects the presence of personnel in specific areas rather than tracking personnel throughout the entire mine. This provides another layer of protection useful to reduce the possibility of inadvertent machine startups when personnel are working in areas where they are not easily seen. The system was tested in the

laboratory to investigate its accuracy in detecting personnel in pre-defined zones configurable by adjusting the power settings, effectively increasing or decreasing the size of the zone. Automatic detection of personnel is especially useful in dusty environments where video cameras may not be effective in spotting mine workers around large equipment or tunnels.

Working Toward a Safer Mine

Wireless machine guard monitoring and detection of personnel are two benefits afforded by leveraging emerging technologies to provide added mine worker protection. By simultaneous wireless monitoring of machine guard status and the presence of personnel in areas where structures and equipment obstruct the line of sight, mines can reduce the likelihood of traumatic accidents that historically occur where administrative controls and training may be insufficient. Further, these technologies may ultimately be used to monitor other operational and safety-related data to create a mine-wide network of information. The integration of such wireless safety technologies is expected to improve the safety of miners by providing additional protections against machine-related injuries. The OMSHR continues to work on improving these technologies and developing partnerships to translate research findings into safer mines for safer miners. ■

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NSSGA EVENTS

AGG1 Online Webinar Series

Contact: Catherine Whalen
(cwhalen@nssga.org)

The Antitrust Laws – What You Can, Can't and Should Do

Dec. 11, 2014 – 1:00-3:00 p.m.

NSSGA Annual Convention and Board of Directors

Spring Meeting

March 15-18, 2015

Hilton Baltimore

Baltimore, Md.

Contact: Cynthia McDowell
(cmcdowell@nssga.org)

AGG1 Academy & Expo

March 17-19, 2015

Baltimore Convention Center

Baltimore, Md.

Contact: Pamala Bouchard
(pbouchard@nssga.org)

Young Leaders

Annual Meeting

April 30-May 2, 2015

Fourt Lauderdale, Fla

Contact: Shannon Grace
(sgrace@nssga.org)

LEGISLATIVE CALENDAR

NOVEMBER

NOV. 3-7

Constituent Work Period (House)

NOV. 24-28

Constituent Work Week (House)

NSSGA

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March 17-19, 2015 | Baltimore, Md.

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