

Proximity Detection Systems – Safety Inside the Red Zone

By Linda Zeiler

One of the hallmarks of MSHA's Office of Technical Support has long been to provide engineering and scientific expertise to federal inspectors, state agencies, and the mining industry dealing with difficult health and safety problems. Often, it has been the introduction of new equipment or methods (such as atmospheric monitoring systems and automated longwall mining in the 1980s) that has resulted in new safety or health concerns to be addressed. Due to increasing automation and technological advances in the last decade or so, Technical Support also has become more involved in the evaluation and approval of new mining equipment and devices to ensure safe application of these new technologies.

Moving into the 21st century under the leadership of Director Mark Skiles, teams from Technical Support have combined these different problem-solving methods to focus directly on finding new engineering solutions that can result in the reduction of accidents. No longer content to just fix a problem after an accident happens, Technical Support looks for ways -- in partnership with manufacturers, government and industry safety professionals -- to adapt new technologies to help minimize or even eliminate a hazard.

The first big success story that demonstrates this approach was described in Coal People Magazine's March 2003 issue. At that time, MSHA, along with industry, labor and glass manufacturers, had developed ways to increase a miner's chance for survival when buried by a surge pile in a dozer. What resulted were new recommendations for surge pile safety, including installation of high-strength glass, radio communication, marking feeder locations, and providing operator capability to shut down the feeder and stacker belt from the cab. The article profiled three miners who were trapped in their bulldozers by surge piles. Because their dozers were equipped with this MSHA-recommended package, they all survived to tell their stories.

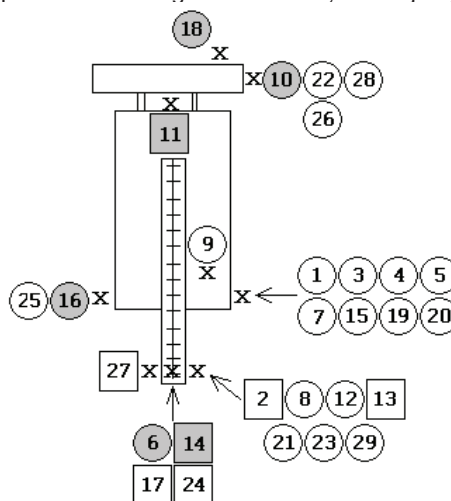
The core team for the Accident Prevention Program in MSHA, Technical Support's Applied Engineering Division, will first research where mining accidents are occurring and then prioritize their focus based on accident frequency and severity. To develop an approach to the problem, they draw on insight gained from previous fatal accidents, engineering conclusions from past accident investigations, and information submitted on MSHA's Web site. Finally, they call upon the appropriate in-house experts from elsewhere in Technical Support (electrical engineers, mechanical engineers, roof control specialists, etc.), and join with government allies, industry partners and willing manufacturers to identify, develop and test technologies that could reduce or eliminate these specific types of accidents.

This year, thanks to taking this engineering approach to accident reduction, we can announce an even bigger success story. Proximity detection systems for remote control continuous mining machines are now available that will eliminate many accidents and will unquestionably save lives. This new retrofit for CMs is a direct result of another successful partnership that involved several years of research, development, and underground testing. The two new systems, the TramGuard™ from Geosteering Mining Services and the "Buddy System" from Nautilus International, were approved by MSHA in 2006 and are now commercially available. This is a remarkable safety accomplishment with far-reaching mining implications and applications, thanks to many dedicated professionals.

Proximity detection is a protection system that can detect the presence of a miner in the hazardous area around a continuous mining machine (commonly referred to as the "red zone") and cause a warning signal to be activated or the machine to be shut down. The use of remote-controlled continuous mining machines became prominent in the early 1980s because the use of remote controls reduced miners' exposure to noise, dust and falling rock. However, eliminating the protection provided by the operator's compartment onboard the machine paved the way for new crushing and pinning hazards.

Reviewing accidents, MSHA found that since 1984, 29 underground miners lost their lives when they were crushed or pinned while working around a remote-controlled continuous mining machine. Forty percent of those fatalities (12) have occurred since 2000 -- roughly two fatalities every year. None of the accidents happened while the miner was actually in the process of cutting coal. Instead, the majority took place while the

miner operator was tramming the machine in preparation for a cut.



This sketch shows a continuous mining machine. The numbers around the sketch represent the 29 miners killed in crushing or pinning accidents around a remote-control

continuous mining machine. The X's represent the location of the victims in relation to the machine. The numbers in circles indicate that the victim was in possession of the remote control transmitter at the time of the accident. The numbers in squares indicate that the victim was someone other than the person in possession of the transmitter. The numbers in gray shading indicate that maintenance activities were taking place at the time of the accident.

The alarming increase in these types of accidents resulted in an earlier effort by MSHA in the late 1990s and early 2000 to eliminate pinning hazards. MSHA, primarily Technical Support's Electrical Safety Division, studied these accidents internally, and also formed an industry remote-control work group to study ongoing remote-control-related accidents and identify possible solutions. MSHA produced a series of Program Information Bulletins during this time period that addressed various hazards associated with the operation of remote-control mining machines. However, the fatal accidents continued to occur.



Electrical Safety Division Proximity Detection Investigators: Brian Malin, Kevin Dolinar, Jerry Dransite, Pat Retzer, Rob Holubeck and Ken Porter (squatting)

MSHA's internal work group wrote a report in 1998.¹ The leading technological recommendation of that report stated that MSHA should look into the possibility of retrofitting remote-control mining machines with the new proximity protection technology referred to as "proximity detection."

Because of the ongoing crushing and pinning accidents, in early 2002 Skiles charged the team of identified experts in ESD to investigate available proximity detection technologies and initiate actions to adapt such technologies for use on remote-controlled continuous mining machines. MSHA conducted a search of available proximity detection systems and concluded that one produced by Canadian-based Nautilus International was the most viable candidate. At that time, Nautilus produced a proximity detection system called the "Buddy System" that was in use on diesel-powered machinery in metal mines in Canada and Australia. Coincidentally, in March 2002, a remote-control-related fatal accident occurred at Massey Energy's Rockhouse Energy #1 mine in Kentucky. In response to that accident, Chris Adkins, then Vice President of Operations for

¹ "Remotely Controlled Mining Machinery Study," A Committee Report, Gary Clark, Bill Warnock, Duane Wease, Jerry Dransite, Aug. 3, 1998

Massey, requested assistance from MSHA to develop proximity detection technology that could be incorporated onto all of Massey's remote-controlled continuous mining machines.



Mark Skiles

In response to Massey's request, MSHA formed a partnership that included Massey Energy, Nautilus International and Joy Mining Machinery, with the goal of developing an MSHA-approved proximity detection system that could be incorporated on remote-controlled continuous mining machines. The partners initially met in June 2002 when Jason Hart, President of Nautilus, demonstrated the operation of the "Buddy System."



Nautilus International's "Buddy System"

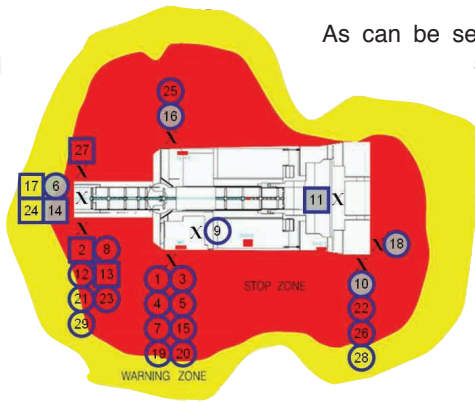
The first field test occurred in June 2003, during which the team encountered several significant problems and were forced to suspend testing. Several system malfunctions occurred, but more significantly, there appeared to be a calibration drift problem. This revealed itself in the gradual increase in required distance between the machine and the operator necessary to maintain machine operability.

As a result, it took almost a year of system modification time for Nautilus to produce a revised design. In July 2004, the second field test occurred with similar results, even though the system

continued

Proximity Detection continued

had undergone a drastic redesign. However, during this second field test, the MSHA investigators discovered that calibration drift was not the real culprit. Instead, they found that the signal produced by the on-board magnetic field-generating antenna was coupling onto the continuous mining machine's trailing cable, resulting in an erroneous indication of the operator's position. This phenomenon was referred to as "parasitic coupling." The problem proved very difficult to overcome because the frequency at which the Buddy System operated was ideal for permitting signal coupling. It took Nautilus a year and a half and four additional field tests to overcome this design problem.



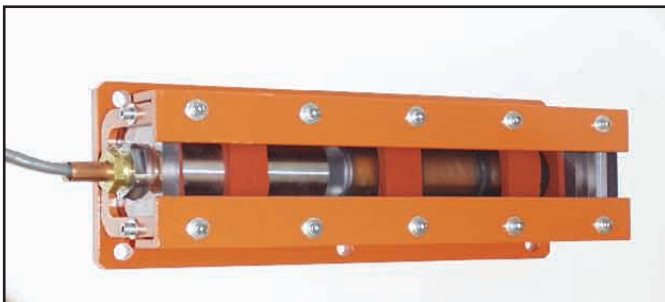
As can be seen in this figure, by strategically locating the Geosteering field generators, the system generated a protection zone that very likely could have prevented the 29 fatal accidents originally shown in the first sketch on page 114.



Massey Mine field testing, Miner Operator

In Nov. 2004, a second vendor, Geosteering Mining Services, LLC, of Huntsville, Ala. initiated its own proximity detection design effort. The company purchased the license for a system referred to as the Hazardous Area Signaling and Ranging Device, designed and patented by

the National Institute for Occupational Safety and Health. Geosteering and its President, Larry Frederick, partnered with Gamma Services International, Inc., MSHA's ESD and NIOSH, and quickly developed the TramGuard™. This system uses a series of field generators housed in explosion-proof enclosures to generate a protection zone around the machine.



Geosteering Field Generator



Buddy System components

In November 2005, the Geosteering system provided consistent warning and shutdown commands in its initial field testing at CONSOL Energy's Jones Fork Mine. It proved to be effective in preventing the machine operator from entering the hazardous area around the machine. MSHA issued an approval for the Geosteering TramGuard™ Proximity Detection System in January 2006.

During the time the Geosteering system was being field tested, Nautilus also introduced a significant revision to its system. The field-generating antenna was significantly redesigned so that 360° of protection around the machine could be provided by one small, centrally mounted intrinsically safe antenna. This modified system (below) was successfully field tested in December 2005, and MSHA issued an approval for the Nautilus "Buddy System" Proximity Detection System in July 2006.

MSHA recently held two press conferences to announce the successful development and MSHA approval of both the Nautilus and Geosteering proximity detection systems. During these press conferences, MSHA discussed the accident history of remote-controlled continuous mining machines, and the design and development of the two systems. Both events included a live demonstration of a proximity detection system operating on an actual continuous mining machine.



Nautilus International demonstrates "Buddy System" during Shinnston, WV press conference



Geosteering LLC demonstrates "Tramguard" System during Clay, KY press conference

Proximity detection technology has the potential to dramatically improve the safety of mining operations in many different areas. In addition to the remote-control continuous mining machine application, proximity detection also could improve the safety of other underground mining machinery such as shuttle cars, scoops and conveyors. Furthermore, this technology could be applied to surface haulage equipment to protect against large vehicles running over smaller vehicles or pedestrians. Proximity detection is currently being evaluated to warn of overhead high voltage lines. It could be applied to dump points to warn the machine operator when he or she approaches the stopping point. MSHA recently conducted a review of all mining-related fatal accidents and determined that approximately 20 percent of all mining-related deaths in the last five years could have been prevented through the use of proximity detection.

The surge pile safety program and the development of new continuous miner proximity protection systems demonstrate the great strides that can be taken toward improving miners' safety and health when the different factions of the mining industry and MSHA work together to achieve a common goal. These projects could never have been successful without the vested interest of each of the partners.

MSHA's Technical Support encourages your input. If you have a good accident reduction idea or a proposed engineering solution to a mining-related safety problem that could help prevent accidents, please submit your ideas to: zzMSHA-MinersTips@dol.gov For additional safety tips, programs, and material that can be used to prevent accidents in the mining industry, we also encourage you to check out MSHA's Accident Prevention Program Web site at: http://www.msha.gov/Accident_Prevention/appmain.htm And for more specific information on TramGuard™ or the "Buddy System", please visit: www.msha.gov/ProxProtection/ProximityprotectionSingleSource.asp

COAL EVENTS

MetCoke 2006 scheduled for October 16-18 at the Doubletree Philadelphia Hotel, Philadelphia, PA, is a gathering for the metallurgical coke and coal industry, offering market analysis and projections, information on the latest technological advances, and solutions to the most pressing problems facing the industry. To register, call 207/781-9614 or email khaney@intertechusa.com.

The 18th Annual '06 RAILFEST Model Train show, sponsored by the Pocahontas Chapter of National Railway Historical Society, is scheduled for November 11-12 at the Bluefield Youth Center, 1780 Stadium Drive, next to Mitchell Stadium, Bluefield, West Virginia. Collectable John Deere display, Railroad Artifacts display. Admission \$5 per person, \$10 per family. Refreshments, rail videos, door prizes, free parking. Call 304/431-2593.

Intertech-Pira will hold its inaugural conference dedicated exclusively to the metallurgical coke and coal industry, India Coke Summit, in India on January 17-19, 2007, at the Taj Bengal Hotel in Kolkata, India. The conference will focus on current trends affecting the metallurgical coke industry in India. Main conference sessions will take place January 18-19 and will feature 18 prominent speakers and two panel discussions. Contact Brian Santos at +1 207.781.9618 or email to bsantos@intertechusa.com.

Pan-European Clean Coal Forum: Maximizing Efficiency and Ensuring the Energy Mix: Latest Cutting-edge Technologies for Cleaner Coal-Fired Power Generation, will be held January 18-19, 2007, at London, England. Coal people involved in power generation, strategic development and acquisition and divestiture will be in attendance with a variety of expert speakers. Contact Sumreen Rizvi at +44 (0) 20 3002 3277 or email to sumreeenr@marcusevansuk.com.

The International Society of Explosives Engineers is accepting registration for the 33rd Annual Conference on Explosives and Blasting Technique to be held at the Gaylord Opryland Resort, Nashville, TN, on January 28-31, 2007. The 2007 program includes a dynamic education program featuring technical sessions, panel discussion, poster session, and workshops combined with over 140 exhibits on the latest technology. As many as 1,600 blasters, manufacturers, government officials and suppliers are expected to attend. Call 440/349-4400 or fax at 440/349-3788.

The Electrical Safety and Reliability Conference & Exhibition, sponsored by the Professional Electrical Apparatus Recyclers League (PEARL), is scheduled for February 24-27, 2007 at the Westin Galleria Hotel in Dallas, TX. A special keynote presentation will be given by Alan M. Mirman Esq. of Horgan, Rosen, Beckham & Cohen, LLC. Exhibits, outside activities and receptions are on the schedule. To register visit www.PEARL.org.

Advance registration is open for the World of Asphalt 2007 Exhibit to be held March 19-22 at the Georgia International Convention Center in Atlanta, GA., and is designed to provide convenient and cost-effective access to exhibits of the latest product technologies and innovations plus industry-specific educational opportunities. To register call 866/229-2386 or visit www.worldofasphalt.com.