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Proximity Detection Systems for Mobile Machines in Underground Mines

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General Comment

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Attachments

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The Mine Safety and Health Administration intends on making it mandatory for all underground coal mine operators to add proximity detection systems to all coal hauling machines and scoops. Mines are dangerous environments to work in for multiple reasons, this new rule will help to save the lives of countless miners every day. I support this new rule and strongly believe the intelligent proximity detection system should be put in place as soon as possible in mines throughout the country.

The Mine Safety and Health Administration (MSHA) is proposing a new rule that will be up for comment until December first. MSHA intends on making it mandatory for all underground coal mine operators to add proximity detection systems to all coal hauling machines and scoops. According to MSHA a proximity detection system is defined as technology that uses electronic sensors to detect when one object is in close range to another or motion in general. Miners operating near coal hauling machines and scoops every workday are in danger of being pinned, crushed, or struck by mobile machines. Based off data from 1984 through 2014 MSHA has projected the new detection system to prevent 70 injuries and 15 deaths within the next 10 years. They also determined from the same data that 42 lives could have been saved and 179 injuries could have been prevented if this equipment was used since 1984.

Not only will this system prevent death and injury but also has other benefits for the mining industry. Mining accidents not only affect the worker but the company as well causing delays and costing money. MSHA states that this new system is not only economically feasible but will also save the mining industry money in the long run.

Before the intelligent proximity detection system (IPD) was invented by the National Institute of Safety and Health there was the Hazardous Area Signaling and Ranging Device (HASARD). Hazardous Area Signaling and Ranging Device (HASARD), is a proximity warning system, that was created by NIOSH. The HASARD alerted miners as they entered dangerous areas around equipment and other threatening work zones (Schifferbauer,2001); it used a low-power, low-frequency magnetic fields. The HASARD system was tested for six months to ensure it was capable to withstand the harsh environments of an underground mine. After being covered and scraped by tons of rocks, sprayed by immense amounts of water, and immersed in mud the system proved its strength (Schifferbauer, Mower, 2001). However, the HASARD system

created by NIOSH was not accurate enough to ensure miner safety, therefore, the intelligent proximity detection system (IDP), was created. This new system continuously tracks the location of miners in comparison to heavy machinery and only disables a machine if it detects danger. This limits irritation from false alarms and full stops of all machine operations (Mining Feature... miner safety, 2011).

Miners face a variety of dangers every single day on the job. Donoghue (2004), does a fantastic job of discussing different types of hazards miners face daily including physical, chemical, biological, ergonomic, and psychosocial. The two major challenges miners must overcome are physical and chemical hazards. Some of the significant contributors to physical dangers include falls, explosions, equipment accidents, entrapment, noise, and heat. According to Saleh and Cummings (2011), explosions are mainly caused by methane gas when concentrations in the mines atmosphere reach between five and fifteen percent. Noise is generated by drilling, ventilation, blasting, etc., and has proved to be very hard to control, therefore, hearing loss remains very common. Heat issues are more common in tropical or very deep underground mines and can be very severe. The temperatures reach so high that deadly heat stroke is very significant and remains a troubling problem. While major chemical contributors include silica, coal dust, and diesel particulates.

A significant amount of these hazards exist because miners are working in confined spaces, using remote controlled equipment, with little visibility due to dust, and poor lighting. Many accidents within the mine cause production delays because the injured must be removed from the scene, the accident must be investigated, finally, cleaned up all before mining can resume, and therefore production is halted losing the company money. Along with production

delay there may also be damaged equipment resulting from the incident, which can cost operators a significant amount of money to fix or replace.

MSHA has concluded that the new intelligent proximity detection system is technologically and economically feasible. The equipment proposed already exists and is currently out on the market readily available to operators. The economic cost was also projected for the mining industry to implement the detection system and concluded the cost was less than one percent of the industries annual revenue proving the system is inexpensive compared to the profits made. MSHA after reviewing and proposing the rule for coal mining, is now interested in proposing these same requirements to underground metal and other mines.

There are various detection systems that could potentially be used to protect United States coal miners besides the IPD system, examples from text are an wireless sensor network and an acoustic position estimation system. Kumar, Singh, and Bhattacharya (2013), discuss a wireless sensor network which allows for communication after an incident occurs. The system simultaneously checks the methane gas levels, temperature, and humidity inside the mine; while also keeping track of the amount of people inside the mine. Search and rescue is simplified because the system informs the rescuers of exactly how many people they are looking for inside the mine after an accident. This same system was also examined by Bo, Xin, Zhongyi, Chengwen, and Junliang (2013), who stated that lack of communication is a major factor in many mine accidents, therefore, a network detection system is prudent. Acoustic position estimation systems are also another fascinating way to protect the lives of miners. Hammer, Pichler, Fenzl, Gebhard, and Hesch (2015), created an acoustic position estimation system which can detect with an accuracy below 25 cm and precision lower than 2 cm. They created such a precise mechanism by placing acoustic detecters on miners hard hats that locate to a large base

station. By using sound instead of sight, the system is not affected by dark, dusty work spaces. Consequently, if the miners are not wearing proper personal protective equipment and leave their hard hats behind, the system is irrelevant and no longer has any ability to save lives, therefore, an individual miners is responsible for his or her own safety. Other types of proximity warning systems are shown below in Table 1, outlining the advantages versus the disadvantages for different systems, along with how the system works.

Table 1. Adopted from Engineering considerations... mining operations, 2012.

Type	Advantages	Disadvantages	Sensing Method
Infrared: Passive	Good for long distance in fog.	Accuracy issues with heavy snow and rain.	Detects objects or person presence by heat energy radiation.
Infrared: Active	Good for long distance in fog. Measures vehicle speed.	Environmental concerns affecting accuracy include temperature, dust, and water sprays.	Emits laser beam to ground. Detects reduced time of reflection by objects in path.
Radar: Pulsed	Compact and easy to install.	All objects trigger the alarm. Snow and ice buildup and angle of incidence accuracy issue.	Measures time-of-flight of a pulse that is transmitted and then reflected off of objects detection zone.
Radar: Doppler	Compact and easy to install. Measures vehicle speed.	Cannot detect stopped objects. Snow and ice buildup issues.	Detects a frequency shift in generated signal due to object in detection zone.

Type	Advantages	Disadvantages	Sensing Method
GPS	Accurate; covers wide area.	Only works on the surface.	A receiver detects satellite signals and triangulates position, transmits location to other vehicles/personnel via radio.
Video Cameras	Simplicity.	Operator must observe monitor. Limited field of view.	Vehicle operator monitors objects in blind spots on cab-mounted monitor.
Magnetic: Passive	Compact and easy to install.	Accuracy issues with metallic objects in field.	Detects change ni Earth's magnetic field when objects enter detection zone.
Magnetic: Active	Great accuracy over short distances.	Only receiver in detection zone triggers alarms.	A transmitter provides a marker signal. A receiver measures signal strength and provides alarms.

After reviewing and researching the proposed rule for the coal mining industry I find it socially irresponsible for the mining industry not to implement this new proposed rule. Old technology has proved unreliable and unfit for the coal mining industry. With the new intelligent proximity detection system the working conditions within the mine will significantly improve, allowing for a safer and healthier environment. There is no reason the mining industry cannot get a hold of the new equipment because it is already commercially available making it easy to obtain and for a fair price, less than one percent of the coal mining's billion dollar revenue a year. In conclusion, I support this new rule and fully believe that the IPD system should be put

into every coal mine in the United States of America to ensure the safety and health of our miners.

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