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Proximity Detection Systems for Mobile Machines in Underground Mines

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General Comment

See attached file(s)

Attachments

Comment regarding application of proximity detection systems for mobile machines in underground mines

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November 10th, 2015

MSHA
Docket No. MSHA-2014-0019

To whom it may concern,

I am writing this in response to the Mine Safety and Health Administration's (MSHA) call for public comment on proximity detection systems for mobile machines in underground mines. I am writing this comment because I believe that miners have a right to be outfitted with the most up-to-date technology in order to help counteract the particularly dangerous nature of their work. According to MSHA accident data, there were 49 fatalities and 4,914 nonfatal days lost in the underground coal mining industry from 2000 to 2009, and I believe that the implementation of proximity detection systems on miners and equipment in underground mines, would help to drastically decrease these statistics.

Specifically, I will be responding to the proposals concerning the need for audio and visual warning alarms and the possibility of incorporating a vibrating alarm along with these audio and visual alarms, the concerns raised about the impact on the equipment operator from this technology, and the request for some alternative methods of deploying this system. I will also offer some insight into the possible solutions that other studies have investigated, and discuss their findings in the field testing of several other proximity detection systems deployed on construction sites and in underground mines.

I believe that the deployment of this technology is a necessity in underground mining operations, and hope the information and suggestions offered in this comment will assist MSHA in coming to the best, and most well-informed decisions in regards to miner safety, and the deployment of this technology in underground mines.

Sincerely,

Ronald Drake

Comment regarding application of proximity detection systems for mobile machines in underground mines

Even though mining safety has become a higher priority in recent years, the number of equipment-related fatalities from 1995-2005 was still anywhere between 37% and 88% (Kecojevic, V., Komljenovic, D., Groves, W., Radomsky, M., 2007). The application of proximity detection systems and audio/visual warning systems in underground mining equipment has shown to increase the detection time of equipment by miners, in some cases by as much as 75% (Sammarco, J., Gallagher, S., Mayton, A., Srednicki, J., 2012). Audio and visual warning systems in mines allow miners and equipment operators to be more aware of their surroundings when working in close proximity with mining equipment. The employment of these proximity detection systems on mining equipment would help to reduce pinning and struck-by accidents; however, the type of proximity detection system and the resulting action the system takes once triggered, should be taken into careful consideration in order to minimize detection time and not cause a situation with further risks.

According to MSHA accident data, there were 49 fatalities and 4,914 nonfatal days lost in the underground coal mining industry from 2000 to 2009, that were a result of pinning or struck-by accidents. Many of these accidents were due to poor work practices while working within the turning radius of a Continuous Mining Machine (Sammarco, J., Gallagher, S., Mayton, A., Srednicki, J., 2012). Had a proximity detection system been in place at the time, the victims and equipment operators could have been notified that they were within an unacceptable distance from each other, and these accidents may have been avoided.

While the presence of proximity detection systems on mining equipment is a good method to improve safety practices in the mining industry, the end result and overall success of the devise is going to be determined by the action taken by the system when it is triggered. For instance, the action taken may be to shut down the piece of equipment when the proximity sensor detects another object or miner that is an unacceptably close to the equipment, as suggested in this proposal. This equipment shut down "fail-safe" however, may not be the most proactive way to alert miners and equipment operators of each other's presence, and may actually put the operator at a higher risk than the miner on the ground. Sudden stops and equipment shut downs, like any other unexpected operations, could put the operator of the machine at risk of injury or death, based on the size, speed, and other related factors of the machine they are operating. Therefore, I believe that incorporating proximity based audio and visual warning systems along with the shut-down procedures of the proximity detection system being proposed, may be a more proactive and safe approach to ensuring miner safety. The addition of these audio and visual warning systems would allow the miner and the operator of the machine to be alerted of each other's presence before they got too close and forced an equipment shut-down, and would allow the shut-down procedures of the proposed system to act as a last resort. This would assure that both the miner and the operator of the machine are put at minimal risk by preemptively alerting them of the possible danger, while at the same time minimizing the detection time of both the miner and the operator once they have been alerted.

Audio and visual warning system prototypes have been tested in both construction sites and underground mines. In 2010, a journal article was published discussing the results of field

testing audio and visual warning systems on a construction site, and while this may not have been in a mine setting, the principle of the tests were consistent with the purpose for implementing similar technologies on mining equipment. The audio and visual warning systems tested were proximity based and designed to improve the safety of the construction site by alerting on-the-ground workers and equipment operators of each other's presence. The system employs both audio and visual warning systems, where the equipment operator receives audio and visual warring signs in the cab of the equipment, and the workers on the ground receive audio warnings from worn personal protection units, and a visual warning from the piece equipment. These audio and visual warnings are based off of proximity detection technology, and activate when the worker or equipment comes to close to the other. These "alert distances" are customized for each piece of equipment, to assure maximum safety in construction zones. This proximity safety system may be able to be adapted into the mining setting to minimize such incidents as "struck-by" or "pinning" accidents.

Another pro-active step taken by this experiment, was the incorporation of a vibrating alarm system, which would alert personnel even if they were wearing headphones or if they were in a particular noisy environment, as a mine would be. During the field tests of this system, all equipment came to a complete stop when the alarm activated, at least 10 meters away from the construction personnel. The tests concluded that the audio, visual, and vibrating warning system was successful in alerting construction personnel and equipment operators of danger (Teizer, J., Allread, B. S., Fullerton, C. E., Hinze, J., 2010).

Another journal article published in February of 2015, focused on a study which investigated the possible uses for applying acoustic technology to mining safety procedures. The developing system uses frequency-modulated measurement signals to overcome the noisy environment, and is working to deal with reverberation and intermediate obstacle problems that would be experienced within a mine (Hammer, F., Pichler, M., Fenzl, H., Gebhard, A., Hesch, C., 2015). The system is based off of a six-loudspeaker system mounted to the mining machinery and a mobile "tag" placed on the miner. The loudspeakers on the machinery and the microphone on the miner's helmet will both emit audible sound, which will increase in intensity as the machine and miner get closer to each other. This prototype is still working to overcome sound reflection problems in mines to assure that the system always gives an accurate estimate of distance (below 2 cm) between the machine and the miner. This acoustic system is specifically designed for the unique mine setting, and is actively working to deal with the common problems, like noise reverberations and obstacles in mines.

Although audio warning systems are working to overcome the noisy environments posed by mining operations, I believe the best approach to maximizing the awareness of miners on the ground and equipment operators is through a visual warning system placed on the equipment. A visual warning system, such as flashing red LED lights mounted on mining equipment perhaps, is going to create the most obvious sensory alert to a worker in a mine. In a study conducted on visual warning systems on mining equipment, it was found that both forward and backward machine movement was detected more quickly by flashing lights, as opposed to directional or dynamic lighting alerts (Sammarco, J., Gallagher, S., Mayton, A., Srednicki, J., 2012). This study did not however, investigate the effects of visual warning

systems given to miners on the ground. A small LED light placed on somewhere like the underside of the brim of a hard hat, may also be a possibility to be paired with the flashing LED lights on a piece of equipment. This would insure that the miner on the ground, even if facing away from the equipment, would see a visual alert. This would also help to avoid the possibility of not being alerted by an audio alarm due to other noise.

Overall, I believe that any type of proximity alert system deployed in mines that have the capability to stop a piece of equipment automatically, should be required to give a signal to the operator of the equipment well before the system stops the machine. This would avoid operator injury from unexpected "shut-down" or abrupt halts of the machine. This would also give the operator time to see the danger and remedy the situation before the machine is stopped automatically.

For all technologies deployed in mines, it is important to consider the different types of safety technologies employed in mines, and how they may be improved or replaced by a more "user-based" system. Much of the current research on safety technology used in mines is centered on the engineering of the technology itself, and the factor of the operator is not always considered in the design process (Horberry, T., 2012). While the pushes for automation in mining equipment continue to grow, it is also important to consider the operator's skill level and compatibility with the equipment during the design process.

I believe that the incorporation of proximity detection systems in mining operations is an important step to take to further ensure the safety of miners and equipment operators, but the many methods in which these technologies are possibly deployed could yield very different

outcomes. In the interest of deploying a system which provides maximum safety benefits to the miners and equipment operators, I believe that audio, visual, and in some cases, even vibration alert systems should be implemented both on the equipment/equipment operators, and the miners on the ground. With both the equipment/equipment operators and the miners on the ground being alerted in two or three different ways, the maximum effect will be achieved by the system in working to protect miners from pinning and struck-by accidents by mining equipment.

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