JOY MINING MACHINERY
A Joy Global Inc. Company

120 Liberty Street
Franklin, Pennsylvania 16323
(814) 437-5731

2010 MAR 29 A 2:21

March 29, 2010

Mine Safety and Health Administration
1100 Wilson, Boulevard
Room 2350
Arlington, VA 22209-3939

Comments on RIN 1219-AB65, Proximity Detection Systems for Underground Mines

To whom it may concern,

Joy Mining Machinery is submitting the following comments in response to the Request for Information as documented in the Federal Register, volume 75, No. 20 dated February 1, 2010.

Joy is in a unique position to provide comments on this subject as we have been involved with Proximity Detection since the initial research project conducted in 2002 as documented in the Background information of this Information Request. In addition we have been involved to some level with each Proximity Detection manufacturer on every generation of design because of the interface to our continuous miner models. Throughout the installations of various generations of systems from the manufacturers, Joy has devoted multiple employees to work with the manufacturers and coal operators to attempt to obtain a working system capable of accurate information which is able to survive the rigors of the mining environment. In addition, Joy has reviewed each manufacturer's system over the past eight years to determine if their Proximity Detection System (PDS) warranted Joy involvement to further develop the system into a commercially viable product to use as a training tool for the operators.

Despite these efforts there is still not a PDS that has proven to be reliable and effective in an underground coal mine. However, we are continuing our efforts and trying to utilize our experience in conjunction with a PDS manufacturer to see if an effective system can be developed for underground mining. Recently Joy entered into a partnership agreement with Matrix Design Group to develop a system for Joy Continuous Miners. Joy and Matrix are currently conducting underground trials on the system which has been in development for four years. Plans are to update the trial systems with improved technology from the lessons learned in the first trial and conduct second trials in the May-October 2010 timeframe. A preliminary release is scheduled for late 2010 which will allow customers to field trial the system (1 or 2 machines) themselves before outfitting their entire fleet. Our plan is to offer a system as an option on our continuous miners in year 2011.

One of Joy's three core principles is "*Zero Harm Mentality*". We strive to design every portion of our equipment to be the safest possible. Our involvement with Proximity Detection which includes the problems encountered underground and the challenge in making the system feasible for

AB65-COMM-2

reliable use causes us concern when we read/hear of others claiming that systems are available for reliable use as a "safety device". We wish to be upfront in our comments and provide a positive yet realistic opinion on exactly where this technology currently stands. Our philosophy has been that an unreliable system does not improve operator safety, and a system must be thoroughly tested and field-trialed before release. We refuse to introduce a system into the mining environment that is unreliable, subject to misuse and used for something beyond its capabilities. Due to reasons as described in the answers to the questions listed below in the Information Request, we have reservations about any description of the Proximity Detection system used as a "safety device". We do anticipate introducing a training tool system that is robust to survive the mining environment, have repeatable results, and provide accurate monitoring and selectable warning/shutdown scenarios. Our initial goal is to develop the system to the point where it can teach the machine operator to stay out of a pre-defined red zone area when operating the equipment. A long term goal is to increase the reliability so that it can be used as a "safety device", but this will likely take several more years of development. We would recommend a "phase-in" approach as the systems develop and prove their reliability and increase their abilities to protect.

With that premise, please find the following responses to each of the 25 questions listed in the Information Request:

1. Please provide information on the most effective protection to miners that you believe proximity detection systems could provide, e.g., warning, stopping the equipment, or other protection. Include your rationale.

Assuming reliable, repeatable, and effective operation of a PDS, and minimizing the effect on production, the most effective protection is stopping machine tram and conveyor swing. If we minimize the impact on the machine operation when the red zone is breached to only those functions that can cause the machine to move toward the operator, this will increase operator acceptance and therefore he will be less likely to find ways to bypass or circumvent the system.

2. Other than electromagnetic field based systems, please address other methods for effectively achieving MSHA's goal for reducing pinning, crushing, and striking hazards in underground mines.

As a general principle moving personnel further away from any equipment reduces the chances of an injury involving that equipment, but developing technologies that could do that in room & pillar mining is difficult because the equipment must be moved frequently and in different directions.

3. In general, reliability is defined as the ability of a system to perform when needed. Please provide information on how to determine the reliability of a proximity detection system. The Agency would appreciate information that describes reliability testing, how reliability is measured, and supporting data.

Reliability of the electronic hardware of a PDS is increasing. The problem with electromagnetic field based systems is interference. The biggest concern being that interference may exist and be unknown to the operator or even the PDS. This can cause the operator to not be protected, when he believes that he is. Much work will need to be

done to at least detect interference (anomalies) and flag the operator, if not protect against these anomalies before the system would be considered reliable.

4. Manufacturers should design their systems to be fail-safe. Please provide information on how miners would know when a proximity detection system is not working properly. Include suggestions for what works best, including your experience, if applicable.

Given all of the elements present in the mining environment, it may not be possible to develop a fail-safe PDS. Specifically, electromagnetic technology has the potential problem of interference due to electrical sources and ferrous-metal objects. This may prevent this technology from providing 100% protection. Other technologies, such as infra-red, light curtains, cameras, ultrasonic, and radar have their merits and their issues. The most significant is their lack of ability to always be able to see out in front of the machine. From an electronic hardware perspective, indicator lights can be provided and the controlled functionality can be disabled if necessary. In terms of interference, it is unknown if this can be detected. If it can be detected then measures can be developed to protect against the anomaly; the operator can be flagged, or the controlled functionality can be disabled.

5. Please describe procedures that might be appropriate for testing and evaluating whether a proximity detection system is functioning properly. Include details such as the frequency of tests and the qualifications of persons performing tests; include specific rationale for your suggestions.

The person performing these tests should fully understand what a PDS is intended to do, fully understand the mining cycle, and how the electromagnetic field based technology works. A properly designed electromagnetic system should not require periodic testing or calibration. It will require validation testing at the time of installation and underground in the application, prior to being put into production. Multiple Personal Wearable Devices (PWD) should be tested to ensure the defined red zone operates as planned in the actual environment. Known interference sources should be introduced to ensure the designed operation of the PDS is maintained.

6. Some proximity detection systems provide a warning before the equipment shuts down. An excessive number of warnings can cause miners to become complacent and routinely ignore them as nuisance alarms. Please describe any experience you have had with nuisance alarms and how you addressed these alarms to assure an appropriate level of safety for miners. In addition, please provide suggestions for minimizing nuisance alarms.

The interface to the operator should be kept simple. The PDS we are developing has indications of system faults, to help the operator keep his machine in production and himself out of the red zone. The only nuisance alarms we have experienced are trips of the red zone due to anomalies.

7. How should the size and shape of the area around equipment that a proximity detection system monitors be determined? What specific criteria should be used to identify this area, e.g., width of entry, seam height, section type, size of equipment, procedures for moving equipment, speed of equipment, and related information? Please provide any additional criteria that you believe would be useful in identifying the area to be protected.

The size and shape of the area needs to be determined based on the speed at which the conveyor tail could swing, the speed the machine can tram, as well as the capability of the PDS which includes the response time of the system.

8. Proximity detection systems can be programmed and installed to provide different zones of protection depending on equipment function. For example, a proximity detection system could monitor a larger area around the RCCM when it is being moved and a smaller area when the machine operator is performing a specific task, such as cutting and loading material. How should a proximity detection system be programmed and installed for each equipment function?

The speed at which the machine can swing during tramming has the most significant impact on the size of the red zone. If the machine is tramming at slower speeds, smaller red zones can be utilized, making the machine more usable to the operator.

9. Since 1983, six fatalities occurred while miners performed maintenance on RCCMs. The fatalities involved three miners crushed in the machine and three miners pinned between the machine and mine wall or roof. Please provide specific information, including experience, on how a proximity detection system might be used to protect miners during maintenance activities and why the system would be effective in each situation.

If the accuracy and responsiveness of the PDS is good enough, the red zone could possibly be shaped for maintenance operations so that personnel could get close to the machine in areas that are not pinch points. It is unknown yet if accuracy or responsiveness of the future state of the art of electromagnetic based PDS will be capable of providing protection for this condition. Perhaps it will help to severely limit the machine functionality if the PDS is disabled for these operations.

10. Some proximity detection systems include an override function that allows the system to be temporarily deactivated. Please provide information on whether an override function is appropriate and, if so, please provide information on the circumstances under which such a function should be used. Please provide information on the types of procedures or safety precautions that could be used to prevent unauthorized deactivation of a proximity detection system.

The PDS will require temporary deactivation in case of system failure while under unsupported roof. We have employed the same functionality as Emergency Stop Override for this function.

11. MSHA found, in its field testing experience that the use of some new technology for controlling motor speed, like variable frequency drives, could result in nuisance or false alarms (shutdowns) from the proximity detection system. Please provide information on other sources of interference, if any that might affect the successful performance of proximity detection systems in underground mines. In addition, please provide information on whether a proximity detection system might adversely affect other electronic devices, such as atmospheric monitoring systems, used in underground mines. Please provide specific circumstances including: (1) types of equipment; (2) adverse effect; and (3) how the adverse effect could be minimized.

Any electrical source or ferrous metal-based object is a potential interference source. We have seen interference due to the trailing cable, DC traction drive, Shuttle car, and wire mesh on roof/ribs. It is unknown yet if these interferences can be detected, let alone whether their effect can be minimized.

12. Commenters who have experience with RCCMs, please describe: (1) any experience with pinning, crushing, and striking hazards, including accidents and near misses; and (2) any unique experience with an RCCM with auxiliary equipment attached.

Joy has assisted MSHA in investigating accidents involving pinning or crushing accidents, as well as being involved in several lawsuits concerning such incidents. In all of these incidents we believe the cause to be a failure of the operator or other personnel to follow safe operating procedures.

13. How should the area that a proximity detection system monitors be determined on an RCCM interconnected with auxiliary equipment?

Testing must be done with the equipment attached and in the actual operating environment.

14. Describe whether there are safety benefits from applying proximity detection systems to underground equipment other than RCCMs. Describe your experience with pinning, crushing, or striking accidents and near-misses involving other underground equipment. Please provide examples identifying the specific types of equipment involved and how proximity detection systems may help provide an additional margin of safety to miners. Also describe any experience you have with respect to obtaining MSHA or other agency approval for systems designed for underground equipment other than RCCMS.

There is possible benefit to applying PDS technology to any equipment in a working Room and Pillar or Entry Development section, as well as feeder breakers. Coordinating the systems on multiple machines and personnel in the same section presents many practical problems. Using PDS systems in all mobile equipment should probably be a long term objective but we believe that it is prudent to first focus on developing a reliable PDS for RCCMs, and then see if the technology can be successfully adapted to other mobile equipment.

15. How might a proximity detection system for remote controlled equipment be different than one for non-remote controlled equipment?

The operator riding on the equipment may not need to be protected as long as the machine is disabled if he/she leaves the operator's compartment. Other personnel in the area would still need to be protected.

16. Manufacturers are evaluating the use of proximity detection systems on multiple pieces of equipment that operate near each other, such as RCCMs and shuttle cars. In your experience, what are the safety considerations of coordinating proximity detection systems between various types of underground equipment?

The machine mounted parts of the PDS we are developing do not transmit an electromagnetic field. As long as the same technology is used on the other equipment, the machine to machine interference should be limited to the effect of the steel construction of the equipment. If different PDS systems are used on different equipment then interference may occur.

17. Describe your experience with the state-of-the-art of proximity warning technology. Include any experience related to whether the current technology is able to accurately locate and protect workers from all recognized hazards.

Electromagnetic technology has the potential problem of interference due to electrical sources and ferrous-metal objects. This may prevent this technology from providing 100% protection. Other technologies, such as infra-red, light curtains, cameras, ultrasonic, and radar have their merits and their issues. The most significant is their lack of ability to always be able to see out in front of the machine.

18. What knowledge or skills would be necessary for miners to safely operate equipment that uses a proximity detection system? What knowledge or skills would other miners working near the equipment need?

Operators and other miners will need training to enable them to understand what they need to do when the system disables the machine due to someone entering the red zone. Maintenance personnel will require training to enable them to quickly interpret the diagnostics to get a machine operational if a system failure occurs.

19. Please provide suggestions on how to effectively train miners on the use and dangers of equipment that uses a proximity detection system. Please include information on the type of training (e.g., task training) that could be used and on any evaluations conducted on the effectiveness of outreach and/or training in the area of proximity detection (e.g., red zone warning materials). How often should miners receive such training?

Machine Operators need to be trained to not rely on the PDS to provide protection for themselves or other miners. It should be thought of as an Operator Training Aid and a supplement to their observation and knowledge of what is going on around the machine and other equipment around them.

20. Please provide information on the benefits of using proximity detection systems with RCCMs. Please be specific in your response and, if appropriate, include the benefits of using proximity detection systems with other types of underground equipment. Include information on your experience related to whether proximity detection systems cause a change in the behavior of an RCCM operator. For example, would the operator need to operate the machine from a different location, such as one that might introduce additional hazards, to remain outside of a predefined danger zone? Please explain your answer in detail and provide examples as appropriate.

From our limited trials to date we have seen that Proximity Detection does require most operators to change behavior. The changes we have seen are positive while not intrusive. For example, at one test site an operator had a bad habit when operating the machine, exposing himself to possible injury. This operator is now not able to operate the machine

in that way due to the implementation of the system. We continue to work through the operator interaction and behavior changes, but have a limited amount of examples to discuss.

The present status of the PDS we are developing is that it does not provide 100% protection 100% of the time. Also, sometimes there are performance delays. These issues result in either the system not providing protection when it should (miners around the machine not knowing this), or the system inadvertently causing the red zone to be larger than it should.

21. Please provide information on the costs for installing, maintaining, and calibrating proximity detection systems on underground equipment. What are the feasibility issues, if any, related to retrofitting certain types of equipment with proximity detection systems?

Since we are in the very early stages of equipment design and are currently prototyping trial samples, we cannot offer any advice on costs. Once a design becomes finalized and we complete the work related to the manufacturing of the different pieces of the system and the installation on the RCCM, then we will be better prepared to cost the system.

Each model of RCCM is different in available locations to mount components, and within each model there are variations which will make it difficult to field retrofit the addition of proximity detection. Most retrofits will need to be done in a shop or during rebuild.

22. What is the expected useful life of a proximity detection system? Please provide suggested criteria for servicing or replacing proximity detection systems, including rationale for your suggestions.

We are designing our PDS to be usable the entire time between rebuilds. The survival of the electronic components appears to be the limiting factor.

23. Some proximity detection systems automatically record (data logging) information about the system and the equipment. Are there safety benefits to having a proximity detection system automatically record certain information? If so, please provide specific details on: (1) safety benefits to be derived; (2) information that should be recorded; and (3) how information should be kept.

Information regarding time, what is happening with the machine in terms of machine functions, and where the PDS thinks the operator is should be stored to continue the development of the technology and in case of a possible accident. The mine operator may be able to use this information to identify areas for improved miner training. It is suggested that this information be downloaded weekly and stored with other production reports. Note that where the PDS thinks the operator is located is only as good as the PDS is capable, in light of possible anomalies.

24. Please provide information on whether small mines or mines with special mining conditions, such as low seam or mine entry height, have particular needs related to the use of proximity detection systems. Please be specific and include information on possible alternatives.

It may be more difficult to accurately determine the position of the operator in very low mines due to the close proximity of possible interference sources in the mine roof and the location of the PWD on the operator. Testing has not yet been conducted in low seam mines so no data is available.

25. What factors (e.g., cost, nuisance alarms) have impeded the mining industry from voluntarily installing proximity detection systems on mining equipment?

The unavailability of a PDS that provides 100% protection around the machine, 100% of the time, and is practical for mining operations. Another factor is the effective detection with small tolerances. For example surface operators can live with errors of +/-2 meters. Operators working underground in close proximity to the RCCM equipment must be tracked to within 150-200mm. As stated earlier, environment makes this very difficult to achieve given that the amount of metal in the area fluctuates.

The above information and responses indicate Joy's ongoing commitment to the safety of mining personnel who utilize our equipment. We will continue to strive to meet our core principle of "*Zero Harm Mentality*" by investing in ideas, concepts and designs that will improve the working environment of all underground mines.

Thank you for giving us this opportunity to address the subject of Proximity Detection. If further information is needed or clarification of the information presented in this correspondence, please contact me at dgthomas@joy.com or telephone at (814) 432-1592.

Best Regards,

David Thomas

David Thomas
Global Certification Engineer