PUBLIC SUBMISSION

As of: 12/20/18 1:17 PM
Received: December 20, 2018
Status: Posted
Posted: December 20, 2018
Tracking No. 1k2-977o-9qps
Comments Due: December 24, 2018
Submission Type: Web

Docket: MSHA-2018-0016
Safety Improvement Technologies for Mobile Equipment at Surface Mines, and for Belt Conveyors at Surface and Underground Mines.

Comment On: MSHA-2018-0016-0001
Safety Improvement Technologies for Mobile Equipment at Surface Mines, and for Belt Conveyors at Surface and Underground Mines.

Document: MSHA-2018-0016-0098
Comment from Mark Ellis, Industrial Minerals Association - North America

Submitter Information

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Organization: Industrial Minerals Association - North America

General Comment

Please see the attached.

(Note: IMA-NA Attachment 2 - NIOSH RI 9672 (2007) is too large to upload to Regulations.Gov. It has been submitted via e-mail to MSHA's Office of Standards, Regulations, and Variances.)

Attachments

IMA-NA Comments on MSHA Powered Haulage RFI

IMA-NA Attachment 1 - ILO Code of Practice of Open Cast Mines (2017)

IMA-NA Attachment 3 - MSHRAC Minutes 11-15-17

IMA-NA Attachment 4 - MSHRAC Minutes 5-22-23-18

Industrial Minerals Association — North America

December 20, 2018

Ms. Sheila McConnell
Director
Office of Standards, Regulations, and Variances
Mine Safety and Health Administration
201 12 Street, South
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Re: RIN 1219-AB91; Docket No. MSHA 2018-0016, Request for Information on Safety Improvement Technologies for Mobile Equipment at Surface Mines and for Belt Conveyors at Surface and Underground Mines

Filed via the Federal eRulemaking Portal: http://www.regulations.gov

Dear Ms. McConnell:

The Industrial Minerals Association – North America ("IMA-NA") is pleased to submit the following comments in response to the Mine Safety and Health Administration's ("MSHA") Request for Information ("RFI") regarding the use of technology to improve mine safety, which was published in the June 26, 2018 Federal Register (83 Fed. Reg. 29718).

IMA-NA is the representative voice of companies which extract and process a vital and beneficial group of raw materials known as industrial minerals. Industrial minerals are the ingredients for many of the products used in everyday life such as glass, ceramics, paper, plastics, paint and coatings, cosmetics, pharmaceuticals, and laundry detergent. IMA-NA's companies and the people they employ are proud of their industry and the socially responsible methods they use to deliver these beneficial products. Industrial minerals include ball clay, barite, bentonite, borates, calcium carbonate, diatomite, feldspar, industrial sand, kaolin, soda ash (trona), talc, and wollastonite. IMA-NA also represents associate member companies that support producers of industrial minerals. The safety and health of our employees are of paramount concern to IMA-NA members.

IMA-NA's comments are structured to be responsive to the questions posed in the RFI. Our comments correspond to the numerical headings outlined in the RFI. IMA-NA's comments are highlighted in **BOLD**.

IMA-NA responds to selected questions from the RFI as follows:

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A. Seatbelts

Seat belt interlocks are engineering controls that prevent or otherwise affect equipment operation. MSHA is particularly interested in engineering controls that affect equipment operation when the seatbelt is not properly fastened.

1. What are the advantages, disadvantages, and costs associated with a seatbelt interlock system?

A.1. The advantage to seatbelt interlock systems is that the mobile equipment cannot be operated unless the seatbelt is connected. The disadvantage is that the seatbelt still can be connected behind a driver or rigged in other ways, losing its effectiveness. Operationally, if mobile equipment must be moved in an emergency, the time needed to connect the seatbelt to engage the equipment could cause delays in moving the mobile equipment quickly, potentially creating a greater hazard. Further, any time a seatbelt is engaged and then disengaged after the mobile equipment is operating, the equipment operator <u>cannot</u> lose control of the equipment, causing unintended consequences. IMA-NA does not have independently verified data to respond to the cost associated with such systems.

2. Are seatbelt interlock systems available that could be retrofitted, and if so, onto which types of machines and how? What are the costs associated with retrofitting machines with these systems?

A.2 IMA-NA does not have independently verified data to respond to this question involving seatbelt interlock systems in off-road mining vehicles.

3. Are some types of mobile equipment unsuited for use with seatbelt interlock systems, and if so, which machines and why?

A.3. All large mobile equipment should be considered for this type of device such as haul trucks, scrapers/graders, wheeled front end loaders, large water or fuel trucks, and wheeled and track dozers. The lack of seatbelt use in small pick-up type trucks or personnel vans has not been the cause of injuries and fatalities based on the MSHA data. Requiring interlock systems on these types of vehicles operated on mine property is an overreach without proven benefit. Further, the maintenance of seatbelts in smaller vehicles would be an onerous obligation to impose on the mine operator.

4. Reliability is the ability of a system to perform repeatedly with the same result. Please provide information on how to determine the reliability of seatbelt interlock systems. Some engineering controls encourage and promote seatbelt use without directly preventing or affecting equipment operation. These engineering controls include audible and visual warning devices, such as lights and buzzers/bells that remind equipment operators to fasten their seatbelts.

A.4. IMA-NA does not have independently verified data to respond to the reliability issue of a seatbelt interlock systems in off-road mining vehicles.

Other types of engineering controls such as audible and visual alarms to remind the operator to use seatbelts can be implemented more quickly with less resistance from mine

operators and equipment operators. These alarms can be lights in the cab or beacons outside the cab engaged when the seatbelt is not connected, or they may be audile alarms inside the cab. Further, mobile equipment operators are more likely to connect the seatbelt to avoid the continuous annoying sound or light.

5. What are the advantages, disadvantages, and costs associated with these warning devices?

A.5. While IMA-NA does not have independently verified data to respond to the costs of alarm systems, these systems should not be costly to implement in off-road mining vehicles.

Other suggested hazard control strategies:

The use of high visibility materials on the front strap of a seatbelt would provide management and other miners the ability to determine if the seatbelt is connected properly. With the high visibility materials on the seatbelt strap, a mobile equipment operator would be more inclined to connect the seatbelt in the proper manner versus not at all or behind the equipment operator.

The International Labour Organization ("ILO") addressed safety in open cast mines in accordance with the decision taken by the Governing Body of the ILO at its 329th Session convening a meeting of Experts on Safety and Health in Opencast Mines in October 2017 to review and adopt a revised code of practice. Addressing seatbelts and safe means of entry and exit, see paragraphs 500 and 501. (See IMA-NA Attachment 1.)

B. Collision Warning Systems and Collision Avoidance Systems

MSHA is also interested in collision warning systems and collision avoidance systems that may help prevent accidents by decreasing equipment blind areas and reducing collisions. These systems detect obstacles and provide the equipment operators with information about their location. The installation of the systems would likely need to be customized to account for variations in height, articulation, and other equipment design features. Such systems would likely also need to have the capability to adjust to mining conditions and environments such as road conditions, weather, and traffic patterns. They would also need to be designed and installed to minimize distractions such as nuisance alarms and unnecessary stops, and to be compatible with other technologies, such as GPS, radar, radio frequency identification tagging, electromagnetic systems, cameras, peer-to-peer networks, and path prediction technologies.

6. What are the advantages, disadvantages, and costs associated with collision warning systems and collision avoidance systems?

7. Please provide information on how collision warning systems and collision avoidance systems can protect miners, *e.g.,* warning, stopping the equipment, or other protection. Include your rationale. Include successes or failures, if applicable.

B.6 and 7. The advantage of a collision warning system is that the large mobile equipment operator is provided time to react to a potential hazardous situation without losing control

of the equipment. This type of warning system should be installed on larger equipment, such as haul trucks, scrapers/graders, wheeled front end loaders, large water or fuel trucks, and wheeled and track dozers. Collision warning systems also should be considered for equipment working around personnel and other machines. The disadvantage to this type of technology is that conditions at a mine may cause nuisance alerts, such as berms or foliage or stockpiles or light banks or structures at waste dump points or hopper dump points or other stationary features. A mine site may not consider such stationary features to be hazards, but the warning system still detects a potential hazard.

The advantage of collision avoidance systems, or otherwise known as semi-autonomous systems, is that they shut down the mobile equipment to avoid a collision. The challenge is for the collision avoidance system to recognize when a collision may occur. Semi-autonomous systems do not require the other vehicles or persons to be equipped with a tag.

On the other hand, a system that requires a transmitter and a tag or receiver can create potential issues if the other vehicles or persons are not correspondingly equipped. Take tagging of personnel, for instance. The vehicle requires a transmitter and receiver and personnel require a tag. If a person does not properly wear their tag or the transmitter does not detect it, the equipment operator believes there is no hazard when in fact that may not be the case.

In both types of systems, once control of the mobile equipment is taken away from the equipment operator, then other unintended hazards arise, such as an operator exiting equipment in an active work area, so procedures for these situations need to be addressed before they occur.

National Institute for Occupational Safety and Health ("NIOSH') Report of Investigation ("RI") 9672 (June 2007) provides valuable research information on the efficacy of various types of warning devices including radar, sonar, infrared, tag-based systems, and proximity warning systems. It is apparent from the NIOSH field testing that all systems had pluses and minuses, however no one system was fail-proof. One theme that ran throughout the field-testing summaries is that nuisance and false alarms would occur and that they were problematic for mobile equipment operators. In the words of the NIOSH researchers in Section 6, at page 47 of the RI, "[H]owever, limitations for all of these technologies exist and they must be communicated to equipment operators and personnel that work near the equipment." Further, NIOSH stated in its summary that "[D]ue to the high probability of nuisance alarms, automatically controlling the brakes based on obstacle detection by a sensor is not recommended." (See IMA-NA Attachment 2.) With these caveats, MSHA cannot implement a single solution believing it will solve all possible scenarios.

8. What types of mobile equipment can, and should, be equipped with collision warning and collision avoidance systems? For example, systems that work well on haul trucks may not work well on other mobile equipment; certain types of equipment may be more likely to be used near smaller vehicles; or some types of equipment may have larger blind areas.

B.8. All large mobile equipment is capable of being equipped with collision warning devices, such as haul trucks, wheeled front end loaders, large water or fuel trucks, scrapers/graders, and wheeled and track dozers. Collision warning technology is becoming standard equipment on Class 1 (Gross Vehicle Weight Rating (to 6,000 pounds)) through Class 5 vehicles (Gross Vehicle Weight Rating (16,001 to 19,500 pounds)). Even though the MSHA data does not support the installation of a collision warning device on smaller vehicles, this opportunity to eliminate potential hazards should be considered. Additional research should be supported consistent with NIOSH RI 9672 and recommendations of the Mine Safety and Health Research Advisory Committee ("MSHRAC").

9. Collision warning systems and collision avoidance systems may require multiple technologies that combine positioning/location, obstacle detection, path prediction, peer-to-peer communication, or alarm functions. What combination of technologies would be most effective in surface mining conditions? Please provide your rationale.

B.9. Due to the many factors that affect mobile equipment safety, MSHA should consider multiple, simple approaches. The more complicated the approach, the less likely effective implementation will occur regardless of the size of the mine operator. Also, time is of the essence and the longer MSHA takes to evolve a solution the less likely a solution will evolve timely. Thus, MSHA can start with the basics which could include effective training of mobile equipment operators and miners. Using a best practice approach, MSHA should distribute immediately throughout the mining industry without regulation the Blind Area Diagrams contained in Appendix A of the NIOSH RI 9672. MSHA inspectors could distribute these training tools during regular inspections of mines. These training tools could also become part of annual refresher requirements. The longer-term approach is to establish performance metrics by which technology-driven systems can be measured. It is irresponsible for MSHA to mandate a technology that is not fully vetted.

10. Please describe situations, if any, in which it would be appropriate to use a collision warning system rather than a collision avoidance system.

B.10. Based on the information contained in the previous answers and the MSHRAC presentation contained below in this section B, removing the operator's control of the mobile equipment by triggering a collision avoidance system should not be mandated at this time.

11. Please describe any differences between a surface coal environment and a surface metal and nonmetal environment that would influence your response to the questions above.

B.11. In coal and metal/nonmetal mining environments, the operations are sufficiently similar, thus the hazards are similar, such that distinctions between the industries are not relevant factors to be considered.

Other safety organizations that have addressed the issue of surface mobile equipment automation:

The NIOSH MSHRAC continues to support research into the automation of surface mining equipment and the design and performance criteria for such equipment. Portions of the minutes from the most recent meetings regarding innovations in automation and smart technologies are provided below. These discussions are pertinent as relate to the work that has been done and to the work left to do. (the underlined portions of the text are for emphasis.)

MINUTES OF THE MEETING OF THE MINE SAFETY AND HEALTH RESEARCH ADVISORY COMMITTEE – November 15, 2017 (See IMA-NA Attachment 3.)

PRESENTATIOIN – SMART MINE/INNOVATIONS INITIATIVE – MINE OF THE FUTURE TEAM UPDATE, MR. JEFFREY WELSH

Page 32: "Mine automation today and in the near future; here are some of the different type of equipment that are being automated. Included are haul trucks, loaders, crushers, drilling rigs, and longwall shearers. This equipment is operated under autonomous control or by remote control. With automation being introduced, mine workers may be exposed to new risks. Workers will have to be concerned with interaction with robotic mine equipment, information overload, rapidly changing operating environments, rapidly evolving technology, critical decision making, and new ways of doing things."

Pages 32 and 33: "Western Australia has had automated equipment operating in mines for a number of years. They have experienced some incidents with automated equipment. Examples include: An autonomous haul truck reversing over a waste dump, a water truck colliding with an autonomous truck at an intersection, a blast hole autonomous drill rig reversing into the rear of a stationary blast hole drill rig, a grader colliding with an autonomous truck, and an autonomous truck backing over an edge. The Government of Western Australia developed a Mines Safety Bulletin No. 110 – Seeking safe mobile autonomous equipment systems. In that bulletin they have contributing factors for those incidents that are broken down into specification and design of safety systems, human factors, and process issues. An example of a contributing factor for specification and design of safety systems is "Detection systems are not included in the design.""

Mr. Welsh went onto to say, "[S]ix research focus areas that could serve to guide NIOSH research direction and the expenditure of resources to achieve worker health & safety have been identified. Collectively, the six research focus areas comprise a conceptual framework that describes the most relevant research areas and the relationships that exist between them, and challenges that must be addressed to understand mine worker health and safety as it relates to automation and smart technologies in the mining industry. For each of those focus areas, the team looked at the definition of each, background information, health and safety implications, current research in those areas, NIOSH comparative advantage, outcome and risks, competencies required, and facilities to conduct research in those particular areas.

The team developed key recommendations for NIOSH. One is to collaborate with mining companies with plans to implement automation & smart mine technology. Hecla Mining and Barrick Gold have shown interest. Two is participate on standards committees/groups addressing safety standards for mining automation, to learn what's going on and to provide our input into the development of the guidelines and standards. Three is partner with universities and research organizations conducting robotics & automation research for mining automation applications. Four is collaborate with the NIOSH Center for Occupational Robotics Research & the NIOSH Center for Motor Vehicle Safety on common occupational health and safety issues. Five is develop staff, gain in-house expertise through training and/or hire. Priorities are: Human Factors, Situational Awareness, and System Safety. Six is initiate a pilot project to gain knowledge, develop contacts, to better focus for our direction.

Key points are: the next decade is going to see a rapid growth and new applications of robotics and automation, this technology holds much promise for improving worker health and safety, this technology has the potential to introduce new worker safety and health issues that will require new and refined prevention strategies, and NIOSH needs to proactively address worker health and safety associated with automation and smart mine technology."

PRESENTATION – SMART MINE/INNOVATIONS INITIATIVE – FY18 NEW PROJECT, Mr. MIGUEL REYES

Page 33: Today I will talk about our automation pilot project. In reality, we know automation is not new, it's not new to mining, and so we're looking at it more from the perspective of the health and safety implications, and really understanding that even though a lot of the decisions are made in terms of improving operations efficiencies, reducing costs of extraction, and driven by productivity in the mining workforce, we're looking at the intended and unintended consequences as a result of introducing automation technologies on a global scale.

Page 34: "In terms of the previous research that I wanted to highlight, the NIOSH Mining Program, the US Bureau of Mines, has really looked at several areas that feed into automating mining technologies, specifically some of the ones that I've highlighted here have occurred over decades of research looking at automating continuous mining machines, guidance systems, teleoperation, control systems, and really looking at different technologies that could be applied to enable automation in mining. But the reality is, with some of the limitations we've seen in the past, there's been rapid growth in that area to now what we're seeing, these types of concepts and technologies being fully trialed and deployed at mine sites. And so, these are just some of the examples, and Jeff did speak a little bit about these, in terms of remote operation of mining equipment. The picture on the top-right is the cab-less haul truck that was featured at Mine Expo several years ago, and also an automated longwall system for an underground mine. And so, we do recognize that there are really good examples of automation. What we want to now start looking at is how

does this impact mine workers as far as the direct interaction or direct use of these types of systems or working even in close proximity with these types of systems?

Some of the things we've learned through past research as far as technology integration is that it could be broken down into different components. And what I'm trying to highlight here is the differences between evaluating technologies, looking at system performance, looking how the performance of the systems are impacted by the environment in which they're incorporated or integrated into, and looking at how to best improve the performance of these systems. In terms of the human factors, there's also a big interest in looking at change management. How is it that we introduce these technologies in mining environments? How is it that we develop a strong safety culture? And how we communicate the introduction of these technologies so that the mine workers can understand how they're going to be interacting with it, how it's going to change their day-to-day operations, and how those technologies can be leveraged to be able to improve their efficiency and productivity. And the third bullet there, looking at training and how do we leverage existing products or developed products, either through NIOSH or other efforts, that can be used to train the employees on how these systems could be used and should be used? And with that, we're looking at things like informational databases in the form of mobile apps or immersive technologies such as virtual reality, which was discussed earlier this morning."

Page 35: "And, so with that, I think with this particular project, the automation pilot, the NIOSH Mining Program developed a very concerted effort to not only look at one aspect of automation in mining, but to include subject matter experts and experience we've accumulated through years of research to be able to target several areas related to automation technologies. And so, with that, there are several examples related to, as I mentioned, proximity detection systems, the PDM being another example, a lot of the lessons learned in terms of system reliability, sensor accuracy, data analytics. There're several efforts currently and previously completed under the NIOSH Mining Program that could really help position us in a good position to address some of the challenges that the industry is experiencing. So, you look at the technology evaluation standpoint, the human factors standpoint, and how those can be merged to provide a more holistic approach to how you introduce those technologies.

In terms of the specific automation pilot, we will be looking, as I said, at other industries and some of the efforts that they're looking at for automation. We will be looking at other existing standards in other industries. One such example is the SAE standards for automating motor vehicles. We do recognize there's a lot of work that's already been done. We want to be able to leverage that and see how that could be transferred and applied to specific mining tasks. What we really don't want to do is just focus on fully autonomous systems. We know we're a long way from having everything in a mine being fully autonomous. There are some examples of that, but there's also several levels in between where you're automating certain mining tasks or automating certain parts of the operation, not others. The reality is that there will be a human element involved in a lot of these cases, and so one of the things we want to look at in terms of the

<u>health and safety benefits is how are the mine workers being affected at each of these levels?"</u>

MINUTES OF THE MEETING OF THE MINE SAFETY AND HEALTH RESEARCH ADVISORY COMMITTEE – **May 22-23, 2018 (See IMA-NA Attachment 4.)**

PRESENTATION – NIOSH MINING PROGRAM FY19 NEW PROJECTS PROPOSED PROJECTS FOR FY19: SPOKANE MINING RESEARCH DIVISION, MR. TODD RUFF

Page 67: "We talked a lot about emerging technologies yesterday. This is really looking at the safety implications and benefits of new technology. We know that we have an area that we can focus on in bringing emerging technology now – that is to improve conveyor safety, especially around maintenance. Also, we will be looking at machine safety priorities for metal and nonmetal and stone, sand, and gravel. So, I'll give you a few details on where we're going with those."

Page 69: "Our final proposal is for a one-year pilot project that will take a closer look at machinery and power haulage accidents in metal/nonmetal and stone, sand, and gravel. Accidents involving equipment, both stationary and mobile, consistently come up as one of the top fatality classifications for these sectors. We need to understand the root causes and use the burden data and feedback from stakeholders to help guide future research in this area. That is the focus of this. We know that conveyors, of course, stand out. As RJ is going to point out, haul trucks also stand out as the top types of equipment involved in these types of incidents. <u>But we really need to dig a little deeper, understand what exactly is going on and where we should focus our research efforts."</u>

Page 74: "Finally, the pilot project on identification of health and safety Issues related to haul trucks was presented. <u>Despite the development of new technologies, little has been done in understanding operator situational awareness and to provide more directed strategies to improve hazard recognition.</u> The pilot will investigate accident causes in greater depth and analyze the perceptual and situational awareness requirements for operating haul trucks safely. It will then provide a roadmap for targeted research and interventions for future efforts."

SUMMARY OF THE MINE SAFETY AND HEALTH RESEARCH ADVISORY COMMITTEE

While great strides have been made, more work needs to be done to establish design and performance standards for automation of large mobile equipment. Further, the interaction of technology such as automation and the human factors associated with such technology must be addressed before implementation of such technologies can go forward universally. Not unlike what private industry is doing with on-road motor vehicles in cities and test grounds around the United States today. NIOSH should continue this research in collaboration with industry and standard setting associations as its plans indicate.

Other suggested hazard control strategies:

MSHA wants to have an immediate impact on improving surface haulage safety related to mobile equipment, it should consider interim control strategies:

- **Effective training of mobile equipment operators and miners using a best practice approach using existing training materials for Blind Area Diagrams as contained in Appendix A of the NIOSH RI 9672. MSHA inspectors could distribute these training tools during regular inspections to all affected mine operators. These training tools could also become part of the annual refresher requirements.**

- **On smaller vehicles, the use of buggy whips with lights or top-of-vehicle strobe lights are other best practices that can be implemented quickly and without regulation.**

In the same ILO report mentioned earlier, control strategies for traffic rules and roads were suggested to avoid collisions of vehicles at paragraphs 562 thru 577.

C. Highwall and Dump Points

Various technologies, such as GPS, can be used to provide equipment operators better information regarding their location in relation to the edge of highwalls or dump points. Other mechanisms, such as ground markers and aerial markers, also could help equipment operators identify their location when pushing or dumping material.

12. Which technologies or systems can prevent highwall and dump point overtravel? Please describe the advantages, disadvantages, and costs associated with these technologies or systems.

C.12. The first most important issue at dump points is the integrity of the ground at the dump point. The examination of dump points by competent persons is imperative to ensure ground stability. Thus, the approach to a dump point should be viewed by the driver which requires a left-hand approach to the dump point, so the driver can observe the ground conditions. Next, the truck should back perpendicular to the dump point so that the truck approaches the berm at the correct angle. The berm should be of sufficient height to give warning to the operator or a sense of contact. The slope of the dump point area should be graded slightly (2 to 3 degrees) uphill to the berm at the top of the slope so that water does not accumulate weakening the ground. Also, dump points should be graded flat side-to-side as necessary to ensure the proper compaction and a level dumping plane. When necessary, adequate lighting must be located at the dump point so that truck drivers can observe the ground stability and that the drivers have good visibility when backing towards the berm. Drivers need to back to berms at a slow speed and never onto the berm.

If a truck is dumping into a hopper, then a stop block must be of sufficient size and properly positioned and stabilized to stop the truck wheels.

Regarding the use of technology on trucks such as cameras or backup radar, these systems should be considered as part of an overall solution and not a single solution.

During a shift, cameras can become dirty and the glare can make it difficult to discern where the dump point berm is located. Back-up radar, which may not respond when equipment is operated at high speed, can provide active protection a passive system may not be able to provide due to environmental issues.

13. Many surface mines use GPS on equipment for tracking, dispatching, and positioning. How can these systems be used to provide equipment operators better information on their location with respect to highwall or dump points?

C.13. IMA-NA does not have independently verified data to respond to the question of GPS on off-road equipment for tracking, dispatching, and positioning of trucks at dump points or highwalls.

14. What are the advantages, disadvantages, and costs associated with ground and aerial markers?

C.14. Ground or aerial markers can facilitate the drivers at dump points provided they are continually relocated as needed. Repositioning these markers cannot be the task of the truck driver and requires a dump point spotter to be constantly adjusting these markers. These devices should not take the place of a well-constructed berm or the procedures set forth in response C.12.

Other suggested hazard control strategies:

In the same ILO report mentioned earlier, the following control strategies for Tips or Spoil Dumps were suggested at paragraphs 300 thru 307. Also, the following control strategies were suggested on loading and dumping at paragraphs 672 thru 674.

D. Autonomous Mobile Equipment

15. Please identify the types of autonomous mobile equipment in use at surface mines.

16. Please describe the advantages and disadvantages associated with autonomous mobile equipment.

17. Please provide information related to any experience with testing or implementing autonomous mobile equipment, including costs and benefits.

D.15 thru 17: IMA-NA does not have independently verified data to respond to the question of the use of autonomous mobile equipment for off-road use. However, the guidance and conclusions provided by NIOSH in the meeting of the MSHRAC points out that much work needs to be done and its recommendations should direct the actions of MSHA. An important consideration is that the research discussed at the MSHRAC meetings involves larger well-funded mining companies. Any solution proposed by MSHA must consider that the vast majority of mining operations may not have the financial and human resources to implement these type technologies, and further the effective

implementation of these technologies is years away. Thus, MSHA should take a cautious approach when addressing this issue that affects all size mining operations. When mandating significant change, MSHA must recognize that the effectiveness of the change is a function of the quality of the product being offered times the acceptance of the change (EC = Quality x Acceptance).

SEE ATTACHED MINUTES OF THE MEETING OF THE MINE SAFETY AND HEALTH RESEARCH ADVISORY COMMITTEE – May 22-23, 2018

PRESENTATION – SMART MINE/INNOVATIONS INITIATIVE UPDATE, MR. JEFFREY WELSH

Pages 25 and 26: Mr. Welsh provided an update on the Smart Mine/Innovations Initiative. Technologies associated with automation robotics, wireless communications, smart sensors, wearable platforms, augmentation of reality, interconnectivity of devices and data analytics are being implemented in the mining industry, particularly in western metal mining. The introduction of these technologies in mining could affect worker health and safety, both positively and negatively. NIOSH wants to proactively address worker health and safety issues that may be associated with the implementation of the new technologies. In the NIOSH "Mine of the Future" report, six key recommendations were listed. Progress has been made on each of those recommendations. One is to collaborate with the NIOSH Centers for Occupational Robotics Research and the Center for Motor Vehicle Safety, both coordinated out of the Division of Safety Research in Morgantown. Two mining program researchers are part of the steering committee and they attend the meetings, and actively participate. Two is to participate on standards committees addressing safety standards for mining automation. A global mining guideline group recently had a workshop in Vancouver on the implementation of automation systems in mining. A mining program researcher attended that meeting and will also attend a June 22nd meeting in Denver. Three is to partner with universities and research organizations conducting automation and robotics research. Mining program researchers interact with the National Robotics Engineering Center in Pittsburgh, and they are using LIDAR to map a limestone mine and determine how the technology could be used for determining control issues. Researchers have also met with faculty in the WVU Electrical-Computer and Mechanical Engineering Departments, where their robotics research is located. Four is to develop staff, gain in-house expertise. In Todd's presentation, he talked about the Emerging Technologies Initiative and the expertise that will be needed. It is part of the hiring plan. Five is to initiate a pilot project to gain knowledge and develop contacts to better focus our direction. At the last MSHRAC meeting, Miguel Reyes talked about a proposed pilot project. The approach that will be used is to post a Request for Information in the Federal Register. It will take a broad look at what's going on in mining automation, covering all sectors, not just metal and non-metal, but coal, stone, sand and gravel. Input from the RFI will feed the direction of the pilot project. Six is to collaborate with mining companies implementing automation and smart mine technology. Three companies, Barrick Gold, Hecla Mining and Rio Tinto, have plans to implement automation technology at their mines, and have expressed interest in collaborating with NIOSH to identify potential health and safety issues and provide solutions to those issues. Initial meetings were held with those

companies. An Emerging Technologies Research Initiative was started to focus on western metal mining automation, with SMRD ("Spokane Mining Research Division") the lead. Plans were to convene a workshop to discuss research needs in this area, and to provide a forum to exchange information, experiences on implementing the advanced technology in metal mining, and to identify potential health and safety risks. The workshop would answer these questions: <u>What extent will automation and smart technologies be implemented in metal mining? What are the emerging health and safety concerns? What gaps exist in occupational health and safety related to automation and smart technologies? Of these gaps, what are the priorities? Would the topic benefit from a mining multipartite partnership?</u>

Initial thoughts were for NIOSH to put together the workshop. But with concerns related to FACA ("Federal Advisory Committee Act"), an alternative approach is to initiate an MSHRAC workgroup to organize a workshop. The remainder of the session discussed this approach to establish an MSHRAC workgroup and they would be the ones who would organize that stakeholder meeting and provide information back to this full committee. The workgroup's charge would be to gather information on the potential health and safety issues related to implementing automation and smart technologies in metal mining. The workgroup would organize and facilitate a public mining stakeholder meeting for discussion around the questions above. <u>The workgroup would draft a report based on the research activities and information gathered during that open stakeholder meeting and present it back to the full MSHRAC committee at a future meeting for discussion and potential recommendations to NIOSH to proactively address those worker health and safety issues</u>. A proposed charge for the workgroup was mailed to committee members in advance of the meeting."

E. Belt Conveyors

The MSHA injury and accident data in the coal and metal/nonmetal sectors is the starting point for these comments and has a consistent theme: lack of guarding; inadequate guarding; failure to power off, lock-out, and block machinery against motion; and lack of proper training of mine personnel.

MSHA Coal Data:

- **30 CFR Part 75.1722(c) or Part 77.400(d): Except when testing the machinery, guards shall be securely in place while machinery is being operated:**
  - **60 injuries over the last 5 years**
- **30 CFR Part 75.1725 (c) or Part 77.404(c): Repairs or maintenance shall not be performed on machinery until the power is off and the machinery is blocked against motion, except where machinery motion is necessary to make adjustments.**
  - **57 injuries over the last 5 years**

MSHA Metal/Nonmetal Data:

- **Climbing on guard 5%**
- **Handling/Dropped oversized and heavy guards 45%**
- **Reached past or around guard 14%**
- **Removed guard during operation 10%**
- **Inadequate guard size / position 14%**
- **Inherently hazardous guard 12%**

18. What technologies are available that could provide additional protections from accidents related to working near or around belt conveyors? Can these technologies be used in surface and underground mines?

E.18. In response to the question, reference is made to ANSI/ASSE B11.19-2010 – Performance Criteria for Safeguarding which provides performance requirements for the design, construction, installation, operation and maintenance of the safeguarding when applied to machines including Guards (see Clause 7), Safeguarding devices (see Clause 8), Awareness devices (see Clause 9), Safeguarding methods (see Clause 10), Safe work procedures (see Clause 11), Complementary equipment and measures (see Clause 12), Inspection and maintenance of safeguarding (see Clause 13), and Training on the use of safeguarding (see Clause 14).

Annex H (Outline of Protective Measures) and Annex I (Safety Solutions in Use) summarize the many options available to industrial operations. For the most part, mine operators have deployed physical guards and have not sought to deploy other sensing devices (scanners and light curtains) or awareness devices, or other interlocks. Other options within this ANSI standard may have applicability to mine operators as MSHA and mine operators seek ways to address the MSHA injury and accident data. Because of the rugged mine environment, not all these options may work. Notwithstanding, MSHA should review these options as a means of exploring all practical solutions for the working environment.

Further, not all these solutions presented in this ANSI standard or the MSHRAC information provided below can operate in both the underground and surface environment. For instance, the use of WIFI enabled systems may have difficulty in communicating in an underground mine setting, or at remote mine operations.

SEE ATTACHED MINUTES OF THE MEETING OF THE MINE SAFETY AND HEALTH RESEARCH ADVISORY COMMITTEE – May 22-23, 2018

ILOTO IFUND PROJECT, DR. DAVID PARKS

Pages 50 and 52: "DR. PARKS: My name is David Parks. I'm a mechanical engineer, Spokane Mining Research Division. We're going to talk about our Internet-Enabled Machine Maintenance Monitoring and Reporting system for improving safety particularly around stationary powered haulage. So, this is a project that's in its second year currently,

but it's consisted of two separate one-year iFund funding periods, and we're hoping to make it a mining project next year.

The problem that we're trying to address is the persistent issue with workers <u>getting entangled in conveyors and stationary haulage</u>. Some work that Todd did a few years back showed that on surface mines of the 41 fatalities there were, 83 percent of those reported maintenance or cleanup as the leading activity involved, and then a further reading of the narratives showed that 29 percent of the time lockout/tagout was performed incorrectly or not at all, and conveyors where the machine that was the biggest issue on surface mines.

Some more recent data that I grabbed shows the same trend. There are quite a few things here but the things that I'm most interested in are at the bottom of the graph here, and we <u>still see that maintenance and repair is by far the most conspicuous activity and conveyors have the highest combined permanent disability and fatalities</u>, although the ore haulage trucks result in more fatalities.

<u>The problem that we see with LOTO is that the current procedures are outdated and often times it will involve a walk to an office where you fill out a paper form, you grab a padlock and a lock hasp, and you lock the machinery out and, in some cases, there are many locks on the hasp as shown here.</u> Each one of those represents a worker, so that's a little bit tedious. And this is required even for minor maintenance, as I've witnessed firsthand trying to install our system. I just wanted to stand on the conveyor for a minute to check the number on my sensor and we had to lock the whole thing out. There's also a lack of perimeter control at gates and critical access points and machine guards are not monitored. So, all these things we think come together to encourage circumvention. Basically, people will try to avoid LOTO if they feel like they can get away with it. And our solution is to start monitoring LOTO and to make LOTO easier and to monitor machinery so that we know when failures are likely to occur, thus maintenance can be planned in advance as opposed to being reactive and rushed.

The things that we're going to monitor are machine guarding, first off, and access points, gates and doors. It's fairly straightforward, a switch is open or closed. We also want to look at proximity and the status of conveyors and the attached equipment, in terms of whether it's powered on or not when the machine guard is removed, for example. And then this would also be compared on the back end with planned maintenance which would be on mobile devices or conveniently located tablets, portals where workers can plan out the maintenance procedure, and then that will go to a database, a machine guard would be removed, but then the system would check to see that the conveyor is powered off and that there has been a plan put in place for the maintenance.

A general structure for industrial IoT is a local network of sensors that can operate without the cloud, but we would also like to have cloud connectivity so that remote viewing is possible for people that are concerned with the safety of the workers while they're not on site.

Generally, there's a trade-off when we're talking about wireless sensor networks. Wireless is the way that we think we're most likely going to go because on a typical site we anticipate that we'll have several hundred sensors and stringing wires all over the place it's not really going to go over too well but, of course, neither is having batteries that need replaced every so often. So, that's a bit of a conundrum and you end up with a trade-off between bandwidth power range and duration of autonomy. Basically, what I'm trying to say with the slide is things like Wi-Fi are really not compatible with this. There are other protocols that are low data rate and more efficient for our purposes."

Page 52: "Things to consider, definitely everyone that hears something about IoT often hears about security issues, so that means that's something we need to think about which means updating firmware regularly on all components, that's definitely necessary. We need to ensure the networks are very healthy so that our batteries last as long as possible, and potentially look at energy harvesting solutions."

NIOSH MINING PROGRAM FY19 NEW PROJECTS

PROPOSED PROJECTS FOR FY19: SPOKANE MINING RESEARCH DIVISION, MR. TODD RUFF

Page 68 and 69: Our fourth proposed project will develop and evaluate new technologies for improving conveyor safety you heard about yesterday. As Dr. Parks mentioned, we'd like to move this work under the mining program and continue to develop and refine the system so that it can be handed off to industry. One thing we tried to point out yesterday, but I wanted to highlight here is lockout/tagout isn't the only issue with conveyors, of course. We see a need for improved training, better methods for maintenance and cleanup, and there's challenges that are unique to small mines that need to be addressed too. We have strong partnerships right now for developing and testing new technology: Oldcastle and Lafarge-Holcim are on board. The final products include the licensing and marketing of a new internet-enabled maintenance monitoring and reporting system, training materials around maintenance, and new technologies that are developed and interventions targeted toward the smaller operations. We covered this in detail yesterday, but the main goal here for the maintenance part of the project is to improve situational awareness in maintenance activities. An unexpected startup, we mentioned yesterday, is one of the most common factors in severe injuries related to maintenance. Status of maintenance activities, the status of guards and access points, the location of personnel prior to startup, really with new technology now can be at the fingertips of the mine personnel and management. It shows on the bottom right there that you can bring that same interface that David brought up—showed yesterday, you can bring that up on your phone. That's where we want to move with that. There's new technology available to do this type of thing and we want to get that to industry.

Our final proposal is for a one-year pilot project that will take a closer look at machinery and power haulage accidents in metal/nonmetal and stone, sand, and gravel. Accidents involving equipment, both stationary and mobile, consistently come up as one of the top fatality classifications for these sectors. We need to understand the root causes and

use the burden data and feedback from stakeholders to help guide future research in this area. That is the focus of this. We know that conveyors, of course, stand out. As RJ is going to point out, haul trucks also stand out as the top types of equipment involved in these types of incidents. <u>But we really need to dig a little deeper, understand what exactly is going on and where we should focus our research efforts</u>."

19. Please provide information related to any experience with testing or implementing systems that sense a miner's presence in hazardous locations; ensure that machine guards are properly secured in place; and/or ensure machines are properly locked out and tagged out during maintenance. Please also include information and data on the costs and benefits associated with these systems.

E.19. IMA-NA does not have independently verified mining data to respond to the question of experience with guarding in mines.

F. Training and Technical Assistance

20. Please provide suggestions on how training can increase seatbelt use and improve equipment operators' awareness of hazards at the mine site.

21. Please provide suggestions on how training can ensure that miners lock and tag conveyor belts before performing maintenance work.

E.20 and E.21: Training is the last cog in any compliance obligation and can impact the acceptance of any change that may be required by MSHA's actions. MSHA and NIOSH have developed training materials that "sit on the shelf" and never make it to the miners. (see discussion in B.9 regarding Blind Spot Diagrams). While MSHA's mandate is inspection/enforcement focused, the writing of citations <u>must</u> never be the only incentive that rewards the inspectors or their supervisors. MSHA needs to evaluate its reward system so that contact with miners through miner interaction and training becomes a metric in an evaluation of the MSHA enforcement personnel. A typical inspection starts with issuance of citations and ends with a closeout on a discussion of the citations that were issued. Rather than only leaving citations behind to a mine operator, MSHA inspectors should consider leaving their experiences and training materials behind to the miners and mine operators. MSHA should not only be focused and proud that it meets the "2" and "4" inspection requirements contained in the Mine Act, but rather it should be proud that it interacted with miners in an informative and teaching manner.

Other effective ways of ensuring the use of seatbelts and the implementation of LOTOTO involve the "buddy system". A best practice is for employees to work with and watch out for their fellow worker(s). For instance, before mobile equipment can be operated, or equipment worked on, communication with fellow worker(s) must be completed. As an example, before the operator of a haul truck leaves the line-up area or a shift transfer is made in the active mining area, the haul truck operator should communicate with their "buddy" to ensure the pre-operative check has been completed and that the seatbelt is connected. Another example, before a worker can work on a belt

conveyor, communication with their "buddy" should take place to ensure the proper safety precautions have been taken. This level of protection requires two individuals to not adhere to the safety practices which is less likely to occur.

G. Benefits and Costs

MSHA requests comment on the costs, benefits, and the technological and economic feasibility of suggested engineering controls to improve miners' safety. Your answers to these questions will help MSHA evaluate options and determine an appropriate course of action.

H. Other Information

22. Please provide any data or information that may be useful to MSHA to determine non-regulatory initiatives the Agency should explore.

Thank you for your consideration of these comments.

Sincerely,

Mark G. Ellis
President
Industrial Minerals Association – North America

Attachments:

IMA-NA Attachment 1
IMA-NA Attachment 2
IMA-NA Attachment 3
IMA-NA Attachment 4