Safety and Health Regulatory Changes and Technology Developments in U.S. Coal Mining

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The US mining industry has been affected greatly by recent coal mining disasters which have resulted in new legislation that will have an impact on mining economic costs as well safety and health of miners. This paper discusses changes that new legislation and regulations are making to the industry, and current research that is producing technologies to make mining safer.

INTRODUCTION

American coal production in 2007 was 1,147 million short tons. Most of this coal is consumed domestically, with annual exports of coal about 50 million tons. One third of annual production is produced at surface mines and the rest from underground mines. This coal is produced by about 82,000 miners working at 1,400 coal mines.

Major improvements in coal mine safety have been made in the US since the Federal Mine Safety and Health Act of 1977. The fatal injury rate in underground coal mines between 1977 and 2004 was reduced by 47.8% to 0.036. The annual number of fatalities dropped from 112 to 14 during that period. Likewise, the non-fatal days-lost injury rate was reduced by 42.6% from 10.87 to 6.24. However, during the past three years a number of coal mining disasters have occurred that have had major impact on mining in the United States.

The recent major mine incidents began in 2006 with an explosion on January 2 at the Sago mine in West Virginia which killed 12 miners. A fire at the Aracoma Alma No. 1 Mine in West Virginia on January 19 caused 2 fatalities. On May 20, 2006 there was an explosion at the Darby No. 1 Mine in Kentucky which resulted in 5 more deaths. On August 6, 2007 six miners were killed by a coal outburst when pillars failed and violently ejected coal over a large area. Ten days later, two mine employees and a federal mine inspector were killed in a coal outburst during rescue efforts. The number of fatalities in US coal mines in 2004 was 28 and dropped to 23 in

2005. Primarily as a result of the above disasters, the fatalities increased to 47 in 2006 and 47 in 2007. This downward trend continued in 2008 when 30 fatalities were recorded.

MINER Act

These major mine accidents caused great public concern and led the US Congress to pass the Mine Improvement and New Emergency Response Act of 2006 (MINER Act) on May 24, 2006. The coal mining disasters and the MINER Act have had very significant effects on the coal mining industry in the US. Some of the major provisions of the MINER Act include:

- Required wireless two-way communications and an electronic tracking system within three years, permitting those on the surface to locate persons trapped underground;
- Required each mine to have available two experienced rescue teams capable of a one hour overland travel response time;
- Required new safety standards relating to the sealing of abandoned areas in underground coal mines, increasing the requirements for strength of the seals;
- Established a competitive grant program for new mine safety technology to be administered by NIOSH;
- Established a Technical Study Panel for Belt Air to investigate the use of air from conveyer belt mine entries to ventilate the mine face;
- Established a permanent Office of Mine Safety & Health in NIOSH, which helps ensure a viable and long-term focus on mining safety and health.

The Mine Safety and Health Administration (MSHA) has responsibility in the U.S. for promulgation and enforcement of Federal mine safety regulations. The MINER Act required MSHA to act on new regulations and set up deadlines by which some of the new regulations were to be finalized.

NIOSH MINING RESEARCH PROJECTS RELATED TO MINER ACT

NIOSH does research to improve occupational safety and health for all workers including miners. NIOSH assumed the sole Federal responsibility for research on mine safety after the closure of the US Bureau of Mines in 1996. NIOSH inherited from the Bureau of Mines the mining research laboratories in Pittsburgh, PA and Spokane, WA. The NIOSH mining program currently has about 245 employees and a budget for 2008 of $39 million.

The current NIOSH mining program is aimed toward seven major strategic goals. These are:

1. Reduce respiratory diseases in miners associated with coal worker pneumoconiosis, silicosis, and diesel emissions;
2. Reduce noise-induced hearing loss (NIHL);
3. Reduce repetitive/cumulative musculoskeletal injuries;
4. Reduce traumatic injuries;
5. Reduce the risk of mine disasters (fires, explosions, and inundations) and enhance the safety and effectiveness of, emergency responders;
6. Reduce ground failure fatalities and injuries;
7. Determine the impact of changing mining conditions, new and emerging technologies, training, and the changing patterns of work.

The intramural research done by NIOSH related to prevention and response to mine fires and explosions is directed toward strategic goal number 5 above. This research is done primarily at the NIOSH Pittsburgh Research Laboratory (PRL). The NIOSH strategy in this area is in order of priority: prevention, escape, and rescue. Our research is designed first at preventing explosions or fires that could endanger the lives of miners, second at technology to allow miners to escape if a serious incident occurs, and third at technology that would facilitate the rescue of miners who might be trapped underground.

Many of the research projects at PRL have direct relevance to preventing fatalities from the types of mining accidents that occurred in 2006 and 2007. Some of these projects will be described next, as well as a few other projects that are likely to have significant impact on American mining in the future.

Mine explosion prevention

Research is being done on explosion propagation and explosion combustion mechanisms through full-scale tests at the Lake Lynn Experimental Mine (LLEM) and through laboratory tests. The

LLEM research includes flame propagation in large volumes of non-uniformly mixed methane, the effects of non-uniform zones of coal and rock dust along an entry, and the effects of coal dust on the ribs/roof compared to floor dust. Researchers also study the amount of rock dust necessary to inert typical mine size dust for both high and low volatile coals. Basic research on the explosion mechanisms and flame propagation attempts to reach a more fundamental understanding of mine explosions. NIOSH and MSHA conducted joint research to evaluate explosion blast effects on mine ventilation stoppings at the LLEM. After mine explosion accidents, MSHA conducts investigations to determine the causes as a means to mitigate or eliminate future occurrences. As part of these post-explosion investigations, the condition of underground stoppings, including the debris from damaged stoppings, is documented as evidence of the strength and direction of the explosion forces (see Figure 1). These results assist investigators in determining the explosion forces that destroy or damage stoppings during actual coal mine explosions. [Weiss et al, 2006]

Figure 1. Ventilation stopping partially destroyed by explosion pressure

Coal dust explosibility meter

The Coal Dust Explosibility Meter (CDEM), shown in figure 2, is the first device that provides an immediate capability for determining if coal dust concentrations in active areas of underground coal mines have been sufficiently mixed with rock dust to reduce the risk of explosion propagation. This meter will quickly determine the explosibility and the incombustible content of coal and rock dust mixtures in coal mines, thereby improving sample analysis and rock dusting practices. The CDEM measures the explosibility of a coal and rock dust mixture by an optical reflectance method. Since rock dust is white and coal dust is black, the intensity of the reflected light depends on the concentration of rock dust in the mixture. The CDEM, when calibrated with actual mine dust mixtures, can be used to determine the approximate percentage of rock dust in the coal and rock dust mixture. PRL developed the theory and technology behind the device, and a prototype was developed in collaboration with the Geneva College Center for Technology Development. NIOSH and partners received the prestigious R&D 100 Award for the PRL-developed meter.

Figure 2. Coal Dust Exposibility Meter (CDEM)

In a recent study, NIOSH personnel accompanied MSHA inspectors on their routine surveys in underground coal mines. While underground, NIOSH personnel and MSHA inspectors used the CDEM to assess the explosibilities of the dust samples. The values of percent incombustible content (% IC) determined by the CDEM agreed well with those obtained later by low temperature ashing (LTA) in both MSHA and NIOSH laboratories. Further, the meter identified some samples as potentially explosible that LTA analysis had found to possess sufficient rock dust for inerting. The CDEM provides more information on the hazards in the mine. Rapid identification of areas with explosible dust mixtures using the CDEM allows for immediate intervention rather than a wait of several weeks for laboratory analysis. [Harris et al, 2008]

Fine coal dust

There are several explosion hazard scenarios that are not sufficiently understood and that are believed to have been contributing factors to the recent mine explosions. Of specific interest is the combustion of large volumes of non-uniformly mixed methane, which may present a different risk than the typical face ignition. Another important question is whether the 65% rock dusting requirement for mine intakes is still sufficient to inert the coal dust, since the regulation was based on the average size of coal dust found in mine intakes during the 1920's. Recent analyses of mine dust samples have shown that the coal dust in many mine intakes is significantly finer in size than the regulations assume. The size of the coal dust is relevant to the amount of rock dust required to inert the coal dust, with more rock dust needed to inert finer sizes of coal dust. Dust samples were collected by MSHA inspectors from underground coal mines throughout the U.S. Samples were normally collected in several intakes at each mine. The laboratory analysis procedures included acid leaching of the sample to remove the limestone rock dust, sonic sieving to determine the dust size, and low temperature ashing of the sieved fractions to correct for any remaining incombustible matter. The results indicate that particle sizes of mine coal dust in intake airways are finer than those measured in the 1920s. [Sapko, Cashdollar and Green, 2006]

Improving methane control practices in coal mines

The goal of the methane control research is to identify and model methane emissions in coal mines to improve the effectiveness of methane control technology, and reduce the explosion hazard for underground miners. Although longwall mining productivity can far exceed that of room-and-pillar mining, the total methane emissions per extracted volume associated with longwall sections are generally higher than those for continuous miner or pillar removal sections. Increased face advance rates, increased productivities, increased panel sizes, and generally deeper workings have challenged existing designs for controlling methane on longwalls. NIOSH examined a number of practices designed to maintain concentrations in mine air within statutory limits and consistently below the lower explosive limit. In a recent report, several practical guidelines are recommended for controlling longwall coalbed methane. All predictions are based on determinations made for the Pittsburgh coalbed in southwestern Pennsylvania. [Schatzel et al, 2008]

Improving underground coal mine sealing strategies

Since 1986, 12 known explosions have occurred within the sealed areas of active U.S. underground coal mines. Most of these explosions destroyed the seals, which are structures built to isolate abandoned mining areas from the active workings. Recent explosions in the U.S. underground coal mining industry suggest that previously accepted seal construction and design methodologies are inadequate. The new MSHA standard "Rules and Regulations Sealing of Abandoned Areas – Final Rule" [Federal Register, 2008] has raised the explosion pressure design criteria for seals from the old standard of 20 psi to 50 psi or 120 psi depending on whether or not the mining company chooses to monitor and maintain the sealed area atmosphere inert. This new standard is based in part on the recently published NIOSH report on "Explosion Pressure Design Criteria for New Seals in U.S. Coal Mines" [Zipf, Sapko and Brune, 2007] that developed the scientific basis for these new seal standards based on the explosion pressures that could develop. The mining community needs engineering guidelines immediately to better meet the new MSHA regulatory requirements for sealing abandoned areas of coal mines. NIOSH initiated a new seals research project which seeks to eliminate disasters from gas explosions within sealed areas of coal mines through improved engineering of the complete sealing process and better education of the mining workforce. Attaining this outcome requires research efforts to

1) Develop fundamental scientific understanding of explosive mixture accumulation and explosion pressures developed by gas and dust explosions within sealed areas of coal mines.

2) Develop engineering procedures for sealing abandoned areas of coal mines including structural design of seals and ventilation planning before and after sealing.
3) Develop management systems to control methane accumulation within sealed areas including monitoring procedures and self- and artificial inertization methods.
4) Conduct technology transfer to educate the mining community about the potential dangers posed by sealed areas and measures to eliminate it.

NIOSH researchers aim to provide engineering guidelines for meeting all aspects of the new MSHA regulations. The new guidelines should provide multiple solutions for sealing that go beyond a "one-size-fits-all" approach. In developing proper engineering design codes for seals and sealed areas, the authors advocate seal designs to resist pressure-time curves that are based on an understanding of the risk involved and not just a simple worst-case analysis.

Mine escape and rescue

A systematic miner escape and safe rescue strategy is necessary when mine accidents such as fires or explosions occur and lives are in danger. NIOSH is investigating how to help miners be capable of timely self-rescue under adverse conditions, first responders and mine rescue teams be capable of rapid, state-of-the-art safe rescue, and management organizations that can effectively support these goals. (Figure 3)

Figure 3. Mine Rescue Team in Training

A NIOSH numbered publication "*Research Report on Strategies for Escape and Rescue from Underground Coal Mines*" is being prepared that will include the research findings, key issues and recommend successful practices in escape and rescue for the US. Researchers have obtained information on escape and rescue practices in several of the major international coal mining areas including Australia, South Africa, Ukraine/Russia/Poland and China. Key issues and successful practices in escape, rescue and incident command were identified from a review of literature from both mining and non-mining sources and in collaboration with stakeholders in the US during regional workshops and interviews. The guidelines summarize strategies for safe and systematic response to underground coal mine fire and explosion incidents. Key actions that warrant significant emphasis and commitment of resources necessary to achieve competent mine emergency response capability are training competency, command center professionalism, universal access to facilities, working communications, integrated escape and rescue systems, and human behavior services.

Refuge chambers

Refuge chambers are one option for safety protection in the event of explosions or fires. In the United States, the use of refuge chambers in coal mines has generated debate. While refuge chambers can save lives, it is also argued that they may cause miners to seek refuge rather than attempt to escape their hazardous situation. There are a number of considerations involved with this approach, including the capabilities of stations, the type and location of structures, design criteria, and maintenance and training issues. Section 13 of the MINER Act required NIOSH to conduct "research, including field tests, concerning the utility, practicality, survivability, and cost of various refuge alternatives in an underground coal mine environment, including commercially available portable refuge chambers." The NIOSH report on this work summarizes the findings of such research, focusing on specific information that could inform the regulatory process on refuge alternatives [NIOSH, 2007]. Further, gaps in knowledge and technology that should be addressed to help realize the full potential of refuge alternatives were also identified. The report concluded that the refuge alternatives have the potential for saving lives of miners if part of a comprehensive escape and rescue plan, and if appropriate training is provided. Two viable refuge alternatives are in-place shelters and portable chambers that are inflatable or rigid. In-place shelters provide superior refuge environment and may possibly be connected to the surface by borehole. However it would not be possible to keep them within 1000-2000 feet of the face, and extended distances would have to be allowed for them to be used. NIOSH testing found operational deficiencies in some commercially available portable chambers that could delay their deployment in mines. With NIOSH's assistance, the chamber manufacturers were able to correct many of the identified deficiencies. Testing and certification of both refuge chambers and in-place shelters would be needed. While additional development is needed, the benefits of these refuge alternatives merit their deployment in underground coal mines.

The 2006 MINER Act directed MSHA to consider rulemaking on refuge chambers. However, Congress subsequently mandated action in language included in the 2008 appropriations bill. MSHA has proposed a regulation for three types of acceptable refuge alternatives: pre-fabricated self-contained units, a secure space that is constructed in place, or materials pre-positioned for miners to use to construct a secure space. The Agency issued the final rule on December 31, 2008. PRL has also begun a new project that will result in training materials and guidelines to help ensure that miners receive adequate training, especially expectations training, on this important topic.

Emergency communication and tracking

Mine tragedies over the past few years have underscored the need for reliable two-way communications between underground miners and rescuers located on the surface. At that time, no system demonstrated the most basic requirements for emergency communications. However, there was considerable optimism that one or more two-way voice communication system prototypes could be further developed and brought to a commercialization phase within a few years. Towards that end, and to fulfill the requirements of the MINER Act of 2006, NIOSH sponsored several research contract initiatives to develop and demonstrate two-way communications systems.

To address the requirements of the MINER Act in a timely and cost-effective manner, the primary activity was the awarding of competitive contracts to develop and test several promising communications and tracking technologies. Three of the communication systems developments are briefly described in the paper.

Survivable leaky feeder mine communication system

Under the Emergency Supplemental Appropriations that accompanied the MINER Act of 2006, a contract was awarded to Pillar Innovations to design, develop and demonstrate a survivable wireless leaky feeder communications distribution system capable of maintaining mine wide operational integrity after an emergency situation such as a mine fire, roof fall, or explosion. Survivability consists of two principle aspects, hardening and redundancy. Hardening involves measures taken to improve the ability of the system to continue to perform after mine incidents, and includes hardening of the cable and other components that are part of the communication system. Redundancy allows the system as a whole to remain operational even if a section of cable is damaged by an event.

An extensive in-mine test program was completed involving both hardening and redundancy techniques. Based on the results of these tests, a system design was developed that takes advantage of the best approaches for hardening and redundancy in providing a survivable leaky feeder system. The design uses a multiple base station loop-around approach, where if the leaky feeder cable breaks, the system reverses transmissions of communications to allow communications with the surface from both sides of the break. Base stations on the surface at different mine shaft locations are connected via a surface fiber optic link to allow the reversing (Figure 4). The design also uses antennas and low-cost cables to provide communication coverage in additional mine passageways and other mine locations where miners may work, and independent redundant trunks inby the last opening to the surface.

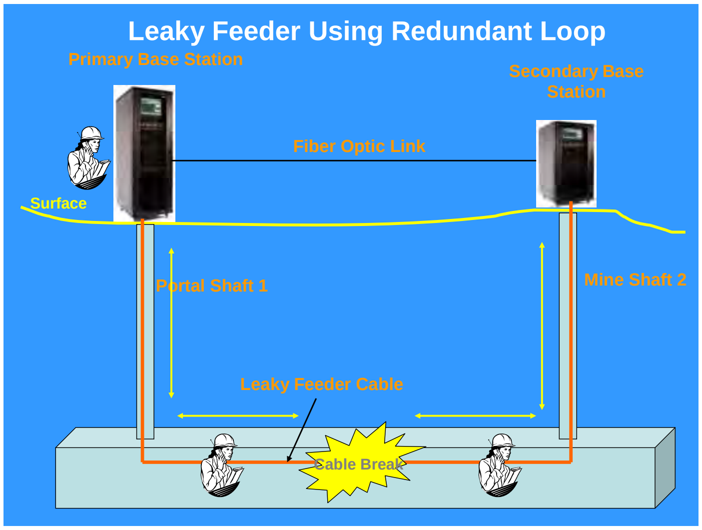

Figure 4. Survivable Leaky Feeder Mine Communication System

The system design described above has been implemented at Consol Energy Loveridge Mine, a large, complex underground coal mine, for long-term system test and evaluation.

This system represents one important building block that mines can use to comply with the MINER Act, and importantly, this system can be upgraded in the future to take advantage of newer technologies for improved functionality.

Wireless mesh communication and tracking system

NIOSH has contracted with L3 Communications to develop a wireless mesh communication and tracking system, and to deploy the system in a cooperating mine in West Virginia. The NIOSH contract includes development of a new digital radio handset. The L3 wireless mesh network is a communications network made up of radio nodes that routes radio signals from the miner's handset to the intended destination, either on the surface or to other handsets within the mine. The node locations are fixed and known to the network, allowing miner handset locating features to be easily integrated into the system (Figure 5).

Wireless Mesh Comm/Tracking Concept

Figure 5. Wireless Mesh Communication and Tracking System

A mesh network is reliable and offers redundancy. When one node can no longer operate, the rest of the nodes can still communicate with each other, directly or through one or more intermediate nodes. The L3 system is designed to operate with an existing leaky feeder system installed in this mine, adding even more redundancy to the system. A handset can act as a repeater for another handset that may not be within range of a node. Backup batteries allow operation after mine power is shut off in emergencies.

A fully functioning pilot system is installed in the Wolf Run Mining Company's Sentinel Mine. An industry demonstration was conducted in November 2008. L3 has a mine safety web site at http://www.gses.l-3com.com/mine_safety/

Kutta medium frequency system

Through an Interagency Agreement (IAA) with the US Army, NIOSH has sponsored a modification to the development of a medium frequency system for use in underground coal mines. Medium frequency systems have an enormous potential as an emergency communications systems in a post disaster scenario. The radios have been demonstrated to have a range of over two miles through "parasitic propagation". This is a characteristic of the radio energy that allows the energy to couple on to metallic structures in the mine, and be received anywhere along the path of the structure as shown in Figure 6.

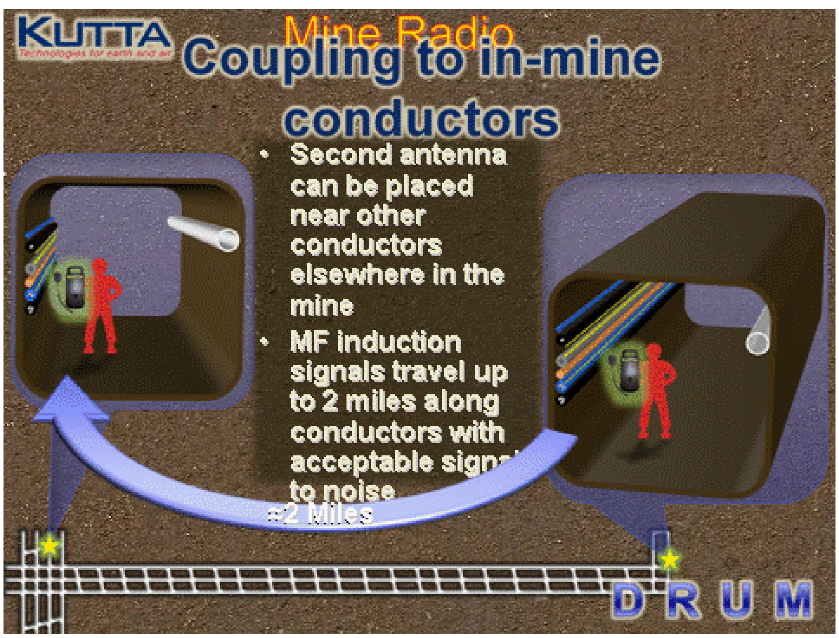

Figure 6. Kutta Medium Frequency System

The advantages of the medium frequency systems are several. Active radio elements (repeaters) can be spaced a mile or more apart, which means far less active elements are required in the mine than with leaky feeder or mesh systems; which in turn means that less vulnerable infrastructure is required. Secondly, the radio propagation paths can be highly survivable, and do not require power. Power lines for instance may be highly damaged, but could still support medium frequency communications. Additionally, recent NIOSH tests have shown that a wire core life line or even a buried wire conductor provides an excellent propagation path with no observable degradation of the radio signal due to the wire being buried. Lastly, the medium frequency system is being designed to be interoperable with existing MSHA-approved UHF/VHF handsets that are used with leaky feeder systems; this will provide substantial flexibility in designing a practical cost effective system. Interoperability with future systems such as wireless mesh systems and through the earth systems will be considered as these products become available in the market place.

Initial pre-production models of the analog point to point medium frequency products are available, and the delivery of the digital multi-hop products is expected in the near future. The system design has been submitted to MSHA for approval.

A NIOSH sponsored workshop on emergency communication and tracking was conducted in May 2009. This workshop included relevant results to date to aid mining companies in selecting and deploying systems best suited for their particular mine to meet MINER Act requirements.

Analysis of belt air ventilation in coal mines

In 2004 MSHA promulgated the final rule on belt air that allows the use of belt entry air in the working sections in most mines. Last year as many as 157 underground coal mines in the U.S. were using belt air. However, tragedies such as the Alma Mine No. 1 fire in 2006 have raised questions about the safety of mine ventilation systems that use belt entry air. In the MINER Act of 2006, Congress required the establishment of a Technical Study Panel on the Utilization of Belt Air and the Composition and Fire Retardant Properties of Belt Materials in Underground Coal Mines. The Panel was charged with providing "independent scientific and engineering review and recommendations with respect to the utilization of belt air and the composition and fire retardant properties of belt materials in underground coal mining." The panel completed its report in December 2007 [Mutmansky et al, 2007]. As indicated by the MINER Act, MSHA proposed a new regulation on belt air in June 2008. One of the panel recommendations specifies that research is needed to reduce air leakage through stoppings placed between belt and intake entries.

NIOSH has initiated a new research project to identify potential safety hazards associated with the use of belt entry air and develop engineering controls for reducing leakage through stoppings. The goal is to develop ventilation techniques that will improve miner safety if a fire occurs in the belt entry. The outcomes of the project will be a better understanding of leakage between entries, the benefits and disadvantages of booster fans in intake escapeways, and a more thorough knowledge of ventilation scenarios with computer modeling and general guidelines for using belt air. Results of the project are to provide information concerning these issues as a response to the research suggestions of the Technical Study Panel and to enable re-evaluation of the current regulations concerning safety of using belt air for ventilation. The results also will be used to develop guidelines that will help mine operators using belt air to reduce the leakage into the intake escapeway in case of a mine fire event and guidelines that will be helpful for monitoring air quality in belt airways to prevent hazardous situations in the belt entry.

Reducing hazards of conveyor belt fires in underground coal mines

The Technical Study Panel also recommended studies on fire-resistant and fireproof belt materials, belt fire suppression systems, atmospheric monitoring systems, and escapeway integrity to improve miner safety. While much progress has been made toward the prevention and control of fires in the mining industry, work is needed to evaluate new technologies and methods to implement the panel recommendations on conveyor belt fire prevention. NIOSH has begun another new research project to reduce the hazards of underground coal mine fires, particularly in conveyor belt entries, by applying recent advances in the areas of fire-resistant and fireproof belt materials, belt fire suppression systems, atmospheric monitoring systems, and computer codes for predicting and assessing in real-time the impact of fire on the mine ventilation system. The project will address the major issues concerning fires in underground coal mines; flammability of conveyor belts, detection, suppression systems, fire modeling of conveyor belts, fire modeling of contaminant spread, and training and maintenance. It is expected that the research output from this proposed project will substantially reduce the number of fires and injuries due to fire and significantly improve the level of fire safety in mines.

Protecting miners during retreat coal mining of pillars

The recent disaster at the Crandall Canyon, which was caused by catastrophic coal outburst during pillar recovery, has focused attention on coal mine ground control. Many questions are being asked about pillar design, bump prevention, and the safety of retreat mining. These issues are central to the protection of every underground mineworker. As a result of Congressional mandate, NIOSH initiated a new project to enhance the safety of miners working in underground coal mines where retreat mining in room and pillar operations is utilized, particularly at depths greater than 1500 feet. The project will review the available NIOSH technology, update and improve it as necessary, and transfer the results to the mining community. Specific activities will include updates to the NIOSH software packages that are currently used for pillar design, the development of bump prevention guidelines, an expansion of the NIOSH case history data bases of bumps and pillar performance, and an intensive technology transfer effort. The project will be conducted in close cooperation with MSHA, university research partners, and the mining industry. Congress has requested a final report on this work no later than December 2009.

Respirable dust control

Dust compliance sampling data shows that elevated coal and silica dust exposures continue to occur for high-risk occupations in the coal and metal/nonmetal mining industries. In addition, recent x-ray surveillance data reported by NIOSH has illustrated an increased CWP prevalence in coal miners employed in the southern Appalachian region of the U.S. mining industry. In response, PRL is conducting a project entitled “State-of-the-Art Technology for Controlling Coal and Silica Dust in Mining”. This project has identified state-of-the-art dust control technologies for various mining methods (e.g., longwall, continuous miner, surface) and is preparing “best practices” documents that summarize these controls. These documents are being prepared as two Information Circulars for distribution throughout the coal and metal/nonmetal mining industries. In addition, this information will be placed on the mining website and burned onto compact discs to facilitate use by our stakeholders. The information will also be formatted for presentation at multiple dust control workshops to further assist in transferring this information to the industry. To date, a workshop focused upon dust controls for coal mining is being planned for November, while a workshop focused upon the underground stone industry is planned for December.

The personal dust monitor (PDM) was developed by NIOSH as a sampler that provides real-time measurement of the respirable dust exposure of the wearer. The wearer can use this information to change dust controls or mining practices in order to prevent dust overexposures. The PDM is combined with the miner’s cap lamp unit and can be worn on a daily basis to provide increased monitoring of worker dust exposures. NIOSH is developing a software program to assist the mine operators with the compilation and analysis of data files generated by the PDM. MSHA is completing changes to the Code of Federal Regulations to allow for the use of the PDM as a potential sampler for compliance purposes. Also, Thermo Scientific has begun selling the PDM to the mining industry and has sold approximately 100 units to date.

CONCLUSION

The US mining industry is in a state of flux following the coal mining disasters that occurred in 2006 and 2007 and the resulting changes in legislation and regulations. Additional changes in mining health and safety regulations are likely in the next few years. The exact nature of these changes is very uncertain at this time. In any case the mining industry is expected to grow and research needs that have been discussed in this paper will have to be addressed by NIOSH and others in the next few years.

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