UPDATE ON MINING HEALTH AND SAFETY RESEARCH

John N. Murphy

Pittsburgh Research Center

INTRODUCTION

It's a pleasure to be with you and to share in this opening session for the 27th Annual Institute on Mining Health, Safety, and Research. As we come together today, I would like to reflect for just a moment on the past Institutes. Much of the progress in Mine Health and Safety has been the subject of presentations and discussions at the previous Institutes, either by identifying the issues, proposing techniques to overcome the problems, or presenting new findings to address important issues for the mining industry. May I extend our thanks and congratulations to VPI and to the planners and organizers of all of these Institutes for their important contributions to our mutual goals of improving mine health and safety.

In the time available today, I would like to accomplish two objectives:

1. Provide my assessment of the current status of the Mining Health and Safety Research Program; and

2. Share with you the continuing need and direction for the Mining Health and Safety Research.

MINE HEALTH AND SAFETY RESEARCH TODAY

Mine Health and Safety Research was conducted formerly at four geographical locations within the USBM, specifically: Pittsburgh, Spokane, Twin Cities, and Denver. Although the Twin Cities and Denver Centers were closed, we have been successful in relocating/maintaining much of the core competencies to conduct a responsive, multidisciplinary Mine Health and Safety Research Program. The current staff at Pittsburgh and Spokane directed toward Health and Safety Research totals 397. This includes Lake Lynn Laboratory, about 60 miles southeast of Pittsburgh, where large-scale mine fire and explosion research is conducted. With the closures and transition we have worked to maintain the core competencies necessary to address Health and Safety issues. In some cases we have made arrangements to provide the requisite core competencies through external organizations. An example is the reassignment of the diesel particulate instrumentation capability from Twin Cities to Pittsburgh. In the case of diesel emission control, due to the cost of relocating laboratories and the lack of the appropriate skills at Pittsburgh or Spokane, the emission control laboratory is now being operated in Minneapolis through a contractual arrangement with the University of Minnesota.

PROGRAM FOCUS AND DIRECTION

Although organizational changes and alignments are important and, I am sure, of interest to this audience, I trust that the most important aspect of the Mine Health and Safety Program is the programmatic focus and accomplishments that are available for use within the industry. In that regard, I would like to use the remaining time to share with you my insights into our program direction and a few selected accomplishments.

We all agree that early involvement by potential customers in research programs expedites the use of the new technology by the customer and reduces the timeframe and cost of technology development and implementation by the private sector. In recent years, we have accelerated and will continue to aggressively seek input and participation in our research programs. In addition, I encourage all components of the industry to consider cost-sharing ventures by which we can expedite the development and application of technology to meet specific customer needs. I encourage you to continue to provide input into our program development. I also encourage you to be more proactive in financial participation in our programmatic efforts, in particular in the final developmental portion of our program. Where applicable, I would encourage the industry to consider using our unique facilities and staff on a cost-reimbursable basis to address site-specific or manufacturer-specific needs and interests.

As I look across the mining industry today, relative to issues that research and development can effectively address, I see an increasing amount of interest in health-related issues. Although it is important that we do not abandon our efforts relative to mine safety, we are expecting to see some shifts in the relative priorities of health versus safety research. Therefore, although past USBM research investment in health-related issues has been about 20% over the past 5 years, I would expect to see an increase in the health investment to about 35% in the next year or two.

Although the details of the coming fiscal year are still being formulated, I would like to share with you some of the principal issues and needs within the industry as well as selected examples of accomplishments and program direction. It is important to note that many of these issues relate to both coal and noncoal. Although in some cases the implementation strategy may vary depending on the type of mining, the underlying technology is the same in many cases. Following is my assessment of issues that are common within all segments of the industry and those peculiar to one component.

GENERAL INDUSTRY ISSUES

Silica Dust Control

Recent NIOSH and MSHA studies have indicated the severity of this health problem. In addition, there had been a proposal to reduce the exposure thresholds to one-half of the current permissible level. Techniques have been identified to reduce exposure to silica. For example, in surface operations, shrouds around blasthole drills have been able to reduce operator exposure by as much as 95%. In underground coal mines, research into silica dust collection by flooded bed scrubbers has reduced the silica which penetrates the filter and gets into the air by 40%. Research is underway to provide control technology to reduce worker exposure both in surface and underground mines; focus areas include longwall operations and roof bolting.

Noise

Noise continues to be an issue of interest and concern. MSHA has proposed rulemaking that would significantly modify exposure limits in mining. Further, NIOSH has examined 20,000 audiograms of miners and reports that miners have 2.5 to 3 times the hearing loss of the non-mining workforce.

Techniques have been identified to reduce some mining machinery noise. Joint studies with equipment manufacturers and rebuild shops are needed to integrate these concepts into current machine designs. Research is underway to assess the effectiveness of earmuffs and various control technologies to reduce machine noise. I believe it would be beneficial to get a current assessment of noise levels and noise exposures inasmuch as the last comprehensive listing on this topic is 20 years old. Such data would be useful in formulating and directing new research in this area.

Diesel Emissions

Diesel power systems have been the mainstay of the noncoal mining industry, and their use is increasing in underground coal mines. Significant progress has been made in control technology (including the adaptation and evaluation of control technologies, such as ceramic and paper element diesel exhaust particulate filters, low-emission engines, new diesel oxidation catalysts, fuel additives, and alternate fuels). Legislation is pending in the Pennsylvania and Virginia legislatures to update diesel use regulations in underground coal mines. Research will be conducted as required relative to measurement, control technology, and maintenance issues to ensure that the mining industry is able to comply with future regulations limiting the concentration of diesel exhaust particulate and gasses in underground mines.

Haulage

This activity is receiving increased attention due to the recent disproportionate number of haulage accidents and fatalities. Research initiatives have been intensified to address this growing problem. The opportunities for correcting this problem lie in the areas of human factors, training, equipment design, and haulage design. I believe that issues such as the increased use of extended shifts need to be carefully reviewed regarding such accidents. In underground operations, one problem area concerns the operation of continuous haulage equipment where operators are stuck or caught while guiding the haulage equipment behind a continuous miner. Our research has identified sensor technology that can be utilized to guide and position the continuous haulage. Laboratory tests have been very positive, and field tests will be conducted this fall.

Ground Control

Issues of ground control continue to be of importance in all sectors of the industry. Recent accomplishments include recommendations that we developed for redesigning the controls on roof bolting machines. During the past decade, several roof bolter operators have been caught and crushed to death by the powerful hydraulic drill boom. Several solutions to this type of problem were developed based on a human factors analysis of the machinery and tasks associated with the bolting function. The report containing recommendations received high praise from the West Virginia Board of Coal Mine Health and Safety. Some of the recommended solutions have already been adopted by the largest U.S. manufacturer of roof bolters, who have more than 70% of the market.

Ten seminars entitled "Preventing Coal Mine Groundfall Accidents: How To Identify and Respond to Geologic Hazards and Prevent Unsafe Worker Behavior" were conducted. The presentations at these seminars approached the prevention of groundfall accidents from two different perspectives: (1) how to train and motivate miners to protect themselves from groundfalls and (2) how to identify and respond to various geologic conditions that affect roof stability in southern Appalachian mines. The seminars were cosponsored by mine operators' associations and State mining agencies in West Virginia, Virginia, and Kentucky. More than 400 persons attended these seminars. I believe that these initiatives have contributed to the drastic decline in the number and rate of fatal groundfall accidents in the eastern U.S. coalfields.

Emphasis is directed toward emerging technologies, such as extended cuts, mobile roof supports used in retreat mining, innovative roof support systems, and projected increases in the use of underground mining in the aggregate sector of the industry. Studies are also continuing on understanding basic rock mechanics given various geologic settings and mine designs. For example, in the area of extended cut, natural gamma and radar coal thickness sensors and infrared coal-rock interface detection technology are being used to improve the safety of remote mining machine operators whose lives could be endangered when guiding machines.

Health and Safety Issues Associated with Automation

The minerals aggregate industry has made substantial progress in the use of plant automation, and other sectors of the industry are increasingly using automation to reduce exposure to hazards and increase production. There are many health and safety issues related to automation, ranging from human error to "software safety." All of the health and safety aspects of this issue are being investigated. For example, a safety panel comprised of industry, academia, and other government agencies has been assembled to identify the most pressing needs concerning mining automation. "Software safety" was identified as the top concern. Efforts are underway to generate mining industry guidelines for this area because no such guidelines exist. The draft guidelines will be generated this year and discussed with the safety panel.

Human Factors

Prior studies have documented the significance of human factors in many mining accidents. Through those efforts, progress in the following areas has been made.

With help from universities, mining companies, MSHA, and other providers of training, we have developed more than 70 interactive simulation training exercises on various mine safety and health topics. According to participants at the 1994 MSHA Summit Meetings on Miners Training and Safety at Small Mines, there is a pressing need for better safety training materials and methods in the mining industry. We have been working to meet this need by developing innovative training methods and materials to address safety and health problems associated with new technologies in mining. The materials have been favorably received and widely used. To date, more than 500,000 copies of these exercises have been distributed by MSHA's National Mine Health and Safety Academy, Beckley, WV.

Software has been developed to provide mining equipment manufacturers and MSHA (the certifying agency) with a quick and reliable method for evaluating mine illumination systems. Poor visibility in underground work areas contributes to many serious accidents. In the past, mine illumination systems where laid out with a trial-and-error approach, using handheld photometers to determine illumination output. The amount of work involved with this technique made it prohibitively expensive to test alternative systems. This meant that most illumination systems in mines were overdesigned and generated excessive amounts of glare. The CAP Mine Visibility Systems that we have developed allow mine lighting system designers to quickly lay out lighting systems that provide adequate illumination while at the same time minimizing glare. All of the major mine lighting manufacturers have purchased the CAP system, attesting to its potential to influence the mine lighting industry.

A user-friendly, PC-based software package (MADSS) was developed to provide the mining industry with access to a national database of mining accident information. The software contains a full set of features for searching and analyzing the MSHA databases. The system is currently being used by top-level MSHA

officials. More than 100 requests for copies of the software have been received.

The opportunities for continued programs through research in training, equipment, and task design are many, and we are encouraged to actively address safety problems using those approaches.

Disaster Prevention

Research on the prevention and control of mine fires and explosions continues to address critical issues. Reliable early-warning fire detection methods are crucial for ensuring sufficient time for the safe evacuation of workers and for permitting successful extinguishment of the fire before it becomes a more serious hazard. Research is being conducted to assess new detection technologies, develop novel fire sensors, and provide detector performance and deployment guidelines for optimizing mine fire detection systems.

The extinguishment of underground mine fires is a difficult and dangerous process. Research is examining new fire-fighting strategies and equipment that minimize the risk to firefighters, novel seals for isolating a fire area, and improved automatic suppression systems based on water-mist technology.

Reliable methods for preventing and detecting hazardous accumulations of combustible substances and rendering them inert are among the most important ingredients in our explosion prevention program. Research is being conducted to develop sensors for assessing the explosibility of gas and dust mixtures and to develop remote methane monitoring technology.

Mine escape during emergencies, with particular emphasis on life support, continues to be a priority. Research on life support is focusing on the design of new respirator systems and life support devices that optimize performance and reduce size and weight, as well as conducting field evaluations of existing respirators. In addition, a careful assessment of respirator physiology may permit modification of the performance requirements of self-rescuers and other breathing devices used in underground mining applications.

COAL MINING

Extended-Cut

Extended-cut mining operations are receiving increased focus relative to health and safety issues. Ventilation, methane control, operator safety with remote-control systems, and mine roof stability are some of the principal areas currently being investigated. One area of related research is that a "Machine in the Seam" graphic computer visualization system is being developed to enhance machine remote control.

Longwall Size

The increasing dimensions of longwalls dictate a variety of needs and issues that are the subject of health and safety research. These include respirable dust, ventilation, entry stability, and mine emergency issues (fires, explosions, escape, etc.). This is a case where a "systems approach" to the area of interest is the only way to proceed. I am optimistic about the progress that will be made in this area in the near future.

Retreat Mining

Many small mines, particularly in the southern Appalachian coalfields, use pillar retreat mining because of greater flexibility and lower capital cost than longwall mining. Unfortunately, pillar extraction often is faced with greater difficulty in maintaining roof and pillar stability. The very nature of the mining operation is also a challenge from the mine worker's perspective, and human behavior issues during retreat mining operations are being studied. A recent research accomplishment has been the development of a model for determining pillar stability during the

retreat mining operation. The model, called Analysis of Retreat Mining Pillar Stability (ARMPS), is now being widely used to design retreat mining sections.

Auger Mining

The use of auger or highwall mining systems, both for surface as well as for underground applications, is increasing and is the subject of various research initiatives. Although there was concern several years ago about explosions during the use of highwall augers, various USBM-proposed technologies and other initiatives have helped to effectively address this problem. Some of the principal concerns currently relate to mine roof control issues and equipment recovery with highwall mining systems. In addition, the proposed efforts to take similar mining concepts underground raise a variety of ground control, ventilation, and operator safety issues that need to be addressed. Guidance technology in the form of inertial laser gyro systems or radar web thickness monitoring will soon see application, thereby minimizing machine burials and improving resource recovery.

NONCOAL

Ground control in metal and nonmetal mines continues to be a focus of our research program inasmuch as both high stress conditions and mine design failures are problematic to the industry. Rock bursts in deep metal mines in the Western United States are still not fully understood, and technologies must be developed to identify and prevent burst-prone conditions. Massive pillar failures have recently occurred in two underground mines, Retsof and Solvay, which resulted in widespread mine collapse. Additional studies are needed to understand longterm pillar behavior for both yielding and nonyielding designs.

Projections indicate that limestone mining will begin shifting from surface to underground operations. Challenges facing the industry will include ventilation, blasting designs, equipment safety, ground control, and worker training. About 5% of the total U.S. stone production comes from approximately 90 underground mines. MSHA data show that 25% of the stone industry's accidents and fatalities occur underground. A significant portion of limestone mining accidents and fatalities involve roof and rib falls. Review of the accidents has lead our researchers to focus on training for underground limestone mining, with emphasis on roof and rib hazards. Training prototypes will be directed toward the two general areas of scaling and roof and rib inspection. The focus will be on perception (visual identification) of hazards; the identification of cues needed in the recognition of hazards. A module will be developed using three-dimensional photographs containing degraded and highlighted underground limestone scenes. Key elements within the module have been identified, and a curriculum and instructors guide will be developed. The prototype training module will be piloted and evaluated this fall.

SUMMARY

The health and safety research staff at Pittsburgh and Spokane, in conjunction with our partners, are moving forward to address the issues of mine health and safety. It is important that we all work together to continue to make the progress that has been realized in recent years.

We are currently working under the leadership of Dr. Gregory Wagner, Acting Associate Director of Mining for NIOSH; and we look forward to a smooth and full integration into NIOSH in Fiscal Year 1997. I welcome the opportunity to be with you as we begin another Institute. Best wishes for a successful meeting, and thank you for the opportunity to share these thoughts with you today.