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Michael Karmis
Conference Co-Chairman
Blacksburg, Virginia
September 1996

INTRODUCTION

This *Proceedings* contains the presentations made during the program of the Twenty-Seventh Annual Institute on Mining Health, Safety and Research held at Virginia Polytechnic Institute and State University, Blacksburg, Virginia, on August 26-28, 1996.

The Twenty-Seventh Annual Institute on Mining Health, Safety and Research was the latest in a series of conferences held at Virginia Polytechnic Institute and State University, cosponsored by the Mine Safety and Health Administration, United States Department of Labor, and the Pittsburgh Research Center, United States Department of Energy (formerly part of the Bureau of Mines, U. S. Department of the Interior).

The Institute provides an information forum for mine operators, managers, superintendents, safety directors, engineers, inspectors, researchers, teachers, state agency officials, and others with a responsible interest in the important field of mining health, safety and research.

In particular, the Institute is designed to help mine operating personnel gain a broader knowledge and understanding of the various aspects of mining health and safety, and to present them with methods of control and solutions developed through research.

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Update on Mining Health and Safety Research

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Keynote Address

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Keynote Address

UPDATE ON MINING HEALTH AND SAFETY RESEARCH

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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.

KEYNOTE ADDRESS

Jerry Jones
Vice President

The United Mine Workers of America

I appreciate the opportunity to address the 27th Annual Institute on Mining Health, Safety and Research here at Blacksburg, Virginia.

It goes without saying that much has changed in the mining industry since the first mining health and safety conference was held by Virginia Polytechnic Institute following the passage of the 1969 Coal Mine Health and Safety Act.

The Institute, starting with that first conference, has played an important role by hosting these annual events. They have been providing the mining community with a wealth of information on the ever changing mining industry. A wide range of general and technical health and safety topics has been part of the conference agenda over many years. The particular subject I want to talk about today is the debate over the future of the Federal Health, Safety Enforcement, and Research programs that have been the foundation of miners' protections for the past quarter of a century.

I would first like to point out that mining health and safety is a subject that is not foreign to me. To the contrary—it is a field in which I have considerable expertise. As you know, I am the Vice President of the United Mine Workers of America. One of my primary responsibilities in that capacity is to oversee the Union's health and safety program. Many experiences in my life prepared me for this role. I grew up in the coal fields and remember the explosions, fires, and roof falls that killed or crippled miners in our communities. I grew up around miners who couldn't breathe because of black lung. Probably the most important personal experience was my many years working as a coal miner in the Illinois coal fields. Like many who grew up in mining communities, upon graduation from high school, I went to work in the coal mines. As a young miner, I quickly began to realize the importance of effective health and safety laws. I started my mining career as a shuttle car operator at the Old Ben #21 Mine near Sesser, Illinois. Working at the coal face taught me how dangerous coal mining could be. I also learned that I was much more fortunate than earlier generations of miners. I went to work in 1966, just prior to the enactment of the 1969 Coal Mine Health and Safety Act. I witnessed first hand the transformation that took place when the Mine Act hit the coal fields. Older miners did not have the protections against the harsh and unforgiving mining environment brought about by the 1969 Coal Mine Act as I did. There were many health and safety improvements in that new Mine Act we did not have before. Companies had to rock dust coal mines to prevent dust explosions. They had to keep respirable dust down to a healthy level. They had to constantly check for methane and have a ventilation plan to prevent explosions. They had to have a roof control plan to stop roof falls and they had to use roof bolts. They had to check equipment for hazards. They had to do many new things. If they did not do these things, the mine would be shut down on the spot. They had to protect miners. That Mine Act caused mines to be much safer for miners. During my mining career, I came to appreciate the significance of that mining law. The year the Mine Act was passed into law, I became a local mine health and safety committeeman at the Old Ben #21 Mine. I was able to see that those new laws were implemented at my mine. I was able to play a part in improving the conditions at my mine.

In 1979 I was given an opportunity to join the United Mine Workers Safety Division. For the next several years, I was able to impact the health and safety conditions at other coal mines. I trained miners, inspected coal mines, assessed new mining methods and technologies and investigated numerous mining accidents. Taking what I had learned over the years, I worked to improve health and safety conditions to make the working lives of miners in Illinois and across the nation better.

I have a personal commitment to the health and safety of the nation's miners. It is a commitment that is far reaching in the United Mine Workers. It is, in fact, the highest priority our organization has for our members.

Given this background, one can well imagine what my reaction was when I heard the news over the past two years about proposals from politicians to dismantle the Federal Health and Safety programs designed to protect the nation's miners.

The federal health and safety programs and agencies under attack were the Federal Mine and Health Act, MSHA (the agency charged with enforcing the Mine Act), along with two research agencies, NIOSH and the U.S. Bureau of Mines. These were federal programs which took nearly a century to create, paid for by the lives of tens of thousands of miners and the agony of hundreds of thousands more disabled from accidents or stricken with life shortening illnesses.

The ill-conceived plans by politicians to dismantle vital protections are mean-spirited and extremely dangerous. I also found it very ironic that while many in the mining industry were paying tribute to enormous improvements of the 1969 Mine Health and Safety Act last year, some misguided politicians were plotting to destroy it.

Over the last two years, the UMWA has had to stand constant guard over the assembly line of legislation, plots, and schemes aimed at stripping away miners' basic health and safety protections. Outraged miners poured into Washington, D.C., to fend off these assaults.

To understand why miners are furious over these actions, one must understand the tragic history of this industry—the price miners and their families paid to achieve basic health and safety protections—progress that was paid for by maimed bodies, young widows and lives shattered forever by explosions, fires, electrocutions, roof falls, machine accidents and black lung disease. Having been a miner and growing up in mining communities, I share that anger. Many of the legislative actions would have eliminated mine site enforcement, mine inspections, workers' rights, and health and safety standards. It would have returned us to a time when America's coal fields were killing fields, where coal mine explosions were commonplace, and deaths from mine disasters and disease made the coal industry a national disgrace. Legislative actions were also introduced which would have destroyed the only Federal Mining Safety Research Program implemented nearly 90 years ago by dismantling the U.S. Bureau of Mines. That was the only federal agency upon which our industry could depend for technical mining safety research.

Miners rely on this federal research to neutralize health and safety hazards that may injure them or make them ill. Research and development of methods to reduce and eliminate coal dust, noise levels, fires, and explosions have been part of that important work, for which there is no replacement.

Legislation was introduced to eliminate NIOSH, the federal agency responsible for monitoring the health risks miners face. NIOSH is the agency which is responsible for providing guidance to the government and mining community on the prevention of occupational illnesses.

While there were attempts to eliminate the Bureau and NIOSH, the big target was the Mine Act. The elimination of protections miners had under the Mine Act, sought by these misguided politicians, ignored history. For nearly a century, the coal industry was allowed to police itself and to comply voluntarily with health and safety standards. No one really knows how many miners were killed in coal mining accidents during the 19th Century; however, records indicate there were thousands. Beginning in 1910, with the creation of the U.S. Bureau of Mines, Congress attempted to improve conditions in the nation's mines through voluntary programs. But the carnage continued. The 1968 Farmington disaster finally convinced Congress that the experiment in voluntary industry compliance had been a miserable failure.

After years of creating ineffective mining laws, congress finally made a commitment to prevent accidents and occupational diseases and provide compensation to the victims of black lung with the passage of the 1969 Mine Act and the subsequent 1977 Mine Act. This legislation set specific standards to prevent explosions, control fires, and other safety hazards. It mandated frequent inspections of the nation's coal mines, penalties for violations of the law and frequent monitoring of respirable dust. To ensure compliance, it vested powers in coal mine inspectors, including the power to inspect mines to cite violations and to shut down an unsafe mine.

The accomplishments of the Mine Act have been impressive and fatality rates for coal miners have declined significantly. In the 25 years prior to the 1969 Mine Act, a total of 12,270 coal miners died. In the 25 years since, the number of miners killed on the job has dropped to 2,764—a 77% reduction in mine fatalities! We keep asking what sensible person would want to destroy such a successful program. These changes did not occur by chance; they were driven by a sound set of rules and strict enforcement. And, although the accomplishments of the 1969 Mine Act are impressive, we can not lose sight of the fact that our work is not finished. More and more fatal accidents involve employees of independent contractors. Small mines, which have had fatal rates much higher than the rest of the coal industry, continue to kill coal miners at a rate far greater than any other. These small mines must be required to operate by the same set of rules as the rest of the industry. This problem has been with us for far too long and must be rectified. The number of fatal accidents at surface mines is growing. We need to curb those accidents.

These problems are not going to go away by themselves. We need to improve upon what we have, not destroy it. It will take a renewed commitment from government, management, and labor, working cooperatively to make these changes come about. Maintaining what we have achieved and fixing the problems that still plague the industry will occur only if the government agencies entrusted with the responsibility of protecting our nation's miners are properly funded and directed.

There were different twists placed on the so-called legislative reform measures. While some politicians claimed the purpose was to make simple changes in the programs, others said the legislative actions were an effort to help balance the federal budget. To achieve that, the legislation called for the merger of MSHA and OSHA as a single agency. Politicians tried to sell the proposal as a simple administrative coupling of two federal agencies. However, such an action would have created an ineffective bureaucratic animal, incapable of dealing with the unique environment of the mining industry. Moreover, this legislation was disguised to strip away vital health and safety laws, including such things as the basic right of miners to anonymously request investigations of unsafe conditions. It would have created an impotent government body, devoid of any enforcement power. We all recognize the budget constraints our government faces and that some downsizing and streamlining is necessary to eliminate this problem. However, we must also be mindful of the sacrifice that such actions would cost an industry's workers who have already paid far too great a price for the current protections provided. We must look elsewhere, and not tamper with the protections miners have, to solve the budget matters. When it comes to mining research, we must have a sound federal program. We realize, however, that we must be more frugal by wisely directing allocated money to important issues such as respirable dust, noise, and the elimination of hazards brought about by the introduction of new technologies. Past programs such as the Star Wars Robotic Programs should not be a responsibility of tax payers.

It was obvious to us that the drafters of the legislation ignored the lessons learned during a century that witnessed over 100,000 deaths from mine disasters and another 300,000 deaths from black lung disease. In fact, the bill closely paralleled the timid and ineffective legislation that was enacted between 1910 and 1952. Had this legislation become law, it would have wiped out a century's worth of protections paid for in blood, death, and human suffering by hundreds of thousands of miners and their families. These kinds of actions do not represent progress; rather, they would return us to a formula that resulted in senseless injury, illness and death in our nation's coal fields. Although there were various legislative actions pursued to achieve these ends, the most notorious was H.R. 1934, better known as the "Ballenger Bill." That legislation died in its tracks.

Should similar actions re-appear in Congress in the coming years, the United Mine Workers will be there. Those who recognize the benefit of a sound health and safety program for coal miners in this country will stand beside us. The others can expect the fight of their lives.

We believe that for this industry to survive, as well as the miners, there must be a sound and effective Mining Health and Safety Program in this country. We need a stronger, not weaker, Mine Act. We need an effective enforcement agency devoted exclusively to mining health and safety. This industry needs the services of a federal agency tasked with assessing the health risks that miners face. We need a NIOSH. This industry needs a sound mine safety research program to identify and solve the safety hazards miners are exposed to. This industry needs these programs to be well funded and supported.

As we all gather here at the 27th Annual Institute on Mining Health, Safety and Research, we need to reaffirm our commitment to vital government programs.

KEYNOTE ADDRESS

Edward C. Hugler
Deputy Assistant Secretary of Labor
for Mine Safety and Health

U.S. Department of Labor
Mine Safety and Health Administration

This morning I'd like to talk about miners' safety and health from a slightly different perspective, and organize my remarks around a question: "If I were a working miner, would I have good reason to feel safer on the job today than a few years ago?"

I believe the answer is yes, with the caution that working miners continue to have legitimate concerns about their safety and health and all of us still have important work to do.

So, let's suppose we are working miners, doing a hands-on mining job, every day in the mines. How do we feel about our safety and health protection on the job? Do we have good reasons to feel more confident about our health and safety today than yesterday? What are our current concerns?

PREVENTING MINE DISASTERS

Weighing on the minds of underground coal miners and their families everywhere is the risk of a disastrous mine fire or explosion. Preventing these tragedies depends on vigilance by miners, mine operators, inspectors--everyone in the mining community.

In the past three years MSHA has done more than ever before to focus attention on preventing mine explosions. This March, we issued improved ventilation standards. For the past two years, we have conducted special focus inspections to detect explosion hazards. We have conducted surprise inspections for smoking materials. And we have stepped up the annual Winter Alert initiative during the high-risk explosion season from October through April.

The past two Winter Alert seasons have been free of mine explosions. The last fatal mine explosion is now 27 months ago. With the determined commitment of everyone in the mining industry, we can see another year free of these tragedies.

But...let's not get complacent. I must tell you, there is also some bad news about explosion prevention. Just this May, we made another series of inspections for smoking materials. And MSHA inspectors found smoking materials in five underground coal mines. It is fortunate that these situations were detected before they could result in disaster. As you know, smoking materials were one factor in each of the last three fatal underground coal mine explosions:

- The Southmountain explosion (VA), with 8 killed, in 1992
- The AA&W explosion (KY), 1 killed, in 1993

- The Day Branch explosion (KY), 2 killed in 1994.

It is especially disturbing that, two years after the Day Branch explosion, and after extensive education efforts in the mining community, we still find smoking materials in five underground coal mines. And one of the individuals with smoking materials was a foreman, who had a butane lighter underground.

Of course, smoking materials are just one potential source of ignition. Ventilation, gas checks, electrical safety, rock dusting, all these lines of defense are critical to prevent explosions. And at times, our inspectors continue to find instances where these lines of defense are not being given the attention they deserve.

In one instance, this April, an MSHA inspector discovered a 13 percent concentration of methane in an underground coal mine. This was in an entry for a longwall that was being set up, and there were miners working inby the area, with no idea that they were in a potentially lethal situation. It is fortunate that the MSHA inspector recognized the situation, and a potential tragedy was prevented.

But, I must tell you, I find this type of incident terribly disturbing. The Federal government should not find this kind of problem. Anyone in the business of coal mining should have systems in place that prevent or quickly detect such a serious threat.

SURFACE HAULAGE

Miners who work on the surface also know MSHA is doing more these days to attack their number one cause of deaths: haulage accidents. From 1990 through July of 1996, haulage accidents on the surface, involving trucks, loaders and the like, claimed the lives of 139 miners in all sectors of the mining industry. Another 500 miners were seriously injured in such accidents during the same 6½ year period. Last year, surface haulage accidents accounted for 25 of 99 mining deaths--more than one quarter of all the fatalities.

In the past two years, MSHA has tried to tackle the surface haulage problem on a national basis. We've alerted the mining community to the problem. We've conducted specially focused inspections on haulage trucks. We've held regional seminars on truck safety. We've distributed a series of new, up to-date training videos for miners who operate and maintain surface haulage equipment. We've alerted the industry to the risks faced by customer truck drivers.

And, we are beginning to see signs of improvement. In the coal mining industry, this year, there's been only one surface haulage death compared with 7 at this time last year. But, there is more to be done. In the metal and nonmetal industry 9 miners have been killed in surface haulage accidents this year.

To help make further progress, this past June a surface haulage task group was formed that includes staff from MSHA, the Energy Department's Safety and Health Research Center (formerly the Bureau of Mines), people in both the coal and metal/nonmetal mining industries, and equipment manufacturers.

They're exploring, for instance, what recommendations might be made to the industry concerning haulage road design. We plan to publish their proceedings in the form of "best practices."

The seriousness of this problem is also reflected in the agenda for the Conference. Several of the technical sessions this afternoon address surface haulage accidents, including what I think you will find is a constructive analysis prepared by MSHA.

CONTRACTOR SAFETY PARTNERSHIPS

There's also another group of miners who have higher fatal accident rates than average, but until recently, very little attention has been given to their plight. These almost forgotten miners are contractor employees. In the coal industry, they may work for small companies that produce coal under contract to large organizations. In both the coal and metal/nonmetal industries, employees of independent contractors do specialized jobs like electrical work, shaft sinking, construction, welding, and blasting. Other independent contractors drive trucks that haul a mine's product to its customers. Over 65,000 such contractor employees were counted on MSHA's books last year.

Alarmingly, these employees of independent contractors have fatal accident rates far above the average for direct employees of mine operators. Last year, independent contractor employees in the coal industry had a fatality rate 33 percent higher than operator employees (0.06 compared with 0.04). And in metal and nonmetal mining last year, independent contractor employees had a fatality rate four times as high as operator employees (0.08 compared with 0.02).

Today, however, these almost forgotten miners have reason to hope that their lot in health and safety can improve. In recent months, MSHA has signed pioneering agreements with three major companies, designed to improve their contractors' safety performance. Each agreement is unique, but all have one principle at their core: working together to prevent hazardous conditions and practices. MSHA provides each mine operator with current, detailed information on their contractors' injury and compliance records. In turn, the mine operators audit the contractors' safety performance and take steps to promote contractor safety. The mining companies may even disqualify contractors from further contracts if they cannot work safely in compliance with standards.

The first of our contractor safety agreements, which was with United Coal Company, has been in place now for about a year, and early results look promising. This agreement covers a number of small operations producing under contract to United. Lost time injuries at the operations covered by the United agreement have declined. As of last month, the number of violations at the operations covered by the United agreement had dropped 26 percent. And, the percentage of serious violations at these operations fell from 46 percent to 35 percent.

We have two additional agreements in place with companies that specifically deal with independent contractors. Contractor employees in all the operations under these partnership agreements have reason to feel confident that they are no longer "forgotten miners." Their safety problems are now getting the extra attention they deserve, and MSHA is discussing possible partnership agreements with several more mining companies.

We are particularly eager to develop partnership agreements covering independent contractors in the metal and nonmetal industry, where the fatality rates for independent contractor employees are highest of all. Agreements of this kind are a "win-win" solution for MSHA, mine operators and miners. We look forward to expanding their protection to more independent contractor employees in the months to come.

NEW ANSWERS IN MINERS' HEALTH PROTECTION

I've mentioned several good reasons why miners can feel increased confidence in the safety protection they enjoy today. But, what about health? For too many years, miners' health protection has, frankly, taken a "back seat" to safety programs.

Today, that's changing. In coal mines, the leading concern, of course, remains "black lung" disease. Coal miners know that today, thanks to the Federal Coal Mine Health and Safety Act of 1969, they run much less risk of this crippling disease. Free x-rays offered to underground coal miners in 1970 revealed more than 11 percent of those examined showed signs of black lung. In 1991, that figure was 3.6 percent. Better, but still too many.

Everyone in the mining community, mine operators, miners, health professionals and others agree: the current system for monitoring and controlling miners' dust exposure has enormously improved health conditions for miners. At the same time, the advent of new technology and experience with the dust program afford us the opportunity to improve it.

For instance, MSHA and the Energy Department's Safety and Health Research Center (formerly the Bureau of Mines) have developed a continuous reading dust monitor that can be mounted on a mining machine. In-mine tests of this dust monitor are under way now. And I know an update on this important new technology is on your Conference agenda.

Next month, we are expecting the report of the Secretary of Labor's advisory committee on eliminating black lung and silicosis. This group was carefully selected for balance and objectivity, with members from the coal industry, labor, and a majority of members who are health professionals with no economic interest in the mining industry. The advisory committee has heard testimony in public meetings throughout the coalfields. In their report, they will give us their recommendations on what we need to do in order to bring coal mine dust control into the 21st Century.

Other health concerns that have been too long shunted aside are being addressed today as well. Recent studies by the National Institute for Occupational Safety and Health (NIOSH), as well as joint surveys by MSHA and NIOSH, reveal a surprising number of cases of silicosis among current mine employees. Surface coal miners involved in drilling have some of the highest silica exposures. To protect these miners, new drill dust control standards went into effect in 1994. But, more remains to be done. Soon, we plan to announce an industry-wide, national conference with other Federal agencies to share information about the silicosis problem, and share possible solutions.

On another front, the use of diesel-powered equipment in underground coal mines has been on the rise. Miners can look forward to new regulations, now in preparation, that will set requirements specifically designed to protect coal miners where diesels are used underground.

We've also held workshops to share information about the particulate matter in diesel emissions, and the latest in control technology. Right now, we are putting together the best ideas on controlling diesel emissions from these workshops and will be making that information available.

Then there is noise. Many people do not realize how many miners lose their hearing as a debilitating side effect of mine employment. According to a survey of coal miners' audiograms, by the age of fifty, 90 percent of the miners had hearing impairment, compared with only 10 percent of non-occupationally-exposed adults. Soon, we plan to publish a proposed rule designed to more effectively prevent hearing loss among miners. Your comments on that proposal will be important to developing regulations that work and afford miners the protection they deserve.

For miners and their families today, there are good reasons for increasing confidence in the protection being given to their safety and their health. But, as I have emphasized, more remains to be done.

We started this year with overall fatalities in the mining industry increasing slightly from 1994 to 1995. One year does not make a trend, but any increase in mine deaths deserves attention. This year, the fatal accident trend in coal mining has begun to improve, with 21 deaths to date compared with 27 last year at this time. That is, so far as I can determine, as low an annual fatality count as the coal industry has ever achieved as of this point in the year. There is every reason to continue in our guarded optimism about the fatality trend in the coal industry.

In the metal and nonmetal sector, however, the picture is not so bright. The metal and nonmetal industry achieved a record low fatalities in 1994, with 40 deaths. Last year, however, the toll rose to 52. And so far this year, there have been 33 deaths in the nation's metal and nonmetal mines, compared with 28 at this time last year. The metal and nonmetal mining industry is still safer than it used to be, but there is reason for concern, if this is allowed to start a trend in the wrong direction.

Summing up the positives and negatives, I think that miners have good reason to feel better protected on the job than ever before. But, as I have said a number of times, there is still work to be done, and it is important work. After all, the topic here is not numbers and trends. These are simply the tools of measurement. The topic here is peoples lives, and preventing tragedies.

Recently, the parents of a miner who died in a mine accident wrote the following to the MSHA investigators:

> *We can't thank you enough for all the hard work, long hours, and conscientious searching for truth that you have done....Because of the undeniable truth of the evidence you have uncovered, we hope that our son...will not have had a meaningless death.*

I know that all of us in the mining community take those words to heart. We can't undo the tragedies of the past. But, we *can* use them to prevent the tragedies of the future, through a determination to learn from experience and the willingness to look ahead.

LUNCHEON SESSION

PROFESSIONAL AWARD FOR COAL MINING HEALTH, SAFETY AND RESEARCH

GAROLD R. SPINDLER
President
Cyprus Amax Coal Company
Englewood, Colorado

Luncheon Address

PROFESSIONAL AWARD FOR COAL MINING HEALTH, SAFETY AND RESEARCH

Mr. James L. Adkins graduated from Logan High School in 1947, and began his professional career with Island Creek Coal Company in Holden, West Virginia, the same year. He furthered his education with coursework at Southern West Virginia Community College and through the continuing education program at West Virginia University.

After working in a variety of positions, from miner to mine foreman, he was appointed safety engineer in 1963, and after five years in the safety field, he was promoted to Safety Director of the Island Creek Division. During his years with Island Creek, Mr. Adkins was active in mine rescue work, and served as the captain of Island Creek first aid and mine rescue teams, winning four national championships.

From 1976 until his retirement in 1992, Mr. Adkins joined Cannelton Industries as General Manager of Safety. In this position, he organized a safety department for the corporation and developed a safety program which resulted in substantial safety improvements for Cannelton.

During his long and illustrious professional career, Mr. Adkins has promoted health and safety in the mining industry in many capacities. He is a member of the American Society of Safety Engineers; served on the safety committees of both the Bituminous Coal Operators' Association and the National Coal Association; was a member of the executive committee and board of directors of the West Virginia Coal Association; served on the executive committee of the National Mine Rescue First-Aid and Benchman Contests and the executive committee of the Mine Inspectors Institute of America; was safety director, Tri-State Council, of the Holmes Safety Association; and was president of the Mingo County Mining Institute and of the National Mine Rescue Association, Post 1, in Welch, West Virginia.

In recognition of his many contributions to the field, he was the 1989 recipient of the Holmes Safety Association Certificate of Merit, and in 1990, he received the Donald S. Kingery Memorial Award for Safety.

The 27th Annual Institute on Mining Health, Safety and Research is honored to present the Professional Award for Coal Mining Health, Safety and Research to Mr. James L. Adkins, in recognition of a lifetime of major accomplishments in this field.

LUNCHEON ADDRESS

Garold R. Spindler
President

Cyprus Amax Coal Company
Englewood, Colorado

The title of this story is "The History of the World of Safety Parts I and II" (for all you Mel Brooks fans).

I am talking about how the history of safety will be written about our industry, and it is the industry of everyone. Better yet, how can we impact the history of safety, since it is within our power to do so. Because Part I has already been written, but Part II is yet to come. The story goes . . . .

PART I

Once upon a time, there was a mining industry that simply could not seem to break through barriers on its way to achieving truly outstanding safety performance. Safety improvement had simply bottomed out. Serious injuries were rising, not falling. There was also an enforcement agency faced with the ever present task of enforcing a law that was designed to achieve outstanding safety performance, but was stalled in its pursuit. There was also a represented segment of the workforce that simply never thought either MSHA or the industry did enough to promote safety. Something has happened. After the first 25 years since the inception of the Mine Act, safety improvement had stalled. The circle of friends became a Tammany Hall of finger pointing. The "politics of safety" had taken over. What was everyone to do?

This "politics of safety" has been born out of a general lack of trust between those involved in improving safety. The causes of this lack of trust are both old and new. MSHA is concerned that the industry is conspiring to do something wrong and sometimes regulates in ways that foster lawsuits and establish precedent rather than improving the safety of the miner. The represented segment of the workforce sometimes believes that every operator is a safety bandit and this interferes with aggressively promoting individual awareness of safety. And the industry believes management has all the answers and the Mine Act has outlived its usefulness. These may be harsh words, but they are the feelings of many in this industry and perhaps in attendance at this meeting.

So what is the current state of safety? MSHA decides that more regulations are the answer (some effective, some impractical and ineffective), and that greater emphasis on enforcement will show industry that they mean business. The industry decides to spend its effort and money in challenging MSHA at every turn in court over the reasonableness of regulations or the interpretation of enforcement actions. The represented segment of the workforce decides to press the issues at every turn, sometimes unreasonable or impractical.

The issues don't really matter (i.e., Mine Act Reform, abnormal white center cases, independent contractor litigation, the challenges to the ventilation regulations). The result is that not enough constructive injury and illness prevention activity is taking place and the statistics prove it. The folks the Mine Act was designed to protect—the miners—are somehow being left out of the equation due to the "politics of safety."

We must not be satisfied with the status quo and must seek new ways of doing things in order to improve safety. Whether or not you believe that enforcement action alone is the key to injury and illness prevention is not the issue. The issue is how can we work together as an agency, industry and workforce to improve the safety lot of the miners within the confines of the Mine Act.

We try at Cyprus Amax "to think out of the box." We have done this, and the growth and performance of the Company is our gospel. What this process has shown us is that barriers to improvement in any area of an operation can be removed if the people involved in the process are given the training, the resources, and management's commitment, and they engage themselves in improving the process. All involved must recognize the changes that have taken place in our industry such as the type and size of equipment (i.e., > 300 ton haul trucks), the type of mining (i.e., large longwalls), and the way work is getting done (i.e., contractor vs. employee). These changes present challenges that must be met each and every day because the consequences of safety failures are unacceptable.

PART II

What can MSHA, the industry and the workforce do to shape the face of safety history? How will the historians relate the events of the second half of the 1990s and into the 21st century? Events that someone looking back might say, "It certainly took courage by the parties to reach their safety goals." The courage to try new ways of promoting miners' safety.

Some of the new ideas that appear to be working:

Compliance Analysis Program (CAP)

MSHA initiated this program using trained inspectors (w/o the authority to issue citations) to assist operators in identifying ways to improve compliance performance. A cooperative effort versus an enforcement effort. So far this program has been well-received at our operations.

Surface Haulage Accident Prevention Task Group

An effort that has brought together the mine operators, equipment manufacturers, MSHA, and Pittsburgh and Spokane Research Centers in order to review ways to prevent haulage accidents. It is too soon to tell, but some of the possibilities coming out of this task group may involve (1) developing resource materials that present a best practices approach to preventing surface haulage accidents and (2) using a different approach to the distribution of safety information so that those who do the work receive the proper training.

The Assistant Secretary's effort to address issues involving contractors has been fruitful, as evidenced by MSHA's contractor safety promotion programs recently entered into with several coal industry companies bringing significant emphasis to a problem area. Also, the Assistant Secretary's "holistic view" of court settlements where the mine operator promotes more safety minded activities gets high marks.

Mine Rescue

Our company just took part in a mine rescue disaster program at our Empire Mine in Craig, Colorado. This program included a competition mine rescue problem and a noncompetition surface and in-mine problem involving mine rescue teams from Utah, Colorado, Wyoming and Jim Walters from Alabama, and officials from MSHA federal and district, MSHA Technical Resources, Pittsburgh Research Center, and city, county and state health care professionals and law enforcement officials, and of course, the press. It also included as the victims of the mine disaster, a dozen or so of the Moffat County High School football team called the "Bulldogs." Although I did not see it, I am told that some of the football players were dragging a little bit after a long day in the mine.

These cooperative efforts are proving worth the time and effort. We need to learn from the process and repeat it in other areas. It will take the trust of those involved to make this work.

Where Can We Do Better?

As a general statement, the parties need to better understand how and why injuries and illnesses are occurring. All too often it appears that the 80/20 rule applies when MSHA allocates its resources. Statistically, 90+ percent of the injuries in the mine are caused by unsafe acts rather than unsafe conditions. Is that the focus of our efforts?

Complete several of the current rule makings or policy initiatives, such as belt air regulations, electrical regulations, revision of the Inspector's Handbook.

Resolve the existing disputes arising out of the ventilation regulations in a reasonable manner. For instance, the issue involving the use of a methane probe should be resolved without litigation. Sometimes, no matter how hard MSHA wants something to work, physical law simply will not allow it to work safely. More harm than good will come from attempting impractical application of this regulation.

How Will Safety History Say We Got the Job Done?

The parties developed a better understanding of each other's needs and were able to work together to get the most out of what they do for safety. The parties involved in the process took charge of their destiny and engaged in the process of constructive discussion as they established their expectations. The parties effectively measured how they were performing and continually improved the process rather than falling into traditional ways of doing business. The parties reallocated resources in such a way as to focus on the real problems and causes of accidents. And most important, all individuals in this industry developed a safety culture embodying individual responsibility for safety.

Remember in the END, our concern for our employees relies on our sincere and genuine concern for their safety.

TECHNICAL SESSION I:

Safety Issues in Surface Mining Operations

Co-Chairmen:

Ronald Mullins
Director of Safety and Training
United Coal Company
Grundy, Virginia

Thomas E. Carroll
Manager of Government Relations and Business Development
Vulcan Materials Company
Winston-Salem, NC

SAFETY ANALYSIS OF SURFACE HAULAGE ACCIDENTS

Robert F. Randolph, Research Psychologist
C. M. K. Boldt, Civil Engineer

U.S. Department of Energy, Pittsburgh and Spokane Research Centers

ABSTRACT

Research on improving haulage truck safety, started by the U.S. Bureau of Mines, is being continued by its successors. This paper reports the orientation of the renewed research efforts, beginning with an update on accident data analysis, the role of multiple causes in these accidents, and the search for practical methods for addressing the most important causes. Fatal haulage accidents most often involve loss of control or collisions caused by a variety of factors. Lost-time injuries most often involve sprains or strains to the back or multiple body areas, which can often be attributed to rough roads and the shocks of loading and unloading. Research to reduce these accidents includes improved warning systems, shock isolation for drivers, encouraging seatbelt usage, and general improvements to system and task design.

INTRODUCTION

Although surface mining has always experienced lower accident rates than underground mining, and these rates have been generally improving, recent increases, particularly in the number of powered haulage accidents, have caused concern in the mining industry. As the most common type of machinery involved in surface accidents, haulage trucks have become the primary target for improving safety performance. This paper discusses the ongoing efforts by the successors to the U.S. Bureau of Mines (USBM) to analyze and solve haulage truck safety issues.

Ideally, accidents would not happen. Operating procedures would eliminate all possible hazards, and these procedures would always be followed. Equipment would be perfectly designed, flawlessly maintained, and never operated outside of design parameters. The worksite would be constant and predictable, introducing no hazards of its own. Unfortunately, this is an unattainable ideal -- the realities of people, machinery, and the mining worksite are constantly pushing one or more of these conditions outside of the ideal. Understanding and controlling the causal factors in haulage accidents is essential to reducing their probability of occurring.

Accident Causes and Solutions

Most accident research now recognizes the role of multiple causes in accidents, including a significant human performance component. In the most detailed study of accident causes in mining, Sanders and Shaw (1988) studied underground mining accidents through an expert-panel investigative procedure. Their research showed that 88% of accidents had at least two major causes. This study also showed that "perceptual-cognitive-motor" errors (related to the more common term, "human error") were a causal factor in 93% of the accidents. While the effort and expense entailed in this type of analysis have so far precluded its use in surface mining, the general principles should be applicable. That is, attempting to identify a single cause for every accident is usually an oversimplification. Also, human performance and limitations will often come into play, even if other factors (poor design, dangerous conditions, etc.) essentially "forced" an error.

In surface haulage, human performance becomes a critical issue because of the unusual demands the vehicles place on their human operators:

- Roadways and work areas change frequently.
- The sheer mass of the trucks sometimes requires control inputs (e.g., braking) far in advance of the desired action.
- In large operations, the drive into and out of the pit is long and tedious.
- Rough roads and loading impacts can subject the driver to dangerous shocks and vibration.
- Visibility is sharply curtailed by the bulk of the vehicle.

Because of these demands, solutions to haulage truck safety problems must consider the human factors aspects of the task, even when engineering solutions seem most appropriate. The specific problems that need to be solved can be determined by studying the accidents involving haulage trucks.

ANALYTICAL APPROACHES

Accident data analysis is an indispensable tool for understanding the causes of accidents. Systematic analysis of large numbers of accidents can reveal patterns and commonalities that might be not be evident when looking at a single incident. The analysis can be based on industry-wide databases of accidents, in-depth analysis of official written accident reports, or data collected especially for the analysis. Each of these approaches has characteristic strengths and weaknesses.

Industry-wide Databases

The most widely used source of U.S. mining accident information is the Mine Safety and Health Administration (MSHA) database collected from the quarterly 7000-1 and 7000-2 forms. In addition to reports published by the agency, the raw data is available from their Internet Web site (http://www.msha.gov). This data is essentially a census of injuries in the U.S. mining industry, although it is conceivable that some accidents are not reported. The current study reports updated statistics from the MSHA database, bolstered by cost estimates from the USBM-developed Accident Cost Indicator model (ACIM) described in more detail below.

Textual Analysis of Official Reports

In addition to the coded information about accidents, there is sometimes a written description available. For instance, accidents reported to MSHA on the 7000-1 form also have a brief description provided by the mining operation. Fatalities have a more detailed textual record in the form of an official accident investigation report. This textual information, because it is free of the constraints of the coding system, can incorporate details about the accident that might be missed otherwise. The fatality reports are particularly informative, containing details about the work procedures, equipment, victims, and even diagrams of the accident site. Unfortunately, this approach is not without its limitations. It is very time-consuming to convert the textual descriptions into a form useful for tabulating and comparing

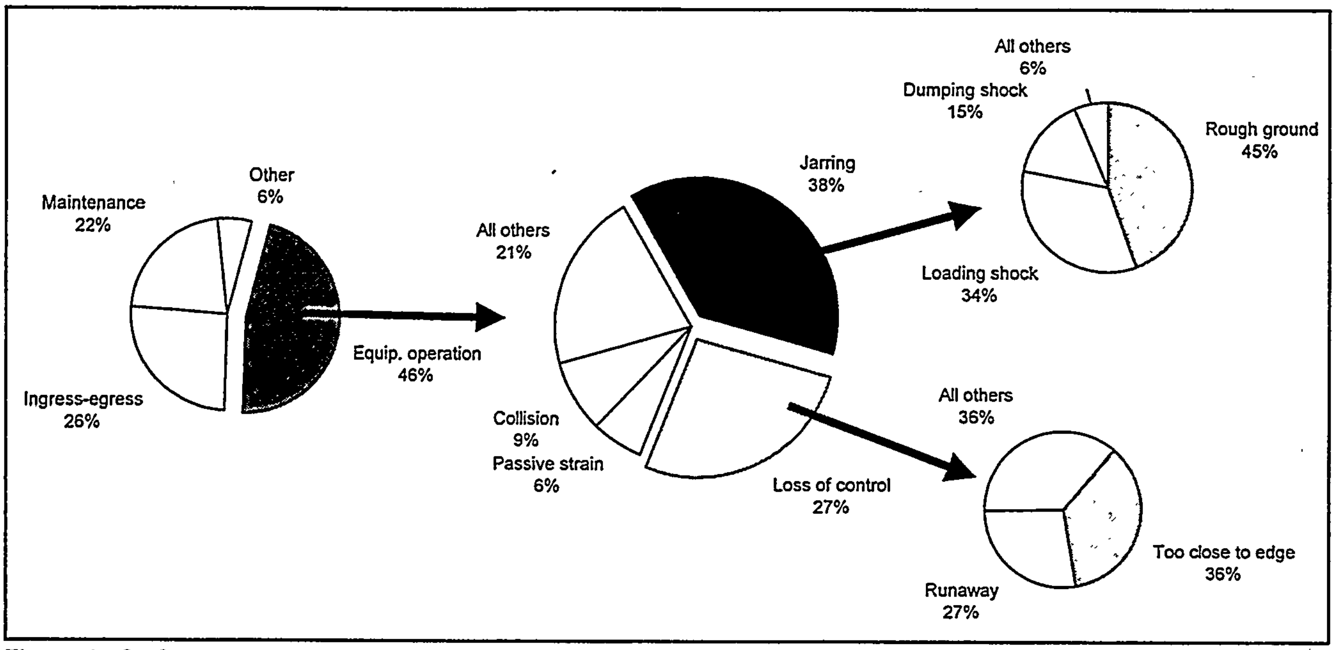

Figure 1. Surface coal haulage truck accident categories in successively higher detail. Based on analysis of written accident descriptions for 1989-91 (Aldinger, Kenney, and Keran, 1995).

large numbers of accidents. Key information can be omitted unless the report writer is following a specified format. This process also requires subjective judgements that may be difficult to duplicate or validate.

This analytical approach was successfully applied to surface equipment accidents by Aldinger and Keran (1994) in an overview of the entire mining industry, and by Aldinger, Kenney, and Keran (1995) in a more detailed study of the coal segment of the industry. They employed a panel to categorize accidents based on the written narratives in the MSHA database. By using the narratives, they were free to develop categories of accidents that were more descriptive than the traditional categories. In their study of surface coal mining, Equipment Operation was the most common category of accident for haulage trucks (46.3%) followed by Ingress-egress (25.8%) and Maintenance (22.1%). Within the Equipment Operation accidents, the most common types were Jarring (37.7%) and Loss of Control (26.8%). The main Jarring categories were Rough Ground (44.5%), Loading Shock (33.5%), and Dumping Shock (15.5%). Loss of Control categories included Too Close to Edge (36.4%) and Runaway (27.3%). Figure 1 shows how these categories and subcategories are related.

Seatbelt usage is another area where the textual information reveals new accident details. While only 163 of the 2,720 accident reports studied by Aldinger and Keran (1994) reported whether or not seatbelts were worn, these cases at least suggest some trends. For instance, none of the fatalities in their study involved a victim wearing a seatbelt. Also, injuries tended to be less severe (involving less time off of work) when seatbelts were worn.

Special-purpose Data Collection

The most expensive, but potentially most rewarding, method of analyzing accident causes is to perform an independent scientific study. Sanders and Shaw (1988) used this method to investigate causal factors in underground mining. They conducted independent investigations of 338 accidents at 20 mines. The investigations resulted in detailed descriptions of each accident, including interviews with employees and a study of the worksite and equipment. The methodology was based on a systems theory of accidents -- that is, accidents result from a system of interrelated factors in workplaces, machinery, people, and social structures.

Although this process yielded unprecedented detail about the accidents it studied, it does have some limitations. The 20 mines studied may not be representative of the industry as a whole, especially since the sample consisted mostly of medium-to-large underground coal mines. This type of study also tends to be quite expensive, costing hundreds or thousands of dollars per investigated accident.

Each of these studies has some merits. The strengths of one approach can be used to complement the weaknesses of others and add missing pieces to the overall puzzle of true accident causes.

ACCIDENT ANALYSIS

The accident trends and breakdowns reported here cover accidents in the MSHA database under the category "Ore haulage trucks, off highway and underground." Accidents classified as occurring underground or to officeworkers were eliminated so that the reported data would reflect surface operations only. The reported data include independent contractors, and, unless otherwise noted, cover the years 1986 through 1995. The 1995 data are currently considered "preliminary" by MSHA.

1986-95 Trends

Surface mining fatalities, including haulage truck fatalities, have been generally declining since 1986. However, although the industry attained a historic low of 54 fatalities in 1994, there was a sharp upswing to 70 fatalities in the preliminary 1995 data. A significant component of this upswing was the rise in haulage truck fatalities from 10 to 17. This increase has been a source of concern in the mining community. It would be even more troubling if there were a similar rise in injuries. Fortunately, lost-time haulage truck injuries declined from 579 in 1994 to 460 in 1995, mirroring an overall surface accident reduction from 9,040 to 7,883 (figure 2). The overall trend since 1989 has been a consistent drop in the number of lost time injuries, with the exception of a slight rise in 1994. The increases prior to 1990 can be attributed to changes and clarifications in reporting practices, rather than an actual rise in accidents (Randolph, 1992; Weaver and Llewellyn, 1986).

Estimated Cost

The Accident Cost Indicator Model (ACIM) (DiCanio and Nakata, 1976) was used to estimate the total cost of haulage truck accidents during 1994, the most recent year for which data are available. The ACIM provides cost estimates based on publicly available data on wages, workers' compensation, medical payments, investigation costs, and other direct and indirect costs. Although it has some limitations, including the omission of data on

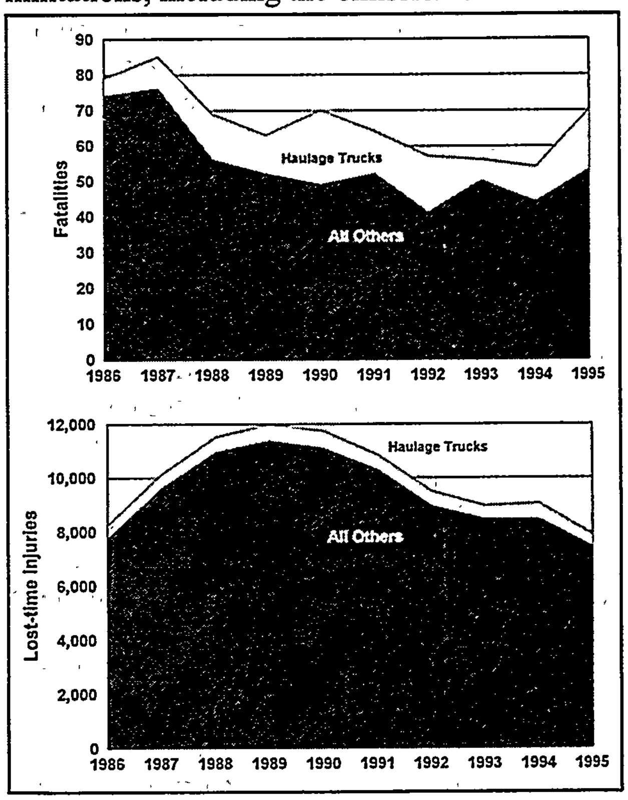

Figure 2. Surface fatalities and lost-time injuries, 1986-95.

independent contractors, it provides a useful guideline on the magnitude of costs suffered by individuals, industry, and society. According to the ACIM, the six haulage truck fatalities in 1994 cost an estimated $2.58 million while the 519 lost-time injuries cost $3.27 million. The total estimated cost for haulage truck fatalities and lost-time injuries in 1994 was more than $5.8 million.

Independent Contractors

The use of independent contractors in the mining workforce is rising. They account for 18% to 67% of the haulage truck fatalities each year (figure 3) and from 4% to 13% of the lost-time injuries. The haulage truck accident fatality rate for contractors has been consistently higher than the rate for mine operator employees, although their lost-time rate has been similar (figure 4). Making conclusions about these accident rate differences is hampered by a lack of information about how many hours are worked by truck drivers. We only know the hours reported by general work location, not by task, job title, equipment operated, or any other more specific characteristics of exposure.

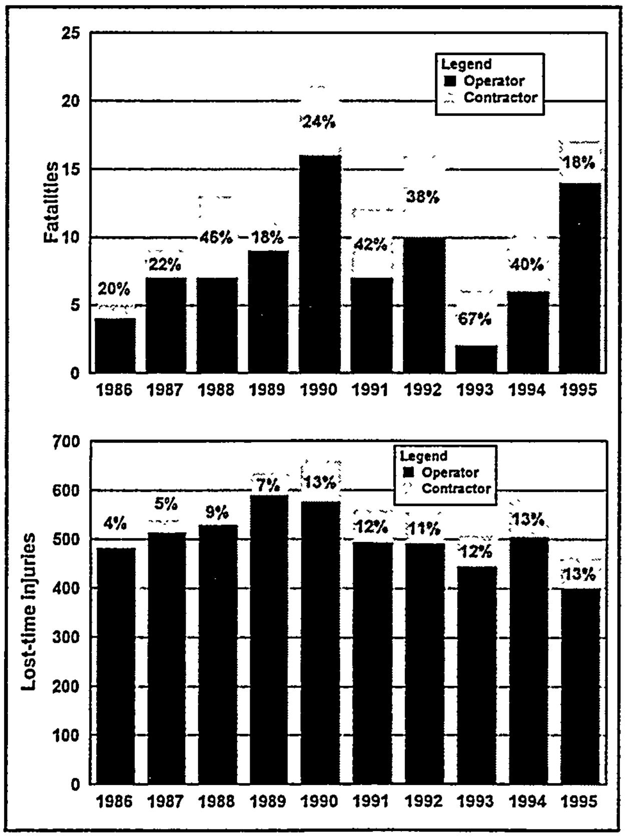

Figure 3. Contractor and operator haulage truck fatalities and lost-time injuries, 1986-95.

Accident Categories

A more detailed picture of haulage truck accidents emerges by looking at the MSHA categories into which they fall (figure 5).

Nature of injury. The "nature of injury" reported for haulage truck fatalities was predominantly "multiple injuries" (64 fatalities) or "crushing" (34) (Figure 5, top left). The nature of lost-time injuries was somewhat different (figure 5, top right). Sprains and strains were the largest category (2,437 injuries), consistent with Aldinger, Kenney, and Keran's reports of jarring as the main accident type.

Body part injured. Haulage truck fatalities tend to be catastrophic, involving serious damage to multiple body parts (figure 5, center left). Lost-time injuries (figure 5, center right)

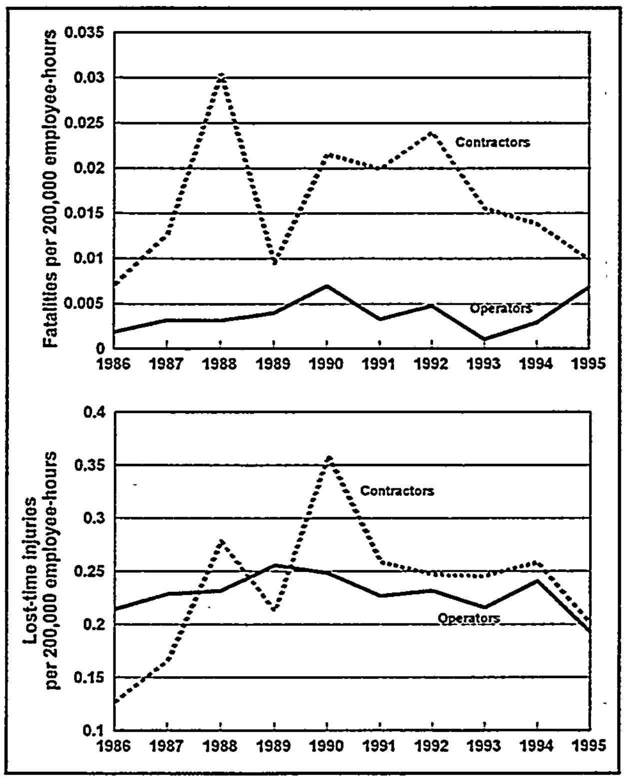

Figure 4. Contractor and operator haulage truck fatality and lost-time injury rates, 1986-95.

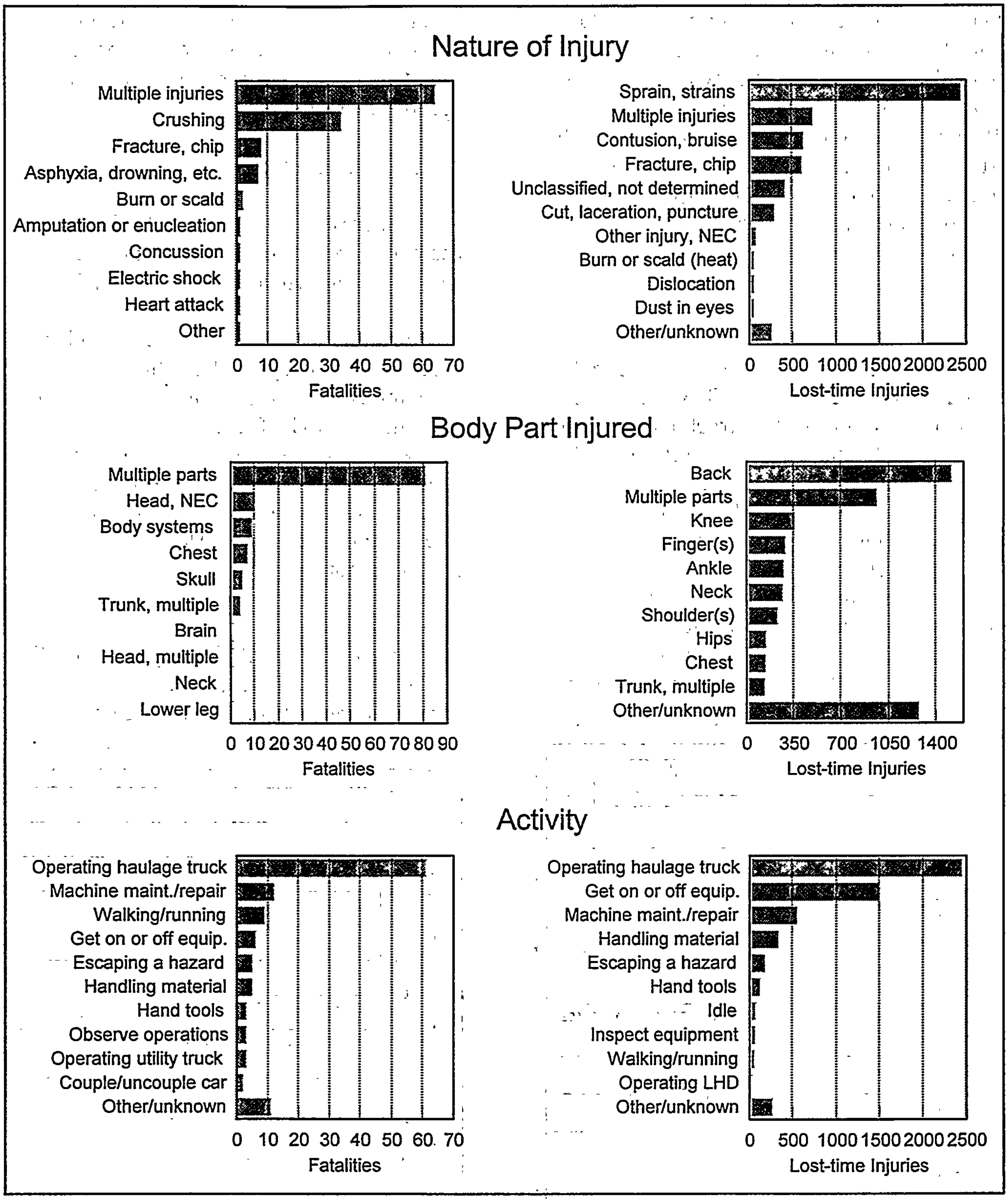

Figure 5. Haulage truck fatality and lost-time injury categories: Nature of injury, body part injured, and victim's activity, 1986-95.

most often involve the back (1,511) or multiple parts (959), which is again consistent with the jarring scenario.

Victim's activity. The most common activity recorded for victims of fatal haulage truck accidents was operating the truck (61) followed by maintenance (12), walking or running (9) and getting on or off the machine

(6) (figure 5, bottom left). Operating the truck was also the largest lost-time category (2,447 injuries) followed by "get on or off equipment" (1,489), maintenance (547), and handling supplies or material (331) (figure 5, bottom right). These categories are roughly consistent with the findings of Aldinger, Kenney, and Keran (1995) despite differences in methods and data.

Mine Size

Small mines differ from large mines in important ways, including different geology, fewer resources, and the special problems confronted by all small businesses. A common perception in the mining community is that small mines, at least partially because of the factors listed above, are less safe than larger operations. Recent analyses of accident rates at different sizes of underground coal mining operations (Peters and Fotta, 1994) showed that small mines had a higher fatality rate than large mines. However, there was no consistent pattern of higher nonfatal injury rates at smaller mines. Less has been reported about the relationship between mine size and safety at surface mines.

This analysis differs from the preceding breakdowns of surface truck accidents in several key ways. Because it examines the characteristics of mining operations as a possible factor in haulage safety, the analysis had to be restricted to surface mines only, excluding the surface operations of underground mines as well as preparation plants and mills. It also excludes independent contractors because the hours worked by these employees are reported by the contract company and cannot be attributed to any particular size of mining operation. This analysis used data from just a 3-year period to minimize the problems of a constantly changing population of mining operations. The accidents were broken down into five mine-size groupings: 1-10 employees, 11-20, 21-50, 51-100, and over 100. There are very many small surface mining operations -- the median mine size is just four employees.

Figure 6 shows the normalized rates (per 200,000 employee-hours) for surface mine fatalities and lost time injuries. The graphs show both the overall rates as well as the rates for haulage trucks alone. The rates are not clearly higher for the smallest mines. The overall fatality rate for 1-10 employee mines (0.0357) was almost the same as that for 51-100 employee mines (0.0349). For haulage trucks only, the rate for 11-20 employee mines (0.0083) was the highest by a very small margin over the over-100 employee mines (0.0081). The numbers of fatalities upon which these rates are based were very small, ranging from just one haulage truck death for 21-50 employee mines during 1993-95 to eight fatalities at mines with over 100 employees. Because lost-time injuries occur in much higher numbers, they can be more useful than fatalities for identifying stable overall trends.

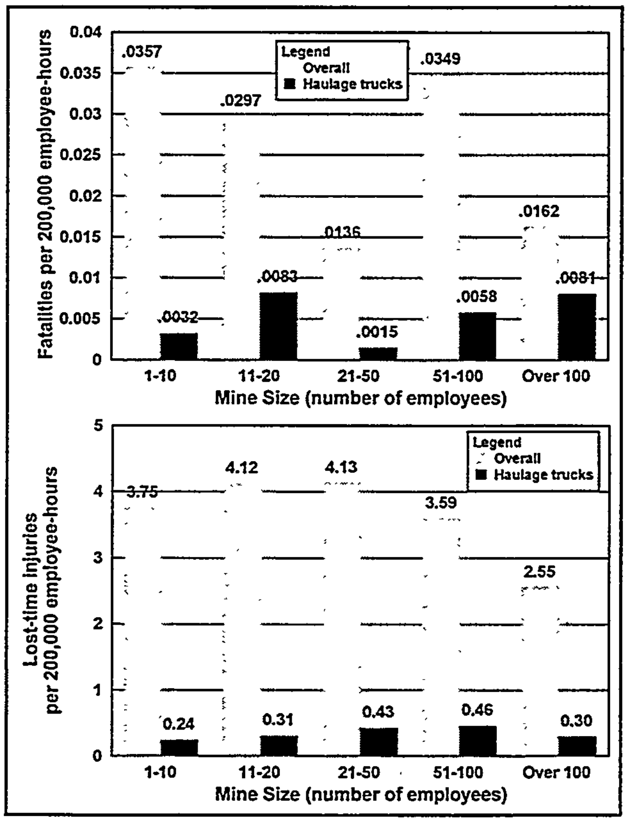

Figure 6. Fatality and lost-time injury rates for different surface mine sizes, 1993-95.

The lost-time rates shown in figure 6 reveal that the highest rates are for the middle-sized mines. The 11-20 employee and 21-50 employee mines have the highest overall rates of 4.12 and 4.13. The peak for haulage truck lost-time injuries is also in the mid-range, but farther along the mine size continuum at 51-100 employees (rate: 0.46). Again, there is no clear trend toward higher rates as mine size decreases.

CONTINUING RESEARCH

In 1995, the USBM laid out new initiatives for improving surface haulage safety based on a history of research (May and Aldinger, 1995). Although the USBM was abolished by Congress in 1996, the health and safety research functions in Pittsburgh, Pennsylvania, and Spokane, Washington, were continued. The surface mining hazard reduction project, formerly conducted out of the USBM's Minneapolis, Minnesota center, is continuing in Spokane. The project, "Hazard Reduction for Surface Mining", is continuing to build on past accomplishments while re-focusing future goals to meet the needs of the newly formed health and safety research centers. The objective for the project is to reduce accidents and injuries associated with coal and metal/nonmetal surface mining. Several strategies are being investigated, including improved operating practices, hazard recognition, and safety and warning devices.

Equipment manufacturers are working to incorporate alarms, improve vision, and improve ergonomics on large equipment. Other approaches involve the development of remote-controlled or autonomous vehicles for specific extremely hazardous or repetitive, simple tasks. Improvements in sensing technology such as GPS, radar, laser, and infrared offer an opportunity to introduce these technological improvements as an aid to vehicle operation and/or control.

Currently the efforts for the Hazard Reduction for Surface Mining project are aimed at:

- *Safety Analyses*. This will review MSHA accident data to determine root causes of recorded accidents. For example, slips and falls from powered equipment are a major cause of injuries. But in evaluating the accident narratives, nearly half the slips and falls are affiliated with jumping from a vehicle or conveyor. Of those jumping, over half were from vehicles which had lost power or brakes. This analysis will help identify operating practices that should be modified or avoided to improve safety.
- *Early Warning*. Existing and developing sensing technology will be reviewed to determine what systems might be easily incorporated onto existing equipment or into current operations to provide warning to operators and others in the immediate proximity. Currently, engine performance (rpm, oil pressure) and machine operating conditions (speed, tilt, load) will be reviewed as possible parameters that could be used or recorded to define machine operating safety. In addition, geotechnical sensing devices, laser surveying, slope monitoring, proximity warning and optical sensing devices will be investigated to determine the potential of short- and long-term applications that might be used to improve equipment operating safety.
- *Operator Safety*. Methods to minimize injury to operators during accidents will be investigated. Previous research on vibration testing done by TCRC will be continued to define and isolate elements that could lessen shock loads to the operator. Methods to promote seatbelt use will also be investigated.

- *Human Factors.* Work will continue to be coordinated with the Human Factors section at PRC to develop effective training and ergonomic support designs for small- to medium-sized coal and metal/nonmetal surface mining operations. In addition, this task will involve investigations of the psychological and physiological factors of reducing operator-induced accidents.

CONCLUSIONS

There is sufficient evidence from a variety of studies, including the data presented here, to identify several key problem areas in surface haulage truck usage. These include:

- *Driver fatalities involving loss of vehicle control.* These accidents can be addressed though a combination of solutions, including haulage roads with less-steep grades, better signs, and longer sight lines. Also, driver visibility can be improved through mirrors, video cameras, and cab design. Drivers can be educated about keeping their equipment within controllable limits. Finally, seatbelt usage should be promoted for those times when loss of control cannot be averted.
- *Strains and sprains from rough roads, and the shocks of loading or unloading.* Road maintenance can smooth out washboarding and other types of bumps. Loading and unloading techniques, such as lining the truck bed with small material before loading large boulders, can reduce shocks. Also, suspensions can be used to dampen the transmitted shocks.
- *Strains and sprains resulting from a slip or fall while mounting or dismounting the truck.* Improved railings, non-skid surfaces, and damage-resistant ladders are some of the ways of helping drivers to mount and dismount their vehicles safely.

Despite the range of data presented here, there are still many unanswered questions to pursue:

- How often are seatbelts used, and how can usage be increased?
- How many truck drivers are in the mining workforce, and how many of them are contractors? Do any of these groups have a disproportionate number of accidents?
- What range of truck sizes are in use. Are some types of accidents more likely for different-sized trucks?
- What haulage safety problems will be solved by automation? What new hazards will be created?
- How can the existing information on improving haulage safety be communicated more effectively?

These issues, and others that will emerge from more detailed analysis planned during the next year, will guide the development of tools and strategies for improving haulage truck safety.

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ANALYSIS OF SURFACE POWERED HAULAGE ACCIDENTS
January 1990-July 1996

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ABSTRACT

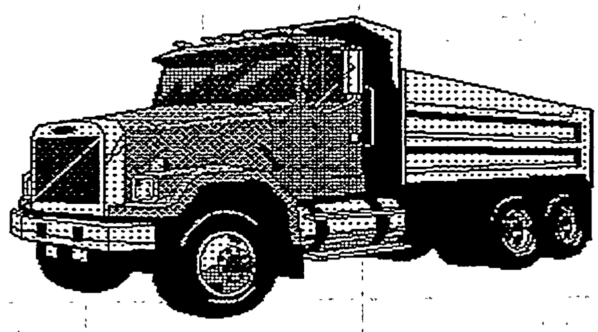
This report addresses surface haulage accidents that occurred between January 1990 and July 1996 involving haulage trucks (including over-the-road trucks), front-end-loaders, scrapers, utility trucks, water trucks, and other mobile haulage equipment. The study includes quarries, open pits and surface coal mines utilizing self-propelled mobile equipment to transport personnel, supplies, rock, overburden material, ore, mine waste, or coal for processing. A total of 4,397 accidents were considered. This report summarizes the major factors that led to the accidents and recommends accident prevention methods to reduce the frequency of these accidents.

FACTORS	FATALITIES	INJURIES	TOTALS
Steep road gradients, Loss of control, or Overloaded truck	49	215	264
Dumping at edge of dump or highwall	25	111	136
Mechanical Failure - brakes, steering, transmission, or drive shaft	20	92	112
Equipment backing over or through berm	8	47	55
Obstructed visibility - Running or backing over pedestrian or smaller vehicle due to "blind spots"	15	31	46
Loading or unloading materials or supplies	14	3	17
Repairing haulage equipment	8	2	10
TOTALS	139	501	640

INTRODUCTION

Information for this report was gathered from Mine Safety and Health Administration (MSHA) Accident Investigation Reports, accident and injury data submitted by mine operators on MSHA Form 7000-1, and other studies conducted by MSHA and the U.S. Bureau of Mines. All powered haulage accidents involving self-propelled mobile equipment used in surface mining activities were initially considered. This report, however, is limited to surface haulage lost time accidents associated with water trucks, front-end-loaders, tractor/scrapers, ore carrier/large trucks, ore haulage trucks, or other utility trucks. A detailed study of 1,300 truck haulage accidents is the primary focus of this report. Of the 1,300 truck accidents reviewed, 640 resulted in traumatic occupational injuries such as severe cuts, broken limbs, internal injuries, or burns. During the six and one-half year period, 139 fatal accidents occurred involving surface mobile equipment. Seventy-two of these involved trucks hauling ore, coal, or waste rock. Another 24 involved utility trucks, such as maintenance vehicles and water trucks. This paper highlights some of the critical factors that contributed to the occurrence of these surface haulage accidents and the severity of the injuries suffered.

The report discusses each factor, with recommended actions for a cooperative safety program involving inspectors, miners, mine operators, maintenance personnel, equipment manufacturers, and mine engineers. The combined resources of MSHA and the mining industry can develop a comprehensive safety program to reduce the number and severity of powered haulage accidents at surface mines.



STEEP HAULROAD GRADIENTS

A total of 640 accidents involving surface truck haulage equipment resulted in traumatic injuries or fatalities. Of these accidents, 117 occurred on road gradients exceeding 7%. A total of 36 fatalities occurred where haulroad gradients ranged between 8% and 23%. Although road gradients were not the specific cause of these accidents, the severity of accidents caused by broken drive shafts, failed brakes, or overloaded trucks was increased when the vehicles operated on steep grades. Broken drive shafts or failed service brakes almost always caused a serious accident. Trucks with loads exceeding recommended capacities severely compromised the safe operation of these vehicles. Generally, metal and nonmetal mining operations use off-road haulage trucks, which travel empty into mine pits and quarries, and are loaded when climbing out of the pits. They do, however, use some of this same equipment to haul water and other material down into mine pits. Coal mining operations frequently use over-the-road trucks, which are designed for highway travel, to haul coal down steep mountain roads.

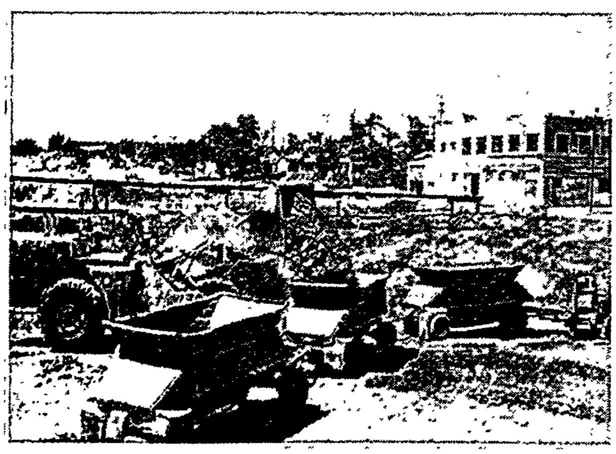
Inadequate haulage road design and construction has resulted in situations where equipment operators, truck drivers, and other workers were operating on gradients much steeper than recommended by the haulage equipment manufacturer. Some manufacturers failed to provide guidance on recommended load limits for mountainous grades since they design their equipment for over-the-road travel, which is regulated by the U.S. Department of Transportation. Imprudent engineering, maintenance, and equipment operating practices place equipment operators and the surrounding workforce at serious and unnecessary risk. Additionally, equipment operators who fail to follow appropriate traffic rules, do not perform pre-operational checks, disregard safe driving habits, or are inattentive to their surroundings also place co-workers at great risk. As grades increase, payloads and/or operating speeds must decrease in order to operate within the designed operating limits of properly maintained equipment. Equipment which is not properly maintained, however, is not safe to operate on any grade.

In 1995, an 18-year-old miner with 3-weeks experience was fatally injured when he lost control of a water truck (converted from a drill truck) he was driving. The truck had a full 3,560 gallon tank and was traveling down a haul road with an average grade of 8.43 %. In this situation, inadequate truck brakes and a faulty transmission, combined with a steep road gradient and the driver's inadequate training and experience, resulted in a tragedy.

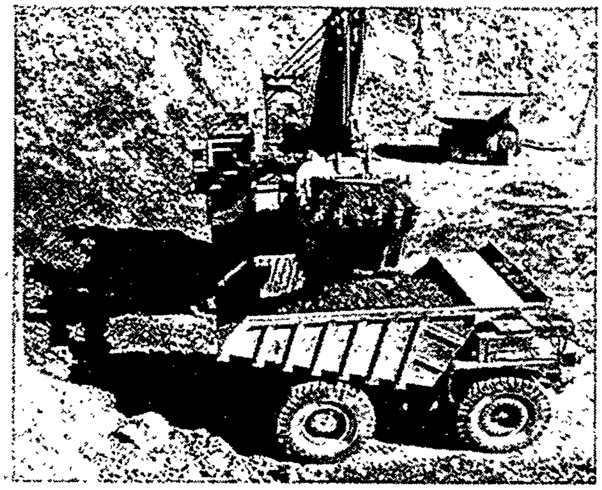
Only six states currently have regulations limiting the steepness of haulroad gradients at surface mines. There is no consensus among them as to maximum grade relative to overall distance of roadways. Nor are there general guidelines for correlating equipment size or type with the loads that may be safely transported over a particular grade. This problem needs to be studied thoroughly so that construction guidelines can be developed that are applicable to the surface mining operations of today. For such a study to be ultimately beneficial and useable by the mining community, it must involve input from mine operators, equipment operators, and equipment manufacturers, along with their commitment to abide by the findings.

OVERLOADING AND INADEQUATE MAINTENANCE AND THEIR ROLE IN CONTRIBUTING TO MECHANICAL FAILURES OF BRAKES, STEERING, TRANSMISSIONS, AND DRIVE LINES

Some of the most frequent accidents recorded during the six and one-half year period under study were related to mechanical failures of brakes, steering, or drive systems. These



problems were sometimes aggravated by overloading trucks and operating trucks on steep road gradients. Unfortunately, some accident



investigation reports do not contain sufficient information concerning truck weight capacity to determine the relationship between load capacities and accident causes.

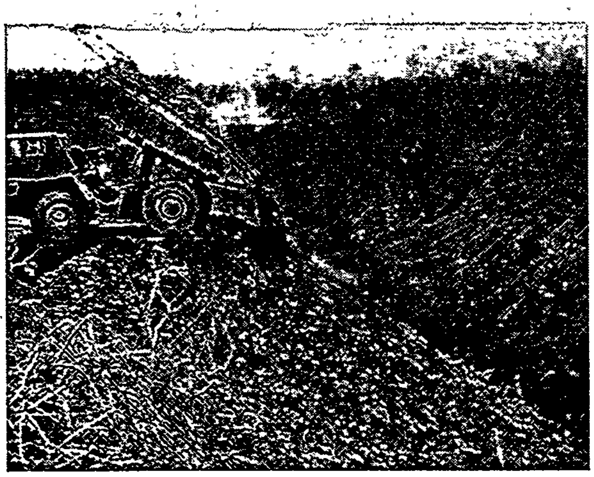
Mine operators, contractors, and equipment operators should recognize the hazards inherent in overloading haulage equipment, particularly on steep road gradients. Brake, steering, and drive-train effectiveness are reduced dramatically when the manufacturers' recommended loading limits are exceeded. Between 1990 and July 1996, 112 of the 640 traumatic injury accidents were caused by failure of the brake, steering, or drive-train systems. Twenty fatalities on surface haulage equipment were directly attributed to the failure of the vehicles' braking systems. This was generally directly related to poor equipment inspection and maintenance practices.

Although there are a variety of maintenance guidelines or standards currently in use by the mining industry regarding surface mine haulage vehicles, there are no uniform guidelines specific to the industry that address maintenance and use of off-highway haulage equipment. The Commercial Vehicle Safety Alliance (C.V.S.A.) Uniform North American Out-of-Service Criteria is sometimes used for over-the-road vehicle inspection and maintenance programs at operations that use these type trucks. This criteria is utilized in the 50 United States, Canada and Mexico. At many mine properties, manufacturers' maintenance guidelines are appropriately used. MSHA inspection experience, however, has found that a significant number of older haulage units do not have manuals readily available for equipment operators.

There are many mining operations with well managed maintenance programs for surface powered haulage equipment. Their vehicles are routinely inspected by equipment operators and qualified mechanics trained to maintain haulage equipment used at these mines. They also ensure the equipment is operated within its design capabilities. Such good practices should be encouraged throughout the mining industry and shared through associations, seminars and training programs for miners, mechanics, mine operators, engineers, and inspectors.

End Dumping at Edges of Dumps and Fills

Between January 1990 and July 1996, 136 trucks and other haulage vehicles overturned while dumping material at edges of dump locations. This type of accident occurred more frequently than any other. Twenty-five (25) fatalities were reported while trucks or other haulage equipment, such as front-end-loaders, were backing up or end-dumping at edges of elevated dump locations. Typically these locations were excess mine spoil fills, waste rock dumps, ore stockpiles, processed mine wastes, or valley fills. Most frequently, the haulage vehicle backed onto unstable fill material that gave way, or backed through a perimeter berm, causing the vehicle to topple backward down the slope or onto its side.



Some dumping accidents occurred during evening or night shifts. According to the accident reports, the work areas were insufficiently illuminated for the truck drivers to see the edges of the dumps when backing, and the trucks were backed too close to the edges of the slopes. The truck operator's ability to examine the stability of dump edges is also severely impaired when vision is limited at night.

In 1996, the 26-year-old driver of a 190-ton haul truck was fatally injured when he traveled through an inadequate perimeter berm, on a 258-foot high, 73% slope leach dump. The accident occurred in the early morning hours, before daylight, and the dump was provided with a single light plant. The victim was not wearing a seat belt and was thrown through the rear window of his truck after it came to rest 444 feet at the bottom of the dump slope.

Dump locations require continual maintenance to keep the berms maintained and the dump on a slight up slope. The practice of keeping the dump perimeter at a slight upgrade prevents natural water accumulations from absorbing into the dump perimeter which can create an unstable slope edge. Keeping a bulldozer operating continually to maintain this slight upgrade and to maintain an adequate dump berm during dumping operations is a prudent method of improving truck driving safety where dumping over the edges is utilized.

The practice of end-dumping over the edges of dump locations should be avoided when possible. Mining operations that dump in this manner should consider alternative methods of disposing of rock or waste material. Some operations in the mining industry dump material short of the edges of dumps and then push the material with bulldozers or other equipment.

Improving truck driver control during backing operations by modifying cab locations and design and rear-view mirror design should also be explored. Additionally, truck driver training should include thorough discussion and training in dumping procedures. It appears that many operators need to focus more and better attention on this area.

TRAFFIC CONTROL, BLIND SPOTS, BERMS, AND ROAD SURFACES

A number of accidents reviewed in the survey involved the control of traffic through surface mining operations, obstructed visibility, and the maintenance of road surfaces and safety berms.

Traffic Control

Traffic control rules and safety signs are required at every mine site regardless of size. Traffic control rules, signs and markers that guide vehicles safely through the operation are essential to preventing accidents. Some of these operations have confusing traffic patterns, which change frequently because of mining activities. These changes are not always marked in a manner that mine support personnel understand. Vehicle right-of-ways are normally established at mining operations, however, it is not uncommon for maintenance vehicles to get in the path of loaded haul trucks. Obviously, a more complex mining operation with various mixtures of equipment requires a very careful analysis of traffic patterns, signs and establishment of rules. Dispatchers should be utilized where the complexity of the mining operation warrants.

Road Berms

Fifty-five (55) accidents occurred when trucks over traveled road berms. Eight (8) fatalities occurred under these circumstances. Steep road gradients, berm construction and maintenance, brake failure, and failure to use seat belts were listed as factors in these accident reports. Failure to use seat belts always resulted in more serious injuries and in eight (8) cases fatalities.

Adequate berms or guard railing are required for all elevated roads on mining operations and have proven to be effective means to reduce serious accidents. Road berms are neither designed nor built to stop runaway trucks. They effectively warn haulage equipment drivers about the close proximity of roadway edges and, properly constructed, can effectively impede over travel from elevated roadways. There are suitable alternative methods to earthen berms, such as guardrails and Jersey barriers. The most appropriate method for the anticipated travel on a roadway should be used.

In 1994, a 50-ton haul truck with defective service brakes was traveling down a 17% grade, went through a berm and tumbled 55 feet to the bottom of an embankment. The truck driver was not wearing a seat belt and died as a reult of the accident.

Blind Spots

Forty-fix (46) accidents occurred when haulage truck driver vision was obstructed due to the configuration or location of the cab. Fifteen (15) of those were fatal accidents in which obstructed visibility from the drivers' cabs was determined to be a significant factor in the cause of the accident. Fifteen (15) of these accidents also involved large capacity haulage vehicles running over smaller vehicles and crushing them. All of these accidents were fatal. Eighty-seven (87) accidents occurred when haulage trucks ran into stationary objects, loading equipment, or another haulage truck. Eight (8) fatalities occurred because of such collisions. Although some of these collisions may have occurred because of driver error, accident investigations indicate that others occurred because there was poor communication between truck drivers or there was obstructed visibility between vehicles. Driver error is used far too often to explain away poor design or work procedures.

Many trucks have zones in which the drivers cannot see the ground, other vehicles, or pedestrians for distances greater than 100 feet from the driver's seat. These "Blind-spot" hazards have caused or contributed to a large number of fatal accidents during the past six and one-half years. Haulage equipment manufacturers, the Society of Automotive Engineers (SAE), and the mining industry should initiate a cooperative effort to improve design of haulage vehicles and warning systems. Innovative cab designs, locations and installation of discriminating warning devices, video cameras, and other state of the art "blind area surveillance systems" would greatly reduce "blind-spot" hazards. Fatalities that occurred where obstructed visibility from the drivers' seats existed may have been avoided with effective discriminating warning devices, cameras, mirrors or improved cab designs.

In 1995, a maintenance supervisor in a pick-up truck, following an off-road haul truck with a disabled radio, was backed over by the haul truck after he stopped on a haulroad in the truck's "blind-spot" area. In this situation individuals were aware of rules and procedures established by the mine operator, however, they were not following them. The haul truck driver had stopped in an active roadway to talk with an oncoming truck driver about his broken radio, rather than returning to the shop or some other safe location as required by company procedure. Also, the mainitenance supervisor had stopped within the "blind spot" area of the haul truck, another violation of established rules. Communications was also a factor in this accident since the haulage truck's radio was broken and drivers were improvising.

In 1996, a 46-year-old electrician was fatally injured when a 240-ton haulage truck ran over the utility truck he was driving. The haul truck was parked when the utility truck came along the side of it. As the haul truck driver began pulling forward, he turned to the right and ran over the electrician. The "blind-spot" to the truck driver's side was 73 feet and there was no side discriminating warning alarm on this truck.

Slick Roads

Sixty (60) accidents involving trucks sliding on slick road surfaces were reported to MSHA. Five (5) of these accidents resulted in fatalities. Mine operators should curtail or appropriately modify operations during inclement weather when road surfaces become slick because of snow, freezing or wet conditions. All operations should have contingency plans to activate when weather has an adverse effect on continued safe operations.

Mine operators construct mine roads according to geographic location, traffic type, expected weather conditions and frequency of use. Haul roads are not always built with adequate consideration for potential adverse weather. Poor drainage and failure to properly surface the roads often create very slick road conditions during inclement weather. Additionally, mine operators sometimes attempt to maintain daily production goals when conditions have deteriorated, which exposes miners to serious haulage hazards.

COMMUNICATIONS, LOADING/UNLOADING MATERIALS, MAINTENANCE AND REPAIR, AND SEAT BELTS

Communications

Most modern complex surface mining operations have effective communications systems in place to enhance driver safety and the safety of the vendors or contractors entering the mining operations. Such good practices of communication should be freely shared in the mining community and regulatory agencies and the practices should be adopted throughout the industry. Forty-six (46) of the obstructed vision accidents reviewed in the six and one-half year period might have been avoided with adequate communication between the drivers of vehicles involved in the accidents and/or a central dispatching operation. Poor communications and obstructed vision were determined to be a primary cause in 15 of the fatal accidents involving collisions.

Unsafe Practices While Repairing Vehicles

Sudden movement of vehicles being repaired resulted in eight (8) fatalities. Pressure to get equipment back into service resulted in inadequate safety precautions during some maintenance and ended in tragedy. For instance, unchocked trucks rolled over mechanics working beneath them; several maintenance personnel were run over after pulling their work trucks into blind spot areas of other vehicles; victims fell from elevated access decks and engine compartments with oil spills on them; and maintenance personnel attempted to test equipment they were not qualified to operate. Most of these accidents could have been prevented if the mechanics and maintenance personnel were thoroughly trained in the hazards associated with the sudden or unexpected movement of equipment.

In 1995, a 46-year-old mechanic was fatally injured while working on the exhaust system of a utility truck. He accidentally shorted the truck's starter solenoid and caused the engine to start, running the rear wheels over him. The truck's transmission was in gear, the wheels were not chocked, the battery was not disconnected, and the parking brake was not set. A change in any of these factors would likely have prevented this tragedy.

Safety Practices While Loading/Unloading Material/Supplies

Fourteen (14) fatalities occurred while truck drivers and others were attempting to load or unload material such as mine equipment, conveyor systems, and "I" beams. These activities usually involve employees from the mining operation assisting a delivery truck driver. Although the work of loading and unloading can be very hazardous, many operations do not have an effective program for ensuring communications and defining the responsibilities of these persons. Signals to lift, lower, and move forward are not uniformly applied and often result in miscommunication. Additionally, many of the people assigned the tasks of loading and unloading equipment and supplies have not been trained in safe rigging practices or proper communications between equipment operators and ground personnel.

Seat Belts

Failure of drivers to use seat belts has caused serious injuries when self-propelled mobile equipment overturned or collided with other vehicles or stationary objects. Accident reports reviewed in this analysis indicate that in more than 200 accidents during the study period, the drivers of this equipment had failed to use seat belts. Most mine operators instruct equipment operators to use seat belts, but many do not have a program which reinforces their use and ensures equipment operators are using them consistently. Also, there is a misconception among equipment operators that it is usually better to jump from an out of control piece of equipment than to ride it out. Fatalities have ocurred when equipment operators apparently jumped from the vehicle. In nearly every instance the condition of the equipment operator's compartment indicated the drivers would have been protected if they had worn their seat belts. MSHA has documented testimonials from equipment operators who have survived falling from highwalls, benches and roadways because of their use of seat belts.

RECOMMENDATIONS FOR DEVELOPING A SURFACE HAULAGE ACCIDENT PREVENTION PROGRAM

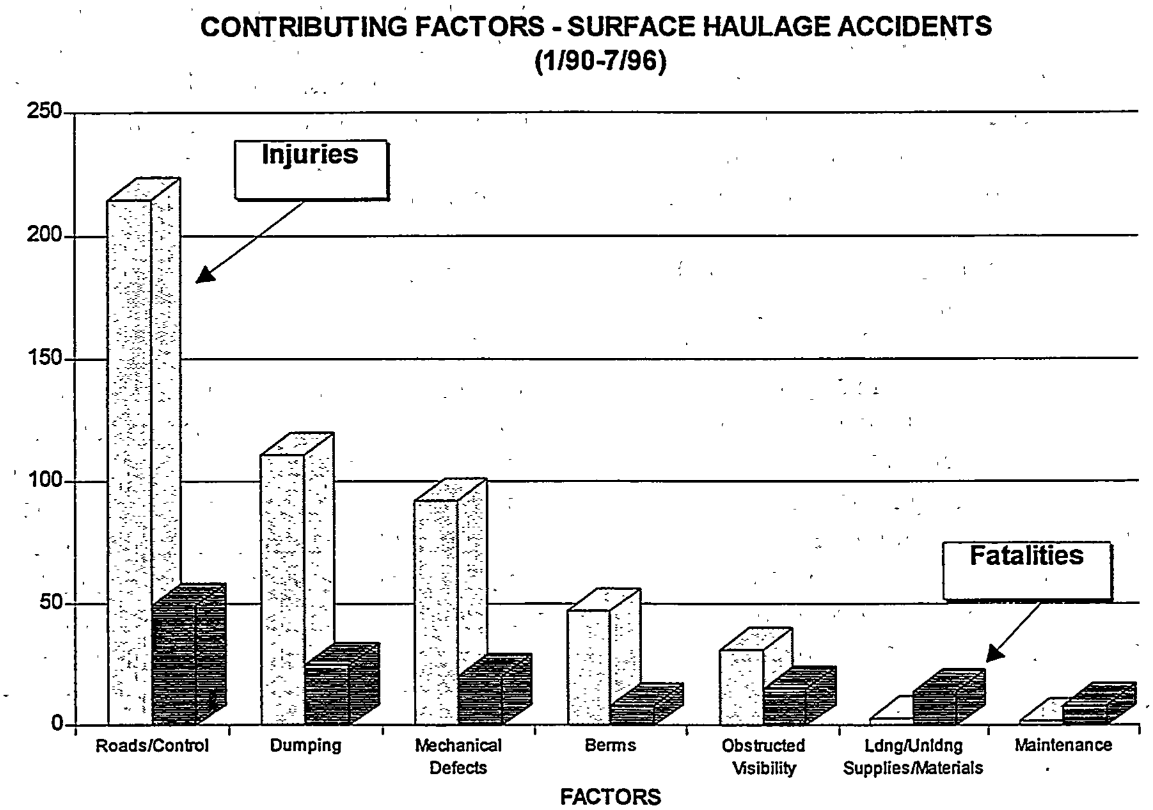
The following issues and recommendations are based on the findings of this study. Implementation of these recommendations can help reduce the frequency and severity of powered haulage accidents at surface coal mining and metal and nonmetal mining operations and mineral processing areas.

Issues should be addressed and ultimately resolved utilizing a cooperative effort between equipment manufacturers, mine operators, miners, mine safety representatives, engineers, State agencies, and MSHA to identify, develop, and implement practical solutions. Some issues require one or more of these participants to effect a solution and the appropriate entity should take the lead on specific recommendations.

This cooperative effort should address the following issues.

Road Construction and Maintenance

- Review current material and develop general mining industry guidelines for the design, construction, and maintenance of haulage roads. These guidelines should be followed as nearly as practicable at



metal, nonmetal, and coal surface mining operations. An engineering and design manual for mine haulage road construction and maintenance should be developed.

- Develop new training for mine inspectors, miners, mine operators, safety specialists, and engineers regarding haulroad design and maintenance utilizing "best practices" available in the industry.

- Mine operators and MSHA should conduct an inventory and technical evaluation of existing haulroads in areas where road gradients may be a factor in haulage safety. Identify unsafe haulroads and haulage practices and take corrective actions. Share good ideas and methods with others in the industry, including various mining associations.

- Associations should actively participate in the development of surface haulage guidelines. They can help ensure information is presented in the most efficient manner to the largest groups possible by coordinating training efforts for mines they represent. At the present time, a joint task group involving industry, MSHA, and manufacturers, is developing a comprehensive surface haulage safety program.

- Mine operators should plan mine road construction according to geographic location, traffic type, expected weather conditions and frequency of use. Contingency plans should be developed for adverse changes in weather.

- MSHA should offer a technical review process for all new haulroad construction that includes review by teams of qualified professionals experienced in haulroad design and construction.

Traffic Control

- Assemble and consolidate a traffic control manual to assist miners, mine operators, mine engineers, and MSHA inspectors to establish reasonable uniformity in the implementation of traffic control methods.

Road Berms

- Continued proper construction and maintenance of road berms is required. Mine operators should ensure that berms are appropriate for the largest equipment which travels the roadway and that they are constructed properly.

- Berm maintenance programs which include routine berm inspections and appropriate maintenance should be established at all mining operations .

- Develop guidelines for construction of safety berms and road surfaces to foster uniformity in compliance. Stress the importance of adequate berm base width and compaction, in addition to normal height requirements.

Dumping Locations and Methods

- Develop general industry guidelines for construction of ore and waste dumps. These guidelines should give examples of factors to consider, such as weather, compaction, loaded equipment weights, slope stability of fills and perimeter berms. This guideline should describe the best methods of maintenance of the dump locations and the dangers associated when undercutting ore or waste stockpiles.

- Develop guidelines regarding end-dumping of material at pit or quarry perimeters or at edges of dump locations, fills, and stockpile areas. Consider best safety practices, such as dumping short of the edges and pushing material with bulldozers or other equipment more suitable for working safely at the perimeters. Distribute guidelines with descriptions of the best practices available to miners, the mining industry, and MSHA mine inspectors.

- Enhance awareness within the industry of the hazards associated with dumping material at the edges of dump locations, fills, stockpiles and highwalls and develop an industry-wide analysis of best practices to prevent these kinds of accidents from recurring. Gather data regarding the safest methods for construction, and make the information available to the mining industry, miners, and MSHA mine inspectors.

- Distribute training materials to equipment operators regarding risks when backing trucks and end-dumping material near unstable dump locations, fills, stockpiles, and highwalls. Truck driver training should include thorough discussion and training in dumping procedures. Have mine inspectors present training materials at mine sites and trade association meetings.

Equipment

- Good maintenance practices should be encouraged throughout the mining industry and shared through associations, seminars and training programs for miners, mechanics, mine operators, engineers, and inspectors. The C.V.S.A. Uniform North American Out-of-Service Criteria or other appropriate methods for removing unsafe haulage equipment from service should be well understood and used by truck drivers, mechanics, equipment operators and inspectors.

- Information on pre-operational inspections, inspection checklists, equipment operational manuals and common traffic rules should be distributed widely. This information should identify the difference in defects which need immediate attention and those which can be scheduled for repair when convenient. Defects which create an imminent danger should be clearly defined, such as the loss of service brakes.

- Manufacturers should review operating manuals and ensure they are complete and that hazardous operations and proper maintenance practices are covered. Equipment should have safety features which would prevent inadvertent starting of the equipment when it is in gear, including features to allow a mechanic to safely jump a solenoid for maintenance purposes. Manufacturers should also provide information regarding safe load limits for all equipment. This should include relevant data regarding gradient ranges for safe operation.

- A cooperative effort should be initiated to develop guidelines regarding field testing of braking systems on the wide variety of self-propelled mobile equipment. This information should be shared with other manufacturers, associations, mining industry personnel, and MSHA to achieve as much consistency as possible.

- Equipment manufacturers should ensure original equipment manufacturer (OEM) parts are available for all equipment. If parts are no longer available, they should notify industry associations and MSHA. Information should be shared with the mining industry when black-market parts are found to have been manufactured and sold.

- Improve truck driver control of backing operations by modifying cab location and design as well as rear view mirror locations should also be explored.

Operating Procedures

- Establish guidelines for determining truck and other haulage equipment operating load carrying capability. Develop procedures to be undertaken by mine operators and MSHA mine inspectors for determining load amounts, such as weight factors for type material being hauled, water amounts being hauled and develop lists describing equipment capacities. Load carrying capability guidelines must take into account haulroad designs and gradients, along with intended operating speeds. MSHA inspectors should have this information readily available to share with mine operators during inspection activity.

- Manufacturers should provide information to clients relative to proper equipment usage and assist in training and developing mine equipment operator training programs.

- Encourage equipment operator seat belt use by having MSHA mine inspectors emphasize the advantages of seat belt use during regular inspections and "walk and talk" training sessions. Develop handout material which describes the use and advantages of wearing seat belts. Testimonials from equipment operators who have had accidents and survived would be of interest to those who use the equipment. Mine operators, miners representatives, equipment manufacturers, and trade associations should stress the importance of seat belt use at every opportunity.

- Clarify the methods to be used for testing brakes and other safety features on haulage equipment. Develop field methods for the equipment operator and mechanic.

- All operations should have contingency plans to implement when weather has an adverse effect on continued safe operations.

- Prepare guidelines regarding the establishment of communications systems at surface mine operations. Radios, signal systems and other forms of communications for equipment operators should be made available for older equipment that is still in use. This equipment should be standard on any new equipment.

Blind Spots

- Haulage equipment manufacturers, the Society of Automotive Engineers (SAE), and the mining industry should initiate a cooperative effort to improve the design of haulage vehicles and warning devices. Innovative cab designs, and the installation of discriminating warning devices, which include front/side/rear video cameras, and the installation of other state of the art "blind area surveillance systems" would greatly reduce "blind-spot" hazards.

- Review Bureau of Mines and industry publications regarding novel cab design concepts and use them in the design of new haulage vehicles.

Training

- Miners' representatives, safety committee members, and persons representing the mine operator in safety matters should take an active part in promoting miner awareness of surface haulage accidents. Serious accidents noted in this study might have been avoided if equipment operators had been made aware of the important role they play in equipment maintenance, safe operations, insight into potential problems, training and their right to have safe equipment to operate and safe roads to travel. Additionally, they should actively take part in making customer and delivery drivers aware of potential hazards in areas where they interact with them. They can significantly help in communicating the responsibilities they have for each other when unloading materials.

- Form a joint industry/miner training committee to develop and conduct a haulage safety training program in conjunction with MSHA. Utilize mine sites with varied haulage equipment in conjunction with MSHA safety training programs for mine operators, truck drivers, safety engineers, technicians, equipment operators, and others associated with surface mine haulage.

- Use experienced truck drivers and maintenance personnel to conduct training. Use a mentoring type program, where a work group can choose from their peers the driver they would most like teaching their son, daughter or close friend to operate equipment. Seek active participation from equipment operators in sharing their expertise with others.
- Continue to train MSHA mine inspectors, mine employees and supervisors in the identification of unsafe dumping procedures and load out practices and remedial actions to take when necessary.

Information

- Develop public awareness programs in selected regions where there are high concentrations of surface mining operations. Provide industry personnel, miners, and the public, including families of miners, with descriptions of hazards associated with surface mine haulage and methods to avoid dangerous conditions. Motivate those at risk to become involved in the solutions for improving their workplace safety.

- Encourage the mining industry to use preventative safety maintenance programs.

SUMMARY

The primary tools to make an effective change in the numbers of surface powered haulage accidents are available through some MSHA and industry training programs and regulatory efforts. Policy clarification, sound engineering, development of guidelines where necessary, and the assimilation of current information, can achieve further reductions in the number of fatalities and traumatic injuries.

This paper attempts to define the hazards associated with mobile powered haulage equipment at surface mines and specifically, truck haulage. The mining industry, manufacturers, miners, and MSHA recognize the serious risks to mine personnel created by steep haulroad gradients, mechanical failure of safety features on haulage equipment, dumping at edges of fill and dump locations, "blind-spots," slick road surfaces, and uncontrolled traffic through mine operations.

There is a substantial need for the mining industry, manufacturers, miners, and MSHA to work together to develop uniform methods for the construction of haul roads and equipment. Additionally, the development of haulage equipment safety maintenance programs, traffic control programs, and engineering programs that eliminate "blind-spot" hazards are essential for improving consistency within the industry. There is also a need to evaluate the hazards to those who do not regularly operate mobile equipment. Several victims in this study were maintenance employees who did not operate equipment on a daily basis. Additionally, the causes and influences of the hazardous conditions or work practices of miners need to be further explored if we are to identify trends that all in the mining industry should address.

Communications, seat belt use, and the exercise of safe work practices while repairing or unloading vehicles are also areas of concern that must be addressed by the mining industry, manufacturers, miners, and MSHA on a day-to-day basis. Contractors, customers, delivery truck drivers, and other mine visitors must receive adequate training, instruction, and, where appropriate, some guidance to help educate them about potential hazards associated with mine environments.

Training programs and vigilance by mine workers, supervisors, mine operators and mine inspectors will ultimately result in safer work places.

In June of this year, a Surface Haulage Task Group was formed that includes persons from MSHA, the Department of Energy's Safety and Health Research Center (formerly the Bureau of Mines), surface coal and metal/nonmetal mining industries, and equipment manufacturers. The Task Group is exploring what can collectively be done to confront the increasing number of surface haulage lost-time accidents and fatalities occurring at both coal and metal/nonmetal mines. The proceedings from the Task Group will be in the form of "Best Practices" and will be published for use by the mining industry. These resource materials will be shared with operators through MSHA's cooperative efforts.

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INCORPORATING SAFETY INTO SURFACE HAULAGE IN THE POWDER RIVER BASIN

Wayne Jeffery and Craig Jennings

Powder River Coal Company

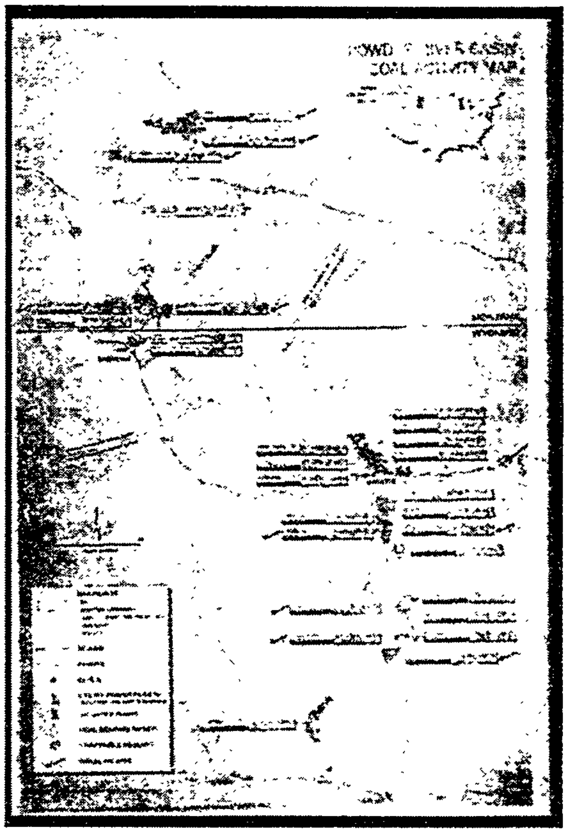
INTRODUCTION

The Powder River Basin (PRB) coal deposit extends from southeast Montana to northeast Wyoming. This paper describes a number of haulage practices and tools in use at several mines of the southern PRB and the way in which safety has been designed into and implemented for surface haulage of coal and overburden. Experiences described herein focus on the northeastern corner of Wyoming.

All the mines in this area rely on safe and efficient movement of enormous volumes of material, and the results achieved in safety underscore the planning and attention to detail present in the PRB. There are currently 12 large surface mines (those greater than 10.0MM tons/year) operating in this area. In 1995, these mines produced over 230.0MM tons of coal.

Powder River Basin Mine Production (1995)

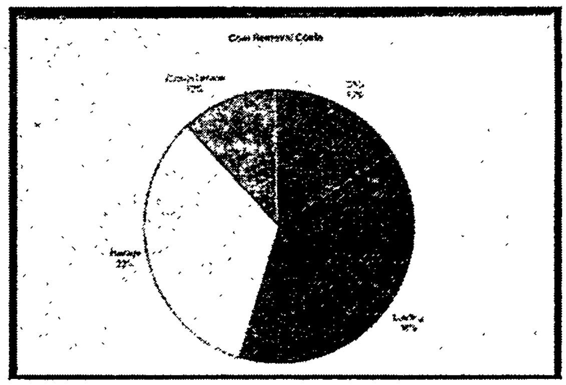
MINE	TONS (000)
Buckskin	11,600
Rawhide	15,355
Eagle Butte	16,942
Caballo	18,357
Belle Ayr	18,772
Caballo Rojo	16,810
Cordero	14,607
Jacobs Ranch	24,645
Black Thunder	36,149
Rochelle	26,036
North Antelope	21,249
Antelope	10,867
Total	231,389



COAL AND OVERBURDEN BENCHES

The coal in this area lends itself to high production and high volume operations using large equipment. The PRB enjoys a low stripping ratio with weak sandstone and silty shale overburden, and a dry climate. The coal deposit ranges from 30 feet to over 100 feet thick, with stripping ratios of 0.5 to 3.0, but in order to be successful in the PRB, mines have to be able to move large volumes of coal and overburden as safely and efficiently as possible. For example, in 1997 Caballo will move about 50MM cubic yards of overburden and 20MM tons of coal. Good working conditions and a talented and dedicated workforce combine to help our mines remain among the safest and most productive in the nation.

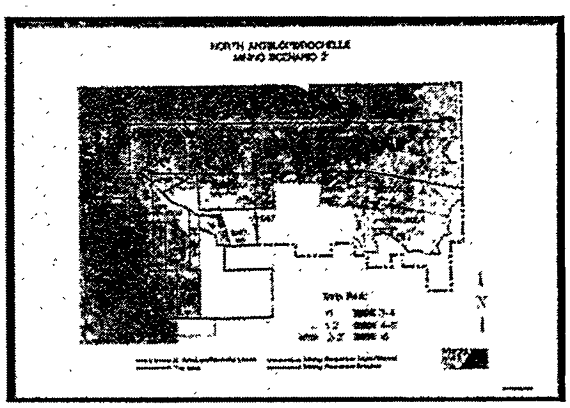
MATERIAL MOVEMENT COSTS



The focus of this presentation is surface haulage, so we start with a brief assessment of the costs associated with haulage. In the case of overburden removal, haulage costs typically account for about 40% of our operating expense.

For coal removal, this figure is about 30%. Because it is necessary to move large volumes of material at the lowest possible costs and because of the impact that accidents have on our operation, operating safely is critical to our business. Our obligation to protect our employees and our obligation to preserve our business are both served best by making safety our first priority.

MINE PLANNING

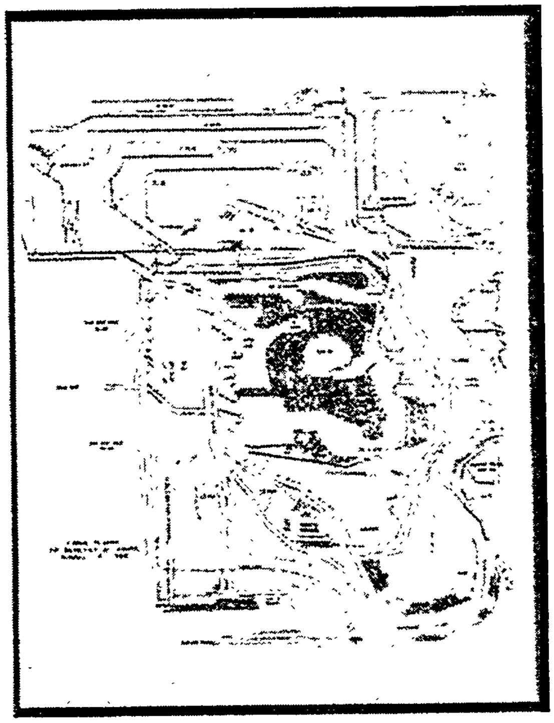


Safety begins with specific mining and reclamation plans in which detailed annual sequences for overburden and coal removal, backfill, and grading are developed.

GENERAL TRUCK/SHOVEL CONFIGURATION

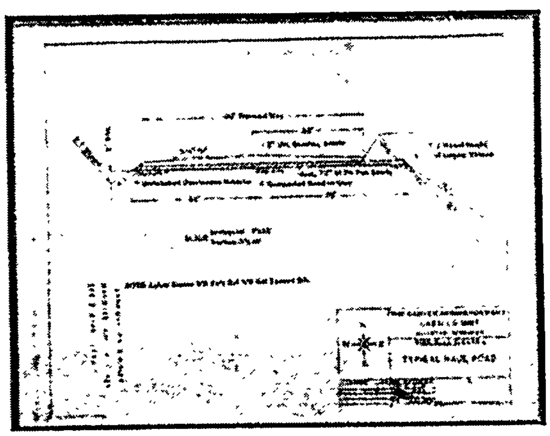
Most operations rely on large shovels and trucks for both coal and overburden removal. This photo is an illustration of a truck/shovel operation with simple end-around haulage.

SHORT-RANGE MINE PLAN



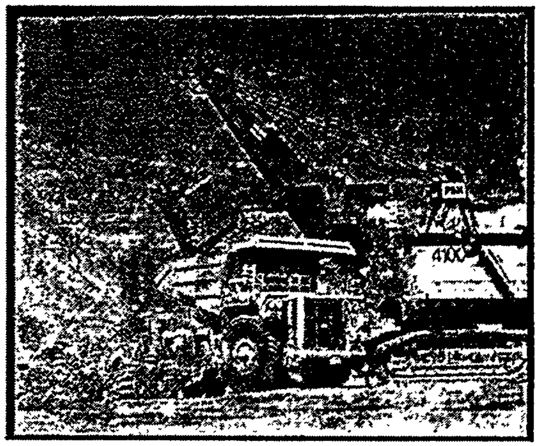
With operations which run 24 hours a day and 7 days a week, each week there are employees returning to work who have been off shift for three or four or even seven days. We use the startup meeting for the first shift back to reorient each crew about significant changes which have occurred during their time off. Overlays such as this allow our supervisors to refer easily to machine locations, traffic patterns, or other items important to the crew and to clarify questions quickly.

TYPICAL ROAD CROSS-SECTION



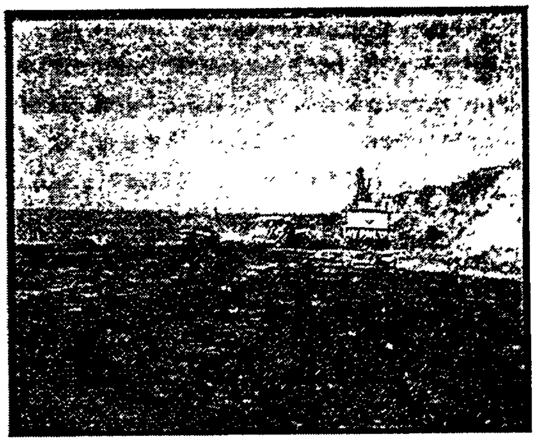
Safety and performance in surface haulage rely on haul road design. At Caballo our haul roads are between three and four truck widths wide, with a 12-15 inch crown in the center of the road to assure good drainage. Road alignment, grades and elevations, curves, berms, and ditching are all designed to facilitate smooth traffic flow and to ensure safety from start to stop. Extensive planning is critical to create roads which are safe and which will hold up to continuous heavy traffic. Careful planning is also important in conserving the materials we use for road aggregate.

240-TON TRUCK/SHOVEL



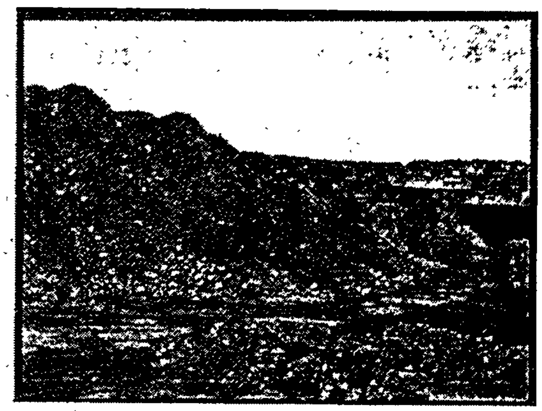
Large equipment is typically used in the Basin such as the 240-ton overburden truck shown here with a 60 cubic yard shovel and a 16-G motor grader.

LOADING BENCH



Operating benches must be designed to assure there is room to safely operate the equipment. At Caballo we try to maintain no less than 150 feet of set room. Less set room impacts visibility and maneuverability, and it can also hurt productivity by impeding general traffic flow and restricting the turnaround for the trucks.

SPOIL DUMP



Dump levels, as shown here, are normally no more than 45-50 feet in height to minimize potential for dump failure. However, this may vary with the material being moved and specific operating circumstances.

TRUCK BUCK DUMPING

Buck dumping is another method we use to maintain dump toe stability. If the spoil is fluid, then buck dumping along the toe of the first row of spoil will help maintain the stability of the subsequent dumps.

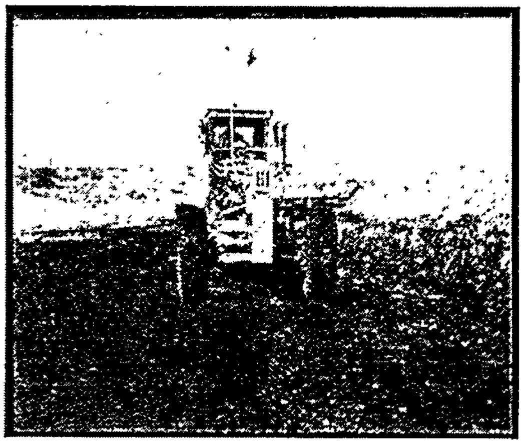
INTERSECTION

Approaches at intersections must have adequate visibility and the roadways should cross at similar elevation and at nearly perpendicular angles. Although cross-traffic patterns may be a necessity in certain instances, these should be planned and minimized well in advance. Adequate visibility will not only aid the safety of employees, but it will directly impact their ability to operate efficiently.

RAMPS

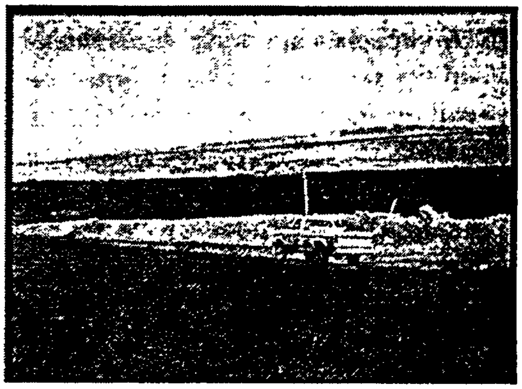
Ramps must be built to meet the grade specifications for the haulage equipment with the least gradeability. At Caballo we use a maximum of 6% grade for main haulage and up to 8% for sneak ramps and short access ramps.

ROAD REPAIR



As important as it is to build haulage roads to a given specification, it is equally important to maintain the roads properly. This picture illustrates a soft spot in the main haul road being subbed out and repaired. Although the southern PRB generally receives less than 15 inches annual precipitation, the poor quality base materials readily available for road construction yield easily to the grinding action of haul tires and this is exaggerated with the presence of water.

BERMS

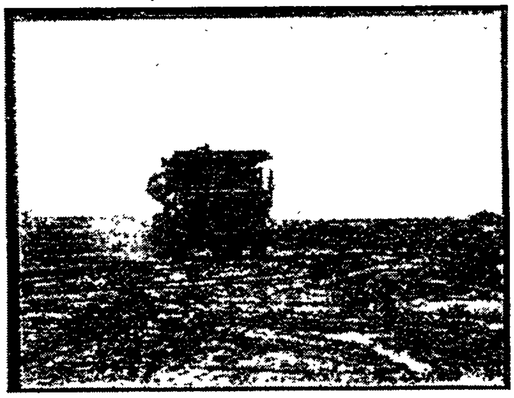


Berms must be built in such a manner that they are axle high to the largest piece of equipment operating on the bench. A large front-end loader is useful in building berms for the size of equipment we operate.

LEFT-HAND TRAFFIC

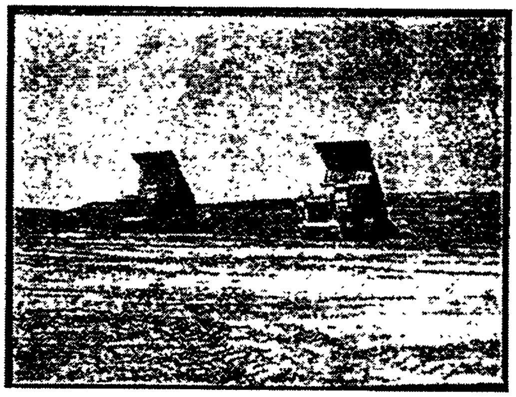
Left-hand traffic has been in use at Caballo since initial startup. With haul trucks as the primary consideration, the original reasoning for this pattern was to place operators out of the path of direct impact in the event of a head-on collision.

TRUCK ON THE DUMP



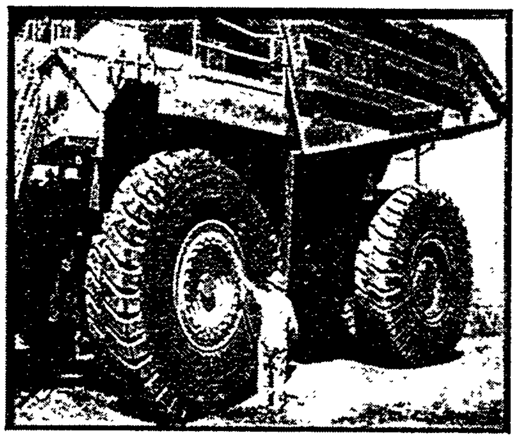
Another reason for left-hand traffic is that it allows the operators of the trucks to always know where the edge of the road is and to get a closer look at the edge of the dump in relation to their left side. When approaching the dump, as shown in this picture, it allows the operator to see any sloughing or cracking on the dump. Not all mines in the Basin run left-hand traffic and there are varying opinions regarding which is best.

TWO TRUCKS DUMPING



On the dump, operators are instructed to back up **to** the berm and not **into** the berm. Operators are also instructed never to back in with other trucks or other equipment on their blind side. To help insure dump stability, operators are instructed to maintain a two-truck width separation on the dump.

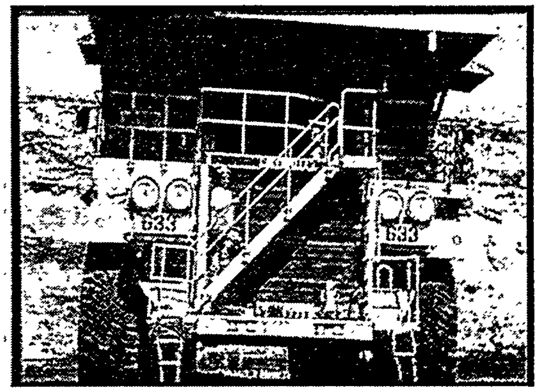
PRESHIFT INSPECTION



The condition of the equipment plays an integral part in achieving excellent haulage results. The operator plays a critical role in determining the safe operating condition of the equipment either during the preoperational inspection, as shown here, or while the operator is running equipment. We have zero tolerance for any piece of equipment that has a safety deficiency. By "zero tolerance" we mean, "If a problem is identified, the piece of equipment is scheduled immediately for repair." For items of major safety concern such as steering or brakes or a fire extinguisher, the piece of equipment is shut down immediately.

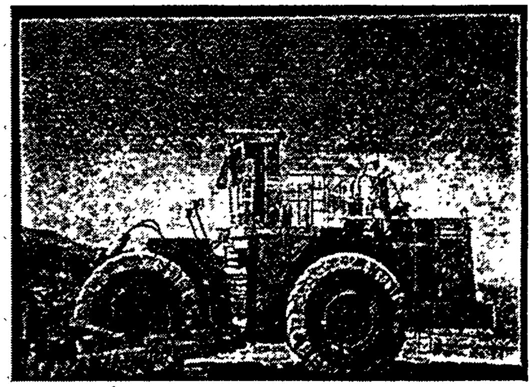
TRUCK STAIRWAY

Over the years, the few injuries we have experienced have primarily been the result of slips and falls while boarding equipment. To address this, boarding stairways have been installed on most of our trucks.



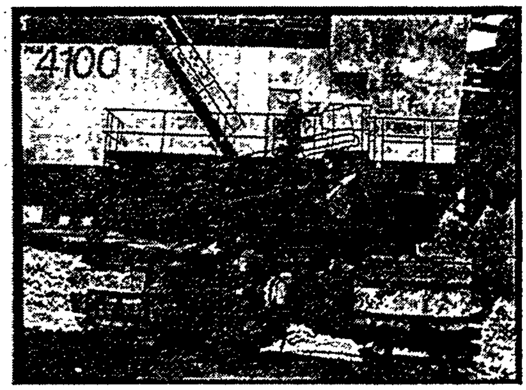
STAIRWAY ON RUBBER-TIRED DOZER

We have also installed these stairways on our rubber-tired dozers.



POWER STEP

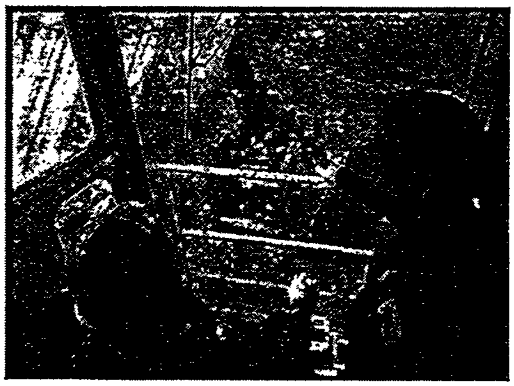
On our shovels, we have installed power stairways or power lifts to provide safe and controlled access up and down with a minimum potential for slips or falls.



BACKPACK

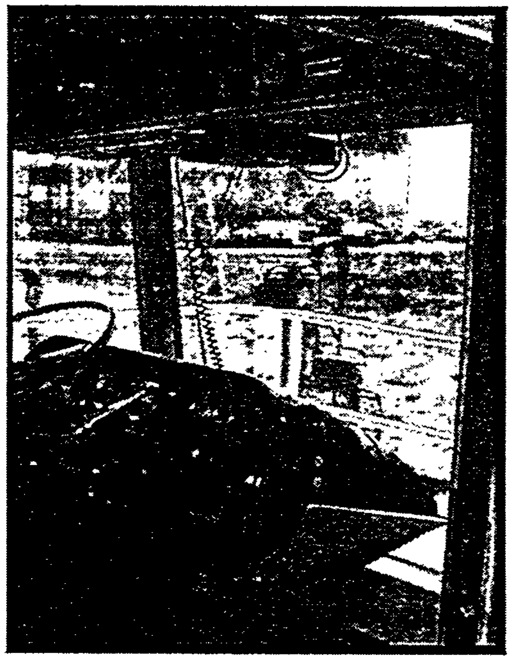
For those pieces of equipment on which we have not been able to establish boarding stairways, we have issued the operators backpacks to allow three-point contact during boarding.

SHOVEL OPERATOR/TRAINER



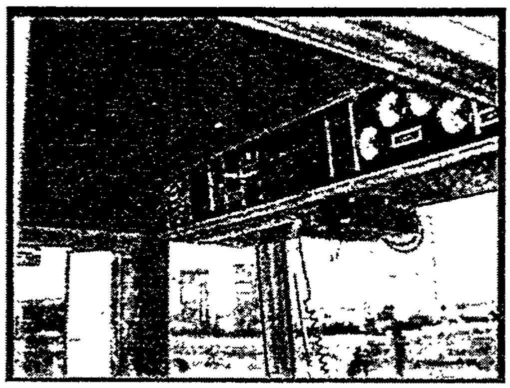
Comprehensive training has proven to be a significant contributor to our safety success. We have designated trainers on each shift who take all operators through a skills training program. This includes both classroom and hands-on contact. The amount of training will vary from a minimum of 40 hours to over 100 hours or more. In any case, no operator is released for duty until both the trainer and the supervisor do a thorough evaluation following a standardized checklist and both are comfortable that the operator is capable of operating safely.

MINE RADIO



Probably no single piece of equipment has contributed more in preventing serious accidents at our operations than the mine radios. Our system is designed so that operators can talk directly from one piece of equipment to another. Over the years, many potentially serious incidents have been limited to close calls or avoided altogether because of this contact. If not for each operator looking out for the other, we could have experienced far different outcomes. Our policy is that no vehicle is allowed to enter the pit without radio contact or escort.

AM/FM RADIOS

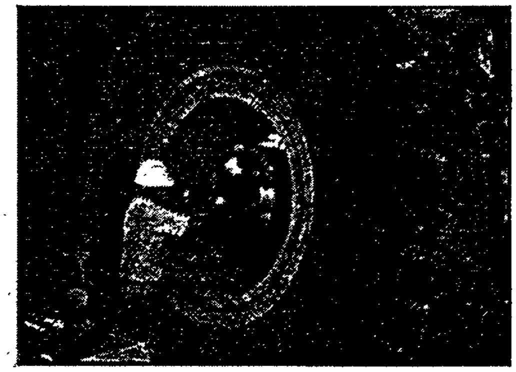


Early on at the operators' request, we installed AM/FM radios in all of our equipment. While originally we feared these radios would distract our operators, in reality, they have proven beneficial by breaking the monotony of operating equipment through the shift.

EQUIPMENT SEATS

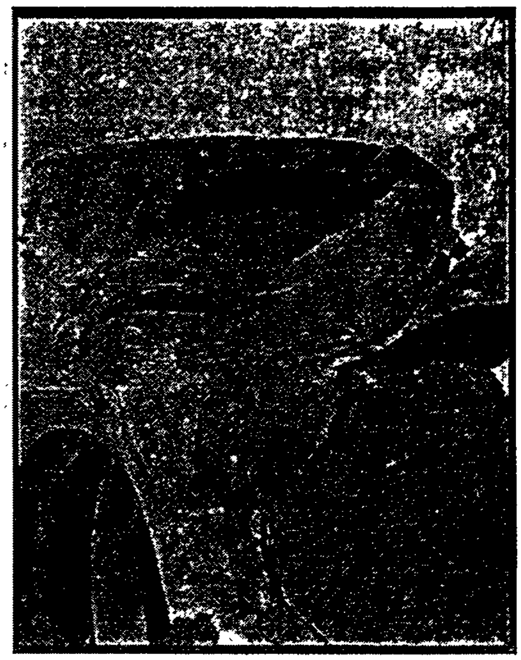
In the late 1980s, our Rawhide and Caballo mines worked with the Bureau of Mines on haul truck seats to prevent back injuries and to reduce operator fatigue. The results of the study showed that the average frequency of vibration on the trucks was around 7 Hz. It is around that same frequency that the human back is most susceptible to deterioration. After testing several different seats on the shake table, the Bureau of Mines confirmed what our operators had been telling us -- that an air cushion seat provided the best attenuation of this frequency.

EQUIPMENT IN SHOP



Regular inspection and preventive maintenance are critical to safe haulage. Equipment is taken down at 250-hour intervals for various PMs. At this time, maintenance personnel not only address the PM items, but also make an inspection of the equipment to identify any potential problems before they occur in the field.

FAILED TIRE

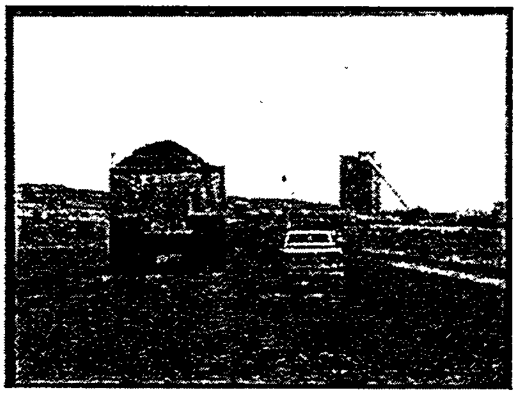


This picture shows what we **DON'T** want to happen. This is a tire which failed on one of our rear-dump haul trucks. Tire maintenance is as important as any other aspect of equipment maintenance. Tire pressures and temperatures are inspected at least daily and tires are moved from the front to the back any time serious cuts, separations, or wear are observed. Only new tires in good condition are run on the front of the trucks.

SUPERVISOR'S PICKUP

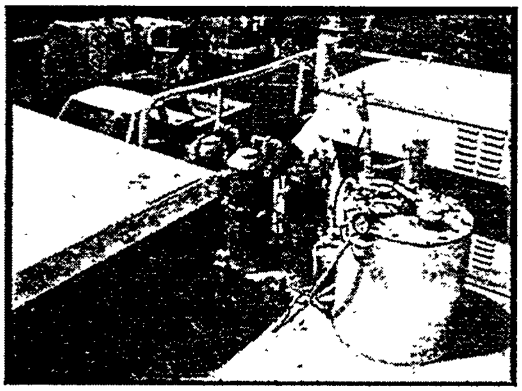
Light-duty vehicles operating in the pit are not only required to have a mine radio, but also are required to have a buggy whip with a light that is at least 10 feet high. These buggy whips help make it possible for the haul truck drivers to see light-duty vehicles. As illustrated, the tip of the buggy whip is about even with the deck of the haul truck.

PASSING



While we discourage vehicles passing, we do allow it provided there is adequate visibility and the passing vehicle first contacts the equipment to be passed by radio and receives acknowledgment to pass. Even with the visibility shown here, this pickup cannot pass if contact and permission are not received.

AUTOMATIC FIRE SUPPRESSION



In addition to a fire extinguisher, all major pieces of equipment are equipped with a fire suppression system. At Caballo, we have mainly manual 90-pound dry chemical systems; however, we are looking at incorporating automatic systems for major pieces of mobile equipment.

PIT AT NIGHT

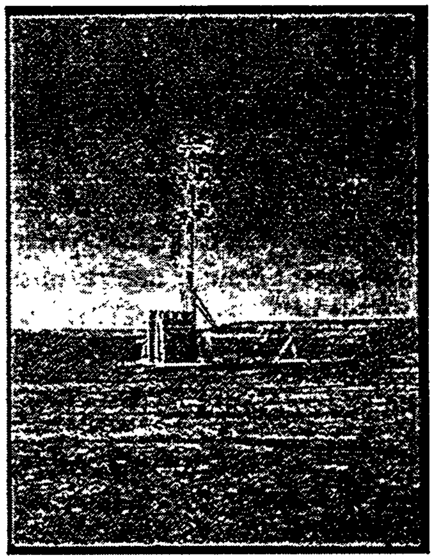
Visibility is a primary objective in a surface coal mine at night. We try to maintain lighting on the haul roads at around 1-2 foot candles and in the work areas around 3-5 foot candles, not counting the equipment headlights. Reflective materials and vests are provided for ground personnel to make them more visible after dark. We also use reflective striping on company vehicles.

HAUL ROAD LIGHTS

Permanent and semi-permanent lights are installed on the primary haul roads. The poles for these lights are either set into the ground or mounted on tires filled with concrete for ballast. We use portable light plants at locations that frequently change.

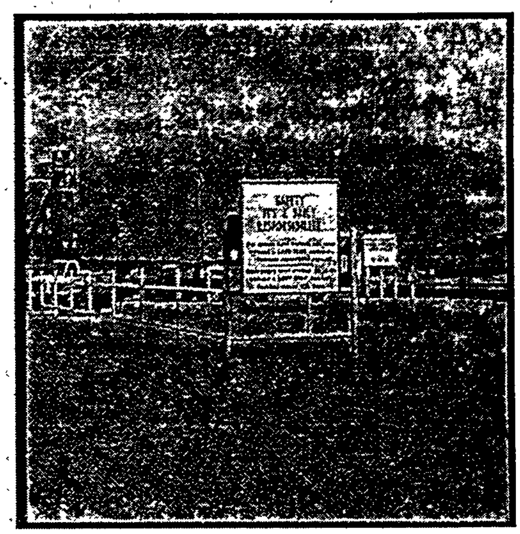
DUMP LIGHTING

On the dumps, we utilize a custom built lighting system that is designed to totally flood the area with light using high pressure sodium vapor bulbs.



ENTRANCE GATE

In closing, we are proud of our employees' accomplishments. Too often in safety, we focus on our accidents or failures, and do not always recognize when we do something right. For example, the magnitude of our employees' accomplishments can be put in perspective when you consider that each overburden truck makes about 60 trips from the shovel to the dump each shift. We run about 10 overburden trucks per shift, two shifts per day, about 363 days per year. This is over 400,000 trips per year without serious accident. When coal haulage is included, we total over a half million trips per year, and our employees have been doing this for almost 20 years. While we have never had a haulage fatality or serious injury related to haulage in the Basin, the potential always exists. As shown by the slogan at the entrance to our mine, if we are to accomplish safety in our operations, it requires effort each day by everyone -- management and all employees.



BENCHMARKING SAFETY & RISK MANAGEMENT PROGRAMS

Peter F. Ward

Benchmark Materials
Research Triangle Park, North Carolina

Before a company can address Benchmarking Safety and Risk Management, it is necessary for it to prepare an honest and comprehensive assessment of its safety philosophies and programs, if indeed it has any. Corporate benchmarks, unlike those cut into the granite milestone (Figure 1) must be adjustable. To establish your position in relation to the industry is fairly straightforward. To modify that position is far more complex.

A corporate benchmark is the result of a complex equation, the factors being past performance, industry indices, and current level of commitment. The modification of this position requires the addition of other factors, time, education, training, and a commitment from the CEO, without which most indices modification programs are doomed to failure. Presidential decrees or memoranda breathing fire and brimstone will not work. Benchmarking should not be viewed as a stand-alone tool. It is both a measurement and a measuring instrument.

To establish your present position may represent a significant first step, but it must not represent the journey. The first part of this presentation will be to analyze the building blocks that must be in place before benchmarking is even an option. There are only four components we need

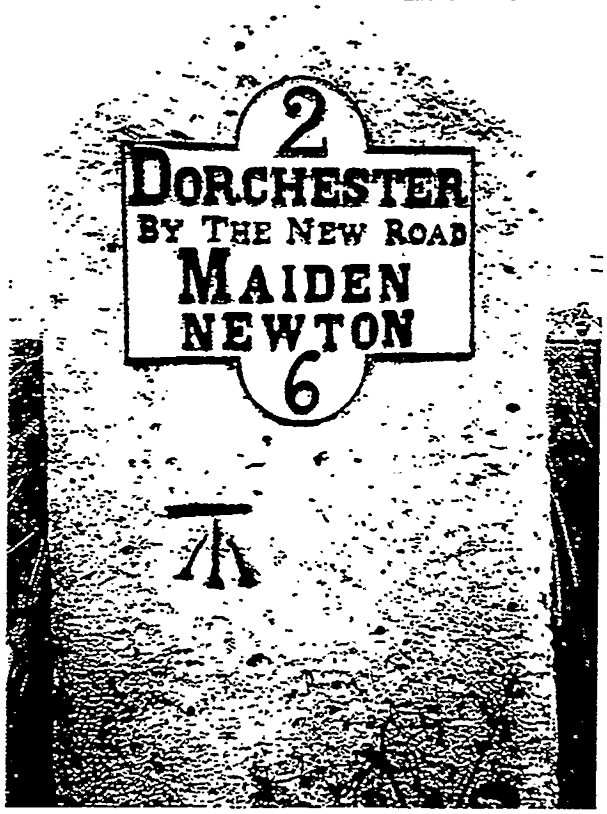


Figure 1 - Granite Milestone

to address. The number of accidents, their severity, their frequency and their cost. All other criteria are sub-directories of these headings. We will start by examining the format used by our company to benchmark our progress over the past four years (Figure 2).

My company, Benchmark Materials, is active in thirteen states and operates 88 quarries, 39 asphalt production facilities, three construction companies and a trucking operation. Payroll is around 2,700 and the production workers accumulate approximately 5.5 million work hours a year.

Those of you in the construction and mining industry will recognize that these three industries contain some of the potentially highest risk occupations after sky diving and bungee jumping. Yet in fact, these industries are inherently safe, just very unforgiving. This being the case, we are looking to measure the natural consequences of unrecognized or ignored hazards. Or, put in a more positive light, we are looking for tools with which to measure the benefits of training and education. Unrecognized hazards are usually the result of insufficient education, training and supervision. Ignored hazards imply that the training was given, the

Benchmark Materials

Minecorp Materials CONSOLIDATED SAFETY REPORT July, 1996	WORK HOURS	MEDICAL CASES	LOST TIME CASES	FATAL	LOST WORK DAYS	TOTAL CASE INCIDENCE RATE	LOST DAY INCIDENCE RATE	LOST TIME INCIDENCE RATE	NUMBER INSPECTIONS	NUMBER CITATIONS	S&S CITATIONS	CITATION COST	CITATIONS PER INSPECTION
COMPANY A	21,658	2	0	0	0	18.5	0.0	0.0	0	0	0	0	0.0
COMPANY B	56,062	0	0	0	0	0.0	0.0	0.0	2	1	0	50	0.5
COMPANY C	41,535	1	0	0	0	4.8	0.0	0.0	0	0	0	0	0.0
COMPANY D	50,964	1	0	0	0	3.9	0.0	0.0	0	0	0	0	0.0
COMPANY E	117,322	1	1	0	3	3.4	5.1	1.7	2	0	0	0	0.0
COMPANY F	76,538	1	0	0	0	2.6	0.0	0.0	4	7	0	350	1.8
COMPANY G	60,190	2	0	0	0	6.6	0.0	0.0	3	6	1	500	2.0
COMPANY H	24,091	0	0	0	0	0.0	0.0	0.0	0	0	0	0	0.0
Minecorp Materials	448,360	8	1	0	3	4.0	1.3	0.4	11	14	1	$900	1.3
THIS MONTH LAST YEAR	457,379	6	0	0	0	2.2	0.0	0.0	10	17	3	$1,450	1.7

FISCAL 1996 YEAR TO DATE

	WORK HOURS	MEDICAL CASES	LOST TIME CASES	FATAL	LOST WORK DAYS	TOTAL CASE INCIDENCE RATE	LOST DAY INCIDENCE RATE	LOST TIME INCIDENCE RATE	NUMBER INSPECTIONS	NUMBER CITATIONS	S&S CITATIONS	CITATION COST	CITATIONS PER INSPECTION
COMPANY A	184,572	7	1	0	35	8.7	37.9	1.1	5	6	0	300	1.2
COMPANY B	579,915	8	1	0	2	3.1	0.7	0.3	21	38	5	4,492	1.8
COMPANY C	432,986	10	2	0	54	5.5	24.9	0.9	11	15	5	1,700	1.4
COMPANY D	354,818	6	0	0	0	3.4	0.0	0.0	11	2	0	100	0.2
COMPANY E	941,930	15	4	0	197	4.0	41.8	0.8	20	9	0	450	0.5
COMPANY F	693,825	4	0	0	0	1.2	0.0	0.0	39	33	5	2,650	0.8
COMPANY G	573,291	8	1	0	3	3.1	1.0	0.3	18	25	6	2,406	1.4
COMPANY H	218,818	2	0	0	0	1.8	0.0	0.0	12	19	2	1,258	1.6
Minecorp Materials	3,980,155	60	9	0	291	3.5	14.6	0.5	137	147	23	$13,356	1.1
YTD THIS MONTH LAST YEAR	4,194,583	69	14	1	420	4.0	20.0	0.7	128	271	76	$96,194	2.2
FISCAL 1995	5,245,438	89	21	1	457	4.2	17.4	0.8	156	325	88	$101,294	2.1
FISCAL 1994	5,322,504	198	42	0	1,567	9.0	58.9	1.6	n/a	n/a	n/a	n/a	n/a
FISCAL 1993								1.8					

Figure 2 - Consolidated Safety Report

STUB HEADINGS / COLUMN HEADINGS	Number of injuries	Incidence rates	Severity measures	Lost workdays	Average severity	Average number of workers	Employee-hours worked	Number of operations	Associated work locations	Average hours per employee per year	Accident classification	Number of occupational illnesses	Coal production (short tons)
Prior year data with and without office 1/	1	1	1		1	1	1	1	1	1			
Work location	2	2	2			2	2	2	2				
	3			3	3								
	4	4	4			4	4	4	4				
	5			5	5								
	6	6	6			6	6	6	6				
	7			7	7								
	8	8	8										
	9			9	9								
	10	10	10										
	11			11	11								
	13										13		
				14							14		
	15										15		
				16							16		
	17			17	17								
	18			18	18								
												21	
	22	22				22	22						
	23	23				23	23						23
Employment size group	4	4	4			4	4	4	4				
	5			5	5								
Type of mineral	6	6	6			6	6	6	6				
	7			7	7								
	15										15		
				16							16		
												21	
State	6	6	6			6	6	6	6				
	7			7	7								
	13										13		
				14							14		
												21	
Part of body injured	8	8	8										
	9			9	9								
	12			12	12								
	19			19	19								
Nature of injury	10	10	10										
	11			11	11								
	12			12	12								
	20			20	20								
Occupation at time of injury	17			17	17								
Accident classification	18			18	18								
	19			19	19								
	20			20	20								
Mineral industry	22	22				22	22						
Type of coal	23	23				23	23						23

1/ For table 1 only, the headings have been reversed to simplify this guide; that is, the data elements indicated in the column headings for this table actually appear as vertical headings.

Figure 3 - Reference Guide to Stone Statistical Tables (Operator Data)

hazard was recognized, but the individual chose to behave in an unsafe way.

Benchmarking is a valuable tool. As the benchmarks on the milestones and church walls gave early surveyors reliable reference points, so the benchmarks we establish in our industry will give us reliable reference points to judge our progress. How does a benchmark differ from a target? Is it merely a question of semantics? Certainly not, for the true benchmark is an engineered reference point, the target is not.

Well, as I said earlier, the first measurements a company must take will establish their current position. What tools are already out there that enable you to achieve this? The Mine Safety and Health Administration publish excellent statistics. These publications are free. The larger book covers the stone industry. The smaller book covers sand and gravel plants. The statistics are two years out of date. The reason for this is that they include lost work days. MSHA would not be able to produce meaningful statistics at the year end that excluded this important field. If you do not monitor your own statistics, you can either get them from here, or on the Internet at www.MSHA.com.

More importantly, you can compare yourself to general mining indices to establish a "norm." Of greater value, you can compare your operation or operations with like companies (Figure 3). As you can see, from the stub headings and the column headings, just about every combination of statistic is available. What you need to do is to tailor your report to meet your needs. As the benchmarking progresses, a company will probably change both the benchmarks and the benchmarked statistics. Most of us prefer instant gratification so my advice for the first year or two of a program would be to focus on lost time injuries. These are the easiest to control, and they are where you will experience the highest controllable costs. Later on, you should switch your attention to the total number of cases. Total cases are a more significant factor, for once you have an accident, the severity is largely a matter of luck. For the benefit of those who are new to these indices I will take a moment to explain them. They are essential tools for any benchmarking of safety and risk management programs.

The Department of Labor uses units of 200,000 hours. Their indices reflect the frequency of a particular reportable event per 200,000 work hours. Thus if a hypothetical non-metal surface mining company that we will call Minecorp Materials wanted to establish its' **L**ost **T**ime **I**ncidence rate (LTI) for a period where there had been seventeen lost time injuries in the course of 850,000 work hours, the equation would be:

lost time injuries x 200,000 / work hours

- or -

$$17 * 200,000 / 850,000 = 4.0$$

An LTI of 4.0 has now established. The next question is, is this good or bad? Here they need to refer to the MSHA report (Figure 4) where they would see that in 1994, the industry average for surface mining was 4.2.

Minecorp Materials might conclude that since they are better than average, there is no need to throw any more money into Safety. BUT dig a little deeper into those statistics, the rate for ALL operations is 4.2. Smaller mines are statistically considerably less safe than larger mines. Minecorp Materials is large. Extract statistics on mines of comparable size and they would find that the major producers have LTIs of less than 2.0. At this point, Minecorp has established an industry benchmark for a company of their size, but this is of no value to them other than as a tool to set the first of their individual benchmarks.

Next they will need to see how their total ***reportable*** cases compare with the industry, this index we call the **T**otal **C**ase **I**ncidence rate

	MINECORP	INDUSTRY	LIKE SIZED
LTI	4.0	4.2	1.8
TCI	8.0	7.0	6.0

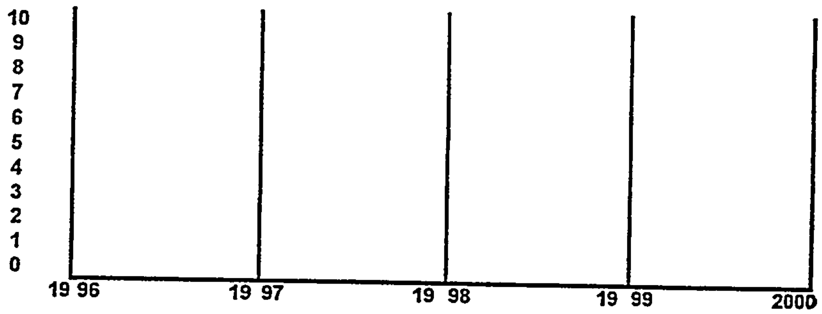


Figure 4 - MSHA Report

(TCI). Once again, taking our hypothetical company we have a total of 34 reportable cases, which of course will include the lost time cases. Using the same equation as we did for the LTI but this time substituting reportable for lost time we have 34 * 200,000 / 850,000. This conveniently gives us a TCI of 8.0. Once again, returning to the MSHA report (Figure 4), we see that the industry average is 7.0. A comparison with companies of like size will show that a TCI of 6.0 is nearer average.

Another very important statistic can be extrapolated from these two indices. This is the fact that in like sized companies, the percentage of lost time injuries, and remember a lost time injury is by definition one where an injured employee misses a complete shift of his or her regular duty, is 33%, but for our hypothetical company the percentage is 50. Minecorp Materials can now see that it is experiencing more total reportable accidents than the industry average, significantly more than peer companies, with a higher percentage of those accidents resulting in lost time.

How can Minecorp benchmark performance based on these numbers? Unless concrete steps are taken to improve the situation there is no reason to believe that the numbers will improve. Therefore does Minecorp create a benchmark that reflects the status quo? If so, what purpose would that serve? A benchmark, as we said earlier, is an engineered reference point. Minecorp would do well to acknowledge that the only number they could significantly alter in year one would be the lost time accidents. That is why I said earlier that though not the best long term index it is the easiest to modify.

I will guarantee you that Minecorp's higher than average lost time accidents do not reflect severity as much as it reflects poor case handling. Injured employees must be returned to meaningful modified duty as soon as possible. Do not let a superintendent dictate to you that he or she does not want an employee back before full recovery. The longer an employee is away the higher the cost of that case. Insurance industry figures put the direct cost of lost time accidents at $2,000 per day. The total cost is estimated to be between three and five times the direct cost. Another good reason to start benchmarking the lost time accidents is the reduced exposure to an employee seeking outside counsel to resolve a compensation claim. For an injured employee who returns to work within 24 hours there is a less than one percent frequency of litigation. For an employee off for 5 days, the risk is ten percent, at 30 days the risk of litigation rises to 27%.

Benchmarks cannot be set arbitrarily. They must either reflect the status quo and be irrelevant, or they must be an engineered goal reflecting an achievable and acceptable level of performance.

Minecorp's figures tell me that they probably have lax hiring practices. At Benchmark Materials we now require an employee to have a comprehensive two step pre-hire physical.. This includes matching physical and mental abilities to tasks. We require a physician to attest to the candidates' fitness to carry out specific tasks as laid out in our hiring manual. Substance abuse testing at hire and random testing thereafter will in time be reflected in lower indices.

Another area that must be monitored is legal compliance. MSHA inspects surface mines twice a year and underground mines four times a year. Establish your current citations per inspections rate and the percentage of Significant and Substantial citations. What is an acceptable rate? The short answer is zero citations. An MSHA inspector is not your friend, he is not your enemy, he is an enforcement agent but he also provides solid benchmarking data. A citation is the federal government's recognition of a hazard on your mine property. If Minecorp has an average of six citations per inspection with two or more of them S&S, I can guarantee that no one on site is MSHA certified. If there is a copy of 30CFR I will also guarantee you that it is at least five years old and unread.

Minecorp must get top down MSHA certification, not the quick and dirty one day special but a comprehensive eighty hour certification starting with the superintendent and foreman and annually working down through the ranks. We are in year three of our program and have not yet found a level at which the training ceases to be assimilated.

Where should Minecorp benchmark their citations? Until the training is underway there is not much they can do except assume a similar number of citations at future inspections. Once they get serious about understanding the laws that govern their trade and embark on top down certification they can anticipate reducing the number of citations by half by the end of year two, and half again in year three. In other words, they can benchmark their MSHA compliance.

Monthly Safety bulletins to each location are an excellent way to keep Safety on the front burner. If your organization comprises several separate entities, a little competition helps drive down the numbers.

This is the monthly status report we send out with our monthly Safety Newsletter (Figure 5). Quarterly, we distribute loss run analyses (Figure 6).

These show total numbers of Compensable, Automobile, General Liability cases as well as other losses including any statutory fines. We break down the numbers into meaningful statistics. As you can see, we convert total dollars into a cost per ton or a cost per hour. These are numbers that mean something to a superintendent. Another significant point here is to always use the reserve value of a case, not the paid to date. The reserve is a far more accurate indicator of the true cost of an accident. Using the incremental costs as a measure serves no useful purpose.

Minecorp Materials

Consolidated Safety and MSHA Report Fiscal 1996

Month of July, 1996

Safety	Hours Worked YTD	Total Injuries			Lost Time Injuries			Lost Work Days			YTD Incidence Rates (Per 200,000 Hours)								
			Year to Date			Year to Date			Year to Date		Total Case (TCI)			Lost Time (LTI)			Lost Day (LDI)		
		Month	Current	PY	Month	Current	PY	Month	Current	PY	Current	Target	PY	Current	Target	PY	Current	Target	PY
Company A	184,572	2	8	9	0	1	1	0	35	24	8.7	3.8	7.2	1.1	0.7	0.8	37.9	14.0	19.2
Company B	579,915	0	9	9	0	1	2	0	2	4	3.1	3.8	3.0	0.0	0.7	0.7	0.7	14.0	1.3
Company C	432,986	1	12	10	0	2	0	0	54	0	5.5	3.8	4.8	0.9	0.7	0.0	24.9	14.0	0.0
Company D	354,818	1	6	12	0	0	1	0	0	63	3.4	3.8	5.6	0.0	0.7	0.5	0.0	14.0	29.5
Company E	941,930	2	19	17	1	4	2	3	197	100	4.0	3.8	3.3	0.8	0.7	0.4	41.8	14.0	19.5
Company F	692,225	1	4	10	0	0	5	0	0	90	1.2	3.8	2.9	0.0	0.7	1.5	0.0	14.0	26.3
Company G	573,291	2	9	17	0	1	2	0	3	137	3.1	3.8	5.9	0.3	0.7	0.7	1.0	14.0	47.1
Company H	218,818	0	2	1	0	0	1	0	0	2	1.8	3.8	1.0	0.0	0.7	1.0	0.0	14.0	1.9
Total Minecorp	3,977,555	9	69	85	1	9	14	3	291	420	3.5	3.8	4.1	0.5	0.7	0.7	14.6	14.0	20.0
Total Year 1995	5,245,438			111			21			457			4.2		1.2	0.8			17.4
Total Year 1994	5,322,504			240			42			1567			9.0		1.2	1.6			68.9
Total Year 1993																1.8			
U.S. Bureau of Labor 1994																			
- Metal/Non Metal Mining													7.0			4.2			
- Sand and Gravel													5.6			3.4			

MSHA	Number of Inspections			Total Citations			S & S Citations			Fines ($)			Citations per Inspection			
		Year to Date			Year to Date			Year to Date			Year to Date		Year to Date			
	Month	Current	PY	Month	Current	PY	Month	Current	PY	Month	Current	PY	Month	Current	Target	PY
Company A	0	5	2	0	6	3	0	0	1	$0	$300	$350	0.0	1.2	1.5	1.5
Company B	2	21	18	1	38	50	0	5	17	$50	$4,492	$72,980	0.5	1.8	1.5	2.8
Company C	0	11	7	0	15	28	0	5	7	$0	$1,700	$2,800	0.0	1.4	1.5	4.0
Company D	0	11	14	0	2	14	0	0	3	$0	$100	$1,100	0.0	0.2	1.5	1.0
Company E	2	20	15	0	9	33	0	0	6	$0	$450	$3,543	0.0	0.5	1.5	2.2
Company F	4	39	40	7	33	73	0	5	28	$350	$2,650	$9,350	1.8	0.8	1.5	1.8
Company G	3	18	22	6	25	44	1	6	9	$500	$2,408	$4,089	2.0	1.4	1.5	2.0
Company H	0	12	8	0	19	26	0	2	5	$0	$1,258	$1,982	0.0	1.6	1.5	3.3
Total Minecorp	11	137	126	14	147	271	1	23	76	$900	$13,356	$96,194	1.3	1.1	1.5	2.2
Total Year 1995			166			326			88			$101,294				2.1
Total Year 1994																
Total Year 1993																

Figure 5 - Consolidated Safety and MSHA Report

ACCIDENT COST REPORT FISCAL 1996

OPERATION	WC			GOV'T PENALTY		TOTAL$	VOLUME	$$$$$$	VOLUME	$$$$$$
	NO.	WORKERS COMP.	NO.	MSHA-MINING OSHA-CONST.	NO.	ALL UNITS	TONS PRODUCED	COST PER TON	HOURS WORKED	COST PER HOUR
COMPANY A	4	1,029	0	100	6	1,233	432,039	0.0029	96,311	0.0128
COMPANY B	18	4,255	0	4,354	46	9,039	5,055,150	0.0018	348,350	0.0259
COMPANY C	15	10,880	1	800	27	32,538	2,589,548	0.0126	249,914	0.1302
COMPANY D	4	21,694	1	0	8	35,920	1,471,706	0.0244	172,213	0.2086
COMPANY E	33	150,415	1	200	47	370,930	2,435,882	0.1523	469,756	0.7896
COMPANY F	2	586	1	1,050	18	21,759	3,190,000	0.0068	376,180	0.0578
COMPANY G	12	20,721	0	400	31	103,313	3,866,848	0.0267	335,304	0.3081
COMPANY H	5	8,499	2	500	19	19,654	1,399,994	0.0140	118,675	0.1656
COMPANY I	0	0	0	0	0	0	0	0.0000	0	0.0000
MINECORP TOTALS	93	$218,079	6	$7,404	202	$594,384	20,441,167	$0.0291	2,166,703	0.2743

Figure 6 - Accident Cost Report

What is our hypothetical company's next move in the benchmarking process? The only numbers they have are the current unsatisfactory numbers (Figure 4). These are not benchmarks, they are the datum points from which their first benchmarks can be struck, so we will place them in the year one column. What other criteria should they use? Citations per inspection, percentage of S&S citations, compensable cases, average cost per compensable case, these all need tracking.

The reason that Minecorp's numbers are out of line with their peer producers can be assumed with a degree of certainty. They do not hire intelligently nor do they train their employees. For Minecorp to strike a benchmark representing an improvement over the status quo, there must be a corresponding change in training and enforcement. As we saw earlier, even with an aggressive program, there will minimal improvements in year one. Working closely with medical providers and insurance Third Party Administrators, Minecorp will be able to reduce lost time cases by 25% even if the total number of accidents remains constant. So benchmark one would be an a LTI of three for year one. This is realistic and will give credibility to the benchmarking process within the company. Depending on when in the year an aggressive training program starts will dictate how much the first year numbers will change. With Minecorp's TCI we would look for a marginal improvement in year one but significant gains over the next two years. Since citations per inspection are a good measurement, they should also be included. Six in year one will no more than match the datum year, but years two and three can be benchmarked significantly lower. Any adjustment in benchmarks must be accompanied by a written strategy justifying the modification, otherwise Minecorp is relying on targets and luck. Looking back for a minute on my company's figures (Figure 5). You will see that year one showed modest improvements and *our* training started in the first quarter. But just look at year two, and we did not start MSHA training for hourly employees until year three.

There are two tools that I strongly recommend to any company about to embark on the benchmarking process. The first will lead to the second. Join trade associations at both regional and national levels. Once you join, become active on relevant committees. Don't just be a due paying drifter. Secondly, single out the Safety Directors of companies with strong programs. Ask them to share their numbers and their strategies. These are both valuable tools for meaningful benchmarking.

How do we at Benchmark Materials modify our numbers to accommodate an organization that is regulated by MSHA as well as other agencies? Eighty percent of our operations fall under MSHA jurisdiction. Once we had established our baseline on these operations, we went on to include all operations on a 200,000 hour base. Our corporate figures are no longer MSHA statistics but Benchmark Materials' statistics that encompass the higher risk construction and trucking operations. They are our benchmarks.

Does benchmarking actually work? We believe it does. The numbers we have shared with you are the real numbers of a company that came from one of the worst in the industry to National Award winners in four years (Figure 7).

The expense was minimal and the rewards, both altruistic and financial, have been remarkable. The benchmarks we establish for our operating companies are not targets, they are scientifically established thresholds beneath which we choose not to operate. Although we are comprised of eight corporations and over 120 locations, we set a common corporate set of benchmarks. Everyone has to contribute. Well, as I said earlier there is a considerable financial payoff. I like to think that this last figure is the proof that everyone's CEO would like to see (Figure 8).

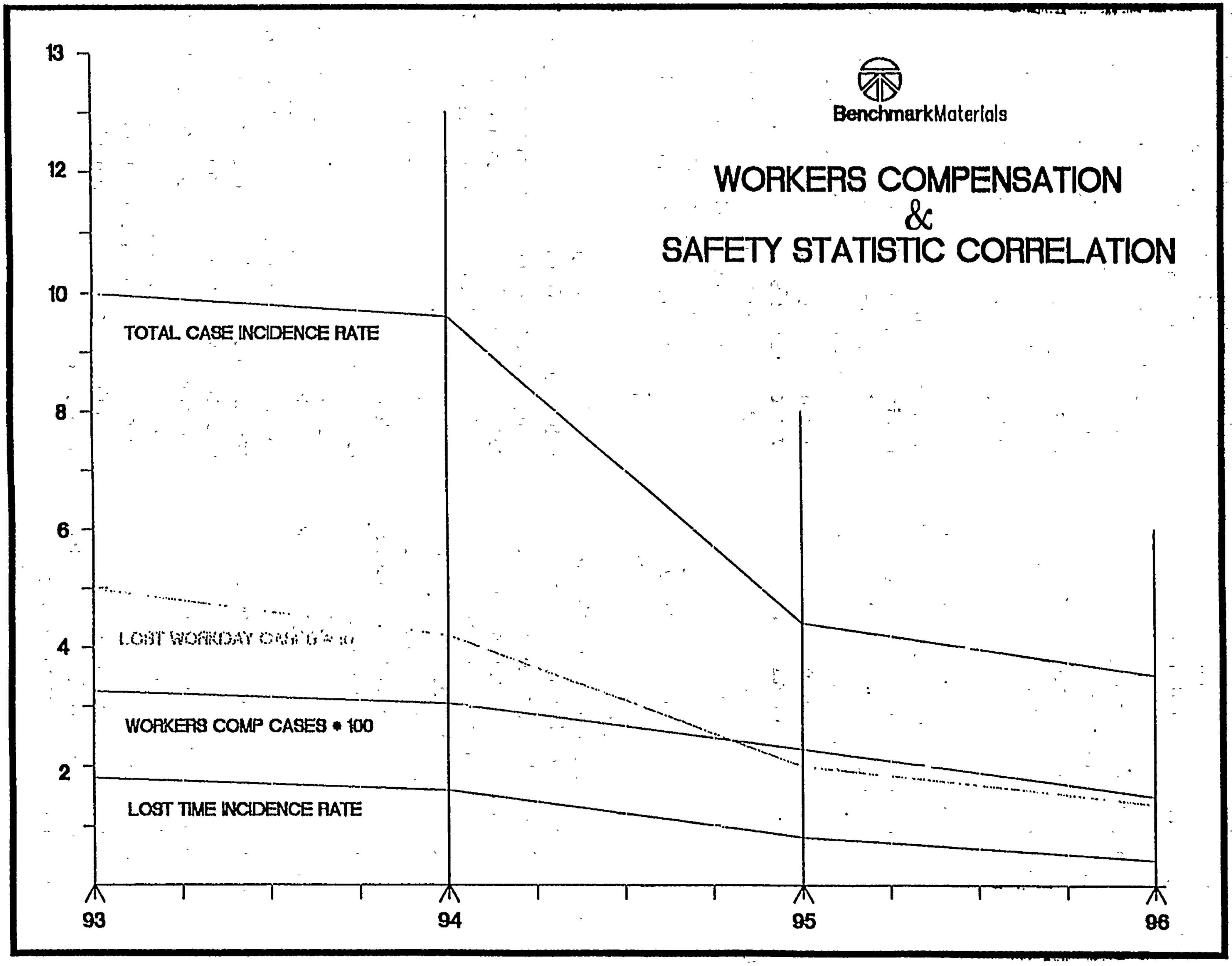


Figure 7 - Workers Compensation & Safety Statistic Correlation - Incidence

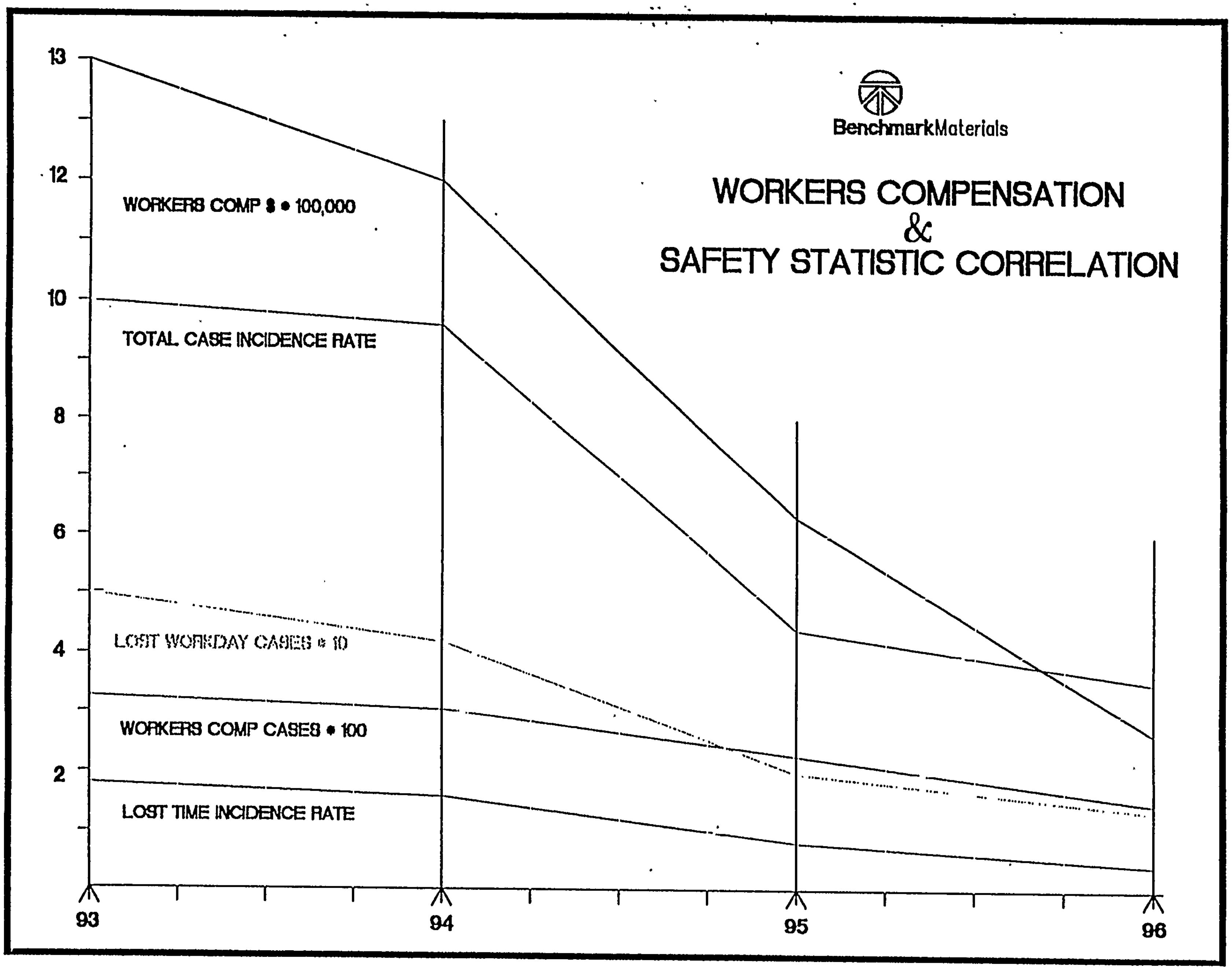


Figure 8 - Workers Compensation & Safety Statistic Correlation - Cost

USING ON-THE-JOB TRAINING TO COMPLY WITH CFR 30 PART 48

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Training approaches in the mining industry are similar to those used to train new drivers to drive the family car. The parents want a driver that produces successful trips with a minimum of risk. They want the operator to be injury free, avoid accidents, keep the transmission in one piece, comply with the law, and control costs. Part of the training goal is to achieve this result with as little effort as possible. Would any mine operator hope for less from the company training program?

Consider how most drivers are trained and the result. Drivers on the highway have varying levels of competence. They learned to steer a car, change tires, obey traffic laws, change oil, operate a clutch, replace wiper blades and other skills by a variety of methods. Drivers learn road signs and road navigation from riding with others in cars. Steering skills are learned on a tricycle and refined in someone's lap. Tire changing knowledge comes by pulling out the operator's manual after a flat tire on a rainy night. Oil change information comes from family, friends, books, television, salespeople, or even an early engine failure. Traffic law knowledge may be the result of reading a book to prepare for an exam. For some, this knowledge may have come from a driver education class in high school or other formal training. It is stressful to think that safety depends on driver training that is often random, inconsistent, slow, and meets minimum standard of performance.

Driver training and industry training have many similarities. This is especially true in small mines. Most drivers were trained as part of a small family unit. They came to driving age one at a time. Each person wanted to get behind the wheel when they were eligible to start. The trainers were not professionals but had an interest in the trainee's success. Time for training was limited. Much of the learning came from watching others perform a task. The training setting varied from driveways to parking lots and finally the streets. Audio-visual materials, training plans, classroom experience, and similar items were limited. Presentation methods were visual, verbal, and practical exercise. The training plan was to show the skill, talk it through, practice for accuracy, and finally move to normal speed. Learning was in segments lasting from minutes to hours and never finished. Trainee motivation was high so some skills were self taught and self practiced even at unauthorized times.

The small mine training challenge is the same one that faced large farm families as children learned to operate equipment, work with livestock, raise crops, and operate within the cycles of farm life. Like farms, many small mines were started as family units and employees were added to make an extended family. Today small mines of 15 people or less are still close groups and have the challenges of an extended family. This is even true of small operations owned by large companies. They are a collection of small operations scattered in remote locations far from the support of the home office.

Like other small businesses, the small mine is not the ideal environment for traditional classroom training. It is a place of constant change and needs flexibility. There are never enough people to keep up with the work. Survival depends on everyone knowing as much as possible to cover for vacations, emergencies, illness, and production demands. Each operation is individually designed with a unique configuration of equipment for a specific deposit. The people have an outdoors orientation and are more interested in equipment and results than administrative procedures. They have the same federal, state, and local laws and regulations on safety, land use, environmental compliance, personnel, etc. as large operations. It is also difficult to find skilled people who will work with the weather conditions, hours, physical requirements, and involvement with heavy equipment. There are no specialists on site for environment laws, safety compliance, training, electrical work, engineering, geology, accounting, or similar needs. New people are hired and trained one at a time. Getting people started soon is critical because the new person needs to work and the operation needs help. Training is done as needed and additional knowledge and skills are added when time is available. Extra equipment, time, or people for training do not exist. Some training can only be done when a repair is needed. Waiting for enough people for a vocational school to start a class or someone from the home office to set up training is not practical.

Every operation is essentially independent. Each location must have training systems in place that will keep it profitable, comply with laws, and adapt to sudden change. The result is a leadership team that is constantly pressured by the diverse and detailed requirements they must remember and complete. They feel that government and even their own companies do not understand the challenges they face.

Small mine training is complicated by the need to train safe and productive employees and meet the Mine Safety and Health Administration (MSHA) requirements. It would be great to think that these two needs are the same but they are not. Effective training of workers can be done without ever reading MSHA regulations. To debate the contribution or limitations that 30 CFR Part 48 makes would be useless since the industry must comply with the Mine Safety and Health Act (MSHAct). Compliance must occur even if the congressional rider on funding prevents MSHA enforcement. The rider limits MSHA's enforcement. It does not release any operator from the requirements of the MSHAct. Failure to make a good faith effort to comply can still put individuals and companies at extreme risk through state and federal courts.

How can a small mine comply with Part 48 and efficiently develop safe and productive workers? Training should start with a review of the operation's training needs. It can be frustrating attempting to fit needs into the detailed specifications of the Part 48 model. Another approach is to start with the Part 48 requirements and then look at the operation's needs. Either way, the Part 48 requirements will dictate that you have a written plan. Part 48 will also dictate the plan's components and much of the format. Even with the difficulties, the most efficient way to organize training is to create a delivery system that meets the operation's needs and the requirements. A duplicate system that trains safety one way and trains production skills another way must be avoided. Two systems are more than wasteful. They are confusing and destructive. Using two systems can undermine the entire training effort. Integrating both needs will reduce training costs, injuries, loss from damage, compliance problems, and frustration.

The first approach to training that most people think about is "group training" in a classroom. They see a mental picture of public school students sitting in a room. Classroom training is correctly remembered as a method of conveying information to a group with similar needs and development. People look beyond how they were trained to drive a car. They fail to remember the limitations of group training in building individual skills or responding to individual needs. Miners remember how group classroom training worked in an annual refresher. They forget how impractical classroom training would be in training a new loader operator to handle a loaded bucket. Some people even feel if it did not happen in a classroom, it was not training. A broad view of training is needed to develop an effective training program. Training methods must be determined by reviewing the training, trainee, and the desired performance.

A second approach is individualized training. This is simply developing and delivering a program to address one person's training needs. It can be done in the classroom or "on-the-job. " The one-on-one nature of this approach encourages excellent communication, resulting in faster learning with better retention. This is an excellent method for training a person to operate a piece of equipment but it is costly. The cost of one teacher per student is too expensive for public schools except in highly specialized training. The cost of equipment to train each mine job individually is just too costly for a local vocational school. The difficulty of individualized training in public education turns into a mandate for small mines. Small mines have highly specialized skills that match perfectly with individualized instruction. The mine is a complete training site with equipment and knowledgeable people. The class size is usually one, because mines have training needs one at a time. Unlike school situations, the people in small mines who are responsible for training and employment select the trainee. This creates a unique situation that cannot be duplicated by public education.

There is a distinction between these training terms. "Group training" and "individualized training" relate to the number of participants. "Classroom training" and "on-the-job training" refer to the setting for the training. Neither of these terms describes the method of presentation. The presentation methods for both approaches to training include lecture, demonstration, practice, programmed instruction, interactive media, coach and pupil, and a host of others. Training can be provided to any size group. It can also be held in any setting. The presentation method will vary with the setting, group size, content, equipment, trainee needs, and instructor. The training will dictate how it is done. For example: Interactive computer training is best suited to an individual at a computer while crane operation may start with a group in a classroom and finish with individuals practicing crane operation on-the-job.

Individualized instruction is most compatible with small mine training. It requires a determination of the needed knowledge and skills, who has them, who will train, how training will happen, when it will be done, and where. While this sounds complicated, the same questions are made on all training, regardless of method. When decisions are made by not making a decision, the result is usually bad. Better planning creates better training and better long term performance.

The most common training in small mines has been individualized "informal on-the-job (IOJT)" training. At its worst, IOJT means a new miner is introduced to a few people, signs a few forms, is given a shovel and told where to clean up. Then when someone needs help the new person is called and shown just enough to get by. With this method an employee eventually learns enough of the job to satisfy the supervisor. The miner may stay if he is not injured, fired, or able to find a better job. Variations of this method have created a kind of natural selection resulting very capable people in small mines. They can take a minimum of knowledge and continue to learn on their own. They also have a good sense of danger that keeps them out of harms way while they are learning. While IOJT built much of the industry, it is not good enough for today's needs. It is every safety director's nightmare. IOJT is what the MSHAct was designed to eliminate. In IOJT, learning is slow, teaches the limitations of others, causes turnover, leaves gaps in learning, causes severe accidents, and it is the enemy of progressive companies. IOJT is not capable of meeting the performance needs of today's mining operations.

The other side of on-the-job training is formal on-the-job (FOJT) training. FOJT has been widely used in the military where job skills are needed but time for schools is not available. It is also recommended by MSHA in *Structuring On-The-Job Training Program* (MSHA Guide, June 1983). FOJT produces performance that is better and faster. It focuses on the performance required and teaches all of the job, not just things as they come. FOJT encourages realism and practice and improves retention. The instructors are the supervisors and workers who know the work and hazards. It is tailored to the individual, the work environment, the equipment, and changes that occur daily. It is measured in safe behavior. FOJT requires a good plan, people focused trainers, and enlightened leadership.

It is important to understand the target of mine training. Whether new miner training is given to new employees or hazard training is given to contractors, the learners are adults. They bring with them their knowledge of the subjects, interests, and experience. Adults have a greater need to see a purpose in training. They ignore things they believe are not relevant. Adults have a shorter attention span than most young people. They prefer hands on learning with high levels of involvement. Adults prefer immediate feedback, but they are less tolerant of disrespect. Their expectations of trainers are high. An adult's knowledge and skills retention is greatest when training is as close to the working conditions as possible. Knowledge and skills taught to adults in the classroom may not carry over into satisfactory performance unless there is an application phase to the learning.

This points to the importance of using FOJT for training the adults that work in mines. A properly designed program will use diverse presentation methods to improve performance by making the training more interesting. The use of some supplementary materials will make knowledge available that is not available at the work site. For example: Some hazard training is more practical if presented on video. Company safety rules may be best taught by allowing the trainee to read them and then discuss questions. The methods for augmenting FOJT are limited by the trainer's creativity and resources. By using individualized instruction as the core concept, and FOJT as the primary presentation method, any or all of these ideas can be used as necessary to meet the trainee's needs.

Developing an FOJT program starts at three levels. First, develop a training session for a small part of one job. An example would be developing a training plan to train a worker to complete a pre-shift inspection on a front-end-loader. This could involve show and tell, coaching, the operator manual, a video, a slide show, a check list, or any similar items in combination. The trainer could be a supervisor or a qualified operator. This is a good place to start a training program since it develops the basic process for preparing future training sessions. It is also simple since manufacturer, commercial, and MSHA materials are available and employees can add company standards and concerns.

The second level is developing an individualized training program for a complete job. The total job of a front-end-loader operator is a example. An individualized training plan is needed to teach the operator to do a pre-shift inspection, operate the loader, choose products, load trucks, level the area, build berms, etc. This training is for safe operation of specific equipment in a specific work environment. It will probably involve several presentation methods and may involve multiple trainers. The training will take several days or even weeks because of the time needed to develop skills to production speed. The trainer must know the performance required at each task. The training plan should be specific enough to give direction to the trainer, but general enough to adapt to the trainee's learning style and rate of development. It should also allow for changes in learning sequence caused by emergencies or production. Planing a complete job requires a written plan for organization, monitoring, and documentation. Better plans create better training but it is important to avoid being buried in detail in the early stages. Starting simply and gradually increasing complexity can improve effectiveness and build a commitment to training.

The third level of individualized instruction is the most difficult and takes a long term commitment. This level requires development of a comprehensive program for all jobs. The key to success is a good plan that allows the development of training plans without overwhelming everyone involved. Starting with all the diversity of varying equipment, work environments, production, individual procedures, and trainee needs in your first plan is not manageable. The comprehensive training program is simply the same process as developing a training program for one person, except it is repeated for every job at the operation. To be accomplished, a simple sequential plan is needed.

The heart of individualized training is a plan to meet one person's training needs. The plan for one person starts with determining the knowledge and performance required on the job. The process can be as complex as resources and reason will allow. A good way to start is with a general job description like those in the Department of Labor's Dictionary of Occupational Titles. A study of the job should be completed next. This can be done by looking at prepared materials, manuals, videos, interviewing workers, etc. A number of tools can be used in this process such as task listing, task analysis, and job safety analysis. From this information an outline can be developed. This outline begins the search for the materials and trainers to complete the plan. It is also important to train the trainer on training principles. Then, a complete training plan can be developed. The training plan can be as simple as a check list used in a pre-shift inspection. It can be as detailed as lesson plans that show subjects, times, instructional methods, instructors, etc. It can be a general plan tailored by the trainer or written for a specific task. It can be hand written on a legal pad or bound in book form. The important part is a plan that can be used to prepare the trainee to be safe and productive and meet the legal requirements.

Training must comply with 30 CFR Part 48 and meet the needs of the operation. While the MSHA rules may seem like a mine field of problems to overcome, they can be helpful. There are few professional trainers in the mining industry to help develop programs. The MSHA requirement for a written plan can help give a training plan structure. The items in Part 48 can act as a check list. Sending the plan to the MSHA district for review can be a major help and concern. The MSHA Training Specialist will point out requirements that appear to be barriers to good training. While these comments may be frustrating, the benefit is finding help from another willing professional interested in the health and safety of people. MSHA is essentially a free consultant service. They understand the difficulties of mine training and the rules. They have seen what works and what does not. Finding ways to work with MSHA can be invaluable. It can help provide a program that meets the operation's needs, complies with the law, and provides added protection against legal actions.

SUMMARY

An effective training program is essential to developing safe and productive employees. The diversity of jobs, lack of specialists, and multitude of requirements make training especially difficult in small mines. The most effective approach for this need is individualized training provided on-the-job. Good on-the-job training takes good planning and delivery. A written plan should be developed that does not overwhelm participants in detail. The plan should meet MSHA requirements. This is cost effective and provides for the changing needs of today's mine operators.

TECHNICAL SESSION II:

Issues in Occupational Health

Co-Chairmen:

Joseph Lamonica
Vice President—Health, Safety & Training
Bituminous Coal Operators' Association, Inc.
Washington, D.C.

Kevin Burns
Director of Safety and Health Services
National Stone Association
Washington, D.C.

MSHA REVIEW OF SILICOSIS AND DUST CONTROL IN MINING

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Mine Safety and Health Administration
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INTRODUCTION

Silicosis has become a forgotten disease. Many miners, when told of the risks of silicosis, indicate that they have never heard of the disease. A 1992 National Institute for Occupational Safety and Health (NIOSH) ALERT, however, pointed out that drilling in rock is hazardous to miners due to exposure to excessive amounts of silica-containing dust. Recent Mine Safety and Health Administration (MSHA) and NIOSH surveys also indicate that silicosis continues to be a significant health risk faced by miners.

A joint field study conducted by NIOSH and MSHA in the Johnstown, Pennsylvania area found 8 cases of silicosis among 150 surveyed surface coal miners. Additional x-ray surveillance studies found 6 cases of disease among 234 current and former surface coal miners in the Poteau, Oklahoma area and 3 cases among 66 surface coal miners in the northern West Virginia area. These studies cannot be used to determine quantitative risk, or prevalence of the disease. They do, however, indicate the unacceptable reality that coal miners continue to develop silicosis.

Surface miners are not the only miners potentially exposed to levels of silica-containing dust that may lead to development of silicosis. NIOSH and MSHA have received reports of disease among underground coal miners. Several of these cases involve coal miners under age 50.

The focus of this presentation is to highlight the specific initiatives undertaken by MSHA's Coal Mine Safety and Health to address this health hazard.

MSHA INITIATIVES

MSHA has embarked on a multi-faceted approach toward addressing silicosis in coal mining. Specifically we have implemented the following activities:

- The promulgation of a drill dust rule in April 1994.
- A special emphasis program which assessed compliance with the new drill dust rule at all surface coal mines.

- An awareness program to improve the understanding of silicosis among MSHA inspectors, miners and mine operators at both surface and underground coal mines.

- A program to assist mine operators in determining the best control technology for reducing potential exposure to both silica-containing dust and respirable coal mine dust at surface and underground coal mines.

- The establishment of an Advisory Committee, at the request of Secretary of Labor Robert B. Reich, to eliminate pneumoconiosis among coal miners.

SURFACE ACTIVITIES

The drill dust rules are codified at 30 CFR 72.620 for surface mines and 72.630 for underground mines. These rules were initially proposed in 1989 as part of the air quality rules. In 1994, they were separated from the air quality rules and published as final.

The surface drill dust standard duplicates a rule which has been utilized in the metal and non-metal side of MSHA for many years. This rule states that when drilling in rock, dust must be controlled by the use of water or other effective means. Enforcement actions are taken based on a visual observation of the drill and the work practices associated with it.

After the surface drill dust standard had been in effect for 6 months, a one-week special emphasis program was undertaken by MSHA to ensure that mines were complying with the new requirements. The program required the commitment of approximately 25% of all coal mine inspectors and involved visiting every active surface coal mine to assess the controls being used on all drills.

Data collected during the program indicated that the vast majority of drills were provided with some type of dust control, most commonly a dry dust collector. However, the dust controls on many drills were not maintained in a working condition. A total of 142 citations were issued during the 1- week emphasis program. The vast majority were for failure to maintain dust controls.

In addition to the new rule the agency has implemented an awareness program. This involved the training of MSHA inspectors on the hazards of silica exposure, the preparation of silica health hazard information and the production of a videotape. The program required MSHA personnel, while visiting surface mines, to (1) provide a Health Hazard Card to each miner and mine operator on the hazards of exposure to silica-containing dust; (2) offer the operator a videotape discussing the hazards of silica exposure; and (3) provide mine operators with information on likely maintenance or compliance problems involving the different drill dust control systems.

We believe that the surface silicosis prevention program is having positive effects. As seen in Figure 1, the percent of highwall drill operator samples, with a quartz concentration greater than 100 µg, has decreased significantly. The change coincides with the implementation of the drill dust rule and the awareness program. You will also notice that there is an improvement involving exposure levels of bulldozer operators. While there are no new regulatory requirements for dust controls on dozers, some mine operators are placing an increased emphasis on installing and maintaining cabs on such equipment. This produces an environment lower in quartz. These operators should be commended for their efforts.

QUARTZ LEVELS of SURFACE COAL OCCUPATIONS

Greater Than 100 ug/m3

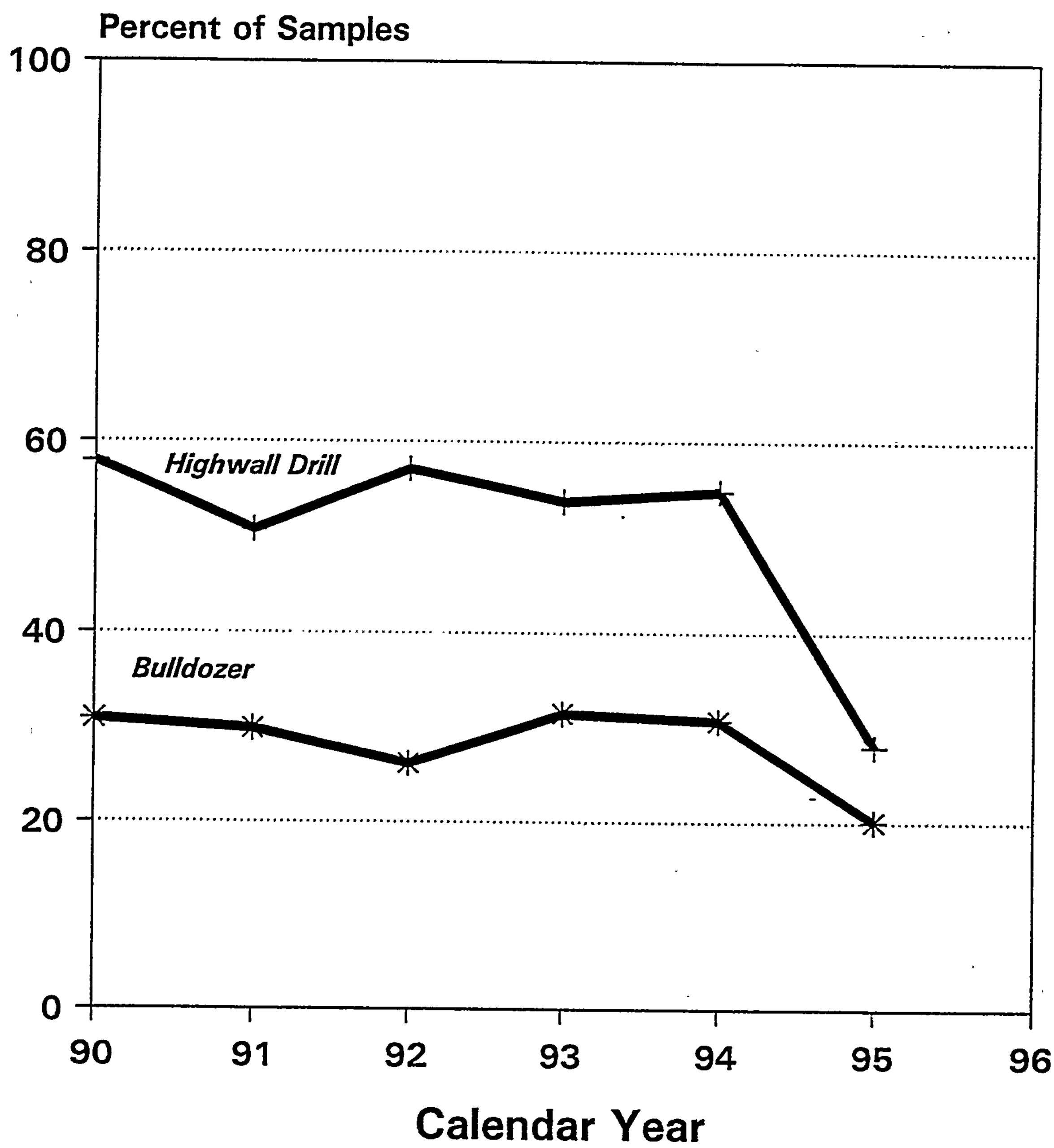

Figure 1

UNDERGROUND ACTIVITIES

Based on the positive reaction to the silica program at surface coal mines, the program was extended to underground coal mines. A Health Hazard Card was prepared and distributed to underground coal miners during normal inspection activity. With the increased attention given to silica and silicosis, the Agency became aware of additional new cases of silicosis among underground coal miners.

The underground program involved specialized training of MSHA personnel in the characteristics and controls for silica. Once trained, these inspectors contacted mine operators with known high concentrations of silica dust in the active workings of their mines. They were asked to participate in a program to improve the control of silica in the mine environment. Mine operators who agreed to participate were provided with surveys of the mine environment for silica, information from the Bureau of Mines on controls for silica dust, suggestions for reducing the silica content based on the survey results, and follow-up surveys to assess the success of the modified controls.

To date, approximately 35 underground coal mines are involved with this effort to identify the best controls and procedures for controlling silica. The use of scrubber systems is one control that promised results not only for reduction of silica but also for general respirable coal mine dust. However, during this pilot program, we learned that many scrubbers in use at mines with high quartz concentrations are no longer equipped with the 30 layer or 40 layer stainless steel scrubber screens which are effective in reducing silica dust. Rather, we now find many scrubbers being equipped with 10 to 20 layer screens. While these thinner screens allow greater scrubber air quantities, they may do little to remove the dust or silica from the atmosphere (Table I) and create a greater risk of overexposure to silica.

The use of flat sprays located in the pan of a continuous miner also have been found to be very effective in reducing general respirable dust as well as quartz concentrations. Proper use of scrubbers, flat sprays and the planning of the mining sequence can have a significant effect on silica exposures.

OTHER ACTIVITIES

MSHA, OSHA, and NIOSH currently are working on an outreach campaign to increase awareness of silicosis. A national conference on silica controls, silicosis prevention and best practices to protect miners is being planned for early 1997. In addition MSHA is preparing a video which will demonstrate the effects of silica, discuss the medical problems associated with the disease, and demonstrate some of the controls shown to be effective in controlling silica-containing dust.

Finally, the Secretary of Labor's Advisory Committee to Eliminate Pneumoconiosis Among Coal Mine Workers has recently completed its deliberations and is drafting its report. Some of the more significant silica-related issues they addressed included:

- Establishing a separate silica standard.
- Considering an adjustment of the standard based on the mixed exposure of coal mine dust and silica.
- Take action to lower silica exposures below the current exposure limit.

The final report for this committee is due in late September, 1996.

Table I
Average dust collection efficiencies (%)

Screen	Feed (-10μ)	Coal (0.7-4.7μ)	Quartz (0.7-4.7μ)
Joy 40-layer	96.2	94.6	90.2
Joy 30-layer pleated	95.8	94.3	91.6
Bondina	97.8	96.9	94.9
Joy 80-layer	99.0	98.3	98.3

In closing, it should be emphasized that there is no cure for silicosis. Accordingly, we must do all that we can to prevent the development of this disease. Prevention only results if we control the silica dust to prevent miners from being exposed.

CONTINUOUS RESPIRABLE MINE DUST MONITOR DEVELOPMENT

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Rupprecht and Patashnick, Co., Inc.

ABSTRACT

In June 1992, the Mine Safety and Health Administration (MSHA) published the Report of the Coal Mine Respirable Dust Task Group, Review of the Program to Control Respirable Coal Mine Dust in the United States. As one of its recommendations, the report called for the accelerated development of two mine dust monitors: (1) a fixed-site monitor capable of providing continuous information on dust levels to the miner, mine operator, and to MSHA, if necessary, and (2) a personal sampling device capable of providing both a short-term personal exposure measurement as well as a full-shift measurement.

In response to this recommendation, the U.S. Bureau of Mines[1] initiated the development of a fixed-site machine-mounted continuous respirable dust monitor. The technology chosen for monitor development is the Rupprecht and Patashnick Co., Inc. tapered element oscillating microbalance. Laboratory and in-mine tests have indicated that, with modification, this sensor can meet the humidity and vibration requirements for underground coal mine use. The U.S. Department of Energy Pittsburgh Research Center (DOE-PRC) is continuing that effort by developing prototypes of a continuous dust monitor based on this technology. These prototypes are being evaluated in underground coal mines as they become available. This effort, conducted as a joint venture with MSHA, is nearing completion with every promise of success.

[1]This project originated under the U.S. Bureau of Mines Pittsburgh Research Center. The U.S. Congress directed (Public Law 104-99, 110 Staf. 26, January 26, 1996) that the health and safety functions of the Pittsburgh Research Center be transferred to the U.S. Department of Energy.

The immediate benefit of this effort will be to researchers, regulatory personnel, and mine personnel, by permitting evaluation of specific mining practices to see which expose mine workers to excessive dust levels. Using this information, mine personnel can optimize mining procedures to reduce dust exposure. MSHA will also be able to use the dust concentration data to judge whether dust plan parameters are adequate to continuously maintaining environmental dust levels below the applicable standard.

The second development recommended by the Dust Task Group was for a person-wearable version of the continuous dust monitor. It will be a system designed to provide a measurement of worker exposure to respirable dust, both during and at the end of the shift.

INTRODUCTION

The current gravimetric approach to measurement of shift average respirable dust concentrations in underground coal mines (*1*), with its inherent delays, cannot provide dust level data quick enough to allow on-site correction of inadequate dust control practices. Furthermore, in April 1991, the Secretary of Labor alleged widespread tampering at several hundred coal mines with respirable dust samples taken by mine operators for compliance assessment. These allegations and a directive from the Secretary prompted MSHA to appoint a special Respirable Dust Task Group to study options to improve monitoring and control of respirable coal mine dust.

In June 1992, MSHA published the report of the dust task group (*2*). This report called for the accelerated development of two mine dust monitors: (1) a fixed-site monitor capable of providing information on dust levels to the miner, mine operator, and to MSHA, if necessary, and (2) a personal sampling device capable of providing both a short-term personal exposure measurement as well as a full-shift measurement.

In response to MSHA's request, the former U.S. Bureau of Mines (USBM) investigated several sensor technologies for continuously monitoring respirable coal mine dust. Most instruments currently on the market for measuring aerosol concentration sense some property of the particles other than their mass. Converting the sensor reading to equivalent mass requires tacit assumptions about the relationship between aerosol mass and the property sensed. These assumptions can lead to significant error. A direct aerosol mass sensing instrument eliminates the potential for error that is associated with converting sensor measurements to equivalent mass concentrations.

One such technology is Rupprecht and Patashnick Co., Inc. (R&P) proprietary tapered element oscillating microbalance (TEOM®) sensor.[2] In USBM laboratory tests of sensor response to vibrations and humidity (*3*), the TEOM® dust monitor exhibited excellent accuracy and stability. Conse-quently, the TEOM® dust sensor has been chosen for use in the high humidity and vibration environment of underground coal mines. Prototypes of a fixed-site machine mountable continuous respirable dust monitor (MMCRDM) based on this sensor are currently being developed, and evaluated in underground coal mines as they become available. The first such evaluation was completed in 1995; the second is scheduled for mid 1996. A commercial version of the monitor is due in early 1997. An effort to use the technology developed for this monitor, in the design of a person-wearable version, is being planned. It will provide short-term personal exposure measurement

[2]Use of manufacturer's name is for identification only.

as well as end-of-shift dust exposure measurement.

MMCRDM REQUIREMENTS

This fixed-site monitor will be mountable on mobile mining machines, most likely continuous miners or longwall shearers, and will continuously sample dust in the vicinity of the machine operator. While MSHA has not finalized how data from such a monitor would be used, it would provide more complete and immediately available information regarding how well dust control practices are working.

With the concurrence of MSHA, the USBM formulated target specifications (Table I) for the MMCRDM (*4*). At the request of MSHA, the sample preclassifier was designed to pass aerosol to the tapered element filter according to the international standards organization (ISO) definition of respirable dust (*5*). In addition to measuring respirable dust concentration in the mine environment, the monitor is to be tamper-resistant and store dust exposure information for 30 days. In operation, the unit will be programmed to display dust concentrations in real time and indicate whether the shift average permissible exposure limit will be exceeded during the work shift.

TAPERED ELEMENT OSCILLATING MICROBALANCE

The TEOM® sensor uses the inertial behavior of a vibrating element to measure the mass of sampled dust (*6*). The active

Table I–Target performance and environmental specifications for a fixed-site MMCRDM

Performance Specification	Standard
Measurement units	Mass concentration of respirable dust, mg/m^3
Measurement range	0.5 to 2.0 mg/m^3 ± 25%
Accuracy	± 25% of reading with 95% confidence
Overload tolerance	100 mg/m^3 for 10 sec 25 mg/m^3 for 30 sec 10 mg/m^3 for 120 sec
Measurement period	30 min cumulative shift average (shift length: 8, 10, or 12 hrs)
Maintenance cycle	30 days unattended, data storage for a minimum of 90 shifts
Safety certification	Must be certifiable by MSHA for use in permissible areas of coal mines
Temperature range (anticipates both underground and some surface operation)	-40 to 40 °C, typically 0 to 30 °C
Thermal shock range	40 to 0 °C
Temperature excursion rate	10 °C/min
Operational altitude/pressure equivalent range	Sea level ± 10,000 ft
Humidity	0 to 100% (typical operation range 30 to 95%)
Mechanical shock (shipping)	1 m drop equivalent,
Mechanical shock (operating)	11 ms period sawtooth impulse shock of 20 g
Vibration (continuous miner)	Sine vibration, 5 to 2,000 Hz, 1.5 g
Vibration (haulage vehicle)	Sine vibration, 5 to 92 Hz, 2.5 g and 92 to 500 Hz, 3.5 g
Power fluctuation	± 25%

element of the system, depicted in figure 1, is a specially tapered hollow tube constructed of metal or an elastic, glass-like material. The wide end of the tube is firmly mounted on an appropriate base plate. The narrow end supports a replaceable collection medium such as a filter and is permitted to oscillate. Particle-laden air is drawn through the collection medium, where particles are deposited. The filtered air is then drawn through the hollow tube. Airflow is controlled by an automatic mass flow controller. As the collection medium collects dust, the mass increases, causing a decrease in the frequency of oscillation. By measuring the change in frequency, one can determine the gain in the mass of dust on the collection medium.

An electronic feedback system initiates and maintains the oscillation of the tapered element. The details of the feedback system have evolved over the years, but typically, a light emitting diode (LED)/photo-transistor pair, aligned perpendicular to the plane of oscillation of the tapered element, detects the frequency of oscillation. The light-blocking effect of the oscillating element positioned between the photo/transistor and the LED modulates the output signal of the photo-transistor, which is then amplified. Part of the amplified signal is used by the feedback system to provide sufficient force to overcome any amplitude damping of the tapered element oscillation. The other part of the amplified signal from the LED/photo-transistor pair is sent to a counter and data processing stage. Here, the frequency of oscillation of the tapered element is calculated and stored in memory.

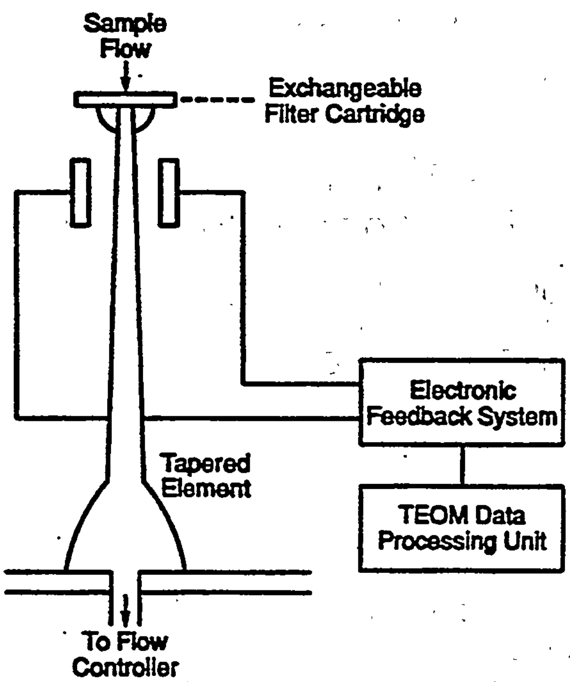

Figure 1. Schematic of the tapered element oscillating microbalance (TEOM) dust sensor.

Benefits/Challenges

Unlike many other aerosol measurement technologies that measure an aerosol parameter correlated with mass, the TEOM® technique measures mass directly. With the appropriate preclassifier, the instrument collects and measures respirable mass. Sampling at 2 L/min for 30 min, the typical measurement accuracy is $\pm$ 15 $\mu g/m^3$. The measurement remains accurate as long as the mass on the filter remains below about 5 to 10 mg.

The TEOM® aerosol monitors would measure any water droplets reaching the collection filter as aerosol mass. Changes in mine air humidity and temperature could also affect the response of the instrument. However, the monitor uses a 50 °C temperature-controlled inlet conditioning system to eliminate or reduce humidity and temperature variations of the sensor. Under these sampling conditions, collected water aerosols evaporate, leaving only solid particulate on the filter.

Since TEOM® instruments operate by measuring the change in frequency of a vibrating element, vibrations from external sources can interfere with the measurement. In the machine-mounted unit, however, vibrations from the machine are damped using vibration isolation mounting of the monitor sensor.

CONTINUOUS RESPIRABLE DUST MONITOR DEVELOPMENT

Under a USBM contract, R&P Co., Inc. embarked on a program to design, build and test ten production MMCRDM's based on the TEOM® aerosol mass sensor.

Three phases are required to complete this work:

Phase 1

Phase 1 has two parts:

(a) Design a research proof-of-concept prototype MMCRDM to be tested using tethered electronics. The prototype must be certifiable by MSHA for an Experimental Permit for use in permissible areas of coal mines. Two of these prototype MMCRDM's were evaluated by PRC and MSHA in laboratory and field tests, primarily for response to machine vibration. Field evaluation was conducted in a continuous miner section of an operating coal mine.

(b) Begin design of two pre-production prototypes. The pre-production prototypes will include prototypes of all the components that will be included in the production models.

Phase 2

Complete the design and construction of the two pre-production prototype MMCRDM's. The design was to incorporate tamper-resistance. The prototypes are machine mountable and certified for experimental permits by MSHA. These prototypes will be evaluated during laboratory and field tests. During the field test, one unit will be mounted on a continuous miner and the other unit will be used in a longwall mining section.

Phase 3

Delivery of ten production model MMCRDM's built to commercial production specification.

PHASE 1 FIELD EVALUATION

Phase 1 laboratory and in-mine evaluation of the prototype of the machine-mounted monitor was conducted as a joint venture with MSHA. Laboratory tests of the monitor sensor were conducted by the USBM in mid 1995. The protocol followed has been detailed elsewhere (7). Field evaluations were conducted in a continuous miner section at Consolidation Coal Co.'s Humphrey No. 7 Mine at Maidsville, WV, from August 10 to 24, 1995.

The monitor configuration tested in the Phase 1 field evaluation is illustrated in figure 2. As designed, this configuration measured 0.3 x 0.55 x 0.2 meters. During the tests, however, the computer control, data logging, sample flow control, and sample pump were removed from the case and placed at a remote location. Only the sample inlet, sample preclassifier, and TEOM® aerosol mass transducer/sensor were attached to the canopy of the continuous miner. This arrangement placed the sensor assembly within 1 m inby of the machine operator while leaving his view of the face unobstructed. As indicated in figure 3, a 215-m umbilical cable containing instrument power, signal, and vacuum lines, connected the sensor through a group of electrical barriers to the electronics located at a data and control center near the section's power center. In this way, the intrinsically safe sensor assembly could be operated at the face, while the

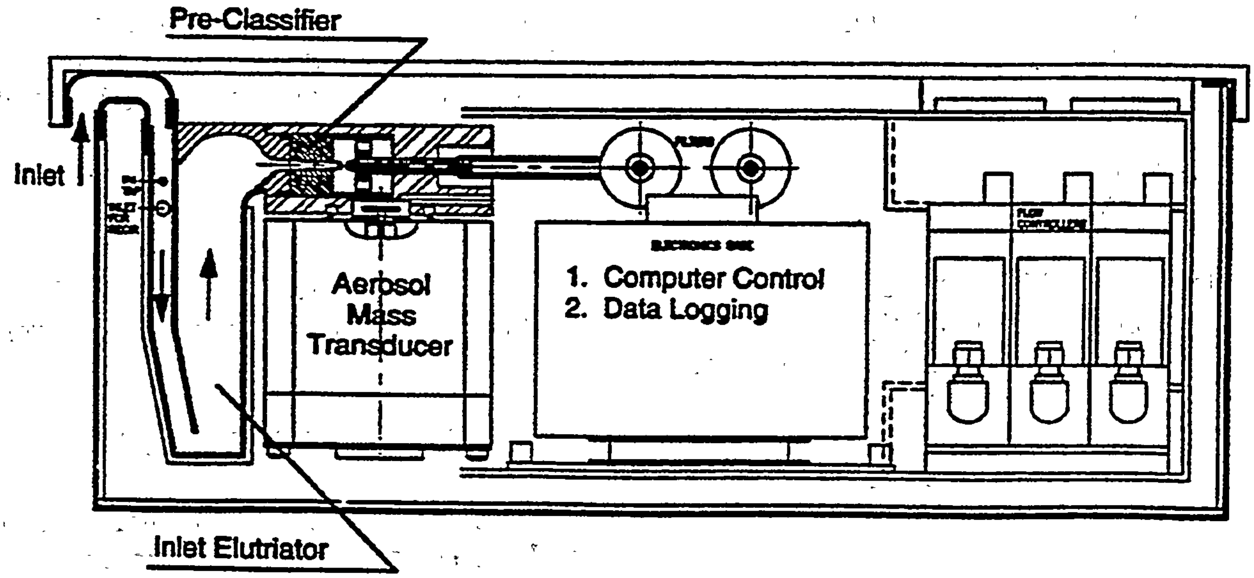

Figure 2. Cross-section view of machine mounted, continuous respirable dust monitor.

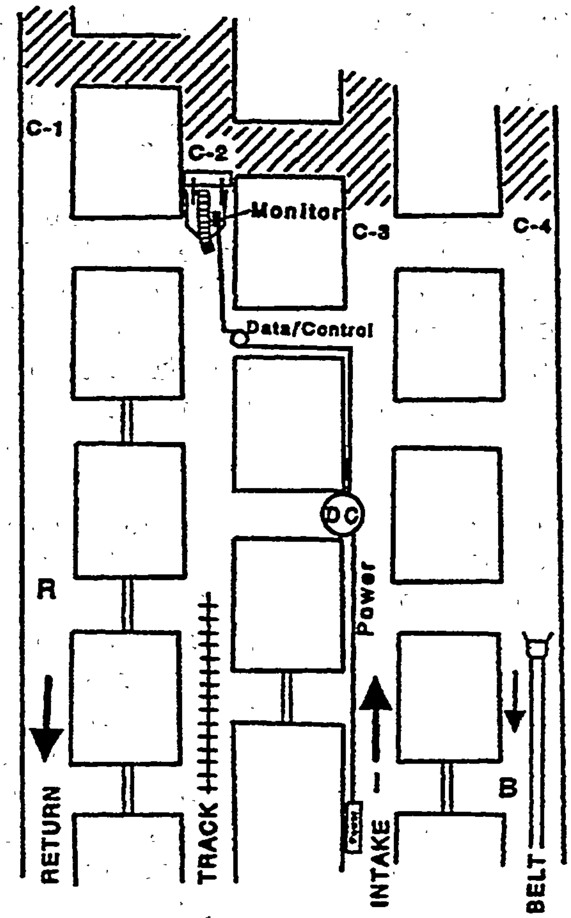

Figure 3. Location of MMCRDM sensor (Monitor) and auxiliary electronics (DC) during phase one evaluation.

nonintrinsically safe equipment was operated in fresh or intake air.

During the field tests, measurements were also taken of machine vibration and respirable dust levels at the position of the monitor. The accelerometers used to measure machine vibration were also connected through a 300-m umbilical cable and electrical barriers to signal amplifiers and a power supply at the data and control center. Data logging for both dust monitor concentration and vibration measurements was done using personal computer-based data loggers. Gravimetric respirable dust measurements were collected for comparison with the continuous monitor measurements using Mine Safety Appliances (MSA) personal respirable dust samplers operated at a flow rate of 1.7 Lpm. This flowrate was used to better approximate the ISO respirable dust criteria used by the continuous monitor.

Table II displays the measurements made during the field evaluation of the continuous monitor. Measurements were done for seven days over a two-week period. Comparison of continuous dust monitor and personal dust monitor measurements of dust concentrations were done on three of the four sample days. The data from the fourth day were not used due to monitor data control damage during the measurement period. A pre-filter (PF) was placed on the monitor on the other three days to explore the effect machine vibration had on the instrument's baseline. Vibration measurements were taken on all sampling days.

RESULTS

During the Phase 1 test, the continuous monitor measured respirable mass concentration in mg/m^3 every 1.7 sec. A 30-sec moving average was applied to these data. As shown in figure 4, this average was displayed graphically in real time by the computer data acquisition system. The figure shows typical results during two coal cutting cycles and one bottom cleaning pass by the continuous miner. Mass concentrations drop to background levels between periods of activity, suggesting that the measurement process is not severely affected by machine vibration. Also, total collected mass values and trends indicated no dependence on water or humidity.

Table II–Primary measurements conducted during the field evaluation of the MMCRDM

Date (August 1995)	Continuous monitor	Measurement Vibration	Personal sampler
15	[1]PF	Yes	No
16	Yes	Yes	Yes
17	Yes	Yes	Yes
18	Yes	Yes	Yes
21	[2]No	Yes	Yes
23	PF	Yes	No
24	PF	Yes	No

[1]Continuous monitor operated with pre-filter.
[2]Continuous monitor data/control cable damaged; data not valid.

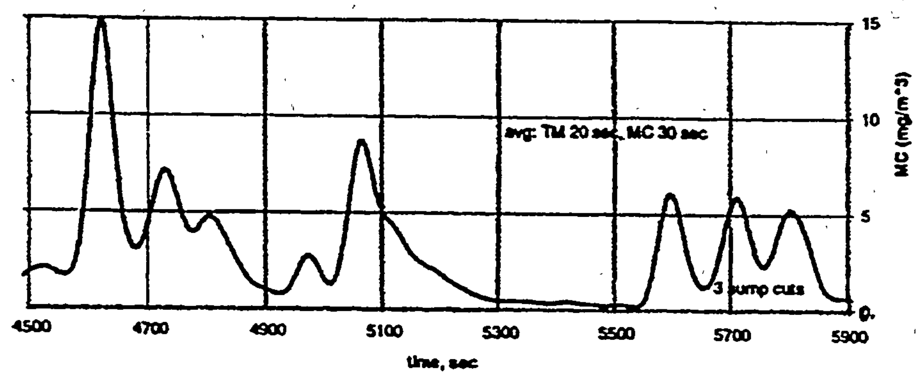

Figure 4. Dust concentrations measured by the MMCRDM on 21 August 1995.

On the last two days of the study, a pre-filter was inserted into the sample path of the continuous monitor. The monitor was otherwise operated normally. At the end of this period, which included one overnight shutdown of the monitor and a cold start half-way through the period, baseline drift for the unit was less than 1 μg of collected mass. This indicates that the sensor is not sensitive to environmental factors such as vibration and humidity.

Typical results for vibration measurements, in units of the gravitational constant (G, rms), made during the last part of the period illustrated by figure 4, is shown in figure 5. These data, collected during three sump cuts, show in detail the machine operation during the cuts. In general, accelerations were an order of magnitude less than those cited in the target specifications of Table I.

Table III includes collateral respirable dust measurements made during the sensor evaluation. The comparison points to a positive bias in the TEOM® results, an average of 20 $\pm$ 13%. This bias can be partially explained by the difference in the preclassifiers used in the TEOM® sensor and the personal respirable dust sampler. Using the measured penetration efficiency of the monitor's preclassifier and the published penetration efficiency of the Dorr-Oliver cyclone used with the personal sampler in combination with an assumed particle size distribution for the collected mine aerosol, a net bias of 12% is predicted. Although not determined, the remaining bias has been attributed to the position of the inlet on the side of the sensor box. With this inlet position, the monitor samples from a volume where air may recirculate, concentrating aerosol mass in the TEOM® sample and producing the noted bias.

PROJECT STATUS

Phase 2 of the project to produce and test a redesigned, self-contained monitor is now underway. Using the results of the Phase 1 evaluation, the MMCRDM has been redesigned. The insensitivity of the unit to vibration and the lower than expected vibration levels permitted a modification in the vibration isolation member that has reduced the size of the sensor assembly. Because of the success using the umbilical configuration, the MMCRDM will be installed in two parts: (1) an intrinsically safe unit containing the sensor and a filter changer, and (2) an explosion-proof enclosure (XPE) containing the computer, pump, power supplies, and electrical barrier circuits. This arrangement will permit a smaller profile sampling unit in front of the

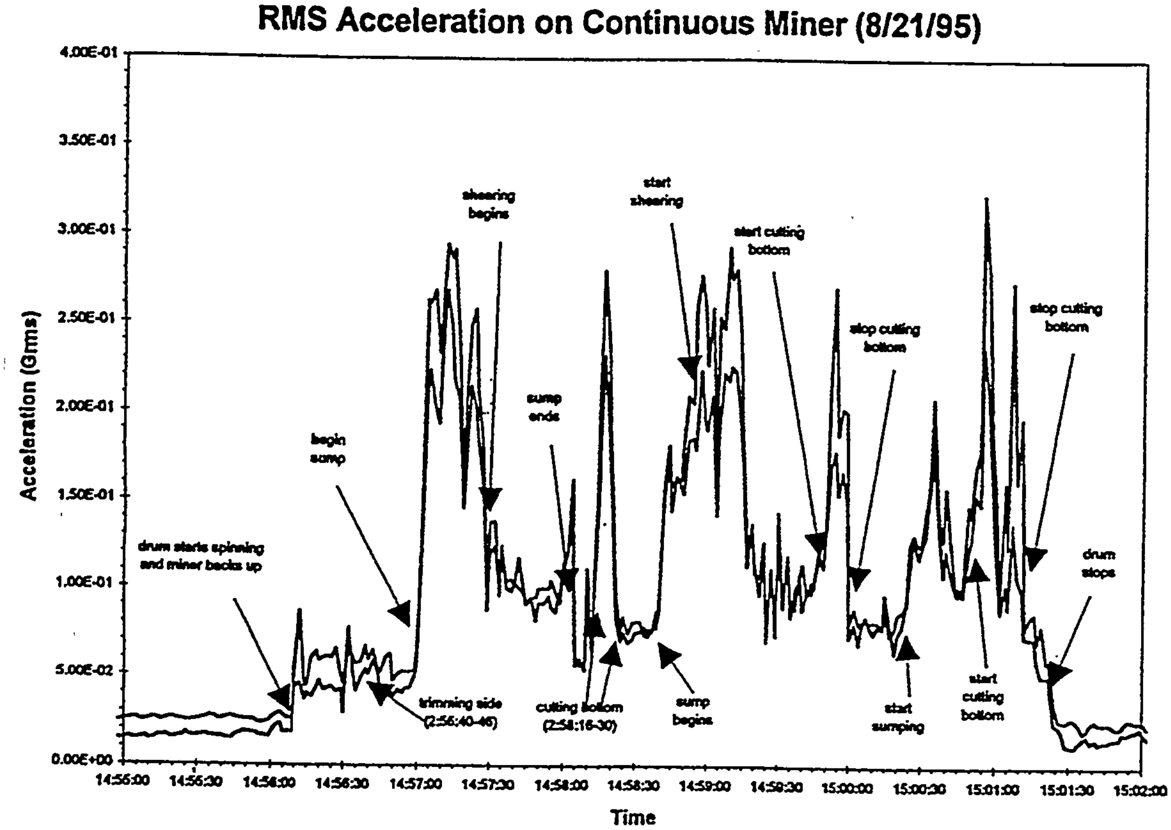

Figure 5. Vibration measured at the MMCRDM on 21 August 1995.

Table III–Comparison between integrated continuous dust monitor mass concentrations and those obtained using the MSA personal respirable dust samplers

Date (August 1995)	TEOM® mass concentration, mg/m³	Personal sampler mass concentration, mg/m³	Difference, %
16	1.26	1.19	6
17	3.09	2.10	32
18	0.40	0.29	23
21	([1])	0.46	NA

[1]TEOM® data not used because of cable break during test day.
NA Not applicable.

machine operator. Also, the use of an XPE preserves the ability to install the monitor components in the existing miner XPE.

The inlet bias problem has been solved by moving the inlet from the side to the top of the sensor assembly, thus putting it in the free sample airstream. Referee sampling will be done using a newly designed personal respirable dust sampler that incorporates the same inlet configuration and preclassifier as that used on the MMCRDM. This will eliminate the need to correct one of the measurements to obtain a valid comparison of respirable dust mass concentration.

The completed monitor, as shown in figure 6, is scheduled for laboratory and in-mine evaluation on both a continuous miner and a longwall section in mid 1996. Laboratory evaluation of the monitor will follow the protocol followed in Phase 1 of the project. During the in-mine evaluation, the monitor will be mounted on the mining machine or, as an option in the case of the longwall tests, on a shield. The monitor will derive electrical power from the miner. It will provide the machine operator with graphical and numeric information on dust concentrations as illustrated in figure 7. A series of collateral measurements, like those performed in the Phase 1 evaluation, will be made during the evaluation. These will include measurements of machine vibration, referee shift average respirable dust concentration collected with personal samplers, face ventilation, water usage, and for a portion of the personal samples, determination of silica fraction of the collected mass.

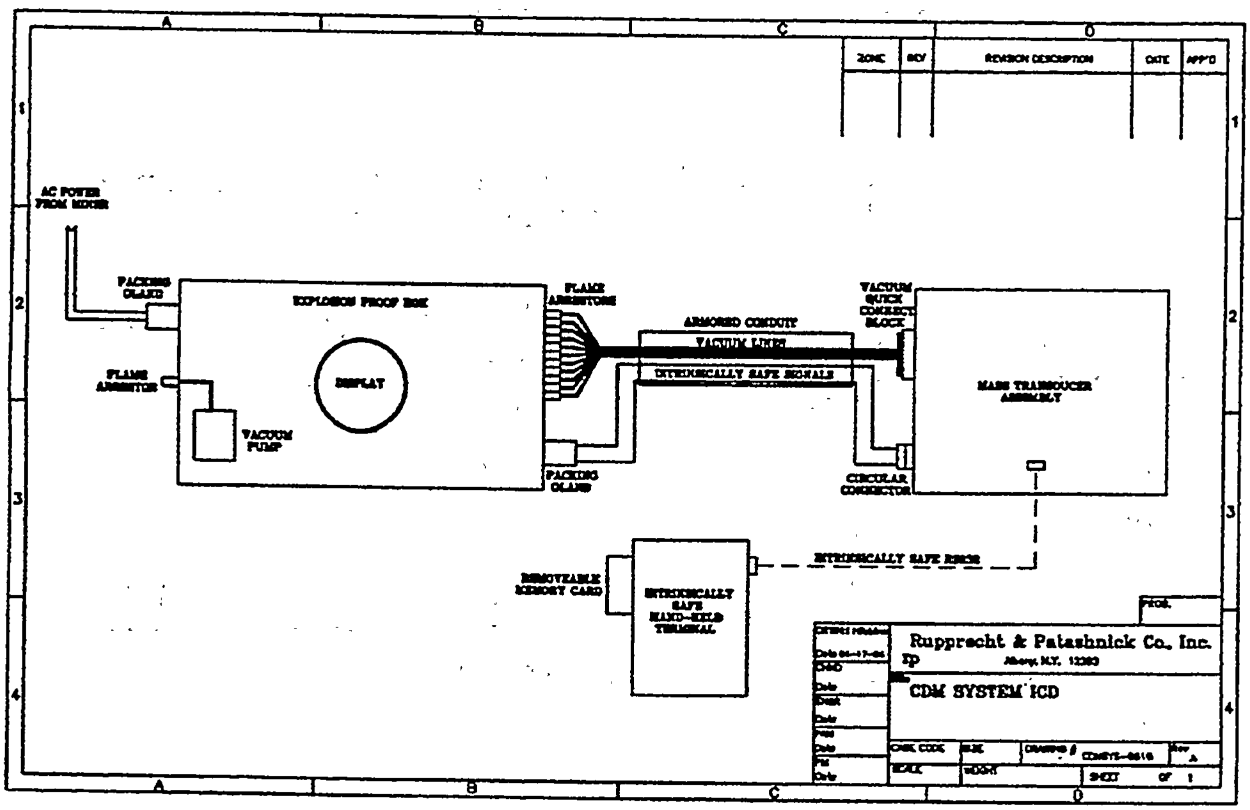

Figure 6. Design of MMCRDM for phase two in-mine evaluation.

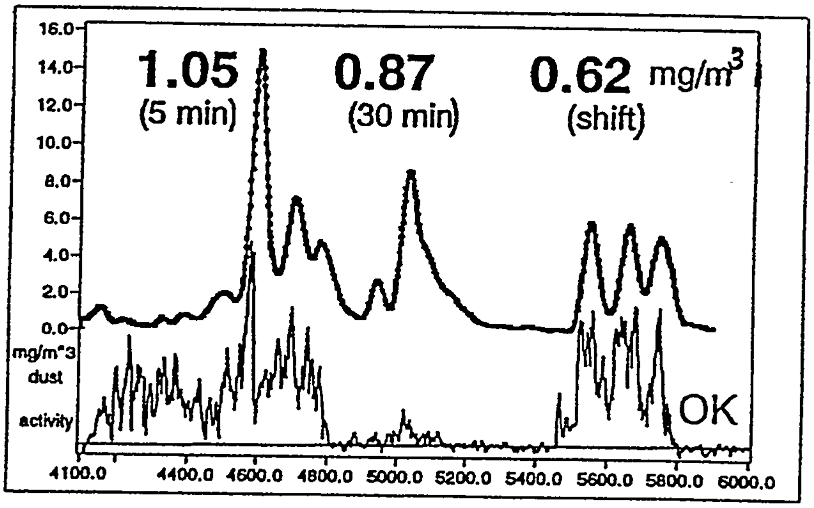

Figure 7. Real-time MMCRDM data display.

The data developed during this phase of the project will be used to finalize the design of the machine-mounted monitor. Following delivery of ten production units in Phase 3, MSHA will use them in in-mine evaluations to develop use strategies for the monitor and will explore its use in MSHA's respirable coal mine dust control program.

SUMMARY

In response to MSHA's Respirable Dust Task Group report, the USBM initiated an aggressive research effort to develop mineworthy devices to continuously monitor respirable coal mine dust mass concentration. The dust sensor technology chosen for development is the TEOM® manufactured by R&P Co., Inc. This technology is desirable in that it measures collected aerosol mass directly. Results from laboratory and initial in-mine evaluations of a TEOM® sensor modified to reduce response to environmental vibrations indicate that the sensor will operate well within the environmental and performance specifications of Table I.

Two pre-production prototype MMCRDM's will be fabricated in mid 1996. After certification by MSHA, this MMCRDM system will be evaluated in both continuous miner and longwall sections of an underground coal mine. MSHA will be involved in these tests as part of a joint venture with DOE-PRC. As a final phase in this development, ten production prototype continuous respirable dust monitors based on the TEOM® sensor will be fabricated for in-mine evaluation. The production versions of the instruments will be used underground to develop use strategies for the monitor.

If successful, this DOE-PRC research will foster development of a family of commercial continuous respirable dust monitors that can be mounted on mining machines, used as portable dust monitors, incorporated in mine atmospheric monitoring systems, and perhaps even be used as personal exposure monitors for mine workers. Such instruments could make accurate, continuous records of dust concentrations in the workplace, a significant development for occupational health and the mining industry.

Using this record, researchers, regulatory personnel, or mine personnel could evaluate specific mining practices to see which ones expose mine workers to the least dust. This information would permit mine personnel to optimize mining procedures to reduce dust exposure. It will also provide mine personnel with an immediate record of daily dust concentration levels, enabling dust exposures to be maintained below federally mandated levels.

FUTURE WORK

MSHA has endorsed the development of a personal version of the continuous dust monitor. This project will be a contract research effort with in-house evaluation of the research product by DOE-PRC. The personal monitoring system would be designed to operate in two modes. The first would be in the form of a personal dust dosimeter that can be interrogated underground or at the end of a shift using a portable reading system. The second configuration will provide continuous monitoring of respirable dust concentrations and would be used as a portable monitor. The system will provide immediate dust exposure information for the user and permit the mine operator to evaluate his dust control system and take effective measures to correct problems as they arise. These efforts would be part of the expanded FY96 MSHA/DOE joint effort and would continue through FY97 into FY98.

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TECHNICAL SESSION III:

Re-engineering Health & Safety Management

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REINVENTING MSHA

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INTRODUCTION

Much has been accomplished in the area of mine safety and health since the enactment of the Federal Coal Mine Health and Safety Act of 1969 and its sister legislation, the Federal Mine Safety and Health Act of 1977. Since the enactment of these two pieces of landmark legislation, the mining community has experienced a continual downward trend in fatalities and serious lost time injuries. Mining technology has developed equipment which permits the safer extraction of coal and other minerals. Mine personnel have developed and implemented innovative mining methodologies which have resulted in safer and more efficient mining cycles. Today, the industry mines approximately one billion tons of coal and has achieved a health and safety record which is the envy of the industrialized nations. In looking back over the years, one can readily determine that the mining community has much to be proud about. However, not withstanding these success stories, this mining community, including labor, management, academia and the regulatory agencies, must guard against becoming complacent and satisfied with these accomplishments. Such complacency will tend to stifle creative thinking and hinder the development of new approaches to mine health and safety. In keeping with this effort to safeguard against complacency, MSHA has done a number of things. For example, it has recently evaluated its current organizational structure in its ten districts. MSHA is also looking at the way it has historically conducted inspections of underground coal mines . During the course of this self evaluation, we asked ourselves two questions. First, does the current organizational structure provide for the most effective and efficient use of Agency resources as they relate to program uniformity, levels of supervisory responsibility, effective communication links and cost effective use of space and personnel resources? Secondly, is there anything that we could do that would complement the inspection effort and at the same time help make the miners' work practices and environment healthier and safer? Today, I would like to discuss with you how MSHA has proposed to address these two questions. The first part of my paper will focus on our district reorganizing efforts. I will conclude my presentation with a discussion on the Compliance Analysis Program or, as it is commonly referred to by those of you who are familiar with it, the CAP program.

DISTRICT REORGANIZATION

Any organizational structure, be it a large corporation, a small sole proprietor, or, as in MSHA's case, a federal agency, must respond to the external and internal influences which help to determine the way it conducts its business. In MSHA's case, we must respond to the mining community's need for a healthy and safe work environment. In order to meet this responsibility, MSHA must utilize its resources in a way that will optimize the most effective and efficient use of these resources. To achieve this optimal use of Agency resources, we determined that we had to (1) improve our services to the mining community by increasing program consistency within and among the districts; (2) improve the lines of communication between mine operators, labor and the district management, and also between our mine inspectors and the district management; (3) reduce the levels of managerial review; and (4) consolidate the use of Agency resources in terms of personnel, space and equipment. In order to realize these goals we decided that the best course of action would be to eliminate the subdistrict managerial span of review and supervision. This reorganization was initiated in April 1995. At that time, MSHA had 17 subdistrict offices located throughout the coal fields. At the present time, we have eliminated 10 subdistrict offices in four districts, those being the Monroeville and Johnston Offices in District 2, New Stanton, PA; the Pineville, Madison and Mount Hope offices in District 4, Mount Hope, WV; the Paintsville and Pikeville offices in District 6, Pikeville, KY; and the Barbourville, Birmingham and Hazard offices in District 7, Barbourville, KY. I should note here that we created a new District office in Birmingham, Alabama, so that we could focus more direct management attention on the technical problems that are unique to those particular coal fields. The elimination of the remaining seven subdistrict offices will take place over the next two years.

We feel that we are beginning to experience the anticipated benefits from this reorganizing initiative. Communication of Agency policies and initiatives between Coal management and mining industry officials and labor representatives has improved. Our response to and resolution of issues are becoming more timely. Our internal communication between inspectors and district management personnel has improved. We have developed a more consistent and uniform implementation of Agency policies and inspection activities within and among districts. The dissemination of inspection policies and managerial guidance has been more efficient due to less opportunity for intervening levels of interpretation. We have become more cost effective in our use of office space and placement of personnel.

We feel that this reorganization effort is in keeping with President Clinton's and Secretary Reich's commitment to downsize and streamline the Federal government. We will continue to evaluate the Agency's organizational structure and when and where change is warranted, which will enhance our ability to meet the needs of the mining community, we will make that change.

COMPLIANCE ANALYSIS PROGRAM

Before I begin my discussion about the Compliance Analysis Program or, as I will refer to it herein, the CAP program, let me assure everyone here that this is not an enforcement program, *per se*. It is an effort to balance the Agency's mine inspection activities by having specially trained MSHA personnel focus on the root causes that influence unsafe work practices or cause hazardous conditions. It will be conducted by experienced mine inspectors who will not have the authority to conduct inspections in accordance with the provisions of the Federal Mine Safety and Health of 1977. They will not be issuing citations and orders. However, they will still have right of entry into the mine, and if they should identify a hazardous condition in the mine, they will notify the mine operator of his or her responsibility to correct the condition in a timely fashion.

The objective of the CAP program is to reduce fatalities, serious injuries and occupational illnesses by enhancing mine operators' and miners' knowledge of major health and safety issues and helping them to develop appropriate solutions. How was this to be accomplished? First, health and safety issues had to be identified. Due to the recent upward trend in surface fatalities and the incidence of overexposure to silica, MSHA decided to focus program resources on these two safety and health issues. District 2, located in our western Pennsylvania bituminous coal fields, was selected as the location for the first pilot CAP program. This selection was influenced by the fact that eight out of 150 miners from the Johnston, Pennsylvania, area who were x-rayed by NIOSH exhibited varying stages of silicosis. Prior to implementation, District personnel conducted four informational meetings to discuss the objectives of the program and to allow for input from miners and operators. Fourteen inspection personnel were selected to participate in the program. Seven persons would conduct inspections while the other seven would be used to contact individual miners and discuss the potential health and safety hazards that could occur during surface mining activities. These latter seven persons would relinquish their Authorized Representative (AR) cards and, as I stated earlier, would have no authority to issue citations and orders. One of the primary objectives was to contact as many surface miners in a three-month period as possible. All of the participants underwent extensive training in silicosis, berm safety, highwall drill inspection, dust sampling and pre-operational inspection procedures for haulage trucks. They were also informed of the results of the recent NIOSH x-ray screening. They were to spend one day at each mine site.

The program was initiated in July 1995, and continued through the following September. Based on the feedback from MSHA personnel and comments from miners and operators, the program was considered very successful. Because of these results, it was decided to extend the surface CAP program for another three months and to expand the program to include underground mines. As with the surface program, the district held informational meetings with operators and miners to discuss the objectives of the program and to allow for their input. Six additional inspectors were selected for the underground program and they underwent training in respirable dust, explosion hazards, firefighting and evacuation plans, use of SCSRs, and mine ventilation. Like their surface counterparts, they relinquished their AR cards along with the authority to issue citations and orders. Because the underground program was initiated in October/November, it coincided with MSHA's Winter Alert program. Much of the training received by the CAP personnel supplemented the objective of the Winter Alert program which focuses primarily on potential explosion hazards in underground mines.

To optimize the use of resources and to contact as many underground miners as possible, program guidelines instructed the CAP personnel to spend no more than two consecutive days at each large mine (mines having more than two sections) and one day at smaller mines. As an addition to the program, forms were now completed after each surface and underground mine visit. This information was not used for enforcement purposes but to determine where resources needed to be focused during future visits. This information was also shared with the mine operators so that they could concentrate on any problems that were identified. Miners and their representatives also received the same information, if requested.

To date, District 2 has four persons participating in the surface program and six participating in the underground program. I should note that all participants are rotated on a periodic basis so that eventually every inspector will have a compliance analysis. District 2 has experienced a downward trend in the number of violations issued at both surface and underground mines since the beginning of the program. We feel this reduction was influenced, to some degree, by the CAP program. A similar program was initiated in District 3, located in northern West Virginia, southern Ohio, and western Maryland. The program has also been conducted at an underground mine in District 4, southern West Virginia. Again, the feedback from all parties has been very positive. These results have convinced us that the program should be implemented nationwide. This past week, we trained an additional 58 inspection personnel to conduct compliance analyses. We plan to have at least one CAP person in each of our field offices. We are cautiously optimistic that the rest of the mining community will experience the same favorable results that the initial pilot programs produced. It will take a team effort to realize this goal. MSHA, management, and labor will have make a joint commitment to the goals and objectives of the CAP program if we want to enhance health and safety in the surface and underground mining environment.

SUMMARY

I have shared with you today two initiatives that MSHA feels will have a positive influence on mine health and safety. One focuses on the optimum use of Agency resources in order to meet our responsibilities to the mining community in the most effective and efficient manner. The other initiative is an attempt to complement and balance the inspection effort by providing an informed analysis of the miners' job procedures and their work environment. Both initiatives, when coupled together, will provide a well-defined, systematic approach for MSHA to follow in achieving its efforts to ensure that each and every miner will be able to leave his or her mine at the end of the shift and return to friends and loved ones. Thank you.

IMPROVING HEALTH AND SAFETY THROUGH GREATER COOPERATION: A LABOR PERSPECTIVE

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United Mine Workers of America

Over the past several years there has been considerable effort in the coal mining industry to improve the future of mining operations and the health and safety conditions through improved labor and management relations.

The United Mine Workers of America has been a major part of that effort. The union, in 1993, for example, negotiated into the national coal wage agreement with several employers a provision called the Labor Management Positive Change Program. That program is better known throughout the industry as LMPCP.

The union recognized the need for a change in labor and management relations in the mining industry and a need for improvement in the way both labor and industry do business. A statement in the preamble on that program, contained in the national bituminous coal wage agreement of 1993, cites the following finding:

> *The union furthér recognized that the mutual objectives of the parties can best be attained by a joint commitment of continuous improvement to working relationships, productivity, health, safety, training, education and investment in technology and more importantly human resources.*

The union is serious about making improvements in areas such as health and safety through greater cooperation. That, however, is not always easy. The coal mining industry has been known for many things over the years; however, good labor/management relations is not among them.

The relationship between labor and management in the mining industry over the years has been one of mistrust and confrontation. The mere thought of labor and management in this industry collaborating to resolve a problem would be quickly viewed as suspect.

A review of the historical background of the mining industry allows one to realize why there has not been a good relationship between the parties. For cooperative efforts between labor and management to work, there must first be a level of trust established. That trust is not something that just occurs. It must be earned, the old fashioned way. Real cooperation must also be backed up by a real commitment for it to work. Miners have been suspicious of cooperative approaches offered by management to resolving problems. They do question the motives. When miners are asked to participate in a joint venture with management, they often ask, "What are they really after?" As we all know, mining is an occupation that can harm you if the environment is not controlled. The failure to control that environment, which has led to numerous deaths, injuries and illnesses over the years, has contributed greatly to the mistrust by miners of those responsible.

False commitments have also contributed to that. If miners hear their management say, "Yeah, I'll get that fixed," whether it is the brakes on a mantrip, a ventilation stopping or coal spillage, and it doesn't happen, what level of trust would an affected miner have in management's word?

If miners see their management arguing with a health and safety inspector over a condition as opposed to just fixing the problem that may affect their health and safety, what message does that send to the miner?

Think about what it means if management displays a lack of concern for conditions that may exist in a worker's environment, that may lead to that miner's injury or illness. If you were that miner, how would you react?

Cooperation in its application is not a one way street. Those that want to cooperate must be able to have an open mind and consider other view points. Cooperation is not just, "Hey, I need your help to get this plan approved, but it is set in concrete, so you can't change it." Cooperation doesn't work either, when the thought is, "I need their help on this one, so I'll ask them, but I don't have to work with them on other matters." Selective cooperation does not work to establish a long term relationship.

Our organization has been approached to establish cooperative labor/management programs to address health and safety concerns. There have been legitimate requests and there have been those that are not. There have been those that have worked and those that have not. The kind of programs that do not last are those where the objective was to have health and safety inspectors back off enforcing the law. Other failed programs include those when there was some impending problem and cooperation was only sought for the short term. Needless to say, these approaches do not work. More importantly, if they are attempted and miners see through them, it is difficult to begin a new relationship.

If one understands and avoids these pitfalls, it is easier to move forward with a cooperative approach. And they can and will work.

One such program which has been showing success is the health and safety program instituted in May of 1995 at the North River Mine in Berry, Alabama. That mine is operated by the Pittsburgh and Midway Coal Company.

The program, featured in a story in the January-February 1996 *UMWA Journal*, outlined some of the results of the program. In 1995, a reduction in both reportable injuries and health and safety violations had occurred when compared to 1994. There was a 17% decline in reportable accidents and a 46% drop in citations per MSHA inspection. Productivity also increased at the mine following implementation of this program.

Things changed at the North River Mine when the mine's health and safety program changed. Miners were given a greater voice in the day to day operations. The union health and safety committees joined forces with the mine management safety department to evaluate mining conditions leading to accidents, injuries, and violations. These safety representatives had real authority to act on problems. They concerned themselves more with what condition the mine was in and fixing the problems, rather than what the inspection agency was doing. Labor/management work teams were established by the local union and mine management to analyze problems and recommend solutions. Violations were dissected to determine root causes.

Mine supervisors attended workshops to educate them on the requirements of the health and safety standards along with the compliance record at the mine. The supervisors were educated on citation prevention. A new safety rule handbook for all employees was prepared and given to employees at their 1995 retraining program.

A personal contact program was initiated to be ongoing, involving work site communications. Miners were given a direct line of communication with mine management.

The work order system at the mine was changed. Miners could send such things as equipment problems needing to be fixed directly to the maintenance department. Work orders involving health and safety received the highest priority.

Special clean up plans were devised, with input from labor and management used to determine how the plans would be formulated. There were several attitude changes to overcome to allow this type of program to be successful. Mine management had to become used to sharing power with a newly empowered work force. Through the commitment of top management at the North River Mine, attitudes did change.

The UMWA has been involved in other health and safety programs, some directly through the LMPCP process and other interests. Labor/management progress to achieve improvements has involved company-wide activity with companies such as Peabody and Arch. Selective health and safety programs have been implemented at mines such as the Cyprus Emerald Mine and the Tanoma Mine in Pennsylvania. Both of those mines were targeted for placement on the potential pattern of violation lists by MSHA.

When these programs are initiated, certain things must happen. First, the employer must have in place a safety department with authority to act. They must be willing to allow that safety department and the mine health and safety committee to scrutinize the mine health and safety program and the conditions at the mine. If the program is successful, the additional time they spend dealing with the problems in the mine is usually recouped through reduced fines for violations, reduced walk around time with MSHA and reduced costs for mine injuries, illnesses and accidents.

There must be an empowerment of the work force. They need to be given an opportunity to be involved in decision making. Mine management must be willing to share some of the power with labor.

As these programs are implemented, the enforcement agencies need to be reminded that they are not to slack off their enforcement role. If the program is successful, there will be a natural lowering of enforcement actions. The enforcement agencies would have less to respond to. If, on the other hand, the enforcement agencies get the wrong message and "back off" enforcement, miners will see that and the program will fail.

Cooperation as a tool to improve health and safety can and does work, but it must be engaged in the right way.

SAFETY TRAINING: PLANNING FOR CONSISTENCY & QUALITY*

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Allegany Aggregates Inc. and affiliates operate six small to medium-sized quarries in Maryland and West Virginia. In 1993, we decided to provide a uniform safety program for all locations. We fully comply with applicable MSHA regulations, but in the case of safety training, we decided to go beyond the general requirements.

Safety training is an investment in our employees that yields tremendous dividends. One accident that results in minor personal injury generates a significant cost to the company. A cut finger that requires sutures affects much more than the injured person. When an accident occurs, everyone in the area wants to stop what they are doing and see what happened. Then someone has to take the person to be treated. During this process, everyone continues to think and talk about the injury instead of doing their job.

In summary, you have lost two employees for at least one-half day, incurred at least $200 in medical expenses, affected your modification experience rate and the worker's compensation premium, and diverted the focus of the employees away from their jobs.

EVALUATION AND POLICY DEVELOPMENT

We evaluated the training program and discovered that there was a wide disparity with the policies and training programs among the operations. The number of injuries was higher than we wanted, and some of the safety records were not acceptable. Training was being conducted, but there were few records kept and no reference to the specific content of training materials.

Our first step in the new program was to develop a comprehensive safety policy that would provide the necessary safety information to all employees. The policy had to cover all safety issues and be easy to read. The goals were to comply with regulations, reduce accidents, reduce costs, provide training and establish a safe working environment for everyone. The new policy was distributed and reviewed by every employee. Each employee signed a receipt

* This article originally appeared in *Stone Review*, February 1996, and is reproduced with permission of the National Stone Association.

stating that he or she received, read and understood the policy.

We believed this system would fulfill our goals. However, a follow-up evaluation proved the contrary. Accidents, injuries and costs showed only moderate improvement. We had provided better training and maintained records of the training, but we still needed significant improvement.

CONSISTENCY AND EMPHASIS

We continued to experience a problem with the consistency of training among operations, so we developed a New Miner Training form (Figure 1). The one-page form identified specific training categories, and indicated classroom or field training. Additionally, the trainer and trainee initialed each category and signed the form to verify the amount of training provided.

A follow-up evaluation showed significant improvement. However, we continued to lack consistency with the format of the information presented. The emphasis was not always placed on targeted areas and there was no method of monitoring the results of the training.

The next step was development of a training manual that would ensure uniform and consistent training. The manual now in use utilizes symbols with instructions to guide the trainer through the sessions, such as "demonstrate the use of a respirator," "issue a copy of a policy," and "have the trainee demonstrate the lockout procedure." The remainder of the manual provides standard text for the trainer to read to the trainee. The manual ensures that the same training material is provided to each new employee.

After the classroom training, the trainee is shown the NSA "New Miner Training" video and selected videos produced by MSHA as the next phase of the program. The videos are helpful because they allow the trainee to

SAFETY TRAINING RECORD

COMPANY ________________ LOCATION ____________ EMPLOYEE ________________

The following Safety training Program shall be performed before the employee enters the workplace. The employee must be trained in each of the following categories. The employee and trainer shall initial each of the categories to ensure the training was properly conducted by the trainer and understood by the employee.

	TRAINING		TRAINER		EMPLOYEE	
CATEGORY	Class	Field	INITIAL	DATE	INITIAL	DATE
Review the "ACT". CFR30 – Parts 56 and 57						
Review the Objective of the Program						
Review the Supervisor's Responsibilities						
Review the Employee's Responsibilities						
New Miner/Refresher and First Aid Training						
Review purpose and requirements of Safety Meetings						
Accident Investigation and Review Procedure						
Disciplinary Action Program						
Visitor Requirements						
Indepedent Contractor Requirements						
Blasting and Warning Systems						
Emergeny Response and Evacuation Plan						
Fire Safety, Prevention and Control						
Hazard Communication						
Confined Spaces						
Alcohol and Drug Policy						
Personal Protective Equipment Requirements						
Hard Hat and Safety Shoes						
Eye and Ear Protection						
Seat Belt Policy						
Safety Belt and Line Policy						
Use of Respirators						
Welding and Cutting Hazards						
Maintenance and Fixed Equipment						
Pre–Shift Inspection Procedure						
Definition and Requirements of Guards						
Lockout Procedure						
Electrical Hazards						
Warning Signals and Signs						
Fall Hazards and Protection						
Access Hazards and Safe Access Protection						
Moving Equipment Hazards and Protection						
Walkways and Travelway Safety						
Housekeeping Requirements						
Mining – Quarry and Roadways						
Pre–Shift Inspection Procedure						
Definition and Requirements of Berms						
Highwall Safety and Maintenance						
Mobile Equipment						
Pre–Shift Inspection Procedure						
Mandatory Safety Defects – Red Tag Out of Service						
Equipment Safety						
Loading, Dumping and Hauling Safety						

Training Certification

I certify that the company provided training classroom and field training for the above categories. I understand the hazards and safety procedures discussed and will comply with the Company Safety Policy and MSHA Requirements.	I certify that the employee was trained in above categories and understands the hazards and safety procedures procedures outlined in the Company Safety Policy.
Employee Signature and Date	Trainer Signature, Title and Date

TRSTREC1-A2

Figure 1 - New Miner Training Form

visualize the physical conditions and equipment discussed during the verbal training.

The next step in the process is field training to enable trainees to relate the classroom training to their work environment. A management representative, such as the safety director or superintendent, accompanies the trainee and identifies actual potential hazards in the workplace. This on-site observation reinforces the earlier training and the necessity for following required safety procedures. When the new employee starts work, additional task training is provided by a qualified person who is specific to the assigned job.

The final step in the procedure was development of a written test. The test is a very valuable tool when evaluating the effectiveness of the safety training program. It also provides the opportunity to review any areas that the trainee did not comprehend during the initial training session.

TRAINING THE SUPERVISORS

The company also recognized the need to train supervisors, who are responsible for the employees. We began annual safety meetings for supervisors, upper management and quarry superintendents during which we discuss the new safety policy and supervisors' responsibilities.

The program has grown from 15 persons in 1992 to over 75 people in 1995, and has included presentations by industry attorneys, MSHA officials, independent contractors and NSA staff. Subjects have included legal processes, regulatory activities and a review of accidents and citations by company superintendents.

At the most recent training program, participants included several non-management personnel, contractor representatives and other area producers. The meetings have been very successful and are essential because training supervisors is as important as training non-management personnel.

We have also recently implemented an Employee Evaluation Program for all employees, including supervisors, which has contributed to the success of the program. Safety violations are assessed in a manner similar to the MSHA citation system. Each category assigns points depending on the level of the violation, and the points are cumulative based on a rolling 12-month period. The progressive discipline ranges from verbal warnings to days off without pay to termination, depending on the severity of the violation and the accumulation of points. When an employee reaches an established point threshold, disciplinary action is automatically imposed.

CONCLUSION

We have seen significant improvements since the comprehensive training plan was put into place. Is it a result of training or, perhaps, good luck? We believe training and employee accountability are the reasons.

The system has worked well and is currently being refined. Any system is temporary in nature. There should always be a follow-up stage and an improvement stage within the cycle. Remember, you will only get out of a system what you put into it.

BENEFITS OF VOLUNTARY INDUSTRY STANDARDS: THE TRIUMPH OF EXPERIENCE OVER REGULATION

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INTRODUCTION

Voluntary international standards for mining machinery may gradually replace many national regulations. The days of establishing voluntary standards nation by nation, inhibiting the important flow of international trade, could be numbered. This does not mean that nations will cease domestic regulatory activities within their boundaries, but rulemaking will pay considerable attention to voluntary international standards and will likely strive for compatibility with voluntary international standards.

International standards setting bodies are developing standards for machine safety. When these standards are complete and adopted, some nations will require machinery to comport with them. International commerce in products that do not conform to these voluntary international standards may be discouraged.

Organizations such as the International Organization for Standardization (ISO), the European Committee for Standardization (CEN) and European Committee for Electrotechnical Standardization (CENELEC), are developing consensus with the participation of Technical Advisory Groups (TAGs) and governmental agencies around the world. This massive effort is one which will affect the international marketplace.

STANDARDS DEVELOPMENT

Voluntary international standards are not a new concept. A great deal of international manufacturing is based on this consensus method. A relatively recent development is that groups of nations have decided that one standard should apply to all machinery, and that commerce in non-conforming goods should be discouraged.

The rationale behind standards development could not have been better stated than it was in the statement of Thomas F. Lambert during hearings of the National Commission on Product Safety in 1970:

> It is better to have a fence around the top of the cliff than to have an ambulance in the valley below.[1]

This is what voluntary consensus standards are all about. They bring rare expertise to the process of enhancing safety and insuring efficiency of operation.

Standardization within the mining equipment industry is not a new idea. We are not Johnnie-come-latelies to this process. On Wednesday morning, November 17, 1920, Colonel Warren R. Roberts, Chairman of the Coal Branch of the Standardization Division of the then American Mining Congress (now National Mining Association) had this to say:

> When the founders of American Mining Congress...selected a motto, they chose one that would indicate the...ideals toward which it would strive. No other words could better have expressed these objects than 'Safety, Efficiency and Conservation'.
>
> As to Safety, Colonel Roberts said:
>
> Safety has been one of the watchwords of our [Mining] Congress from the beginning. Not only have the officials of our [Mining] Congress improved every opportunity to promote safety as applied to the mining industry, but they have been among the first to conceive ways in which improved and safer methods and practices could be brought before the mining industry.

As to Efficiency, the Colonel called it a much abused and misapplied expression. But one which "has never been misunderstood by the officials of our [Mining] Congress." He went on to state that:

> ...if we would gain the confidence of others...we must first be able to show them that we have applied intelligently to our own affairs the advice we offer them. ...Due to this fact our [Mining] Congress has had much influence with the mining industry in promoting efficiency added to safety.
>
> The Colonel then addressed Conservation:
>
> Conservation is a most popular expression with those who seek to gain public influence. ... The wiser and more patriotic of our citizens began to plead for conservation of these great resources...and...this word became very popular with many persons who are always ready to ride into public favor on the crest of some friendly wave. Such use of any national movement like conservation naturally creates much prejudice with our people, and this must be overcome by the industrious and wise efforts of those who are seeking to promote real conservation. Our Mining Congress has been diligent in its efforts to conserve the energies, the capital and the resources of the mining industry, thereby living up to its motto of "Safety, Efficiency and Conservation."[2]

The principles remain solidly the same. National Mining Association adheres to those articulated by Colonel Roberts 75 years ago. Standardization in crucial aspects of mining equipment and manufacturing may result in Safety, Efficiency and Conservation.

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[1] 2 National Commission on Product Safety Hearings 145 (1970).

[2] Proceedings and Papers of the Standardization Committees of the American Mining Congress, Denver, Colorado, November 15-20, 1920, pp. 21-22.

The constancy of these principles is amply demonstrated by the remarks of Richard Lawson, NMA President and CEO, in a recent edition of *Mining Voice*, a publication of NMA:

> ...manufacturers of mining equipment are committed to reducing the risk of product-related injury to ever-lower levels. Voluntary standards, utilizing the vast expertise of this industry, respond strongly to this desire for significantly reducing injuries in the mining industry.

INDUSTRY SELF-REGULATION CAN BE BENEFICIAL

Private standards organizations, such as American National Standards Institute (ANSI) and the American Society of Mechanical Engineers (ASME) among many, many others, promulgate thousands of voluntary standards to promote safety. As examples, ASME developed a standard type of cutoff device to prevent boiler explosions. The American Water Works Association (AWWA) promotes safety through standards that set the thickness of pressure piping to prevent pipeline explosions. The American Society for Testing and Materials (ASTM) sets standards for polystyrene and polyurethane to prevent fires. The American Nuclear Society sets standards for the containment of nuclear materials during transport to prevent radiation escape. ASTM also maintains a critical standard for the mining industry establishing the integrity of the manufacture of rock and roof bolts and accessories which are critical to the control of roof in underground mining areas, saving miners' lives. This standard is so important to the safety of underground miners that it has been incorporated by reference into the Code of Federal Regulations. NMA and many agencies of government were involved in its development. These, and many more, alert manufacturers to safety concerns and assist them in altering products to reduce danger.[3]

Safety is of paramount importance. However, additional benefits accrue from a well organized and on-going program of voluntary standardization.

> Standards are important for every company because standards influence the designing, the manufacturing and the marketing of many products worldwide. Standards, if adopted throughout the world, create a large market instead of many fragmented markets.[4]

Similarly:

> As we look to the future, standards will become even more important. American companies must understand that standardization is a strategic business issue that has a direct impact on new product development. There is a direct relationship between leadership in standards and leadership in technology. American standards bodies must lead the way in international activities.[5]

The benefits of voluntary industry standards are too numerous to mention, but one last example needs to be addressed. According to Ameritech Chairman and CEO Richard C.

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[3] Industry Self-Regulation and the Useless Concept "Group Boycott," Vanderbilt Law Review, Volume 39, Number 6, November 1986.

[4] Gary Tooker, Vice Chairman and CEO, Motorola, Inc., as quoted in Standardization: A Management Tool for Building Success, American National Standards Institute, p.1.

[5] George M.C. Fisher, Chairman of the U.S. Counsel of Competitiveness and CEO of Eastman Kodak, as quoted in BusinessWeek, October 16, 1995.

Notebaert, his company saved $83 million dollars in nine months through strategic standardization. "That is a sizeable sum of money," he said, as if we didn't know.

THERE ARE DANGERS IN VOLUNTARY INDUSTRY STANDARDS PROGRAMS

Unless the standards programs are properly managed and are careful not to stray from the rules governing such programs, there can be some legal ramifications. The most obvious is the anti-trust implication, where the setting of standards can be used by one group of competitors to maintain output restraining conduct like price-fixing or any other type of concerted action which tends to restrict the market, control or influence prices or the terms and conditions of purchase or sale. There is a danger that industry self-regulation can be used to punish industry members who would deviate from a prescribed code of conduct which may tend to favor one class of industry members over another.

Clearly, the procedures for establishing voluntary industry standards must be strictly followed, and no discrimination in enforcement of a standard can be permitted against any company.

ESTABLISHMENT OF CONSENSUS STANDARDS

The easiest way to describe a proper procedure for the establishment of voluntary industry consensus standards is to describe in short form the procedure in use by the National Mining Association (NMA). These ten points are a greatly compressed version of how a voluntary consensus standards process works.[6]

First: A statement of anti-trust compliance must be annunciated, stating that the intent is total compliance. Legal guidance is necessary.

Second: Members of a standards committee should be appointed by the highest ranking person in the organization, and their terms of office should be established.

Third: Officers should be appointed, and their responsibilities should be carefully defined.

Fourth: What constitutes a quorum should be established. A majority is sufficient.

Fifth: The agenda and the minutes of any meeting must be meticulously kept.

Sixth: Working groups of experts from within the industry who regularly work with and address the subject matter of a standard to be developed should be identified and appointed. They should meet regularly to develop the industry standard for presentation to the full committee.

Seventh: A working group should have a statement of assigned task which precisely defines the objective of any standard which may result.

Eighth: Once the working group has developed a consensus standard, it should be sent to the full Standards Committee, which

[6]Procedures of the Committee on Standards and Recommended Practices, October 28, 1988.

should check for compliance with the statement of assigned task. If it does comply, it should be sent to the industry, appropriate government personnel, academia, and other interested parties for comment. If it does not meet the statement of assigned task, it should go back to the working group for repair. After repairs, it should go back to the full committee, and from there to the consensus group for comment.

Ninth: Response to all comments should be provided in writing, whether addressing them requires further explanation, amendments, or outright rejection. Publication of the results of this review should include notice of the opportunity for appeal of any ruling.

Tenth: The Chairman of the organization or of any division within the organization should present the completed standard for adoption by the organization, at the highest level, such as the Board of Directors or Board of Governors, or Executive Committee.

It is critically important to adhere to procedures as set forth by the standards-making organization, and to keep detailed records of all deliberations and results.

NATIONAL MINING ASSOCIATION STANDARDS PROGRAM

National Mining Association long ago recognized that voluntary industry standards could do an excellent job of customizing standards to the unique environment that is mining. Three difficult areas were chosen for the development of mining machinery standards because they reflected important safety areas that could be addressed by voluntary standards.

DIRECTION OF CONTROLS MOVEMENT

The uniqueness, variety and evolution of underground mining equipment has resulted in much diversity in the placement, design and operation of controls. Space limitations inherent in some underground mining environments can make difficult the use of machinery with the standard operator's position designed for most surface equipment, which places the operator facing in the direction of forward travel with the controls located in front of him. Even this concept of "forward" is confusing on some underground machines because they may travel as often in one direction as in the opposite direction. The purpose of this NMA proposed standard is to improve the operator's ability to predict how the machine will respond when he moves a control in a given direction. This proposed standard deals with one aspect of the ergonomics of control design: the direction of the movement of controls and the results of activating the controls.

ILLUMINATION ON UNDERGROUND MINING MACHINERY

This proposed standard sets forth the illumination recommended at the mine face not covered by governmental regulations. It is understood that, in some instances, Federal illumination standards will provide illumination sufficient to meet the requirements of the voluntary industry standard. In these instances, the NMA standard requires no further illumination. This is in keeping with the NMA philosophy which dictates that standards will be developed only when needed, and when they will be an improvement over what currently governs.

This standard only seeks to meet its objective by facilitating the recognition of controls governing machine operation and the activation of emergency devices; the identification in and along the path of a moving vehicle; an awareness of the initiation and direction of machinery movement; and navigation of specified areas on-board and around machines. The standard adopts the concept that safety in underground coal mines can be improved by the addition of illumination on machinery and also by means that will enhance the benefits of existing illumination.

STANDARDIZATION OF HAZARD IDENTIFICATION LABELS ON MOBILE UNDERGROUND MINING MACHINERY

This proposed standard has as its objective a very narrow purpose: to insure uniform design and format of hazard identification labels that will serve to reduce the possibility of accidents resulting from failure to recognize a potential machine-related hazard on many types of mobile underground mining machinery.

As with many standards, this proposal is designed to act in conjunction with standards already in place. In this case, it is intended to supplement ANSI Z535 American National Standard for Product Safety Signs and Labels.

It is not that there is anything wrong with ANSI Z535. Quite the contrary, NMA relies on Z535 because of its inherent clarity and quality. However, the unique mining environment requires refinement that only mining industry experts can bring to the final design to fulfill the object of the hazard identification exercise: clear warning to workers under the circumstances of the moment.

STATUS OF NMA PROGRAM

NMA is in the process of balloting all three standards to achieve the consensus necessary to promulgate a voluntary consensus standard. Once a voluntary consensus standard goes through the review, balloting, appeal and adoption processes, it can then be presented to international standards organizations. Manufacturers adhering to the standard could be more competitive in these areas.

ONE EXPERIENCE WITH GOVERNMENTAL STANDARDS

The Mine Safety and Health Administration (MSHA) worked closely with NMA and other organizations to insure that the benefits of voluntary consensus standards could be brought to the mining industry consistent with the health and safety of underground miners. The development of governmental regulations began, but this time with the concept that independent, third-party laboratories would be one of the entities that would evaluate equipment for approval underground. The result was the drafting of 30 Code of Federal Regulations (CFR) Part 6.

There were many reasons that government and industry cooperated in the development of the new 30 CFR Part 6. First, the Approval and Certification Center was overwhelmed with work, and increasing demands from industry for approvals were creating substantial backlogs. Those backlogs were a serious impediment to the introduction of new mining equipment into underground mines. A system was proposed which would mesh three alternative methods of approval of underground mining machinery and equipment. A third party, such as a testing laboratory, could be chosen by the manufacturer to perform testing, with the results sent to MSHA for review and possible certification. Or, the manufacturer of the equipment could submit its own testing results to MSHA, which would be closely reviewed, and, if acceptable, be the basis for approval. Or, the manufacturer could submit the machinery and equipment to MSHA in the usual fashion, using their agency expertise and facilities as required.

The proposed 30 CFR Part 6 did not work out in the way the parties had originally envisioned it. It was supposed to leave a great deal of leeway for the adoption of international standards by domestic manufacturers. It fell short of that goal. The intention was to open the testing and evaluation process to as many qualified entities as possible. Instead, unfortunately, its precise wording tended to create monopolies in the testing phase of the program. This is quite the opposite of what was intended. Other serious flaws, including significant cost increases to manufacturers, and open-ended auditing costs to both manufacturers and producers, made the proposed 30 CFR Part 6 unacceptable to the industry.

However, 30 CFR Part 6 is not irredeemable. If it is recast in such a manner to permit a wide range of testing and document production options, and allow the adoption of some voluntary consensus standards, without unnecessary re-writing or enhancement, then much progress can possibly be made.

This is an example of where industry and government can clash. Industry brought to MSHA a proposal that would meet its needs, and help MSHA fulfill its mission of insuring the safety of mining equipment. It was essentially a plan that would permit the development of voluntary consensus standards with significant input from both government and industry.

By the time it was published as a proposed rule it had undergone a remarkable transformation, where more layers had been placed between the development of a machine and its ultimate approval. Costs could be increased substantially. The time from development to approval was increased, rather than decreased as intended.

This is not to assign fault to any entity. It is simply to point out that, however difficult it is to promulgate voluntary consensus industry standards, it can be as difficult to develop domestic government regulations, keeping them focused, and promulgating them. Government agencies, like industry, have many competing constituencies. It is difficult for a clearly defined, narrowly drawn regulation to emerge. While private sector voluntary standards may not be faster to effectuate, they can sometimes exceed government regulation in their clarity and focus.

CONCLUSION

Voluntary industry standards will never completely replace governmental regulations. Safety, cultural and political considerations will always intervene in the process that seeks to assure the safety of mining equipment around the world, and many governmental agencies have been tasked under specific laws to perform these functions. That is why the voluntary consensus standards process includes government agencies in the review process. However, most involved should be those experts within the industry, those who work on a daily basis with the design, development and manufacture of mining machinery. The process of developing voluntary consensus standards is an evolving, learning process.