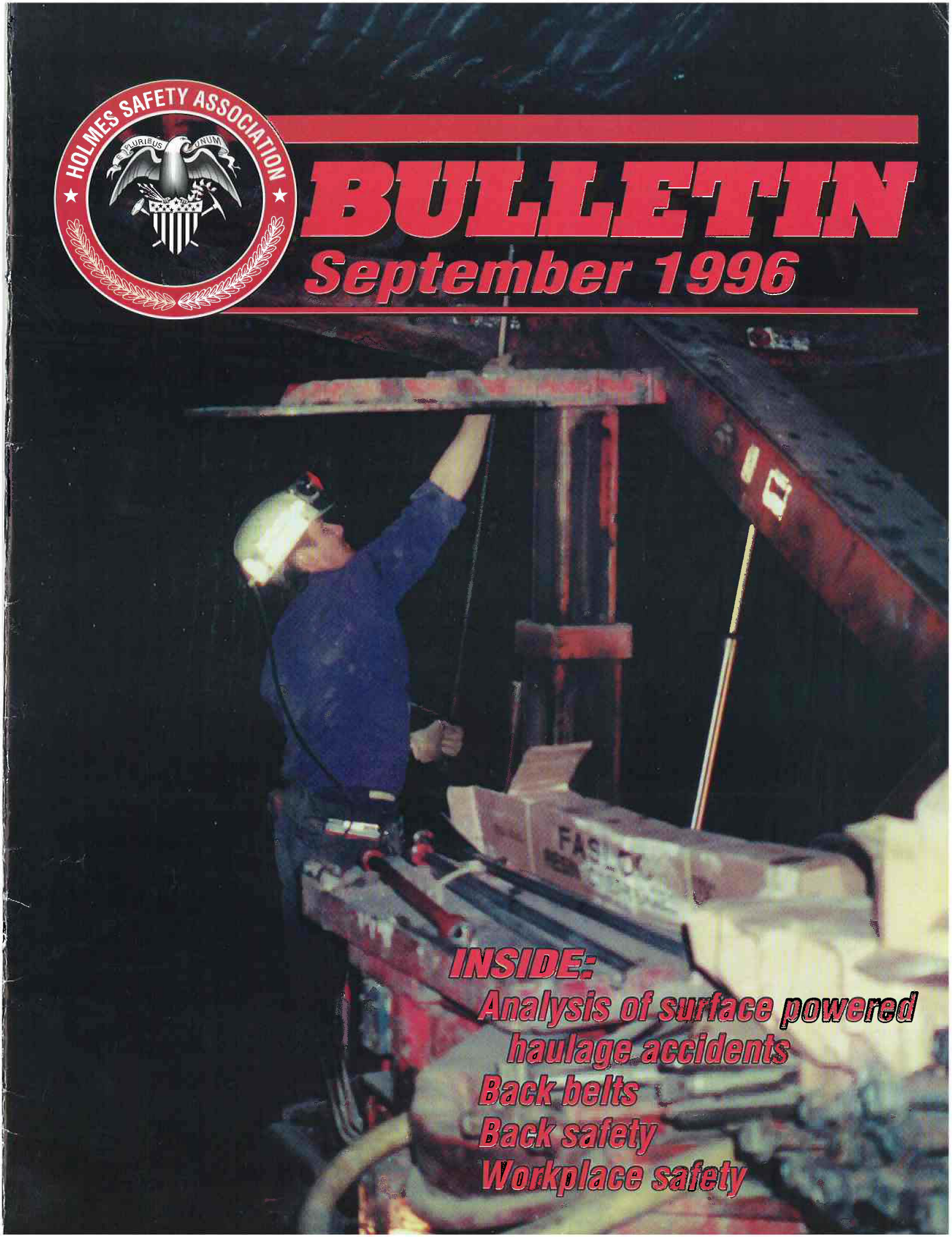
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The *Holmes Safety Association Bulletin* contains safety articles on a variety of subjects: fatal accident abstracts, studies, posters, and other health and safety-related topics. This information is provided free of charge and is designed to assist in presentations to groups of mine and plant workers during on-the-job safety meetings.

PLEASE NOTE: The views and conclusions expressed in *Bulletin* articles are those of the authors and should not be interpreted as representing official policy or, in the case of a product, represent endorsement by the Mine Safety and Health Administration.

THIS MONTH'S COVER: Once again, thanks to Gary Jessey of Acquire's *Coal Today* for the use of this photo of a roof bolter at work.

KEEP US IN CIRCULATION
PASS US ALONG

Analysis of surface powered haulage accidents

January 1990 to July 1996

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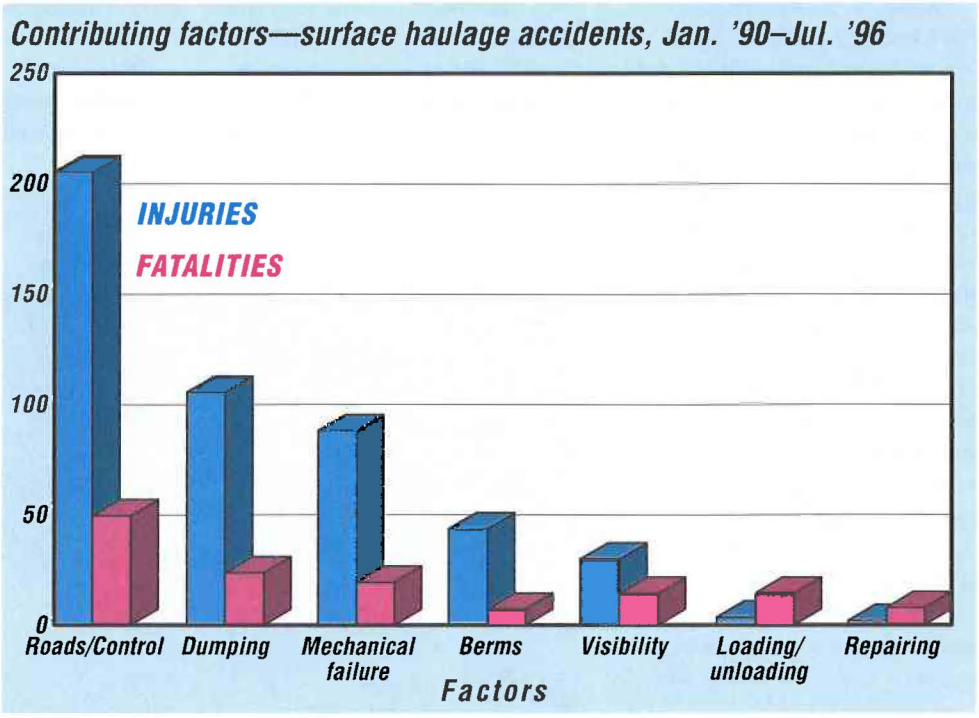
Abstract

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.

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



Coal stripping operation in Kemmerer, Wyo.

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.

A Cat TS 475-41 working for R.E. Hazard in San Diego, Calif.

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 January 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 it's 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

◀ Dumping overburden

the slope or onto its side.

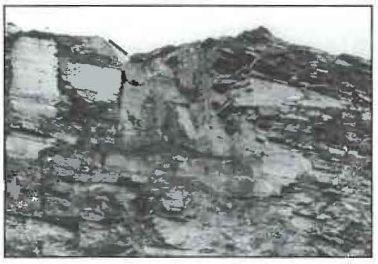
Some dumping accidents occurred during evening or night shifts. According to the accident reports, the work areas were insufficiently illuminated for the truck drivers to see the edges of the dumps when backing, and the trucks were backed too close to the edges of the slopes. The truck operator's ability 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 during dumping operations to maintain this slight upgrade and adequate dump berms 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.



A series of photos detailing a fatality from the fall of a haulage truck over a cliff and the resultant destruction. The progression depicts an approach view from the top; the view from below showing the face of the cliff and the dumping overhang; the view straight down from the lip of the cliff; and two views of the complete damage to the vehicle.

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 methods 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 result of the accident.

◀ *The remains of a vehicle that was crushed when it moved into the blind spot of a large haulage truck*

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 maintenance 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 driver's 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 conditions. 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

A 240-ton capacity haul truck can be loaded in 7 or 8 passes from the 994 loader with its 21-cubic yard bucket.

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 may 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 occurred 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

A Euclid 170-ton capacity (R-170) rear dump hauler at work in the Cyprus Copper Mine in Pima, Ariz.

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:

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

◀ *A high percentage of people killed in heavy equipment-related fatalities were not the operators of the equipment*

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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To your health...

A tomato a day keeps the doctor away

Researchers at the Harvard School of Public Health, Boston, have released data suggesting that for good health, you might want to substitute at least a tomato a day for the proverbial apple that is so often recommended.

A report published in the Dec. 6, 1995, issue of *The Journal of the National Cancer Institute* uses results from a nine-year study of the dietary habits of 47,000 men between the ages of 40 and 75. Based on that data, researchers claim that men who eat at least 10 servings a week of tomato-based foods significantly reduce their risk of prostate cancer.

The most common source of tomatoes for men in the study was spaghetti sauce, but researchers also saw benefits when the men ate the tomatoes raw, drank them as juice or savored them in pizza. Scientists say the agent in tomatoes that helps prevent prostate cancer as an antioxidant called lycopene. Tomatoes and tomato products supply about 90% of the lycopene in a man's diet.

Statistically, men in the study who ate 10 or more servings of tomato-based foods a week experienced a 45 percent reduction in the rate of prostate cancer compared with those with a low tomato consumption rate. Men who ate four to seven servings realized a 20% reduction.

New treatment for nearsightedness

The U.S. Food and Drug Admin. has approved a new laser system to correct nearsightedness—promising news for the 60 million Americans affected.

An article in the Oct. 23, 1995, issue of *The New York Times* reports that the system uses an excimer laser to flatten the cornea so the eye can focus properly. Summit Technology of Wal-tham, Mass., developed the system, known as photorefractive keratectomy. It is expected that the procedure will cost from $1,500 to $2,000 for each eye.

Reprinted from the May 1996 issue of the National Safety Council's ***Safety + Health*** *magazine—1121 Spring Lake Dr., Itasca, IL 60143-3201.*

On March 16, 1995, at the Berkshire Holmes Safety Association Seminar held in Pittsfield, Mass., Frank Bushika, Site Manager of Bushika Sand & Gravel, Inc. was awarded a "Certificate of Honor" for having worked fifty-seven years without incurring a lost work-day injury. From left-to-right: Frank Bushika, Site Manager; James Petrie, District Manager, MSHA, MNM; Peter Naventi, President, Berkshire Holmes Safety Association

BACK BELTS: The debate continues

By Graydon P. Megan

Debate politics. Debate religion. But debate back belts? For an unlikely debate, it has been passionately joined by workers, employers, belt manufacturers, scientists, public health agencies, medical professionals and public interest groups. The debate includes not only whether the belts work, but why they might work, the safety (or danger) of their use, and the good (or bad) science behind research that supports (or debunks) their use.

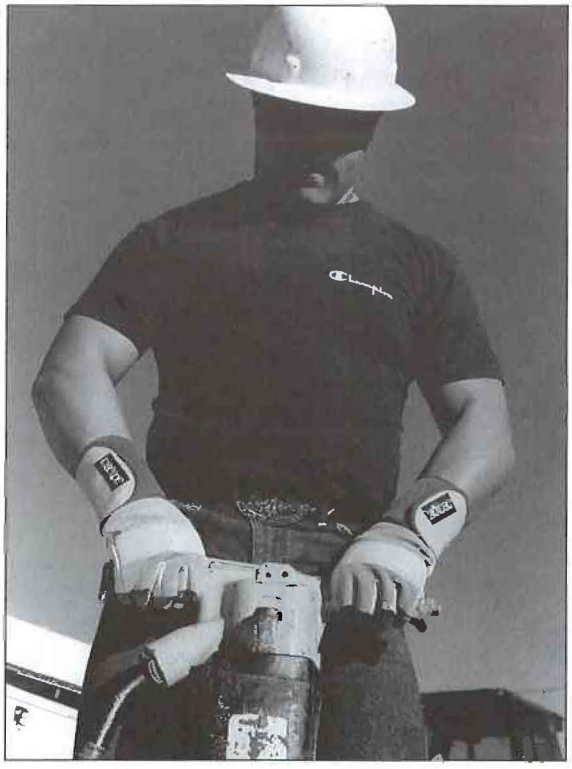
What is not under debate is the scope of the problem the belts are supposed to address. Back injuries account for nearly 20 percent of workplace injuries and are the leading cause of injuries to workers under the age of 45. Estimates put the annual cost of back injuries at $20 billion to $50 billion. Little wonder that workers, employers, ergonomics specialists and manufacturers of supportive devices all hope to find a magic bullet to solve the problem.

Conflict arises

"Companies pass back belts out like candy," says Gene Giles, manager of safety and health, Stamping and Frame Division, The Budd Co., Rochester, Mich. "You see them everywhere, often not worn properly. Employees are rarely trained in proper lifting techniques or even how to use the belts correctly. And wearing a back belt can give a false sense of security—people think they can lift more than they can." In a few sentences, Giles has summarized the entire debate over back belts.

Thomas F. Votel is president of Ergodyne, St. Paul, Minn., a company that manufactures back belts and other personal-support and ergonomic products. He is quick to defend his products. "Criticism often is of the product, when it should be of the process. We do not suggest belt use in every situation." According to Votel, a company whose workers face lifting problems should first ask, "Is there a solution that uses ergonomic principles?"

Votel says that employers and their employees cannot always control the lifting environment. Workers in industries such as parcel delivery and pickup, food service and baggage handling may find that the customer controls the variables of the lifting task. And solutions to lifting problems may be hard to apply in jobs such as



All photos for this article were generously provided by Denis Norlander of Chase Ergonomics, 5921 Midway Park Blvd., N.E., P.O. Box 92497, Albuquerque, NM, manufacturers of industrial strength soft goods

construction, child care and healthcare. In those situations, Votel says, "back belts, combined with training and education, can be powerful tools to reduce the possibility of injury for vulnerable workers."

With the two sides of the debate so clearly defined, couldn't scientific inquiry settle the issue? In a word, no. Scientific studies have failed to demonstrate that back belts can prevent lifting injuries, although some studies have shown that the belts may be useful postinjury.

Back to basics

Most lifting injuries occur because of excessive load or pressure on the lower back. Excessive load can occur when a load is simply too heavy to lift or places weight too far from the spine, whether in front or to the side. Lifts that involve excessive reaching or twisting can produce injury. Workers also may sustain injury when they fail to use proper lifting techniques or attempt to perform a job that is beyond their capabilities.

What is not under debate is the scope of the problem back belts are supposed to address.

In principle, all parties involved in the back-belt debate agree that companies should use engineering controls and take administrative steps to make lifting safe and prevent injuries. Back-belt manufacturers are the first to recommend that companies train employees in safe lifting techniques. They say companies should use ergonomic principles to determine whether they can reduce the lifting task by use of gravity or other lifting aids and whether changes in workstation layout can reduce lifting tasks. Job rotation and other administrative controls also can decrease the chance of injury.

Marilyn Joyce, director of The Joyce Institute, Seattle, defines the role of ergonomics. "The science of ergonomics is really based on looking at the root causes of a problem, engineering them out, and then training the workers to behave properly within that environment. Belts are a Band-Aid and don't really solve the problem."

Look at the history

According to Theodore Braun, director of ergonomics for Liberty Mutual Insurance Co., Westborough, Mass., the use of belts to provide lifting support goes back at least to the second century. In the Middle Ages, armorers often fashioned back supports for their clients. More recently, weight lifters have used wide leather belts to provide extra support as they lift heavy weights.

In 1982, Dr. Thomas Votel, an occupational health physician on staff at United Hospital in St. Paul, Minn., developed a wide elastic band to provide back support for healthcare workers required to lift patients. Improvements in materials and refinements in design led to an early version of the familiar back belt with suspenders used today. In 1983, Votel founded Ergodyne to make and market his back-support belt. Thomas F. Votel, Dr. Votel's son, now heads the company.

Ergodyne has plenty of company in its field, with dozens of companies that now either make or market a variety of back support products. Experts estimate that sales of back supports reached 12 million units in 1994.

Some good science, some bad science

Researchers have conducted dozens of studies on the use and effectiveness of back belts over the last few years. None of them have satisfied both camps in the great debate. All of them have faced hurdles to reach reliable conclusions.

Unlike tests of the efficacy of new medicines, researchers cannot evaluate belts in double-blind tests. No placebo will convince people they are wearing a belt when they are not. For ethical and practical reasons, reputable researchers provide training in safe lifting techniques and strength conditioning for test subjects, even those not using the belt. And there is a phenomenon in research called the "Hawthorne Effect."

The effect takes its name from a study that concluded that the workers

studied responded to the attention paid to them by the researchers rather than to the changing variables in the study. So it is with backbelt research. Often it is hard to separate the effects of back belts from the effects of the attention paid to the wearers and the work.

And then there are the details. No national standards exist on how to design and construct the belts. Some are fabric, some are leather. Some are rigid molded devices, most are not. They vary in width, rigidity, closures, presence or absence of

suspenders. And even if belts do work to decrease lifting loads, no one agrees on how they do that. Most evidence points to the fact that belts can increase intra-abdominal pressure, and by so doing spread loads on the spine over more of the body's structure. Researchers also postulate that belts can reduce injuries by limiting spinal flexion, particularly excessive bending either forward or to the side.

Dr. Nicolas Walsh, professor and chair, Department of Rehabilitation Medicine at the University of Texas at San Antonio, conducted a 1990 study on back belts, "The Influence of Prophylactic Orthoses on Abdominal Strength and Low Back Injury in the Workplace." The study concludes that use of custom-molded rigid back belts by employees trained in proper lifting did not adversely affect abdominal strength and did reduce lost time from work injuries.

Dr. Walsh, who is the editor in chief of *Archives of Physical Medicine and Rehabilitation,* points out that studies of back belts must be well-designed to produce results with any value. "The debate may not be about the studies' results but about their design."

Agencies review results

The National Institute for Occupational Safety and Health conducts research and makes recommendations on how to prevent workplace injuries and illnesses. NIOSH summarized its review of the back-belt issue in a report entitled "Back Belts—Do They Prevent Injury?" (NIOSH publication No. 94-127) which it issued in July 1994.

According to the report, "After a review of the scientific literature, NIOSH has concluded that, because of limitations of the studies that have analyzed workplace use of back belts, the results cannot be used to either support or refute the effectiveness of back belts in injury reduction." The report goes on to examine specific questions and issues related to back-belt use and concludes that the best way to protect workers is through ergonomic approaches designed to reduce the hazards of lifting. In NIOSH's view, belt use remains a personal decision.

A National Safety Council technical advisory report on the use of back belts, issued in September 1995 by the Ergonomics/Human Factors standing committees of the Industrial and Labor divisions of the Council, comes to a similar conclusion. The National Safety Council stresses that several conditions and controls should be in place before companies consider the use of back belts in the workplace. Companies should reduce or mitigate risk factors through ergonomic intervention. Also, they should use engineering controls, work method analysis and administrative controls to reduce worker exposure to lifting injuries.

Some scientific reports on back-belt use note increased blood pressure and heart rate in some belt users due to increased intra-abdominal pressure. Therefore, the National Safety Council recommends that individuals who consider belt use be medically screened for cardiovascular and general health. To maintain strength and flexibility, companies should consider a simple exercise program for workers who use back belts. The program should be under the guidance of a healthcare professional.

◀ *Photos kindly provided by Chase Ergonomics of Albuquerque, NM*

Support for back belts

If science hasn't yet proven that back belts are effective, some studies show that the belts may offer benefits in certain circumstances. These benefits and manufacturer claims have been enough to convince many companies to try the belts.

Don Chaffin, professor and director of the Center for Ergonomics at the University of Michigan, Ann Arbor, believes the best way to help people avoid back injuries is to modify the workplace. But, he adds, "Anecdotal evidence strongly suggests that back belts help some people with back pain. I believe that the back belt should be part of the medical armament to help people deal with their back pain."

The debate may not be about the studies' results but about their design.

David Sheriff, senior vice president of operations for Astron DS in Chicago, believes in the belts. The company furnished every employee with a back-support belt, provided training in safe lifting and then made belt use mandatory. And he thinks the belts have helped prevent injuries.

But after trying the mandate for a year, the company found it difficult to enforce. As a result, Astron DS no longer requires belt use. "The problem is compliance," says Sheriff, speaking of how difficult it was to ensure that employees actually used the belts. "It was a matter of trust and it turned into an administrative nightmare, so we no longer require the belts, although we still recommend them."

Thomas A. Walsh, corporate health and safety manager for United Parcel Service in Atlanta, says his company is neutral on belts. "In some cases, wearing a belt makes people feel better, but the hard research isn't there. We're not recommending belts and not saying 'Don't wear them.'"

Jury is still out

The results of several studies will be available in the next few months. One or more of these studies may provide definitive answers on the value of back belts. In the meantime, companies whose employees face lifting hazards should examine the ergonomics of their lifting tasks. These companies should use engineering controls and administrative measures to reduce hazards.

If employees or employers still are inclined to use back belts, even after the company has implemented engineering controls and taken administrative measures, they should use them only in closely controlled conditions. These companies should screen employees for cardiovascular and general health, and train them in both safe lifting techniques and proper belt use.

The debate is far from over. Marilyn Joyce of The Joyce Institute puts it this way: "The case is yet to be made for the safety and the effectiveness of back belts. But a lot of research is still going on, so all of us need to keep an open mind."

Photo kindly provided by Chase Ergonomics of Albuquerque, NM

Sources: Theodore Braun, director of ergonomics, Liberty Mutual Insurance Co.; Don Chaffin, professor and director, Center for Ergonomics, University of Michigan; Kenneth A. Drew, manager of safety and health, Boeing Co.; Sheree Gibson, independent ergonomics consultant; Gene Giles, manager of safety and health, Stamping and Frame Division, The Budd Co.; Kirby Hibbard, national sales manager, OK-1; Marilyn Joyce, director, The Joyce Institute; Dr. William Marras, professor and director of the Biodynamics Laboratory, Ohio State University; Dr. Stuart McGill, professor, Occupational Biomechanics Laboratory, University of Waterloo; John Montgomery, manager of environmental safety, American Airlines; Gary Orr, industrial engineer OSHA; David Sheriff, senior vice president of operations, Astron DS; Thomas E. Votel, president, Ergodyne; Dr. Nicolas Walsh, professor and chair, Department of Rehabilitation Medicine, University of Michigan; Thomas A. Walsh, corporate health and safety manager, United Parcel Service; Loren Wolf, president, MSIC (MusculoSkeletal Injury Controls).

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Back safety—moving odd-shaped items

When lifting first consider the weight and your limitations, then check for nails, sharp edges and weak bottoms and if you can get a good grip. Get help for heavy or awkward loads. Proper lifting involves bending your knees and keeping your back straight.

1. **Heavy bags** should be grasped on opposite corners. When you get the bag up to your waist rest it on your hip, then swing it up on one shoulder if you plan to carry it more than a few feet.
2. For **Flat Stock** such as a full 4 x 8 sheet of plywood, use proper gloves or hand pads. Pick up carefully with the bottom edge resting on the fingers of one hand. The other hand should be on the top edge to hold and steady it.
3. Roll **barrels** on the floor when possible or use a handcart designed for the job. Big cans with handles should be carried by two people whenever possible.
4. **Lone pipes or boards** should be carried on your shoulder. Keep the front end high to prevent hitting a person who doesn't see you.

One of the best ways to minimize the chance of devastating back injuries is to keep back muscles in shape through proper exercise. Regular walking is one of the best exercises for the back. **We should be begging our employers to move the parking lot a mile from our worksite.**

Reprinted from the July 12, 1996, issue of Michigan's State Grants Mine Safety Training Newsletter 96-3: ***Michigan Mine Safety.*** *Produced by the Mining Engineering Department of Michigan Technological University in Houghton. Manager—Dave Carlson 906/487-2453, Email: dcarlson@mtu.edu or Mary Ewert—-906/487-2272 Dept. Chair - Francis Otuonye 906/ 487-2610 Internet Home Page: http:// www.mm.mtu.edu/mine_safety/ mine.html*

World Class Safety—article two from a series of three articles by Tom Smith on the...

Application of statistical process control to safety in small mines

"When the platoon is waist deep in alligators and swamp, a good manager usually says 'press on', but a good leader says 'let's go around'." World class safety needs good leaders.

Question—Tom, you advocate the use of control charts for safety management. Isn't this approach reactive in that accident-prevention actions take place after the accidents happen?

Smith—"Effective use of control charts requires an understanding of the thinking of statistical process control (SPC). Safety, like quality is an outcome of your management system. Understanding what a control chart represents will stop your managers and technical persons from looking in the wrong places for solutions to safety problems. The thinking of SPC helps managers understand that accidents/incidents are influenced 85% by common causes (by the system), and 15% special causes.

Control charts do not solve safety problems. They merely tell you if your numbers of accidents/ incidents are stable and on target—data that are essential in isolating their real causes. The collection of data needed to prepare a suitable control chart is not a time-consuming process. The difficult part is creating an organization that uses and supports the thinking of SPC for continual improvement of safety.

Control charts should not exist in a vacuum or be used as a report card to be filed away. Managers, technical workers, and departments will have to cooperate to get the safety system to continually reduce accidents/incidents. Effective use of control charts is needed to guide and monitor continual improvement of safety."

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Workplace safety begins with an attitude

Attitude is the key to a successful safety program in the workplace. Positive attitudes about safety grow from an awareness of the importance of the need to follow safe work procedures at all times. Unfortunately, this awareness is not an automatic attribute of our employees. It must be developed by well-rounded, fair, consistent and aggressive management supported program that promotes enthusiasm, understanding, communication and knowledge. The employee must want to follow the correct safety procedures.

The importance of attitude

Developing a positive attitude in the employee regarding safe, quality production is one of the most important tasks of the front-line supervisor. The supervisor must get to know his or her employees and work with them as a team. Teamwork is critical to company growth. Most employees just want to know that supervisors care, so communication becomes one of the keys to the program.

How do you measure up?

- What does front-line supervision know about subordinates and their families?
- Do employers feel comfortable enough with supervisors to talk about programs or take them into their confidence?
- Do supervisors show sincere concern and follow up on safety defects or work procedures?
- How often do supervisors discuss safe, quality production?
- Do supervisors equally and fairly distribute the workload?
- Are supervisors firm, fair, and consistent in disciplining employees or do they show favoritism?
- Does the supervisor attend and/or conduct regular safety meetings?
- Do supervisors work with the safety staff and ask the employees for input to ensure that the safety meetings are interesting? Are they well planned?
- Do supervisors check their work areas daily for defects and insist that employees do the same?
- Do supervisors praise employees when it is warranted?
- Do supervisors communicate well with employees so they understand what is expected of them?
- Do supervisors counsel employees on safety after an injury or incident?
- Do supervisors communicate with other departments on injuries or incidents to ensure that they don't happen again? (Incident investigation is a fact-finding mission, not a fault-finding mission.)

Responsibility

Have you ever asked, "Who is responsible for safety?" If your answer was anything other than "everyone", you're wrong. Superintendents and general foremen must ensure that all supervisors working for them are knowledgeable people who are interested in the safety and well-being of their employees and who follow proper safe procedures as prescribed by management. The supervisor must plan and direct his or her employees, and ensure that they are properly trained in safe work procedures. He or she must make sure that work areas are inspected for defects and that any found are addressed and corrected and see that proper safety equipment and tools are provided and used to safely complete a job.

From planning to implementation, there is no such thing as an unsafe job if we follow the correct work procedures and practice safety awareness. It has been proven that incidents can be prevented when we work at it. Safety is, and always will be, everyone's responsibility.

How do you measure up?

- Do you ensure that your employees receive training or instruction in the safest and most efficient method to complete each task?
- Do you monitor work activity to ensure they follow established, safe, productive job procedures and not take shortcuts that could cause incidents?
- Do you correct or secure defects when you find them or when they are brought to your attention by employees?
- Do you follow up for correction on every situation or defect brought to your attention?
- Do you correct all safety violations immediately (job methods, procedures, personal protective equipment)?
- Do you remind your people, in conversations and written communication, to work safely?
- Do you play a leading role in the safe, quality production of a the crew, department and plant?

Awareness

Safety awareness is the heart of a safety program. Unless it is thoroughly developed in the individual, the safety program can never be sound. A company can provide job training and a clean, defect-free work environment, but if employees do not practice safety awareness, incidents will result. Consider this: 95% of incidents are caused by workers who fail to:

- inspect work areas or equipment
- use the proper work methods, procedures or tools for the job
- guard or warn

• clean up or complete a job

So, when an employee asks who is responsible for safety, your answer should be, "Everyone working here—not only for their own safety, but also for their coworkers' safety."

Each and every member of a company's supervisory staff has the knowledge and professional expertise to turn a company into the safest, most productive in the industry today if we all work at it.

Reprinted from the National Safety Council's ***Mining Newsletter****.*

1995 safety awards

On May 29, 1996, safety awards and safety recognition plaques were presented to representatives of Arizona's safest mining operations by Douglas K. Martin, Arizona's State Mine Inspector. The special Safety Awards & Recognition Luncheon was held at the Hyatt Regency on the first day of the Southwest Safety Conference.

Small mines

Recognized as the safest small mining operation in the state was **Yavapai Materials** of Prescott.

Medium mines

Garnering the award as the safest medium-sized mining operation in Arizona was the **Peter Keiwitt Co.**, operator of **San Xavier Sand and Rock** in Tucson; **United Metro** in Phoenix; and the **Tanner Co.** in Yuma.

Unfortunately, there were no operations qualifying for an award in the large-mine category. The award categories are based on employment. Employment under 50 is considered a small mine; from 50 to 250 is a medium-sized mine, and employment over 250 is considered a large mine.

Safety improvement

Earning a special recognition award for safety improvement was the San Manuel Mine of BHP Copper.

Both the management and the work force have demonstrated commendable teamwork in reducing serious accidents at the nation's largest underground mine.

No lost-time accidents

Recognition awards for no lost-time accidents over a prolonged period of time (in excess of a year) were awarded to:

• **CDK Construction.** This contractor has logged over 500,000 work-hours at Arizona mines over the last three years without a single lost-time accident.

• **Salt River Sand and Rock**, with an average of 220 employees, has completed 319,488 hours without a lost-time accident in 1995.

• **Cyprus Tohono**, with 178 employees, has achieved 362,500 work hours without a lost-time accident in the last year.

• **The Superior Companies; Winkleman Division.** This small (five-person) gypsum operation near Winkleman not only has an accident-free record, but also sets a fine example of good operating practices.

• **Phelps Dodge Morenci— Mine Maintenance Group.** Three hundred seventy-six employees continue to work accident-free and keep the equipment at the nation's largest copper mine operating safely.

• **Cyprus Sierrita Corp.**— SX-EW. Personnel from this group have worked for several years without a reportable accident. During this time, they have accepted the challenge of increasing output with a smaller work force.

• **Phelps Dodge Morenci— Materials Management.** The forty-five employees in this group worked 101,320 accident-free hours last year.

• **Phelps Dodge Morenci— Metcalf Concentrator.** One hundred ninety-seven employees worked 410,909 accident-free hours last year.

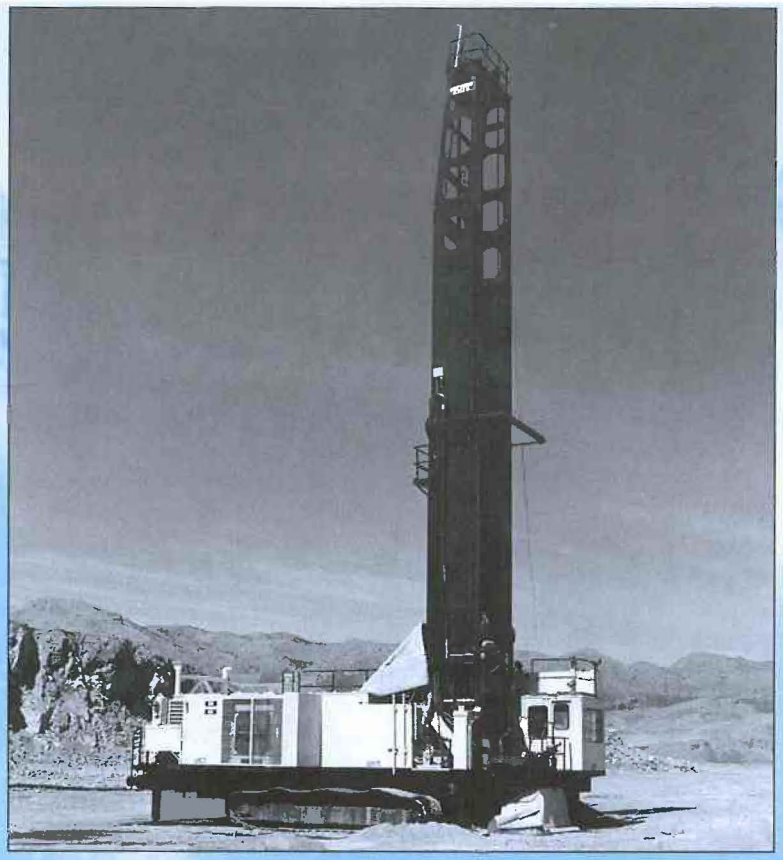
• **BHP Copper—San Manuel— SX-EW**. The twenty-seven employees who worked 54,493 accident-free hours last year not only have a perfect safety record, but also operate one of the cleanest copper operations in the state.

• **Phoenix Cement Co.** One hundred twenty-eight employees worked 319,500 accident-free hours last year.

• Last, but certainly not least, **Phelps Dodge Morenci's Hydrometallurgical Operations,** the largest in the world, producing 1,500,000 pounds of copper per day, received a safety recognition award. This award was presented at Morenci by Douglas Martin and U.S. Congressman J.D. Hayworth, so a large contingent of the work force could participate in the occasion. We hope all mining companies, including contractors who work at mines, will do their utmost to be included in the list of safe operations for this and succeeding years.

Next year, the selection will be made earlier than in the past—in late January, rather than late April. To this end, all Arizona operators are asked to send their quarterly labor and accident reports into the Arizona State Mine Inspector's Office in a timely manner.

Reprinted from the Volume 4, Number 3 (Jul-Sep) 1996 issue of Miner Details—a publication of the State of Arizona's Office of Mine Inspection.



Bucyrus-Erie blast hole drill, Duvall Sierra, Tucson, Ariz.

Blasting concepts

Drilling accuracy: the key to successful blasting

By Calvin J. Konya, Ph.D.—a founding member of the Society of Explosive Engineers and president of Precision Blasting Services located in Montville, Ohio. This article appeared earlier in COAL's sister publication ***Engineering & Mining Journal.***

Accurate execution of any blast involves accurate blasthole drilling. It is not uncommon to find blastholes on surface blasting operations drilled up to 50% in error on some burdens and spacings. These large errors change the distribution or energy density in the rock mass and cause boulders, flyrock, high ground vibration, and poor fragmentation, as well as other problems associated with blasting. Best results occur if blastholes are drilled within one hole diameter of their desired location. Normally, a driller will have problems collaring a hole at a specific location and will have to move over. This type of occasional drilling error is acceptable. However, it should not occur on the majority of the holes within the blasting pattern.

Burden—The burden distance on a blasthole is the most important dimension in a blast. If blasthole burdens are too large, the holes will not break to the entire depth. Very often toes are left in front of the blastholes. Rock fragmentation also suffers if burden distances are large. When burden distances are too small, rock will break fine, but it can be ejected into the pit, forming a low muck pile, and may cause flyrock. Small burdens result in higher costs and loss of energy. The burden distance also effects vibration. When burden distances are small, vibration drops. When burden distances are excessive, vibration increases dramatically as much as five times the vibration level that would occur with properly designed burdens.

Spacing Dimensions—Spacing is normally defined as the distance between two blastholes along the row as the row is firing. The spacing on blastholes can cause two effects to occur. If the spacing is too close, preshearing can occur with fragmentation becoming coarse, and the walls between holes are commonly bowing inward into the solid. If spacing distances are too far apart, the rock between holes is not properly broken and very often we can see that the face is bowing outward between blastholes.

Control of Burden and Spacing Pattern Dimension—How can management get information and control of drilling problems? This seems to be a difficult task because of the need to quantitatively assess the drilling accuracy between one pattern and another. Actually, a simple method can be used for the supervisor to tell how well a driller is doing on a particular job. The general procedure is as follows: Measure all of the burden dimensions in the blast with a tape and use a simple statistical package, which is contained on most calculators, and determine the mean value or average value of the burden and the amount of error for one standard deviation.

Assume a 20-hole pattern and a design burden of 15 feet. Actual measures of the burden values are as shown in Table 1. The mean value of this data is 14.3 feet and one standard deviation is 1.22 feet. Comparisons can be made between different drillers, and standards for

drilling can be set using this criteria. This same procedure can be used with the spacing dimension as well as the depth of blastholes.

Blasthole Depths—Correct blasthole depths are extremely important in order to break to a specific grade or floor level. It is not uncommon to find some blastholes drilled a few feet deeper than the intended hole depth, and also some holes are drilled shallow. In general, the deep holes are not a problem because the blaster can tape the hole before loading. If the hole is too long, the blaster can place drill cuttings in the bottom to bring the hole to the proper depth. The problem, however, occurs when holes are short. It is very unlikely that if the blaster tapes the blasthole and finds it to be a foot or two short, he or she will bring back the drill and try to drill the hole deeper. Those short holes will commonly cause bumps or humps in the floor, which will require some secondary excavation technique to remove them. The same general statistical method to determine the accuracy of drilling of the burden and spacing can be used on the hole depth. Every hole is measured in the pattern, and the mean value and standard deviation can be determined to rate the driller's accuracy.

Drill Angle Accuracy—The inclination of the mast on the drill is an important consideration, especially in deep holes. Mechanical and electrical devices are available to help the driller position the mast so that each drillhole enters the ground at the same angle. Visual estimation of the drill angle is a poor procedure. Figure 1 shows what can happen with bench height and how much error will occur in feet if the drill steel is at the wrong angle.

Figure 1.—Graphic detailing how heights can vary with drilling angles

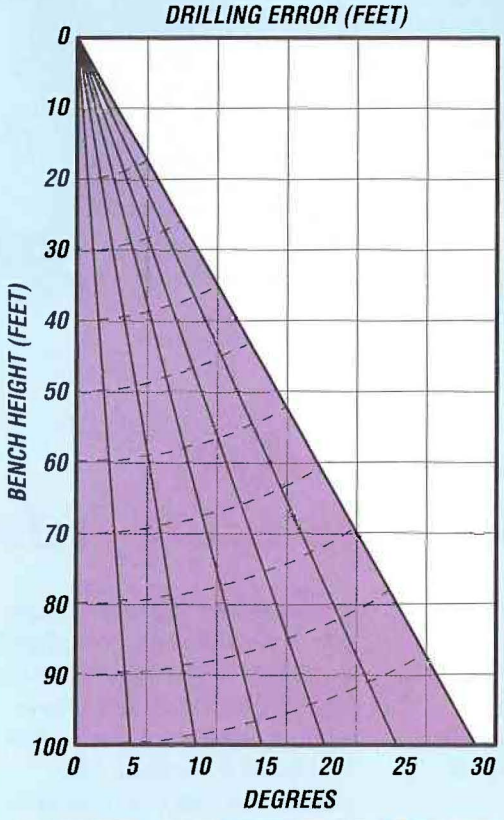


Table 1

Hole No.	Burden (feet)
1	13
2	14
3	15
4	12
5	16
6	14
7	15
8	15
9	14
10	16
11	14
12	15
13	15
14	13
15	16
16	12
17	15
18	15
19	14
20	13
Std. deviation	1.22
Mean	14.30

For example, let us assume that we are drilling a 100 foot deep hole and the drill angle is off by 5°. Figure 1 shows that the drilling error at the bottom may approach 8 to 9 feet and the hole will be shorter than intended. In other words, the vertical dimension into the bench will only be about 98 or 99 feet.

Drill angle accuracy can be a very important consideration. If blastholes are drilled at improper angles, the bottom burdens and spacings can vary greatly from the distance on the surface where the holes are collared.

This error can be more compounded when we are drilling angle holes for either production or wall control. For example, if one is drilling holes on a 15° angle that are 100-feet long, one can go to the figure and see that the vertical dimension on the blasthole with a 15° angle is only about 96 feet. On the other hand, if the angle is at 25°, we can see that the penetration into the bench on the vertical is only about 90 feet. The drilling error at the bottom of the 100-foot long bench would be again about 8 to 9 feet.

In order to get proper blasting results, it is important that the bottom of the holes be at the proper location and that the drill enters the ground at the proper angle. It is also important to have the proper dimensions on the surface for burden and spacing. These burden and spacing numbers should not be estimated. They should be carefully measured before drilling and the holes should be measured after drilling. A statistical basis should be used to judge the accuracy of the driller and the pattern. If the blastholes are not drilled properly, the explosive cannot function properly. The explosive cannot compensate for the problems in drilling.

Reprinted from the April 1996 edition of Intertec Publishing's **COAL** *magazine.*

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Dust at work: preventing silicosis

Dirt can hurt!

What is Silicosis?

Silicosis is a terminal lung disease caused by breathing air containing respirable crystalline silica (RCS) (respirable particles are fine enough to enter the lungs). The most common form of crystalline silica is quartz, which is a constituent of almost all mined materials and is the main constituent of common sand. Silicosis may either be Acute or Chronic.

• **Acute Silicosis** is caused by intense overexposure to RCS over a 6 month to 2 year period. Sand blasting is one occupation that, without proper protection, can expose a worker to concentrations sufficient to cause acute silicosis. Symptoms include shortness of breath, cough, fever and weight loss. There is no specific treatment for this type of silicosis and the disease usually progresses rapidly until death by respiratory failure.

• **Chronic Silicosis** is caused by exposure to lower concentrations of RCS over a longer period of time. RCS causes scarring of the lung tissue which makes it increasingly difficult to breath. As with Acute Silicosis, there is no known cure. Death usually occurs from respiratory failure. In a study done by NIOSH in Michigan for the years 1989-90, victims of Chronic Silicosis shortened their life expectancy by an average of 13.2 years.

Who is at risk?

Mining, Quarrying, and Ore Loading & Transport are usually high on the list for potential exposure to silica dust. All naturally occurring rocks and ore bodies contain some silica.

What can be done to Reduce the Risk?

1. Safer machinery and tools:

• Fully enclosing dusty processes.
• Using local exhaust ventilation or dust collection equipment to suck dust away from the operator.
• Using tools with dust extraction (vacuum) devices.
• Using water to suppress dust (tool attachments, sprays at crushers, screens and transfer points, hosing down piles, wetting haul roads frequently).
• Operator enclosures which have an effective air filtration system..
• Using abrasives other than sand for abrasive blasting.

2. Safe work procedures:

• Wetting down dusty work areas or processes prior to work.
• Working upwind of dust sources where possible.
• Posting warning Signs where necessary.
• Developing & Standardizing work procedures to address dust problems.
• Training all employees on appropriate work procedures.
• Good housekeeping practices.

3. Respiratory (breathing) protection:

• Fit testing of all employees required to wear respiratory devices.
• Training employees in the proper use of respiratory devices.
• Making sure employees understand the hazards of dust and the importance of respirator use.
• Regular checking and cleaning of non-disposable respirators.

Photo electronically adapted from an illustration in a flyer in Moldex-Metric, Inc.'s brochure 8000-728 REV A 2/96

*Reprinted from the July 12, 1996, issue of Michigan's State Grants Mine Safety Training Newsletter 96-3: **Michigan Mine Safety**. Produced by the Mining Engineering Department of Michigan Technological University in Houghton. Manager—Dave Carlson 906/487-2453, Email: dcarlson@mtu.edu or Mary Ewert—906/487-2272 Dept. Chair - Francis Otuonye 906/487-2610 Internet Home Page: http://www.mm.mtu.edu/mine_safety/mine.html*

MSHA alerts underground coal mining community on silica hazards

The Mine Safety and Health Administration (MSHA) has begun a special program to encourage adoption of improved techniques to control crystalline silica dust exposure in underground coal mines, Assistant Secretary of Labor for Mine Safety and Health Davitt McAteer announced, Mines where substantial quantities of quartz-bearing rock must be mined through or drilled during the mining process are the most likely to have high concentrations of quartz in respirable dust.

"Crystalline silica or quartz dust is an especially hazardous component of respirable coal mine dust," McAteer said. "Overexposure can result in silicosis, a lung disease which in severe cases can be fatal. We have begun working with underground coal mine operators and miners to determine how

successful their current methods to control silica dust are and to encourage adoption of the latest control techniques. Our agency also will be working to increase the awareness of the health risk from silica exposure by educating both miners and mine operators."

MSHA health specialists will visit selected underground coal mines over the next four to five months to discuss the silica hazard with miners and mine operators, take special samples, analyze the quartz dust control techniques in use, and assist mine operators in trying new control methods. The program will concentrate on mines that are likely to exhibit significant quartz concentrations in respirable dust due to their geologic features and mining methods.

Mine operators who are participating in the MSHA program will be encouraged to try innovative methods to control quartz dust. MSHA will help mine operators evaluate new control measures If a particular method is tried but fails to achieve results at a given mine, the mine operator in this program will not be penalized for the failure but will be encouraged to continue experimenting until an effective combination of techniques for that mine is identified, McAteer emphasized. Mine operators who have not been contacted by MSHA, but are interested in participating in this program, should contact the MSHA district office which has jurisdiction over the mine.

"All of us in the mining community need to work together on the problem of reducing silica exposure," McAteer said.

The special quartz dust control program being conducted this year supplements *MSHA* s regular, ongoing program of respirable dust sampling by coal mine operators and MSHA inspectors to determine compliance with respirable dust standards. Currently, all coal mines are required to keep miners' respirable dust exposure levels at or below 2 milligrams per cubic meter of air. In the case of a mine with high levels of silica-containing dust, a standard below 2 milligrams per cubic meter is established to protect miners from overexposure to quartz.

Improved methods to control silica dust can include changing the size of the bits that cut coal and rock, locating water sprays where they will be more effective, and using different filters in machine-mounted air scrubbers. For instance, a recent study by J.F. Colinet and others, of the U.S. Bureau of Mines, *Laboratory Evaluation of Quartz Dust Capture of Irrigated-Filter Collection Systems for Continuous Miners*, identified a synthetic filter medium that may more thoroughly remove quartz from the mine air than most other filters currently used in U.S. coal mines.

This synthetic filter medium is currently being evaluated by MSHA in several coal mines. In addition, several mines are exploring the use of a new wet roof drilling technique, using less than 1 gallon of water per hole drilled, which results in the control of nearly all dust generated. The use of a specific water spray located under the boom of a continuous miner has been shown to reduce quartz dust concentrations.

According to a study by MSHA personnel T.F. Tomb, A.J. Gero, and J. Kogut published last December in *the Journal of Applied Occupational and Environmental Hygiene,* a substantial number of samples taken by MSHA in coal mines during recent years show quartz exposures in excess of 100 micrograms per cubic meter, the level at which current MSHA standards are intended to limit coal miners to quartz exposure. In addition, over the period 1985 through 1992, the article reported an increase in the quartz percentage to which coal miners in certain occupations were found to be exposed. Operators of continuous mining machines, cutting machines and roof bolting machines, along with these employees' helpers, are the underground coal mine employees most frequently exposed to excessive quartz dust.

McAteer said that MSHA has learned of several severe cases of silicosis among underground coal miners in recent years. "We are urging all coal mine operators and miners to take this hazard with the utmost seriousness."

"We know of one underground coal miner who died from silicosis while awaiting a lung transplant," McAteer said. "Another underground coal miner has been diagnosed with silicosis in his 40s. It is critical to make sure such tragedies do not recur." Last year, MSHA launched a special program focusing on silica exposure among drillers at surface coal mines after the National Institute for Occupational Safety and Health (NIOSH) discovered a number of cases of silicosis among surface coal mine employees in Pennsylvania. In 1994, the agency also issued a rule to require effective dust controls on drills.

In addition, Secretary of Labor Robert B. Reich last January appointed a nine-member advisory *committee* to make recommendation; on the elimination of black lung disease and silicosis among coal miners.

Reprinted from the United States Department of Labor's Philadelphia, Pa. regional Information Office's publication: News.

For further information contact the Mine Safety and Health Administration's Katharine Snyder at (703) 235-1452.

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Helping your wounds heal

Introduction

The most important protection each of us has is our skin. It provides a barrier against the outside world, and helps maintain the environment inside the body. Unbroken skin is our first line of defense against infection. But sometimes the skin does get injured and a wound is the result. Even a minor wound—a scrape, cut, or minor burn—may become infected. Infection occurs more often when the skin doesn't heal well or quickly, and more germs are able to enter the wound. Thus, wound healing is essential for guarding against infection.

Physicians and scientists are always trying to discover how skin injuries heal in order to find the best methods of wound care. This article summarizes this information for you, and tells what helps wounds heal, what is harmful to the healing process, and how you can help certain types of wounds heal. By working together with your doctor, nurse, and pharmacist, you can participate in the most effective care of your skin wounds.

How wounds heal

Wounds heal in a complex series of steps beginning almost immediately after injury. The blood pools and starts to clot, forming a bridge over which skin from one side of the wound can cross to meet skin from the other side. If the wound is large, specific cells begin to grow and divide to fill in the area. Special cells in the new tissue begin to stretch across the wound and then pull the wound edges together. The skin also pulls the edges of the wound together. During this time, the body releases chemicals that act to turn each step on and off. These chemicals also direct the body to send special blood cells to the injured area to protect it from germs that may have entered through the wound.

When you look at your skin you may think that most wounds heal within a few days. But, underneath each wound, the healing continues. If nothing goes wrong during the next few months, the area will become smoother and stronger. Healing will continue until the area is as close to its original condition as possible.

What factors affect wound healing?

Wound healing depends on some factors that are under your control, including diet, temperature, moisture, and wound protection. However, other factors cannot be controlled, such as the type, location, and size of a wound. Age and presence or absence of illness or infection also affect how well a wound will heal.

What are some general measures to help wounds heal?

There are some things we can do to help cuts, scrapes and minor burns heal quickly.

Wounds should be kept comfortably warm. Warmth shortens the time it takes for wounds to heal.

A well-balanced diet, rich in vitamins and minerals, is important if wounds are to heal properly. This becomes even more important as you get older.

Diabetics must stick to their diets, check their blood glucose level carefully and often, and take insulin as required. Without good blood sugar control, even a simple wound, such as a cut, can end up as a chronic skin ulcer. Control of diabetes is very important to proper wound healing.

What is harmful to wound healing?

Some common aids for cleaning wounds can be harmful. For example soap can delay wound healing if it is not rinsed off completely.

Cleaning a wound with a tissue, cotton ball, or cotton-tipped swab can leave paper or cotton fibers in a wound that can delay its healing.

Although not usually harmful to closed wounds, over-the-counter cortisone creams, lotions, and sprays to reduce redness or swelling should be used carefully. Cortisone can cover up signs of infection by reducing swelling and redness. Cortisone can also cause thinning or permanent discoloration of the skin.

Infected wounds do not heal properly. Germs can kill skin and tissue, preventing repair of all types of wounds. To avoid infection, the use of a topical (applied to the wound) antiseptic is suggested. An antiseptic kills germs that can cause infection.

Selecting a topical antiseptic

Active ingredient:

The active ingredient is the most important factor in choosing a topical (applied to the wound) antiseptic. Active ingredients are listed on the label, sometimes followed by the amount of ingredient in the product. Although there are many topical antiseptics on the market, there are only a few that have a broad spectrum. What does this mean? Basically, broad spectrum means that the product can stop the growth of many types of bacteria, and may even stop yeasts and other fungi and viruses from growing. When you use a broad-spectrum antiseptic you increase your chances of preventing or controlling skin infection.

Also remember, when you put an antiseptic on a wound, it doesn't have to hurt to be effective.

Type of topical preparation:

There are several types of preparations to choose from; each has advantages.

Ointments stay on the wound's surface and do not penetrate well into the skin. Because most ointments are made with a petroleum jelly base, they do not wash off easily from the skin surface. Ointments can also form a seal

over a wound, stopping loss of moisture and protecting the skin.

Cream or lotion-based antiseptics penetrate into the skin and keep a wound moist. They also protect the wound by forming a thin seal over the area, but this seal is not as protective as that of an ointment. Creams and lotions are easier and less painful to apply than ointments, making them helpful in wounds that are sensitive to touch. Also, creams can be used on wounds wet from serum. Creams and lotions can also be washed off the skin easily, which is very important in preventing damage to delicate new skin growth.

Gels become liquid when put on the skin, but then dry to a greaseless film that gives some protection by forming a thin seal over the wound. Gels can make a wound feel cool, but can also be drying.

A liquid antiseptic can help keep an area moist, especially when used with a wound covering. Liquids can also help make a wound feel cool. Antiseptic-containing liquids can be drying if no wound covering is used.

Aerosol spray antiseptics are helpful when a wound is sensitive to touch, for example, in burns. Some antiseptic sprays can also form a thin seal to protect the wound. Sprayon antiseptics can also provide moisture if covered quickly. Like liquids, if not covered, aerosol sprays can be drying.

Care of cuts, scrapes, and minor burns

Selecting a wound covering

There are several types of wound coverings on the market. When choosing a covering, make sure that it will **not** stick to the wound. That way, when you remove the covering, you won't damage the delicate new skin growth and reopen the wound.

An adhesive bandage or non-stick sterile gauze kept in place with adhesive tape, and used along with a topical antiseptic to provide moisture, is a good way to protect a simple wound. For wounds on fingers or toes, gauze or bandages can be held in place with tubular gauze. There are also wound coverings available that already contain antiseptics, so you don't need to buy the antiseptic separately.

There are some new wound coverings available other than the adhesive bandage or gauze. These coverings are usually made up of sterile, gel-like substances that copy the body's environment. The gel is usually covered with an adhesive material to keep it in place. Many of the products also let air reach the wound. These wound coverings help complex wounds such as skin ulcers and burns to heal. If you do choose one of these coverings, check with your doctor or pharmacist to find out if the topical antiseptic you have chosen will be affected by the covering. The new wound coverings are much more expensive than adhesive bandages and may make little difference to the healing of a simple, minor wound.

Specific suggestions for beating simple wounds

Step one: Examine the wound

Before starting to treat any cut or scrape, look at it carefully. If the edges of a cut cannot be brought together easily, if the wound is a serious burn, if the wound is deep or a puncture, or if you are not sure what to do, talk to your doctor or go to the nearest emergency treatment center. However, if the wound is clearly minor, you will probably be able to care for it yourself.

Step two: Cleansing

Start by washing your hands, especially under the fingernails. Although no skin is sterile, washing should lower the number of germs on the hands and reduce the chance of germs entering the wound, causing infection. Using ordinary soap and water is fine, or you can use an antiseptic-containing skin cleanser instead.

When treating a minor cut or scrape, the first step is to remove any foreign material or dirt. Then, gently clean the wound with either a mild soap and water or an antiseptic-containing product. Rinse the wound well with water if soap or a foaming antiseptic product containing a soap or detergent was used.

Step three: Protecting the wound

Once the wound is rinsed well, use a topical antiseptic to prevent infection. After putting the antiseptic on the wound, cover the wound with a sterile bandage or whatever covering you have chosen.

For best results, a simple wound should stay covered for at least two days. The covering should fit snugly against the wound, but should not cut off blood flow. The bandage should not be removed except to look at the wound if you suspect infection.

And remember:

If you have a fever, you must contact a doctor immediately. If the wound has pus, or you have more than a reasonable amount of redness, swelling, or pain, see your physician promptly. If a wound does not heal after several days, call your doctor. The wound may need stitches, or may need to be cleaned out more thoroughly.

Conclusion:

A physician's years of training and practice make him or her the best resource when it comes to providing sound, balanced medical advice. Treat doctors, nurses, and pharmacists as a resource. Don't be afraid to call and ask questions; that is what they are there for.

The most important protection against infection that each of us has is our skin. By helping the skin heal properly when it gets damaged, we are protecting ourselves from many possible infections. The more we know about what is helpful and harmful to wounds, the better we can care for them and ourselves.

Reprinted from The Purdue Frederick Co.'s: ***Helping your wounds heal.***

THE LAST WORD...

When primitive man screamed and beat the ground with sticks, they called it "witchcraft." When modern man does the same thing, they call it "golf."

Before a fight, two men are boasters; afterwards, only one.

The future belongs to those who know how to wait.

Better to turn back than lose your way.

Once a word is out of your mouth, you can't swallow it again.

Noblemen make promises, and peasants have to keep them.

The shortage will be divided among the peasants.

If you're tired of a friend, lend him money.

Even the woodpecker owes his success to the fact that he uses his head.

You're getting old when the gleam in your eye is the sun hitting your bifocals.

Experience is the best teacher. One reason: you get individual instruction.

NOTICE: We welcome any materials that you submit to the Holmes Safety Association Bulletin. We DESPERATELY need color photographs suitable for use on the front cover of the ***Bulletin.*** We cannot guarantee that they will be published, but if they are, we will list the contributor(s). Please let us know what you would like to see more of, or less of, in the Bulletin.

REMINDER: The District Council Safety Competition for 1996 is underway—please remember that if you are participating this year, you need to mail your quarterly report to:

Mine Safety & Health Administration
Educational Policy and Development
Holmes Safety Association Bulletin
P.O. Box 4187
Falls Church, Virginia 22044-0187

Please address all editorial comments to the editor, Fred Bigio, at the above address. Phone: (703) 235-1400

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This month's cover: A JOY 4LS longwall shearer, courtesy of Joy Technologies, Inc. We welcome ***any*** *materials that you submit to the Holmes Safety Association* ***Bulletin****. We especially need color photographs (8" x 10" or larger—color negatives are acceptable) for our covers. We cannot guarantee that they will be published, but if they are, we will list the contributor(s).*

Because of the recent federal shutdown, we did not publish the January issue of the Bulletin. We regret any inconvenience.

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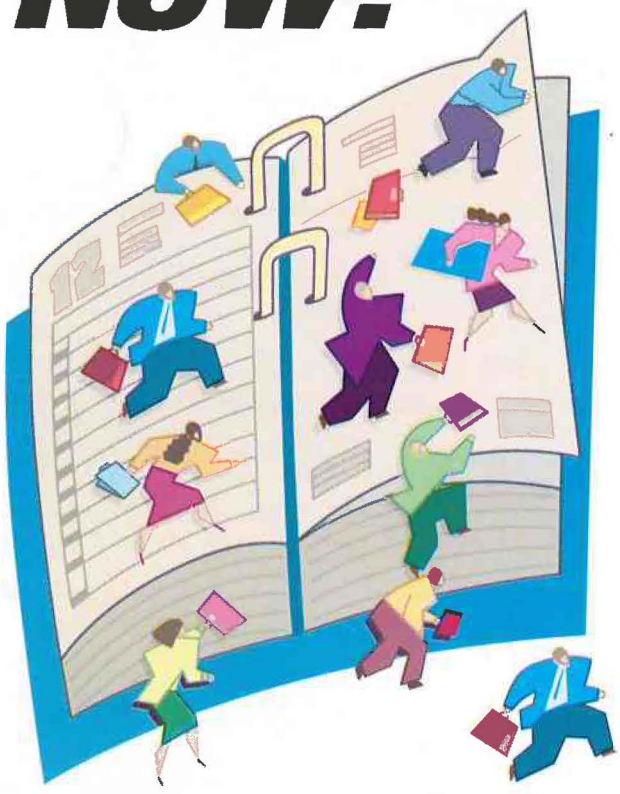

- *Oct. 15-17, 1996 TRAM Conference/National Mine Instructors Seminar, National Mine Academy, Beckley, WV*
- *Oct. 17-19, West Virginia Coal Mining Institute & Central Appalachian Section SME Joint Fall Meeting, The Greenbriar, White Sulphur Springs, WV*
- *Oct. 24-26, Kentucky Coal Association Annual Meeting, Marriott Griffin Gate Resort, Lexington, KY*
- *Nov. 7-8 (tentative), Kentucky Mining Institute Annual Meeting/Exhibit, Rupp Arena, Lexington, KY*