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C O N T E N T S

Reducing roof bolter operator cumulative trauma exposure

Ergonomics considerations for reducing cumulative trauma exposure

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Musculoskeletal injury is a term used to describe a wide range of soft tissue disorders which affect the nerves, tendons, and muscles. Common examples include lower back pain, tendonitis, and carpal tunnel syndrome. The majority of these injuries are not the result of sudden mishaps, but usually develop gradually from repeated wear and tear. Symptoms may first appear after weeks, months, or even years. Symptoms may result from many types of activities, performed at work or at home, and it is often difficult to attribute a single event. In fact, it is more common to identify the factors which may have contributed to the development of the condition. The terms repetitive strain injuries or cumulative trauma disorders (CTDs) have been commonly used to refer to disorders that have occurred due to work related activities (Putz-Anderson, 1988; Fraser, 1989).

Three main risk factors contribute to CTDs: force, repetition, and awkward postures. Any one or combination of these may contribute to the development of CTDs. Therefore, the design of equipment in conjunction with the required tasks should attempt to reduce these risk factors. Examining the layout of the work area to help identify tasks which may contribute to cumulative trauma is necessary. The following list (Putz-Anderson, 1988), describes ergonomic concerns that, overall, should be **minimized** at the work area:

Roof bolting in a low-seam mine often requires operators, such as this one, to maintain awkward postures.

Crowding or cramping the worker:
a work area layout may unnecessarily constrain movements of the worker.

Twisting or turning:
placement of tools and materials may require the worker to twist the spine to fulfill the requirements of the job.

Repeated reaching motions:
the layout of the work area may require the worker to lean to reach and grasp the necessary tools and controls.

Misalignment of body parts:
the arrangement of the work area may require the worker to frequently have one shoulder higher than the other or have the neck or spine bent to one side.

While many of these concerns are a function of equipment design and environmental conditions, making workers aware of these issues may help them to adapt their work habits to reduce risk of injury. Additionally, this information is useful when conducting an ergonomic evaluation of a work area and associated tasks.

Cumulative trauma exposure and coal mining

Although coal mining has become more mechanized, many jobs continue to be labor intensive and repetitive in nature. They entail tasks that, performed over time, can take a toll on the soft tissues and joints. The fact that the mining industry has an aging workforce may compound the problem. In 1986 the mean age of the coal mining workforce was 39 years and the median total years of experience was 11 (Butani, 1988). In 1992 the mean age of the coal mining work force was 42 years and the median total years of experience was 18 (NMA, 1995). As a person ages, the body's resilience to chronic wear and tear is reduced which may cause a worker to pay an increasingly higher health price for performing the same task (Grandjean, 1988; Putz-Anderson, 1988).

The United States Bureau of Mines (USBM) conducted an evaluation at an underground coal mine concerned about early warning signs of cumulative trauma. In particular, they were concerned about increased frequency of aches and pains reported by roof bolter operators. The primary roof bolting machine used at this mine, and thus the main focus of this evaluation, was a dual head, walk-through roof bolting machine. However, many of the identified issues and recommendations to follow will be applicable to other roof bolting machines as well.

Evaluation overview

Lost time incidents

The mine provided the researchers with 43 lost time incident descriptions. They consisted of all lost time incidents involving roof bolter operators for the period January 1, 1991 to August 30, 1994. It should be noted that those responsible for compiling incident descriptions usually identify the immediate activity as the cause of the injury. While this may be appropriate for some incidents, others may require more thorough examination of activities including those leading up to the incident. For cumulative trauma incidents there may be a combination of any number of factors which can lead to injuries. For this evaluation, researchers wished to identify roof bolting activities and operator injuries having characteristics consistent with cumulative trauma exposure. After examining the incident descriptions, 14 were selected and contained the following characteristics:

Five of the fourteen incidents involved pain in the back, neck, shoulder, or elbow.

• Two incidents occurred while putting a roof bolt in a drilled hole.
• Two incidents occurred while lifting bolting supplies
• One incident occurred while torquing a roof bolt

Nine of the fourteen incidents involved a strain or sprain injury to the ankle, knee, or hip resulting from a slip, trip or misstep.

• Seven incidents involved stepping or kneeling on uneven floor, loose materials on the floor, or equipment cable.
• Two incidents involved an operator stepping into or out of the drill platform of a bolting machine.

Interviews

During a mine site visit, interviews were conducted with roof bolter operators and a nurse who had treated many roof bolter operators. The objective of the interviews was to learn about bolting tasks and working conditions, to identify safety hazards, and to discuss the details of accidents and injuries. The interview data was analyzed to identify similarities in injuries and pains; tasks that may contribute to cumulative trauma; and aspects of the working environment that may contribute to cumulative trauma.

Twelve roof bolter operators were interviewed. The most common injuries cited were:

• lacerations and cuts to arms and face,
• shoulder, neck, and arm strains and pains,
• ankle sprains and twists, back pain and strains, and knee strains, and
• numbness in legs.

Operators said that roof bolting tasks require a lot of lifting, carrying, bending, reaching and stretching. Common activities cited as contributing to their pain and discomfort included: leg pains while leaning out to see the drill hole; hand and elbow pain from using the controls; sore knees, back, and shoulders from bending and twisting to put up pins or lift and position drill steels, wrenches, and bolts; shoulder and elbow aches from picking up and holding drill steels; and knee and back aches at the end of the shift from standing all day.

Comments made during the interviews concerning the roof bolting machines, broken into responses and associated issues are described in table 1. Many comments may apply to a variety of bolting machines.

The interview with the nurse provided information similar to that given by the operators. The most common ailments reported were aches, pains and muscle soreness. The most frequent complaint was shoulder pain caused by reaching and retrieving tasks.

TABLE 1: Interview responses and issues concerning roof bolting machines.

INTERVIEW RESPONSE	ISSUE
Operator canopy obstructs vision.	Operator must lean out from under canopy to see hole.
Work area in operator platform too tight.	Operator must do a lot of twisting to do job.
Drill controls are too close together.	Operator cannot fit gloved hand around controls to operate properly.
Tram levers are too tight on some machines.	Operator must apply excessive force to activate the controls.
Shortage of maintenance personnel and a lack of knowledge of how to maintain machines. Machines are not repaired adequately.	Insufficient support of boom causes play in boom and thus drill steels have a tendency to break.

Observations

Observations included operators bolting the top and ribs and an experienced bolter operator discussing the layout and operation of a roof

Table 2: Observations and issues concerning roof bolting machines.

OBSERVATION	ISSUE
Confined operator platform causes operators to twist and stretch to get drill steels, bolts, plates, and wrenches.	This places operator in awkward postures creating stress to the muscles and joints, particularly in the back and the knees.
Supply trays are positioned at heights well above the operators' waists.	Lifting and retrieving tools and bolts is stressful to the neck, arm, and shoulder.
Tops of control levers are positioned well above waist height.	The operator must work with the arm and wrist in awkward postures.
Operators lean against the back rail of operator compartment and out from under the canopy while performing drilling and bolting tasks.	This places the operators in awkward postures. Also, it is putting them at risk of being hit by falling top.
Operators shift their weight to the side of the body corresponding to the hand which places the drill steel into the drill chuck.	The muscles on the opposite side of the body, particularly the low back muscles, are stressed and may become fatigued.
Operators frequently extend their arm up and out to hold onto steels while drilling, and onto bolts while installing them.	This is stressful to the neck, arm, and shoulder muscles.
Drill steels are being inserted into the drill chuck usually at knee level or lower.	The operator must do more bending which stresses the low back muscles.
Transfer of supplies from the back of a bolting machine to supply trays involves frequent lifting, carrying, and twisting.	This places operator in awkward postures creating stress to the muscles and joints, particularly in the back and the knees.

bolting machine. After reviewing observation notes, video tape, and still photographs, key items were identified and are listed in table 2. Some observations are specific to the type of machine observed, while others are more general and can apply to many different bolting machines.

Issues and recommendations

Analysis of data obtained from lost time incidence reports, interviews, and observations was used to identify roof bolting factors which pose risk to the development of CTDs. These issues were:

- materials handling,
- operator orientation in work space,
- vision obstruction,
- control bank design, and
- slipping and tripping hazards.

For each issue a brief description will be provided followed by recommendations for reducing cumulative trauma exposure. Recommendations address the three elements which define a system: human, equipment, and environment. Recommendations directed at the human element are intended to increase worker awareness of risk factors. This knowledge can then be motivation for workers to modify their behavior to reduce exposure. Equipment recommendations address modifications to existing equipment which can be performed at the mine site or retrofitted by the manufacturer and recommendations that would require more significant changes that should be addressed in the design of future roof bolting machines. Environmental factors play an important role in human-machine interfaces. The underground mining environment is particularly challenging for equipment designers. For this reason, environmental limitations were considered when developing recommendations.

The recommendations are intended to be used as a guide for more comprehensive examinations of roof bolting activities. Each mine should conduct a mine specific evaluation due to varying conditions, equipment, and workforce. An evaluation team with diverse members including roof bolter operators, first line supervisors, engineers, and safety personnel is an effective approach for developing solutions (Hamrick, 1992; O'Green *et al.*, 1992; Carson, 1993). Additionally, more specific information is available concerning human factors considerations for reducing roof bolting hazards (Turin *et al.*, 1995) and for designing underground mobile mining equipment (see related internet resources at end of paper).

Figure 1.—Supplies piled on the back of a bolting machine

Materials handling

Roof bolter operators were observed performing two types of material handling tasks. The first involved retrieving supplies and loading them into supply trays. The second involved lifting and handling steels, bolts, plates, and wrenches while performing bolting tasks.

Figure 1 depicts supplies piled in a disorganized manner on the back of a bolting machine. Operators must bend, pull, slide, gather, and lift armfuls of supplies. Often supplies will shift and roll toward the operator. Once in tow, supplies are carried to the front of the machine and placed into trays. This process is repeated often over the course of a day. Although the worker has control over the size of a load and the pace of work, the walkway is narrow and they often assume awkward postures while carrying a cumbersome load.

The bolter operators may be able to minimize their risk to supply handling problems by maintaining order among the supplies piled on the machine. However, it may be possible to improve the layout of the work area thus easing supply handling for operators. For example, barriers are created by limited space in the operator platform and a supply tray that is located to the side of the operator at arm's length and too high (see figure 2). The result is that the operator must do frequent lifting while twisting and reaching.

Twisting and reaching while lifting can cause stress to the musculoskeletal system and increase the risk of injury (Grandjean, 1988). Twisting while handling supplies requires an asymmetric exertion where the load is in one hand and/or to one side of the body. This has been shown to be more hazardous than symmetric exertion, where the load is held in both hands at the center of the front of the body. Frequently, acute low back pain is associated with asymmetric activities. During interviews, several operators cited back pain on one side of the back, the side opposite the arm used to grasp drill steels and bolts. Reaching while lifting also places a worker at risk. It is important to keep an item being lifted or carried as close to the body as possible and at a low height. The further the load is from the spine, the greater the stress to the low back. The higher the load is held above the hips, the greater the stress to the upper extremities and back. Additional information is available concerning materials handling in low seam coal mines (Gallagher *et al.,* 1992). Furthermore, many of the recommendations in this document can be applied to higher seam mines.

Recommendations

• Evaluate the delivery, packaging and transport of roof bolting materials. For example, deliver materials as close as possible to the working area. Ensure that items are packaged in appropriate sized bundles.

Figure 2.—Bolter operator retrieving supplies froma tool tray mounted on a bolting machine

• Modifications to materials handling tasks should be geared toward carrying supplies as close to the body as possible, restricting the size of the load, and minimizing lifting distances.

• Supplies handled from the operator platform should be held slightly below elbow height, at about the height of the hip. There should be no barriers in the path which would require the operator to lift the supplies up and over.

• Evaluate supply tray design, reposition supply trays, or redesign the method of stacking and retrieving supplies. For example, supply trays can be designed to better accommodate necessary items, relocated to minimize handling materials, and positioned to reduce awkward postures and excessive force required to access items.

Operator orientation in work space

Roof bolter operator compartments are designed so that the operator faces the control bank. However, much of the work is performed at either side of the compartment. Drill steels, bolts, plates, and wrenches must be acquired while turning toward the inside of the machine. Reaching to insert tools or bolts into the drill chuck must be done while turning toward the front of the machine. The orientation of the operator's compartment is a direct contributor to the asymmetric exertion which was discussed in the materials handling section. It is recognized that the orientation of the work space would be difficult to change for existing machines; however, these issues should be considered as technological advances when designing future generations of roof bolting machines.

Jobs that require a worker to repeatedly reach above, behind, and/or to the side can contribute to shoulder disorders, even if the motion does not involve a heavy lift. (Putz-Anderson, 1988). Take for example a supermarket cashier who moves merchandise across an optical scanner. These cashiers do not repeatedly perform heavy lifts yet have experienced shoulder problems related to the motion required to do their job (Wilson & Grey, 1984).

Operators stand while working in high coal seams. Standing throughout a work day is very taxing to the lower extremities. Bolter operators spend a good portion of the time leaning toward the drill head side of a machine while performing bolting tasks. Having the body weight distributed to one side for extended periods is particularly stressful to the joints and soft tissues of the back and lower extremities on that side of the body.

Another concern related to operator orientation involves extending the arm and reaching up. Roof bolter operators were observed placing drill steels and bolts in the chuck and leaving their hand in place as the drill boom was raised (see

Figure 3.—Front end view of a dual boom, walk through bolting machine. The operator on the left is operating drill controls with his palms. The operator on the right has his left hand on the bolt while inserting it into the roof.

figure 3). As their hand moved upward their arm extended and their shoulder flexed. This motion, repeated over time, will cause stress to the joints and surrounding soft tissues.

Recommendations

- Bolter tasks and equipment should be designed to minimize shoulder abduction, where the upper arm is extended and no longer hangs straight down from the shoulder. This will keep the shoulder in a neutral posture and reduce stress.
- Operator work areas should be designed to facilitate operator tasks based on operator reach and visibility requirements.
- Examine position of supply trays in relation to operator (either lower trays or raise operator to achieve proper positioning).
- Utilize anti-fatigue mats on platforms or use shoe inserts.
- Consider a height adjustable, padded rail at back of operator platforms.
- Buyers and manufacturers of equipment should consider operator position, coal seam height, size of compartment, location of control bank, supply handling, and orientation to drill chuck when designing operator compartments.

Vision obstruction

Operator canopies on roof bolting machines, which protect operators from falling top, also can prevent them from having a clear view of the mine roof and subsequent hole being drilled. Consequently, operators may place themselves in postures which cause stress to the neck and back to see what they were doing. This posture used over time could result in neck and back strain and increase the risk of being hit by falling top.

Recommendations

- Ensure use of an operator canopy appropriate for the seam height. For example, in high seams, a canopy intended for a lower seam height will not extend high enough. This may obstruct the operator's line of sight to the hole.
- Future equipment models should consider alternative operator canopy and roof support designs aimed at improving operator vision of the roof.

Control bank design

It is critical to ensure that a work area is not located too high or too low. When it is too high, the shoulders must be raised frequently to compensate, which stresses the neck and shoulder muscles. When the work area is too low, the worker must bend over which causes stress to lower back muscles (Grandjean, 1988).

Bolter operators have been observed working in postures where the shoulder was raised in an undesirable position while force was exerted to activate controls. This was

TABLE 3: Elbow and hip heights for select male sizes (Pheasant, 1986)

	5th percentile	50th percentile	95th percentile
Elbow height (in.)	40.2	43.5	46.9
Hip Height (in.)	32.9	36.0	39.2

due to the tops of control levers being positioned at a height above waist level.

Two factors determine the desired height of a standing work station, the size of the operator and the type of work being performed (Grandjean, 1988). For example, precise or delicate work should be performed at a height several inches above waist height. Light work should be performed at approximately elbow height. Heavier work, such as roof bolting tasks should be performed at slightly below elbow height. Therefore, it is desirable for the operator to adjust the platform such that the tops of the controls are slightly below elbow height (approximately hip high). If the work area is too high when the platform is adjusted to its highest level, the operator could place something on the floor of the operator platform to elevate himself. Table 3 defines desired work station heights for a range of sizes of males which can be used as a guideline.

It is important that the spacing of controls not be too close. While control spacing may vary somewhat on each machine, the distance between tops of adjacent control levers, with the exception of the drill and feed levers, on one bolting machine was measured at 3/4 of an inch. Operators were observed operating control levers using the finger and thumb or the palm.

A small male operator (5th percentile) has a hand thickness of 1 inch measured at the metacarpalphalangeal joint of the middle finger. The same measurement for a large male operator (95th percentile) is 1.3 inches (NASA, 1978). An operator should be able to grasp the control top with the fingers wrapped around it. Grasping the controls in this manner allows an operator to easily generate the force required to activate it. A distance of 3/4 inch between control tops is too close for the bare hand of a small male and, therefore, inadequate for the gloved hand of any operator. Levers like the ones examined require a moderate amount of force. When they are operated by the finger and thumb this can stress the tendons controlling the fingers. Using the palm to operate controls can cause damage to the soft tissue of the hands (see figure 3).

Recommendations

• Ensure that operator platform position with respect to control bank position is adjustable to accommodate most workers. Also, workers must be educated on how they should position themselves in relation to the controls.

• Assess the control bank to determine what changes could be made to improve future iterations. A redesign of the control bank should allow an adequate amount of space between each control to accommodate the thickness of a 95th percentile male gloved hand. However, minimizing the total breadth of the control bank is also important. It may be necessary to examine combining functions or consider different types of controls.

Slipping and tripping hazards

Although no operators were observed to slip or trip, the existence of these hazards was apparent. Loose materials from the top were observed to fall into and around bolting machines with regularity. Hazards of the environment combined with narrow walkways and uneven floor on bolting machines place the operator at greater risk of slipping or tripping. In addition, when an adjustable operator platform is used its position relative to the walkway can vary creating an uneven threshold between the platform and the walkway. Daily exposure to these hazards could result in frequent twisting and strain to the lower extremities.

Recommendations

• Evaluate thresholds between walkways and operator platforms with special consideration given to slipping and tripping hazards.

• Improve housekeeping practices and implement an active program to evaluate.

• Increase worker awareness of slipping and tripping hazards.

Summary

The information presented is intended to provide the reader with an awareness of factors which may contribute to cumulative trauma injuries to roof bolter operators. The recommendations developed should be useful to equipment manufacturers and to the management and workforce at underground coal mines. Their common goal should be to reduce the risk of roof bolter operator cumulative trauma exposure.

Some of the problems identified in this report would require significant equipment design change. Equipment manufacturers should take into consideration factors which contribute to cumulative trauma exposure and make them an integral part of future equipment design. However, there are changes that could be implemented at the mine site or when a machine is sent back to the manufacturer for retrofitting. For example: changing control bank height with regard to operator position, installing a padded rail at back of operator compartment, and utilizing anti-fatigue mats or shoe inserts.

It is anticipated that mines could use the recommendations to provide roof bolter operators with task specific training. Elements for this training would include: awareness of the types of injuries consistent with cumulative trauma exposure, awareness of risk factors that contribute to cumulative trauma, proper materials handling procedures, and work procedures to reduce bending, lifting and reaching during bolt installation tasks. Training can have a more immediate impact than equipment redesign. Although, for many issues addressed in this evaluation, the impact will not be as effective as changes to equipment.

Other duties as assigned… in between bolting entries this miner helps secure the brattice.

The mine environment provides a unique challenge to equipment designers and places significant constraints on the design of equipment. However, manufacturers will often build a machine for use at a specific mine operation. When this occurs there is an opportunity for builder and customer to identify elements important to worker safety. Many of the issues presented may be addressed by options or features currently available or may be incorporated during machine construction. In order to ensure that the right tool is used for the job at hand there must be clear communication between designer and user. Therefore, it is apparent that the most effective long term solution would be for mine operators and manufacturers to work together to evaluate existing equipment and to develop future generations of mining equipment that incorporate sound ergonomic design principles.

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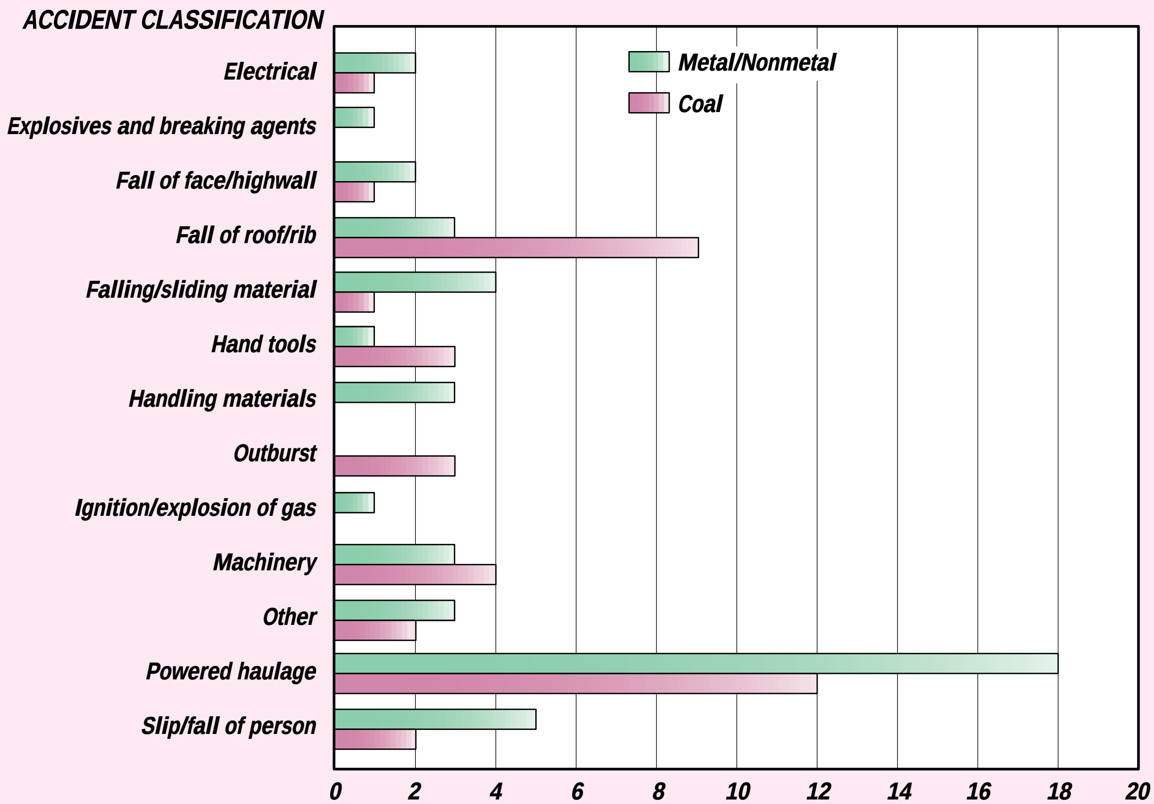
Related internet resources
Human Factors Recommendations for Underground Mobile Mining Equipment. *Accessible through NIOSHPRC World Wide Web page located at www.usbm.gov, last modified October 7, 1996.*

FATALITY SUMMARY, JANUARY-DECEMBER 1996*



* Based on preliminary accident reports as of 12/31/96

Fatality summary, January-December 1996

This article updates the status of fatalities occurring in both coal and metal/nonmetal mines from January through December of 1996. Based on preliminary accident reports, as of December 31, 1996, 84 fatalities occurred at coal and metal/nonmetal mining operations. During 1996, coal experienced 38 fatalities and metal/nonmetal had 46 fatalities. Powered haulage fatalities in both coal and metal/nonmetal were the most frequent accident classification—36 percent of the total fatal injuries.

Summary of coal and metal/nonmetal statistics:

Coal mining

Twelve of the fatalities were classified as powered haulage and nine were classified as fall of roof/rib. Twelve coal fatalities occurred each in Kentucky and West Virginia. Twenty-seven fatalities occurred underground and eleven occurred on the surface.

Metal/Nonmetal mining

Eighteen of the fatalities were classified as powered haulage. Slip or fall of person accidents accounted for five fatalities. Falling or sliding materials accidents accounted for four fatalities, and three fatalities each were classified as: fall of roof or back, handling materials, machinery and “other”. Fifteen fatalities occurred at limestone operations and ten occurred at sand and gravel operations. Thirty-four fatalities occurred at surface operations, and twelve fatalities occurred underground.

Submitted by: John Forte
MSHA Academy, Beckley, WV

Holmes Safety Assocation proposed constitution changes

*In accordance with Section 15 of the **Holmes Safety Association** Bylaws, Section 11(d) selection is proposed to be amended as follows:*

Amendment to Sec.11(d) Holmes Safety Assoc. Bylaws

In order to reflect the National Scope of the Holmes Safety Association, the Annual Society spring meeting location should be rotated among the following four zones listed below. Annual meeting site location will be rotated in the following order: Zone one, Zone two, Zone three, Zone four. Each year, at the annual spring meeting, representatives from the following four zones may petition Executive Committee to consider their particular location as a meeting site for the next meeting in their particular zone. Should no representative of a particular zone desire to host the next annual meeting, the annual meeting site will be rotated to the next zone.

Zone 1

Mississippi	Tennessee
West Virginia	South Carolina
Maryland	Louisiana
Alabama	Virginia
Georgia	Washington, DC
Arkansas	Kentucky
North Carolina	Florida

Zone 2

Missouri	Washington
Montana	South Dakota
Iowa	Wisconsin
Oregon	Wyoming
Nebraska	Alaska
Illinois	Idaho
North Dakota	Minnesota

Zone 3

Michigan	Ohio
New York	Connecticut
Maine	Indiana
New Jersey	Rhode Island
New Hampshire	Pennsylvania
Delaware	Massachusetts
Vermont	

Zone 4

California	Arizona
Kansas	Hawaii
Nevada	New Mexico
Oklahoma	Utah
Colorado	Texas

Supporting Rationale

By realigning some of the locations Zone 1 and placing them in Zone 2 will more evenly distribute the representation of Holmes chapters around the country.

Submitted by: Robert Glatter, National Secretary/Treasurer, HSA

Hidden costs of on-the-job injuries add up to more than time

How many dollars do you lose each year because of on the job injuries? $5,000?, $50,000? Usually, we call them accidents but that is too easy a term for a very involved process.

Every day in your [mine or] plant there are accidents of one kind or another: minor falls, slips, strains, cuts, spills, near misses. Ninety-nine percent of these accidents go unreported and, usually, go unnoticed. The only accidents reported are those resulting in an injury requiring some medical attention other than first aid.

And it's these job-related injuries that often result in some time lost from the job—from a few hours to several weeks, depending upon the severity of the injuries. More important, these time-loss injuries contribute heavily to the compilation of each company's workers' compensation premiums.

Necessary expenses

As profit margins continue to shrink for mine owners and competition becomes keener, many mine operators are searching for ways in which to cut overhead—from cutting back on the number of employees to abolishing unprofitable services. A line item in every company's operating budget is: Workers' Compensation Premiums, a necessary expense of doing business.

What are your annual workers, compensation premiums—$10,000, $25,000, $50,000 or more? Check it out, and at the same time check out your time loss injures over the past three years (premiums are based on the time-loss injuries of the past three years).

Workers' compensation premiums are based on the sum of three calculatons:

• **Job risk rate**—How accident-prone is a particular job? Obviously a roof bolter or a common laborer has more of an injury risk than an office clerk. There are over 700 job risk classifications, and the higher the job risk classification, the higher the job risk rate.

• **Applicable wages rate**—The higher the wages paid to a particular group of workers such as roof bolter operators or continuous miner operators or muckers, the higher the wages rate that compose the second part of workers' compensation premiums.

• **Company's time loss injury (experience) rate**—This is where those time loss injuries really count. When a worker is injured on the job, workers' compensation insurance pays two items—medical costs of the injury and wage compensation. The medical costs depend upon the severity and duration of the injury.

If a preparation plant worker hurts his back while carrying bags, and the injury requires back surgery and a hospital stay, the medical bills will be in the thousands of dollars. However, if the injury is a mild back strain, requiring rest and muscle relaxants, the medical expense is minimal.

Factoring in wage compensation

Wage compensation is the other part of the time loss experience rate calculation. Any wages lost as the result of a job injury are usually compensated at 2/3 of the injured worker's regular hourly rate up to a state-imposed maximum of so much per week. This weekly maximum is usually higher in jurisdictions where the cost of living is higher.

Every hour an injured worker is paid via workers' wage compensation, wage compensation increases that company's experience rate. Medical costs and wage compensation together account for the company's loss-time injury experience rate.

In terms of the three items that determine workers' comp premiums, the first two are about the same for all mining companies.

Mining companies have similar kinds of employees—continuous miner operators, haulage truck operators, general laborers, loader operators, etc. Also, in each locality, employers pay their employees about the same wages in order to remain competitive in the labor market

For the most part there are no variables with these first two items that comprise workers' comp premiums. It is with the loss-time experience rate that the differences occur: Any operator with few or no time-loss injuries has an advantage over a competitor since his workers' comp premiums will be less.

Direct costs

Further, there is another variable, often overlooked, with time-loss injuries. Workers' compensation insurance companies claim that the workers' compensation premiums paid are only one part of the employee injury expense. The premiums they pay are the visible or direct costs of on the job injuries.

These direct costs are only the tip of the total injury iceberg.

Adding up hidden costs

There are also indirect costs which are seldom accounted for. These indirect or hidden costs are: lost time to supervisor and co-workers when the injury occurred; lost time in investigating the injury; lost time in completing all the paper work involved; lost time in finding a replacement; lost time in hiring and training a replacement; overtime paid to make up for lost time in replacing the injured worker; loss of productivity with a new crew member such as slower production, damage to equipment and tools; payment of wages to the injured worker when he/she returns to part-time light duty. And the hidden costs to the company do not account for the economic loss to the injured worker and his/her family.

To calculate the dollars lost in hidden injury costs, insurance companies use the factor of four times the actual medical and wage compensation costs. So for each lost-time injury, add together the medical and compensation costs from your worker's comp insurance company report and multiply by four (hidden costs) to arrive at the total cost of that particular time loss injury.

If you have no accidents in any particular year, the only injury costs you have are your workers' compensation premiums. Also, for every year in which you have no lost-time injuries, or in which you decrease your time losses from the previous year, your premiums decrease. Conversely, each time loss injury increases, your premiums increase as well as your hidden costs.

A bottom-line consideration

Workplace safety is a bottom-line consideration. Many mining companies chalk up literally thousands of dollars in workers' comp premiums and injury hidden costs to "the cost of doing business" with little or no thought toward the establishment and enforcement of a strong safety program. Safety programs, even with incentive projects, are much less expensive than the injury costs outlined above.

But employee injuries are not a way of life in the workplace and are not a necessary cost of doing business. Rather, most injuries can be prevented with a company mindset that is directed toward instituting a company safety program that has both incentives and enforcement.

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HSA Bulletin articles categorized

Special thanks go to Robert McGee of the Pennsylvania Bureau of Deep Mine Safety for submitting copies of the HSA articles by category from May 1989-December 1996. If you are interested in obtaining a copy of this categorized listing, please contact Bob Glatter at (703) 235-8264 or Merle Moore at (304) 256-3531.

Alternative arrangements

by Alan L. Dessoff

Every other week, most employees in the headquarters of ARCO Coal Company in Denver, Colo., take a three-day weekend. They also can take President's Day, Good Friday and Veterans Day holidays either on their designated days, or whenever they want throughout the year.
At The Doe Run Company's headquarters in St. Louis, Mo., employees can arrive and leave a half hour earlier or later than the company's normal working hours of 8 a.m. to 4:30 p.m.

Meanwhile, at some of Doe Run's mines and mills, workers put in l0-hour shifts, three days on and three days off. Similarly, Phelps Dodge Corporation is experimenting with four days of 12-hour shifts followed by four days off at one of its field operations.

Flexible scheduling like this is part of a trend in American business and industry to provide workplace options for employees without jeopardizing operating efficiency. In fact, according to a recent article in Hemispheres magazine, management consulting firm Hewitt Associates found that 73 percent of the major corporations it surveyed in 1995 offered flex time.

Many companies that have tried flex time say it boosts employee morale and productivity, which go hand-in-hand, thereby generating positive bottomline results. Mining companies that have adopted alternative schedules have been able to lower costs per ton by 10 to 20 percent—"a dramatic improvement," according to Richard Coleman, president of Coleman Consulting Group in Koss, Calif.

Phelps Dodge employees who work the four-and-four schedule are truck shop, field maintenance, and electrical workers at the company's mine in Tyrones, N.M. "They have nearly perfect" attendance, reports Tom Foster, Phelps Dodge vice president and controller. "So it evidently has an impact on their enjoyment of their work," he says.

Circumstances dictate

Not all workplace operations lend themselves to alternate work scheduling like flex time in offices or different shift structures in mines and manufacturing facilities. "We will only consider those types of schedules when they have no negative impact on operations, stresses James Stack, vice president of human resources at Doe Run. While employee convenience is a key factor, work scheduling basically is a business decision.

Coleman agrees. "It's a cost-efficiency measure. Meeting customers' needs better and staying competitive are driving more companies to alternative schedules," Coleman asserts. "Their goal is to lower costs per ton."

Often, says Coleman, alternative schedules are determined by decisions to operate some industrial facilities or the equipment in them more hours than at other places. "Sometimes it makes more sense to run your best piece of equipment all the time; or to shut down two older plants here, but run five other newer, more efficient plants around the clock."

Union rules determine work

schedules in many types of jobs, and arrangements that differ from the norm frequently are subject to labor negotiations.

"However," says Coleman, "the last industry contract with the United Mine Workers of America produced a breakthrough," allowing union and management for the first time to agree on different types of scheduling at individual sites.

As a result, some mining companies "are just starting to look at creative schedules," says Coleman. While the companies' incentive is to be competitive with non union mines, workers recognize that maintaining that competitiveness will preserve jobs and boost company profits—good news for labor and management alike.

Doe Run instituted its alternative work options for the convenience of its employees. Driving to and from corporate headquarters proved to be a difficult commute for some employees because of the building's location. Highway construction in the area aggravated the problem.

So Doe Run began offering limited flex time schedules. With the approval of their supervisors, employees can work from 7:30 to 4 or 8:30 to 5 if it helps them avoid traffic tie-ups during normal commuting hours, explains Stack.

At Doe Run, the locations of the company's mines and mills present other problems. They are mostly in rural areas, which means some employees must drive 50 miles or more each way every day, says Stack. Under the alternate work schedule available to them, they still put in a 40-hour week but in only four work days, not five, thereby reducing driving time and mileage.

Similarly, Caterpillar Inc., headquartered in Peoria, Ill., allows employees to start work between 7 and 8 a.m. and leave accordingly, says Emmy Wright, public communications representative.

In addition to easing transportation problems, flexible arrangements also allows employees "to accommodate their personal schedules better," says Wright. For single-parent households or families with two wage-earners, flexible working hours allow employees to coordinate schedules with caregivers for children or elderly relatives.

With more continuous time off, many employees devote time to self-improvement. Several such employees working flexible schedules at the Phelps Dodge mine have signed up to take courses at nearby Western New Mexico State University, reports Foster.

Enlarging the scope

ARCO Coal's hourly employees have worked different shift schedules—8, 10 or 12 hours—for years, depending on operational needs, says Charlene Wilson, manager of compensation and benefits Now the company is considering offering those arrangements to human resources, accounting and other support personnel at the mines. As at Doe Run, it has to do with the length of their commute," states Wilson.

Meanwhile, at ARCO's headquarters in Denver, office employees enjoy several flexible work options. Arriving and leaving at different times is only one of them.

Most ARCO employees work 9 days in two weeks and every other week, they can take a three-day weekend. In the first week, they put in 9-hour days Monday through Thursday, with 8 hours on Friday, totaling 44 hours. The next week, they again work four 9-hour days, totaling 36 hours, but take Friday off.

It averages 40 hours a week, and ARCO has arranged it so half the group is off one Friday and half the next. Thus, a partial staff is always there.

The flex time option "has gone over extremely well; people love it, because they have that three-day weekend every other week," Wilson declares. Some employees, she notes, have chosen to stick to a traditional five-day. 8-hours-a-day schedule.

Then there are the holidays. This year, for the first time, ARCO removed President's Day, Good Friday and Veterans Day from the standard holiday schedule in its Denver office. Instead of closing, the office remains open on those days. Employees still can stay home and observe the holidays as designated, or they can go to work and take the holiday time wherever they want, perhaps adding it to their vacations.

You always can come up with attractive schedules for employees," says Coleman. "They may not be traditional, but a lot of people prefer schedules that give them more time off."

Finally, ARCO Coal has initiated another change in office procedure. It has extended casual dress on Friday, a popular practice throughout corporate America, to the rest of the week. Now, employees can come to work every day wearing just about anything—within reason.

We haven't had to counsel anybody about inappropriate dress," says Wilson. "People love it."

ARCO Coal sees no need, however, to extend the practice to its field operations. "They obviously have casual dress there all the time," quips Wilson.

No matter what changes companies choose to make, one thing is clear: most employees appreciate a little flexibility. As competition increases for workers with top skills, offering the benefit of alternative work schedules may help companies attract and keep both their people and their loyalty—perhaps the best benefits for the company to have.

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1997 National Conference to Eliminate Silicosis

A National Conference to Eliminate Silicosis, sponsored by MSHA, OSHA, NIOSH and the American Lung Association, will be held March 25-26, 1997, in Washington, D.C. The conference will provide a forum for representatives of business, labor, health professionals, and the government to exchange information and share specific techniques to prevent silicosis. The two-day event will highlight best practices in equipment and engineering controls and training, respiratory protection, and health surveillance programs, as well as other timely topics. The goal is to have every participant leave the conference armed with practical ways to control silica dust and prevent silicosis, along with knowing where to turn for advice or help. Anyone who plays a part in controlling workers' exposure to crystalline silica should not miss this dynamic forum. This includes small and large employers, managers, workers, health and safety committee members, representatives of labor organizations and trade associations, industrial hygienists, engineers, trainers, occupational health nurses and physicians, and representatives from federal, state and local governments. For further information and registration details, contact Donna Green with MSHA at (703) 235-2625.