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C O N T E N T S

Energy management alternatives for aggregate producers

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Ed. Note. The following article is excerpted from Dr. Kohler '5' presentation at the 1996 NSA/U.S. Geological Survey Automation Conference in Atlanta.

Historically, the cost of electricity to produce a ton of stone has not been a concern to most producers. Over the past decade, however, electricity costs have been escalating at a rate that places them second only to health care. During the same time period, the selling price of aggregate products has been relatively constant, and in some cases has even decreased. Reducing costs has become a key to survival.

The electrical cost to produce a ton of product is highly variable and depends on many factors. Given the nature of these variables, it is difficult to make sweeping generalizations. Thus, the producer paying $0.90/ton may actually be operating at an optimal point insofar as energy costs are concerned, whereas the one paying $0.20/ton may be missing opportunities to save money.

Activities to reduce the amount of money spent on electrical power can be divided into two broad categories: cost control and energy control. Cost control activities focus on obtaining the most favorable rate schedule from the utility. Energy control activities reduce costs by actually reducing energy usage and changing the pattern of consumption. Both categories must be a part of a comprehensive energy management plan.

Cost control

Two opportunities exist here: make changes to the rate schedule or its riders and attachments; negotiate more favorable pricing under the existing schedule.

Negotiated rate schedule

Each utility publishes a set of rate schedules that apply to different classes of users. Industrial users are typically classified by the amount of power they use and the voltage level at which the power is purchased. A variety of special provisions or riders may be available, depending on which rate schedule applies. Thus, the rates at which the industrial user purchases power appear to be "cut and dried," and this is the case at many plants. However, others may be getting a better rate than printed on the schedule, based on their ability to negotiate the more favorable rate.

State regulatory agencies generally restrict the amount of deviation from the published schedules, and many tariffs permit negotiated rates only if necessary to preserve jobs, or as an incentive to create new jobs . However, the utilities are uneasy over the free-market rules now being enacted, and are anxious to keep existing customers happy. Towards this end, it should be recognized that they may be able to offer financial incentives in lieu of a reduction in the rates. Such incentives can be as simple as relaxing the dates and limitations on a seasonal rate structure, or more involved, such as offers to upgrade capital equipment or quality of service.

Producers can negotiate a variety of favorable items, and there are concessions that can be given to reduce the producer's costs. Success will depend largely on the producer's understanding of what to ask for, rather than negotiating tenacity.

Rate schedule changes

The rate schedule the company has been under may no longer be the best one. Over the years, the number of hours of operation and the number of active production months may have changed, or perhaps consumption is significantly different now than when the rate schedule was first selected. As a result, it may be possible to achieve annual savings of 20 percent or more, simply by switching to a different schedule or examining rider options.

The two most popular and well-known riders are time of-use and demand-side management (DSM). Both offer significant savings, if the associated constraints are acceptable at a given operation. If, for example, the plant layout (and operating permit) allow crushing at night time, significant savings can be realized through a time-of-use rider.

A common DSM rider is curtailable or interruptible service. If the plant can stockpile sufficient material so that it can shut everything down—except perhaps the offices, shops, and scale house—for a few days at a time, then very large savings can be realized.

A change in rate schedule or the associated riders must be carefully analyzed to ensure that it will result in the desired savings. One way to do this is to enter monthly usage data for the past three years into a spreadsheet, and compute the monthly and annual costs under the various possible schedules and riders. After these analyses are completed, an informed decision can be made.

Service voltage changes

Most schedules offer more favorable rates if the power is purchased at a higher voltage. The highest voltage available on a specific property is fixed by the voltage of the utility's aerial line, and few aggregate operations are large enough to justify a change to the utility's distribution system. Nonetheless, many plants still buy power at low voltage—i.e., the utility owns the transformer— and therein lies the opportunity for savings.

Many older properties have one transformer that is owned by the utility; the plant has a low-voltage distribution system. Sometimes, these plants are plagued with a variety of electrical problems, such as premature motor failures. In these situations, the additional savings that could be obtained by changing to a medium voltage system and owning the transformer is substantial. Quantifying these benefits is somewhat difficult, and requires an analysis of power system design alternatives in addition to an economic analysis.

In a new installation, it may appear to be cheaper for the utility to own the transformer, but after analysis it is almost always advantageous for the company to own it.

Energy control

Generally, it is possible to reduce the amount of energy used to produce a ton of product, which will reduce both the energy and demand charges, and to reallocate the energy usage per unit time, which will reduce demand charges. The process of doing this is loosely known as energy management.

The first step is to analyze energy consumption, i.e., to perform an energy audit, and then to evaluate the efficacy of various alternatives. Differences in operations result in a need for different approaches to energy management, but at most operations, it is appropriate to consider simple energy conservation, equipment replacement, process modification, load shedding, and on-site generation.

The energy audit

An energy audit is needed to determine exactly how much energy is being used, when, and by what. Accordingly, the major effort in an energy audit is an on-site instrumentation and data collection program.

At a minimum, each transformer on the property should be instrumented, and its power parameters recorded for a reasonable period of "representative" operation, usually at least one to two weeks. At the same time major loads should be instrumented and recorded. This should be done when the plant is in a heavy production mode, although it need not be during the highest month of usage. Depending on the goals of the audit, other electrical loads may also be instrumented and recorded.

The audit will yield valuable information on loads that contribute to coincident and peak demands, load factors, power factor, process efficiency, and electrical performance measures, among other things. A variety of engineering and economic analyses can be performed once these data are available.

Although it is also necessary to also collect and analyze historical records, such as past utility bills, to aid the decision-making process, it is the quality of the instrumentation effort that will establish a baseline for the overall success of the energy management effort.

Simple energy conservation

Many of the actions that could be taken to reduce energy consumption are really energy conservation measures. The most basic of these is: turn it off if you are not using it. Obviously, there are certain practical limitations to this in the plant, but there are other opportunities, as illustrated by the following actual cases:

- A bank of electric heaters was left on, unnecessarily, during the late spring and fall months. The peak demand for the year was always established during the same time period. By terminating the use of these heaters, the company reduced energy and demand charges significantly;
- An exhauster fan in a bituminous concrete plant was turned off between customers, with an annual savings of several thousand dollars.

The cost of one kW used for one hour is so small that it is easy to dismiss any conservation measure that only saves a few kW. However, if that 1 kW is active when the peak demand for the month occurs, its economic impact will be on the order of 1000 times more than the cost of the energy alone; if that peak demand determines the ratchet or base demand charge for the next year, the cost of that 1 kW of wasted consumption may well exceed 10,000 times the cost of 1 kW-hr.

Equipment replacement

If a new plant is being constructed, or existing equipment has to be replaced, it makes sense to consider a more energy efficient replacement, and in most cases, the added cost of the more efficient unit can be justified. Motors, transformers, electric heaters and capacitors (to correct power factor) are the electrical equipment types usually considered for replacement.

Process modification

Often an improvement in the process, or some of its elements, will result in a savings of electrical energy or a reduction in demand.

Such improvements are often more easily justified because they enhance other aspects of the process, such as quality, or reduce other costs, in addition to reducing the monthly electric bill.

Water handling

A large amount of energy is used to move water around a plant, yet little thought is given to the design and installation of pumps and piping. Motors and pumps are often grossly mismatched, piping is incorrectly sized, and the entire system is sometimes poorly maintained, thereby amplifying losses.

Sumps, reservoirs, and tanks are sometimes used advantageously to reduce electrical costs, although not as often as practical. The pumping system should be examined to ensure all of the pumps being used are actually needed. The contribution of the pumps to the monthly demand should be scrutinized, because it is likely that they are major contributors.

Crushing and screening

Any inefficiencies in the processing plant will translate directly into increased energy costs. Many of these inefficiencies can be worked out of the plant with small modifications or even changes in maintenance procedures. Identifying these and taking action can result in significant savings.

Automation

An often overlooked benefit of plant automation is the reduction in power costs. A properly automated plant can reduce the number of hours needed to produce product, and as a result the amount of electrical power used will be lowered. Another benefit is simply the ability to use the automation system's capabilities to monitor and then provide graphs of power consumption. A first step in reducing consumption is to understand patterns of usage and the capabilities of the automation system can be a valuable tool in this regard.

Drilling and blasting

The mining and processing operations are interrelated yet it is common to focus more on individual segments, rather than on the system. When evaluating drilling and blasting costs, for example, crushing costs may not be considered. Yet, crushing represents a significant portion of the electrical load. Thus in optimizing drilling and blasting, power costs should be considered in addition to the traditional considerations of drilling, blasting, and loading. In a recent test of a stemming plug, for example, it was found that the electrical energy required for primary and secondary crushing dropped by nearly 10 percent.

Load monitoring and load shedding

It has been found that plant personnel can do a better job of reducing both demand and consumption if they know what the usage is throughout the work day. Stand-alone load monitoring systems can be purchased, or if the plant has an automation system, load monitoring can be added easily and economically, if it is not already present.

Based on a good knowledge of electricity usage, personnel can manually schedule certain activities to avoid increasing the demand at a given time. The next step is to automate the scheduling, based on monitoring, so that certain loads can be shed or prevented from coming online whenever the demand is above a certain threshold.

On-site generation

On-site generation is sometimes imperative in areas where utility service is unavailable, or where it would be uneconomical to extend the plant power system to satisfy a need for electrical service. Beyond this, on-site generation is often considered as a means of reducing high electrical bills. This can only be justified in very unique circumstances.

One situation where on-site generation should be considered is peak shaving. If the base demand is being set by a predictable and otherwise unavoidable loading during one or two months of the year, it may be practical to use a generator to supply this portion of the load.

Summary

Electrical system costs, and especially power costs, represent an area where significant savings can be achieved in many operations. If plant automation is being considered, then there is a natural opportunity to address plant inefficiencies, thus reducing energy usage and power costs. If the plant is already automated, there are still a number of possible areas in which consumption or demand can be reduced.

Energy usage throughout the operation must be audited, and the appropriate engineering analyses must be performed. An economic analysis, preferably based on a discounted cash flow internal rate of return, must be performed to determine the relative merit of various energy-reduction alternatives. Tariffs, rate schedules and riders change with time, and should be examined periodically.

In any case, it is crucial that an information-based decision be made, rather than one based on speculation and assumptions.

*Reprinted from the December 1996 issue of the National Stone Association's **Stone Review.***

Eleven Western states report reclamation costs over $2.7 billion

While MSHA issues warnings about abandoned mine sites and the Bureau of Land Management tries to close off dangerous sites, Western states report that cleanup of inactive and abandoned hardrock mines may cost well over $2 billion.

States do not uniformly keep track of abandoned mines. Some states have fairly accurate counts of abandoned mines and other states can only guess. But according to a report by the Western Governors Assn., the 11 states that have reported back to the association claim that reclaiming the abandoned mine sites may cost $2.78 billion. Below is a list of states that reported to the Governor's Assn and their statistics on abandoned sites.

Alaska: An estimated 432 mine openings, of which 129 were deemed hazardous, covering an estimated 27,680 acres. Estimated reclamation cost: $5 million to $10 million.

Arizona: 80,000 sites covering 96,653 acres of disturbed land, 40,000 acres of mine dumps and 200 miles of polluted waters. These sites do not include Indian lands. Estimated reclamation cost: $654 million.

California: 2,484 mine sites, with 1,685 mine openings, 578 miles of polluted streams and 171 mine dumps. Estimated reclamation cost: not reported by the state's Inactive and Abandoned Mines Lands report.

Colorado: An estimated 20,299 mine openings, 13,486 acres of disturbed land, 11,800 acres affected by mine dumps, 1,298 miles of polluted streams and 1,125 hazardous structures. None of the sites was deemed in danger of subsidence or collapse. Estimated reclamation cost: $245 million, including mine sites within the boundaries of Superfund sites if it was assumed the sites would not be remediated under the Superfund program.

Idaho: An estimated 8,700 exploration sites with a total 27,543 acres of disturbed land and mine dumps. Estimated reclamation cost: $316 million, plus another $1.4 million to conduct a statewide inventory of abandoned hardrock mines.

Montana: 19,751 sites covering 148,000 acres; 1,118 miles of polluted streams; mine dumps on 14,038 acres; 20,862 acres of disturbed land; 1,845 acres of subsidence-prone areas; and 1,174 hazardous structures. Estimated reclamation cost: $912 million. Cost estimate includes the state's proposed Superfund sites.

Nevada: An estimated 50,000 that pose significant hazards and 1,000 acres of distsbed land. Estimated reclamation cost: $2.5 million. Cost estimate based only on hazardous mine openings and does not include environmental impacts.

New Mexico: 7,222 abandoned mines on 25,320 acres of disturbed land, and 69 miles of polluted streams. Estimated reclamation cost: $332 million.

Oregon: An estimated 3,500 abandoned mines on 9,200 acres. Estimated reclamation cost: Between $57 million and $77 million.

Utah: An estimated 20,000 abandoned hardrock mines. Sites cover 25,020 acres, with at least 83 miles of polluted streams. Estimated reclamation cost: $175 million.

Wyoming: State reports no data, but reported an estimated reclamation cost of $45 million.

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Technology on the job

Health

More precise eye surgery is possible using laser radar (ladar) technology originally developed by the Ballistic Missile Defense Organization for missile targeting and space docking. Orlando-based Autonomous Technologies (407/282- 1262) has adapted ladar technology to track irregular eye movements during excimer laser surgery. The ladar system is used in a product called T-PRK to improve the accuracy of photorefractive keratectomy. T-PRK's LADARvision steers the excimer beam to track the eye and increase the accuracy of the procedure. An IR laser scans the patient's pupil to detect slight and involuntary saccadic eye movements, adjusting the beam accordingly. T-PRK units are undergoing clinical trials at five sites across the U.S., with marketing efforts underway in foreign markets.

An antibacterial high-chair has been introduced by *Playskool*. The 1-2-3 High-Chair is constructed with Huntersville, N.C.-based Microban Products' antibacterial components embedded in the plastic to inhibit the growth of bacteria, mold, fungus, etc. The nontoxic material is colorless, odorless, does not wash off, and lasts the life of the product. The high-chair sells for $80. For more details, call Playskool at 800/752-9755.

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An effective silicosis prevention program

By Kelly Bailey, Occupational Health Manager, Vulcan Materials Company

Silicosis is an incurable lung disease that is caused by the inhalation of respirable, crystalline silica containing dust particles in excessive quantities over a period as short as a few months (acute silicosis) to as long as 15 to 20 years or more (chronic silicosis). Since silicosis is incurable, the only way to eliminate the disease is to prevent it from occurring in the first place. Silicosis can be stopped from causing more serious harm if it is caught early enough and exposure to respirable silica containing dust is controlled. This is where a good occupational health program comes into the equation.

First of all, it is important to understand what is meant by the word "exposure." To have an adverse health effect due to an agent, the dosage must be sufficient enough to overwhelm the body's natural defense mechanism. Different people have different capabilities in this regard, so not everyone's safe level of exposure is the same.

The degree of exposure is the product of two variables: the concentration of the agent and the duration of the exposure. Reducing either or both of these variables will lower the likelihood of disease.

In the case of silica and silicosis prevention, the mineralogy of the ore deposit is a very significant factor in designing a prevention program. Silica is one of the most common minerals on earth, and occurs in most types of rock. Quartzite is almost pure silica; sandstone can be 20-40 percent or more silica; granite averages around 20 percent silica, but can be as high as 50-60 percent; and limestone averages around four percent, but can be as high as 20 percent. The higher the concentration of silica in the deposit, the higher the risk for silicosis. Since it will take less respirable dust with a high silica rock to achieve an unsafe level of exposure, better dust control will be needed as the silica content increases.

Additionally, most deposits being mined are not uniform with respect to geology. Silica concentrations can differ dramatically in the same mine and even within the active face being mined. In practical terms, this means that a safe exposure today may be an unsafe exposure tomorrow and vice-versa. This is one of the reasons for having your own exposure monitoring program.

Another important factor in silicosis prevention is the particle size of the silica in the air. To cause silicosis, the silica particles must be respirable and able to reach the smallest airways and air sacs in the lungs. This means the particles must be around three to five microns in diameter. When a respirable dust sample is collected, a device (cyclone) is used prior to the collection filter to separate and remove particles that are too large to be taken into the lungs. The cutoff point is 10 microns, or about l/50th the size of the period at the end of this sentence. These are very small particles—particles the human eye cannot see.

Even though the particles of concern are not visible, it goes without saying that when you see a dust cloud in your operation, it contains particles that are of respirable size. This type of observation, in industrial hygiene jargon, is a qualitative assessment of exposure. No measuring instruments have been used, yet a possible source of overexposure has been identified.

Another qualitative assessment of exposure in silicosis prevention is the mining process itself and how the ore is handled. Several studies in the scientific literature indicate that freshly fractured or recently broken silica particles are much more dangerous than those that have aged for 60 days or more. Thus, those jobs involving the crushing and drilling of silica containing ores, where newly broken particles are generated in high concentrations, have a higher risk of silicosis. These types of jobs, and others that involve freshly fractured ore, should be placed in the highest priority for exposure assessment and control.

And that leads to one of the most important components of a silicosis prevention program, respirable silica dust sampling, or quantitative exposure assessment. You may ask "Why should we do sampling if MSHA is already sampling during their inspections?" The simple answer: Whose operation is it, yours or the government's?

MSHA has a primary mission in its sampling activities: Are you in compliance or not? The level of sampling done by MSHA at a single operation is wholly inadequate to ensure that your employees are not at risk of getting silicosis. The sampling effort required is not overwhelming, but it is more than what MSHA does. It needs to be a continuing program since most deposits change over time with respect to silica content and jobs change frequently resulting in both lower and higher exposures. Only you have a handle on the variables that may affect your employees' exposures to silica. It is appropriate to have a program in place to assure yourself that exposures remain in control.

You may believe that you do not need a sampling program because you do not have a silicosis problem since no one has filed a workman's compensation claim for silicosis. But, the only way to really know whether you have any employees with silicosis is to perform medical testing. The typical chronic silicosis case that is seen in rock quarries takes a long time before it causes a disability. Silicotics with advanced disease usually die of heart failure, which can easily be dismissed as a heart attack. You don't know unless you know. If you have overexposures to silica, then you could very well have employees with early silicosis. Early stage silicosis is not fatal. Late stage silicosis usually is.

How do you go about setting up a sampling program? You can choose to use consultants, your insurance carrier, or do it yourself. Consultants are usually too expensive for operations with five or more plants to evaluate, and insurance carriers may or may not be willing to support your needs adequately. If you elect to use in-house personnel, which is what I recommend if you have more than five operations, you need to select your sampling personnel carefully. They must be knowledgeable of the operations, good with math, be able to write legibly, and most importantly, be trained properly.

Vulcan has a formal, one week sampling training course. The samplers are taught to sample dust, noise, solvents, and welding fumes as well as how to record information properly etc. It is important that all necessary information is recorded at the time samples are collected so that accurate interpretations of the results and accurate decisions regarding controls can be made. Vulcan' s industrial hygiene monitoring form is used to ensure that needed information is addressed.

MSHA also has a dust sampling workshop which is held at its Beckley, WV academy. Courses are conducted periodically throughout the year. Sending sampling personnel to a formal course is critically important to the success of any program.

Once you have trained people, they need to be equipped properly. A set of five sampling pumps with battery charger and cyclones costs anywhere from $4000 to $5000. It is important to get radio frequency protected, constant flow sampling pumps since they will not be affected by the two-way radios frequently used in mining operations, and they will maintain accurate air flow through the cyclone and across the collection filter. Preweighed sampling filters already loaded into sampling cassettes can be obtained from the laboratory that will be used for sample analysis.

Only labs certified to do silica analyses by the American Industrial Hygiene Association should be used. Laboratory analytical costs for the preweighed filter, cassette, gravimetric analysis of the dust quantity, and the quantity of crystalline silica in the dust can run from $55 to $85, depending on the number of samples being analyzed. Typical turnaround time for analysis is two weeks.

In any self-sampling program, the initial focus should be on the jobs with the highest potential exposure. This is done to quantitatively assess the exposures that you have qualitatively assessed through observations. The purpose of a sampling program is not to simply collect large numbers of samples. Rather, it is to identify and evaluate problems, determine the appropriate exposure controls, and to reassess the exposure to ensure that the installed controls are effective. If you are not going to take this process to the logical end, which is to fix the problems, then you should question why you want a sampling program in the first place. In a typical size quarry of 2025 employees, you should plan on sampling the highest potential exposure jobs at least twice a year during high production periods for a total of approximately 10-15 samples per year, depending on the quarry equipment, conditions, and work practices. Samples should not be collected on rainy days. The sampling objective is to determine exposure levels for the worst case conditions. If an overexposure is found, there are a number of questions that need to be asked to find the optimum exposure control(s). Remember, the degree of exposure is a product of two variables: concentration and time. Reducing either variable reduces exposure.

Using as an example the need to clean up spillage around the crushers in a secondary plant, there are simple approaches that may solve an overexposure problem:

- Find the cause of the overexposure and explore all feasible ways to eliminate it. Sometimes the solution is as simple as a change in the process flow which eliminates the spillage and thus the problem.
- Reduce the concentration factor. If the task needs to be done, can it be done before or after the production shift, when there is less dust in the air?
- Reduce the time factor. Instead of cleaning up all the spillage in one day, clean up only a portion of it each day. Another alternative would be to use more people to do the job. This reduces the exposure time for one person resulting in lower exposure to more people.
- Explore alternative methods. Cleaning up the spillage with a high pressure water hose instead of shovels and brooms can reduce the time required and also (because the spillage becomes wet) reduce the concentration.
- Supply the worker(s) involved with respiratory protection. If the time or concentration factors cannot be reduced sufficiently, then physically reducing the amount of dust inhaled by the employee(s) may be needed.

The other side of a comprehensive occupational health program designed to prevent silicosis is a medical surveillance program that emphasizes the respiratory system. Periodic chest X-rays, pulmonary function testing (PFT), and a comprehensive respiratory and smoking history are essential parts of a silicosis prevention surveillance program. PFTs are designed to assess the elasticity and proper functioning of the lungs. Many lung diseases affect the PFT results. Typically, smoking causes an obstructive type of abnormality, while a pneumoconiosis causes a restrictive abnormality. Combinations of the two abnormalities can also occur.

At Vulcan, in addition to all new employees receiving a baseline medical examination that includes the respiratory tests, all employees working in the Construction Materials Group are offered medical testing of the respiratory system. In our granite operations, these tests are performed every other year, while in our limestone operations the tests are administered every third year. All tests are performed in an on-site van, and take only 20-30 minutes per employee.

If a lung abnormality is possibly job-related, the employee is referred to a pulmonary specialist for a full respiratory medical examination. This examination is administered to obtain a definitive diagnosis of the abnormality, and is paid for by the company. Vulcan believes the screening chest X-ray is an important tool in the detection of silicosis, however, it should not be the only tool used to definitively diagnose the disease. All silicosis cases are reported to MSHA. Most silicosis cases seen in the program are detected in employees acquired in the acquisition of a business. All cases of silicosis uncovered in the program are at the earliest stage and thus are not life threatening.

In addition to silicosis, non-occupational lung abnormalities have been detected in the program, which have led to early treatment and more successful outcomes for employees. This benefit of the program greatly reduces overall medical insurance costs and has saved the lives of a number of employees in the 11 years the program has been in existence. Another benefit of the program has been the steady decrease in current smokers and the reduction of high blood pressure in the workforce.

Vulcan has also examined the grouped medical testing results for purposes of detecting any long term occupational health trends in the workforce.

Use of the medical testing data as an employee benefit (individual improved health monitoring), as a means to reduce medical costs by finding medical problems early, and as a measure of silicosis prevention and company wide health assessment, gives the best return for the dollars spent. Vulcan views both the exposure monitoring and the medical surveillance programs as the right thing to do, both morally and from a business perspective.

You don't know unless you know.

This article was adapted from a more detailed paper by the author, which will be presented during the Aggregates Industry Seminars to beheld at NSA's Annual Convention in Orlando, Fla.

Reprinted from the December 1996 edition of the National Stone Association's ***Stone Review****.*

Digging for home

For a unique perspective on a miner's life, pick up *Mama is a Miner*, a picture book written by George Ella Lyon and illustrated by Peter Catalanotto.

The story is narrated by a little girl whose mother works in a coal mine. Catalanotto's soft paintings alternate between scenes of the family at dinnertime and Mama's work underground. Each page that shows Mama checking a continuous miner or rock dusting mine ribs also shows a glimpse of the family kitchen.

"I'm digging for home," Mama tells her daughter.

The illustrations portray modern mining machinery, including a mantrip, conveyor belts and a continuous miner. No other male miners are shown, but Mama has friends among her male coworkers. The child narrator voices concern for her mother's welfare, but Mama says, "Safety first," and the warmth of the illustrations reinforce the story's feeling of security.

The girl's father and brother are pictured in the book, but the only voices are those of Mama and her daughter, who is learning by example how to feel comfortable either in her home or in a mine.

Reprinted from the November/December 1996 edition of the National Mining Association's ***MiningVoice.***

Now hear this!

Sound has many "faces": It can be soft and melodic; it can be pleasing to the ear; it can also be harsh and unpleasant; it can be annoying, distracting, and even painful.

The human ear is a fragile and sensitive system. Exposing our ears to extreme noise can cause hearing damage. Over time, many common noises—from whirring power tools to loud music and honking car horns—can cause hearing loss, depending on their duration, intensity, proximity, and the length of time and number of times a person is exposed to them. Such noises are the leading cause of hearing loss among adults, resulting in one-third of all hearing deficits. In the United States, 28 million people, including one-third of those between 56 and 74, and half of those over age 85, are hearing-impaired.

The brain perceives sounds as having different pitches (tones) and levels of intensity (loudness). Pitch, which corresponds to the frequency of a sound wave, is measured in cycles per second expressed as Hertz (Hz). The pitch of human speech ranges from 300 Hz for very low tones to 4,000 Hz for very high tones. Young children, who have the best hearing, can often hear sounds between 20 Hz (corresponding to the lowest note on a large pipe organ) to 20,000 Hz (corresponding to the high shrill of a dog whistle).

The intensity of sound, which corresponds to the amplitude of a sound wave is measured in decibels (dB). The decibel scale runs from 0 dB (which includes the faintest sounds detectable by the human ear) to more than 180 dB (the deafening noise during a rocket launch). Because decibels are measured logarithmically, a small increase in decibels indicates a substantial increase in intensity. Thus, a 10-dB increase indicates a sound that's 10 times louder than 10 dB, and 30 dB is 100 times louder than 10 dB.

How much is too much?

Most experts agree that noises below 80 dB are generally safe, but many common sounds exceed that level. According to the National Institutes of Health (NIH), prolonged exposure to any noise above 90 dB can cause gradual hearing loss. NIH cautions that regular exposure to sounds of 110 dB for more than one minute raises the risk of permanent hearing loss and recommends no more than 15 seconds of unprotected daily exposure to sounds exceeding 100 dB. The approximate dB levels of some common sounds are:

- 140 dB: Rock concert, fire-cracker, air-raid siren, power drill, gunshot
- 120 dB: Jet takeoff, auto horn, snowmobile, thunderclap
- 110 dB: Chain saw, pile driver
- 80-100 dB: Subway
- 90 dB: Lawn mower, motorcycle
- 80 dB: City traffic, alarm clock, hair dryer, office equipment
- 70 dB: Vacuum cleaner
- 60 dB: Normal conversation
- 40 dB: Refrigerator humming, office noise
- 20 dB: Whispered voice

As a general rule, a noise may be harmful if you have to shout over it to be heard; if the noise hurts your ears or makes your ears ring; or if you're slightly deaf for several hours after the noise stops. The longer you're exposed, the more damaging the noise may become. Also, the closer you are to the source of the noise, the greater the potential for harm.

Types of hearing damage:

• **Threshold Shift**: You lose the ability to hear softer sounds; sounds with higher frequency may also be hard to hear; normal conversation may seem muffled. Many times threshold shift can be temporary (lasting several hours). Permanent damage can develop with continued exposure to harmful noise.

• **Traumatic Hearing Loss**: Results from a single, short-term exposure to extreme noise levels. This condition can result in deafness. Traumatic hearing loss can be temporary or permanent.

What you can do

If you work in a noisy environment or use power tools or noisy yard equipment, you should certainly protect your hearing with earplugs or earmuffs. These devices decrease the intensity of the sound that reach the eardrum by blocking the auditory canal and preventing sound waves from reaching the eardrum. To be effective, earplugs must totally block the auditory canal with an airtight seal. Earmuffs fit over the entire outer ear and are held in place by a headband. They form an air seal around the entire circumference of the outer ear, so that the auditory canal is blocked, but they won't seal around eyeglasses or long hair. Properly fitted, earplugs and earmuffs can reduce noise levels by 15 to 30 dB. Simultaneous use of both usually adds 10 to 15 dB more protection.

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COAL; A perspective from the United States' largest producer

By B. R. Brown, chairman, Consol Inc.

The bottom line for the U.S. coal industry? It is the prospect of long term health of our industry that should attract investment dollars.

An ad ran in early March in the *Wall Street Journal* and in several other financial publications portraying "innovative thinking" by a stock brokerage firm. The ad showed a 15-scoop ice cream cone—each scoop a different flavor. The ad touted that in investment banking, "You do not scoop up 15 awards with plain vanilla."

As a coal producer, I see something different and worrisome:

- Instability. There is no solid base. Try to take a lick and you will end up with a mess on your lap.
- Indecision. There is a different flavor for every taste. This indicates that there is serious lack of commitment.
- High fat content. This may be all right in investment banking, but fat went out of style long ago in the coal business.

While stockbrokers may provide the "flavor of the month," in our industry, there is something to be said for a different approach. I would rather produce a large scoop of plain vanilla, a classic flavor, as long as the scoop is plentiful, of high quality, and can be made at a low cost. I would place my bets with a flavor that endures.

An appetite for plain vanilla

Consol is what I would characterize as a classic vanilla company. We focus our core business on being a producer of low cost, high-quality coals in North America. Consol's coal mining operations are supported by a worldwide marketing network and technical expertise. Everything we do hangs on that framework. In 1995, Consol generated revenue of $2.3B on sales of over 70 million (M) short tons (st). Consol is the largest U.S. producer of bituminous coal.

We are primarily an underground mining company. Of our 26 mining complexes, 15 have longwall mining systems, employing a total of 20 longwalls. We are the largest U.S. coal exporter and the largest producer of metallurgical coals. Our support businesses in coal transportation and terminals, materials supply, and coalbed methane recovery reduce our costs and support the growth of our coal mining business. Our long term debt is "A" rated, and our commercial paper is rated AI and PI by *Standard & Poor's* and *Moody's* [rating organizations].

Consol believes in the importance of the U.S. coal industry to the nation's economy. We believe that our industry will continue to play the predominant role in providing fuel for electricity generation at least through the first half of the next century. We project demand for U.S. coal to reach 1.2 billion short tons by 2005, increasing at a rate of 1.5%/yr. This projection is based on electricity demand that is growing at an average rate of 2%/yr., assuming GDP (gross domestic product) growth of 2.4%/yr. Coal fired generation should retain its 55% share. This should occur despite the share gain projected for natural gas because the nuclear segment's share should decline over the decade.

"Weight watchers" cum naysayers?

Consol sees several regulatory and economic factors affecting decisions regarding fuel choice.

During the Carter Administration of the 1970s, coal fired electricity generation was recognized as a high priority for national security and as a way to maintain competitive advantage. Today, however, global climate change is the primary issue driving U.S. energy policy. By signing the Rio Treaty in June of 1992, the United States agreed "to limit man-made emissions of greenhouse gases to a level that does not interfere with the global environment."

The Rio Treaty guideline was reinforced in a follow-up meeting held in Berlin in March 1995. In what now is called the Berlin Mandate, the parties from the developed nations, including the United States, strengthened their commitments. The Clinton Administration has agreed to a process (to be completed in 1997) to set specific targets and timetables for greenhouse gas emissions beyond the year 2000. This was a significant concession by the United States given the importance of coal to its domestic economy.

The plan, the Climate Challenge Program, is in place. In it, power generators state their "aims" to control greenhouse gas emissions by volunteer programs. However, it is apparent that the administration's goal of maintaining greenhouse gases at 1990 levels will not be attained.

The Clinton Administration's energy policy has actively promoted natural gas and renewables for electricity generation. This policy has been "fueled" by the global climate change debate and also by emerging regulations on nitric oxides and air toxins. In this current political environment, it is difficult for utility executives to promote new coal fired generation, even though they may know it's the most competitive alternative. They have to ask themselves the following questions:

- Will coal fired power plants be hit by a carbon tax or by a CO_2 cap?
- What will final NO[x] regulations look like?
- How will Air Toxins issues be resolved?

Rational decisions to come

Consol believes that sound minds will prevail in the long run when cost/ benefit analysis is allowed to operate. However, the short-term solution for decision makers planning new generating capacity is to turn to natural gas. Natural gas plants are politically expedient: they have shorter construction time, lower capital cost, and less environmental hassle. These factors are important when one has a short term view and a high discount rate.

Conventional wisdom holds that competition is coming for electricity generation. Attention will turn to developing and operating the lowest cost generating capacity possible. Base-loaded coal plants will be run harder, without consideration of artificial boundaries established by a utility's franchise territory. The lowest variable cost plant, both in fuel and conversion to electricity, will be the winner in the new competitive environment. This will eventually translate into a new coal fired capacity as one looks out beyond the year 2000.

The other wild card in coal's favor is that nuclear generation has likely peaked. No new plants are being built, and certain nuclear plants may not obtain extensions for their 40-year operating licenses. Even if they did obtain extensions, some extensions may be uneconomic, which could create additional demand for coal fired power.

Those with short-term viewpoints need not apply.

My current view is that the coal industry is a long term play, and Consol is in the business for the long haul. Consol has shown its long term commitment by investing in additions to our reserve base, by developing new mines, and by continuing to fund the largest privately-owned coal research organization in the United States.

Within the last six months, we added two major reserves of Pittsburgh seam coal in the vicinity of our Bailey and Enlow Fork complex in southwestern Pennsylvania. These reserves, with about 330M st (clean recoverable), will ensure a long life and expansion potential for our Pittsburgh seam, medium sulfur coals. These coals have the advantages of high heat content, low cost, and proximity to eastern markets and East Coast ports.

Consol continues to advance the development of its low sulfur steam and metallurgical coal reserves. An example is the Cheviot project in Alberta, Canada. A commitment to a major metallurgical coal mine in this reserve, with our partner, Luscar, is planned in 1997.

Consol also has two major reserves of low sulfur, compliance coal located in central and southern West Virginia. Each of these properties is ready for development into a 3M st/yr. mine. However, we will not give away these reserves. Commitment awaits a signal from the marketplace that it is ready to pay, in the price of coal, for new capital investment.

In the area of research, we support efforts to improve mining costs by safer and more productive equipment and by refined mine engineering. We also work hard on combustion and clean coal technology issues that face our customers.

You will hear that some players in our industry take different approaches by redirecting their investment dollars. Some have talked about vertical integration, about becoming power generators. Others have talked about horizontal diversification. However, I doubt that you will hear either from us. There are more than enough investment opportunities in the coal business, and that's where our competitive advantages reside.

I would submit that the companies in our industry that are positioned for profitable growth have the following attributes:

- Existing operations that produce coal at a profit at market prices;
- An economic reserve base that can sustain mining beyond the next few years;
- Good transportation links to power plants that will dispatch under a competitive environment;
- Access to export markets;
- Low debt structure that enables flexibility for acquisitions and development projects.

The character of our industry "10 years out" is being established. There will be continued slow growth for this year and the next three to four years. That will mean profit gains will have to come from productivity gains. I would expect Consol to increase productivity this year about 12%, or about 4 st/man-day. Look for continued reductions of people. We have moved from 8 st/man-day to 35 st/man-day in 20 years, from 24K employees to 8,500, and from producing 44M st/yr. to 74M st/yr. Also, look for more restructuring and industry consolidation. There will be fewer but larger mines. With western, low Btu sub-bituminous surface mines producing in the 20-50M st/yr range and deep bituminous mines in the 5-10M st/yr, you do not need more than roughly 100 major mines to produce the 1.2B st that will be in demand 10 years from now. An example of deep mines would be the Bailey Complex in southwestern Pennsylvania to be expanded to 19M st/yr. The companies that will attract investment will be the holders of the low cost mining operations with extensive reserves capable of expansion and the addition of new capacity.

The railroads will continue to be an ever important element to coal industry profits. In many respects, the railroads will hold the key to success for coal where the product must be transported long distances. The day will be won by the lowest cost fuel on a delivered-cost basis that is converted efficiently to electricity. When we look at companies, we try to look beyond the EBIT (earnings before income tax) numbers. We look for sustainability of cash flow, the quality of the reserve base, mining technology, and experience to sustain performance and confront new situations.

Consol's future

Consol's ownership situation has been the focus of much speculation in the coal trade magazines. Consol is owned 50% by Du Pont and 50% by Rheinbraun, the mining subsidiary of RWE, a large German conglomerate.

Du Pont has expressed interest in selling its share in Consol. The timing and final outcome of any transaction is pure speculation. It all depends on whether the right party steps forward with a compatible view of the coal industry, with interest in a partnership with Rheinbraun, and with enough cash to satisfy Du Pont.

We've been through many ownership changes in the past that have not altered the philosophy of Consol:

1966—the Conoco acquisition of a publicly-owned Consol

1981—the Du Pont acquisition of Conoco (hence Consol)

1991—the sale of 50% of Consol to Rheinbraun

I do not believe that another change in ownership will alter the way we do business. We were classic vanilla, and the flavor is still the same 20 years later.

Reprinted from the September 1996 edition of Intertec Publishing Corp.'s ***Engineering and Mining Journal.*** *Features section: Pg. 16FFF*

Needs identification survey reveals industry's health and safety concerns

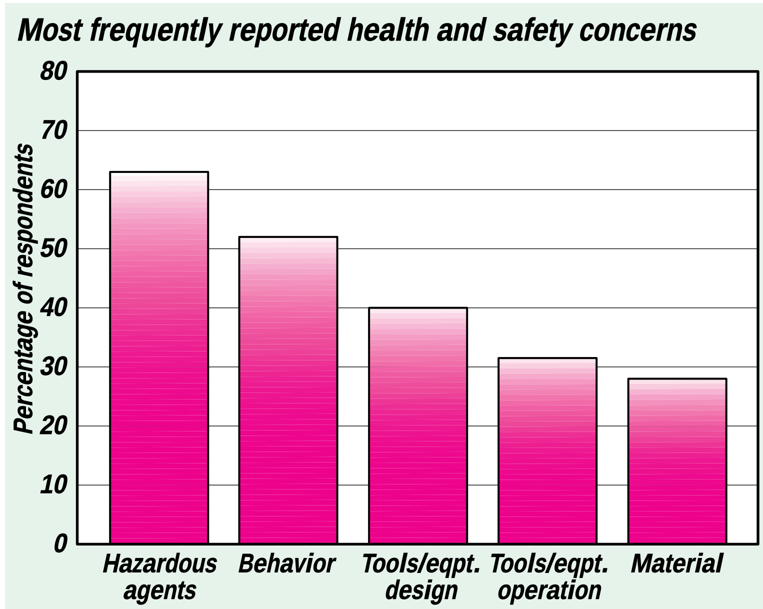
Hazardous agents, behavior pose greatest threats

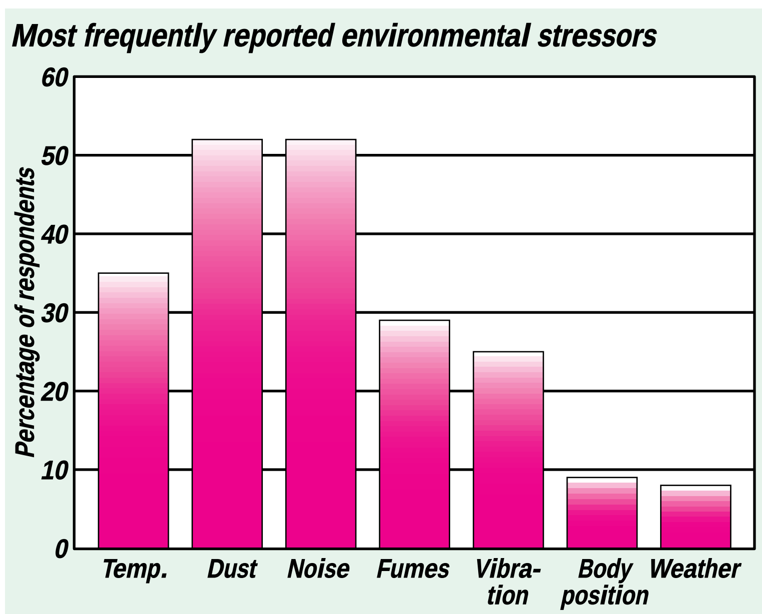
A major needs identification survey by the Ontario Natural Resources Safety Association (ONRSA) has shown environmental factors and behavior are seen as the greatest threats to the wellness and comfort of people on the job.

These two factors, followed by the design of tools and equipment, and the operation of tools and equipment, were pegged as the key health and safety concerns among 778 interviewees—both managers and workers—at 325 natural resources worksites around Ontario [Canada].

While there is strong awareness of health and safety, especially in larger firms, the survey shows the concerns expressed may not be translating into action to tackle the problems.

In July 1995 the ONRSA, with assistance from Laurentian University's Center for Research in Human Development, began a broad-based team initiative to identify the health and safety needs of its Ontario mining, forestry, and pulp and paper clients. Between July 1995 and May 1996, the survey was prepared, staff were trained to conduct it, surveys were completed, responses were coded and entered and an initial analysis was drafted. In the summer of 1996, ONRSA staff had their first look at the preliminary information and began the process of developing strategies to address the identified needs. Since then, several staff members have made presentations of the survey overview. The data will now be subject to more in-depth studies by staff, our sectors and other concerned researchers. Where our survey has raised new questions, more targeted sample surveys may be required.





According to Executive Director John Connors,

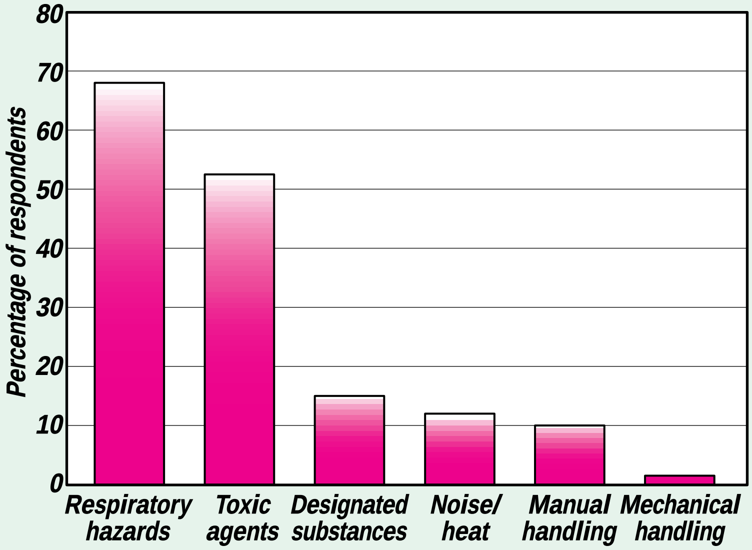
"the collected data and analysis will remain relevant and valuable for some time, as the reported conditions and opinions will not change easily or quickly. ONRSA and its successor organizations will be able to use the information as the basis for decisions on the development of new programs, products and services over the next few years. The information also provides a baseline to evaluate the success of our efforts both present and future."

Survey respondents were asked to: describe their health and safety program; list actual and planned health and safety initiatives; describe any in-house needs studies or evaluations undertaken; and identify actual health and safety problems relative to tools/equipment design and operation, materials, personnel, and the workplace environment. Data was broken out by question, by sector, by firm size, and by respondent status (labor, management, health & safety representative, certified member).

An initial overview analysis has revealed the following key findings:

First, *environmental stressors* are perceived as significant threats to the wellness and comfort of people in the worksite. Stressors included temperature, respirable dust, noise, fumes, vibration, body position and weather. This finding was reinforced by a subsequent question about materials, to which the most frequently reported problems were respirable dust, chemicals, designated substances, noise and heat.

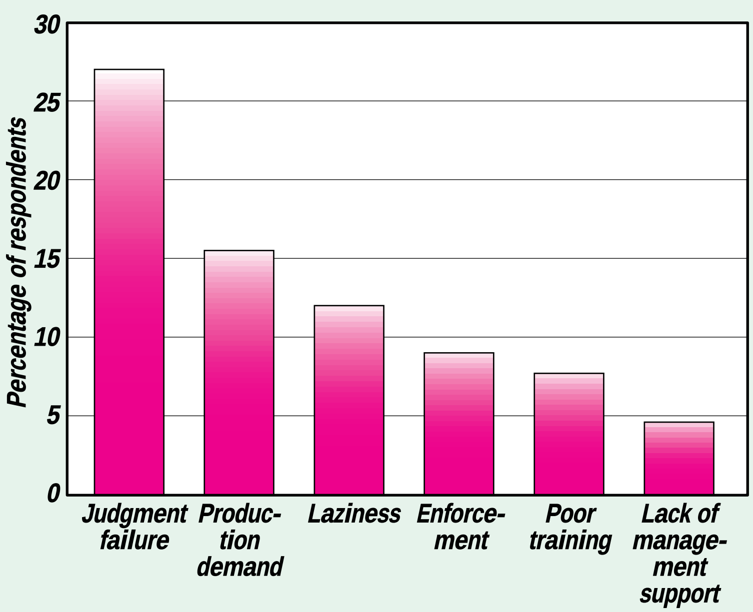
Most frequently reported material stressors



Second, *attitudes*, as evidenced by *behavior*, were cited as a health and safety risk in worksites. Respondents reported that management and workers generally have the skills to do their jobs and understand the health and safety consequences of not applying their knowledge and skills. Despite that, they *do not consistently apply* their knowledge, skills, and understanding. As a result, they place themselves and others at risk.

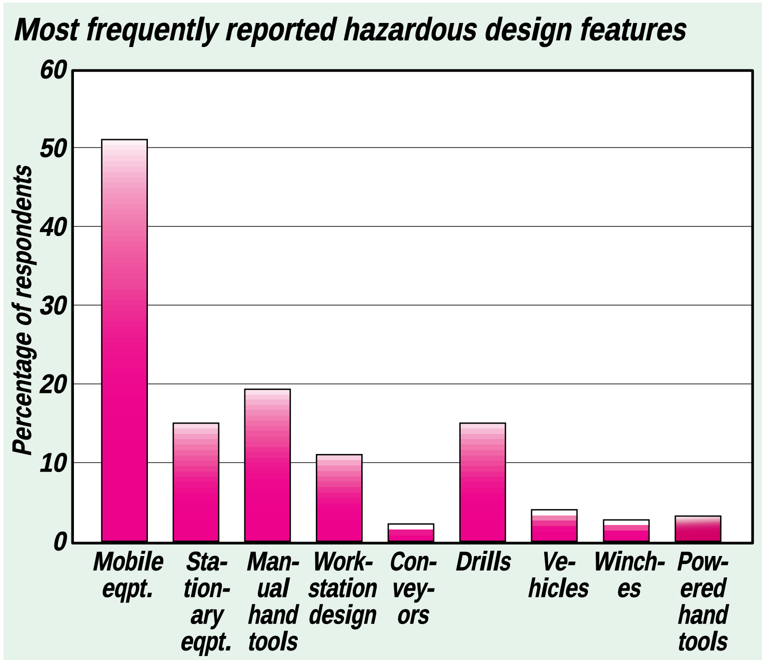
When questioned about the possible reason for this inconsistency, poor judgment, followed by production demands, laziness, lack of enforcement, poor training and poor management support were the most frequent replies. This disparity between knowledge and application is a central challenge to improving health and safety in the workplace. Further research and creative solutions will be required to bridge this gap between knowledge and action.

Most frequently reported reasons for inconsistent acts



Third, the *design of tools and equipment* was reported as potentially hazardous. The descending order of most. frequently reported design risks were with: mobile equipment, stationery machinery, manual hand tools, workstation design, conveyors, drills, chain saws, vehicles, powered hand tools and winches.

Fourth, the *operation of tools and equipment* was viewed as hazardous. These hazards relate to secondary factors such as age, maintenance, retrofitted modifications, conveyor maintenance and failure to



lockout.

In addition to these findings, there emerged two additional and very general observations:

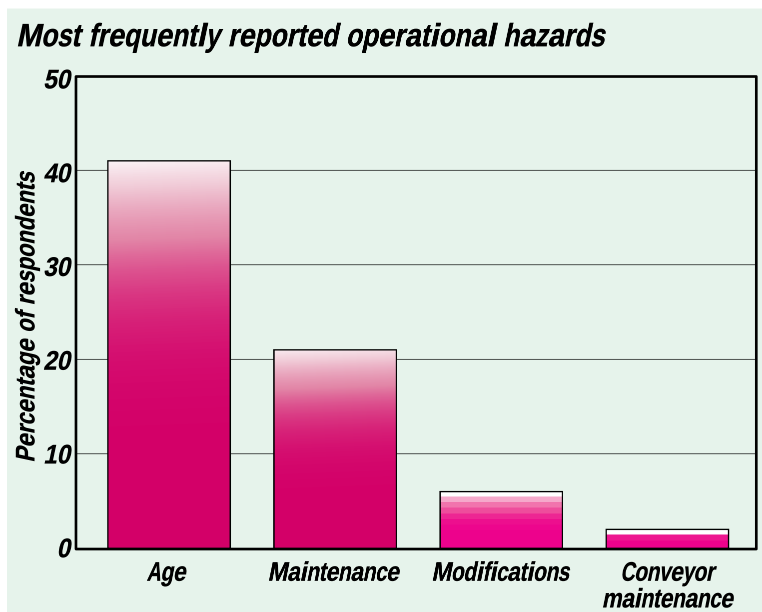
First, there appears to be a proportionally greater awareness of health and safety in firms of increasingly greater size.

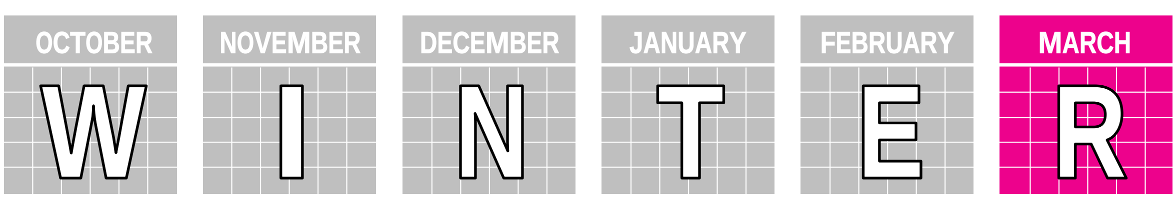
Second, there seems to be a gap between the health and safety problems firms reported, and the health and safety initiatives they listed as undertaken or planned.

These key findings and observations will help industry, workplaces and their safe workplace association(s) to better focus on their more pressing health and safety issues, while at the same time better targeting their efforts to the worksites with greater needs.

A complete overview report (more than 35 pages of text and color graphs broken down by sector and firm size) is available from the ONRSA for $15.00 [Canadian].

Reprinted from the November/December 1996 issue of Ontario [Canada's] Natural Resources Safety Association's ***Health & Safety Resource.***





ALERT reminder: ● *Always maintain adequate mine ventilation and make frequent checks for methane and proper airflow.* ● *Know your mine's ventilation plan and escapeways. Properly maintain methane detection devices. Communicate changing mine conditions to one another during each shift and to the oncoming shift.* ● *Control coal dust with frequent applications of rock dust.* ● *Make frequent visual and sound checks of mine roof during each shift. NEVER travel under unsupported roof.*

Machine automation and radio remote control systems; mining, talking boxes

By Mark Whatley and Nigel Cottell

A radio control provides a means of remotely communicating instructions from an operator to a machine. The operator has a radio transmitter, fitted with buttons, switches or joysticks, which he uses to input machine commands. A radio receiver is mounted on the machine and responds to the commands sent from the transmitter by activating corresponding functions on the machine. In principle this is identical to the control of a model aeroplane or car. So why can't a model maker's radio be used to control mining machine?

The main difference between radio systems used to control models and those used to control mining equipment is security and safety. Security and safety go hand in hand and are the most important features of a radio remote control system. The radio system must not respond to incorrectly transmitted or corrupted data. Noise or incorrect signals can be generated by other radio systems working in the neighborhood, or spurious radio emissions sent from "noisy" electrical equipment. To ensure that only correct radio data signals are accepted, Moog mining radio remote control systems incorporate a number of protective features.

Moog remote control radio systems transmit data in blocks. A new block of data is sent at regular intervals typically every 50-100 milliseconds; each block of data is split into 3 sections.

a) The "address code" is a unique code that is set in the transmitter and receiver units. A receiver will only respond to radio signals that contain an address code that is identical to its own. If it is different, the receiver discards and ignores the data and does not implement the instructions.

b) The "data" portion of the block contains instructions relating to those outputs on the receiver to be operated. The information is received as a digital bit stream of "1"s and "0"s which has been encoded by the transmitter.

c) The check sum is a series of bits sent by the transmitter which are specific to the data in that block. On receipt of a block of data, the receiver performs a check sum of its own and compares this with the one sent from the transmitter. If these differ, the whole block of data is discarded and ignored. At least one acceptable block of data must be received within a specific time. If this time is exceeded or radio transmission signals cease completely, the receiver automatically switches all outputs to a default condition. This ensures that in the event of a transmitter becoming damaged or inoperable, all outputs from the receiver will default to a known condition. By correctly interfacing the receiver outputs to the machine it can be ensured that a machine runaway cannot occur.

A Moog radio transmitter sends a frequency modulated carrier signal with the modulation levels representing the "0"s and "1"s of the data stream. There is a selection of well established techniques for modulating the carrier wave and Moog have adopted a number of these to suit specific applications. The choice of modulation system is concerned with minimizing the effects of noise and distortion of the transmitted signal in the underground environment. The choice of carrier frequency depends on the regulations of the country where the radio is to be used. In the UK it is in the unlicensed band 458.5 to 458.8 MHz. Drawing together the various protection techniques employed in the Moog system results in a radio control with a high level of integrity, security and safety.

Coal mining applications

The introduction of remote radio control equipment to the coal mining industry first occurred about 20 years ago and has steadily gained wider acceptance over the years. Radio control technology has been applied to both longwall shearers and continuous miner applications.

Longwall Shearers. On the most up to date longwall shearers, radio remote control has been highly integrated with the whole machine control concept. On one of the most advanced machines, the Anderson Electra shearer, radio control is fundamental to the whole machine control.

The radio receiver directly controls functions on the machine such as the haulage speed, direction, cutter height and water control etc. The miner controls the shearer machine with a small, intrinsically safe, handheld radio transmitter which has a number of membrane push buttons. Operation of the push buttons on the transmitter activate or deactivate functions in the receiver which in turn operate the machine.

Speed control of the machine is accomplished via the push buttons and an integrator. This monitors the time that a button is held depressed, and via a ramp function converts this to an analogue speed command. Various power sources are available for the transmitter, including throwaway batteries, rechargeable NiCad batteries, or power from the miner's caplamp battery. The radio receiver on the Electra machine not only receives and acts on information that has originated from the transmitter, but also communicates with the machine control computer. This computer, known as IMPACT, communicates with the receiver via a high speed digital serial link. The IMPACT computer has overall control of the machine and collects data from subsystems and sensors located around the machine. It also communicates with other minewide equipment and can receive instructions from the surface. Using and interpreting this information the IMPACT computer instructs the radio receiver to control certain functions to protect the machine or regulate coal production. For example, should the machine encounter hard ground, the IMPACT computer will recognize a change in the cutting motor current and will instruct the radio receiver to limit the maximum machine haulage speed. This ensures that the machine is always working within its design envelope and is not being abused. Similarly, it is possible to produce too much coal and overwhelm the transport system. If this occurs IMPACT can be informed and in turn the receiver is instructed to reduce the amount of coal being produced. From the operator's point of view, remote radio control allows the miner to oversee the machine's operation from the best possible position. This allows accurate and easy control of the cutting drum and ensures that a high quality product is produced with a minimum of spoil. On double-ended shearers the radio system is configured to provide independent control of each end of the machine by two separate miners each with his own radio transmitter. Interlocks are built into the receiver to ensure that the same machine function cannot be controlled by both miners simultaneously. This further enhances machine operation and improves productivity. Remote radio control also allows the miner to move along the face at a rate that is variable to suit the conditions and is not tied directly to the speed of the machine. On a difficult section the miner may allow the machine to move slightly ahead of him, knowing that he still has full control and can catch up on an easier section ahead. Radio remote control enhances safety as the miner can stand back from the machine under the roof supports.

Continuous Miners. On continuous miners the application of remote radio control occurred as a result of a drive to improve safety, productivity and ease of operation in low seams. Radio applications on continuous miners fall into two categories; retrofits to refurbished machines and applications to new designs.

In general, radio systems used for retrofits to older continuous miner designs are not integrated with a machine control system. On most machines the radio system simply allows the miner to manually control the machine from a safer or more advantageous viewing position.

Many of these machines have a constant displacement hydraulic system with open centre manual control valves. One of the problems in retrofitting a radio control system to this type of machine is how remote actuation of these valves can be achieved with the minimum of alteration to the existing hydraulic system. Moog Controls Limited, in conjunction with Caledonian Mining Company Limited, has developed an intrinsically safe electrically operated proportional control valve that can interface to a standard open centre manual control valve and will allow remote actuation of the manual valves. This has the advantage that the machine can still be driven manually if required, or can be used under remote control. An added benefit of fitting remote radio control to continuous miners is that where roof conditions and mining inspectors allow, machines are performing deep advance cuts in unsupported ground. This has significantly improved productivity without compromising safety.

Newer designs of continuous miners and bolter miners such as the Dosco TB2500 machine, the Voest Alpine ABM20 machine and the Anderson KBII machine have been designed to use radio remote control from inception. In these machines the design of the hydraulic system reflects the higher technology that is incorporated. The machines use a constant pressure hydraulic system and utilize both analogue and digital Moog mining servo valves to control machine functions. They are very much "State of the Art" machines and have highly integrated machine control systems to sequence the cutting, bolting, cleaning up and advance process.

Hardrock and tunnelling

In hardrock applications the mining method often dictates that for safety reasons it is necessary to use radio remote control. Many underground mining applications in hardrock use a mining method known as pillar and stope mining. In this process a room or stope is produced in the ore bearing rock. The roof of the stope is successively blasted from above and the rock removed from the floor of the stope. To facilitate removal of the rock, it is necessary for a mobile loading machine i.e. a scoop or LHD to enter the stope and remove the fallen rock. In this position the machine has to work under an unsupported roof and safety considerations do not permit manually driven machines to operate. A mine where this method of extraction is successfully used is the Tara Lead and Zinc Mine in Ireland. In this mine, which is operated by Outokumpu Oy of Finland, Moog radio control systems have been fitted to Tamrock Toro scoops to allow remote control of the loading process. The radio receivers fitted to the machines have been specially designed for hardrock use and have high power outputs. These outputs are used to directly drive hydraulic control valves that operate functions such as the steering, bucket, and engine control, eliminating the need for extra interface units. The transmitter used for this application is designed for use with mobile machines. The unit is a harness or belt-mounted device that can accommodate two 4-position joysticks and up to 25 two- or three- position switches. Although initially designed for use in the hardrock environment the unit has been designed to be intrinsically safe. It has been submitted for IS approval and will be used in this form later this year. Power for the transmitter is supplied from a separate battery or from the miner's caplamp battery. Fig. 4 shows a typical radio system used in a hardrock environment.

Civil tunnelling

In civil tunnelling, remote radio control has been applied to the control of the segment erector head in tunnel boring machines (TBMs). When a civil tunnel such as a sewer or transport tunnel is bored it is usually necessary to line the inside of the tunnel with a precast concrete lining. This lining is built from a number of interlocking segments that fit together to form a complete ring. As the tunnel progresses it is necessary to continually build new rings inside the machine.

When the machine advances these are fitted inside the tunnel and are bonded into position with a grout compound. Segment erection has always been recognized as one of the most dangerous aspects of tunnelling, because the manhandling of the large heavy segments can easily trap and injure people. The drive to improve safety and reduce manpower involved in the tunnelling process has led to the application of radio equipment for control of the segment erector.

Traditionally, control of the erector is achieved by fixed manual control valves or by a fixed pendant. In the restricted environment of a tunnel boring machine this can lead to a situation where the operator cannot directly see to position and place the segment. Radio remote control allows the operator to control the erector from a safe position and provides the best possible view of the process involved. Applications of radio to tunnel boring machines use a radio transmitter that is derived from the unit used to control longwall coal shearing machines. A number of different receivers is available to complement the transmitter, the exact choice depending on the specific application and the complexity of the TBM machine. The receivers available range from a simple 16 function unit to a microprocessor-based model that has 36 outputs and can communicate with a host computer.

Future developments

Machine sophistication is on the increase. It is inevitable that radio remote control systems will develop to provide additional functionality. This will certainly include two-way communications where machine data can be sent back to the operator. This has already been developed by Moog and is being applied to advanced applications in the USA. It may include a visual video link to allow the operator a better view when working over large distances, or it may develop to a point where the machine is fully controlled from the surface.

All of these developments are technically possible. The extent to which these features are developed and implemented will depend on the economic returns and safety legislation. Short distance radio remote control can lead to immediate and tangible productivity and safety improvements. The benefits of long distance or surface control are more difficult to quantify. It is quite possible that safety legislation will be required before further technical advances can be implemented into production systems.

*Reprinted from the July 1994; Volume 18; No. 7-8 issue of **World Mining Equipment**. Copyright 1994, page 11—Information Access Co., a division of Ziff Communications Co.; Copyright 1994 Metal Bulletin plc (UK)*

Safety notebook.

By Carl Metzgar

Pre-shift inspections Part I: Clean, well-maintained equipment ensures safety and productivity.

It is personally frustrating that the Mine Safety and Health Administration (MSHA) has to have standards and has to enforce standards in areas that are in the selfish best interest of miners and operators.

MSHA standards

56.18002—A competent person designated by the operator shall examine each working place at least once each shift for conditions which may adversely affect safety or health. The operator shall promptly initiate appropriate action to correct such conditions.

56.14100—Self-propelled mobile equipment to be used during a shift shall be inspected by the equipment operator before being placed in operation on that shift.

These two standards cover place and

equipment to be used in place. The requirement exists so miners and others at the plant site are not exposed to uncontrolled energy and the hazards that go with it.

Place standards

Consider how energy can be transferred and cause injury. A welding rod stub or a short piece of reinforcing bar, a screw or a bolt on a concrete floor under a shoe makes a real good roller bearing. A person walking and stepping on a piece of welding rod can have a foot slip out of control and 130 to 230 pounds hit the floor. The weight of the person falling is enough so that when the floor is hit, there can be injury. Falls often happen just inside doors. When people go from the light to the dark, it is hard to see the floor and what is on it. The lack of light is part of the problem and the fact that the person is not looking is another part.

That is why there has to be a deliberate effort to inspect the floor so it is safe to walk.

One small example for place.

Equipment standards

Mobile equipment is also a challenge. A 12-^yd.sup.3 loader or a 50 st truck represents a lot of energy. In normal driving, the mass and speed can do a lot of damage. To prevent that damage, the brakes are checked before the equipment is used. The hydraulic lines are checked so the risk of fire is reduced. The fire extinguisher or fire suppression system has to be checked and functional.

The inspection of the equipment has to be systematic and complete. How does that get done? It is obvious—a checklist is used. When the checklist has the space for negative answers in a line and all the blocks are checked off with the same pen and the same mark, there is a question. Has the inspection been made or has the form just been marked off? This situation calls for follow-up on the part of a supervisor to make certain that the inspection has been done.

Back to place. Not all catwalks and walk-ways are equal. Some are new and some are old. Some are wide and some are narrow. The plant inspector has been easing past a steel box installed to protect a switch box for 15 years. It is necessary to turn sideways and take a deep breath to get past.

Is it safe or unsafe? The inspector is okay. Suppose an idler has to be carried past the same box. Is it safe or unsafe? It is probably unsafe. Remember back injuries occur during lifting and twisting.

The catwalk was installed at one width. It is now a lot narrower because the box was added. A worker can't safely carry a load past the box. It may be 15 years late, but the pre-shift inspection should turn up the unsafe condition. Get the box moved even if it has to be rewired.

Since the first hazard mentioned was a cylinder represented by re-bar or welding rod and it was on a shop floor, the example was for place. Consider a drink can in the cab of a piece of equipment. We now have either a hazard or a distraction. Either could be part of some uncontrolled energy transfer if the can keeps a pedal from functioning the right way.

Cab floors and shop floors both have to be clean.

Clean work places and well-maintained equipment are keys to safety and productivity. It shouldn't take an MSHA standard to cause miners and operators to take care of themselves and their own selfish interest.

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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, government, and health professionals 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, and knowledge about 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.

Predictive maintenance puts the operator in control

By Al Bessen, Operations Manager, CSR/American Aggregates Corporation

Below left, the crosshairs are on a wire that is 30 degrees hotter (colored area) than the wires surrounding it. This thermal profile indicates a loose connection on a starter wire for a vertical fresh water pump. Below right, the high-voltage cut-out on the left is 200 degrees hotter (colored areas) than the one on the right. The middle cutout also shows signs of a loose connection. A visual inspection found the knives themselves to be loose.

The use of predictive maintenance technologies as part of an aggregates plant maintenance program will reduce downtime, reduce repair cost, increase production and increase profit.

A much too common view in the aggregates industry places a primary focus on plant production, classifying maintenance as only a cost. In reality, with poor maintenance there is poor production, and without maintenance there is eventually no production. Without production, there is no profit; therefore, costs associated with repairing or maintaining production equipment must be viewed as an investment, not merely a cost interfering with production.

Without a proper maintenance program, a machine runs until it fails. It is assumed that if a machine is running then no maintenance is required. This approach, known as reactive maintenance, disregards machine efficiency and uptime, both far more significant factors in cost of production than maintenance. There will always be some reactive maintenance. There are ways, however, to mitigate the impact of unplanned failures.

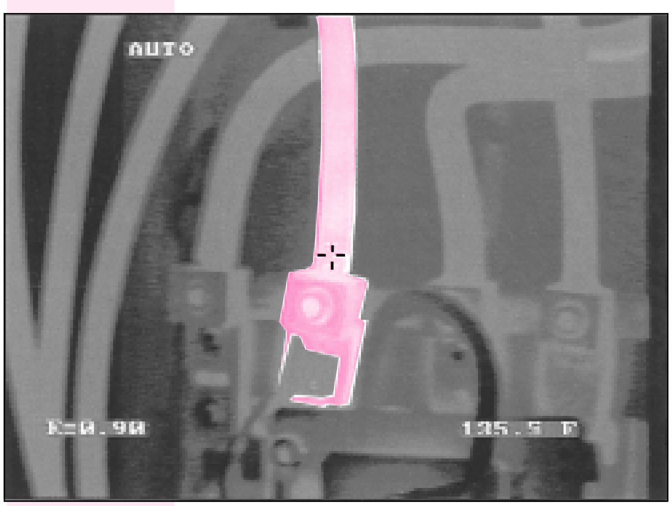
By scheduling inspections, lubrication, and certain component replacement based on time or production intervals, reactive maintenance is reduced. This is a preventive approach to maintenance and is a necessary element for a successful maintenance program. It does not, however, provide any means of predicting failures before they occur.

Predictive maintenance is the most technologically advanced element of a maintenance program. It uses microprocessor-based monitoring technology to evaluate the condition of operating equipment. The most common methods used are vibration analysis and infrared thermography. Vibration analysis shows misalignments, imbalances, bearing faults and electric motor faults in mechanical equipment. Infrared thermography detects heat related faults such as loose connections, imbalanced phases and shaft misalignment in electrical equipment. The ability to repair these faults before a failure minimizes the negative impact of unplanned downtime on production and reduces repair cost.

Information derived from a predictive maintenance evaluation provides current data on equipment condition. The data is trended for future reference to measure changes in condition and define appropriate alarm levels. This enhances preventive maintenance service or replacement. New and rebuilt components can also be measured to provide base line or acceptance criteria and to define design limitations, ensure proper operation or determine the end of a life cycle.

The actual time required to set up an equipment database and to collect, analyze and report data for a typical 1,000,000 tons per year limestone plant is three days. The majority of this time is spent in field analysis and reporting. The cost of a minimal vibration system is approximately $30,000. An infrared thermography system will vary between $30,000 and $60,000. Training is usually provided by the manufacturer and may entail up to six weeks over the first year.

The objective of any maintenance



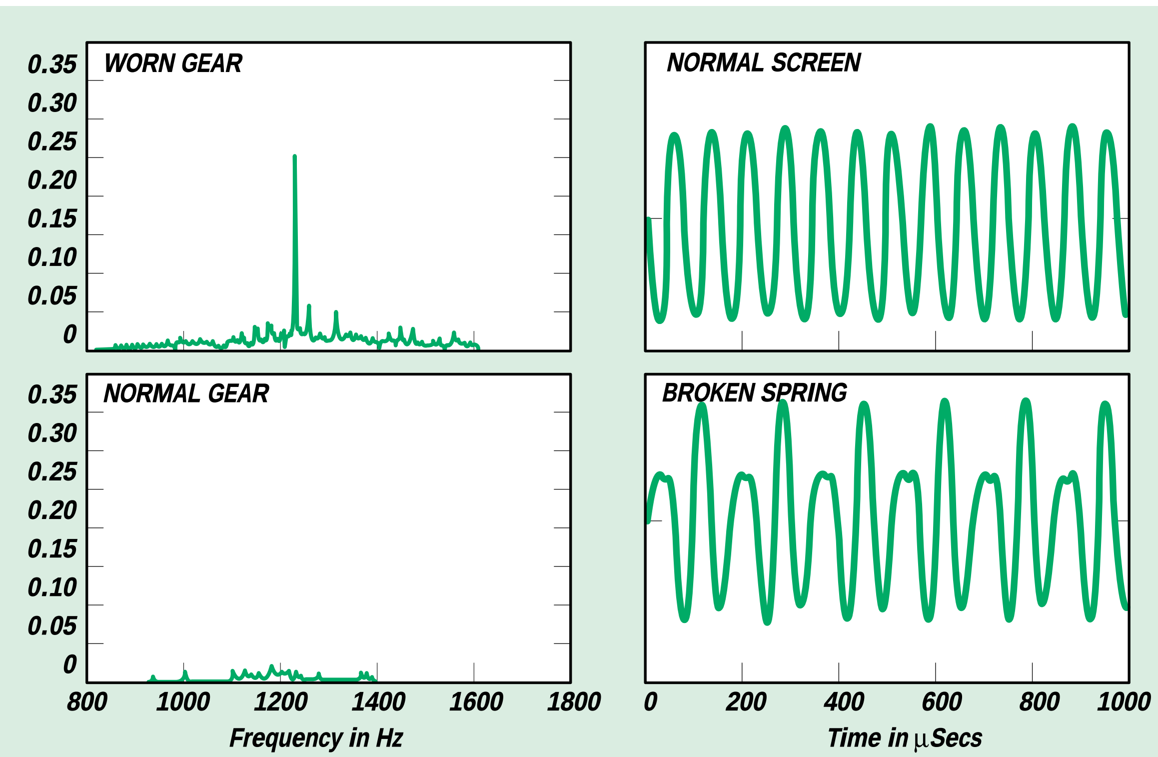
program should be to ensure the reliability and productivity of equipment.

Technology will enhance a basic maintenance program but will never replace good planning and a competent maintenance crew. It is important to remember that predictive maintenance is only one part of an aggregates plant maintenance program. It provides information that, when used correctly, will:

- Reduce downtime by reducing unplanned outages caused by equipment failure.
- Reduce repair cost by preventing minor maintenance issues from becoming major repair issues, by reducing time spent troubleshooting and by reducing catastrophic high cost failures.
- Increase production by reducing downtime and increasing efficiency, resulting in higher production output.
- Increase profit by increasing production output and decreasing repair costs, leading to lower unit cost of production.

With the foundation of a basic predictive maintenance program in place, its scope can be widened to include such advanced techniques as multi-channel analysis, thermal and flux analysis, ultrasonics and tribology. These techniques have proven effective in other industries but to date have had only limited exposure in aggregates plants. As we advance toward the 21st century, these technologies will help redefine the approach to maintenance throughout the aggregates industry.

Reprinted from December 1996 edition of the National Stone Association's ***Stone Review****.*



At top left, the spectrum of a worn gear on a shaft-mounted gear reducer; lower left, the spectrum of a normal gear. The top right waveform shows the throw of a normal screen, the lower right, a screen with a degraded set of rubber doughnuts.

Technology on the job

Miscellaneous

Environmentally 'cleaner' dry cleaning is the result of a new system developed by Los Alamos Lab and Hughes Aircraft that replaces harsh dry cleaning chemicals with a liquid carbon dioxide cleaning process. Under 800-1,000 lb. of pressure, carbon dioxide acts like a liquid-and serves as an organic, entirely recyclable solvent that extracts dirt from clothing. When the liquid carbon dioxide is allowed to return to its gas state, the dirt just falls out. Repressurized, the carbon dioxide can be used again. The only waste generated by the process is the volume of dirt removed from the garments. The liquid carbon dioxide system cleans any material that is currently dry cleaned, as well as furs, leathers and sequins. Global Technologies, a limited partnership including Hughes and dry cleaning supply manufacturer Caled Chemical, demonstrated the system for the first time last month. For more details, call Gary Kliewer at 505/665-2085.

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