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THE COAL MINER

TRUE—he plays no grandstand role in life
But his importance is vital, great and just:
For without his toil in earth's caverns deep,
Civilization would soon crumble into the dust.
AD 1964 From his poem – Vachel Davis

(Dedicated on State Capitol Lawn, Springfield, Illinois, October 16, 1964)

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Listed are honorary members from the beginning of the Institute as far as our records reveal. Honorary members were not approved or elected every year. According to the IMI Constitution and Bylaws adopted June 24, 1913, Article II, Section 2: "*Any person of distinction in mining may be elected an honorary member of the Institute by two-thirds vote....*" In 1983, this section of the Constitution was amended to: "*Annually, one or more members recommended by a committee and approved by the Executive Board, who has rendered outstanding service to the Illinois Mining Institute, and thereby to the coal industry of the state, may be elected as an Honorary Member with dues being waived.*"

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*Affiliations listed are at time of award.

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PROCEEDINGS
OF THE
ILLINOIS MINING INSTITUTE

ANNUAL MEETING
104th YEAR
Collinsville, Illinois
Thursday and Friday, September 26-27, 1996

The opening session of the 104th Annual Meeting of the Illinois Mining Institute was convened at 10:00 A.M., Thursday, September 26, 1996, in the LaSalle Room of the Gateway Center. Bert Hall, President of the Institute, presided.

OPENING REMARKS

Bert Hall: Good morning. Welcome to the 104th annual meeting of the Illinois Mining Institute. My name is Bert Hall, and I have the privilege and honor of serving as this year's President of the Mining Institute. I have a couple of points from an administrative standpoint before we get started. The business meeting will be held tomorrow, Friday morning, at 9:00 o'clock here in this room. We ask that everyone attend that can attend. We will elect officers and board members and discuss the finances of the Mining Institute and receive reports from the colleges about the IMI scholarships. Also, if anyone knows of any deceased IMI member, please tell Heinz or Phyllis, or anyone at the registration desk so that we can take their names down for recognizing them at the luncheon today and during the business meeting tomorrow. So, if you do know of anyone who has passed away, please help keep our list up to date. There will be guards posted at the entrances; they have been instructed to refuse entrance to anyone without an IMI badge, just so that we know the people attending are members.

Our luncheon speaker today after this technical session is Pete Lilly who is President and Chief Operating Officer at Peabody. I would also remind everyone of the fellowship tonight from 5:00 to 7:00 P.M. in the exhibit hall. I would encourage everyone to attend and to meet with exhibitors and friends. We have a raffle going on for two airline tickets and a set of golf clubs. The airline tickets have been donated by Roberts & Schaefer, and the golf clubs are donated by Jim Justice of DuQuoin Iron and Supply. I encourage you if you haven't purchased the raffle tickets to please do so. It is one of the ways we raise money, especially for the scholarships. The IMI is especially proud of its scholarships that we provide. We are currently providing scholarships for $10,000.

With that I will turn the meeting over to Gregg Bierei, who is Manager of Environmental Services at Arch of Illinois.

TECHNICAL SESSION I: DEVELOPMENTS IN MINING TECHNOLOGY

Thursday, September 26, 1996
LaSalle Room, Gateway Center

Gregg Bierei: Thank you Bert, I would like to thank everyone who has come to the first of two technical sessions of the 104th meeting of the Illinois Mining Institute. I believe we have some good papers to present; many are on the leading edge of technology.

Our first speaker is Mr. Richard Stahura. Dick Stahura is recognized as a pioneer and leader in the search for an effective and practical method to clean and seal belt conveyor systems. After stints with two other manufacturers of material handling equipment, Dick joined Martin Engineering in 1963. A mathematics and physics graduate of St. Francis College, Dick has now spent more than 25 years dealing with material handling systems and the control of "DURT." This term is used for materials released by conveyor belt carry back and transfer point spillage. Dick has circled the globe searching for durt and has spread the gospel for proper conveyor belt design to eliminate the release of fugitive dust. With that I would like to introduce Dick. His paper is "Keeping Conveyor Belts Clean."

Richard Stahura: Thank you, Gregg.

Gregg Bierei opens the Thursday morning technical session.

KEEPING CONVEYOR BELTS CLEAN AND SAFE

RICHARD P. (DICK) STAHURA

Martin Engineering
Neponset, Illinois

INTRODUCTION

My all-time favorite garage mechanic, gadgeteer, mechanical wizard, and philosopher lived in my home town in the coal fields of Pennsylvania. One of his businesses was a tire dealership, and so people would consult him on tire problems ranging from off-road earth hauling equipment to racing cars. One evening I got into a conversation with him about tires, and I asked him for advice on how the average car owner could prolong the life of his tires. His answer was simple: "Wash your car daily."

His explanation was that when the average person has a clean car, he or she drives with more care. They ease out of the driveway. When following, they don't get too close, for fear of getting splashed. They don't want bug spatters all over the windshield, so they drive a little slower. They ease over railroad crossings. They come to a gravel road or to a construction zone and go much more cautiously.

"You watch the same driver when his car is dirty, and he bounces over railroad crossings, dirt roads, pot holes. He'll start faster, drive faster, and stop faster. In general, he abuses his machine. And so tires–and other components–just don't wear as well or last as long."

This conversation took place over 40 years ago. Now, from my own observations, I'd say he was right on target. And now, when a client asks me how they can improve profitability, my answer is: "Keep your operation clean." At a clean plant, the equipment lasts longer and there is less unscheduled downtime for repair or replacement. So production efficiency stays up. In addition, the clean plant is safer, has better morale, and is hassled less by regulatory agencies. Conversely, at a dirty plant, equipment breaks down, so it needs premature replacement with the added overhead of downtime for replacement. Employees reflect a sloppy attitude in both safety and in their attention to work requirements. And the regulatory agencies pay more attention. These factors can be considered "The Price of DURT." For clarification, let me give a definition of the word "DURT". It's my name for the material that escapes from the conveying system. It's the fugitive material underneath conveyor belts and around transfer points. It's the airborne dust particles that is carried away from transfer points. It's the wet muck that cakes on the support hardware of conveyors.

Let me review the reasons for my answer. A clean plant's equipment lasts longer. There are less surprise failures. Therefore, production

that is scheduled is realized. Downtime–and the resulting loss of production–occurs more often in dirty plants.

THE BENEFITS OF A CLEAN PLANT

A clean plant handles a product as few times as is necessary, so efficiency is high. When material becomes fugitive and has to be gathered up and reintroduced into the system, this inefficiency increases the cost of production. Or if the fugitive material is lost and cannot be salvaged, it even more dramatically increases the inefficiency. The cost of producing this lost material is lumped together with the overhead to raise the cost of the whole operation.

A clean plant is usually safer. There are fewer accidents which are costly in both personnel and in production. A study by the U.S. Bureau of Mines on accidents states that a high percentage of accidents are conveyor-related, and that for the most part, the victims were in a dangerous situation because of "DURT" from a conveyor.

A clean plant has better employee morale. People tend to feel proud that their place of work is a showplace. Who would brag about working in a sewer? A happy employee is more likely to give his or her best effort.

A clean operation seldom receives harassment from OSHA or MSHA. Why? Because it is obvious to these agencies that management is running a "tight ship"–doing its best to do things properly, efficiently, in everyone's best interest.

The problems that arise from "DURT" are obvious and costly. Then, why are so many operations dirty? The answer to that is, usually, the people who can cause things to happen in the plant are not aware of the "DURT" problem. With the increased use of computer systems, profit leaks will easily be spotted and brought to the attention of these managers. "DURT" will be exposed for the costly problem it is.

"DURT" FROM CONVEYOR SYSTEMS

Studies have shown that the conveying system can be the predominate cause of fugitive material. An engineer for a major steel company studied their fugitive material problem and determined where it was coming from. His work showed that 80 percent escaped from the conveyor belts. The next step was to devise a program to eliminate this "DURT." The solution adopted was to install belt cleaners; but these cleaners quickly became inefficient, allowing fines to be carried back to become "DURT" piled along the conveyor way.

Finally, it was determined that servicing the belt cleaners weekly would control the problem. The maintenance cost on the belt cleaners rose by a factor of 10, but the service requirements for the other conveyor hardware fell dramatically. The savings in labor–labor no longer needed to clean up "DURT" along the beltway–was $1.5 million.

It is generally accepted that carryback on belt conveyors causes "DURT". But the quantity—just how much "DURT" there is—is not documented. What is needed is a method to measure the amount of carryback on a belt, and the amount of this material that becomes fugitive.

Quantifying the Problem

I often use a device of my own design to measure the amount. It consists of a collection pan beneath a one inch wide scraping blade. When the blade is pressed against the underside of a moving belt, it scrapes the surface free of any residual particles. By weighing the amount of material collected in a ten-second period and multiplying that figure by the width and speed of the belt, you can establish a measurement of the material being carried back on the belt.

When I tell clients that a carryback of one gram for every meter of belt length can result in over 2.7 tons per week of fugitive material from a single conveyor belt that is moving at 800 feet per minute, they are generally amazed. Here's the calculation:

800 ft/minute = 243.48 m/minute
X 1 gram/m X 60 min./hr X 8 hours/shift X 6 days/wk
= 1,548 #/wk for one-shift per day of operation.
or 3,096 #/wk for two-shift per day operation.
or 4,644 #/wk for three-shift operation per day.
For round-the-clock, 7-days-per-week operation, the carryback would total 5,418 pounds or 2.709 tons.

Then I go out to their belt and measure their actual carryback and typically find it to be more in the neighborhood of five to ten grams per meter of belt length.

I invite you to take a spatula and scrape a meter of length clean from one of your typical belts. Weigh the material you've scraped and make your own calculation of the amount of material that is in a position to become fugitive and add to your "DURT" problem. For safety's sake, scrape from a belt that is not running. I believe you'll be surprised, scared and saddened by the amount of material you'll find.

Let's look at an example at what this kind of fugitive material can cost an operation. A barge unloading facility on the Ohio River incorporates a bucket type unloader that discharges to conveyor belts to bring the coal to their storage pile. So much of the material being unloaded escaped from the system and fell into the river during the barge unloading, that they had to dredge the unloading site three times per year in order to float a loaded barge into the slip. Each dredging cost $25,000 and filled one or more 300-ton capacity barges. This coal was sold back to the station by the dredging company, which means they paid for this coal twice.

By plugging the leaks and eliminating carryback on the conveyor, the plant reduced the need for dredging to once per year. By reducing fugitive material, this facility created a direct savings of $86,000 per year from an investment of less than $15,000 in new equipment, sheet metal fabrication and controls.

Here's another example. A global mining company did a study directed at evaluating their various methods of materials handling. This study pointed out that the use of belt conveyors as a transportation system held particular advantages in terms of:

- lower personnel costs;
- lower energy costs; and
- lower maintenance costs.

The study also indicated conveyors offered the potential for a higher degree of automation in the firm's material handling. But the study exposed a considerable profit drain, through loss of material which became fugitive during its conveying.

The company's combined annual production of just two minerals, iron ore and coal, is over 60 million tons. A study of the handling at their port sites–without regard to their mines and process plants–indicated that material spillage amounts to approximately .05 percent of the total throughput. That means a material loss of 30,000 tons. If there was no fugitive material, there would be 30,000 tons of additional material to be sold.

The true costs added to their operation should not be limited to the loss of saleable material. In reality, this cost includes the expenses incurred cleaning up the lost material, as well as the cost of unscheduled downtime, which can stem from one of several "DURT" related causes, such as:

- build-up on idlers and pulleys, causing them to fail or misalign the belt;
- a conveyor fire shuts down the plant; it is traceable to an idler bearing seized to a "DURT" build-up;
- a health, safety, or insurance inspector judges the operation too dirty and mandates a shutdown and clean-up; and
- the loss of services of a valuable employee injured in a "DURT"-related accident, such as a fall from a slippery catwalk, or getting caught in a pinch point during clean-up work.

These expenses–difficult, if not impossible, to tabulate–add to "The Price of DURT." In an effort to reduce spillage and increase profit, this global mining firm instituted a plan to control the "DURT" from their belt conveyors.

CONTROLLING DURT

Let's look at conveyor systems, and the ways they cause "DURT".

Carryback control at the head pulley. The head pulley where the conveyor discharges is the single most important area of the conveyor to examine when your purpose is to control fugitive material. This is because the carryback on the belt accounts for the majority of fugitive material. Carryback can best be prevented with the installation of well-designed belt cleaners at the head pulley.

The problem comes because most often not enough room is provided in the design of the head frame and housing for an adequate belt cleaner system. And this is because designers do not take into account the sticky nature of the conveyed material when it is in its worst condition. Once the conveyor is designed, a belt cleaner specialist will be consulted for a recommendation on how to prevent carryback. But when the designer discovers that there is not sufficient room to accommodate the number of cleaners recommended, that recommendation will be compromised. The conveyor designers are not held accountable for the carryback specifications of the conveyor, so it is natural for them to "save money" and do less than the recommendation. Or, they will find a belt cleaner supplier who will provide equipment that will fit into the system with the vague promise that it will do the job. This is the way it is, and the way it will continue to be, until specifications establish a quantitative amount of carryback that is allowable.

To analyze the material in its worst condition may take some doing, but believe me, it's worth the effort. Unless you do, you cannot have an efficient belt cleaning system. And if the cleaner is inefficient and you get a bad run of material, the conveyor will become a mess in a matter of hours, or even minutes. An efficient belt cleaner designed for worst case materials will be a case of overkill under normal conditions. But when the material changes, you'll be prepared.

One of the keys to effective belt cleaning is the mating of blade to belt. It stands to reason the more perfect the blade mates with the belt, the better it will clean. Anything that makes it more difficult for the blades to stay in perfect contact as the belt moves must be considered as being undesirable. These factors would include out-of-round pulleys, or the poor choice or installation of lagging. Any vibration of the belt's surface can lower cleaner efficiency and adversely affect the life of the belt.

In any case, you will discover that it generally requires more than one device to properly clean the belt when the material is sticky. We recommend multiple belt cleaner systems, composed of a pre-cleaner and one or more secondary cleaners (fig. 1)

Pre-cleaner. The pre-cleaner is designed to remove the majority of the material clinging to the belt right at the face, so these fines can join the main cargo discharged from the belt. This device acts as a lopper blade, removing the heavy layer of carryback, leaving only a skim of fines to be removed by the secondary cleaner(s).

The position of the pre-cleaner blade in relation to the belt places it in a peeling position. With an angle of attack of less than 30°, this pre-cleaner blade cleans with very little tip pressure against the belt, resulting in low

wear rates for both the blade and the belt surface. If this angle of attack were greater (a "scraping" position), more pressure would be required to hold it in position against the onslaught of material. Since the objective of a belt cleaner is to prolong the life of the conveyor components by removing fines, it would certainly be counter-productive if the cleaner itself contained the potential for damage to the belt. Lower blade pressure means that the tensioning system will be able to relieve the blade from the belt when a mechanical splice moves past the cleaning edge.

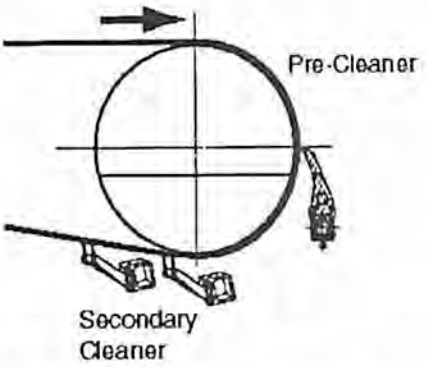

Figure 1. Multiple cleaner system.

Secondary Cleaners. The positioning of the secondary cleaner(s) is critical. The closer the carryback is removed to the discharge point, the lower the potential for fines build-up in the dribble chute. It is best to install secondary cleaners so blades contact the belt as it leaves the head pulley.

For a secondary cleaner, I recommend a design that incorporates multiple blades approximately six inches wide that span the belt. Because this cleaner must be as efficient as possible, the blade must mate with the belt as flat as possible. There are peaks and valleys on the surface of the belt that the cleaner must adjust to instantly. The individual blades afford the best chance to effectively clean this moving surface.

The blades themselves should be of a hard material that resists the heat build-up from its scraping action against the belt's surface. Narrower blades that are individually suspended have the best potential to remain in precise contact as the belt surface passes across the cleaning edge.

Again, the angle of attack of the blade to the belt is an important consideration. For this cleaner, I recommend a scraping angle, as blades in a peeling position are quickly honed to extreme sharpness. This raises the risk of an untrained or "in-a-hurry" adjustment that, while it may provide good cleaning, applies too much pressure to allow instant release from obstructions such as mechanical splices. Again, the cleaner and tensioner must allow a splice to pass without damage.

Dribble Chutes and Scavenger Conveyors. The build-up of fines on the dribble chute must be prevented. Often, a belt cleaner is judged to be inefficient, when in reality scraped off carryback fines have built up in the dribble chute and encapsulated the cleaning device, preventing it from performing the job it was designed to do.

One way to solve the dribble chute build-up is to create a dynamic sub-floor in the chute. This is accomplished by mounting a sheet of smooth,

low-friction, abrasive-resistant plastic, such as UHMW Polyethylene, so the plastic is parallel to the chute floor but free to move. Use a "U" shaped piece of metal to support the sub-floor at one end; leave the other end unsupported (fig. 2).

By installing the vibrator on the "free" leg of the "U", the vibratory action is transmitted through the leg and the plastic, providing dynamic action to prevent material build-up. Because this installation is not connected to the chute wall, there is no force applied to the structure to cause metal fatigue and cracking.

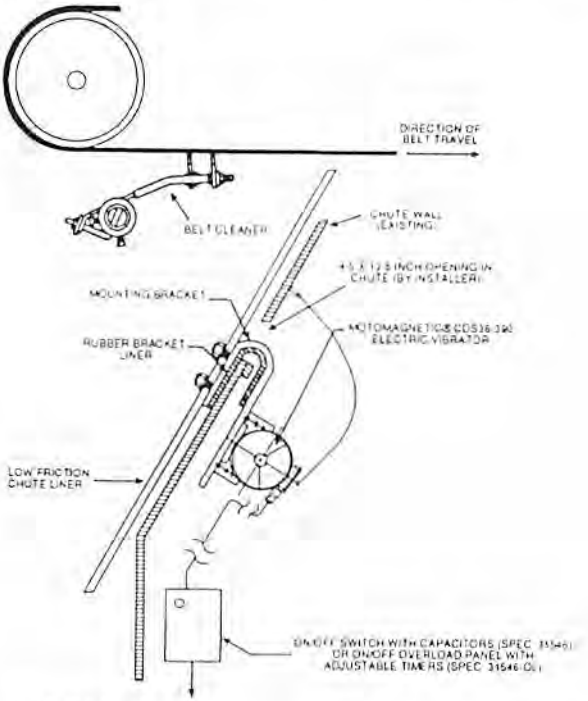

Figure 2. Vibrating dribble chute.

Another special consideration is the use of a dust suppression system on the conveyor. If it incorporates water sprays to wet conveyed material, it can accelerate the problems in belt cleaning. The fines become even more sticky, until they reach the point where they can overpower the cleaner. The designer should consider this and include a belt cleaning system that will handle this added carryback. In some cases, particularly if the system has only limited space at the head pulley, a scavenger conveyor may be required to return fines to the main material load.

Belt Cleaner Maintenance. It is important to provide access to your belt cleaning devices. This will allow operations personnel to make inspections and provide appropriate service as needed, perhaps even several times a day on those occasions when the material is in its "worst case" condition. Access windows with easy-to-operate closure doors should be

installed on both sides of the pulley, and in line with the axle of the belt cleaners.

You'll want to perform required adjustments in the shortest possible time, without the need for extended conveyor downtime. (MSHA does not permit service to be performed around a moving belt.) It would also be desirable if all adjustments and blade replacement could be performed with minimum tools. For this reason, I recommend the track-mounted type of belt cleaner which permits an operator–even if he isn't a tool-carrying maintenance man–the ability to remove the cleaner and provide any necessary service during a brief conveyor outage.

Transfer points. At the opposite end of the conveyor from where the conveyor belt delivers its cargo is another "DURT" producing area—the loading zone. Here, the culprit most often blamed for escaping material is the skirt rubber. This rubber is installed to provide a seal between the moving belt and the stationary steel which directs the material onto the belt. It would seem obvious that for this to be accomplished efficiently, the belt's line of travel should be as steady as possible, and the weight of the material load should be kept away from the rubber sealing system. But this is not typically the way loading zones are designed.

Loading zone spillage is best controlled by a three-part program consisting of:

- proper belt support to minimize belt sag;
- wear liners inside the chute to protect the sealing system; and
- multiple-layer edge seals to contain any escaping fines.

Belt Support. If a transfer station has the objective of being "DURT" free, or at least to allow as little "DURT" as possible, the designer should do whatever possible to keep the belt's travel line consistently straight. This is fundamental and must not be compromised. The loading of the belt with its cargo, the tensioning of the belt by the counterweight, the type, spacing and arrangement of idlers, the construction and shape of the belt in the loading zone, and the type of pulleys employed: all these factors influence the running line of the conveyor.

It is important to keep the belt from sagging between idlers under load (fig. 3). Any measurable belt sag, even one that is not apparent to the naked eye, is enough to permit fines to start a grinding action that produces wear on rubber skirt and belt surface and allows the escape of materials to the environment.

If a belt was supported by a flat table that prevented its moving in any direction except in a straight line, it would be easier to place skirt rubber against it and expect to maintain a constant seal while the belt was in a traveling mode. Loaded or unloaded, stopped or in motion, the belt's position would be the same. The conveyor system designer should attempt to achieve a support system for the belt that is similar to the table's ability to keep the running line true.

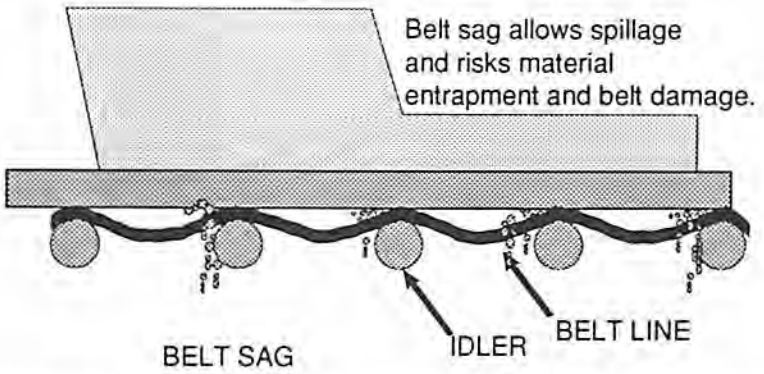

Figure 3. Conveyor showing belt sag and material entrapment.

Idlers should be aligned with care and matched so as not to produce humps or valleys in the belt. Idlers should be checked for concentricity, for the more they are out of round, the greater tendency for the belt to dance. Impact idlers with a rubber disc for the rolls, are more likely to be out of round than the regular steel idlers. Of course, the conveyor designer should consider that when the idlers are eight to ten inches apart, they share the impact load to a much greater degree than when placed at a 12- to 18-inch interval. Consequently, rubber impact idlers may not be necessary unless you are dealing with large lumps–say, two and a half inches or larger.

Slider Beds and Cradles. So important is the flat-table concept to good transfer point sealing that many designers are now using slider beds or cradles (fig. 4) instead of idlers in the transfer point. This is accomplished by using bars that feature the ability to cushion impact through the incorporation of a shock-absorbing elastomer. These bars are then covered with a surface layer of plastic with low friction and wear-resistant properties. A cradle made with these bars may add slightly to the friction of the conveyor and, hence, to its power requirements. But this marginal increase in energy consumption is more than offset in the profit picture by the elimination of the expenses for the cleanup of spillage and the downtime required for idler maintenance or belt replacement.

Impact-absorbing systems placed under the load zone with entry and exit idlers allow large impacts, yet prevent the belt sag. This support system features a slick top cover to allow the belt to slide across, along with underlying layers of rubber to absorb the impacts.

Lighter-duty side-seal cradles (fig. 5) can be used in the non-impact areas. Placed directly under the chute wall/skirting seal system to maintain an effective seal, these support systems provide a long life and slick wear surface.

Intermediate idlers should be used in conjunction with the belt support systems to reduce the power consumption of the conveyor system.

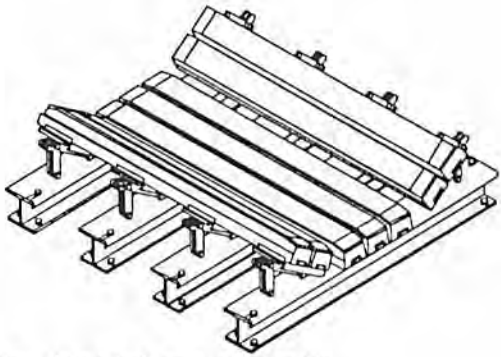

Figure 4. Impact-absorbing belt support cradle.

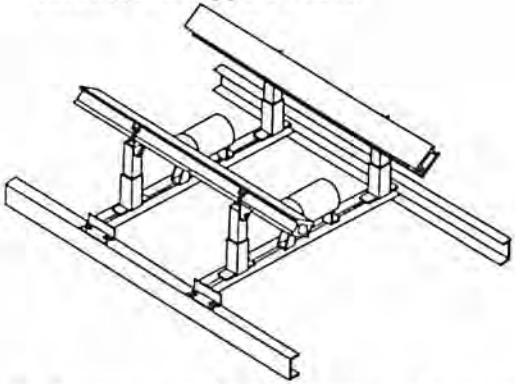

Figure 5. Side-seal belt support cradle with center rollers to reduce friction.

Wear Liner. Wear liner is a flat sacrificial surface placed inside the chute wall to form a long-lasting barrier to produce the edge seals. If left uncontrolled, this side-loading of the material places tremendous pressures on the seal. This leads to accelerated wear of the sealing strip, and, in turn, to spillage and the risk of major belt damage. But the wear liners inside the chute form a line of defense, shielding the seal from the forces of the load.

Liners can be installed against the chute walls, or with an open area between the actual wall and the wall (fig 6). This spaced wear liner is then used as a pickup area for the dust collection system, or as auxiliary free area to shelter the sealing system from loading material. Liner materials could be mild or stainless steel, abrasion-resistant plate, ceramic-faced or hard-faced steel, rubber, urethane, or plastic, depending on the specifics of the application. For all wear liners, the cross-sectional area of the chute should be checked carefully to make certain that the liner does not interfere with flow. It is critical that wear liners be installed as a smooth seamless layer that widens in the direction of belt travel, to minimize material entrapment and the risk of belt damage. Great attention must be given to the bottom edge to avoid pinch points that can trap material and injure the belt.

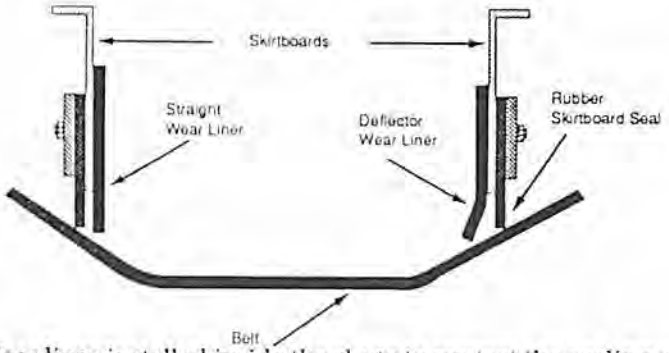

Figure 6. Wear lines installed inside the chute to protect the sealing strips from material forces.

Skirtboard Seal. Over the years, elastomer strips have been used as a seal along the side of the load zone. But these rubber or plastic strips have met with problems in maintaining effective sealing performance. Too often, they were required to bear the total responsibility of containing the material load. Asking these thin, flexible strips to contain large volumes of material over long periods of time is begging for failure.

However, once belt support and wear liner have been correctly installed, the seals at the sides of the load zone now needs to contain only small particles–fines and dust, a job the elastomer sealing strips are more suited to perform.

Like multiple layers of clothing protect the body in cold weather, multiple barrier sealing systems (fig. 7) form several lines of defense. An effective sealing system provides two layers of elastomer: a primary seal against the chute wall, to prevent the escape of most particles, and a secondary seal that lies on the belt surface outside the chute, to prevent dust from escaping the system. Tensioned against the belt by its own internal resilience, this multiple-layer sealing system requires only occasional maintenance to keep sealing performance at maximum.

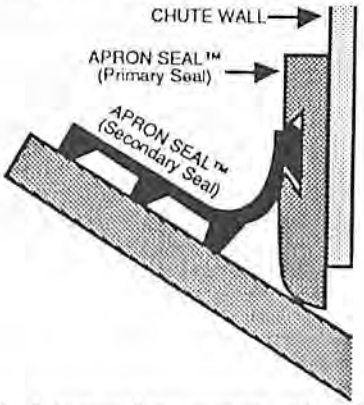

Figure 7. Multiple-layer sealing system, using two strips of elastomer.

CONCLUSION

Ease of maintenance is essential to the concept of having a "DURT"-free conveying system. Management may be committed to a "clean plant" philosophy, but the need to keep production up will cause "DURT" considerations to be compromised. Maintenance crews cannot call out for the belt to be down for a lengthy period in order to change out an idler or belt cleaner. That would be too costly to production efficiency. Consequently, all items that serve as components in the fugitive material control system should be designed to feature easy maintenance and replacement.

"DURT" is a costly problem. It decreases production efficiency, increases the costs of maintenance, poses a safety risk, and acts as a lightening rod for the attention of environmentalists and regulators. By taking positive steps to control fugitive materials and eliminating the sources of "DURT," you improve your operation–in safety, in the quality of work life, and in production efficiency. These improvements will appear in the balance sheet. Reduce the "Price of DURT." The first step is to THINK CLEAN!

Gregg Bierei: I've been working with our next speaker for a few years, Mr. Wesley Hofmann. He is presently Archveyor coordinator at Arch of Illinois' Conant Mine at Percy. Wes is a graduate of Pennsylvania State University with a B. S. degree in mining engineering. He has over eighteen years experience and has previously worked with Jim Walter Resources, AMAX Coal, and Arch Mineral Corporation in various operations and engineering positions. He will tell us a little bit about the Archveyor automated mining system which is a new technology available here in Illinois in the near future.

Wesley Hofmann: Thank you Gregg. Good morning everybody.

THE ARCHVEYOR™ AUTOMATED MINING SYSTEM–IMPLEMENTATION AT THE CONANT MINE

WESLEY J. HOFMANN
Arch of Illinois
Percy, Illinois

INTRODUCTION

Arch Mineral Corporation, through the Arch Technology Department, has developed an automated continuous haulage mining system called the "Archveyor™." The original technology came from a Russian patent. Kloeckner-Becorit (K-B) further developed the system and called it the "Mobile Conveyor." This system was utilized in both coal and trona mines in the United States and Canada. Consolidation Coal designed their version of this continuous haulage system, called the "Tramveyor." The Tramveyor is presently operating in their Dilworth Mine, in Pennsylvania. This system has no computer guidance system related to the continuous miner or the Tramveyor. Arch Mineral Corporation has further developed this continuous haulage mining system. Our system is a programmable, logic-controlled (PLC) automated mining system. A highwall version of the Archveyor™ is being operated at Arch of Wyoming near Hanna, Wyoming. This paper introduces the first underground version of Archveyor™ to be implemented at Conant Mine in southern Illinois. During the development process, the Archveyor™ mining system consists of a continuous miner, a bolter car, the Archveyor™ (itself), a stageloader, and an operator's cab. During the secondary mining process the bolter car is taken out of the system.

CONTINUOUS MINER

The continuous miner is a modified Joy 12CM miner with a fourteen-foot cutter drum. This miner has a maximum cutting height of 12 feet, 1 inch. The guidance system consists of a gyro to maintain the continuous miner on a particular azimuth. Gamma detectors are incorporated on the miner to provide information of the continuous miner's cutter head location within the coal seam. Inclinometers are mounted on the continuous miner to provide additional information of the continuous miner's body pitch and roll, as well as the miner's cutter head and pan location within the coal seam. This machine is provided with a standard CSE 140BLD methane "sniffer" sensor. Also, an atmospheric detection system is incorporated into the system. The continuous miner has a Trolex explosive gas sensor mounted just outby the cutter motors. This detection system shall provide continuous methane detection during the active mining cycle. A rotary resolver, or

distance measuring encoder, provides information to the PLC of the distance between the continuous miner and bolter car during development, or the continuous miner and Archveyor™ during the "winging" or secondary mining process. Cameras are mounted on the continuous miner to provide the remote operator a view of the left and right side of the cutter head. An additional camera is mounted on the Archveyor™ and bolter car to monitor location of the continuous miner's tail. During the PLC-controlled mining process, the continuous miner and subsequent Archveyor™ mining system will only advance forward. The system must be switched to a different mode of operation in order to back the system out of a given cut.

BOLTER CAR

The bolter car is a modified JOY 14CM in which the cutter head and pan sections have been replaced with a receiver end, an automatic temporary roof support (ATRS), and four drill masts (fig. 1). The front (inby) two drill masts pre-drill the hole at a specific adjustable length for the installation of a roof bolt. The rear (outby) two drill masts' primary functions are to anchor the bolts in the pre-drilled holes. The rear masts also provide the ability to extend the length of the hole if required due to the lithology of a specific area. Also, these rear masts have the capability to swing or telescope out to spot-drill and anchor additional bolts as needed. The roof bolt pattern will be a 5 by 5 foot maximum pattern (fig. 2).

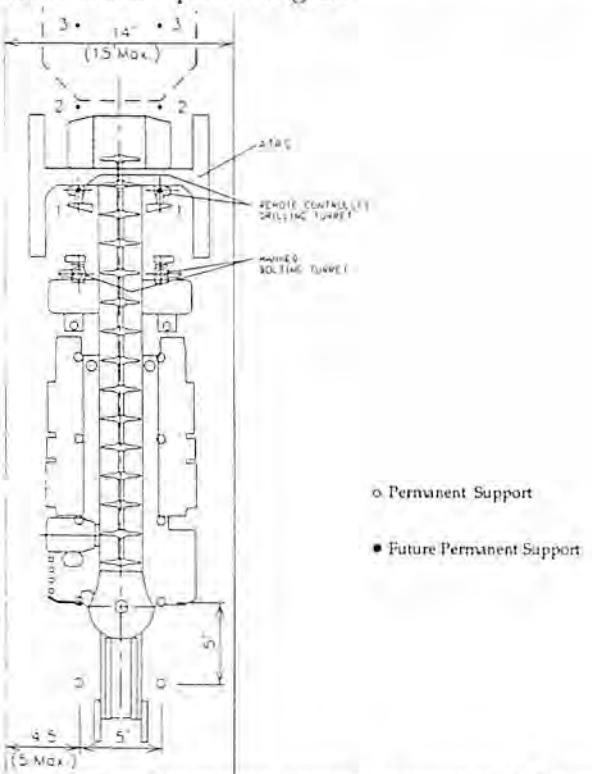

Figure 1. Bolting pattern and sequence, using bolter car in 14-foot wide entry.

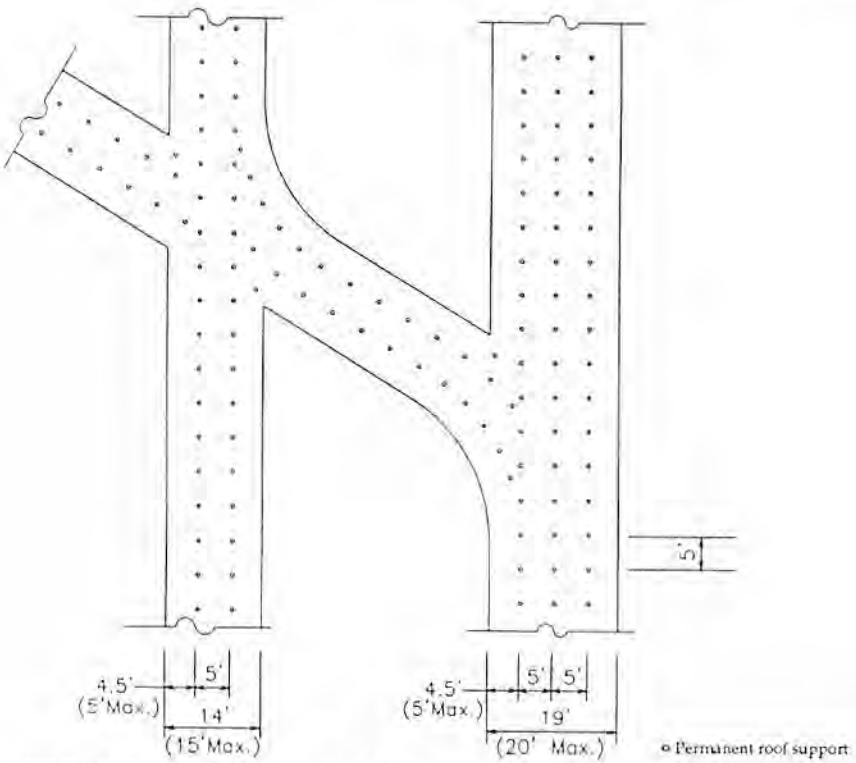

Figure 2. Full roof bolt pattern and spacing.

A slurry duster system has been incorporated within the Archveyor™ mining system. During the panel development phase, the bolter car is utilized to maintain the wet dusting. The wet dust will be applied as the bolter car trams from row to row during the roof bolting process. The wet dust process will be followed by dry dust in a systematic manner.

ARCHVEYOR™

The total length of the Archveyor™ is 521 feet. The Archveyor™ pan sections are 483 feet in length with an outby section making up the final 38 feet. The typical pan's outside width is 62 inches. The chain conveyor area is 33 inches wide, with 23 inch high sideboards. The Archveyor™ utilizes its chain conveyor to tram in either direction and to convey coal. During the tram cycle, a two-speed gear box allows the Archveyor™ to travel at approximately 50 feet per minute (fpm). During the loading cycle, the chain conveyor operates at approximately 170 fpm. Since the Archveyor™ trams on its chain conveyor, the Archveyor™ must clear enough of its chain conveyor to advance forward an appropriate distance to continue the loading process. The outby vehicle provides the framework for the 475 gallon hydraulic tank, the power distribution box for the continuous miner, bolter car and Archveyor™, the blowing auxiliary face fan and the discharge tail that dumps the coal onto the low-low stageloader.

The Archveyor™ has an oxygen and air velocity sensor located on the inby end. These two sensors are a part of the same atmospheric detection system tied to the continuous miner. These sensors provide constant information pertaining to the mining atmosphere and the ventilation provided through the auxiliary fan and blower tubing.

The Archveyor™ is a self-tracking system that follows either the continuous miner or the bolter car, depending on the operational mode. The PLC system receives information from the steering devices located on the inby end of the Archveyor™ which in turn guides the Archveyor™.

There are a total of 20 emergency stops on the Archveyor™ pan sections. One is located on each side every 50 feet along the system.

Low-Low Stageloader

The outby vehicle of the Archveyor™ dumps coal onto the low-low stageloader. The stageloader is an independent piece of equipment that dumps into the section's feeder/breaker. The low-low stageloader differs from other systems in the manner that the section's panel belt does not travel through it. The stageloader is a totally independent coal conveyance system.

Operator's Cab

The operator's cab is an environmentally controlled unit. It provides heat, air conditioning, and a filter system. The heater/air conditioning unit provides the proper temperature for the computers and PLC. The dust filtration system will reduce any harmful particulates from entering the computer, the PLC, and the control panel within the operator's cab.

MINE PLANS

The Archveyor™ system will be an additional fourth unit at the Conant Mine. Arch of Illinois will operate and monitor the efficiency of this system in four different modes of operation. The first panel is a scheduled nine-entry room and pillar panel (fig. 3). The second panel will be an eight-entry panel that will mine back into the previous nine-entry panel (fig. 4). These two panels will provide information concerning multiple-entry panel development.

The second mode of operation will be secondary mining of the pillars between the eight- and nine-entry panels. Arch of Illinois will evaluate the present pillaring plan (fig. 5) and/or a slab-type pillaring plan (fig. 6). The slab-type of pillar recovery may be more conducive for the Archveyor™ continuous haulage system.

The third mode of operation consists of a four-entry headgate/tailgate type of development (fig. 7). This type of development will be utilized in the mine plan to set up the winging process. The belt entry will be nineteen feet wide in order to accommodate the side by side Archveyor™ stageloader assembly. The other three entries will be driven fourteen feet in width for full face mining of the continuos miner's drum (fig. 8).

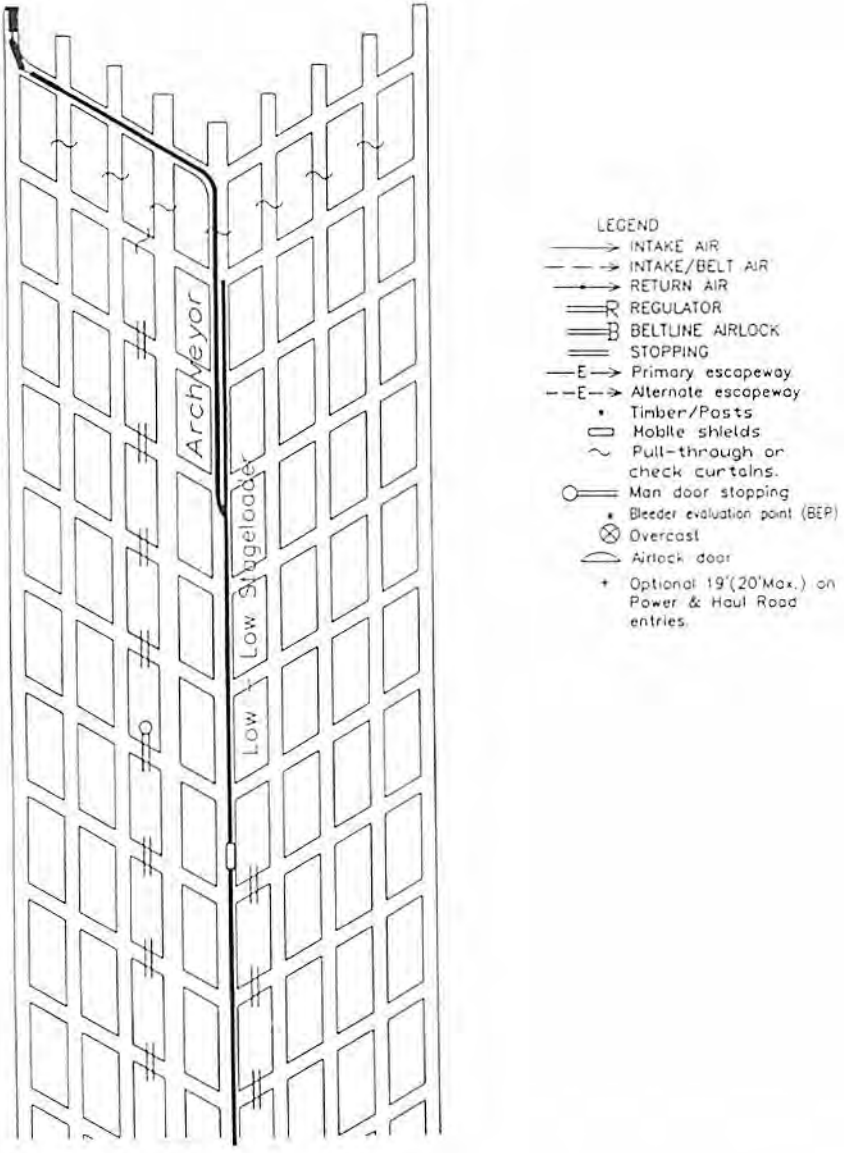

Figure 3. Archveyor™ multiple-entry development; typical nine-entry system.

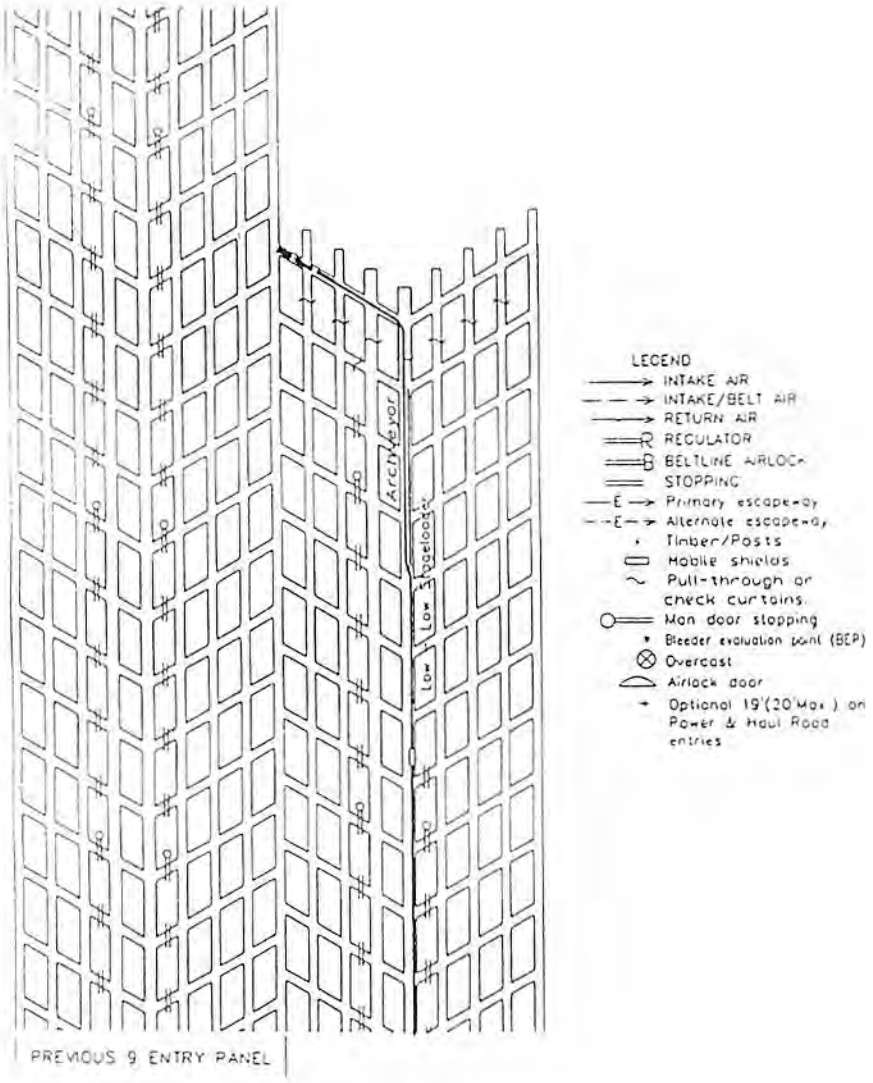

Figure 4. Archveyor™ multiple-entry development; eight-entry system, cutting back into the previous nine-entry panel.

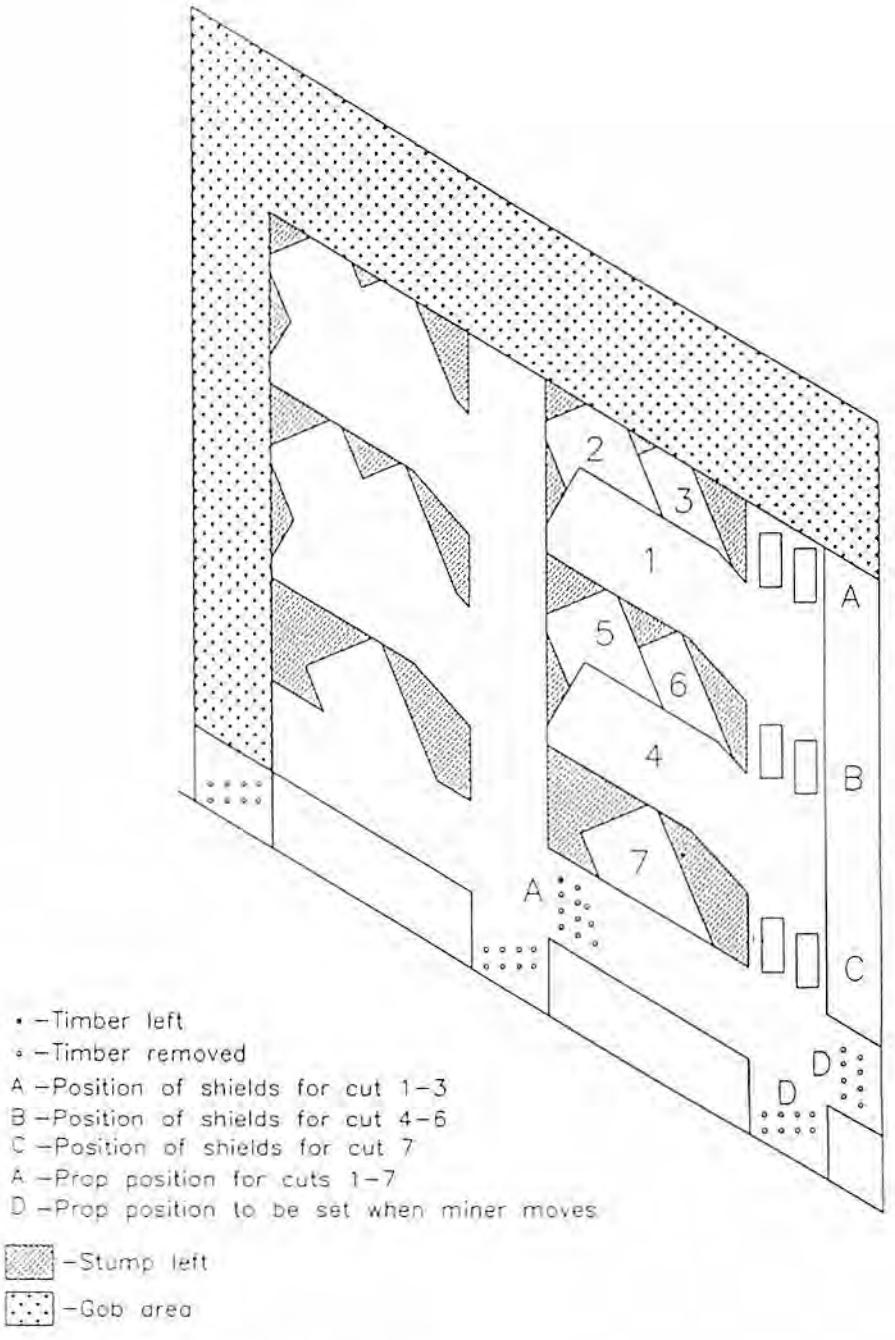

Figure 5. Typical pillar extraction.

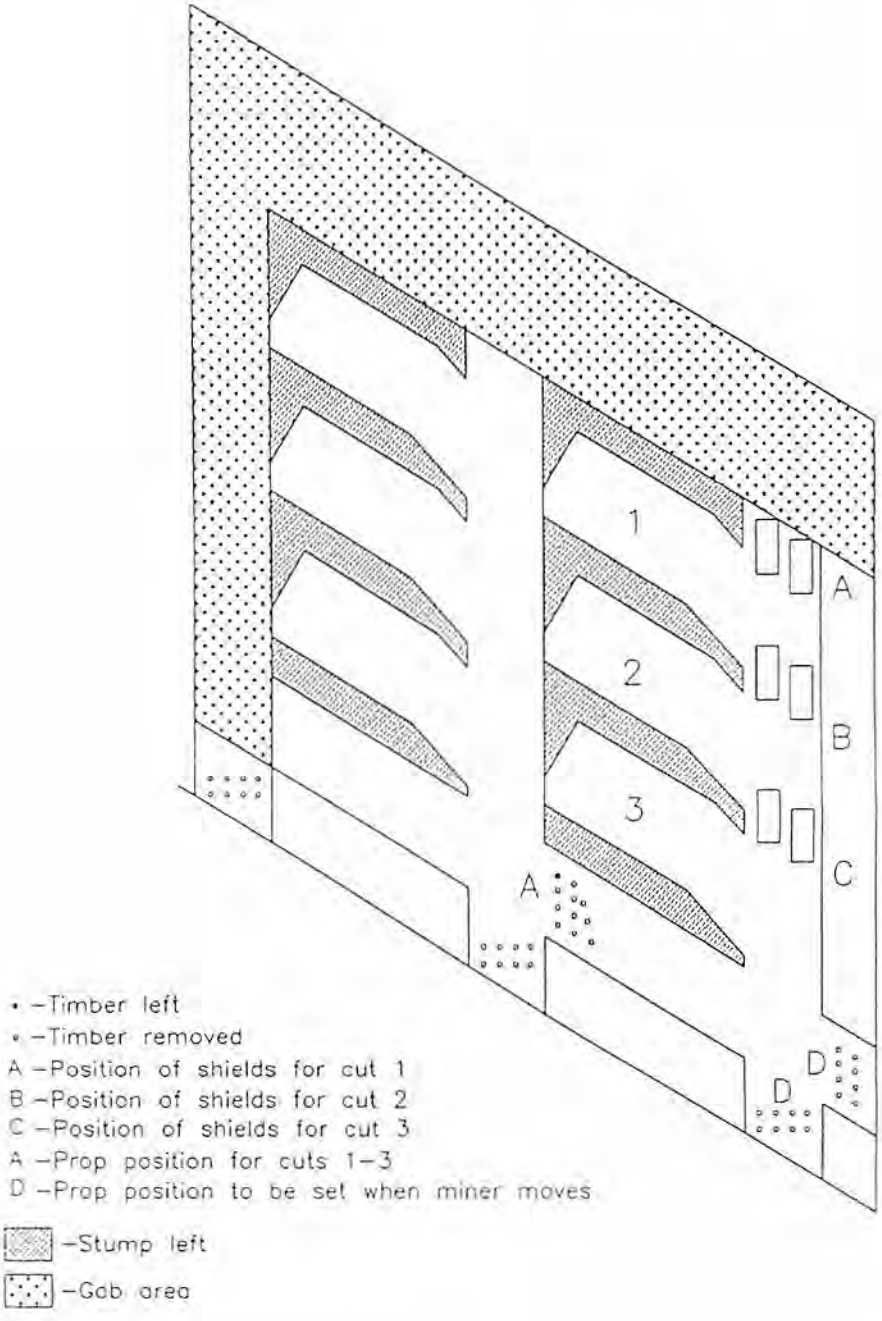

Figure 6. Slab-type pillaring extraction.

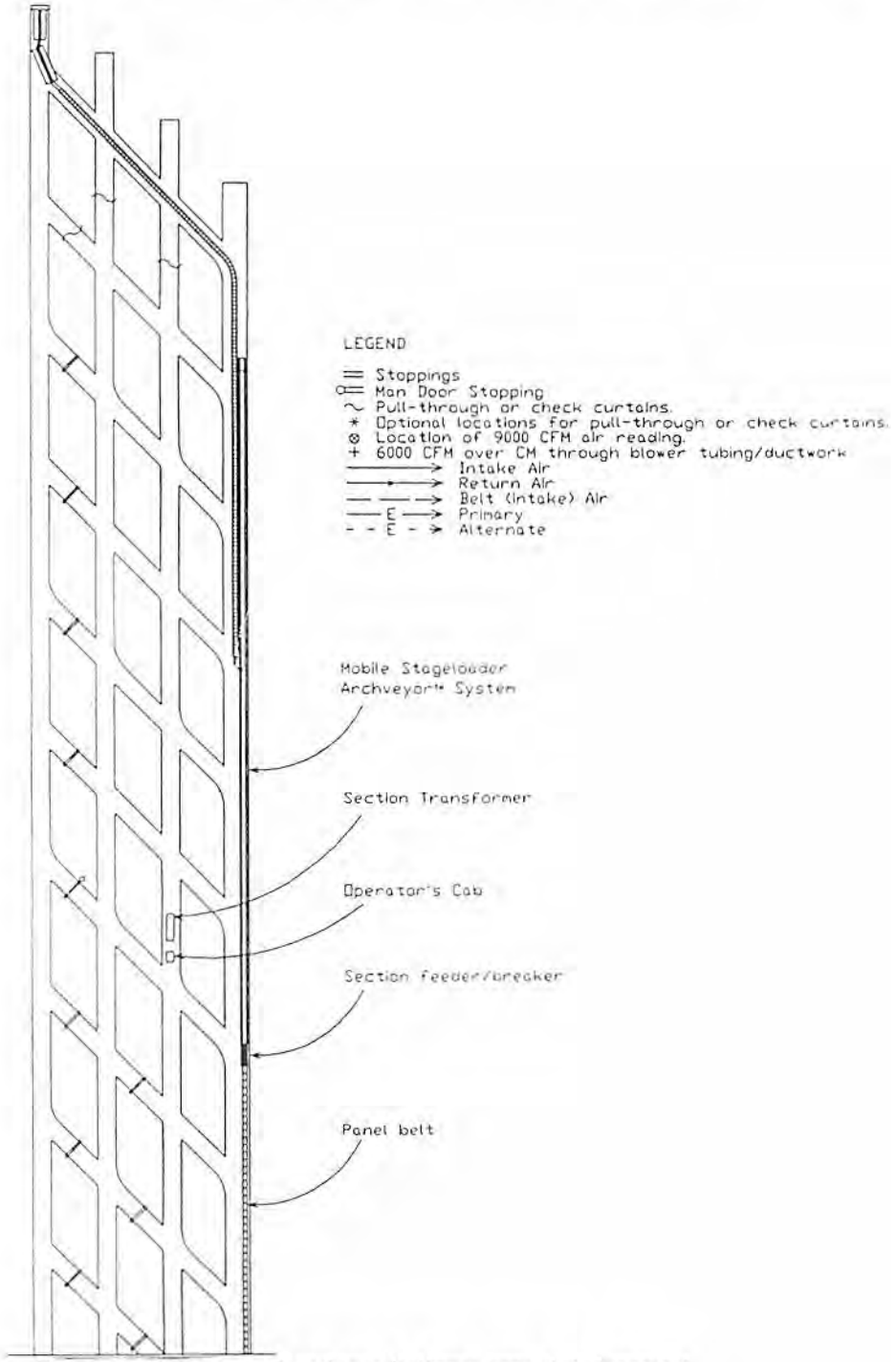

Figure 7. Four-entry headgate/tailgate type development.

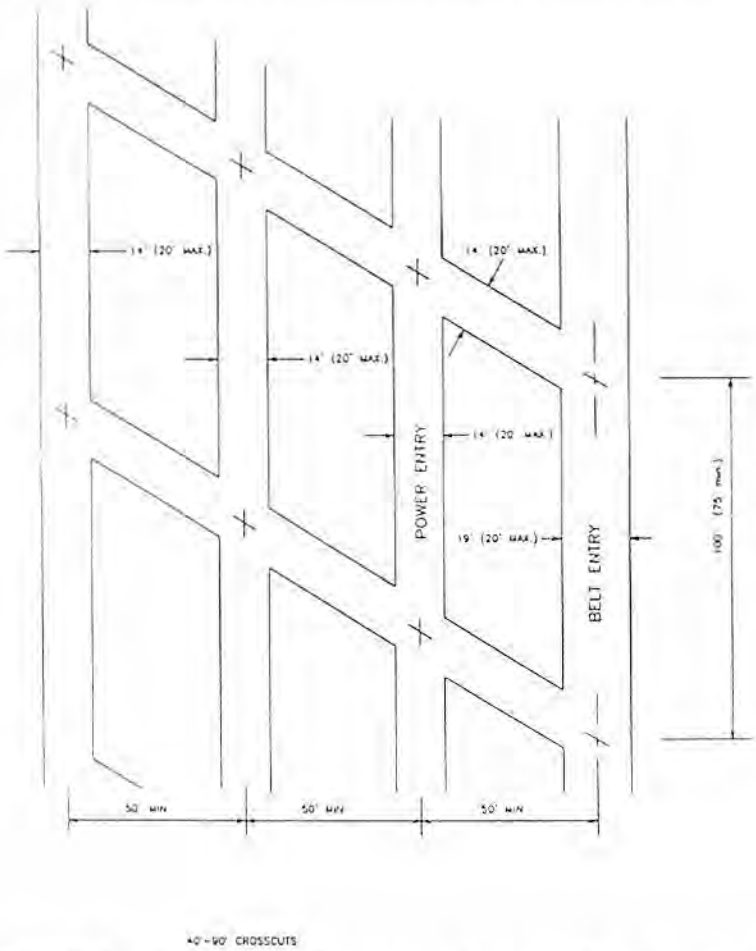

Figure 8. Mining configuration centers, Archveyor™ continuous haulage.

The final mode of operation is the winging process itself. The wing cut is that portion of the mining process that removes the coal between the two Archveyor™ development panels (or the headgate and tailgate entries). The wing cut shall be driven from one development panel to the other with a predetermined web (or fender) of coal remaining between the active cut and the previous cut. This web of coal shall be determined by entry widths, amount of overburden, and general geologic conditions in the specific area of the mine (fig. 9). The wing cut entry will not be supported by any roof control device. This will reduce the mining costs for this system. Also, the Archveyor™ mining system requires no personnel to be exposed to the hazards associated with the active face area, thus providing a safer working condition for the mine personnel.

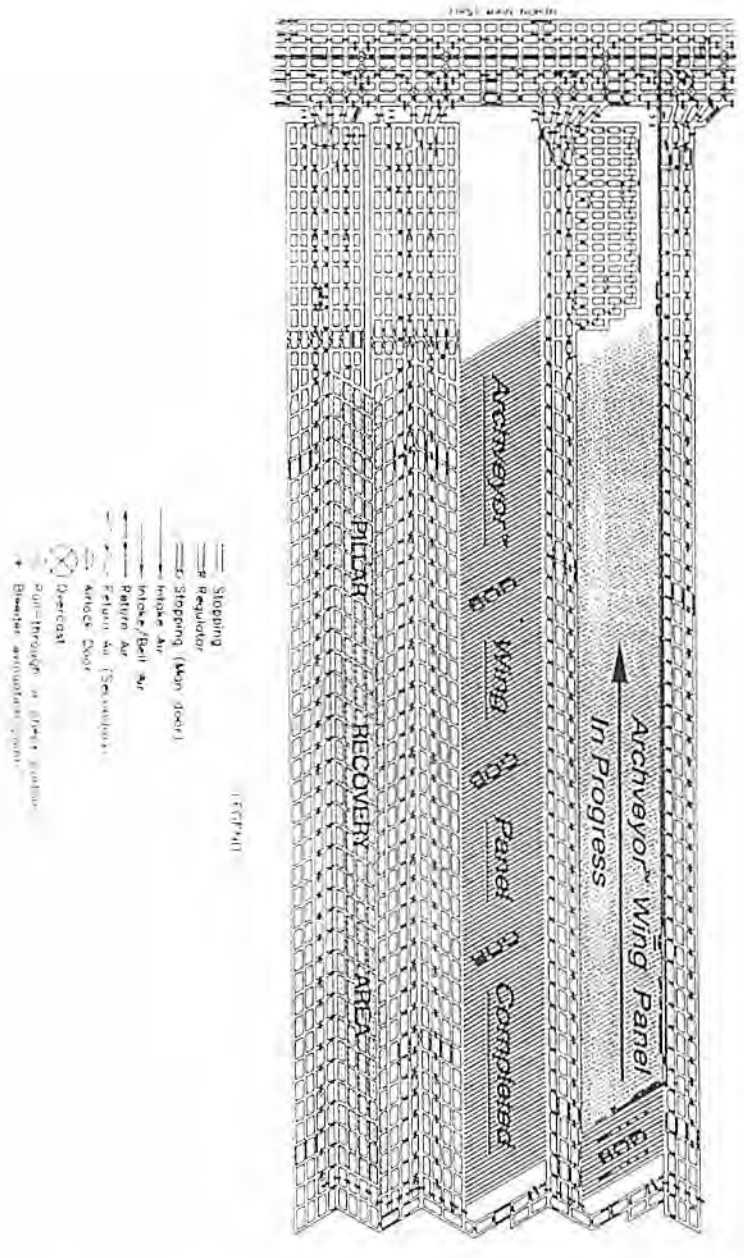

Figure 9. Typical mining pattern for potential underground Archveyor™ application.

CONCLUSION

One of Arch Mineral Corporation's missions is to provide an innovative, motivating work environment and to operate safe, low-cost mines that utilize our resources effectively and efficiently. The implementation of the Archveyor™ at the Conant Mine is one step toward achieving our mission.

Gregg Bierei: Our third speaker this morning is Ian Carr. He is currently director of Engineering for Addington Enterprises of Ashland, Kentucky. He is a graduate of Paisley University, Scotland. His previous experience includes vice president of engineering for Metec, also a highwall mining entity; manager of production and development for Eimco Coal; and chief design engineer for Joy Manufacturing Co. His paper this morning will be about the Adcar Highwall mining system.

Ian Carr: Thank you. Good morning ladies and gentlemen.

[Mr. Carr's paper, entitled "The Adcar™ Highwall Mining System," was not available for publication.]

TUNNELING THROUGH A "FAULT" – THE CHANNEL FILL OF THE ANCIENT GALATIA RIVER AND A COUPLE OF "REAL" FAULTS

TODD A. GROUNDS

Kerr McGee Coal Corporation-Galatia Mine
Harrisburg, Illinois

INTRODUCTION

Construction of the Kerr-McGee Galatia mine began in 1982. Production began in 1984, initially from the Springfield (No. 5) Coal (locally called Harrisburg (No. 5) 550 feet below the surface, then in April 1985, from the Herrin (No. 6) Coal, about 100 feet above the No. 5 seam. The room-and-pillar method was used to 1989 in the Herrin and to 1992 in the Springfield seams when they were converted to longwall mining, respectively. Only the required development work is performed by continuous miners.

A heavy-media preparation plant with a six-million ton annual clean-coal capacity cleans the coal. By the end of 1996, we will have shipped over 40 million tons of steam and metallurgical coal mostly to utilities. Annual production now exceeds six million tons. Production from the Springfield Coal can be used in coking coal blends or as a steam coal with a high heating value and a relatively low sulfur content. Coal from the Herrin seam is a medium-sulfur steam coal with a high heating value. Because production from the Herrin (No. 6) does not meet the Clean Air Act Amendments (CAAA) Phase I compliance standards, we were forced to cease mining operations in this coal bed, leaving 170 million tons of minable coal in the ground. In July 1994, the Galatia Mine became a single seam operation in the Springfield (No. 5) Coal only, which left us with two alternatives: (1) to continue to mine the Springfield Coal with one longwall at an annual production of about three million tons, and with greatly reduced revenue and marginal profit and corresponding layoffs in a county already hard hit by four mine closings in the past two years and an unemployment rate approaching 20 percent; (2) to mine through a mile of rock, more commonly known as the Galatia Channel, to get to a low-sulfur reserve in the same coal bed to the north of the existing mine area and establish a separate mining operation.

We chose the second alternative. Even though this required an initial investment of $25 million, we believed it was the proper strategic move. The "Galatia North" reserve has over 40 million tons of salable coal, with an average sulfur content of around one percent. By developing it as a separate reserve, we would not only have a premium product that would

comply with Phase I, but we would also be able to blend it with our other Springfield (No. 5) reserves so that the entire mine would produce a product that would be salable as a Phase I compliance coal.

Furthermore, we would be able to use the longwall equipment from the abandoned Herrin (No. 6) Coal, allowing us to maximize production. With a concurrent expenditure of $5 million to expand the preparation plant, we could increase annual production by 50 percent to six million tons per year.

The Galatia North facility would consist of intake and return air shafts with an elevator for personnel and small supply ingress and egress. A substation would provide electrical power for the north area. Paved roadways, security stations, microwave communications facilities, and water and sewage facilities would allow expansion to a complete portal facility, including administrative office and bathing facilities, when dictated by production economics. Full utilization of both longwalls and coal blending to meet customer needs would ensure our survival in Illinois, a state that has been devastated by the CAAA. The state's annual coal production will likely drop from 60 million tons to 30 million tons or less by the year 2000.

CROSSING THE GALATIA CHANNEL

Crossing the Galatia Channel presented its own set of challenges. We contracted with the John T. Boyd Company to assist us in determining the geologic characteristics of the channel and in developing a mining plan. We drilled a series of core holes on approximately 400-foot centers along the proposed tunnel route. The holes were geophysically logged, cores described in detail and subjected to geotechnical tests, and hydrologic tests were performed on the boreholes. A cross section of the proposed route was prepared from the data showing stratigraphy, rock hardness, RQD values, analytical results from the geotechnical testing, and the correlation of the coal, limestone and sandstone strata. Not surprisingly, we found three basic rock types: claystone, sandstone, and shales of varying hardness. What did surprise us was that the unconfined compressive strength of the hardest material, the massive sandstone, was only 6,000 to 7,000 psi, while the laminated sandstone and shale strata typically showed strengths from 3,000 to 5,000 psi. We had cut materials nearly this hard with continuous miners in the past, with relative ease. We thought that mining through the channel would not be difficult from a material hardness standpoint. Pump tests indicated that expected water inflow quantities would be minor to moderate in the various strata, with the highest estimate being 20 gpm. Such quantities, if encountered, should be easily manageable. Our greatest concern was with the areas between the coal seam and the channel where the weakest rock (claystone) was present and significant roof control problems could be expected. We planned to use arch supports in these transition zones. Arch selection was based on an assumed requirement to

support rock load of approximately 20 feet. Available data used to construct the cross section also suggested that 1,000 feet of entry–700 feet in the south and 300 feet in the north–might require such support.

With the help of the Boyd Company, a mining plan was finalized. A tunnel route with a non-uniform gradient was selected to avoid excavation within the harder, massive sandstones. Openings 18 feet wide and 8 feet high were chosen and deemed appropriate for construction and future utility. As intake and return air shafts would be installed on the north side of the channel, a two-entry crossing would not only be adequate for coal haulage and personnel and supply travel, but it would also take less time to complete than a three-entry system. With crosscuts every 200 feet, pillar dimensions would be 32 feet by 182 feet, providing a least-value safety factor of 2.3. Because mining would be conducted simultaneously in both entries, ventilation for each entry had to be separate and distinct. It was decided that 50-hp Joy series 1000 Axivane fans with 36-inch diameter fiberglass tubing would be adequate to supply the required air quantity and velocity.

A contract was signed with a tunneling contractor on March 2, 1992, to drive two parallel tunnels 4,500 feet in length across the Galatia Channel. Because of adverse geologic conditions, the contractor was not able to commence tunneling until June 1992. These conditions, resulting from a wash-out area where the coal seam was absent for several hundred feet, had to be mined through prior to reaching the channel. Two roadheaders, one in each entry, were selected by the contractor for the excavation work. This was consistent with Boyd's estimate of five months to drive the tunnels using roadheaders versus eight months with continuous miners. We needed to reach the Galatia North reserve by the end of the year so that the bottom area could be developed and the gate entries for the first longwall panel could be completed by the end of 1993. We had low-sulfur coal contract commitments beginning in 1994. Tunnel excavation began on June 24, 1992, and advancement was 62 feet in the first week. Arch supports were installed in the belt entry beginning in July. The travelway entry roof was believed to be competent enough not to require arches. Tunnel advance was 256 feet in July.

On August 10, 1992, a massive roof fall occurred in the travelway entry. Obviously, arch supports were necessary. August footage was 273 feet. September advancement was only 121 feet; October, 250 feet; November, 168 feet; and December, 174 feet.

By January 8, 1993, the contractor had advanced the tunnels only 1,340 feet, averaging 6.77 feet per day. At this rate, the Galatia North reserve would not be reached until April 1994, and the first longwall panel not developed until sometime in 1995. Coal supply contracts were at risk. Our livelihood was at risk. Tunnel advancement was only 25 percent of that promised. In six months of work, there had been several contractor management changes, high employee turnover, numerous mining prob-

lems with methods and practices, and excessive cost overruns. Over $5 million had already been spent. Progress was unacceptable. The contract was terminated.

Mine personnel took over the project on January 8, 1993. The project was completed on July 9, 1993. In only 183 days, Galatia's employees, using continuous miners, advanced the tunnels 3,166 feet for a daily rate of 17.3 feet, two and one-half times that of the contractor. They had driven 3,166 feet in 15 days less than it had taken the contractor to drive 1,340 feet. The additional cost to complete the channel crossing was less than one-half of what had previously been spent. Savings resulting from coal supply contracts not being canceled are conceivably orders of magnitude greater.

As a reward for our superlative effort, Mother Nature blessed us with another challenge. Less than three months after reaching the North Reserve, we hit the first tectonic fault encountered in 10 years of mining. (Some say it was because we didn't have "no fault" insurance). Fortunately for us, the fault was as if it had been copied right out of a textbook. For the most part, the fault zone was narrow and the area of stress disruption was immediate to the fault line. There were places where you could see the coal seam, see the actual fault line intersect the seam, follow the fault line visually, and see the coal seam again after 15 feet of displacement. Obviously, we incurred delays because of having to mine through the fault. Grades had to be set and followed. Cutting rock is slower than cutting coal. But, because of the narrowness of the fault zone, supplemental roof support requirements were minimal, and we were back in the seam and on level ground after a distance of only about two crosscuts.

Unfortunately, because of its direction, the fault cut across the main entries and the tailgate entries of our first longwall. We had to cross it twice within one month. Fortunately, by then, we were practiced at mining rock and crossing faults, so the delay was minimal given the mining conditions. But unfortunately, the fault had a sister, about 4,000 feet to the east. We had encountered not only a fault but a graben. Webster defines a graben as a depressed segment of the crust of the earth bounded on at least two sides by faults. The earth's crust was depressed. Well, we were depressed too. We couldn't sacrifice our geologist to the gods of mining or of the earth or whatever, although we felt like it, so we decided just to mine through this fault too, and we did.

CONCLUSION

Today, we are about to start our fifth longwall panel in the Galatia North area. Things certainly didn't go as planned, but I guess that's what is fascinating about mining. Things never go as planned. It is a constant challenge to your intelligence, perseverance, and ability to overcome adversity. It is what we love about it. When you do succeed, despite all the obstacles, and when you do it safely and by working together with a group

of people dedicated to doing things right, as I have had the good fortune to do, it makes it all worthwhile. Survival is the name of the game.

We will survive at Galatia. We will survive because we are committed to doing things safely. We will survive because we are committed to doing things right. But most of all, we will survive because of our people. I can't begin to tell you how much I have learned from working with Galatia's people, of which I have been one almost nine years. I hope you have learned a little something here today.

Thank you for your attention. Again, thank you for inviting me. At this time I will be glad to try and answer any questions you may have.

Gregg Bierei: Any questions? Dick asked me to relay to you that there is a free manual on belt construction at Martin Engineering booth. That concludes our first technical session. The luncheon is at 12:30.

Heinz Damberger: The luncheon will be here in this room. We are well on time, so there is no problem. They will be putting in the tables so we need to move out. There are still tickets available for the luncheon. Buy raffle tickets.

LUNCHEON MEETING

Thursday, September 26, 1996
LaSalle Room–12:30 P.M.

Bert Hall: Welcome to the 104th annual meeting luncheon. We have a good crowd today, especially considering the weather. My name is Bert Hall, and I am honored to be this year's president of the Mining Institute. At this time, I would like to introduce the head table. On my far left, Ian Carr who was a speaker earlier this morning; Gregg Bierei, chairman of the Thursday morning technical session; Mike Reilly, retired President and CEO of Zeigler Coal and recipient of the honorary membership this year; Chand Vyas, President of Zeigler Coal; and Pete Lilly, president and CEO of Peabody Holding Company. To my far right, Wes Hofmann, one of this morning's speakers; Todd Grounds, and Richard Stahura, both speakers this morning; and Fred Bowman, Director of the Office of Mines and Minerals; and Bob Gilstrap of Midstate Coal Co. Fred, I'll let you introduce the others.

Fred Bowman: This is Dave Lidwell, Superintendent of Midstate Coal Company and Linda Hildabrand, our reclamation person.

Bert Hall: I would like to recognize any past presidents of the IMI. Would you stand please. [Applause]. Are there any honorary members from previous years? Would you stand? [Applause]. I would also now like to recognize Phyllis Godwin and Heinz Damberger, whom all of you know, too; they have done an excellent job. [Applause]

SCHOLARSHIP AWARDS

At this point in time, I would like to introduce George Woods. George will introduce the scholarship committee and introduce the college representatives.

George Woods: An important function of the Illinois Mining Institute is the scholarship program. And again this year, the IMI has awarded $10,000 in scholarships to four area colleges and universities. I will call on a spokesperson from each university to come up and introduce their students. First, from the University of Missouri-Rolla, Dr. Wilson.

George Woods

John Wilson: Thank you very much. It is always a pleasure to come to the IMI meeting. This year, we have four students from UMR receiving IMI scholarships. We have a junior, sophomore, senior and a freshman. All four students are from the state of Illinois. I would like to introduce Shannon Orr, a freshman from New Berlin, Illinois; come up and receive your scholarship please [Applause]. James Witt. James is from Belleville and is a sophomore [Applause]. Jeffrey Shaffer. Jeffrey is a junior who received the award last year, too. Jeffrey is from Decatur, Illinois [Applause]. The last one is Mark Schmidt. Mark is from Arlington Heights in the Chicago area and is a senior [Applause]. I would just like to say again

how grateful we are to get these scholarships. It has been a big part in helping us to have a really strong program. Thank you.

Dr. John Wilson with University of Missouri scholarship winners, left to right: Mark Schmidt, Jeffrey Shaffer, Dr. Wilson, James Witt, and Shannon Orr.

George Woods: From Southern Illinois University we have Dr. Lyle Cline.

Lyle Cline: I am filling in for Dr. Chugh this morning. Before I talk about the scholarships, I would like to acknowledge Dr. Julia Schroeder who is with us as our guest from John A. Logan College; she has helped us institute a two plus two program: if they go two years at John A. Logan in pre-engineering, they can come to us and we can get them out in two years. Julia would you stand please? [Applause] Julia, by the way, is the sister of Wayne Isaacs whom many of you know from Peabody. We appreciate the scholarship money. We really put it to good use we feel. We have several here. Patrick James Clay [Applause]. James Miller [Applause]. Kacey Grimes is not with us today. Maybe I can take her's to her. Randall Rockrohr [Applause]. And last is Kaleb Swenson [Applause].

Professor Lyle Cline with SIU student scholarship winners, left to right: James Miller, Kaleb Swenson, Lyle Cline, Randall Rockrohr, and Patrick Clay.

George Woods: From Illinois Eastern Community Colleges, Tom Kucharik.

Tom Kucharik: As you might know, we have a cooperative program with area colleges. And we have a cooperative program with Southeastern Illinois College in Harrisburg; the students that we are going to honor come from there. We have three students who are going to be honored; one couldn't be here because he had an exam today, Charles Treat. We also have Harvey Niehaus; Harvey is from Carmi, Illinois [Applause]. James Hise from Equality, Illinois [Applause]. I would like to say we appreciate this, and the students appreciate this especially because it does help them get through their college and go on. Most of the students are planning on going on. Harvey has already planned on going to SIU.

Tom Kucharik with IL Eastern Community College scholarship winners: James Hise (left) and Harvey Niehaus (right).

George Woods: The representative from Rend Lake College, Gene Mitchell.

Gene Mitchell: On behalf of Rend Lake College, I would like to thank the IMI for this grant that we are going to give to a very worthy student today. As you know, Rend Lake College is in the southern Illinois area. We have about 2,500 students. We have several articulations with the universities in our area. We are happy to be participating in this and in being thought of when these grants come out. I am sure that Amanda Mays, who is our student receiving the grant, appreciates it as well. Amanda is attending Rend Lake College, attempting a two year degree. She is thinking about going on to Southern Illinois University. She is from Mulkeytown. [Applause]. We thank you very much.

George Woods: That closes the scholarship session. I would like to remind you that the raffle tickets support this scholarship program, so please be generous.

Gene Mitchell of Rend Lake College presents certificate to Amanda Mays.

Bert Hall: Thank you, George. Just one comment about the scholarships. The IMI gives away $10,000 for the scholarships. The IMI is made up of everyone that is here and you should be proud of that figure; we hope that we can continue it. One of the ways that we do that is with the raffle tickets. I told Heinz I would plug it every time I got a chance. So, if you haven't bought raffle tickets, please do so. There is a set of golf clubs that is donated by DuQuoin Iron, and Roberts and Schaefer has donated two airline tickets to anywhere in the United States.

At this point, I would like for everyone to stand and have a moment of silence for our deceased IMI members. [CHARLES R. WEIR, Paul Weir Company, Dec. 1995. CLETUS BROECKER, retired from AMAX Coal Company; was President of the Institute in 1966-67 when he worked at Ayrshire Collieries of Indianapolis. In 1978, Mr. Broecker was made an honorary member for life of the Illinois Mining Institute. TOM SADLER, Old Ben Coal, Honorary member for life in 1992 and a long time active member of the IMI Advertising Committee.]
Thank you.

HONORARY MEMBERSHIP AWARD

At this time, I would like to make the presentation of the Honorary Membership to Mr. Mike Reilly, IMI president during the centennial year, former president and CEO of Zeigler Coal. Also making this presentation will be Mr. Chand Vyas who was Mike's successor at Zeigler.

Chand Vyas: Thank you and good afternoon. I appreciate the chance to introduce to you today someone who has had not just a major positive impact throughout his career in Illinois mining, but also on Zeigler and me. Let me explain what I mean.

Let me explain what I mean.

Among other interests, Mike and I both share a love of golf. There is a rule of thumb among golfers that says: If you can't break a hundred, watch your game. And if you consistently break 90, watch your business. Today, Mike seems to have solved both of those concerns. But, I'll let you determine which one of us is watching the golf game.

When I first came to work with Mike in 1982, he had already enjoyed what most of us would consider a full career in the armed forces, real estate and mining. Mike joined Zeigler Coal and Coke Company on January 1, 1963, earning, I believe, about $8,000 a year as a sales production coordinator. A generation later, prior to his retirement, Mike was chairman and chief executive officer of Zeigler. In the intervening years, his titles included assistant secretary and assistant treasurer, vice president of administration, assistant to the president and chairman, president and chief executive officer.

Bert Hall (left) & Chand Vyas (right) award 1996 Honorary Membership certificate to Mike Reilly.

During Mike's tenure, he saw the early day mergers of Bell and Zoller and Moffatt Coal Company. He saw Zeigler itself become a subsidiary of a larger company, and he later paved the way for Zeigler to regain its independence. As chairman and CEO, Mike then oversaw one of the biggest expansions in the history of coal mining through the acquisitions of Old Ben Coal Company and Shell Mining Company.

As you all know, Mike's leadership has carried over into the broader coal industry. He is a former president of this distinguished group and a past chairman of Bituminous Coal Operators' Association, the Illinois Coal Association, as well as the chairman of the National Coal Association. Mike found time for the community as well. He served as a director for St. Elizabeth's Hospital in Belleville, Illinois. He served as an Illinois Division board member for the United Way, and he served as an executive board member for the Boys Scouts of America.

Mike did more than fill worksheets; his legacy is one of calm leadership amid turbulent change with a unique blend of skills and personality that earned the hard work and respect of all those around him. We are in a rapidly shifting environment for coal, and for our company. Just as the Zeigler of 1995 was not the Zeigler of ten years before, so, too, our current company's profile is being remade each and every day. And Mike remains an important voice for change as Zeigler's Chairman of the Board.

They say that for leaders paths are not found, paths are made by walking. And true leaders will only find paths behind them. I assure you, Mike, that the one behind you is clear and well-traveled.

I am pleased today to honor a generation of accomplishments by a man who for years symbolized Zeigler and all we stand for and a man who I am proud to call a close personal friend. Ladies and gentlemen, I am pleased to present Mike Reilly. [Applause]

Mike Reilly: Just a few short comments. Thank you very much Chand for the kind words. Many of the accomplishments that I have been lucky enough to make really were due to Chand and many people who have worked with me, including many members of the IMI.

I remember my first full-time job when I was 18, a year after I got out of high school; it was with Freeman Coal in 1951, February 12, on Lincoln's birthday. I remember that date. Well, 45 years later I retired. The coal industry has been good to me, and I've tried to be good to it. But this award especially means a lot to me. When we moved the company to southern Illinois, I moved to Belleville. So, I've been in Illinois, and I've been involved with the IMI for a long time. I remember the early meetings in Springfield as being a lot different than they are today; they were a pretty wild group there, and things have really calmed down. Anyway, it is a great honor. I thank you all. I thank the IMI and the committee, President Bert Hall, and all of you for this honor.

RECLAMATION AWARD

Bert Hall: At this time, we will do the presentation for the 1996 Reclamation Award by the Office of Mines and Minerals, Mr. Fred Bowman.

Fred Bowman: I receive a considerable amount of personal pleasure in this award this year. Midstate Coal Company is going to receive three awards today. I will make a presentation on two of those. One is our state award for reclamation from the Land Reclamation Department and the

Fred Bowman presents state reclamation award to Bob Gilstrap of Midstate Coal Co.

second one I received earlier this week in Chicago at the annual meeting of the Interstate Mining Compact. They received honorable mention at the national meeting. But before I hand these to those two gentlemen, I must tell you a little bit about the permit process as it pertains to Midstate.

We issued the permit in 1992. Shortly after issuing the permit, it was challenged by a particular group, and we had to go into an administrative hearing that was quite costly and quite lengthy. In that period, the mine was shut down for approximately ten weeks through the winter months. Those of you in the mining business know what that does. Through all that adversity, they came out of that, and one of my staff, who has a rather critical eye as it pertains to reclamation, said that very likely the reclamation at Midstate's Rapatee mine was probably the best reclamation he had seen in his present job of soil's handling in twenty years. So, as I said, it has been a long process, but I have the state award, honorable mention for a national award, and it is my understanding you are going to receive another national award. It is a job well done. I am happy to be able to do this. Bob [Gilstrap]. [Applause]

With that I'll turn the podium over to Linda Hildabrand, and she will present the next award.

Linda Hildabrand: It is my pleasure to be here on behalf of the National Association of State Land Reclamationists. We are an organization representing the state regulatory professionals in about 23 different states throughout the country. For a number of years now, we have also had a mined land reclamation award both in the coal category and a non-coal category. And as one of Midstate's former inspectors who kind of helped them through those dark days, as it were, it is really my pleasure this year to present them with the National Mined Land Reclamation award from NASLR, the National Association of State Land Reclamationists. [Applause]

Linda Hildabrand presents the national reclamation award to Bob Gilstrap of Midstate Coal Co.

Bert Hall: Our luncheon speaker for today is a very familiar face to everyone in here. I was real pleased with the fact that he accepted the invitation to be our luncheon speaker today. He is President and Chief Executive Officer for Peabody Holding Company, Mr. Pete Lilly.

Pete Lilly: Thank you, Bert. I asked Bert to be brief, and he was. Mike I want to congratulate you and just say that we in the coal industry appreciate everything that you've done for our industry, both here in Illinois and throughout the country. You've been a real pillar and a model for us to follow. Thank you and best wishes. [Applause]

I also want to congratulate all of you scholarship recipients and wish you all the very best success as you finish school and enter your careers.

LUNCHEON ADDRESS

PETER B. LILLY

Peabody Holding Company
St. Louis, Missouri

INTRODUCTION

Thank you, Bert, for that kind introduction. It's a real honor for me to address the Illinois Mining Institute. The Institute has a long and distinguished history and I am, indeed, flattered to be invited to address your annual meeting. It's also good to be back in southern Illinois again and among old friends. As many of you know, I spent five years in the mid-80s at Kerr-McGee's Galatia Mine. I had the pleasure of working with and getting to know many of you. Let me say that Illinois coal miners are among the safest and most productive miners in the world and I'm proud to be associated with you.

In the short time since I left here, the Illinois Basin coal industry has gone through probably its most devastating era. And much of that pain and suffering has to be placed at the doorstep of federal legislation, specifically the Clean Air Act. It probably stands as the classic example of how government laws and regulations aimed at the "greater good" of all Americans can have devastating impacts on certain markets and regions of the country. I'll talk more about that later.

Before I get into my thoughts on the coal industry, particularly here in the Illinois Basin, and some of the issues and challenges ahead, I'd like to tell you something about my organization, the Peabody Group of companies.

BACKGROUND

Peabody started out right here in Illinois 113 years ago as a small retail coal business. Today, the Peabody Group is the largest private sector coal producer in the world. This year, our 28 mining complexes in the U. S. and Australia will sell more than 160 million tons of coal to 139 electric generating plants and 29 industrial plants in 31 states and 14 foreign countries.

In the western United States, Peabody owns four companies: Peabody Western Coal Company, Powder River Coal Company, Lee Ranch Coal Company and Powderhorn Coal Company, which, collectively, will produce more than 110 million tons of low-sulfur coal this year. Our Powder River Coal Company in Wyoming is the volume and profit leader of the Peabody Group. Powder River's four mines will account for more than 85 million tons this year. Working our way east, Peabody owns three companies in the Midwest: Peabody Coal Company, Patriot Coal Company

and Thoroughbred, which in turn owns 33 percent of Black Beauty Coal. In West Virginia, we own Eastern Associated Coal Corp. Our Eastern U.S. companies will collectively account for about 40 million tons in 1996. And on the other side of the world, the Peabody Group includes Peabody Resources Limited in Australia from which we serve the Australian and Pacific Rim markets. So, that's what the Peabody Group looks like, and I can tell you that it certainly creates some complex management issues for us to deal with.

ISSUES FACING THE COAL INDUSTRY

Today, I'd like to share with you my perspective on some of the issues facing the coal industry; including the challenges and opportunities I believe are out there, and put those in the context of the outlook for Illinois Basin coal.

The top three issues as I see them are:

- Effect of electric utility deregulation;
- Impact of the Clean Air Act Amendments; and
- Implications of the global climate change debate.

These issues are all somewhat interrelated, as are some corollary issues such as aging and depleting mines in the Midwest and East, the growth of union-free mining operations and corresponding decline in union-produced coal, and increasing competition from other fuels, such as natural gas.

Effect of Electric Utility Deregulation

First, let's take a broad-brush look at these issues. In the past 12 to 18 months, deregulation and competition in the power business have shaken up our industry in a more significant way than at any other time in my memory. As utilities are deregulated and subjected to price competition for the first time, they in turn, squeeze fuel suppliers; and as you all know, they're squeezing us hard. Some of you may have read recently in Forbes Magazine a quote from one of Peabody's customers, and likely one of your customers as well. He said, "We extract a pound of flesh, a pint of blood and a first-born son." And he was talking about us; the companies that sell him coal.

And although most of us have dealt with an intensely competitive coal market for a number of years, the bad news is that the downward price pressure on all suppliers will intensify. And this is after we've seen coal prices fall 42 percent in real terms over the past nine years. It's especially bad news for coal producers with high-priced contracts expiring soon.

The good news is that if the generation of electricity becomes truly rationalized and competitive, there will likely be a large incremental market for coal. By some estimates the average coal-fired power plant now runs at

about 60 percent of capacity. As coal prices decrease, coal will likely become more competitive, and utilities should start using more of their underutilized coal-fired capacity. This current underutilized capacity could consume 100 to 200 million additional annual tons of coal, depending on your assumptions, and could be a plus for Illinois Basin producers. This is particularly good news for successful coal mines that can achieve the necessary cost reductions and truly become competitive. The fact is that the overall coal market in the United States will continue to grow. The U.S. Energy Information Administration now projects coal consumption by the domestic utility industry to increase 150 million annual tons between 1994 and 2010. The area of greatest growth in production is in the western United States, particularly the Powder River Basin.

Impact of Clean Air Act Amendments

And that leads to the major reason for the phenomenal growth in demand for Western low-sulfur coal: the passage in 1990 of the Clean Air Act Amendments which set limits on the amount of sulfur dioxide power plants could emit. As a result, the coal industry has gone through massive restructuring and consolidation. The demand for low-sulfur western coal has boomed, while there has been a substantial reduction in demand for coal produced here in the Illinois Basin.

Peabody, and I know many of your companies as well, went through a wrenching period as far as our high-sulfur, midwestern mines were concerned, trying to get ready for Phase I to take effect in 1995. Just ten years ago, Peabody operated eight mines here in Illinois, employing about 3,000 workers who produced about 11 million tons of coal annually. Today, Peabody Coal Company has one mine, Marissa, which produces about 3.8 million tons per year with about 400 employees. Throughout our industry, the high-sulfur mines which have become the lowest-cost and most productive, have survived; those which didn't, or wouldn't, have closed.

Unfortunately, many of those closing are operations represented by the United Mine Workers of America (UMWA). Many could not lower costs and increase productivity as rapidly as required to survive. And others, after the lengthy strike in 1993, simply didn't reopen. The result is that the percentage of union-produced coal east of the Mississippi has dropped about one-third, from about 320 million tons produced in 1989 to about 210 million tons produced last year. In the Illinois Basin, union-produced coal has fallen from about 90 million tons mined in 1990 to less than 55 million tons in 1995. It should not surprise you that virtually all the growth in the Midwest has been at union-free mines.

Coal prices used to reflect the cost of union-produced coal. Today, the cost to produce union-free coal determines prices. There are positive signs that the union culture is changing to become more responsive to market pressures. The Labor Management Positive Change (LMPC) process called for in the 1993 National Bituminous Coal Workers Association

(NBCWA) has made a significant difference in productivity and teamwork at our mines, and I would expect you've experienced a similar result. And the fact that the contract re-openers were settled early, and that we've agreed on industry-wide cooperation in communicating some of the issues I'm discussing here today, I view it as very good news for both the UMWA and those of us with union mines.

Getting back to the impacts of the 1990 Clean Air Act Amendments (CAAA), I'd like to review what's happened since Phase I went into effect in January 1995, particularly what's happened in the Illinois Basin, which has suffered the most substantial consequences.

As you are all well aware, the demand for Illinois Basin coal has declined more than 32 million tpy from 1990 to 1995. The primary reason for reduced demand for Illinois Basin coal is fuel switching on the part of utilities largely to Powder River Basin low-sulfur coal.

Interestingly, utilities have over-complied with the CAAA's Phase I requirements, and the cost of emission allowances–which can be purchased to offset the burning of high-sulfur coal–has dropped dramatically and is projected to remain around $70 to $80 per ton for quite some time. There are still plenty of allowances for those utilities that can buy high-sulfur coal cheaply, and there is also plenty of low-sulfur coal to be had. Therefore, many older coal-fired plants can be used until 2005 to 2008 with no costly additions for emissions reduction. In other words, no new scrubbers will be built; there's no need to build them.

As we look ahead to the start of Phase II in 2000 and beyond, the learned scholars predict that demand for Illinois Basin coal will continue to decline by another 15 million tons per year. The decline will likely continue through about 2005, when many of the older coal-fired plants will start to be retired. Between 2005 and 2010, demand will begin to strengthen, increasing by 10 to 20 million tons in that five-year period, depending on whose forecast you subscribe to. It's also during this period that I think we will see new coal-fired baseload capacity beginning to come on stream.

No matter what time period you look at, there is only one way that coal, especially our Illinois Basin coal, can successfully compete. And that's on cost. Just as the Clean Air Act has taken away opportunities for the Illinois Basin, deregulation of electricity generation and cheap emissions allowances could actually open up new possibilities–for the lowest cost producers in the Midwest. The centrally-located Illinois Basin is well positioned to take advantage of coal-tolling and coal by wire opportunities, but only if coal prices are competitive. Today, coal competes favorably at existing U. S. power plants, fueling 23 of the 25 lowest-cost plants. But natural gas competes favorably for incremental capacity and can be built more quickly and economically than coal-fired plants. And natural gas is considered to be both publicly and politically more acceptable than coal.

Implications of the Global Climate Change Debate

This leads me to another major issue for our industry. And that is the global climate change debate.

Here's where we are right now. The United States and 159 other nations have ratified the U. N. Framework Convention on Climate Change. This requires that developed nations – and I emphasize developed – implement measures to reduce their greenhouse gas emissions to 1990 levels by 2000. In addition, these 159 nations have adopted a mandate to strengthen their commitments to reducing greenhouse gas emissions. But here's the rub: developed nations, the United States, for example, will adopt policies that establish quantified CO_2 reduction objectives within specified time frames. Developing nations will participate in establishing policies for the developed nations, but they will not be required to commit to reducing their own emissions. In other words, these developing nations, America's trading competitors in the world market, will require the U. S. to reduce its greenhouse gas emissions to 1990 levels, but they will not have to reduce their own emissions at all.

The United States has endorsed the adoption of a binding emission target for the mid-term that would be implemented through emission trading mechanisms.

As the number of emissions permits made available is reduced to meet the emission target, their value at auction will increase. This will effectively increase fossil fuel prices and reduce demand for the most carbon intensive fuels: coal, then oil, and then even natural gas. No fossil fuel would ultimately escape the impact of this type of program, but certainly coal will be hit first and hardest.

Clearly, the global climate change issue is one of the thorniest ahead for our industry. It is a highly political issue in which there is considerable scientific uncertainty. Moreover, the limitations agreed to at the Geneva conference will ultimately lead to more expensive electricity, less competitive U.S. exports, and a reduced standard of living for Americans.

At Peabody, we support constructive, cost-justified steps based on sound scientific evidence with participation by all nations. We believe further research is needed to assure that there is sound scientific basis for any unilateral action taken to reduce greenhouse gas emissions.

Another Serious Challenge: Basic Profitability

Moving from the environmental issues, basic profitability is another serious challenge facing the coal industry as a whole. In addition to people, equipment, reserves, and transportation, the condition precedent to an available, competitively-priced supply of coal, is capital. And access to capital is predicated on a company's financial health and strength. As an industry, coal has taken a beating for the last decade; but, we've consolidated and tried to become more productive. And we are. Today, we're producing 17 percent more coal than we did ten years ago, from 45 percent fewer mines and with 42 percent fewer miners. We've adapted to shorter-term coal supply agreements and started using newer, larger, more efficient

technologies–not always to improve profitability, but often to maintain profitability in the face of declining prices and expiring contracts.

The side effect of this consolidation of production is that mines are being depleted at a faster rate. Replacement of these depleting mines looms as a significant problem in my opinion. Some financial analysts have expressed concern about the coal industry's ability to attract capital for the development of new mines to replace existing operations that are being depleted at faster rates. Here in Illinois, some five mines have closed, or will close in the space of about a year–representing nearly 12 million tons of production.

Any healthy industry needs healthy suppliers to provide certainty and stability over the long run. A deregulated utility industry will be no different. Long-term coal supply agreements have been the traditional method of creating certainty of fuel supply and providing the basis for financing the development of new mines. But to power generators who will be selling electricity on more of a spot-market basis in the deregulated future environment, long-term contracts will be less useful.

As the last of these above-market price, long-term agreements expire or get renegotiated in the next few years, those mining operations that have not knuckled down and reduced operating costs will probably close. And consolidation will likely continue as utilities demand more sophisticated, capable and cooperative coal suppliers, with whom they can develop stable and equitable business alliances.

In short, our most important task is to ensure that the economic advantages of coal are so overwhelming that they cannot be ignored or subjected to political whim. To remain the "politically correct" fuel of choice, coal must continue to be the low-cost electricity generator.

The bottom line is this: the only part of the equation that we as coal producers can control is cost. And if we think the industry is competitive today, it's going to get even more so in a deregulated environment.

In response, at Peabody, we've launched an initiative this year called Project Century. Our goal is to permanently remove $100 million from our annual operating cost structure. The objective is to implement the cost-saving ideas of our employees at every level of the organization. We have asked our employees to think creatively, to ignore the conventional boundaries of their functional areas, and to find ways to do things better, safer, faster, and cheaper.

CONCLUSION

In conclusion, to unlock the maximum value to all stakeholders in the coal, transportation and electricity generating industries, we will have to accept new ways of thinking. We must be willing to consider the changing needs of our key business partners – sharing the rewards, as well as the associated risks. If we can do this, we can meet the major issues head-on and succeed into the next century. I've enjoyed being with you today. Thank you.

Bert Hall: Thank you, Pete. At this time, the normal procedure is to turn the meeting over to the incoming President which will be John Lanzerotte. However, he was not able to make it today. We will introduce at this time the Second Vice President, Gregg Bierei.

Gregg Bierei: Thank you, Bert. At this time, I would like to take the opportunity on the behalf of the IMI to say thank you to Bert Hall for all the hard work and dedication during the last year. The result has been another successful year for the IMI. In appreciation, I would like to present him with this gavel. [Applause]

Bert Hall: Thank you, Greg. This just about wraps up this part of the luncheon. I do want to remind everyone that the exhibits are open. I encourage you to go visit with the exhibitors. The fellowship tonight is from 5:00 to 7:00. Again, I encourage you to come back for free food and drinks. I want to remind you, too, that the drawing for the raffle tickets is at the close of the meeting tomorrow. I encourage you to visit the exhibits and to come back at 5:00 for the fellowship. With that, I will adjourn the luncheon meeting, thank you. [Applause]

Greg Bierei presents the souvenir gavel to President Bert Hall.

FRIDAY MORNING
Business Meeting

Bert Hall: Good morning everybody. I want to welcome you to the Business Meeting. My name is Bert Hall; I am honored to serve as the IMI President for this year. The first order of business today will be the Secretary-Treasurer's report by Heinz Damberger.

SECRETARY-TREASURER'S REPORT

Heinz Damberger: Good morning everybody. There are always two parts to my presentation; one is membership and attendance. We have 289 people who either picked up their packets because they are pre-registered or who registered on site for the meeting. This does not include the people who are here in connection with the exhibits, which is another 300 or so. About 100 pre-registered members have not yet picked up their packets; so we are probably running at about 630 or 640 including the pre-registered [Final count: 549] . This is a bit lower than last year, but not a dramatic change compared to recent years. Membership has been holding fairly steady. We have been losing 20 to 30 members a year. Considering where the industry is, we are doing quite well.

The financial report is, of course, an important part. I have copies of the financial report if anybody wants to study it in more detail than I will present. The report was reviewed and approved by our Auditing Committee. We show, overall, an increase in our assets of almost $700. However, that is a little deceiving: we had a printer break down and had to buy a new printer; so if you look at the cash balance at the end of the year, we are down by about close to $1,400 from last year. Overall, though, this result is pretty much as we had projected: we had projected a $600 surplus, but with the unexpected expense, we are about on target.

We are holding our own on advertising; it is down a little. The dues are up some because we raised them; however, fewer people are attending. Trade exhibits represent the biggest income item. A new item this year is the vendors' fee for vendors who do not exhibit or advertise; the Executive Board established this fee because of the benefit vendors get by coming to the meeting where their clients are.

For the coming year, we foresee a decrease in our cash balance of about $1,700. When I made my presentation to the Board yesterday, I had given them $3,000 because there was a mistake in our calculation: we had carried forward a $1,300 loss from last year into this year, which was included in that $3,000. So really the projected loss is only $1,700. The Board decided to eliminate the continental breakfast on Friday morning (we will seek sponsorship from our advertisers and exhibitors). Basically, that will put us in balance again because the continental breakfast is about $1,800. [Note: The projection presented to the Board of a $3,000 decrease in year-

end cash balance was correct; the $1,300 deficit must be included in the FY96/97 budget].

FINANCIAL STATEMENT SUMMARY

Cash Balance Beginning 9/1/95	$31,625	Cash Balance Ending 8/31/96	$30,251
INCOME		EXPENSES	
Advertising	17,766	General Operating Expense	25,658
Annual Dues	17,275	Annual Meeting Expense	26,413
Luncheon Receipts	2,295	Publication Expense-Proceedings	10,837
Exhibit Fees	24,988	Scholarships	10,000
Registration Fees	4,185	Mining History Fund	32
Short Course	0	Subtotal Expenses	72,940
Interest	890		
Mining History Fund	209		
Centennial Souvenirs	295		
Convention Raffle	1,141		
Miscellaneous	321		
Vendor Fees	1,500		
Convention Cash	700		
Subtotal Income	71,566		
TOTALS	$103,191		$103,191

ASSETS AS OF AUGUST 31, 1996	
Fixed Assets	
Equipment & Furniture	$15,257
Liquid Assets	
Cash	30,251
Bonds	500
	30,725
TOTAL ASSETS ON 9/1/96	46,008
TOTAL ASSETS ON 8/31/95	45,328
1995-96 GAIN	$ 680

A major item in this coming year is included in the bottom line of course. The Board gave me permission to conduct a thorough audit of our books. We have never done this during the last twenty plus years. We hired a certified public accountant who is familiar with the type of organization that we are who will look at the way we conduct business and also some of the tax implications. We have had some major changes in the types of

income that we have, exhibits in particular, and I want to make sure that our tax-exempt status is not affected. The audit will cost about $1,000

Bert Hall: Thank you, Heinz. Next on the agenda is the Nominating Committee's report. Dave Whitcomb is the chairman of that committee.

NOMINATING COMMITTEE REPORT

Dave Whitcomb: Thank you. Here is our slate for officers and board members:

President:	John Lanzerotte
First Vice President:	Gregg Bierei
Second Vice President:	John Hill
Secretary-Treasurer:	Heinz Damberger
Four Board members to serve three-year terms:	Joseph Angleton
	Darrell Auch
	Y. Paul Chugh
	John Wilson

Bert Hall: Are there any nominations from the floor? If not, will someone move to accept the proposed slate? [*It was moved and seconded to accept the slate of officers and new board members as presented. Members voted for the slate unanimously.*]

HONORARY MEMBERSHIP COMMITTEE REPORT

The next item is the Honorary Membership Committee report. Steve Rowland chaired the committee. Steve is not here this morning. However, that announcement was made yesterday at the luncheon, and the recipient was Mr. Mike Reilly, an excellent choice. The presentation was made during the annual luncheon.

ADVERTISING COMMITTEE REPORT

The next item is the Advertising Committee's report. Joe Pileggi is the co-chairman along with Ken Barker. Again, neither one of them are here this morning. Heinz and I did sit in Wednesday night on the Advertising Committee meeting. The exhibit hall is full, and that is a strong indication that we have a really good committee; they do a lot of work and they should be recognized for the amount of work that they do.

Next is the Scholarship Committee report by Chairman John Lanzerotte.

SCHOLARSHIP COMMITTEE REPORT

John Lanzerotte: Thank you. All of you here are aware that the IMI sponsors scholarships, $10,000 for the 1996-97 school year. SIU-Carbondale,

$4,500; $3,500 goes to the University of Missouri at Rolla; $1,500 to Illinois Eastern Community Colleges; and $500 to Rend Lake College. The scholarship fund provides much needed dollars in the academic community and helps greatly to ensure that in the future, talented, qualified and skilled technical folks are available to integrate into the mining industry. With that I would like to introduce the representatives of the various institutions and have them tell us briefly about current activities at their institution and how the funds are being utilized. I would like to start first with Dr. Paul Chugh.

Paul Chugh: Thank you, Mr. Chairman, and good morning, everyone. Let me begin by conveying our sincere thanks to all of you for your confidence in the Department of Mining Engineering and your financial support for the students. I am pleased to report to you that the department is in really sound health and has the support of the university administration. During 1995-1996, we graduated six students with B.S. degrees and five students with M.S. degrees. All students with B.S. degrees were successfully placed in industry, in coal or aggregate. Students with M.S. degrees were either placed in the graduate school for Ph.D.s, or in the industry. All of the students in summer coop work in 1996 were also placed. We placed 18 of them this summer. The 1996 fall enrollment is 27 juniors and seniors. We do not recruit from high schools; we only go to the community colleges so we can get them graduated in a couple of years. We expect to graduate seven to eight students with B.S. degrees next May and five or six with M.S. degrees. We are quite confident that we will be able to place all of them.

We are concentrating on dual degrees: mining-mechanical/mining-electrical which are our best sellers. Our industrial advisory board consists of about thirteen people from just about every company, and they are playing a very strong role in shaping our department. Mr. Richard Shockley is now the chair of our advisory board because Mr. Charlie Bollier retired from Peabody, and he decided that he could not serve on the board.

We established a two plus two program with John A. Logan College last year whereby during the second year at John A. Logan, students would take some mining classes, and then they would transfer over to our department. This was the first year, and we have five students from John A. Logan College who are participating in the two plus two program. We will be establishing a similar program at one of the community colleges in the Chicago area over the next year to serve the aggregate industry.

Our graduating students spent one week at the MSHA academy to obtain training in mine health and safety. We have a very strong relationship with MSHA, and it works out very well.

In the area of research, the department faculty productivity is outstanding. We attracted about $750,000 in external research from federal, state and industrial sources last year. We are pursuing research in coal combustion residues management, which is the problem for our industry, and we are putting a lot of our eggs in that basket and having quite a bit of

success. We are doing a lot of work in the area of efficient coal processing; design of efficient mining systems for ground control and subsidence; and finally dust control. Our dust control area is picking up over the last couple of years. We will have at least one demonstration, hopefully within the next couple of weeks, at a coal mine.

In the service area, we are holding an interactive workshop on coal combustion residues management at SIU-C, October 29-31, 1996. This is being organized in collaboration with the Office of Surface Mining. We are expecting 150 to 200 people. Registration cost is only about $50. I encourage you people to come and join us.

Under a United Nations grant, we trained four Chinese engineers for acid-mine drainage. Under a U.S. AID grant, we provided assistance to India in the area of fly ash management. We are presently attempting to develop a relationship with the Polish coal industry to assist them with health and safety issues under a World Bank grant. They have contacted us.

Now, I will take one more minute here to preach to the choir. As you know, the U.S. Bureau of Mines was abolished last year, and I gave a report last year at this meeting. Twin Cities and Denver Research Centers were completely shut down. The Pittsburgh Research Center and Spokane Research Center will be merged with National Institute for Occupational Safety and Health, effective October 1, 1996. Their funding has been drastically cut to $40 million only, as compared to $120 million or $130 million prior to last year. The environmental group at the Pittsburgh Research Center has been merged with the U. S. Department of Energy. All of the university-based, minerals-related research programs were completely abolished last year. So that is the status of the Bureau of Mines. The future of the minerals-related industries in the U.S. depends on global competition, and that means cost-efficient mining through improved mining systems. Until the present government has gotten their act together to determine how they would like to organize mineral-related funding, I would like to urge industries to work with universities and state research agencies to keep forging ahead.

America has one of the largest and most efficient minerals industries in the world. The current federal situation presents us with a challenge. America always rises to meet the challenge, and I think this is a time to build partnerships between the universities, the state agencies, and the industry to build a future.

Let me thank all of you once again for supporting our department. Your money is being very efficiently utilized. Last year we gave five scholarships from the money that you gave us which included grants of about $500 to $700 each semester. We are working to meet the needs of the industry in this area.

Let me tell you what Joe Spivey's office keeps telling me: "You've got to bring the industry back to this area," and I can assure you our faculty

is working very hard to meet that challenge. Thank you once again.

John Lanzerotte: Thank you very much, Dr. Chugh. John Wilson, University of Missouri-Rolla.

John Wilson: I would like to update you on the activities of Mining Engineering at the University of Missouri-Rolla. We graduated 25 students in the last academic year: nine in December and 16 in May. I am pleased to say that all graduating seniors received multiple job offers, however, only two went into the coal business. Most graduates entered the gold, copper and aggregate businesses, and some in the explosives and equipment industries. It is good that our degree program and reputation provides this diversity.

I am personally very pleased with this outcome because these graduating seniors were the first 25 students that I recruited five years ago, and if they hadn't got a job, my claim that they would definitely get jobs on graduating would have left doubts in the minds of our current students!

This last year was also a very successful one for recruiting. We now have 107 students, including undergraduates and graduate students. I thought we may have gone down due to the large graduating class; however, we went up by a few students and have been at a strong level for the last two or three years.

The job market is exceptionally good for mining engineers outside of the midwest coal industry. We have been able to capitalize on this in several ways.

The way to get good men and women into the mining business requires a concerted recruiting effort because, in general, students don't know much about mining engineering. Moreover, we have very few students coming into mining who are actually the sons and daughters of mine engineers, as was the case in the past. Undecided freshmen coming to UMR seldom know anything about mining. So, to get their attention, one has to highlight things such as all of our students in mining engineering are getting jobs, there are summer employment possibilities, and that there are scholarships available for mining students who are qualified. The IMI scholarship plays a meaningful part in this regard, helping us to recruit and retain students in mining. Because scholarships are so important to our recruitment effort, I have solicited help from precious metals, base metals and stone and aggregate companies. To date, we've been very successful in getting scholarships from companies such as BHP Minerals, Kennecott Copper, Cominco, and others.

In many ways, heading a department at a University is like running a small business. For example, one must keep funds coming in to assist in student enrollment, as well as for research funding to meet university expectations. To date, we have been successful in raising scholarship funds which go back in the form of financial support to bright young men and women for our mining profession. Some companies are attaching summer jobs to their scholarships, as well as requiring a student to become proficient in a foreign language.

It seems every time I come to an IMI meeting I announce that someone has retired: this time it is Dr. Charles Haas. He worked at the university for 36 years where he specialized in rock mechanics. I am pleased to say that we were able to recruit Dr. Larry Grayson, who was recently with the University of West Virginia. In recent years, we have assembled a team which is a good mix of industry/academic personnel. Larry is a very welcome addition to our team at UMR.

In the near future, we will be seeking a person to fill a new position founded in the name of Robert H. Quenon. Tom Holmes, the retired Chairman of Ingersoll Rand, who is a graduate of University of Missouri, thought it fit to seek corporate support to provide funds for an endowed professor or chair in mining engineering at his old school. Tom Holmes also considered Mr. Bob Quenon as a good role model for mining engineers in the future, so we now have the Robert Quenon Professorship established, which will become a fully funded chair position within the next three years. A search has begun to fill the Quenon Professorship position which, when complete, will enhance our program even further.

We have been very active in developing an international flavor to our mining program, in line with the globalization that is taking place in the mining industry. Many of the companies that now visit Rolla have operations in South America, Africa, Australia, and other foreign countries. So far, we have developed an exchange program with the Western Australia School of Mines and the University of La Serena in Chile. In the near future, we plan on also having a linkage program with the University of Witwatersrand in South Africa. These universities were chosen because of their strong mining programs and the fact that the countries in which they are located are well known for their mining industries.

The UMR research programs continue to include coal drying and briquetting, pipeline transportation, explosives, water jetting, safety and health in mines, mine ventilation, rock mechanics, etc.

As far as student activities are concerned, our students sent men's and women's teams to the national Inter Collegiate Mining Competition in Montana and were successful in winning the men's competition for the third year in a row. In addition, the women's team won the women's competition for the second year in a row. The UMR mine rescue team placed fifth in a national competition that was held in Iberia, LA. Our students are an active group who also participated in a phonathon to raise money to help offset some of the costs associated with participating in these events. Student representatives also attended MINEXPO in Las Vegas, and the National SME meeting in Phoenix, AZ.

One final comment. The University of Missouri-Rolla was ranked second in the nation among public universities in terms of the average ACT scores of new students entering our programs. Georgia Tech was ranked number one. I am pleased to say that we in Mining Engineering are getting our share of these high grade entry-level students that come to UMR. This

year we have over one third of the students in our program with a cumulative GPA above 3.0. This satisfactory performance is because of our ability to attract good entry-level students as a result of the availability of scholarships, summer job opportunities, and placement on graduation. So, our program is doing very well, and we thank you for your support.

John Lanzerotte: Thank you, Dr. Wilson. The last college to hear from is Illinois Eastern Community Colleges, John Howard.

John Howard: Thank you. Illinois Eastern continues to survive. We have a surprisingly high workload. We have faculty members working up to 80 hours a week trying to meet the needs of industry, primarily. We are diversifying into new areas, trying to be more specific in tailoring our services to the needs of the industry. It is a win-win situation right now. As a result, we are still able to maintain five facilities in Illinois; one in Harrisburg in southeastern Illinois, the one Dr. Chugh mentioned, John A. Logan; we have one in Marissa at the former Peabody training center; and we have one in conjunction with Lincolnland Community College in Springfield. We have 14 full-time people working very hard and, for the most part, doing a very good job. We are proud of them.

We have three scholarship recipients this year. We have a viable associate degree program where students are still finding glimmers of opportunity despite the state of the industry. The three recipients all came from our two-year program at Harrisburg at Southeastern Illinois College. Personally, and on behalf of the administration and faculty, staff, and students, I want to thank the Illinois Mining Institute for its continued support and to thank the industry for allowing us to participate in your training needs and for giving our die-hard, purposeful associate-degree students an opportunity for a job interview. Thank you, very much.

John Lanzerotte: Thank you, John. Again, on behalf of the Scholarship Committee, we greatly appreciate the comments this morning. It is great to hear the vitality that exists in the academic community, and, again, it can't help but give one a reason for optimism in looking at mining and careers in mining and the state of the mining industry in the future. Are there any suggestions or comments with respect to the Scholarship Committee?

One more thing, I would like to thank John Howard, George Woods and Mary Kay Enrietta for the help they give us every year on preparing the certificates. It is a great help. With that, I will turn it back to President Bert Hall.

Bert Hall: Thank you, John. Are there any other items at this time that anyone would like to bring up. If not, before we close the business meeting, I would like to remind everyone that there is a free continental breakfast in the exhibit hall from 8:00 to 11:00 A.M. I would like to ask you to go visit with the exhibitors to make them feel welcome; we want them to come back next year. We were full this year, and I was glad to see that. We encourage you to buy the raffle tickets; they help support the $10,000

scholarships, along with other fund raisers we have that raise that money. Roberts and Schaefer donated the two airline tickets to anywhere in the United States and Jim Justice from DuQuoin Iron donated the golf clubs. I also would encourage everyone to return to this room at 11:00 for the second technical session. It is a good program, and I would like to see good participation in it. With that I will close this business meeting, thank you.

TECHNICAL SESSION II: Potpourri of Relevant Issues for Illinois' Coal Mining Industry

John Hill: Good morning, my name is John Hill. I am Vice President of Midwest Operations for Cyprus AMAX Coal Company. I'd like to welcome each of you to the second technical session, and I apologize right up front to our speakers for the sparse crowd. It usually picks up a little bit as we go on; let's hope that is the case today. We have what we think is a very interesting program for the second technical session. When Gregg and I were putting the program together this year and soliciting speakers, we tried to look at some of the issues that we thought were pertinent to today's Illinois coal mining industry. And what we saw is what Heinz has characterized as a pot pourri of different issues that we thought might be of interest for you. We cover the spectrum everywhere from new technology which our first speaker will talk about, to probably one of the oldest concerns in the industry and that is how do we interact with our employees.

Our first speaker today is Michael O'Grady. He is a sales engineer with Trimble Navigation and he has a territory that includes Illinois, Indiana, Michigan, Ohio and Kentucky. He is going to talk about High Precision Global Positioning for Mining Applications. Michael is a returnee to the Midwest. He tells me his wife is from the St. Louis area. He is a graduate of the Texas Agricultural and Mechanical University at College Station. And having lived outside of Houston for a couple of years, I am well familiar with that institution and the graduates of that institution. Now, I was informed that being a native of West Virginia that if I started with the Aggie jokes, he would start hillbilly jokes; so, there won't be any Aggie jokes this morning. They are interchangeable, and they will work with both. You can actually interchange the same title with Illinois as well.

I will tell one quick story before Michael gets started, and it is a reminder to all of our speakers today. There was a young man who went to the seminary, hadn't wanted to do anything else in his life time; that is all he ever thought about being. He practiced and he studied hard in the seminary; he worked hard and he finally got his degree. He started out in a very little small circuit. He didn't know what to expect. He got the directions to his first church and got there on Sunday morning. And when he got there, it was time for services to start, and there was just one old farmer sitting on the front row. He had his bib overalls on and his plaid shirt.

The young man was really distressed; so he turned to the farmer and he said, "Sir, I just don't know what I ought to do. It is just you and me."

The farmer said, "Well, son, I'll tell you what, if when I got up this morning, loaded my wagon with hay and went out to the field there wasn't but one cow showed up, I'd feed it."

The young preacher said, "Thank you, brother, that is what I needed." He launched into his sermon and he preached and preached and preached. About two and a half hours later he sat down and said, "Well, brother, what did you think?"

And the farmer said, "Well, if when I loaded my wagon with hay this morning and had gone out to the field and had but one cow there, I would not have tried to feed him the whole wagonload."

And with that, we'll get started, Michael, Thanks.

Michael O'Grady: Thanks, John.

John Hill opens Technical Session II.

HIGH PRECISION GLOBAL POSITIONING SYSTEM FOR MINING APPLICATIONS

MICHAEL O'GRADY
Trimble Navigation, Ltd.
Elgin, Illinois

INTRODUCTION

I want to discuss today's satellite technology that has lead to the development of a system that will increase safety and production in surface mining. The Department of Defense is maintaining a satellite system made up of 24 NavStar satellites that allow us to use their frequencies to position equipment anywhere on Earth.

BACKGROUND

The previous satellite system was called the Transit system or Sat-Nav. It consisted of low-orbit satellites (not many up there) that ground-based receivers needed three days of logged data to process sub-meter accuracy positions. With the NavStar network of satellites, centimeter accuracy can be achieved within just a few minutes.

THE GLOBAL POSITIONING SATELLITE SYSTEM

The Global Positioning System (GPS) satellite network was initiated in 1978 by the Department of Defense (DOD) and reached its full constellation of 24 satellites in 1993. Control operations at Colorado Springs monitor and update the 12-hour orbits that are approximately 20,000 kilometers out in space. Their rise and set times do change by 4 to 5 minutes each day. If SV 5 rises at 5:00 A.M. today, it will rise tomorrow at 4:55 A.M.

Trilateration from satellites is the basis of the system. We can use transmitted frequencies from the satellites to our receivers to determine the range. With precise time from atomic clocks, we can determine what time the frequency left and what time the frequency arrived, giving us the delta time. Knowing that radio waves travel at the speed of light, gives us the 186,000 miles per second that we need. Now with these two bits of information, we have all we need to determine the range from a satellite: SPEED X TIME = DISTANCE. The more satellites we track the more and better triangles we can make.

Satellite ranging lets us determine our position. If we are tracking one satellite, we are somewhere in a sphere that has a radius of the range we determined. If we are tracking two satellites, we have to be in the intersecting area of the two spheres. Now with the third satellite, the three spheres only intersect in two points. If we need to determine which point is the correct

position, we need a fourth measurement or we can make an assumption. Usually, one of the two points is a ridiculous answer. The incorrect point may not be close to the earth, or it may have an impossibly high velocity. The computers in GPS receivers have various techniques for distinguishing the correct point from the incorrect one.

To measure travel time, GPS needs very accurate timing, which it achieves with some tricks. Along with distance, you need to know exactly where the satellites are in space. High orbits and careful monitoring are the secret. Finally, you must correct for any delays the signal experiences as it travels through the atmosphere.

The *Pseudo Random Code (PRC)* is a fundamental part of GPS. Physically it is just a very complicated digital code, or, in other words, a complicated sequence of "on" and "off" pulses. The signal is so complicated that it almost looks like random electrical noise. Hence, the name "Pseudo-Random." There are several good reasons for that complexity. First, the complex pattern helps make sure that the receiver doesn't accidentally sync up to some other signal. The patterns are so complex that it is highly unlikely that a stray signal will have exactly the same shape. Since each satellite has its own unique Pseudo-Random Code, this complexity also guarantees that the receiver won't accidentally pick up another satellite's signal. So, all the satellites can use the same frequency without jamming each other. And it makes it more difficult for a hostile force to jam the system. In fact, the Pseudo Random Code gives the DOD a way to control access to the system. But there is another reason for the complexity of the Pseudo Random Code, a reason that's crucial to making GPS economical. The codes make it possible to use "information theory" to "amplify" the GPS signal. And that is why GPS receivers don't need big satellite dishes to receive the GPS signals.

Timing

On the satellite side, timing is almost perfect because they have incredibly precise atomic clocks onboard. But what about our receivers here on the ground? Remember that both the satellite and the receiver need to be able to precisely synchronize their Pseudo-Random Codes to make the system work. If our receivers needed atomic clocks (which cost upwards of $50K to $100K), GPS would be a lame duck technology. Luckily, the designers of GPS came up with a brilliant little trick that lets us get by with much less accurate clocks in our receivers. This trick is one of the key elements of GPS, and, as an added side benefit, it means that every GPS receiver is essentially an atomic-accuracy clock. The secret to perfect timing is to make an extra satellite measurement. That's right. If three perfect measurements can locate a point in three-dimensional space, then four imperfect measurements can do the same thing. If everything were perfect (i.e., if our receiver's clocks were perfect) then all of our satellite ranges would intersect at a single point (which is our position). But with imperfect

clocks, a fourth measurement, done as a cross-check, will NOT intersect with the first three. So, the receiver's computer says, "Uh-oh! There is a discrepancy in my measurements. I must not be perfectly synchronized with universal time." Since any offset from universal time will affect all of our measurements, the receiver looks for a single correction factor that it can subtract from all its timing measurements that would cause them all to intersect at a single point. That correction brings the receiver's clock back into sync with universal time, and bingo!–you've got atomic accuracy time right in the palm of your hand. Once it has that correction, it applies it to all the rest of its measurements, and now we've got precise positioning. One consequence of this principle is that any decent GPS receiver will need to have at least four channels so that it can make the four measurements simultaneously.

With the Pseudo-Random Code as a rock solid timing sync pulse, and this extra measurement trick to get us perfectly synced to universal time, we have got everything we need to measure our distance to a satellite in space. But for the triangulation to work we not only need to know distance, we also need to know exactly where the satellites are. That 11,000-mile altitude is actually a benefit in this case, because something that high is well clear of the atmosphere. And that will mean it will orbit according to very simple mathematics. The Air Force has injected each GPS satellite into a very precise orbit, according to the GPS master plan. On the ground, all GPS receivers have an almanac programmed into their computers that tells them where in the sky each satellite is, moment by moment. The basic orbits are quite exact, but just to make things perfect, the GPS satellites are constantly monitored by the Department of Defense. They use very precise radar to check each satellite's exact altitude, position and speed. The errors they're checking for are called "ephemeris errors" because they affect the satellite's orbit or "ephemeris." These errors are caused by gravitational pulls from the moon and sun and by the pressure of solar radiation on the satellites. The errors are usually very slight but if you want great accuracy, they must be taken into account. Once the DOD has measured a satellite's exact position, they relay that information back up to the satellite itself. The satellite, then, includes this new corrected position information in the timing signals it's broadcasting. So a GPS signal is more than just Pseudo-Random Code for timing purposes. It also contains a navigation message with ephemeris information as well.

COMPLICATIONS TO OVERCOME

With perfect timing and the satellite's exact position, you'd think we'd be ready to make perfect position calculations. But there is trouble afoot.

Up to now we have been treating the calculations that go into GPS very abstractly, as if the whole thing were happening in a vacuum. But, in the real world, there are lots of things that can happen to a GPS signal that

will make its life less than mathematically perfect. To get the most out of the system, a good GPS receiver needs to take a wide variety of possible errors into account. Here is what they 've got to deal with. First, one of the basic assumptions we have been using throughout is not exactly true. We have been saying that you calculate distance to a satellite by multiplying a signal's travel time by the speed of light. But the speed of light is only constant in a vacuum. As a GPS signal passes through the charged particles of the ionosphere and then through the water vapor in the troposphere, it gets slowed down a bit, and this creates the same kind of error as bad clocks. There are a couple of ways to minimize this kind of error. For one thing, we can predict what a typical delay might be on a typical day. This is called modeling, and it helps. But, of course, atmospheric conditions are rarely exactly typical. Another way to get a handle on these atmosphere-induced errors is to compare the relative speeds of two different signals. This "dual frequency" measurement is very sophisticated and is only possible with advanced receivers. Trouble for the GPS signal doesn't end when it gets down to the ground. The signal may bounce off various local obstructions before it gets to our receiver. This is called multipath error and is similar to the ghosting you might see on a TV. Good receivers use sophisticated signal rejection techniques to minimize this problem.

Problems at the Satellite

Even though the satellites are very sophisticated they do account for some tiny errors in the system. The atomic clocks they use are very, very precise, but they're not perfect. Minute discrepancies can occur, and these translate into travel-time-measurement errors. And even though the satellites' positions are constantly monitored, they can't be watched every second. So slight position or "ephemeris" errors can sneak in between monitoring tunes. Basic geometry itself can magnify these other errors with a principle called "Geometric Dilution of Precision" (GDOP). It sounds complicated but the principle is quite simple. There are usually more satellites available than a receiver needs to fix a position, so the receiver picks a few and ignores the rest. If it picks satellites that are close together in the sky, the intersecting circles that define a position will cross at very shallow angles. That increases the error margin around a position. If it picks satellites that are widely separated, the circles intersect at almost right angles and that minimizes the error region. Good receivers determine which satellites will give the lowest GDOP.

Security Measures

As hard as it may be to believe, the same government that spent $12 billion to develop the most accurate navigation system in the world is intentionally degrading its accuracy. The policy is called "Selective Availability" (SA), and the idea behind it is to make sure that no hostile force or terrorist group can use GPS to make accurate weapons. Basically, the

DOD introduces some "noise" into the satellite's clock data which, in turn, adds noise (or inaccuracy) into position calculations. The DOD may also be sending slightly erroneous orbital data to the satellites which they transmit back to receivers on the ground as part of a status message. Together these factors make SA the biggest single source of inaccuracy in the system. Military receivers use a decryption key to remove the SA errors, and they're much more accurate. Fortunately, all of these inaccuracies still don't add up to much of an error. And a form of GPS called "Differential GPS" can significantly reduce these problems.

Differential GPS

Differential GPS involves the cooperation of two receivers, one that's stationary and another that's roving around making position measurements. The stationary receiver is the key. It ties all the satellite measurements into a solid local reference. Remember that GPS receivers use timing signals from at least four satellites to establish a position. Each of those timing signals is going to have some error or delay depending on what sort of perils have befallen it on its trip down to us. Since each of the timing signals that go into a position calculation has some error, that calculation is going to be a compounding of those errors.

An extenuating circumstance. Luckily, the sheer scale of the GPS system comes to our rescue. The satellites are so far out in space that the little distances we travel here on earth are insignificant. So if two receivers are fairly close to each other, say within a few hundred kilometers, the signals that reach both of them will have traveled through virtually the same slice of atmosphere, and will have virtually the same errors. The solution: reference receiver measures errors. That's the key to differential. We have one receiver measure the timing errors and then provide correction information to the other receivers that are roving around. That way, virtually all errors can be eliminated from the system, even the pesky Selective Availability error that the DOD puts in on purpose.

How does a reference receiver measure errors? The idea is simple. Put the reference receiver on a point that has been very accurately surveyed and keep it there. This reference station receives the same GPS signals as the roving receiver, but instead of working like a normal GPS receiver, it attacks the equations backwards. Instead of using timing signals to calculate its position, it uses its known position to calculate timing. It figures out what the travel time of the GPS signals should be, and compares it with what they actually are. The difference is an "error correction" factor. The receiver then transmits this error information to the roving receiver so it can use it to correct its measurements.

Since the reference receiver has no way of knowing which of the many available satellites a roving receiver might be using to calculate its position, the reference receiver quickly runs through all the visible satellites and computes each of their errors. Then it encodes this information into a

standard format and transmits it to the roving receivers. It is as if the reference receiver is saying: "O.K., everybody, right now, the signal from satellite #1 is ten nanoseconds delayed, satellite #2 is three nanoseconds delayed, satellite #3 is sixteen nanoseconds delayed...," and so on. The roving receivers get the complete list of errors and apply the corrections for the particular satellites they're using.

APPLICATION IN THE MINES

Why are we bringing GPS into the mines? Productivity, safety, and increased accuracy. I established several systems in surface mines in east Texas that have been in place for several years now. They rarely use their conventional survey equipment any more. They have increased their productivity by three. Weather is not a factor anymore for staking out or collecting positions (no line of sight required). All the tools for labeling or coding positions, continuously collecting positions for area volume calculations, are in the data collector. Most of the surveyors have modified their vehicles to mount the GPS antenna outside the cab. They just drive to the area where the surveying is needed and remain seated while collecting positions.

We are in a developing stage with Caterpillar to design an autonomous vehicle system. With real time GPS as the guidance for precise positioning, we will have the ability to operate heavy equipment without the need for drivers. This will add productivity and, more importantly, safety to these areas.

CONCLUSION

Changes to the way we used to survey in the mining industry are being replaced with the Global Positioning System. It has proven to be a system that is more accurate and after the typical learning curve that is required by any new system, will lead to higher productivity; hence, financial rewards are in the immediate future.

John Hill: Any other questions for Michael? Thank you very much. Just as a little edge on the last comment Michael made. A vice president of one of our sister companies was out at Las Vegas for the mining show and Caterpillar had a regular tour going to the proving grounds. He said that they sat there and watched for over two hours while trucks and shovels operated independently of any operators based on this technology. Basically what happened is the foreman took a hand held unit and drove the route the truck was supposed to drive and then dumped that into a computer, and through this GPS technology, the monitoring system gave the truck remote control commands to follow that same route. Each time the shovel was re-positioned, he drove the route again. He said for two hours

straight, the equipment ran without any human input. Pretty amazing technology; those of us who drive trucks and operate dozers are a little bit scared, but otherwise it is pretty amazing.

We will switch gears for our second presentation. I think that one thing that in Illinois we have a tendency to ignore now because the industry is in such difficult condition, is some of the geological aspects of our business. I think it is important from a technical standpoint to continue to focus on those things, to continue to understand what our reserve bases look like and what is the geology of our coal basin. I would like to introduce to you now Tim Rohrbacher. Tim is a mining engineer and manages the U.S. Geological Survey's Coal Availability and Recoverability projects based in Denver, Colorado. Prior to working for the USGS, he held various management and engineering positions with the U.S. Bureau of Mines and geotechnical and environmental consulting in the coal and mineral industries. Tim received his B.S. in geology and M.S. in geochemistry from the University of Toledo. He studied mining engineering at Michigan Tech. I'd like to turn the program over now to Tim Rohrbacher.

Tim Rohrbacher: Good morning, ladies and gentlemen. We appreciate the opportunity to present to you information concerning the National Coal Resource Assessment and results from the National Coal Availability and Recoverability program.

COAL RESOURCE ASSESSMENTS USING COAL AVAILABILITY AND RECOVERABILITY METHODS

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U. S. Geological Survey
Denver, Colorado

INTRODUCTION
The National Perspective

The U.S. Geological Survey (USGS), in conjunction with state geological surveys and other federal agencies, has initiated a study and developed methodology to reassess the nation's major coal resources. This study differs from previous coal resource assessments of the USGS, U.S. Bureau of Mines, and the Department of Energy's Energy Information Administration, because this program:

- Identifies and characterizes the coal beds and coal zones that will provide the bulk of the nation's coal-derived energy during the first quarter of the twenty-first century;
- organizes geologic, chemical, environmental, and geographic information in digital format and makes these data available to the public through the Internet or other digital media, such as CD ROMs;
- includes coal resource availability and coal recoverability analyses for selected areas;
- provides economic assessments of the minable resources; and
- provides methodology to perform socio-economic impact analysis related to coal mining in specific geographical areas as small as a county.

The national coal resource assessment project, begun by the USGS in 1994, focuses on five major coal-producing regions: the Appalachian Basin, the Illinois Basin, the Gulf Coast Region, the Northern Rocky Mountains and Northern Great Plains Region, and the Rocky Mountain and Colorado Plateau Region (U.S. Geological Survey, 1996). These study areas are shown in dark shades on figure 1; areas that will not be studied are shown in light shades of gray.

The program methodology (fig. 2) involves collecting available coal bed information and ultimately determining the total coal resources and reserves of the major coal beds. The following data are collected: lithologic descriptions; thickness of coal beds, overburden, interburden,

and partings; quality of coal beds; chemical analysis of overburden, interburden, and parting; rock mechanics characteristics and geologic structure information; active and abandoned mines; social and industrial constraints, such as towns, highways, power lines, gas and oil wells and pipelines, and railroads; and environmentally restrictive areas, such as endangered animal and plant species habitats, rivers, alluvial stream valleys, wetlands, National Forest surface ownership, National Parks and Monuments, forest preserves (state and private), raptor habitat, and elk and deer winter range.

Figure 1. National coal resource assessment regions.

Figure 2. Coal availability, coal recoverability, and the national coal resource assessment program.

These spatial data are then stored in digital databases accessible to geographic information system (GIS) programs that produce geologic and coal quality models. Data can be manipulated and analyzed through two different systems. The first-used system was the raster-based GIS programs named geographical resources analysis support system (GRASS), developed by the U.S. Army Corps of Engineers. GRASS is used to generate contour and isopach maps and to produce volumetric analyses of the coal beds; it also allows integration of various resource characterization and distribution coverages as previously mentioned. The second GIS system used is the vector-based ARC/INFO programs developed by Environmental Systems Research Institute, Inc. In this system, isopach and contour maps are processed using interactive surface modeling (ISM) software developed by Dynamics Graphics, Inc., (Hettinger and others, 1996) then converted to ARC/INFO to allow integration of geologic and geographical coverages. Other programs, such as Stratifact, assist in coal-bed correlations and produce coal bed or coal-zone models. Coal quality isopleth maps are developed whenever sufficient data are available.

Resource volumetrics are then generated, and a total tonnage is calculated. Results are reported on the Internet as they become available. The first NCRA area completed, the Kaiparowits Plateau study in Utah (Hettinger and others, 1996), may be accessed at http://sedwww.cr.usgs.gov:8080/energy/kaip.html. Preliminary results from a second NCRA area, the Powder River Basin of Wyoming were reported in Flores and others, 1996 at the Annual Pittsburgh Coal Conference. A national summary report is scheduled for 1999. Coal availability and recoverability analyses, pre-feasibility mine planning, mining economics, and socio-economic impact analysis are employed for value-added information to the NCRA. The rest of this paper describes these techniques and shows how they can enhance the study of the nation's major coal beds, by examples from the Wasatch Plateau, Utah, and the Powder River Basin, Wyoming.

COAL AVAILABILITY/RECOVERABILITY STUDIES

The general combined coal availability and recoverability study (CARS) methodology (Rohrbacher and others, 1993a) is shown in figure 3. After the total in-place resource is calculated, previously mined resources and resources restricted by social, environmental, and general technical concerns are subtracted, resulting in coal available for mining. Pre-feasibility mine planning is then applied to the available coal, after which resource losses from technical mining restrictions and recovery losses are subtracted from the available resource, resulting in a minable resource. Potential washing losses are then subtracted and the resulting tonnage is the recoverable coal resource.

The U.S. Geological Survey and the Kentucky Geological Survey started coal availability studies in 1986 in the 7.5-minute Matewan Quad-

rangle in eastern Kentucky (Eggleston and others, 1990). Upon successful development of a program methodology to determine coal resources available for mining (Eggleston and Carter, 1987) and realistic results of the pilot study, the program was expanded to the remaining coal states in the central and northern Appalachian Basins (Carter and Gardner, 1989), then to the coal states in the Illinois Basin, and then to the western coal basins. More than 50 cooperative studies by state geological surveys and the U.S. Geological Survey have been completed in the Appalachian, Illinois, and Powder River Basins (Carter, 1996). Coal availability studies historically have used 7.5-minute quadrangles to determine the amount of coal available for mining after environmental, social, legal, industrial, and general technical restrictions to mining were subtracted from the total resource (fig. 3).

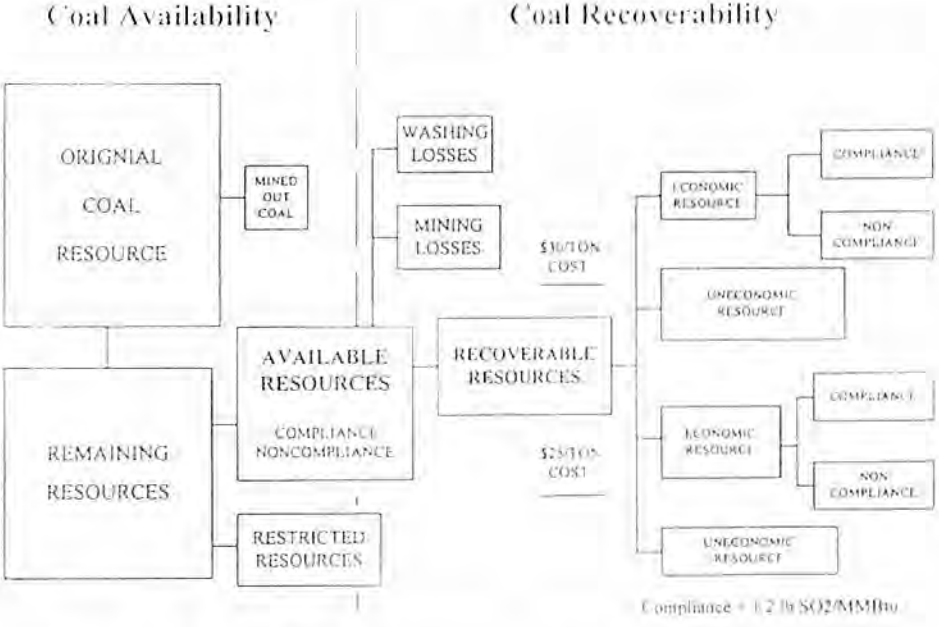

Figure 3. Coal availability and recoverability methodology.

During the early 1980s the U.S. Bureau of Mines began conducting domestic and international coal mine evaluations (U.S. Bureau of Mines, 1993; and Sherer, 1994) to determine the competitiveness of U.S. coal on the world market. A representative number of small, medium, and large surface and underground mines from the major coal-producing regions in the U.S. were evaluated (Clarke, 1983) as a basis for comparing similar operations in other major coal-producing countries in the world (Canada, South Africa, Australia, Columbia, Venezuela, England, Poland, Indonesia, and Russia). More than 100 domestic coal mining operations (fig. 4) were

evaluated and up-dated during the 1980s and 1990s. These evaluations were used to develop the coal resource evaluation program. They form the basis for economic analysis of coal resources in the recoverability portion of the national coal resource assessment.

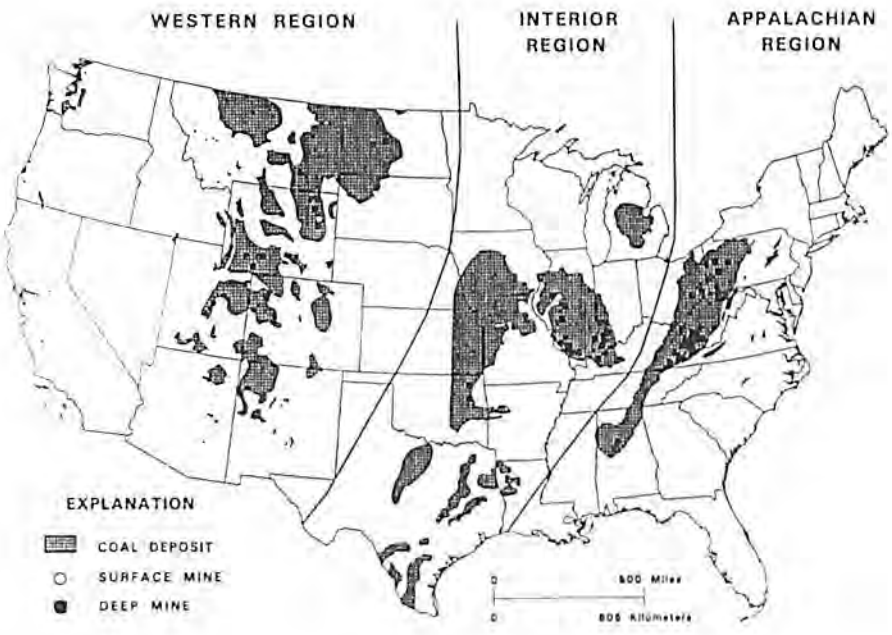

Figure 4.* Coal fields and mine evaluation sites in the conterminous United States.

Coal recoverability studies, begun by the U.S. Bureau of Mines (Rohrbacher and others, 1993) in early 1989, utilized the coal availability study data, geologic models, and restrictions. Then, by modification of the geologic models to reflect mining conditions, addition of technical restrictions and resource recovery rates, and the design of pre-feasibility mine plans, a recoverable resource for mining was calculated. Those resource numbers are entered into an interactive costing program, COALVAL, to produce estimated mining costs (from property acquisition through load-out of the coal into rail cars) for the recoverable resources (Suffredini and others, 1994). The costs are summarized in increments from less than $4 per

ton to costs greater than $50 per ton, and include a break-even cost to determine reserves at a set point in time. More than twenty 7.5-minute quadrangles have been studied using COAL VAL in the Appalachian Basins, the Illinois Basin, and the Wasatch Plateau in Utah. The example in figure 5 indicates economically recoverable resources (seven percent of the total resource) at break-even costs for 13 central Applachian quadrangles.

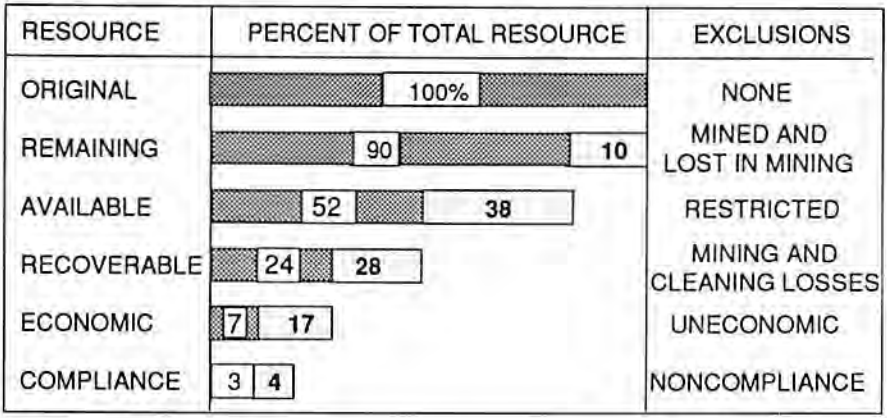

Figure 5. Summary of coal availability and recoverability studies in the central Appalachina region.

A summary of coal availability and recoverability studies (fig. 5) for the central Appalachian Basin (Scott, 1995; U.S. Bureau of Mines, Intermountain Field Operations Center staff, 1995) indicates that approximately 52 percent of the total in-place resource in the areas studied is available for mining, and approximately one-half of that available resource, or 24 percent of the total in-place resource, is recoverable. About seven percent of the total in-place resource can be mined in today's economy at a profit. Approximately 50 percent of these economically recoverable resources (just three percent of the total in-place coal resource) is compliance coal.

Socio-economic impact analyses were begun in 1992 for Pike County, Kentucky and continued in 1993 in Boone County, West Virginia (Geroyan and Teeters, 1995). These studies employ the modeling package IMPLAN and describe the structural interdependence of the producing and consuming sectors of local populations. At the county level, IMPLAN characterizes the size of the present industries, income earned, number of jobs, and amounts spent to purchase goods and services by households, businesses, and government. Alternative production and employment scenarios can then be generated and compared to each other to determine the effects of reserve depletion or start-up of new mining ventures on the local and regional populations.

RECENT CHANGES IN COAL AVAILABILITY/RECOVERABILITY STUDIES

During 1994 the U.S. Bureau of Mines began looking at methods to apply the coal availability and coal recoverability methodology to areas larger than single 7.5-minute quadrangles. Studies conducted for the U.S. Forest Service in the Manti-La Sal National Forest (fig. 6) on the Wasatch Plateau of Utah, modeled five coal beds over portions of fifteen 7.5-minute quadrangles, (Osmonson, 1994). More recently, models developed by the Kentucky Geological Survey in 1995 and 1996 for areas in western and eastern Kentucky, respectively, have included over thirty quadrangles or portions of quadrangles (Weisenfluh, 1996) .

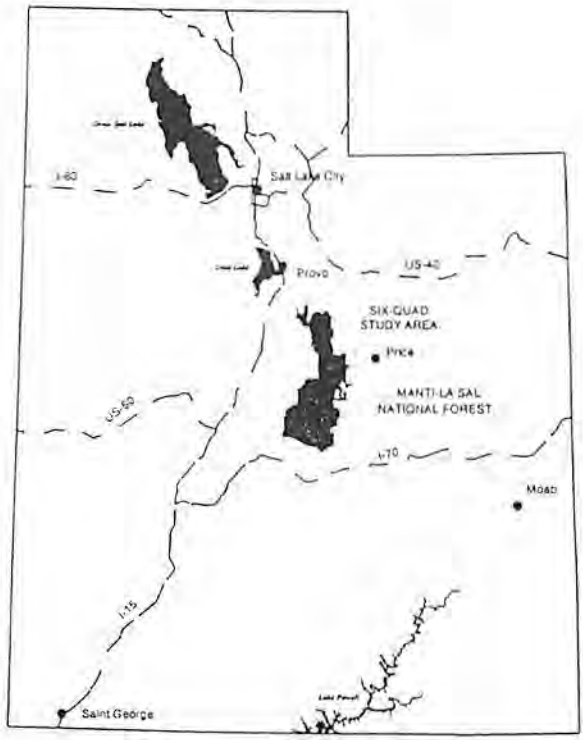

Figure 6. Location map, Manti-La Sal multi-quadrangle study area.

The time required for collection of geologic information increases as the size of the study area increases, but because many geographic, environmental, social, and geologic data bases are now in digital form within the public domain, much of the information can be acquired from outside sources and merged spatially through (GIS) modeling (Ferderer,

1996). As a result, construction of geologic and mining models and calculations of recoverable resources and mining economics require far less time today than five years ago due to advances in computing and data base organization.

An example of merging different digital data bases with GIS modeling (Roberts and others, 1993) is shown in figure 7, which depicts land and mineral status, areas of highest resource recovery potential, streams, highways, railroads, towns, and general mine, prospect, and drill hole locations in and around the Manti-La Sal National Forest study area.

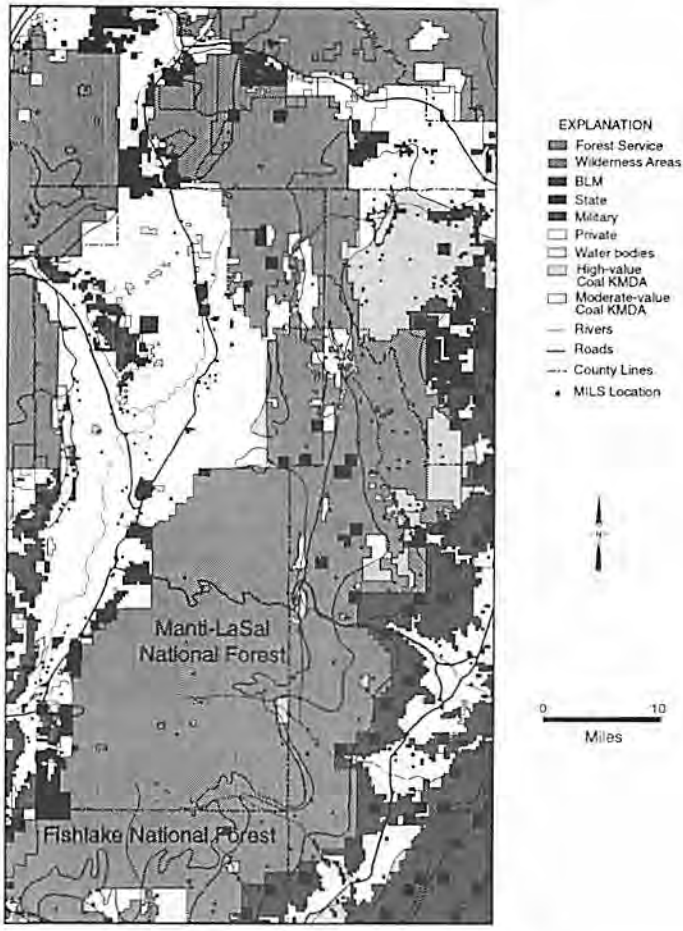

Figure 7.* Merged land status, surface ownership, mineral information location data points (MILs), and mineral development potential for the Manti-La Sal National Forest, central Utah.

The coal availability and recoverability spatial data bases for the Manti-La Sal National Forest study contain geologic and mining information, such as lithologic descriptions, thickness, quality of coal beds, geologic structure information, active and abandoned mine areas; social and industrial constraints, such as private dwellings and buildings, highways, power lines, gas and oil wells and pipelines, and environmentally restrictive areas, such as endangered animal and plant species habitats, rivers, alluvial stream valleys, wetlands, National Forest surface ownership, raptor habitat, and elk and deer winter range.

Once the data bases were constructed and imported into a usable form, the geologic models were prepared, the geographical areas or polygons of restrictions were determined, and the coal resource was modeled by computer (fig. 8) for mine plans that were applicable within the Manti-La Sal National Forest (Osmonson, 1994). The purpose of this study was not only to model a multi-quadrangle area and to determine the available and recoverable resources and potential reserves, but also to determine the minable coal resource that would be affected if the U.S. Forest Service declared that no mining-induced caving could take place within the area of influence of rim-rock habitat (cliff faces). Our results indicate that, within the study area, this restriction could potentially affect the recovery of more than 500 million tons of 0.6 percent sulfur, 12,700 Btu/lb coal. Figure 8 shows the six quadrangle Manti-La Sal study area of the Hiawatha seam with coal-bed outcrop; outlines of current and abandoned mines; data points and circles representing resource reliability categories (areas of influence); pre-feasibility mining methods; and environmentally sensitive raptor habitat on massive sandstone cliffs.

EVALUATING THE POWDER RIVER BASIN COAL RESOURCES

Other coal availability and coal recoverability studies are located in the Powder River Basin (PRB) of Wyoming, one of the major coal-producing areas of interest in the national coal resource assessment. Total coal resources for the PRB have been estimated in years past; the current study is concentrating on the major beds where coal is being produced–the Wyodak coal zone.

The area of development of the Wyodak coal zone in the southern Powder River Basin (fig. 9) has been divided into three geologically different and geographically separate areas or "pods". The "northern pod" is located north of Gillette, may have the most complex geology, and contains the lowest average salable coal quality for the area (low to moderate sulfur, 0.34 to 0.55 percent, and lowest average heating value, 8,260 Btu/lb). The "southern pod" includes the area from the Jacobs Ranch Mine south to the Antelope Mine (south of Wright, Wyoming), and contains the highest average salable coal quality (low sulfur, 0.20 to 0.44 percent and highest average calorific value, 8,749 Btu/lb.) and moderately complex geology. Located south of Gillette, and north of the Jacobs Ranch Mine (north of Wright, Wyoming),

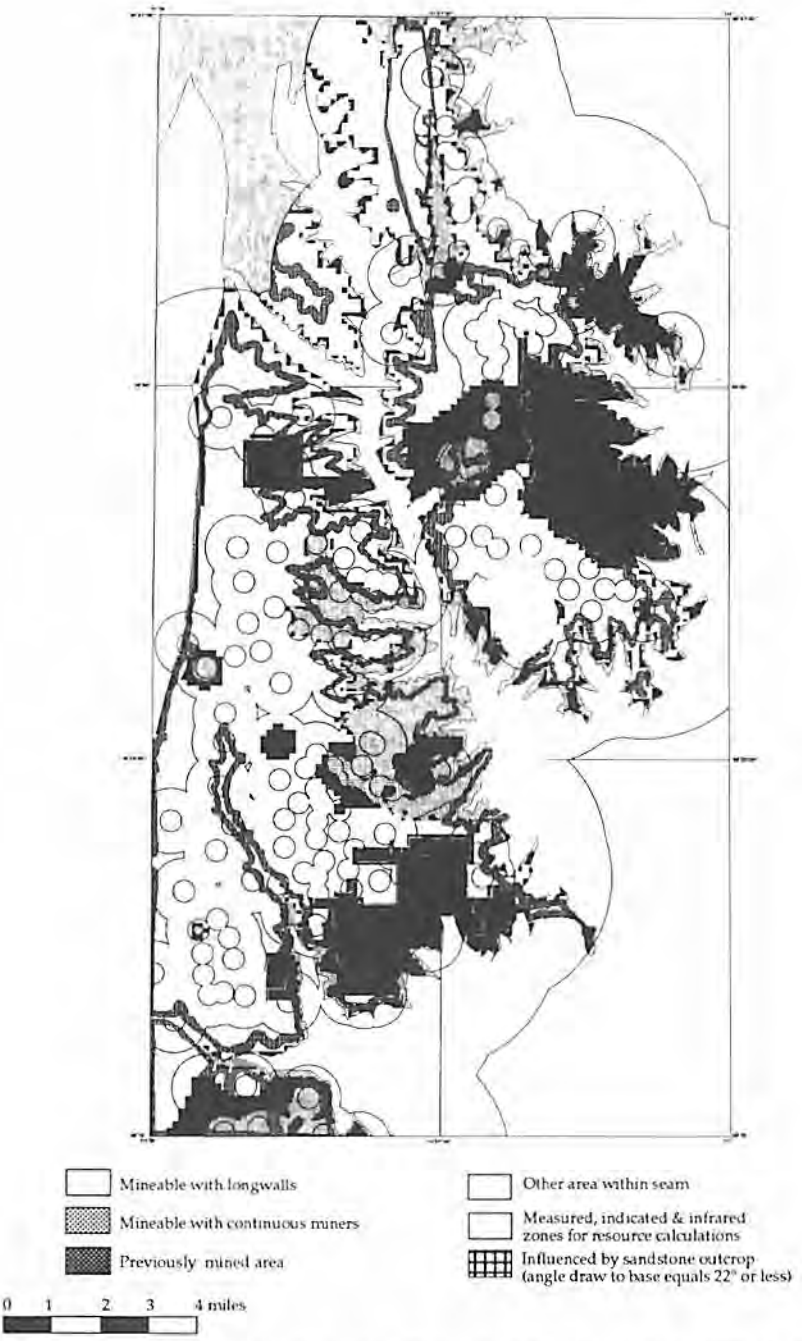

Figure 8.* Pre-feasibility mine planning for the Hiawatha seam, Manti-La Sal National Forest, showing resource reliability categories, proposed layout of mining methods, and raptor habitat on sandstone cliffs.

the "middle pod" contains low sulfur (0.30 to 0.38 percent) with with an average caloric value for the PRB (8,445 Btu/lb), in a moderately complex geological setting. Each "pod" is separated from its neighboring pod by increasingly complex stratigraphy and by major changes in the quality of coal.

Coal availability studies of the minable beds in the Hilight Quadrangle (located in the southern-most part of the "middle pod") were completed by the USGS in 1995. Results indicate that approximately 60 percent of the in-place resources are available for mining (Molnia and others, 1996). Coal recoverability studies of the Hilight Quadrangle resources were initiated in 1996 and are scheduled for completion in 1997.

Employing the same methodologies developed from the multi-quadrangle Manti-La Sal and western Kentucky investigations (Weisenfluh, 1996), coal availability and recoverability investigators are currently modeling the Wyodak zone of the "middle pod" and will determine the available and recoverable coal from portions of twelve quadrangles in the "middle pod" (fig. 9).

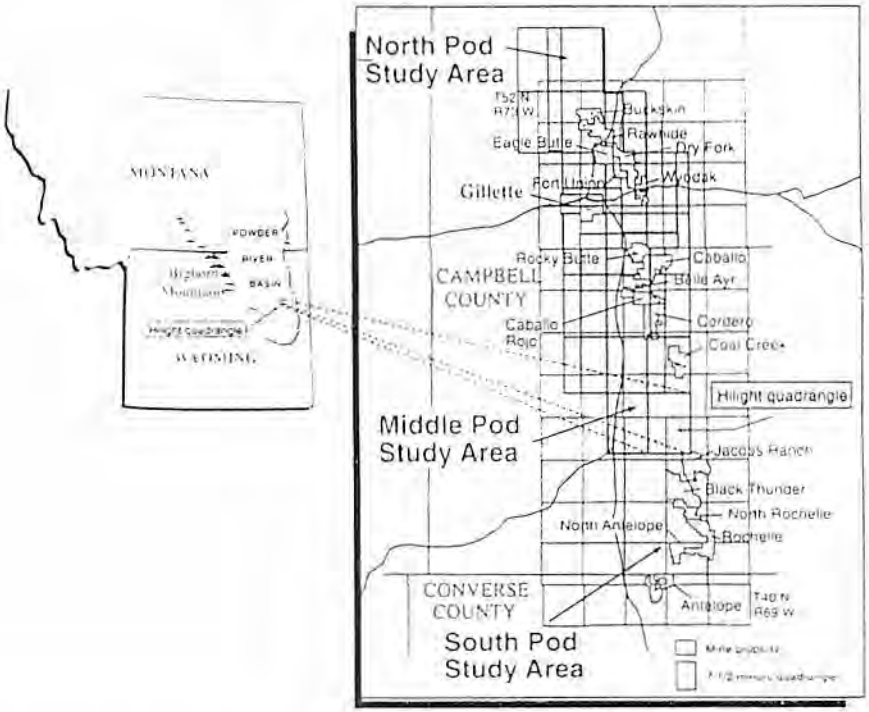

Figure 9. Wyodak coal bed development in the southern Powder River Basin.

This coal availability and recoverability analysis of the "middle pod" of the southern Powder River Basin in Wyoming will add value to the national coal resource assessment for those resources by indicating how much low-sulfur, low-cost coal is available for mining within the study area and how much can be economically developed using today's market costs.

ACKNOWLEDGMENTS

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Colin Treworgy: Thank you, Tim. Tim has given us the national perspective on the coal resource, coal availability and coal recoverability studies. I am Colin Treworgy, Senior Geologist with the Illinois State Geological Survey, and what I want to show you is some examples of what we are doing in Illinois right now as part of this project and give you some ideas as to how this information might relate to the whole national picture of coal availability.

AVAILABILITY OF COAL RESOURCES FOR FUTURE DEVELOPMENT IN ILLINOIS

COLIN TREWORGY

Illinois State Geological Survey
Champaign, Illinois

INTRODUCTION

The Illinois State Geological Survey (ISGS) in cooperation with the U.S. Geological Survey (USGS) is conducting a series of studies of the availability and recoverability of coal resources in Illinois. The goals of these studies are 1) to determine the quantity, characteristics, location, cost of mining, and recoverability of resources available for future mining in Illinois and 2) to identify the significant geotechnical and land use factors that limit the availability of coal for development.

Traditional estimates of coal quantities reported by the ISGS, USGS, and U.S. Department of Energy, such as identified resources or demonstrated reserve base, report the total amount of coal in the ground that meets very broad criteria of thickness and drill hole spacing. While these figures are necessary for very long-range energy planning, they provide a misleading picture of resources attractive for mining over the next twenty years. Resources are deposits of coal "in such forms and amounts that economic extraction is currently or potentially feasible" (Wood et al. 1983). The demonstrated reserve base is that portion of the resources "that meets specified minimum physical and chemical criteria related to current mining and production practices" (Energy Information Administration 1996). In actuality, much of the resources and reserve base cannot be mined or cannot be mined profitably due to environmental and regulatory restrictions, the presence of towns and other cultural features, current mining technology, and geologic conditions.

The ISGS attempted to provide some perspective on minability of resources by subdividing resources into categories of "high," "moderate," and "low" development potential (Treworgy and Bargh 1982). Due to lack of detailed knowledge about specific restrictions on mining and the then limited capability to integrate information on restrictions with resources, the classification of resources by their development potential was very general and did not consider many significant geotechnical restrictions to mining.

To address these problems, the USGS is sponsoring a program to determine the quantity of coal that is "available for mining under current and foreseeable conditions" (Eggleston et al. 1990). The concept of the USGS coal availability studies is to use detailed studies of sample areas, generally 7.5-minute quadrangles (an area of about 56 square miles), to identify restrictions to mining. The sample areas selected are representative of

conditions for a broader mining district. The restrictions identified in the sample areas are then extrapolated to larger regions to estimate the total amount of available coal.

This paper describes the study of available coal resources in Illinois, provides an example from the study of the Galatia Quadrangle, presents cumulative results for the quadrangles completed to date, and makes a preliminary extrapolation of some of the findings. Six published reports on this project, including the results from individual quadrangle studies, are available from the ISGS (Treworgy et al. 1994, Treworgy et al. 1995a, Treworgy et al. 1995b, Jacobson et al. 1996, Treworgy et al. 1996a, and Treworgy et al. 1996b).

To provide a framework for these investigations, the state was divided into seven regions, each with differing geologic and physiographic conditions (fig. 1). The available resources of coal are being assessed for two to six quadrangles in each region. Findings from the individual quadrangle studies will then be extrapolated to produce an estimate of available coal resources for each region and, ultimately, the entire state.

The methodology for each quadrangle study area is to map the resources and related geology of all coals present within the quadrangle. Mining engineers and geologists from three or four companies familiar with mining in the conditions found on the quadrangle then are interviewed. In the interviews, the company representatives examine the maps of the quadrangle, delineate the areas they do and do not consider to be suitable for mining, and explain the factors they considered in reaching their decisions.

The information obtained from the interviews is combined to produce a set of criteria defining available coal resources in that quadrangle. Although mining experts seldom agree on all details of the criteria defining available coal, this process helps us to identify land use patterns, geologic conditions, and other technical factors that impose significant restrictions on the availability of coal.

As of the fall of 1996, assessments of available coal have been completed for eight quadrangles and studies are underway in five additional quadrangles. We plan to complete studies of about 26 quadrangles in order to have sufficient information to extrapolate the results to the statewide level.

To date, twelve mining companies and consulting firms, plus the Illinois Office of Mines and Minerals, have participated. The expert advice and data we have received from these organizations have been invaluable to the success of the project. By the time the project is completed we hope to have worked with all the companies actively involved in the coal mining industry in the state.

EXAMPLE OF QUADRANGLE STUDY

The study of the Springfield Coal in the Galatia Quadrangle provides a typical example of our quadrangle assessments. The Galatia Quadrangle is located in Saline County, just north of the city of Harrisburg.

The coal seam ranges from less than one to more than eight feet thick (fig. 2). About 90 million tons of the resources in the quadrangle have been mined or left as pillars. The Galatia channel, an ancient river that flowed through the Springfield peat swamp, crosses the northern and western edges of the quadrangle. The coal is missing in the channel and may be split into multiple benches adjacent to the channel. Numerous faults, part of the Cottage Grove Fault System, disrupt the coal across the southern part of the quadrangle.

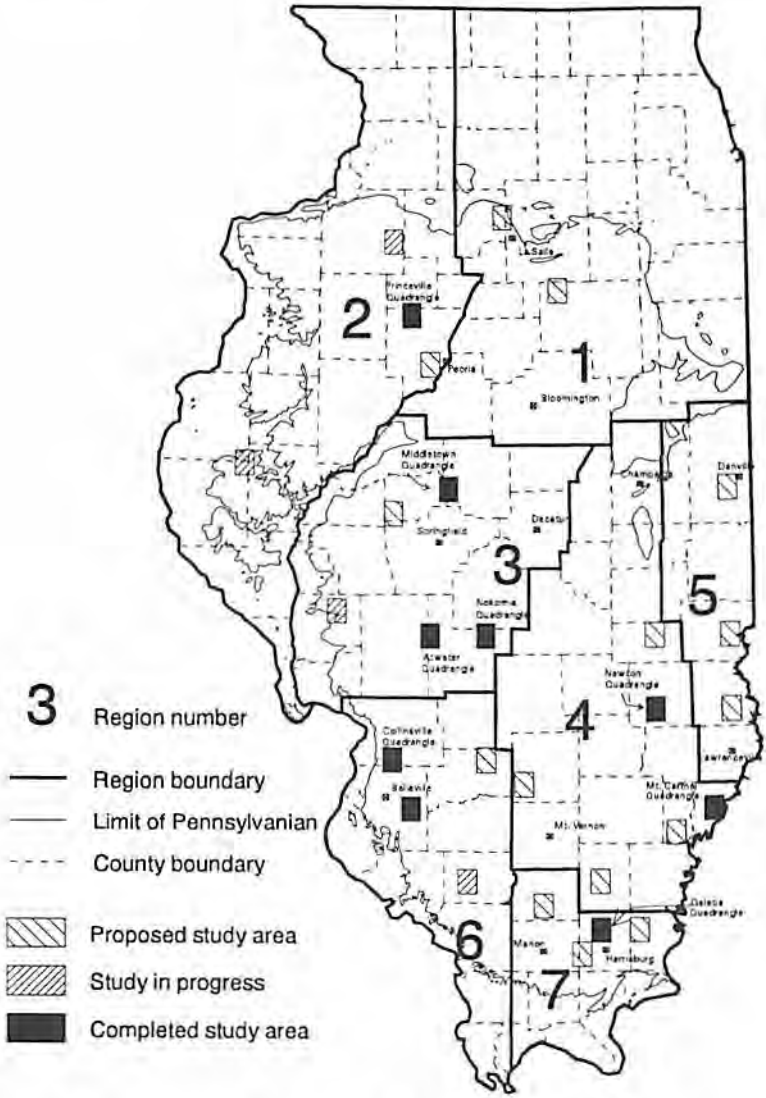

Figure 1. Quadrangles selected for coal availability studies.

Figure 2. Thickness of the Springfield Coal in the Galatia Quadrangle (from Treworgy et al. 1995a).

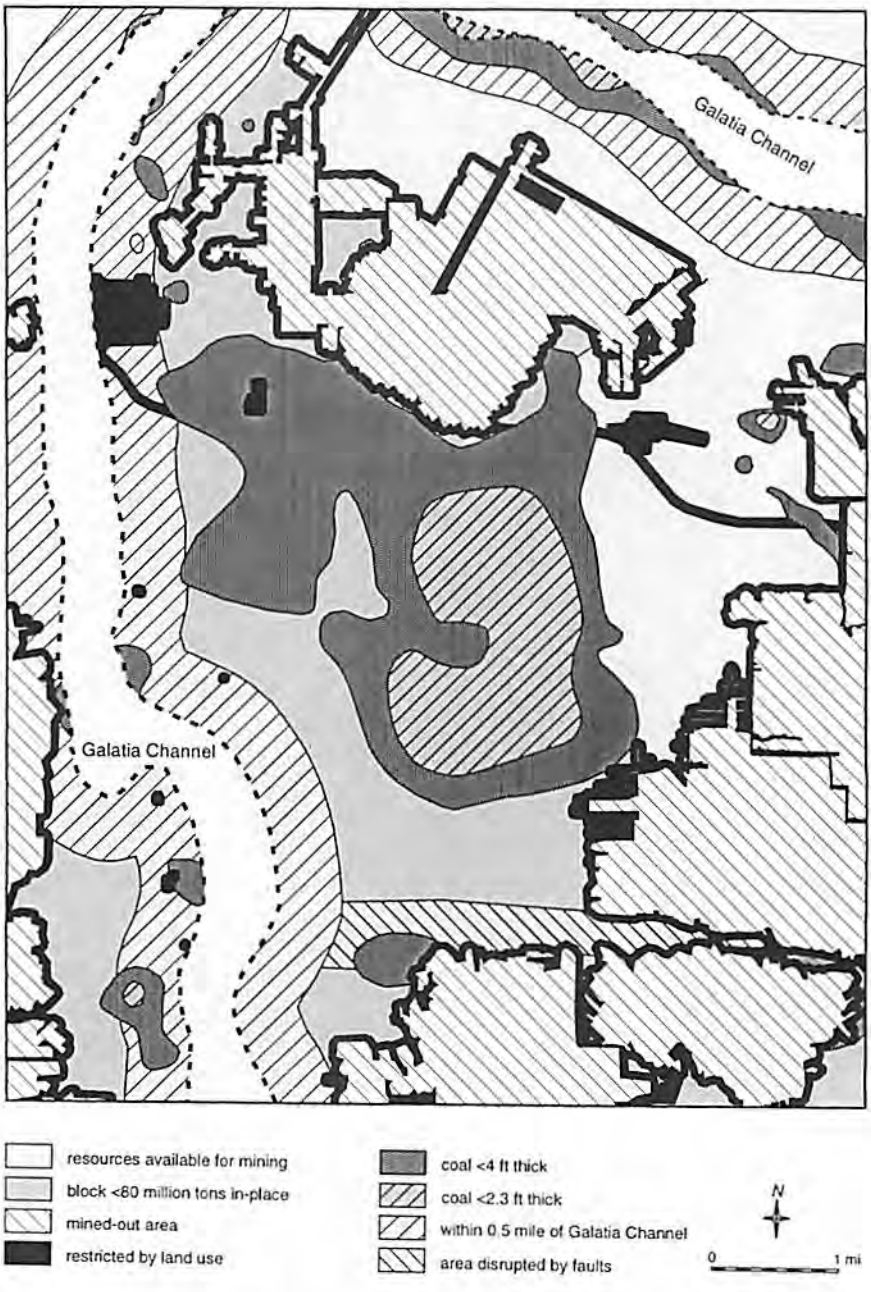

Figure 3. Availability of Springfield Coal resources for underground mining in the Galatia Quadrangle (from Treworgy et al. 1995a).

Through interviews with mining experts, several restrictions to future mining were identified (table 1; see Treworgy et al. 1995a for a complete description). Based on these restrictions, only 15 percent of the Springfield Coal resources originally present in the Galatia Quadrangle remain available for mining (figs. 3 and 4). Mining has already removed or otherwise eliminated 30 percent of the original resource; another 20 percent is eliminated by poor mining conditions associated with the Galatia channel, 13 percent reside in blocks that are too small or convoluted to mine, 10 percent are in seams that are too thin, ten percent are restricted by land use (e.g. they underlie surface features which preclude mining or are within 300 feet of abandoned mines), and two percent are restricted by faults.

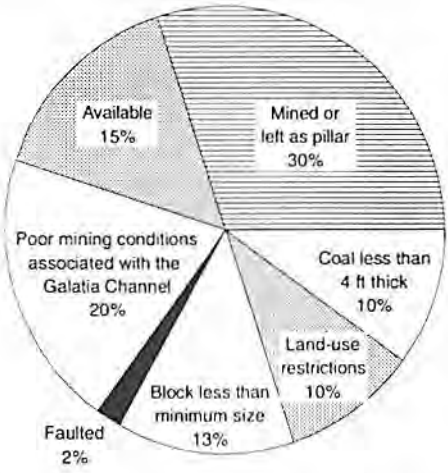

Figure 4. Factors restricting the availability of underground-minable Springfield Coal in the Galatia Quadrangle (from Treworgy et al. 1995b).

RESULTS OF QUADRANGLE STUDIES

The amount of available coal resources in the eight quadrangles completed to date has ranged from as little as 18 to as much as 76 percent of the original resources (fig. 5). Geotechnical factors such as thickness of the coal and overlying bedrock, roof and floor conditions, faults, and size of the mining block account for most of the restrictions on coal availability. Land use features such as towns, cemeteries, and interstate highways restrict from about one percent to almost 22 percent of the resources in the eight quadrangles. Cumulative availability of coal resources in the eight quadrangles is 45 percent of the original resources. Technical factors restrict 40 percent and land use six percent; three percent of the original resources have been mined or left as pillars.

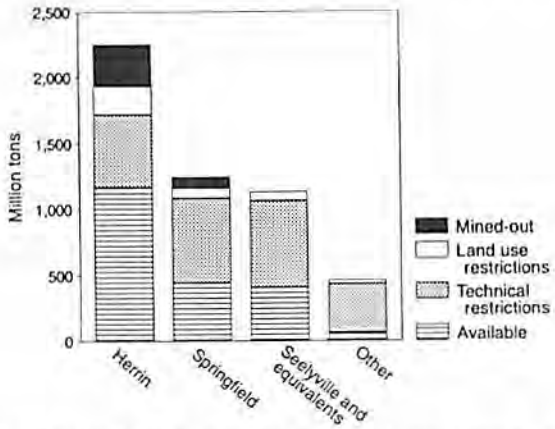

Figure 5. Availability of coal resources in eight quadrangles in Illinois (from Treworgy et al. 1996b).

Slightly more than four billion tons of resources representing 16 seams have been assessed so far. On a seam basis, the Herrin Coal has the highest availability, more than 50 percent of original resources, compared to 36 percent of the Springfield and Seelyville Coals and less than 13 percent of the other coals (fig. 6). The high availability of the Herrin Coal reflects the relatively thick, uniform character of this seam and the excellent mining conditions associated with it.

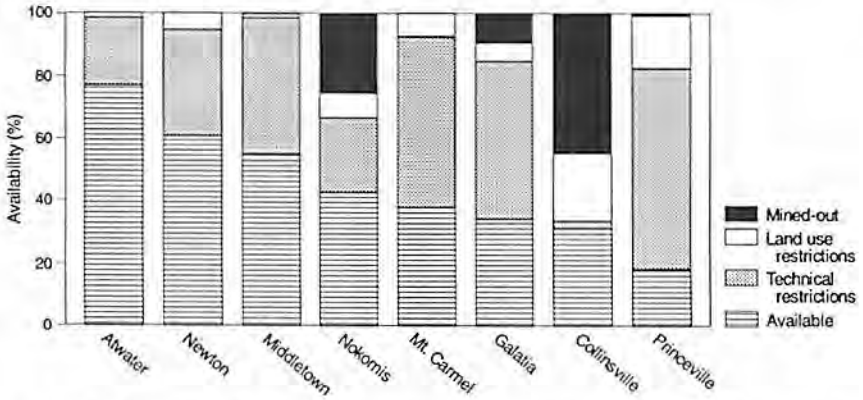

Figure 6. Tonnage of available resources by seam in eight quadrangles in Illinois (from Treworgy et al. 1996b).

EXTRAPOLATION OF FINDINGS

In the final stage of this project, findings from the individual quadrangle studies will be extrapolated to the entire state and, with the assistance of the USGS, the recoverability and cost of mining will be assessed. To offer an example of what the extrapolation will look like, the Herrin Coal resources were screened to identify areas of the state free from

some of the major restrictions identified in the quadrangles completed to date (thickness of bedrock, roof stability and mining conditions, block size, towns, and interstate highways). This is just a preliminary extrapolation; the remaining quadrangle studies will identify additional factors that will be used to refine the extrapolation.

Figure 7 shows the areas of the state where the Herrin Coal is free from major restrictions and more than 5.5 feet thick. The approximately 25 billion tons of resources can be considered to have mining costs roughly

Figure 7. Available Herrin Coal resources greater than 5.5 feet thick.

comparable to those at currently active mines. They are, for the most part, at shallow to moderate depths. These resources are suitable for longwall mining because they are in large contiguous blocks and are relatively free from surface development and geologic anomalies, such as faults. For the most part, these are high-sulfur resources, but there are some low- and moderate-sulfur deposits as well.

CONCLUSIONS

This preliminary extrapolation suggests two conclusions. First, ample resources of Herrin Coal are available with characteristics comparable to those in currently active mines. Secondly, because of these ample resources, the cost of mining in Illinois will not be driven up by lack of available resources with favorable geologic conditions. While these findings will not help companies weather the current competitive market conditions, they do suggest that, over the long term, Illinois can continue to be a significant contributor to the nation's coal production.

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John Hill: Thank you Tim and Colin. Our next presentation goes along with our theme of potpourri of relevant issues. This issue, although we have a tendency to minimize it many times, is probably one of the most important issues facing our business right now. Our business has traditionally been: How should I price my product relative to the other competitors in my business? Traditionally, we have priced our product based on our mining costs and based on what we thought our competitors would price their product. Our world, either fortunately or unfortunately, is changing dramatically, in terms of how our product is used. Our next speaker is going to talk about that, and I think she will probably bring into focus pretty clearly the fact that over the next few years we will have to change our focus from: Do I price my product relative to my competitors? to: How do I price my product such that my customer, the utility, can sell power in a deregulated environment?

Our next speaker is Lisa Krueger. Lisa is an employee of Illinois Power Company. She has a B.S. in chemical engineering from the University of Missouri at Rolla. For a long period of time she has worked in the fuel and bulk power sales group at Illinois Power, and, during that time, she was instrumental in developing Illinois Power's phase I compliance strategy. She has also done extensive work in bulk power marketing for Illinois Power. She has recently moved to the finance group, but I want you all to know she is still a coal person at heart. Lisa.

Lisa Krueger: Thank you and good morning. I'm Lisa Krueger. It is a pleasure to be here today.

ELECTRIC UTILITY RESTRUCTURING

LISA KRUEGER
Illinois Power Company
Decatur, Illinois

INTRODUCTION

Good morning. I'm here to talk to you this morning about some of the changes that are happening in the electric utility industry. Lots of words like utility restructuring, competition, deregulation, open access and regulatory reform are being bandied about all over the country in discussions concerning the future of the electric utility industry. What does all this mean, and what does it mean for the coal industry?

CHANGES IN THE ELECTRIC UTILITY INDUSTRY

Over seven years ago I came to work for Illinois Power. Before deciding to join Illinois Power, I had lunch with a person I admired and respected to get his advice on going to work for Illinois Power. His advice was: "Lisa, you'll hate working for an electric utility–nothing ever changes." Needless to say, I didn't take his advice. And he couldn't have been more wrong about changes in the electric utility industry. Shortly after I began to work for Illinois Power in the environmental area, the Clean Air Act Amendments of 1990 were signed by President Bush, which had a dramatic impact on Illinois Power and the coal industry.

So, what changes are happening and are expected to happen in the electric utility industry? What is causing these changes to occur?

Some drivers of the changes in the electric utility industry are changes in federal policy. Others include enhanced global competition, disparity in electric rates, and, most importantly, desires of customers to choose their electricity provider.

In 1992, the Federal Energy Policy Act allowed for the formation of power marketers. Power marketers are companies who can physically take title to electricity and have the right to resell that electricity to wholesale customers such as municipals, cooperatives, other electric utilities, and other power marketers. This has caused significant changes in the bulk power or wholesale power business, which I will discuss in more detail later.

Also, another monumental change that has impacted the bulk power or wholesale marketplace is open access for transmission. Historically, electric utilities have used their transmission systems to deliver electricity to customers within their service territory and to deliver electricity to their neighboring utilities. Now the Federal Energy Regulatory

Commission (FERC) is requiring electric utilities to "unbundle" their transmission service from their electricity service and to allow others to use the transmission system at comparable prices. Needless to say, this unbundling has caused electric utilities to really think about the pricing of transmission service. FERC is also requiring a "functional" separation of the generation business from the transmission business that is having a profound impact on the bulk power marketplace.

The coal industry, and a lot of other industries, are facing enhanced global competition. This enhanced global competition requires us to provide our products and services better and at lower costs than ever before. As a result, we often put pressure on our suppliers to help us both remain in business and be successful. I know Illinois Power's friends at Peabody and Arch have felt pressure as a result of the enhanced competition in the electricity marketplace. Even though electric utilities still have a regulated service territory, utilities still compete to attract new customers to their service territory. Recently, Illinois Power was successful in attracting a new plant to our service territory–an Alcoa plant. It is our understanding that we were successful because of our competitive prices, our reputation for providing reliable service, and our reputation for being innovative and a leader in promoting competition and regulatory reform.

When you look around the country, there are significant disparities in electric retail rates. These disparities are evident within the state of Illinois as well. The reason is because rates for electric utilities have traditionally been based on the costs of providing electricity service to retail customers. In the competitive bulk power marketplace, and the retail electricity marketplace of the future, the market will set the price for electricity service.

Which brings me to the primary force driving change in the electric utility industry–customers. Customers want lower prices and, as a result, the ability to choose their electricity supplier. The electric utility industry is one of the last regulated industries to undergo fundamental changes. We are all familiar with the changes that have occurred with the telecommunications industry: the option of being able to choose your provider, the option of having multiple providers, and the new service options such as call waiting, caller ID, and call forwarding. I personally have had the option of choosing my natural gas supplier in a retail experiment in Springfield. Customer choice of electricity supplier is in the future envisioned by Illinois Power.

Let's step back from this world of the future and talk about the changes that have occurred in the bulk power marketplace over the past few years. Talking about these changes may help us get a glimpse of what the future might really look like when customers have the ability to choose their electricity provider.

In the electricity "marketplace" of yesterday, electric utilities had two broad customer classes–and I use the word "customer" loosely. "Ratepayers" who were an electric utility's customer simply because of

where they choose to live or locate their business. These customers didn't choose the electric utility–they chose a location and because of that location they were the electric utility's customer. The other customer class was wholesale customers. Wholesale customers could be other investor-owned utilities, municipal utilities, or cooperatives. An electric utility is not obligated by law to "serve" these customers but does so because of the economic benefits. Generally, an electric utility plans the expansions of its system so that it will be able to reliably provide service to "ratepayers." As a result, there are periods of time when it has generation is excess of its needs, the utility could then use this generation to provide service to wholesale customers.

Prior to joining Illinois Power's financial group in August, I was responsible for Illinois Power's bulk power operations. During the three or so years I was involved with bulk power operations, many, many changes occurred. And it wasn't just because of me; the marketplace changed. Traditionally, the bulk power business was a good 'ole boy network. Utilities bought and sold electricity to interconnected utilities only–customers were very limited. Also, pricing was generally based on marginal costs, primarily fuel and incremental operation and maintenance expenses, plus a percentage for profit. In some cases utilities bought and sold "capacity." Capacity was the right, but not the obligation to buy energy. Utilities bought capacity to assure they would be able to provide energy reliably to their retail customers given the long lead time to build new generation.

While I was involved in bulk power operations, Illinois Power went from buying and selling wholesale energy with about 10 companies to probably more than 50 companies. And we are talking to many more companies than this about potential transactions. There are more than 200 companies registered as power marketers with FERC. We are doing business with a lot of power marketers as well as buying transmission service from other utilities to reach bulk power customers that were not directly interconnected with our system. Our customer base (as well as amount of competition) expanded significantly.

Because of the expansion of the bulk power marketplace, changes have occurred in the way bulk power is bought and sold. The term of transactions is decreasing. More and more transactions are occurring on a short-term basis. The hourly marketplace has become much more active. Also, bulk power purchasers are more willing to buy energy for just the period of time they expect to need the energy rather than contracting for capacity for the whole year or season. Bulk power customers may only buy capacity for the month of August rather than the whole summer season. Also, the size of transactions is decreasing. We used to deal in 50 MW or so increments, and now we are doing transactions as small as 1 MW. As a result of the size of transactions decreasing and the number of market players increasing, the volume of transactions is increasing at a rapid rate. As a result of enhanced bulk power competition, prices on average have

gone down and profits on a transaction-by-transaction basis have also gone down. Another challenge of enhanced competition in the bulk power marketplace is that the risk of losing money on a transaction has gone up. As more and more players have entered the marketplace, the ability of a utility to "cut" a transaction when they need the energy for retail customers or to sell with cost-plus pricing is becoming a thing of the past. Now more and more bulk power customers are demanding fixed pricing, and the market is responding. In a cost-plus world, it was virtually impossible to lose money on a bulk power transaction–not so with fixed pricing.

FUTURE OF THE ELECTRIC UTILITY INDUSTRY

What does tomorrow hold? More suppliers, more customers, in more transactions, more risk, more services.

The future we see at Illinois Power is a world where all electricity customers have the ability to choose their electricity supplier, not just bulk power customers. That is, you and I will have the ability to choose our electricity supplier for our homes, much as we do today with our long-distance phone provider. The question in our minds at Illinois Power is when? In the bulk power marketplace, we have seen the unbundling of energy services. What services you might ask? Well, in the bulk power marketplace you can buy a megawatt hour at a certain location and pay for transportation to another location. You will likely have to pay for voltage support, and you may even have to pay someone to follow your load if it isn't consistent. Who knows what other services will be provided in the future? Who ever dreamed they needed caller ID before the deregulation of the telephone industry?

In the future we see a world where the energy component of electricity service will be priced based on market conditions, not a utility's costs. Transmission services and distribution services will likely still remain regulated due to the nature of the service and prices may remain based primarily on costs.

One thing that customers and regulators will likely not allow is a degradation in the reliability of electricity service. There are lots of discussions going on today on how to assure reliability given open access of the transmission system. Some think an independent system operator (ISO) is needed, but this has yet to be decided.

I would like to talk to you for a few minutes on the actions Illinois Power has taken to prepare and promote for a future involving customer choice. Illinois Power looked around and saw that much of the growth in the electricity marketplace was in underdeveloped countries. As a result, we formed Illinova Generating, which is a world-wide independent power producer. We also saw the growth in the bulk power marketplace and formed Illinova Power Marketing, Inc., which is a FERC-regulated power marketer focusing primarily on the bulk power market in the western part of the U.S. We also formed Illinova Energy Partners that is offering energy-

related services, such as energy management for industrial and commercial customers. All of these companies, including Illinois Power, are under the Illinova umbrella. These preparations were part of Illinova becoming positioned for the future.

Illinois Power has also made significant progress in reducing our costs, in an effort to make us a more competitive company. We have re-engineered our processes to become more efficient. We have also placed plants that we do not expect to be competitive in the marketplace in cold-standby status. We also converted one plant to dual coal/gas capability, given it was not expected to run very frequently in the competitive marketplace.

Energy Choice 2000

Illinois Power has also been a leader in promoting customer choice for electricity service in Illinois. Illinois Power has been actively working with thousands of Illinois electricity consumers to develop a legislative proposal to allow customers to choose their electricity supplier. Our legislative proposal was originally called Energy Choice 2000, which called for a gradual phase-in of open access, beginning with larger industrial companies and working toward residential users.

Illinois Power was also the first utility in the nation to begin a customer choice experiment. In 1993, Illinois Power began working with our industrial customers to address their concerns about enhanced competition in their businesses. Illinois Power also wanted to learn how to manage in a future electricity environment where customers had the ability to choose their supplier – and wanted our customers to learn as well. All of us involved in the development of this experiment wanted to use it as a way to foster the transition to a more competitive electricity environment.

Our experiment was designed to be a controlled program of limited scope and duration, which allowed eligible customers access to other electricity suppliers. Illinois Power would continue to provide transmission service to the participating customers to deliver the electricity from their supplier of choice. The total amount of capacity available in the experiment is 50 MW, which is available to customers who meet eligibility requirements, including a 15 MW minimum load, and who receive service at 34.5 kv or above. Illinois Power had 21 customers who met this eligibility requirement. There were rules on how the capacity would be divided among the eligible customers.

Two customers were receiving electricity from an alternate supplier within 24 hours of approval of the experiment by FERC. Within the first week, seven customers were receiving electricity from an alternate supplier. As of August 12, 15 customers were participating in the experiment and 43 MW were being provided by seven third-party suppliers. As you can see, not all customers chose to participate in the experiment. I'm sure the reasons varied, but I know of at least one Illinois Power customer,

Peabody Coal Company, who decided not to participate in the experiment because of loyalty to Illinois Power. We are their electricity supplier and they are one of our main coal suppliers.

EFFECTS ON THE ILLINOIS COAL INDUSTRY

What do all these changes that are occurring or expected to occur in the electric utility industry mean for the Illinois coal industry?

As electric utilities face a more competitive future, so will the coal industry. Electric utilities will feel tremendous pressure on electricity prices, and, as a result, coal companies will feel tremendous pressure on coal prices. When Illinois Power generates electricity from a coal-fired power plant, almost 70 percent of the marginal costs of production are fuel-related. In a competitive market, like the bulk power marketplace today, electricity prices tend to gravitate toward the marginal cost of production.

Illinois Power and some of our coal suppliers have first-hand knowledge of the laws of supply and demand. If you price your product or service right, whether it is coal or electricity, it will sell. In the competitive electricity marketplace of the future, all of us involved in the industry will need to know more about the forces impacting the electricity marketplace. In the competitive bulk power marketplace, we look at regional electricity demand, the availability of generating units in the region, and how the transmission system might impact transactions. This is a dynamic and competitive market and things change quickly. In the future, we might be considering such things as, should we take delivery of coal at one of our plants or can we sell it for a higher price in another region, or should we deliver it to someone else's plant and have them convert it to electricity because electricity is demanding a higher value in that region. The electricity marketplace is only going to get more complicated, and we will all need to know more to be successful.

CONCLUSION

In our customer choice experiment, we saw examples of competition creating new partnerships and alliances. For example, a power marketer and a municipality combined forces to deliver electricity to an Illinois Power customer. The new competitive environment will be different for all of us, and I'm sure we will see different relationships than ever before. The challenge for all of us is to come up with creative and innovate solutions to be successful in the electricity marketplace of the future.

John Hill: Our last two presenters are going to talk about an issue that is very important to all of us in the industry. We just talked about issues around pricing our product. But we can't have a product come to market if not for dedicated employees. So our final two groups of speakers will talk

about human resource issues in the mining environment. The first two speakers will be from Peabody Coal Company's Marissa Mine, not far from here. The first speaker will be Ty Becker. Ty is the President of Union Local 2412; he has been instrumental, along with Terry Hird, who is the mine superintendent at Marissa, in developing a labor and management positive change process at Marissa. They have worked the last two years in trying to change the relationship there so that everybody at the mine understands the forces at work in the marketplace, particularly with the perspectives for today.

There is a change; Terry is going to go first. Terry has been at Peabody since Hitler made corporal. He has worked at Peabody in various operating and engineering positions throughout the Midwest, primarily in western Kentucky and southern Illinois. Terry has a B.S. in mining engineering from the University of Wisconsin in Platteville. Currently he is a mine superintendent at Marissa. He is a registered professional engineer in Kentucky. I'll turn it over now to Terry and Ty Becker.

LABOR MANAGEMENT POSITIVE CHANGE PROCESS (LMPCP) AT MARISSA MINE

TERRY HIRD
Peabody Coal Company, Marissa Mine

TY BECKER
Local UMWA 2412
Marissa, Illinois

INTRODUCTION

Terry Hird: Thank you for the opportunity to talk to you about the "Labor Management Positive Change Process" (LMPCP) and the Marissa Mine.

In the 1993 National Bituminous Coal Wage Agreement, there is a provision that allows for the establishment of the UMWA-BCOA labor management positive change process. This process provides the mechanism to deal with change. The major goal of this process is to increase job security, competitiveness, financial stability and opportunity for all employees covered by the agreement. Ty Becker, President of Local 2412, will tell you the Marissa story concerning the LMPCP process. Ty has been in the mining industry for over 20 years and has seen how the industry and its people have changed over the years. It is my pleasure to introduce to you Ty Becker.

LMPCP AT MARISSA MINE

Ty Becker: Thank you, Terry. On behalf of the United Mine Workers and Peabody Coal Company Marissa Mine, I want to thank the Illinois Mining Institute for this opportunity to be here today. I would like to take this time to share with you how union workers and management at the Marissa Mine have changed to a more cooperative relationship so that we both may have a long and prosperous future.

One of the first things we did was to form a partnership and set up a steering committee made up of the following:

Local Union President–Tyrus Becker
Safety Committeeman–Larry Todd
Mine Committeeman–Andy Ryder
Superintendent–Terry Hird
Chief Electrician–John Valler
Mine Manager–Bob Price

We set some goals for Marissa Mine. The main and most important goal was that we continue to mine beyond the year 2000. We wanted to develop and implement a more cooperative working relationship; a relationship based on honesty, integrity, and mutual trust. We also wanted to utilize employees' responsibilities, skills, and ideas. We wanted to reinforce the shared belief that an ongoing partnership between labor and management is essential to the long-term success and growth of our industry.

We should explore non-adversarial processes, including mediation to settle disputes at the mine. If the mine is to continue to compete in a very tight market, we also need to explore new ways and means to improve productivity, safety, efficiency and competitiveness so that we are able to meet and exceed customer needs. Realizing that our customer, Illinois Power, is so very important to our future, we must focus a lot of attention on their needs.

At the mine, we were looking to solve some problems through a WIN-WIN solution versus a WIN-LOSE solution, because a positive action will result in a positive reaction.

When we began LMPCP, the first step was to understand the business side as well as the labor side so we could focus on the important issues, such as greater job security. Both labor and management underwent training sessions to better understand the future of the coal industry, market conditions, customer needs and the mine itself. Honest answers began to build trust.

Some of the issues and problems we faced were tough and quite controversial: absenteeism, contractual days, poor safety performance, an alternative work schedule and a way to implement some new ideas.

Before I show some of the successes we have been able to achieve, I want to say that John Hill played a very big part in this endeavor. John had spent the last two years at Marissa Mine before leaving last month and deserves a great deal of credit for helping to choose the road that will lead Marissa Mine beyond 2000.

Here are some of the current results of issues we wanted to improve at Marissa:

- Employment has increased from 281 union employees to 332 employees;
- production increased from 3.1 million tons to 4.1 million tons;
- cost per ton was lowered over $5.00 per ton in the last two years;
- accidents have been reduced by 50 percent;
- we increased sales and helped develop new sales; and
- we have been able to improve attitudes (and let me say that you cannot put a price or cost figure on what a good attitude means to any business).

One very important thing for Marissa Mine is the opportunity for new coal reserves to be permitted. We believe that if Marissa Mine can be a low-cost, safe and profitable provider, Peabody Holding Company will support its future.

Yesterday, you heard Mr. Pete Lilly talk about the different companies under the Peabody group. He mentioned the union mines in West Virginia and here in the Midwest, as well as the non-union mines in the Powder River Basin and in Indiana and Kentucky. At Marissa Mine we believe that if we can continue to improve productivity, cost per ton will be reduced and safety improved; this will make Marissa Mine very competitive, and as a union operation, it must be considered a large part of Peabody Coal Company's future plans.

CONCLUSION

Again, as a unionized operation, we must focus on the following:

- Improve customer relations by working closer with Illinois Power, helping them meet some of their challenges in the future, like utility deregulation, Phase II of the Clean Air Act Amendment, NOx emissions, and global warming. We must focus on the customer because of the difficult market conditions of the coal industry.

- At Marissa Mine, we are going to continue to work on improving the relationship between union labor and management because we know and understand that there are still many challenges that we must face. If we are to be successful in meeting these challenges, it will come about through new techniques and the continuing hard work through LMPCP activities.

John Hill: Thank you Terry and Ty. Our next speaker will present the position of human resources in a union-free environment. Robert Schmidt works for Zeigler Coal Company and is Director of Human Resources, Safety, Training and Management Development for the multi-division complexes with 1,200 employees. He is currently located at Bluegrass Development Company, Lexington, Kentucky. Bob was previously Vice President and General Manager for Big River Coal Corporation, St. Louis. Before that he was employed at Arch Mineral Corporation, NACCO Industries in Ohio and Consolidation Coal Company, Pittsburgh, PA. Bob received a B.S. in education and safety from Clarion University and a M.S. in safety management/psychology from West Virginia University. He is more than qualified to speak to us about "Human Resources in a Union-Free Work Environment." Bob.

Robert Schmidt: Thank you, John. It is a pleasure to be here today.

HUMAN RESOURCE MANAGEMENT IN A UNION-FREE ENVIRONMENT

ROBERT P. SCHMIDT

Bluegrass Coal Development Company
Lexington, Kentucky

INTRODUCTION

The title would suggest that there are two separate styles in managing companies: those that are represented and those that are union-free. In actuality, the management style is the same for both types of operations. For example, Zeigler Coal Holding Company has both types of operations; union-represented and union-free, and we fundamentally manage them the same.

A review of past employee relations shows that from the 1920s through the 1960s, there were two opposing positions which were anti-union and pro-company. The atmosphere was almost always confrontational and was normally a win/lose relationship, at best.

It is good to first clarify terminology. A union is a third party who represents employees to management. Non-union is usually referred to smaller operations with limited resources and workers who are not represented by a union. Union-free operations are those that are not represented but practice positive employee relations and attempt to develop a win/win situation. This latter should be the management style regardless of whether or not employees are represented.

ZEIGLER COAL MANAGEMENT PHILOSOPHY

We like the three-legged-stool approach to management. There are three major concerns for any enterprise: financial performance, customer satisfaction, and employee satisfaction. All three legs are equally important.

The key to incorporating this philosophy is also the key to positive employee relations. An operation must have an "open-door policy" where face-to-face communication is the rule, not the exception. Management must be available and must be visible. Tom Peters, a well-known and highly-acclaimed management consultant, states this in his principle of MBW: managing by walking around.

In some cases, small work groups, structured by shift or by job classification, can informally communicate in an open setting. I commonly refer to these as focus groups. They provide a forum and an opportunity for issues to be identified. The first step in problem-solving is to realize that there might be a problem. It also provides the opportunity to get feedback from all employees. Some operations might initiate ad hoc work groups

that are voluntary in structure and are designed to meet and discuss issues on safety, productivity, costs, and policies and procedures. Their existence is short-term, and when they complete their objectives, they are normally disbanded.

COMMUNICATION IS THE KEY

Probably the most positive and dynamic of any employee relations techniques is the utilization of employee attitude surveys. No matter how effective communications might be within an organization this process provides the means to increase positive employee relations. The process consists of four parts: the survey questionnaire, sessions with group feedback, development of action plans, and follow-up sessions. The questionnaire presents a list of 30 questions that are given to all employees. Group feedback sessions are conducted to communicate the results of the survey to all employees. Subjects are also identified that need to be dealt with. Action plans are then formulated to address issues that were identified, and follow-up sessions are conducted with all employees to communicate the action plan.

Fundamentally, an open communications program is demonstrated through many communication activities: daily meetings, monthly meetings, quarterly meetings, a letters-home program, and various newsletters.

Our communication objectives can be summarized as involving the following:

- total work force involvement "a voice";
- opportunity to express ideas and opinions;
- opportunity to question plans and procedures; and
- understanding the company's vision and goals.

The most prominent of our objectives is investing in people. As a company, we can acquire reserves and purchase equipment. In fact, all companies can do that, but the factor that most determines how successful we are as a company is the investment we make in people. We want to provide the best skills training available for our hourly employees. We also train our supervisors how to efficiently manage their resources. One of the most important of these is effective communication. Middle and upper management also receive training to improve their skills in management communication, business development, and finance. To be the best in our industry, we need to have the best educated work force. This means not only textbook knowledge, but also knowledge about our business.

Our overall communication goals are:

- increase pride in the organization;
- minimize concern over job security and develop a win/win atmosphere;

- gain trust and confidence in management;
- increase cooperation between teams; and
- increase and improve communications ("walk the talk," make management visible, know that action speak louder than words).

An excellent communications program is the key to fair, consistent and equitable employee relations. And it makes no difference whether it's a represented work force or a union-free work force.

John Hill: Thank you, Bob. That concludes our technical session today. I want to thank the speakers for their fine presentations and to thank you all for attending. I will now turn the floor back to President Bert Hall.

Bert Hall: Thank you, John. That was a very good session, and I appreciate all who came to hear the speeches this morning.

This concludes our 104th annual meeting of the Illinois Mining Institute. Thanks to the program chairmen who arranged two fine technical sessions this year, and thanks to all of our speakers, exhibitors and, especially, thank you for coming.

There will be a drawing for our raffle prizes in the lobby immediately following adjournment here. The first ticket drawn will be for the free trip for two to anywhere in the continental United States sponsored by Roberts and Schaefer Company. The second ticket will be for a set of golf clubs donated by Jim Justice of DuQuoin Iron and Supply. Thank you all for supporting our raffle; as you know, it helps fund our scholarship account. [*Paul Barber of Arch Mineral Corporation won the free airline tickets, and Doug Dobbins of Old Ben Coal Company won the set of golf clubs.*]

We hope you all have a safe trip home and please come back again next year.

Bert Hall draws the winning lottery tickets at the end of the 1996 meeting.

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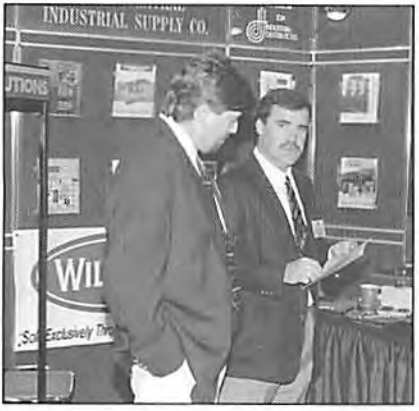

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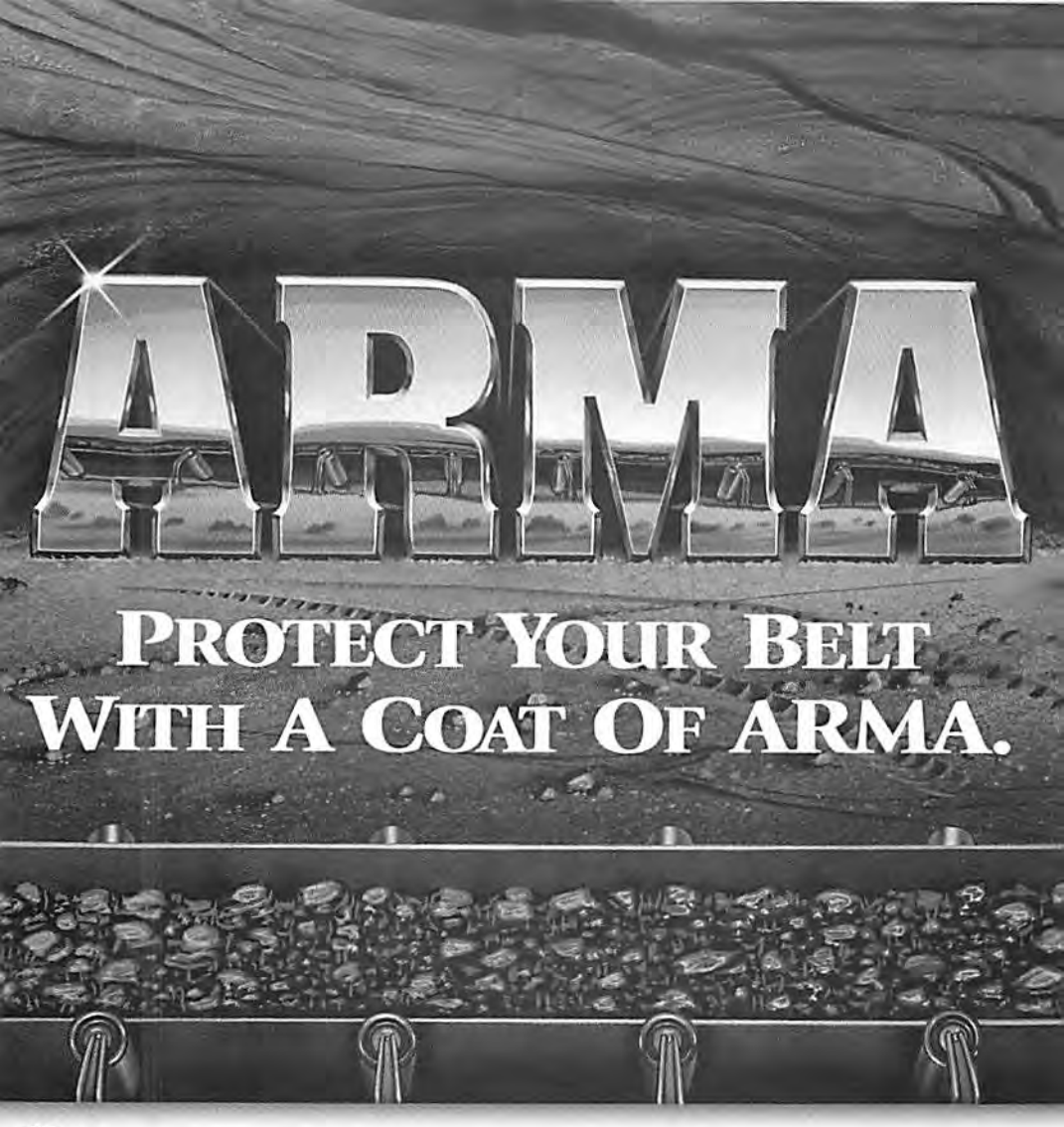

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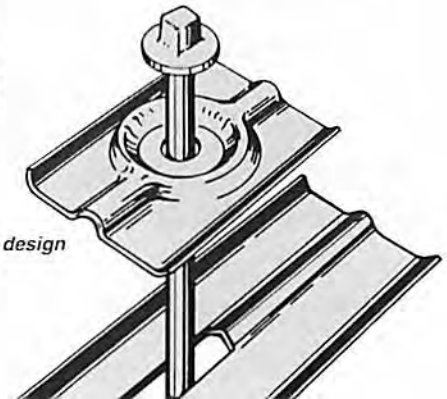

Low profile plate design

Advantages of unique channel plates

- Designed exclusively for use with T-2 through T-5 channel

- Embossed channel plates are designed to replace the 4" x 4" flat plates thus eliminating the plate and bolt head being pulled through the channel from excessive roof pressure
- Distribute bolt tension load uniformly over entire plate and channel. Bolt plate and channel work as a complete system to resist longitudinal and lateral movement
- Two plate designs. One is a ***low profile donut embossed plate*** for a small hole, two-piece point anchor system. The other is a large hole, ***high profile dome plate*** for a one-piece bolt system
- Lightweight. Easy to handle. Offers increased strength and safety over other systems
- For use with any bolt system. Specifically designed for INSTáL® Point Anchor System with non-slip anchor
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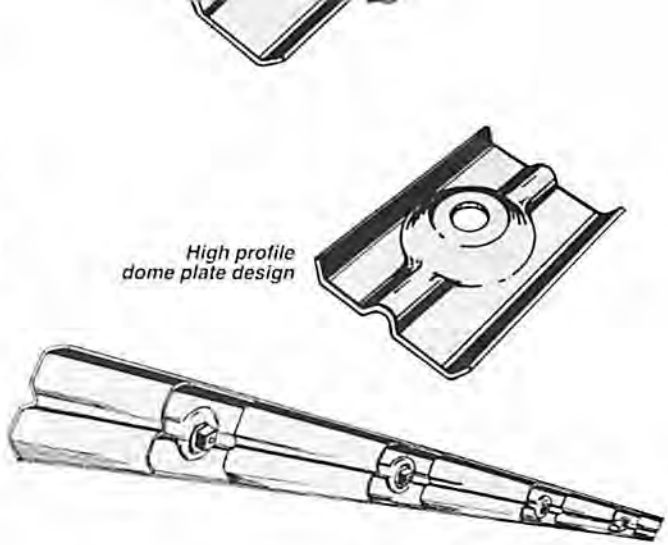
- Systems meet current F-432 roof plate specifications



High profile dome plate design

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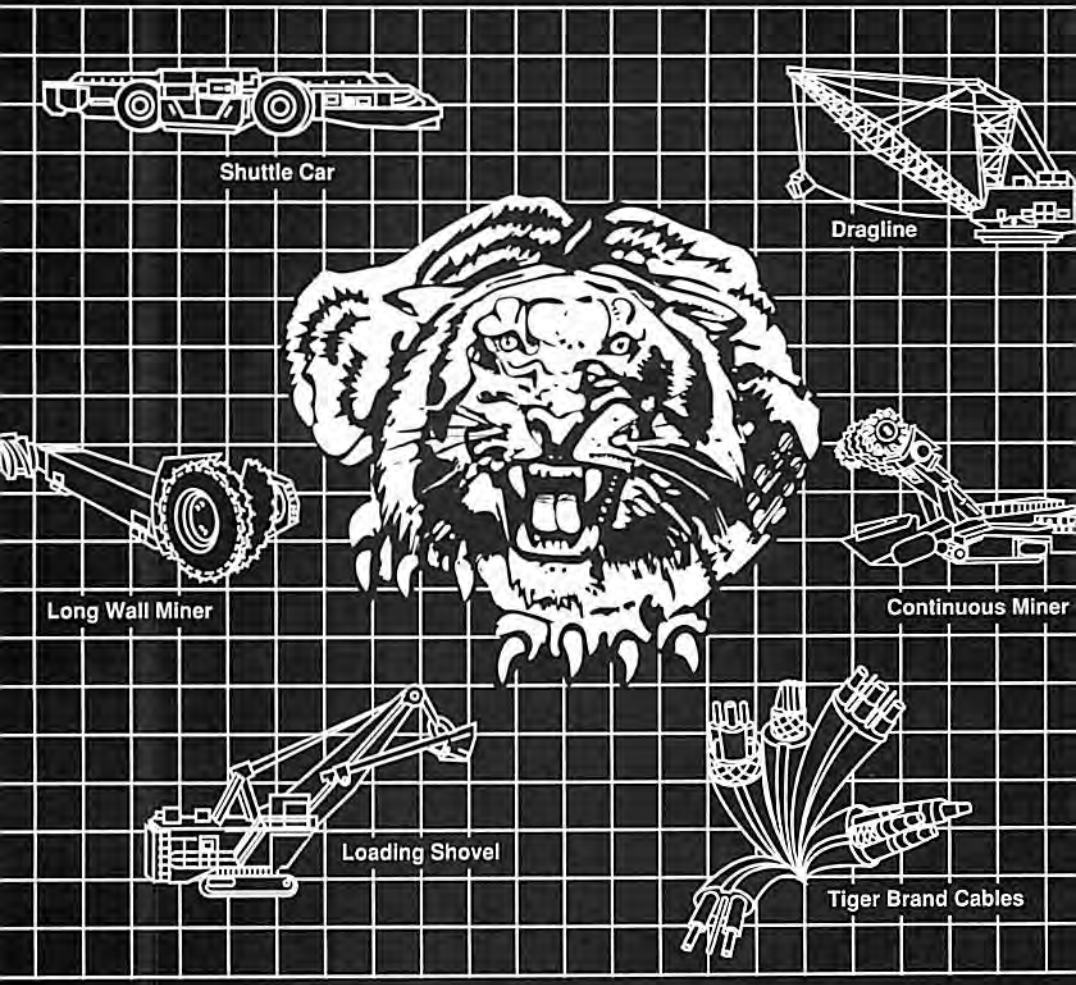

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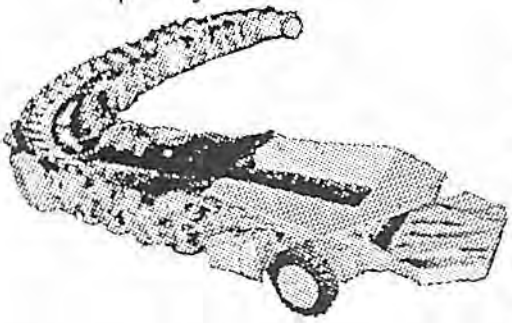

Peabody Coal Company's Marissa Business Unit remain committed to being the industry's safest and most productive coal miners, still a part of Peabody's proud tradition in Illinois. The Peabody Group's mission is to be a world-wide supplier of low-cost energy, which contributes to economic prosperity and a better quality of life.

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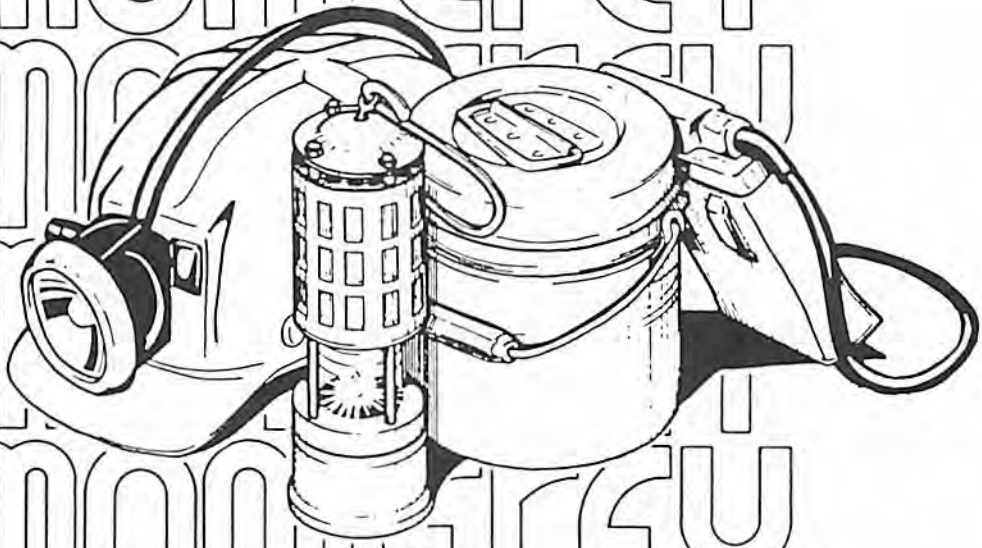

Your 14th Century Peasant Cottage
Was Coal-Fired...

So was your 17th Century Castle...

And your 19th Century Railroad...

Your 1940s Automobile Plant...

Your 1970s Disco...

Your 1996 Personal Computer...

Your 1998 Electric Car...

And your 2022 Hovercraft...

Not a lot of people realize that our houses today are coal-fired, because coal fuels well over half of our nation's electricity. Or that air emissions have declined even as coal use has doubled in recent decades. Or that mining today is highly mechanized and very safe. Or that reclamation leaves the land in as good or better shape than before.

Coal has caught a lot of heat over the years. The King of England first attacked its environmental effects in the 1300s. Blake's satanic mills were coal-fired. And what did naughty children get for Christmas? Our product, of course.

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Zeigler Coal Holding Company, the nation's largest independent company devoted solely to coal, is proud to set the record straight about an industry that is used to taking its lumps. And we are also proud to be the largest coal producers in Illinois.

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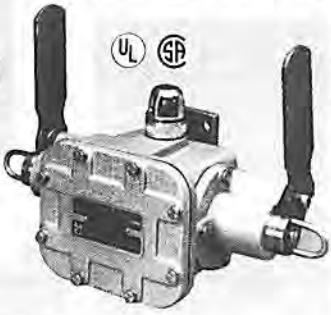

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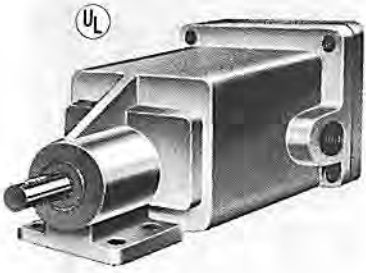

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