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The Institution of Mining and Metallurgy

Longwall Dust Control Research

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Introduction

The Bureau of Mines has been active in respirable dust research since passage of the Federal Coal Mine Health and Safety Act of 1969. Until several years ago, the main thrust of the research program was on the development and new and improved dust control technologies to reduce the miners' exposure to respirable dust in mines employing conventional and continuous mining methods. As a result of the efforts of the Bureau of Mines, the Mine Safety and Health Administration (MSHA), and the coal mining industry, significant progress has been achieved in lowering the dust levels in these mines from over 5 mg/m^3 in 1969 to less than 2 mg/m^3 today. This is reflected in the number of citations issued by MSHA in recent years. Based on inspection data, at least 95 pct of all conventional and continuous mining sections are currently in compliance at any given time.

Although this is an impressive accomplishment, several types of mining operations, primarily those employing longwall mining methods, continue to have great difficulty in complying with the current 2 mg/m^3 Federal dust standard. At any given time, over 50 pct of longwall sections are out of compliance (1), including about two-thirds of the sections using double-drum shearers. Therefore, over the past several years, the emphasis of the respirable dust program has been on solving the longwall dust program as industry shifts to greater utilization of this mining method. This trend has been prompted by the need to improve productivity and to meet our growing demand for coal. Unless effective dust controls are developed and implemented, the full potential of this very promising and productive mining method will not be realized. The Bureau's research has been successful in demonstrating that cost-effective engineering controls can indeed be developed to reduce dust levels at longwall operations. In addition, because of the need to more accurately evaluate the application of a curtain suspended from the roof between the rib and the stage loader (figure 2) has proven to be quite effective in alleviating this problem. The curtain is usually located 4 to 6 feet back from the corner of the face so that maximum shielding is provided without interference with the drum. The curtain only has to be in place during the actual cut-out operation and is usually advanced every other pass. Concentrations monitored with and witout the curtain indicated that the curtain can reduce operators' exposures by 50 to 60 pct during this phase of the operation.

Conveyor Belt Screens

Finally, the dust exposure of most longwall shearer operators is primarily attributable to the machine itself. The dust cloud originates at the face, and the exposure of the operators depends largely on how quickly this dust spreads into the walkway. Conveyor belt screens (figure 3) placed on the gob side of the body of the machine can enhance the airflow over the machine and provide a cleaner air split in the walkway over the shearer operator.

An evaluation of the effectiveness of conveyor belt screens has been conducted on four longwall mining operations. In all cases, reductions in the respirable dust levels were observed at the operators' locations while the machine was cutting, and instantaneous dust measurements show the dust was being isolated and held to the face area by the use of the screens. With proper placement of external water sprays, which are discussed in the next section, no significant rise in dust levels in the walkway occurred until just downwind of the return-side drum. Seam height, machine design, and operator acceptance may limit the size of conveyor belt screens installed on the shearer body. However, most of the shearers in operation are suitable for some type of screen installation, and this should result in a reduction in dust levels in the walkway adjacent to the machine.

Improved Water Usage

Water application is the principal means used for dust suppression on coal mining operations. Insuring that an adequate quantity and quality of water is delivered to a properly designed shearer water-spray system is paramount to effectively controlling dust levels at longwall operations. Many operations, however, do not have an adequate water delivery system, which results in ineffective control of dust generated by the shearer.

Optimized Water Delivery

Upgrading the primary water supply system may contribute to a significant reduction in dust levels along the longwall face. This may be accomplished through the following: (1) increasing pump capacity for additional flow and pressure, (2) increasing line sizes to decrease pressure losses and decrease maintenance downtime, and (3) improving water quality by installing a "non-clogging" filtration system.

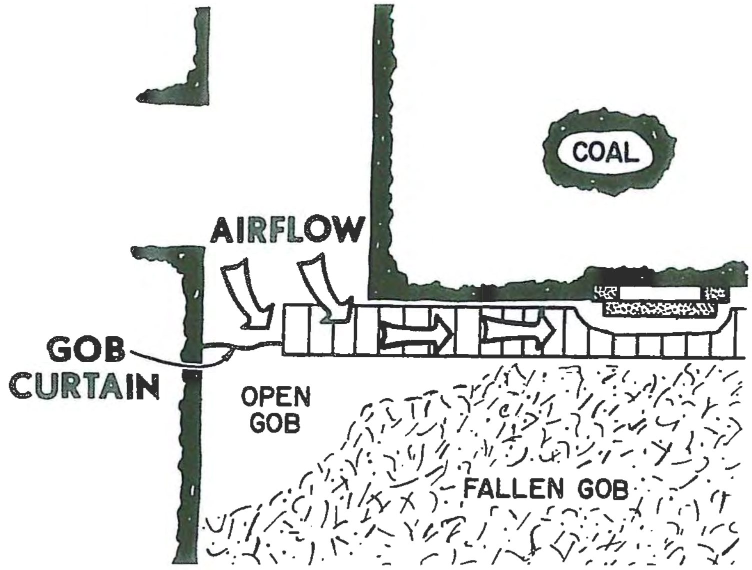

FIGURE 1. - Gob curtain used to enhance face airflow and prevent short-circuiting of air to the gob.

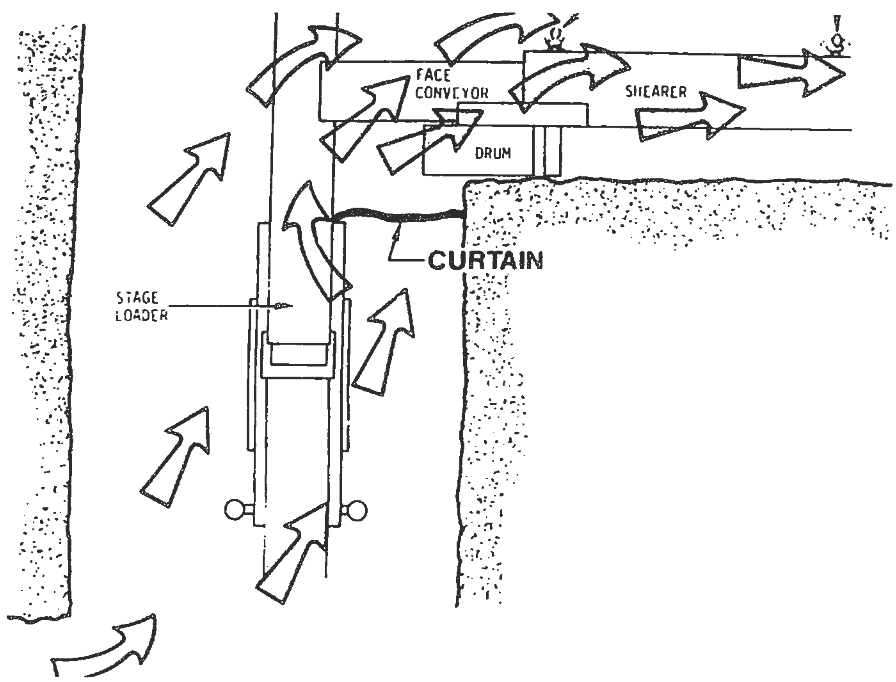

FIGURE 2. - Curtain installed in headgate to shield lead drum from primary airflow.

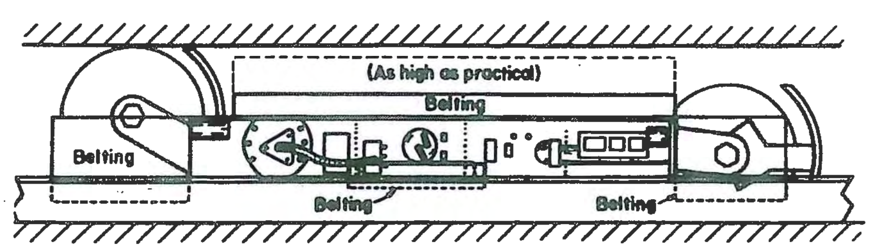

FIGURE 3. - Conveyor belt screens mounted on the body of a double-drum shearer.

An optimum water supply system should include a 3- or 4-inch-diameter supply line with a booster pump capable of supplying 100 gpm at 1,000 psi. If the machine is not equipped with an overpressure regulator for the cooling jacket water, it is imperative that such a regulator be installed.

The water supply hose from the end of the hard pipe to the shearer should be at least 1-½ inch in diameter, and a 2-inch-diameter hose would be preferred if there is room in the cable tray. These line size recommendations will allow operators to realize water pressure and flow gains at the shearer.

The utilization of a good filtration system will improve water quality and is a prerequisite to an effective water spray dust control system. Such a filtration system (figure 4) has been developed by the Bureau of Mines (2). The major component of the system is a commercially available hydrocyclone that will remove minus 1/8-inch to 60-mesh particulate. The plus 1/8-in material is removed by a flushable Y-strainer which is upstream of the hydrocyclone. This system should be installed in tandem with flow meters and pressure gauges at the end of the water supply pipe.

An additional flushable Y-strainer with a 60-mesh screen can be installed on the shearer. A pressure gauge installed at the inlet to the shearer can be used to monitor the performance of the water supply system. Improvements resulting from such modifications can reduce the dust concentration at the shearer operator position by 40 pct.

Shearer Spray System

Research by the Bureau has indicated that shearer operator dust levels depend largely on how fast dust from the unwind drum spreads into the walkway. Water sprays on the shearer body can have a large effect on dispersing the dust cloud because each spray moves air like a small fan, generating strong cross-currents of air around the shearer. Poorly designed spray systems, especially those with nozzles pointing upward, will stir up much more dust than they suppress. Results of this research have led to the development of a novel shearer-spray system called the "shearer-clearer."

The "shearer-clearer" system (figure 5) partitions the airflow around the shearer into a clean split and a contaminated split. The dust cloud is confined to the vicinity of the coal face, while the shearer operators remain in the clean split on the gob side of the machine. The hardware is inexpensive and can be installed in a single shift. It consists of several strategically mounted water sprays and one or more passive barriers. This system has been described in detail in the Bureau of Mines Technical Progress Report (3).

To date, three underground evaluations of this system have been conducted, one in northern West Virginia, one in southern Illinois, and one in central Pennsylvania. A fourth demonstration is currently in progress in a mine in southern Utah. Results indicate that dust reductions between 50 and 60 pct may be obtained at the shearer operator's work position. With the improved water delivery system previously described, this dust reduction may be increased to 70 to 85 pct. Currently, ten longwall operators have adopted this dust control technique.

Further improvements in the shearer water spray system may be obtained by relocating the face side cooling water sprays. These face-side sprays set up an air circulation pattern as illustrated in figure 6. Air induced by the sprays to flow towards the face simply turns around and moves back over the shearer, bringing dust with it into the walkway.

Water from the cooling jacket sprays should be directed to a manifold at the end of the shearer, spraying straight down onto the panline. This modification can result in significant reductions in respirable dust levels measured at the shearer operators' locations. Moreover, the adverse air circulation effect of the face-side sprays will be minimized. As a result, the additional water being directed onto the panline will reduce dust from that source.

Finally, the selection of the proper nozzle type is important if effective dust controls are to be achieved. The Bureau has recently completed studies to determine the dust knockdown performance of the most commonly used water spray nozzles. The results of this study are shown in figure 7. These findings indicate that atomizing nozzles provide the best use of water for dust scrubbing, although mine environment limits their use because of susceptibility to damage and early fouling. The performance of atomizing nozzles is approximately by hollow-cone spray nozzles. Full-cone, venturi-assisted, and flat-fan spray cones operate at similar dust scrubbing levels and are about two-thirds as effective as hollow-cone spray nozzles. Other advantages of hollow-cone nozzles include their ability to move reasonable amounts of air at moderate pressures (100-150 psig), their lower tendancy to clog, and the fact that, for a given operating pressure, lower water flow rates are obtained than with the other types of nozzles.

Improved Cutting Parameters

The major source of dust on most longwall shearer operations is the cutting action of the shearer drums. Any face personnel required to work adjacent to or on the return side of the shearer will be exposed to the large quantity of dust produced by the machine. However, modifications in machine design and cutting sequence can be used to effectively reduce the amount of dust produced as well as the respirable dust exposure of most longwall face workers.

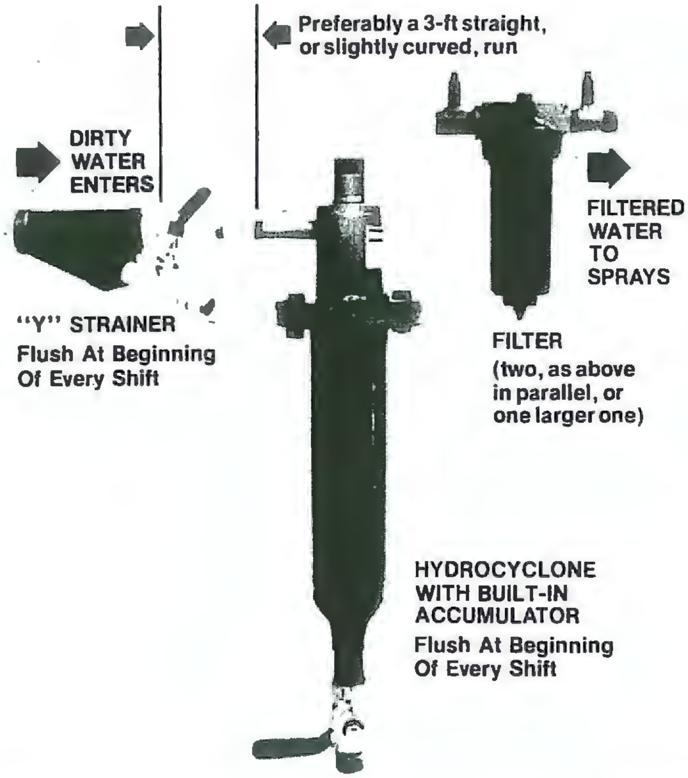

FIGURE 4. - Hydrocyclone water filtration system.

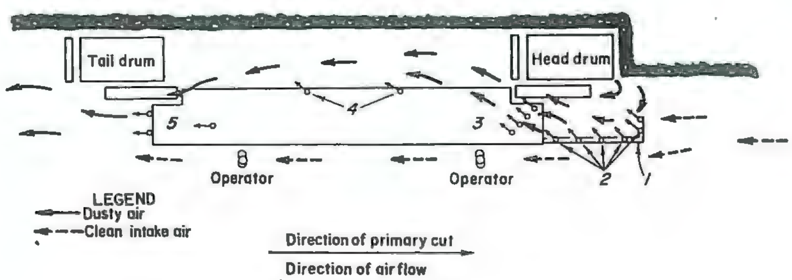

FIGURE 5. - Shearer-clearer water spray system for double-drum shearers.

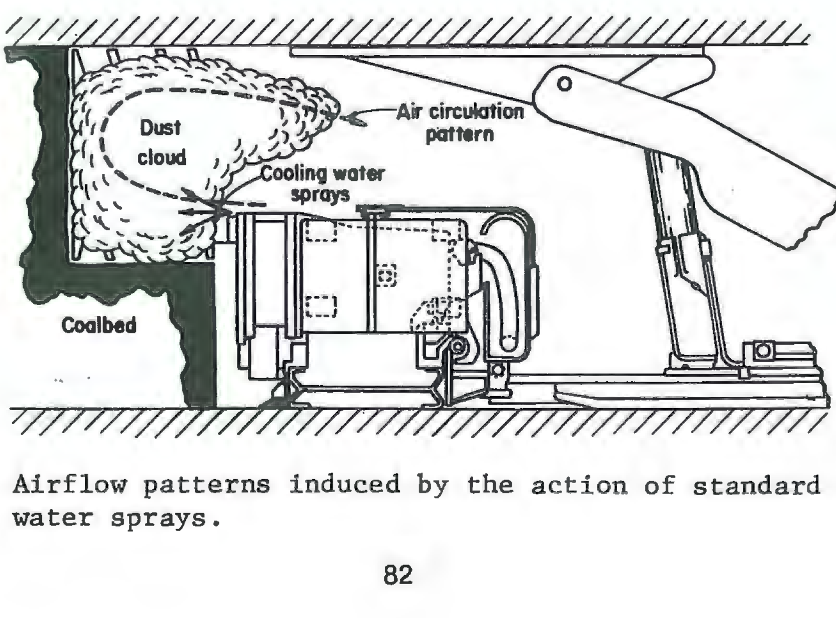

FIGURE 6. - Airflow patterns induced by the action of standard cooling water sprays.

Slow Speed Deep Cutting

Studies conducted in Great Britain by the National Coal Board's Mining Research and Development Establishment (4) and in the United States by the Bureau of Mines (5) have shown that deep cutting with slow speed drums can substantially reduce the amount of dust generated during coal cutting. As deep cutting removes larger coal fragments, the specific energy requirements of the operation are reduced and less coal surface area results. Dust generation and shearer power consumption are also reduced. The lower rotational speed minimizes the fanning action of the cutterheads and thus reduces the amount of coal fines that become airborne.

The Bureau recently conducted a field test to demonstrate and quantify the relationship between deep cutting and the creation of airborne respirable dust for longwall mining with a double-ended ranging drum shearer. The test plan called for systematically altering the depth of cut both by changing the drum speed while maintaining constant shearer haulage speed and by reducing the number of picks per line from two to one.

The test results (figure 8) indicated that at the mid-face position, airborne respirable dust generation was strongly dependent upon the relationship of depth of cut to drum speed. A 60-pct reduction in the measured dust levels resulted from doubling the depth of cut (from approximately 1.7 to 3.4 inches) by reducing the drum speed from 70 to 35 rpm. Removal of every other vane pick resulted in a 20-pct reduction in respirable dust over the range of 55- to 70-rpm drum speed. Shearer power consumption was also significantly reduced with deep cutting. Based on these results, it is recommended that longwall shearers be operated at the lowest available drum speed wherever possible.

Modified Unidirectional Cutting Sequence

Currently, 75 pct of the double-drum shearers in operation employ a unidirectional cutting sequence. On half of these operations, the primary cut is taken as the shearer travels from the headgate to tailgate ends of the face, with the roof supports to be advanced on the intake air side of the shearer. Typically, the leading (tailgate) drum is taking a full cut during the head-to-tail pass, and the trailing (headgate) drum is cutting bottom coal (figure 9a). In this mode of operation, the dust generated by the trailing (headgate) drum can spread out into the walkway and increase the respirable dust exposure of both effectiveness of any control technique, the Bureau has also been able to develop and demonstrate a new measurement and evaluation strategy. This strategy has been adopted as a standard and will be incorporated in all future in-mine evaluation programs. This paper addresses the advances in longwall dust control that are available for immediate application, and also other current areas of research aimed at eventually solving the longwall dust problem.

Recent Advances in Longwall Dust Control

The Bureau of Mines has successfully developed and demonstrated cost-effective controls to minimize the face workers' respirable dust exposure. These include improved face ventilation techniques, an optimized water delivery and shearer-spray system, and improved cutting parameters.

Improved Face Ventilation Techniques

As with all mining methods, ventilation is the primary means by which to control dust on longwall operations. Providing adequate amounts of air to dilute and carry the airborne respirable dust down the face and prevent its migration to the walkway has been a problem for longwall operators.

Gob Curtains

Specifically, loss of air into the gob in the headgate area has prevented the utilization of the maximum available air to ventilate the face. Moreover, this air, laden with dust, may reenter the face area, thus compounding the dust problem at longwall sections. A simple and inexpensive but effective technique to assure optimum direction of the available air to the face and prevent recirculation is to install a check curtain along the support line at the headgate end of the face (figure 1).

Headgate Curtains

In many longwall operations, misapplication of the primary airflow may actually contribute to increased dust levels. As the shearer cuts into the headgate entry, the drum is exposed to the primary ventilation airstream. The high-velocity air passes through and over the rotating drum, picking up large quantities of dust, which is then carried over the shearer operators, head and tail drum operators. As an alternative, if the trailing drum is "free wheeling" or cutting minimal coal during the head-to-tail cut (figure 9b) and bottom coal is taken by the tailgate drum during the tail-to-head cleanup pass, both operators are able to work on the intake air side of the primary dust-generating source (drum) except when cutting out at the head. This modified cutting sequence would save wear on the conveyor and help to eliminate overloads, as well as reduce the respirable dust exposure of both shearers operators. This modification is only applicable to longwall operations currently cutting unidirectional head-to-tail and to those operations where this unidirectional cut would not produce operational constraints.

As experiment applying this modified cutting sequence was tried on a double-drum longwall section

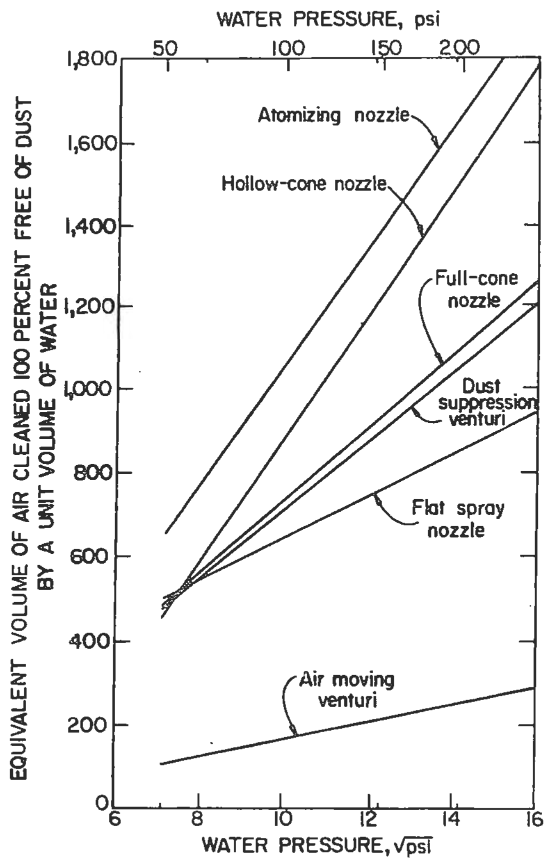

FIGURE 7. - Results of spray nozzle dust knockdown testing.

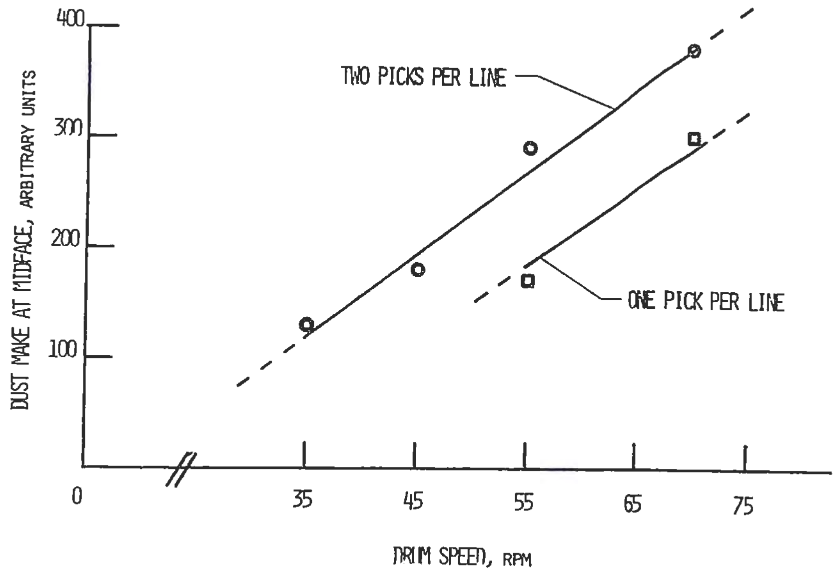

FIGURE 8. - Results of underground deep cutting evaluation.

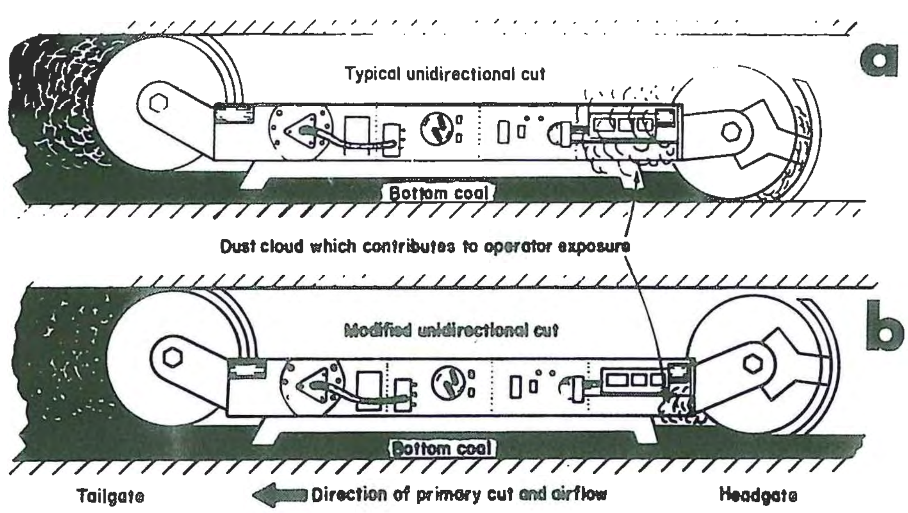

FIGURE 9. - Typical and modified unidirectional cutting sequences.

operating in a 7-foot seam in the Illinois Coal Basin. Alternating head-to-tail cut passes were made utilizing the two cutting sequences described above. Cutting all of the bottom coal with the trailing (tailgate) drum on the cleanup pass resulted in a significant decrease in dust at the operator's control. Discussion with mine personnel indicated that it would not present any operational problems or decrease production to cut all the bottom coal on the tail-to-head pass. This modification may even help to prevent problems the section is having in overloading the stage loader during the head-to-tail cut pass.

The Bureau estimates that this modified unidirectional head-to-tail cutting sequence could be employed on over 40 pct of the double-drum longwall sections currently in operation. This modification should be an effective and simple method of reducing the shearer operator's respirable dust exposure on these operations, especially when cutting rock in the bottom.

Measurement and Evaluation

Traditionally, gravimetric samplers have been used by both enforcement and research personnel to measure respirable dust concentrations in underground mines. These samplers are operated over the full shift, yielding time-weighted average concentrations. This type of monitoring has been used for evaluating compliance with the dust standard, as well as for evaluating the severity of dust sources and the effectiveness of dust control techniques. While this approach is the most appropriate indicator of the full-shift respirable dust exposure of underground workers, its effectiveness as a research tool has been limited. Thus, the Bureau of Mines has initiated several programs to provide improved sampling strategies and instrumentation for use on longwall mining operations.

Instantaneous Measurements

One such technique involves the use of the GCA-RAM I dust monitor, developed under Bureau contract and described in Technology News Bulletin No. 72 (6), to obtain real-time measurements of the dust levels. This instrument provides drift-free, instantaneous readings which correlate reasonably well with gravimetric measurements.

Two sampling strategies have been developed for use with the RAM and longwall operations. One technique, called the "moving sample" method, involves a survey engineer who talks at the midpoint of the shearer while carrying the RAM monitor. Dust levels and face positions (support number) are taken while the shearer is cutting during all phases of the mining cycle.

Figure 10 shows the results of measurements obtained using the "moving sample" method. On this particular operation, a significant increase in the 8-hour average respirable dust exposure of the tail-drum shearer operators had been measured. This fact indicates that the primary source of the tail-drum operator's exposure is the dust generated by the head-drum cutting bottom rock on the head-to-tail cleanup phase of the mining cycle. This information enabled the mine operator to concentrate his efforts on the dust-generating operation that was contributing the most to the employee's exposure. This reduced the overall time and expense the operator incurred during his efforts to control dust levels on the operation. In addition, the "moving sample" method can be used to provide information relating changes in face airflow to changes in the dust levels, and also to show how face-specific (rock partings) and cutting-sequence (cutting the wedge) variables can affect dust levels.

In the "stationary sample" method, the RAM is used by the survey engineer while standing at a fixed location on the face. As the shearer approaches, he records the dust level and the distance to the shearer at 10-second intervals. These measurements typically start when the shearer is 20 feet from the sampling position, continue as the shearer passes, and extend until the shearer is 20 feet on the other side of the sampling position.

Figure II shows the results of measurements obtained using the "stationary sampling" method. During this research program, the Bureau wanted to evaluate the effectiveness of various shearer water spray systems. The solid line in figure II represents a typical dust profile around a shearer equipped with an external spray system with the nozzles oriented against the primary airflow. The broken line in figure II represents a typical dust profile around a shearer equipped with an external spray system with the nozzles oriented with the primary airflow. Note that with the sprays oriented with the airflow, no significant increase in dust levels occurs until 5 to 10 feet on the return-air side of the shearer. However, with the sprays oriented against the airflow, the dust levels start to increase 5 feet on the intake air side of the shearer.

Finally, the Bureau of Mines has recently developed and documented an uncomplicated and inexpensive sampling strategy, based on short-term gravimetric sampling. This technique utilizes approved gravimetric sampling equipment that is already available to all mine operators.

The sampling strategy is carried out by a survey team consisting of two individuals. Each individual collects multiple (three or four) gravimetric samples during selected segments of the mining cycle. Multiple samples are necessary to insure accuracy, and to obtain a valid average measurement of the respirable dust concentration, when sampling for short periods of time (typically 20 to 30 minutes). To facilitate sampling, the gravimetric instruments may be carried in a sampling package, or a "sampling vest" may be used. This vest permits free use of both hands,

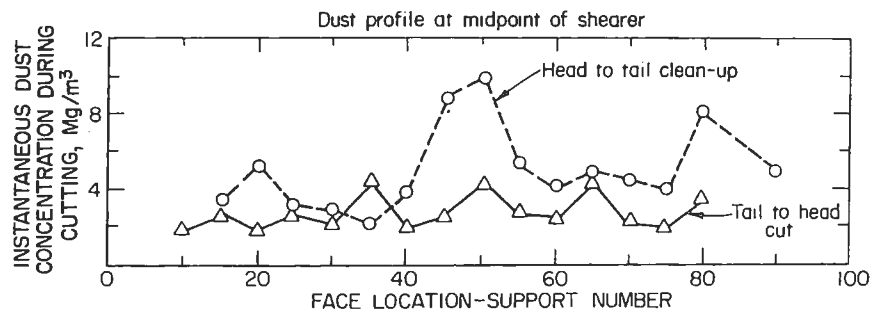

FIGURE 10. - Test results utilizing the moving sampling method.

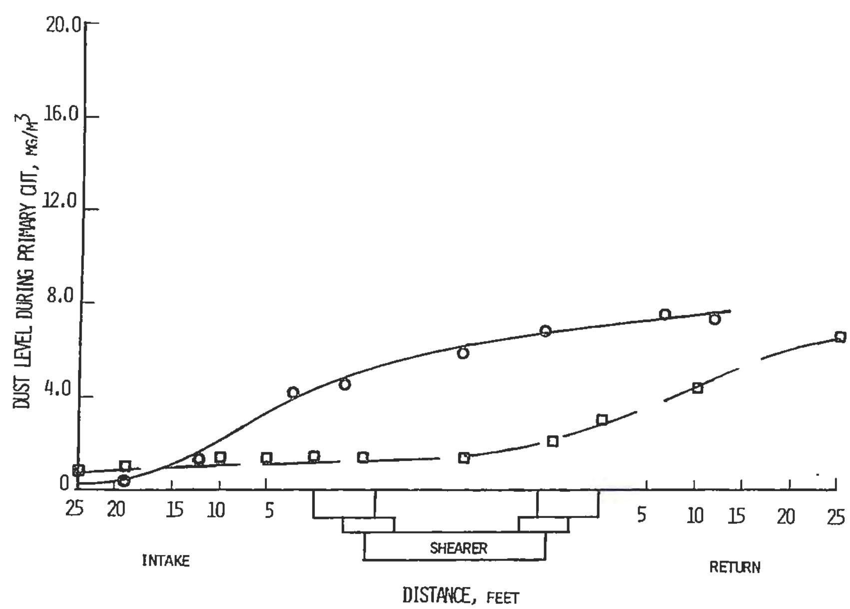

FIGURE 11. - Test results utilizing the stationary sampling method.

allowing for measurements of engineering parameters (airflow, etc.) and added safety.

Typically, one individual positions himself at the midpoint of the machine, while the second individual remains approximately 15 to 20 feet on the intake air side of the shearer. Both individuals maintain their positions, traveling with the shearer. The gravimetric instruments are operated only while the machine is cutting, and separate filters are used for the individual segments of the cutting sequence.

Table 1 shows the results of short-term gravimetric sampling used to evaluate the effectiveness of a newly developed shearer water spray system. During this study, both a conventional and the newly developed shearer water spray system were installed on the same machine, so either could be operated independently. These results represent the average measurements obtained during eight mining cycles, alternating between the two spray systems. As the results show, the new shearer water spray system was approximately 26 percent more effective than the conventional spray system.

Table 1. - Results of Short Term Gravimetric Sampling

Conventional Water Spray System:	
Dust level 20 feet on intake air side of shearer	1.38 mg/m^3 (A)
Dust level at midpoint of shearer	2.74 mg/m^3 (B)
Dust level produced by shearer (B-A)	1.36 mg/m^3 (C)
Newly Developed Water Spray System:	
Dust level 20 feet on intake air side of shearer	1.89 mg/m^3 (D)
Dust level at midpoint of shearer	2.89 mg/m^3 (E)
Dust level produced by shearer (E-D)	1.00 mg/m^3 (F)

System Effectiveness:

$$\frac{1.36\ (C) - 1.00\ (F)}{1.36\ (C)} \times 100\% = 26.5 \text{ improvement with new spray system}$$

These advances in dust-sampling strategies and instrumentation have led to significant improvements in the techniques used to evaluate longwall dust sources and dust control procedures. These techniques have been adopted as a standard and will be incorporated in all future in-mine evaluation programs conducted by the Bureau of Mines. In addition, because of their simplicity and effectiveness, these techniques may be used by individual mine operators to improve dust control on their longwall sections.

Current Areas of Research

While considerable progress has been achieved in developing and documenting the effectiveness of a number of longwall dust control techniques, because of its extent and complexity, the control of respirable dust continues to be the most critical problem facing longwall operators employing double-drum shearers. In response to this problem, the Bureau of Mines is actively pursuing a program designed to develop and make available the technology necessary to enable longwall operators to comply with the dust standard without inhibiting coal production. The following summarizes the current ongoing research efforts that will have a significant impact on the mining industry in the near future.

Shearer-Mounted Dust Collector

The use of dust collectors for capturing and removing dust during coal cutting has proved to be quite an effective technique on continuous miners. Early attempts to apply this technology to longwall shearers met with little success because of a number of mechanical problems. Retrofitting of existing machines increased the length of the shearer body, creating severe problems when cutting out at the headgate. This resulted in damage to the collector unit, rendering it inoperable.

To overcome these problems, the Bureau undertook a major effort to design, fabricate, and test a modified double-drum shearer incorporating an improved scrubber unit within the body of the shearer. Testing in a full-scale mockup of a longwall face to evaluate the capture efficiency and other mechanical parameters of the scrubber revealed serious deficiencies in the centrally mounted 10,000-cfm scrubber unit. These included low dust-cloud-capture efficiency for main ventilation flow rates above 20,000 cfm, high cost (i.e., $100,000), mechanical complexity, and a significant increase in shearer size. Incorporation of this type of scrubber unit within the shearer body was therefore not a practical approach to alleviate the dust problem at longwall faces.

The major thrust of this program has been redirected toward the application of water-powered dust collection devices. These offer low cost, small size, and high reliability. The three devices currently being evaluated are the extraction cowl, the ventilated drum (figure 12), and the spot scrubber (figure 13).

Laboratory evaluations conducted to date show that the extraction cowl and the ventilated drum can be very effective (up to 80 pct) at controlling the dust from the lead drum. However, the efficiency of the extraction cowl for controlling the dust from trailing drum is considerably less than the efficiency of the ventilated drum. Both these devices employ water-powered air movers. The ventilated cowl consists of a hollow cowl, with a water spray manifold mounted internally. The ventilated drum consists of tubes,

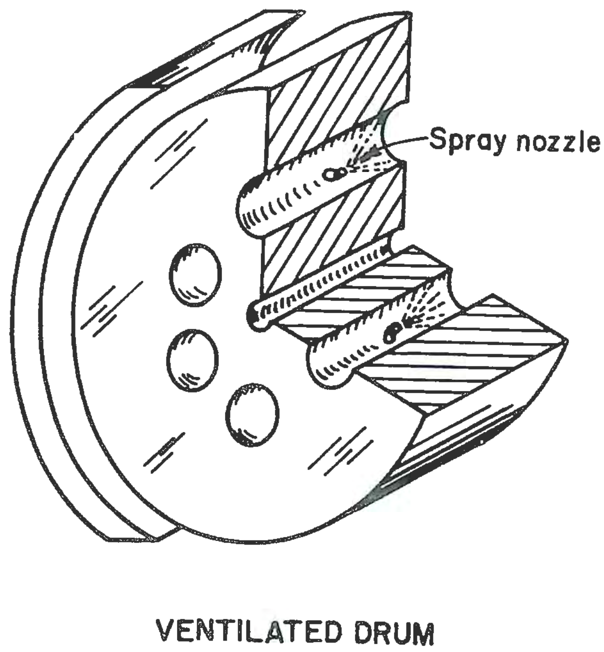

FIGURE 12. - Ventilated drum for use on longwall shearers.

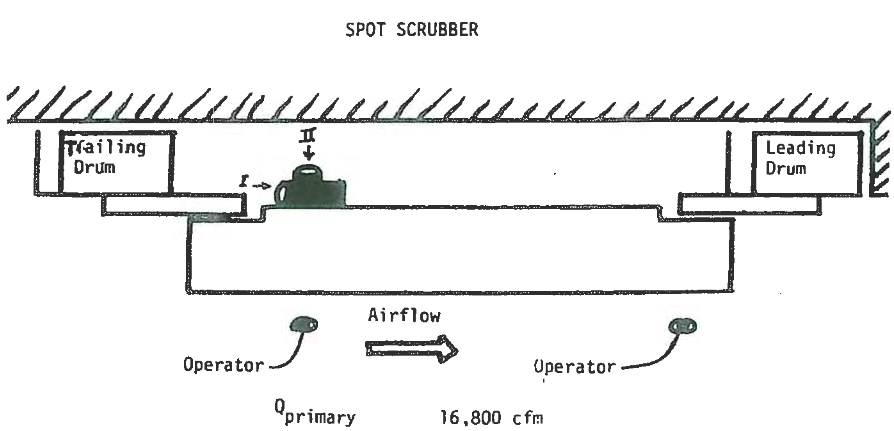

FIGURE 13. - Spot scrubber located on longwall shearer.

mounted in the drum hub, with internally mounted sprays (figure 12). Both devices utilize the water sprays to entrain and clean dust-laden air.

Although studies conducted with the spot scrubber have shown it to be very effective at reducing dust from the trailing drum when cutting with ventilation, the utilization of this dust control technique is limited. The spot scrubber must be operated in a downwind position from the dust source and therefore may not be suitable for use in both directions of cutting. The performance of these devices is highly dependent on primary ventilation airflow rates and to a lesser extent on the water spray system.

Efforts will continue to be directed toward optimizing the efficiency of the ventilated drum for controlling dust from the trailing drum. In addition, spot scrubber evaluations will continue to determine the optimum operating parameters and locations for the effective utilization of this dust control technique.

Evaluation of Longwall Dust Sources

Previous studies here and abroad have identified the need to isolate and better understand the various sources of longwall dust so as to provide a reliable basis for decisions concerning dust control research and strategies. Such a study is currently ongoing under the sponsorship of the Bureau. Its objective is to define and quantify the relative contribution to the overall dust exposure of each of the major dust-producing elements and processes associated with longwall mining.

An underground evaluation was recently completed. The data collected during this survey are being analyzed to determine the relative contribution of the following dust sources: shearer, roof supports, pan conveyor, state loader, and intake contamination levels. In addition, the contribution if the various parts of the cycle, such as cutting to headgate, cutting to tailgate, sumping in, flitting, and cutting out, will be assessed. Finally, on the assumption that the shearer is the most significant source of airborne respirable dust on the longwall face, an effort will be made to determine the respective contributions of the clearance rings, vanes, and cutting and loading of the leading and tailing drums.

Effects of Engineering Parameters on the Control of Respirable Dust

Although considerable effort has been expended to determine the optimum operating parameters of a particular dust control technique, the changes in efficiencies resulting from variations in these operating parameters have not been accurately documented. In addition, the balanced interactions between various dust control techniques have not been adequately defined.

Recognizing the need for the documentation of this information, especially in light of the requirements of the respirable dust control plan required from all mine operators, such a study is currently ongoing under the sponsorship of the Bureau. The main emphasis of this program has recently been directed toward longwall mining operations. The objective of this program is to determine how the interaction between the engineering controls specified in the dust control plan affects and respirable dust exposure of longwall face workers.

To date, an extensive analysis has been conducted using the data collected during the MSHA longwall respirable dust survey (1). Results of this analysis have indicated that both the shearer operators' and the jacksetters' exposures are directly related to the changes in the airflow (quantity and velocity) and water (pressure and flowrate) parameters. The remaining work will concentrate on an extensive survey of a particular longwall section, to determine the relationship between variation in a given set of engineering controls and the corresponding variation in face workers' dust exposures. Results of this work should indicate which are the most significant dust control parameters used on longwall operations. In addition, the results of this program should provide Government and industry with guidelines for determining where their efforts can best be spent to alleviate the longwall dust problem.

Survey of Dust Control Research

Extensive dust control research has been conducted to date by both the Government and the industry. The results of these studies are, however, contained in numerous but fragmented sources not easily utilized by the mining industry. In an effort to provide the mining industry with guidelines, the Bureau is compiling and consolidating the pertinent results of the various studies into a dust control handbook.

The handbook will provide state-of-the-art information on dust control for underground mining operations and will include an extensive bibliography for persons interested in more detailed information about a particular dust control technique. Although the handbook will be most useful as resource material for persons who are familiar with longwall dust control, the basic information will be valuable to persons not having a background in this area.

Because of the difficulty many operators have in controlling dust on longwall mining sections, the handbook will place special emphasis on longwall dust control. This information will allow an operator to develop a systematic approach to longwall dust control. In addition, the relative benefits of comparable techniques will be discussed. This handbook will be available through the National Technical Information Service by early 1982.

Mine Demonstration of Longwall Dust Control Techniques

Past work by mining companies to control dust on longwall operations has been done primarily to comply with health standards. As a result, many of the dust control techniques tried were not extensively tested, and the results were ambiguous and often overlooked. Because of the severe problem the coal mining industry is experiencing with longwall dust control, the Bureau of Mines has initiated an intensive program for the systematic evaluation and documentation of currently available dust control technology. These demonstrations will be conducted on longwall operations using double-drum shearers since this is where the respirable dust problem is more severe. Results of this program should enable the coal mining industry to select the best available control technology with the least adverse impact on coal production.

This program is a multi-year, major joint Government and industry effort. Currently, 10 major mining companies have committed funding and test sites for conducting underground demonstrations. Arrangements are being made to conduct demonstrations at approximately 35 longwall operations, representing every major coal basin in the United States.

Control technologies have been divided into three main categories - ventilation, water application, and machine and cutting sequence designs. Twenty-four individual techniques, representing a broad range in each of these categories, are scheduled for demonstration and documentation. In addition, future modifications to the program may be made to test and demonstrate emerging technologies for longwall dust control.

Category 1 - Ventilation

Although ventilation is primal to effective dust control on longwall operations, minimum standards for face ventilation airflow have not been developed, and several novel ventilation techniques have not been adequately demonstrated. Therefore, this program will concentrate on the following face ventilation techniques:

- Changes in Face Ventilation Airflow (figure 14)
- Reducing Intake Air Dust Levels
- Curtains Along the Face
- Air Sprays Located on Roof Supports
- Air Canopy Installed on the Roof Supports (figure 15)

Category II - Water Application

Until recently, guidelines for shearer water spray systems have been vague, and the design has often been left to the discretion of the mine operator. As previously discussed, the Bureau has developed an improved external water spray system for longwall shearers; however, information on optimum spray type and operating parameters is vague. In addition, recent advances in the areas of water infusion and foam application have been developed but not adequately demonstrated. Therefore, this program will address the following techniques for water usage on double-drum shearer operations:

- Drum Spray Changes
- Venturi Sprays
- Cowl With Sprays
- Variations in Water Pressure and Volume
- Automated Variable Water Supply System
- Front-Mounted Roof Sprays
- Wetting Agents
- Foam
- Water Infusion

Category III - Machine and Cutting Sequence Designs

Results from recent Bureau research efforts have indicated that several variations in machine design and operational modes can effectively reduce or control the amount of dust generated during the longwall mining operation. The viability of several of these techniques has not been adequately documented, and the mining industry has been slow to accept the operational reliability of those that have. The following areas will be focused on during the course of this program:

- Operational Difficulties Associated With Deep Cutting
- Bit Design
- Drum Design
- Hollow Shaft Ventilation
- Reversed Drum Rotation
- Wide Web Cutting
- Passive Barriers
- Remote Control of the Shearer and Supports
- Reduce Dust From Support Movement
- Evaluate Cutting Sequence

Results of this intensive research effort should produce significant improvement for dust control on longwall mining operations. The broad scope of the program, as well as the dedication of both the Bureau of Mines and the mining industry, demonstrate a joint commitment for solving the longwall dust problem. The ultimate outcome of this program should result in a healthier work environment for longwall face workers while maintaining adequate production levels from longwall mining systems.

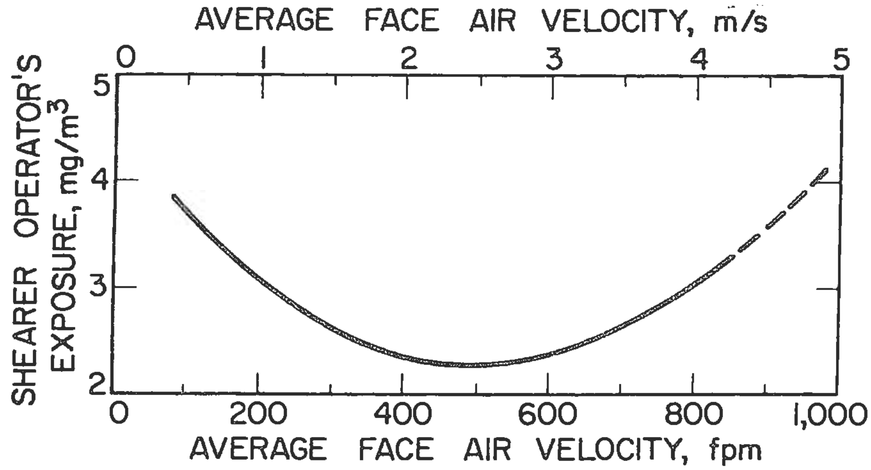

FIGURE 14. - Respirable dust concentration vs. changes in face ventilation airflow.

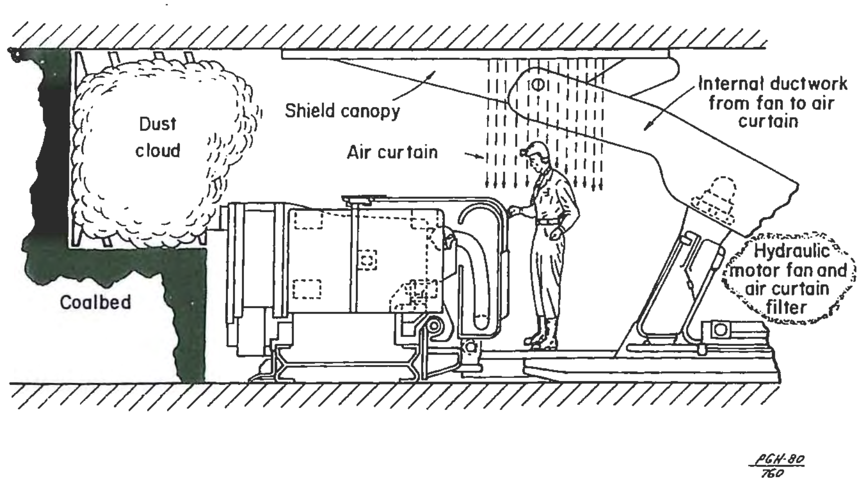

FIGURE 15. - Air canopy installed on the roof supports.

Conclusion

Over the past several years, the Bureau of Mines has been successful in developing and documenting the effectiveness of a number of dust control techniques for use on longwall operations. The utilization of these controls will lead to reduced respirable dust levels, thus reducing the health hazard to the face worker. While considerable progress has been achieved to date, the Bureau of Mines continues to pursue an aggressive program of dust control research. The ultimate goal of this program is to develop the technology that will allow longwall mine operators to comply with the dust standard while realizing the full production potential of this mining method.

References

1 Nesbit, R.E. Summary of a Technical Survey of All Longwall Sections for Compliance With the Respirable Dust and Noise Standards. Presented at the 4th Institute on Coal Mining Health and Safety, Colorado School of Mines, Golden, CO, Nov. 29-Dec. 1, 1978.

2. Divers, E.F. Nonclogging Water Spray System for Continuous Mining Machines: Installation and Operating Guidelines. BuMines IC 8727, 1976. 10 pp.

3. Kissell, F.N., N. Jayaraman, C. Taylor, and R. Jankowski. Reducing Dust at Longwall Shearers by Confining the Dust Cloud to the Face. BuMines TPR 111, 1981. 21 pp.

4. Hamilton, R.J. Principles of Machine Design and Operation Related to Dust Production and Control With Particular Reference to Longwall Mining in the United Kingdom. Paper in Proceedings of the Symposium on Respirable Coal Mine Dust, Washington, D.C., November 3-4, 1969, Comp. by R.M. Gooding. BuMines IC 8458, 1970, pp. 160-178.
pp. 160-178.

5. Strebig, K.C., and H.W. Zeller. The Effect of Depth of Cut and Bit Type on the Generation of Respirable Dust. BuMines RI 8042, 1975, 16 pp.

6. U.S. Bureau of Mines. Improved Respirable Dust Monitor. Technology News Bulletin 72, October 1979.

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