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Longwall Dust Control Where We Are and Where We Need To Go In the 21st Century

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Abstract

Although the number of operating longwall mining systems in the U.S. has remained relatively constant over the past five years, U.S. longwall production levels have increased significantly during this period. Longwalls account for over 40% of U.S. underground coal production. While longwalls are highly productive and offer other advantages, operations employing this method of mining continue to experience dust standard compliance problems. Increased longwall productivity has meant that far more dust is being produced.

Recent research has lead to an improved understanding and advancement of longwall face ventilation and water application systems, and machine design and operation. However many changes, such as lower dust standards and new equipment designs and operations, are appearing on the horizon that will require further research emphasis and investigation, as well as more attention to secondary dust sources and emerging technologies.

The Dust and Toxic Substances Control Branch, of the National Institute for Occupational Safety and Health's Pittsburgh Research Laboratory (NIOSH-PRL), in partnership with industry and labor, has examined several basic principles of longwall face ventilation systems, and evaluated the effectiveness of numerous improved face ventilation techniques. An optimum water management system has been designed for longwall faces that should ensure that an adequate and appropriate quantity of water is delivered to a properly designed shearer water-spray system to effectively control dust levels at longwall operations. Modification in machine design and cutting sequence have been developed to effectively reduce the amount of dust produced, as well as the respirable dust exposure of most longwall face workers. Data is presented that documents the overall impact of this technology throughout the U.S. industry.

Discussions have been held with industry representatives, machine manufactures, labor, and regulatory agencies in an attempt to identify those issues of concern that research must continue to address. Results of these discussions, and the required focus of longwall dust research in the 21st century will be presented.

Introduction

Longwall mining equipment and operational practices have improved dramatically throughout the decade from the early 1980's through the mid-1990's. Longwall mining now accounts for approximately 50% of the coal produced underground in the United States. Average shift production has increases from approximately 1,500 tps in 1983, to over 3,600 tps in 1995. Historically, longwall mining operations have had difficulty in maintaining compliance with mandatory Federal dust standards. In the early 1980's, 31% of the compliance samples collected by the Mine Safety and Health Administration (MSHA) exceeded the 2.0 mg/m^3 respirable dust standard. For fiscal year 1994, 20% of MSHA-collected samples exceeded the standard. Although significant gains in longwall dust control have been made, these have been overshadowed by the significant increases in coal extraction rates. The increase in coal extraction rates has been accompanied by a continuing effort to maintain compliance with the respirable dust standard.

However, as more coal is mined, more dust is generated (Webster, 1990). The increase in longwall coal extraction rates has meant that far more dust is being produced which must be controlled. Approximately 25% of longwalls today are capable of extracting in excess of 6,000 tps, with several capable of extraction rates in excess of 10,000 tps.

Longwall Dust Sources

Previous research was conducted in cooperation with the longwall mining industry in 1983 (Jankowski) and 1994 (Colinet), to identify the sources and levels of respirable dust, and ventilation practices applicable to typical longwall faces in operation during these time periods. The cutting action of the shearer was identified as the primary source of respirable dust during both surveys. Ventilating air quantity has been shown to impact respirable dust levels downwind of the shearer, and with the shearer being the largest dust source on the longwall, increasing the quantity of air supplied to the longwall would be one of the most important changes that a longwall operator can make to improve dust levels. However, contribution of dust from coal transport through the stage loader/crusher, and dust liberated during support advance, are now found to be significant (Figures 1 and 2). During the 1983 study, the open design of the crusher, and modest levels of water application to the coal product allowed high levels of respirable dust to be generated and released into the primary airstream. By 1994, levels of water applied to the mined product had increased by 200%, and most stage loader/crushers were completely enclosed. However, face lengths and shearer tram speeds had almost doubled requiring rapid and constant support advance with associated increasing levels of dust liberation. The impact of ventilation on support dust liberation has not been established.

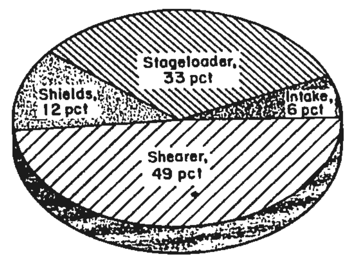

Figure 1. Longwall dust sources, 1980's.

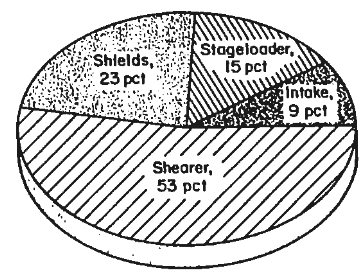

Figure 2. Longwall dust sources, 1990's.

Ventilation Procedures Developed and Implemented to Minimize Dust Levels

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 dust down the face and prevent its migration to the walkway has presented unique challenges for the longwall mining industry. At first glance, the ventilation of a longwall face appears deceptively simple, air comes in on one side, courses over the face, and exits. If workers are to be kept out of the dust, they are simply kept upwind of the dust sources. Unfortunately, there can be high intake dust levels, air that leaks back behind the shields (especially near the shearer), and operators that need to see the downwind drum, all of which potentially place personnel in areas of high dust concentrations. Researchers, in cooperation with the longwall mining industry, have identified and documented the effectiveness of certain improved face ventilation techniques for longwall operations. These studies have shown that assessment of the primary intake alone is not sufficient; the direction and utilization of the primary airflow is critical for dust control. Substantial improvements can be obtained through application of these advanced techniques.

Higher Air Quantities and Volumes Help Control Airborne Dust

In most longwall operations, the face airflow is usually measured at the crosscut in the headgate entry. Although this intake quantity often exceeds 30,000 cfm, this measurement is often not representative of face airflow. Ventilation measurements should be taken at every 10th support; the resulting profile can be used to determine "average" face airflow, effective utilization of the primary intake, and air loss to the gob. Airflow along the face is seldom uniform; a measurement at any single location may not be representative of the average face airflow. With a ventilation profile, the mine operator can discover problem areas and more accurately determine the specific ventilation parameters on a given longwall face.

Face air velocities of at least 400 to 450 fpm appear to be the minimum appropriate for dust control (Mundell, 1979). Once again, these values are for the average face velocity profile and should be maintained for the entire face length. With optimum air utilization, these values would equal minimum average intake air quantities of 20,000 cfm for a 5-ft coal seam and 30,000 cfm for a 7-ft seam. In the past, air velocities above 650 fpm were thought to cause entrainment of dust from coal transport and dust liberation during support movement. Recent studies by MSHA (Tomb, 1992) now show that as face air quantities increase even beyond 1,200 fpm, respirable dust levels due to dust generated along the face decrease. NIOSH is currently attempting to identify a cooperative mine site at which to conduct further studies of the impact of air velocity increases on dust entrainment along the face.

Minimum average face air velocities of 400 to 450 fpm help to control respirable dust in three ways. The higher air velocities provide greater air quantities for better dilution of intake dust as well dust generated during support movement. Higher velocities over the shearer help to confine the dust to the face area and lower contamination in the walkway. Finally, these higher velocities improve diffusion of dust from stagnant areas in the headgate and along the support line.

Curtains in Headgate Provide Better Direction of Primary Airflow

Often, loss of air into the gob in the headgate area prevents maximum utilization of the air available to ventilate the longwall face. The gob behind the first few supports remains open owing to the roof bolts in the headgate entry, and a large gap usually exists between the first support and the entry rib. As a result, a substantial portion of the ventilation air from the headgate entry leaks back into the gob, lowering the airflow along the face. Moreover, this air laden with dust generated during gob falls may reenter the face area, compounding the dust problem.

A gob curtain, installed between the first support and the rib in the headgate entry, can force the ventilation airstream to make a 90° turn, staying on the face side of the supports, rather than leaking into the gob. The curtain is suspended from the roof to the floor and advanced with the supports at each pass.

Previous researchers (Jankowski, 1983) have collected extensive face air velocity data with and without the gob curtain in use. The average face air velocity with the curtain installed was approximately 35% greater than without the curtain. The biggest improvement due to this curtain is seen at the first 25 to 30 supports, where the increased air volume lowers dust concentrations through dilution. The gob curtain is easy to use, install, and maintain, and it is fabricated from material that is readily available in all mines (Figure 3).

In many longwall operations, misapplication of the primary airflow may actually contribute to increased dust levels. One source of extreme concentrations of respirable dust for longwall shearer operators is the headgate shearer drum as it cuts through into the headgate entry. As the drum cuts into the entry, it is exposed to the primary ventilation airstream. The high-velocity air passes through and over the drum, picking up large quantities of dust; this dust is carried into the walkway and over the shearer operators. Although this operation is usually of short duration, he resulting dust levels are extremely high. Concentrations ranging from 20 to 30 mg/m^3 have been measured at several mines, using instantaneous dust monitors at the operator position. Thus, the cumulative effect on full-shift exposure levels can be significant, particularly on high-production faces where this operation may be performed six to eight times per shift.

To overcome this problem, some coal mine operators use a "cutout" curtain in the headgate to shield the lead drum from the ventilation airstream as it cuts out into the headgate. The curtain redirects the primary air so that it flows out and around the drum. The curtain is usually located 4 to 6 ft back from the corner of the face, so that maximum shielding is provided without interference with the drum, and is suspended from the roof between the panel side rib and the stage-loader. The curtain need only be in place during the actual cutout operation and is advanced every other pass (Figure 4).

Previous researchers (Jankowski, 1986) have conducted underground evaluations to document the improvements achieved through installation of a cutout curtain. Dust levels at the operator positions were monitored using instantaneous

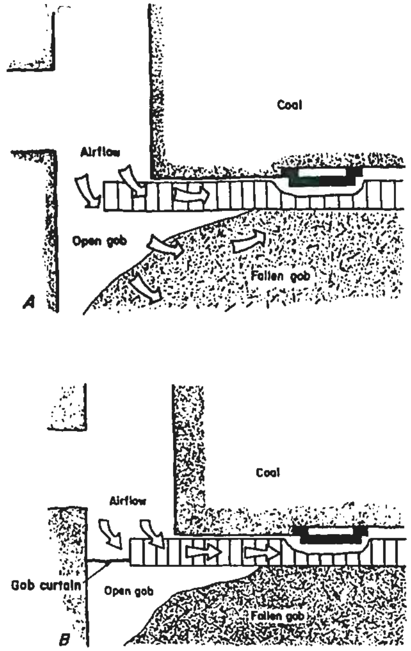

Figure 3. Location of gob curtain at longwall headgate.

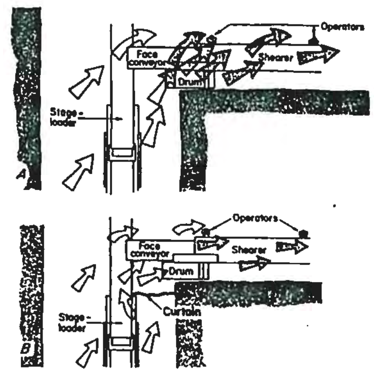

Figure 4. Location of cutout curtain at longwall headgate.

the dust monitors as the shearer cut out and cleaned up at the headgate. Concentrations monitored with and without the curtain indicated that the curtain can reduce exposure of the tailgate shearer drum operator by 50 to 60% during this phase of the mining cycle. To achieve these improvements, the curtain must be installed tightly against the mine roof and must extend sufficiently into the headgate entry.

Impact of Belt Entry Air

An increasing number of mines are either using or petitioning to use belt entry air to ventilate active longwall face areas. Using the belt entry as an intake entry may allow delivery of more air to the face, providing better dust and methane dilution. NIOSH, as part of its goal to improve the health of the Nation's miners, recently conducted underground dust surveys to further explore this topic (Potts, 1992). Results of these studies have shown that a 1,000-ft increase in belt entry length or a 200- to 500 st per-shift increase in production resulted in roughly a 0.1-mg/m^3 increase in dust. Dust levels inby the belthead appeared to be independent of belt entry airflow, over the range of airflow observed during the surveys. During the 1993 study, six of the operations surveyed were utilizing belt air to ventilate the longwall face. The average dust level in the belt entry just outby the stage loader

was 0.6 mg/m,^{3} while the average intake concentration was 0.5 mg/m^3. Any potential increase in face intake dust levels appears to be negated by the potential for increased dilution that can be obtained with additional air brought up the belt entry.

Compliance data analyzed by MSHA (MSHA, 1989) have shown that mines using belt entry air to ventilate work areas did not have significantly different respirable dust levels at the designated occupation than mines not using belt air. According to MSHA, in one district, mines using belt entry air had a significantly lower mean dust concentration than mines not using belt air. From a theoretical standpoint, applying the dilution formula shows that if belt entry air represents additional air brought to the face and if belt entry dust levels, including those at the stage-loader and crusher, can be maintained below the average dust level measured at the designated occupation, it is beneficial from a dust compliance perspective for the mine to use belt entry air to ventilate work areas.

Using the belt entry as an additional source of intake air results in an increased number of outby dust sources. The conveyor belt itself is a source of dust, and the stage-loader and crusher are always in intake air if the belt entry is used to ventilate the face. Researchers have conducted extensive research and have demonstrated effective technology to control dust from these sources (Organiscak, 1982).

Assessment of Changes in Face Ventilation Practices

As previously stated, researchers at NIOSH's Pittsburgh Research Laboratory conducted extensive in-mine surveys which can be used to obtain an insight into the changes which have taken place in longwall face ventilation practices, and an evaluation of its' impact on face dust levels at operating longwall from the early 1980's to 1990's. Twelve longwalls, representing the eastern, mid-western, and western U.S. coal mining regions, were surveyed during each time period, and represent a cross-section of conditions existing during each period. Several generalities can be drawn from analysis of these data sets, and certain specifics can be obtained from six mines which were surveyed during both surveillance periods.

Table 1 shows a summary of longwall ventilation parameters and dust levels from the twelve operations surveyed during the two surveillance periods. In general, these values are in good agreement with national averages reported yearly, and with results of a 1993 survey of high production longwall mining sections (Jankowski, 1994). On average, results of this study indicate that average face air velocity has increased by approximately 27%, from 327 fpm in 1983 to 415 fpm in 1993. When comparing only the six longwalls surveyed during both periods of surveillance, average face air velocity has increased by 20%, from 374 fpm in 1983 to 453 fpm in 1993. Results of a similar study showed the average face air velocity on longwalls increased by 100 fpm during the same time period. During the same time period, longwall panel face lengths have increased by approximately 40%, meaning that on average, longwall mine operators are delivering approximately 10,000 cfm of additional air to the longwall panel in 1993 then was being delivered in 1983.

When comparing changes in dust levels during the same time period, average dust levels at the tailgate location decreased by approximately 47%, from 6.6 mg/m^3 in 1983 to 3.5 mg/m^3 in 1993. Similar dust reductions (46%) are observed when comparing only the six longwalls surveyed during both surveillance periods. Headgate dust levels decreased between 56 to 66%.

Projections from recent surveys suggest that half of the longwalls in operation today utilize the belt entry to bring intake air to the longwall face, resulting in an average face air quantity of approximately 55,000 cfm. Over 90% of the longwall faces in operation today utilize headgate curtains to assist in directing the primary intake onto the face, avoiding air loss to the gob in the headgate area. Average face air velocities can be significantly improved through the installation of headgate curtains.

Impact of Water Spray Systems on Face Ventilation Effectiveness

Design and operational parameters of the shearer water spray system can have a significant impact on face ventilation effectiveness. Water sprays oriented perpendicular to, or upwind into the primary ventilation can cause high levels of dust to be transported away from the face area and into the primary airstream. Water sprays are very efficient air movers, and if applied properly can be used to augment the primary airflow and reduce the amount of shearer generated dust which is transported into the face walkway.

Operating Spray Pressure

All shearer cutting drums in operation since the late 1970's have been equipped with drum mounted water sprays. The purpose is to apply water for dust suppression directly at the point of coal fracture, and to add moisture to the product to minimize dust liberation during coal transport off the longwall face. Once respirable dust becomes airborne and is released into the primary airstream, it remains airborne the entire length of the longwall face. Although very effective at minimizing dust generation at the point of coal fracture, shearer drum water sprays can actually increase airborne respirable dust levels if operated at too high a water pressure level. Instead of suppressing dust generation, these sprays force the dust out away from the cutting drum, and allow it to mix with the primary airflow, where it is then carried throughout the entire cross-sectional volume of the longwall face. Studies (Piemental, 1984) have shown that increasing shearer drum water spray pressures above 100 psi can increase the shearer operators dust exposure by 25 pct. At operating pressures exceeding this level, the drum sprays force dust out away from the face and overwhelm the dilution capacity of the primary ventilation. The optimum operating drum spray pressure appears to be between 70 to 100 psi. Water flow rate should be increased by increasing the nozzle orifice size, rather than the operating spray pressure.

Air-Directional Water Spray Systems

Water sprays are very effective air-moving devices. Water sprays mounted on the shearer body act very much like small fans, moving airflow and entrained dust in the direction of their orientation. Poorly designed shearer-mounted spray systems with nozzles directed upwind at the cutting drum actually carry the dust

away from the face and upstream of the drum, where it mixes with the clean intake air and is carried out into the walkway over the shearer operators.

Researchers have devised a novel shearer spray system, called the shearer clearer (Jayaraman, 1985) , which takes advantage of the air moving capabilities of water sprays. It consists of several shearer-mounted water sprays oriented downwind to augment the primary ventilation airflow, and one or more passive barriers which split the airflow around the shearer into clean and contaminated air-splits. The air-split is initiated by a splitter-arm, extending from the gob-side corner of the shearer body, from which conveyor belting hangs down to the panline. Spray manifolds mounted on the splitter-arm confine the dust cloud generated by the cutting drum, further enhancing the air split. The dust-laden air is drawn over the shearer body and is held against the face by two spray manifolds positioned between the drums. The air is then directed around the downwind drum by a set of sprays located on a downwind splitter arm. Operating pressure must be approximately 150 psi, measured at the nozzle, to assure effective air movement.

In underground tests, the shearer clearer has reduced operator exposure from shearer-generated dust by approximately 50 pct when cutting against face ventilation, and 30 pct when cutting with ventilation. Although a properly installed and operated shearer clearer system controls dust at the operators's position more effectively than does a conventional spray system, it cannot compensate for insufficient primary ventilation, or reduce operators exposure from other dust sources.

Results of this study have shown that the longwall mining industry has thoroughly embraced this development. Over 95% of the longwalls in operation today have implemented some type of air directional water spray system on the shearer to augment the primary face airflow, confine shearer generated dust to the face area, and lower dust levels in the face walkway. This concept, and its acceptance and application by the industry, is illustrated in Figure 5. The average respirable dust level profiles around the shearer are shown for the six mines which were surveyed during both surveillance periods. The average respirable dust level 20-ft on the intake air side of the shearer remain unchanged, and are not impacted significantly by the air directional water spray system on the shearer body. However, the respirable dust level at the midpoint of the shearer, and 40-ft downwind of the shearer have been reduced between 20 to 25%.

Shearer cooling water has historically been discharged through spray nozzles oriented against the primary airflow or directed into the face, causing dust to be carried back into the walkway. An alternative for discharging cooling water are panline spray manifolds, mounted at both ends of the shearer, aimed down onto the panline. This minimizes turbulence caused by face-side sprays. Respirable dust reductions of up to 35 pct at the shearer operators location can result (Jayaraman, 1985).

Machine Design and Utilization

As previously stated, 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

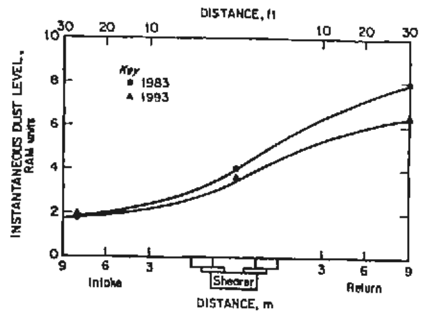

Figure 5. Directional water spray systems augment primary face airflow.

quantities of dust produced by the machine. However, modification 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.

Deep Cutting

Deep cutting is a function of drum speed and machine advance rate. Typical shearer drum speeds at U.S. mining installations average 50 rpm, and tram speeds average 30 fpm. With deep cutting, larger fragments of coal are removed and less coal surface is exposed, resulting in a reduction of airborne dust. The slow rotational speed minimizes the fanning action of the cutter-head, thus reducing recirculation and regrinding of the cut coal and minimizing the amount of coal fines liberated into the airstream. A previous NIOSH field test (Jankowski, 1988) had confirmed the benefits of slow-speed deep cutting. Average power consumption decreased as drum speed decreased, and bit penetration increased. A 60-pct reduction in dust generation was achieved by reducing the drum speed 50%. Average power consumption decreased as drum speed decreased and bit penetration increased. Reducing drum speed is one of only a few changes a longwall operator can make to increase output, reduce respirable dust, and decrease machine power consumption.

Reverse-Drum Rotation

Research conducted by NIOSH (Strebig, 1975) has shown that reversing the rotation of the shearer cutting drum can actually increase productivity while minimizing dust generation. When cutting from tail to head using conventional rotation, both drums attempt to load material between the shearer ranging arm and the pan. Since the loading aperture is no more than a small slit, this results in the drums becoming choked and a reduction in tram speed. By contrast, when the direction of drum rotation is reversed, the position of the loading zones changes. The leading drum loads out of the bottom quadrant, while the trailing drum loads through the cowl. In both cases the zones increase substantially compared to loading with conventional rotation. Results are similar during the head-to-tail cut.

To evaluate the efficacy of reverse-drum rotation, a multiple underground evaluation of reverse rotation was conducted. Respirable dust levels, shearer power consumption, tram speed, and production rates were monitored. The shearer operator's dust levels were reduced by 40 to 85 pct, while intake dust levels along the face were reduced between 15 to 40 pct. In addition, when geological conditions permit, reverse rotation can lead to improved loading, increased tram speeds, and improved product size. These features can contribute to an overall productivity increase.

Modification of a shearer to reverse rotation can normally be achieved at minimal cost to the mine. Other than the labor costs involved in changing over the drums, the expense of the conversion is minimal. A primary constraint when considering the use of reverse-drum rotation is seam height. With drum rotation from floor to roof, large slabs of rock can be caught by the drum and thrown over the machine body. This is usually dependent upon the clearance between the top of the machine and the roof and becomes a potential safety hazard with seam heights above 7 ft.

Optimizing Shearer Drum Designs

There are a number of variables to be considered when formulating drum design specifications. These include such items as the number of vanes, bit type and placement, etc. A number of approaches may be considered in determining which, if any, variables need to be changed when drums are rebuilt or fabricated. Mine personnel may apply their own knowledge and experience, or they may consult a drum design expert, to efficiently apply effective dust control technology.

NIOSH has developed an expert system (Wirch, 1988) that provides operators with site-specific advice on longwall drum design. The system requires no programming experience to operate and provides its own instructions. It also supplies users with printouts of data sheets, survey forms and recommendations, as well as graphics illustrating recommended corrective actions. The longwall drum design expert system is a computer program that can cost-effectively place the knowledge and experience of a consultant at every U.S. longwall face. It contains all of the pertinent knowledge on longwall drum design research and applies it as any human expert would. It asks for site-specific information, diagnoses the problem, and recommends corrective measures. The expert system will prioritize the applications and select the most effective techniques in an efficient manner.

Industry Concerns and Recommendations

Selected representatives of the longwall mining community were contacted and asked to list areas of respirable dust control which they felt remains an area of concern, and provide recommendations as to how these concerns may be best addressed. Most expressed a concern that current dust control technology is marginally adequate to meet existing dust standards, and that the implementation of existing controls have reached their maximum application levels. Main mine ventilation systems are being taxed to provide airflow rates found on a number of longwall mining systems, and waterflow rates at some longwalls exceed 300 gpm. Several industry representatives stated that production levels are being compromised by the need to provide adequate dust control, and the operation of the longwall and outby haulage systems are being negatively impacted by the levels of moisture being applied at the face. In general, it was felt that unless novel alternatives were identified, further development and application of longwall systems would be impeded. Three general areas were identified, and include control of shearer dust, control of support dust, and control of dust during face and outby haulage operations.

Industry representatives have suggested a number of novel research areas which may serve to address their concerns. Broadly divided among the categories discussed above, their recommendations were as follows:

Control of shearer generated dust:

- Develop a machine-mounted scrubber system, such as that found on CM's;
- Develop novel methods of water infusion, applicable on today's high extraction rate longwall panels;
- Explore methods to reduce the amount of water applied on the longwall, while maintaining or improving dust control - specific areas mentioned included the use of high pressure spray water, surfactants, foam application, and water alternatives;
- Explore novel methods of drum and cutting system design, to reduce the amount of coal fines produced;
- Develop machine control systems, which place face workers in areas of low dust exposure.

Control of support generated dust:

- Explore methods to incorporate dust collector technology into the design of face support systems;
- Explore methods to reduce roof friability, reducing the amount of respirable dust produced by the crushing action of the support canopy;
- Determine the relationship between dust pickup and air velocity passing over the support canopies, and recommend optimum velocities to minimize support dust transport along the face;
- Develop passive barriers/containment systems for shield support systems.

Control of dust during face and outby haulage operations:

- Develop new dust collector/scrubber systems for belt transfer and stage loader applications;

Explore methods to reduce the amount of water applied during coal transport, while maintaining or improving dust control - specific areas mentioned included the use of surfactants, foam application, and water alternatives;

Investigate alternative systems for coal transport, and determine feasibility for application of these systems into the overall longwall system design.

NIOSH's Office for Mine Safety and Health (OMSH) is aggressively pursuing development of a updated Strategic Plan for mine health and safety research. Implementation of this plan is scheduled for October 1998. Part of this effort involves obtaining input from OMSH's stakeholders, regarding their needs and priorities. Through discussions such as those detailed above, OMHS is attempting to focus its dust research program into the 21st Century.

Summary

The number of operating longwalls has remained relatively constant over the last five years, while longwall production levels have increased significantly from approximately 2,400 tps in 1988 to more than 3,600 tps in 1995. This increase in production was accompanied by a continuing problem with maintaining compliance with the applicable dust standard despite the fact that the average respirable dust concentrations on longwall have remained below 2.0 mg/m^3. The rate of continuous compliance has decreased from 40 percent in 1990 to 28 pct in 1995, while the percentage of longwalls in noncompliance two or more times increased from 23 pct in 1990 to 32 pct in 1995. Recent statistics make it apparent that significant gains have been achieved in the area of longwall dust control. Average dust levels at the tailgate location have decreased by approximately 47%, from 6.6 mg/m^3 in 1983 to 3.5 mg/m^3 in 1993.

The average face air velocities at U.S. longwall mining installations is 415 fpm. It would appear that face air velocities in the range of 400 to 450 fpm appear to be sufficient for dust control. The average section water usage at U.S. operations is 135 gpm. Average drum water spray pressure is 85 psi. Water flow should be increased by enlarging the nozzle orifice size, rather than the operating spray pressure. All U.S. longwall mining installations utilize some sort of directed external water spray system, to confine shearer generated dust and prevent it from migrating out into the walkway. All U.S. longwalls have equipped the shearer with radio-remote control. This allows the machine operator(s) to remain upwind of the shearer during the mining operation, and is a significant aspect of their efforts to maintain an acceptable dust compliance record.

The longwall mining industry has adopted and implemented a broad, scientific approach to longwall dust control, based on results of the research conducted during the past decade. Continuing joint research efforts, between NIOSH's Office for Mine Safety and Health and their stakeholders, have been identified, which should represent the next generation of longwall dust control technology and enable all face personnel to work in an environment that is free of excessive levels of respirable coal mine dust.

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Table 1. Percentage Change, Longwall Operating Parameters and Dust Levels, 1980's vs. 1990's.

All Mines Surveyed		Six Mines Surveyed 1983/1993	
Avg HGD 83 Avg HGD 93 % Change	1.6 0.7 56%	Avg HGD 83 Avg HGD 93 % Change	1.5 0.5 66%
Avg TGD 83 Avg TGD 93 % Change	6.6 3.5 47%	Avg TGD 83 Avg TGD 93 % Change	5.9 3.2 46%
Avg VEL 83 Avg VEL 93 % Change	335 415 27%	Avg VEL 83 Avg VEL 93 % Change	375 450 20%
Avg FL 83 Avg FL 93 % Change	500 710 43%	Avg FL 83 Avg FL 93 % Change	545 685 25%
Avg EXR 83 Avg EXR 93 % Change	10.1 21.6 114%	Avg EXR 83 Avg EXR 93 % Change	11.8 20.1 70%

HGD = Headgate Dust Level, mg/m^3
TGD = Tailgate Dust Level, mg/m^3
Vel = Face Velocity, fpm
EXR = Extraction Rate, t/min.
Fl = Face Length, ft