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Factors Affecting Respirable Dust Generation From Longwall Roof Supports

By John A. Organiscak, Jeffrey M. Listak,
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UNITED STATES DEPARTMENT OF THE INTERIOR

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UNITED STATES DEPARTMENT OF THE INTERIOR
Donald Paul Hodel, Secretary

BUREAU OF MINES
Robert C. Horton, Director

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UNIT OF MEASURE ABBREVIATIONS USED IN THIS REPORT

ft	foot	psi	pound (force) per square inch
ft^2	square foot	psig	pound (force) per square inch, gauge
h	hour	pct	percent
in	inch	ton/ft^2	ton per square foot
mg/m^3	milligram per cubic meter	ft/min	foot per minute
mm	millimeter	L/min	liter per minute
m/s	meter per second		
μm	micrometer		

NOTE.--See appendix B for explanation of RAM units.

FACTORS AFFECTING RESPIRABLE DUST GENERATION FROM LONGWALL ROOF SUPPORTS

By John A. Organiscak,[1] Jeffrey M. Listak,[1] and Robert A. Jankowski[2]

ABSTRACT

The Bureau of Mines conducted a survey of eight shearer longwall operations to identify factors that affect respirable dust generation from longwall roof supports. The longwalls surveyed were in coal seams located in different geographic regions of the United States. Data were collected on mining (geologic) conditions, support design, operational characteristics, and amount of respirable dust generated from roof supports. Analysis indicated that mining conditions are the main factors that affect the generation of dust during roof support movement. Both roof strength and depth of cover above the coal seam showed relationships with the amount of support dust generated. Several practices are currently employed to effectively control roof support dust; however, some of these controls are limited. More research and development is needed to improve dust control technology for longwall roof supports.

[1]Mining engineer.
[2]Supervisory physical scientist.
Pittsburgh Research Center, Bureau of Mines, Pittsburgh, PA.

INTRODUCTION

Previous Bureau research on dust sources at shearer longwall operations has shown that roof support movement can generate a significant amount of respirable dust (1).[3] Investigators found that as much as 31 pct of the respirable dust to which shearer operators were exposed was generated by the cyclic movement of longwall roof supports (1).

On most longwalls in the United States, the major source of dust is the cutting action of the shearer drums, and the major effort has been to control dust from this source. Thus, very little research has been done on the control of support-generated dust in the United States (1). Some research has been done in Europe, but only limited technology has resulted.

To fill this gap, the Bureau conducted a recent study to gain a better understanding of conditions that contribute to high levels of support dust on longwall mining operations. The objective was to identify the inherent characteristics of longwalls having high levels of support-generated respirable dust. This report describes the study and presents the findings.

The problem was addressed by conducting dust sampling at longwalls in the eastern and western United States having a wide range of dust levels generated by support movement. The criteria used for assessing the origins of respirable dust were local geology, support design, and operational procedures. The data were collected and analyzed for correlations, in an attempt to identify the characteristics that influence dust generation.

SURVEY DESCRIPTION

Eight shearer longwall faces using shield supports were surveyed (fig. 1).[4] The characteristics and dust concentrations of these longwalls are shown in appendix A. The longwalls surveyed were located in seven coal seams (table A-2 in appendix A) at varying depths of cover, in different geographic regions of the United States. Geologic conditions were observed during the survey, and drill-core data from the vicinity of the panels were obtained from mine personnel.

During the survey, four types of immediate roof were identified. Compressive strengths of these roof types were estimated (based on observation) for use in relating the support load exerted on them to the dust generated (2). The four roof types and their estimated compressive strengths were as follows: coal, 650 psi; weak shale (soft), 4,000 psi; strong competent shale, 10,000 psi; and weak siltstone (soft), 4,000 psi. The estimated roof strength and roof type for each of the longwalls surveyed are given in tables A-1 and A-2, respectively.

Supports used at the longwalls surveyed were either two- or four-legged shields. The pertinent characteristics of the shields were setting pressures, yield loads, support dimensions, and leg specifications. From these data, the average setting-load density exerted on the roof by the supports at each longwall was determined. As an indication of the roof's susceptibility to crushing under the support setting load, a roof loading factor was devised from a ratio of the average roof strength to the average support setting-load density. The lower the value of this factor, the more likely the roof was to crush under set load.

Dust samples were taken at each longwall, and operational procedures were observed. Support dust was measured by using GCA[5] Real-Time Aerosol Monitors (RAM's) and short-term gravimetric

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[3]Underlined numbers in parentheses refer to items in the list of references preceding the appendixes.

[4]Frame and chock support faces were not included in this survey because only a limited number of these installations are in use, and their application in the United States is quickly diminishing.

[5]Reference to specific products does not imply endorsement by the Bureau of Mines.

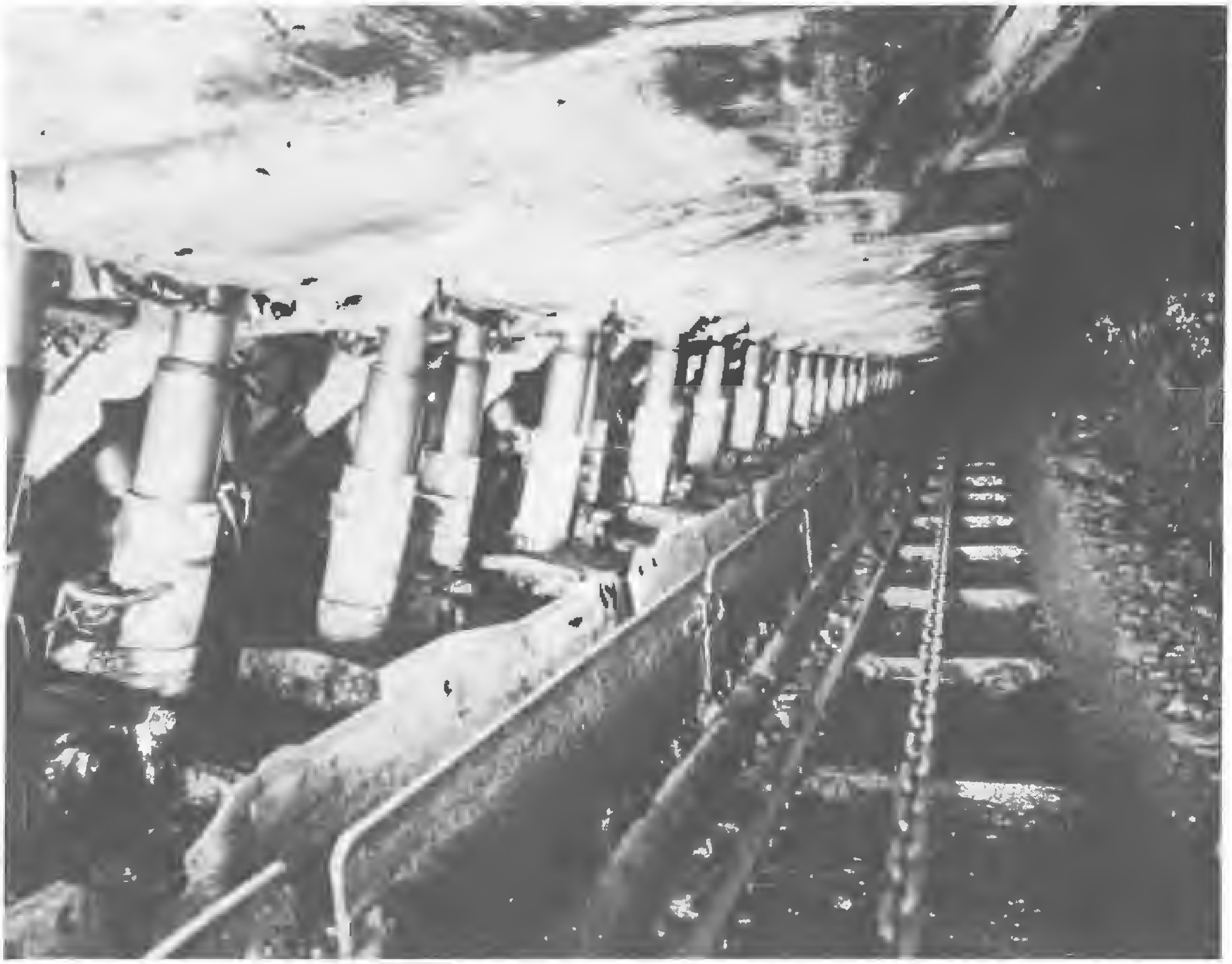

FIGURE 1. - Typical longwall shield face.

samplers immediately upwind and downwind of support movement along the face. (For details of the sampling strategy, see appendix B). Ventilation data were collected at each longwall. At some of the longwalls, the effect of ventilation on the dilution and diffusion of support dust at various distances downstream of support movement was determined from RAM measurements. (See appendix B.) Additional information about operational procedures was collected, including support advance practices, support dust control practices, and horizon control of the roof and floor with the shearer.

LONGWALLS WITH LOW CONCENTRATIONS OF SUPPORT-GENERATED DUST

At two of the longwalls surveyed (longwalls A and B, as identified in appendix A), dust concentrations generated by support movement were very low. The average respirable dust concentration was < 0.5 RAM unit[6] as measured with the RAM's and < 0.5 mg/m^3 as measured with the gravimetric samplers.

An example of low dust concentrations generated by support movement along the face is shown in figure 2, a plot of the instantaneous measurements made at longwall A. The difference between the immediate downwind and upwind concentrations

[6]Ram units are explained in appendix B.

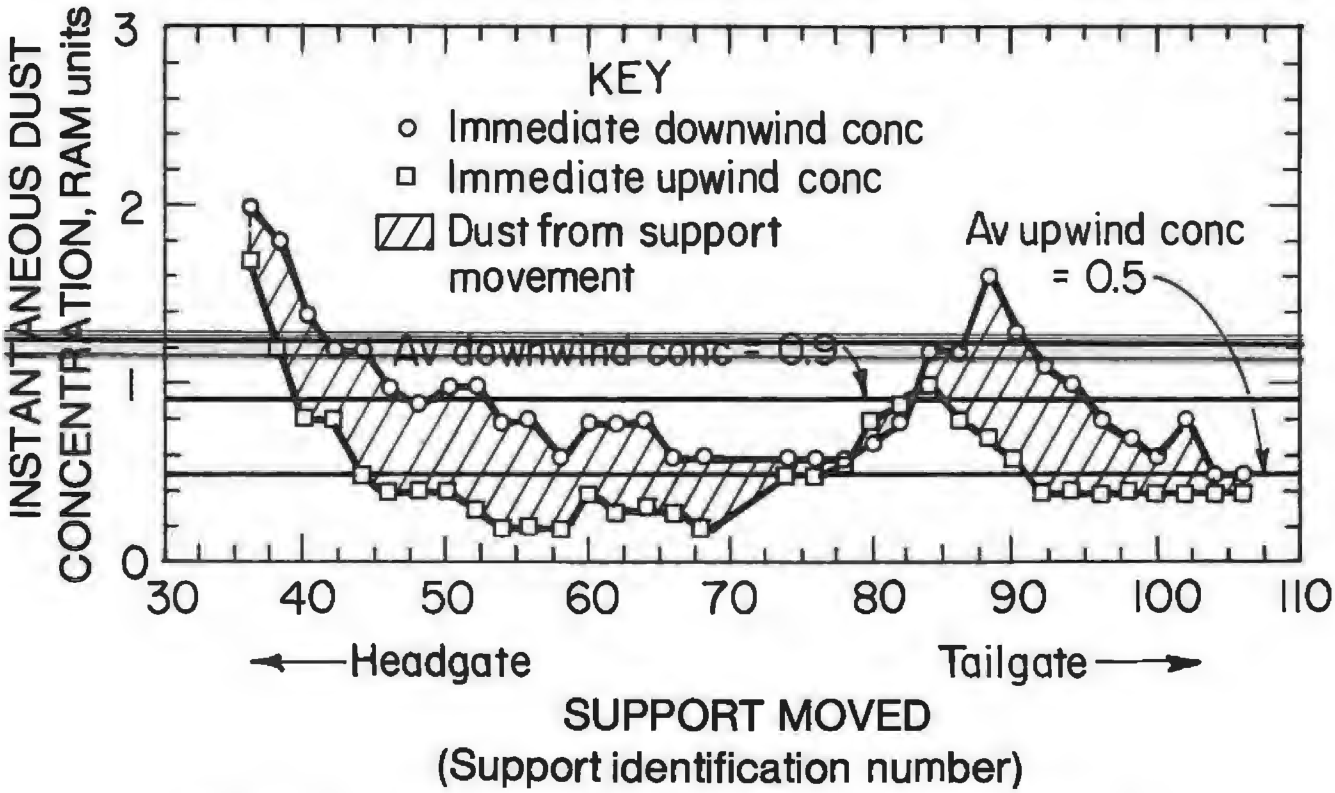

FIGURE 2. - Instantaneous roof support dust concentrations at longwall A.

measured during support movement indicated the dust concentration generated by the supports (the shaded area between the two curves). The average downwind dust concentration was 0.9 RAM unit, and the average upwind dust concentration was 0.5 RAM unit, resulting in an average dust concentration of 0.4 RAM unit generated by the supports. The difference between the dust concentrations of the downwind and upwind gravimetric samples made concurrently with instantaneous sampling at this longwall yielded 0.3 mg/m^3 of dust generated from support movement.

Dust concentrations produced by the supports at longwall B were similar to those produced at longwall A; the average instantaneous and gravimetric concentrations were 0.4 RAM unit and 0.1 mg/m^3, respectively. Besides the similarities in support-generated dust concentrations, longwalls A and B had many similarities with respect to mining conditions, support design, and operational procedures.

GEOLOGY

The mining conditions at longwalls A and B were very similar. Longwall A was located in the Lower Kittanning coal seam, with a mining height of about 5 ft. The mining face was horizontal, with no major irregularities in the coal seam. The immediate roof was composed of 48 ft of dark-to-medium-gray hard shale. This roof was very competent in front of the canopy tips and caved readily at the rear of the supports. Its assumed compressive strength was 10,000 psi. The floor was a dark-to-medium-gray claystone of excellent quality. The cover over the panel was 320 ft deep and was formed of thick sandstone and shale strata interlaced with thin coal seams.

Longwall B was located in the Campbell Creek coal seam. The mining height was approximately 6 ft. The coal seam had no major irregularities and was relatively flat. The immediate roof consisted of

5 ft of a gray hard shale overlain by 32 ft of gray sandstone. This roof behaved very well, being competent in front of the canopy tips and caving readily behind the supports. (Its compressive strength was also 10,000 psi). The floor was a gray sandstone of excellent quality which provided a firm surface for the support bases. The cover over the panel was 500 ft deep and was composed of thick sandstone and shale strata interlaced with coal.

Thus, both longwalls had excellent mining conditions.

SUPPORTS

The supports used at the two longwalls were identical: four-legged lemniscate shield supports, each with a 55-ft^2 canopy bearing area. The setting pressures and yield loads of these supports were 4,350 psig and 564 tons, respectively. The side seals on the flushing shield were spring-activated with hydraulic override. The supports could be moved in the contact-advance mode from a bidirectional adjacent control.

The strong shale roof at both longwalls was assumed to have had a compressive strength of 10,000 psi. The load density set on the roof by the support at a setting pressure of 4,350 psig was 113.9 psi, resulting in a roof loading factor of 87.7 (roof compressive strength/load density at set pressure) at both longwalls. This roof loading factor indicated that the roof had a strong resistance to crushing under the setting loads of the supports.

OPERATIONAL PROCEDURES

Both longwalls A and B used a unidirectional cutting sequence with contact advance of supports in one of the cutting directions. Also, each mine maintained good horizon control during mining. Contact advance and good horizon control reduce the amount of debris that is reground and crushed into respirable dust.

Also, both longwalls applied water to the roof to reduce dust entrainment when supports were moved. Longwall A freewheeled the leading drum near the roof during the cleanup pass to apply water. Longwall B wet the roof using a venturi spray mounted on the shearer body and directed downstream at an angle of approximately 45° relative to the roof. The average velocity of the air at the face, traveling in a head-to-tail direction, was 580 ft/min for longwall A and 289 ft/min for longwall B.

LONGWALLS WITH MODERATE CONCENTRATIONS OF SUPPORT-GENERATED DUST

At four of the longwalls surveyed (longwalls C, D, E, and F), moderate amounts of respirable dust were generated by the supports. Average respirable dust concentrations measured with gravimetric samplers were between 0.5 and 2.0 mg/m^3. Average respirable dust concentrations measured with the RAM's ranged from 0.6 to 2.4 RAM units.

A typical example of instantaneous dust concentrations measured at a longwall with moderate amounts of support-generated dust (longwall F) is shown in figure 3. Again, the difference between the immediate downwind and upwind concentrations measured during support movement (the shaded area) represented the dust generated by the supports. Peak support dust concentrations were measured at areas of the face with deteriorated roof conditions. The average downwind dust concentration was 2.0 RAM units, and the average upwind dust concentration was 0.3 RAM unit, resulting in an average dust concentration of 1.7 RAM units generated by the supports. The corresponding difference between the downwind and upwind gravimetric sample concentrations yielded an average dust concentration of 1.5 mg/m^3. The other longwalls (C, D, and E) also had moderate dust concentrations, and instantaneous peak concentrations similar to those measured at longwall F were measured at deteriorating roof areas along their faces.

GEOLOGY

Longwalls C, D, E, and F were located in three different coal seams, but had similar mining conditions. Longwall C was located in the 6-ft-thick Eagle Seam. Longwall D was located in the 6-ft-thick Pittsburgh Seam. Longwalls E and F were

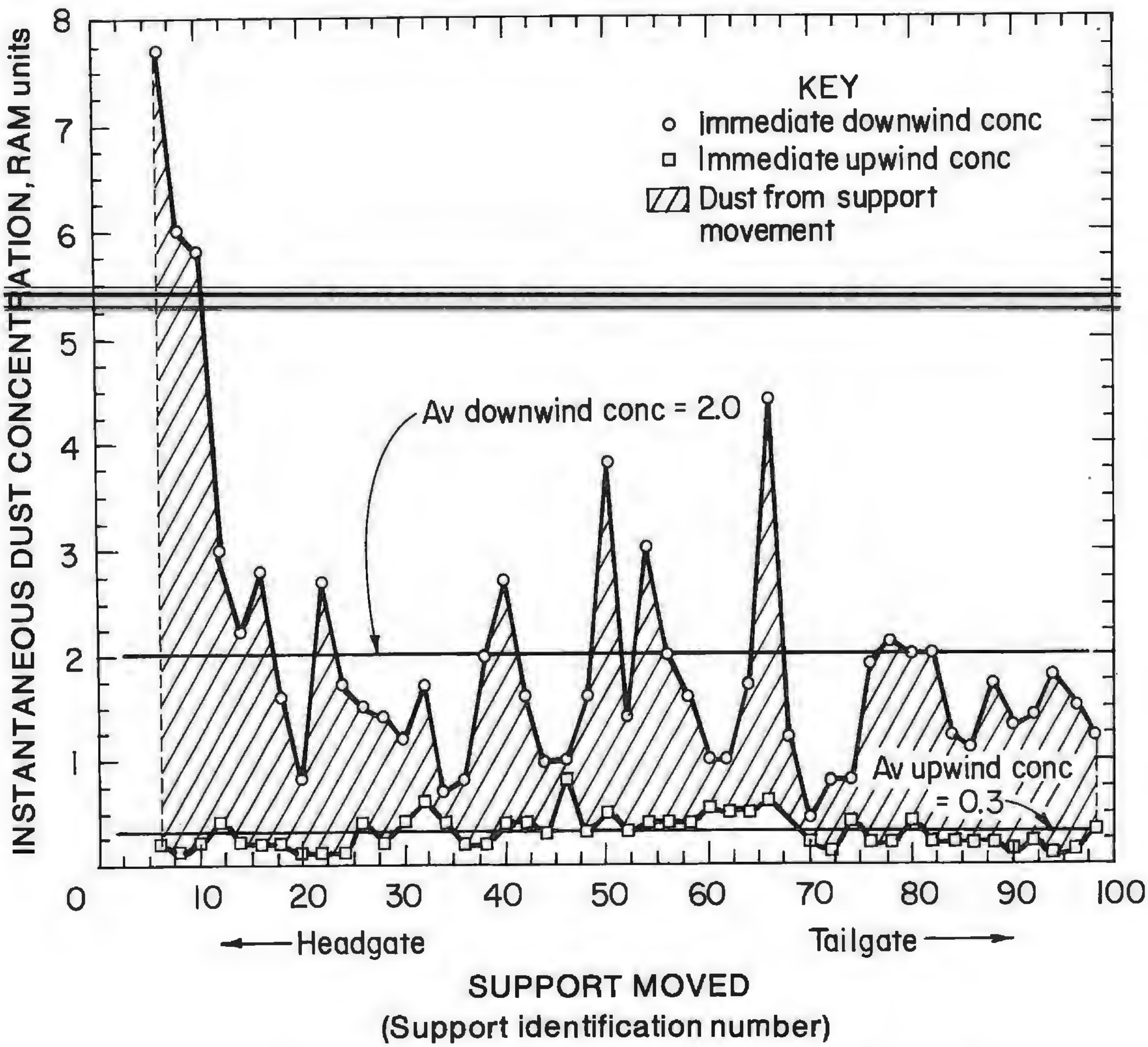

FIGURE 3. - Instantaneous roof support dust concentrations at longwall F.

located in the 9-ft-thick Blind Canyon Seam. No major seam irregularities occurred at any of these longwalls except at longwall D, which had 1 ft of rock parting in the middle of the seam. Each of the longwalls had a fairly soft friable roof composed of shale (longwall C), coal (longwall D), or siltstone (longwalls E and F). The floor at longwalls C and D was a wet, soft shale; at longwalls E and F, the floor was a wet, soft mudstone.

Depths of cover over the longwall panels ranged from 430 to 1,600 ft. In general, the longwalls under greater depths of cover had somewhat higher concentrations of support-generated dust. The stratigraphic composition of the overburden for longwalls C, D, E, and F consisted mainly of shales, sandstones, limestones, siltstones, and coal seams.

General mining conditions for these longwalls were fair to good.

SUPPORTS

All four longwalls used two-legged lemniscate shields that were basically similar in design, but with some differences. The shields used at longwalls C, E, and F had extendable forepoles. The canopy areas with the forepoles retracted were 42.0, 42.8, and 42.8 ft^2, respectively; with the forepoles extended, they were 52.7, 59.0, and 59.0 ft^2, respectively. The shields used at longwall D had no forepoles and had a canopy area of 50.7 ft^2. The setting pressure for longwalls C, E, and F as 4,350 psig; for longwall D, it was 4,000 psig. Yield loads at longwalls C, D, E, and F were 426, 352, 472, and 472 tons, respectively. The canopy areas with the forepoles retracted were used for the load-density calculations for longwalls C, E, and F because the forepoles were not extended on most of the shields at these faces.[7] The side seals on the flushing shields at these longwalls were spring-loaded with hydraulic override, and the supports could be moved in the contact-advance mode from a bidirectional adjacent control.

Loading densities exerted on the roofs at longwalls C, D, E, and F were 134.7, 40.3, 108.3, and 108.3 psi, respectively. At longwall D, the load density on the roof was significantly lower because of the fairly large canopy area and smaller props on the longwall D shields. The roof loading factors (roof compressive strength/average set load density) for longwalls C, D, E, and F were 29.7, 16.1, 36.9, and 36.9, respectively. These factors were significantly lower than the roof loading factors of longwalls A and B, indicating that the roofs over longwalls C, D, E, and F were more susceptible to crushing and grinding during support movement.

OPERATIONAL PROCEDURES

Each of these four mines advanced the supports during the head-to-tail pass. Longwalls E and F did not utilize contact advance; longwalls C and D utilized contact advance in some areas of the face where the floor was strong enough to keep the supports from digging in.

At all four longwalls, the floor and roof were cut fairly evenly. However, the supports would sink or dig into the floor, and some of the weaker roof areas would break off in front of the canopy tips, leaving cavities on top of the canopies. These cavities developed highly stressed roof-contact areas that fractured and crushed. When the supports were dropped significantly before being advanced, a thick layer of debris would build up on the canopy, and this debris was subject to further crushing and grinding during set loading. At longwalls C and D, the support movers lowered the front of the canopy and cleaned the debris off some of the shields into the panline. This was a very dusty operation and was conducted upwind of the shearer operators and other face personnel. If debris needs to be cleaned off the canopies, it should be done downwind of all workers. One longwall (longwall F) utilized spray manifolds on the shields to suppress support dust.

Ventilation airflow was less than 200 ft/min at three of these longwalls. Longwalls C, E, and F had average face air velocities of 167, 184, and 179 ft/min. Longwall D had an average face airflow of 402 ft/min.

LONGWALLS WITH HIGH CONCENTRATIONS OF SUPPORT-GENERATED DUST

At two of the longwalls surveyed (longwalls G and H), large amounts of respirable dust were generated by the support movement, with average respirable dust concentrations above 2.0 mg/m^3 as measured with gravimetric samplers. Average respirable dust concentrations measured with the RAM exceeded 2.0 RAM units.

A typical example of instantaneous dust concentrations at a longwall with large amounts of support-generated dust (longwall G) is shown in figure 4. Again, the shaded area between the two curves represents the dust generated by supports. The average downwind and upwind RAM measurements were 6.1 and 0.6 RAM units,

[7]The forepoles would be utilized mainly to catch loose material separated from the roof in some areas of the face. Therefore, there was probably very little if any loading of the roof with the forepoles.

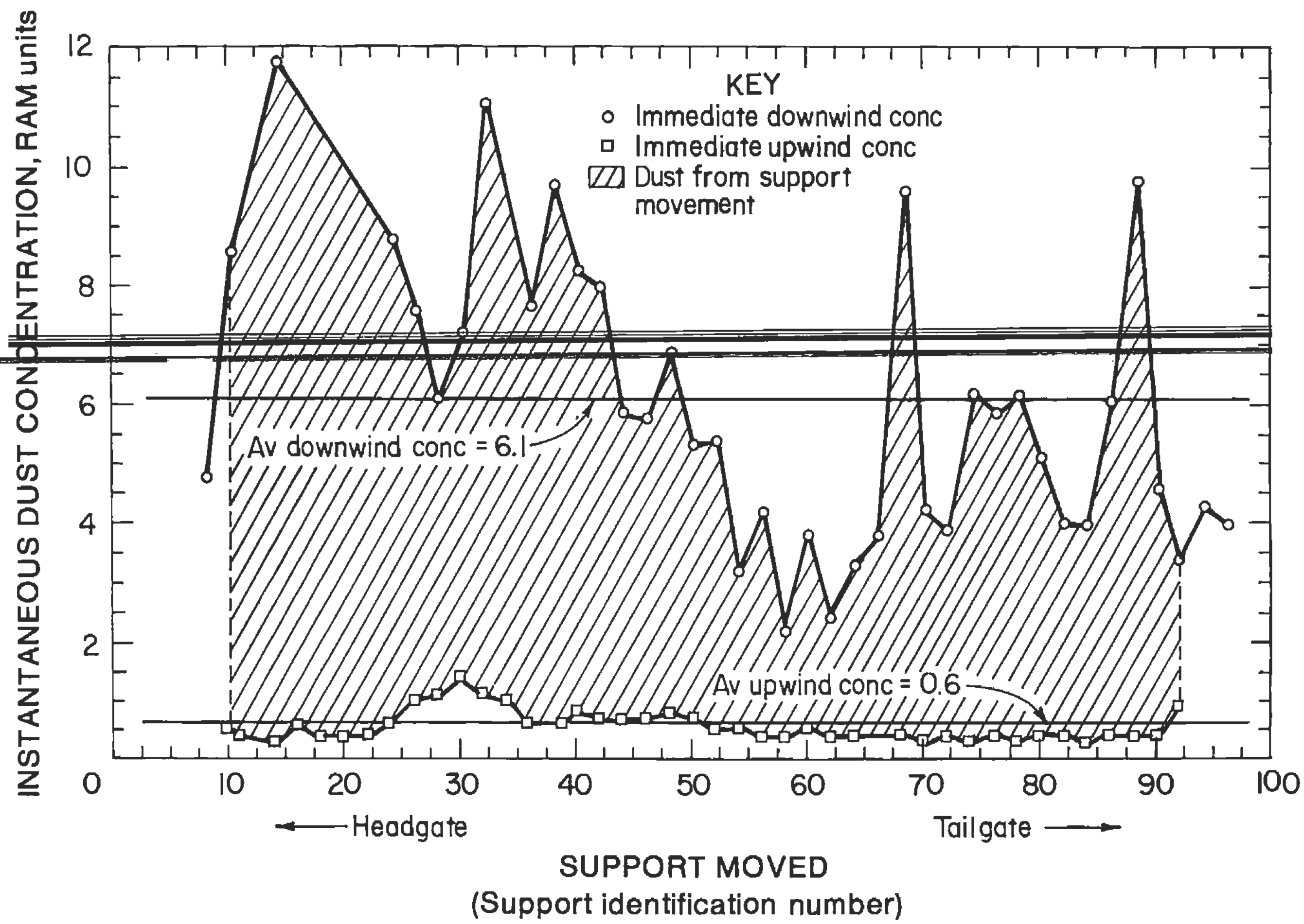

FIGURE 4. - Instantaneous roof support dust concentrations at longwall G.

respectively. The amount of dust generated by the supports varied significantly along the face. The highest and lowest dust concentrations measured downwind of the supports were 11.8 and 2.2 RAM units, respectively. Less dust was generated by the supports at longwall H, but the amount of dust generated was still significant. The average RAM and gravimetric measurements of support-generated dust for both longwalls were 2.6 RAM units and 3.0 mg/m^3. Instantaneous RAM measurements showed that support dust concentrations varied at longwall H but were more consistent than at longwall G.

GEOLOGY

Mining conditions at longwalls G and H were similar. Longwall G was located in the Hiawatha coal seam, with a mining height of about 8 ft. The mining face was horizontal, with no major irregularities in the coal seam. The immediate roof was composed of 1 ft of coal overlain with 10 ft of sandstone. This roof was fairly competent in front of the canopy tips and caved readily at the rear of the supports. The assumed compressive strength of the coal roof was 650 psi. The floor was a dry sandstone of excellent quality and provided a firm surface for the support based. Overlying this longwall panel was 1,600 ft of overburden composed of sandstones, mudstones, siltstones, shales, and coal seams.

Longwall H was located in the E-Seam. This coal seam is characterized by local thickening and thinning due to the presence of rolls in the coalbed. The strata above the coal seam are composed of sandstone, shale, and mudstone. The seam is fairly flat, with a 2° to 3° dip in the northern direction. At the longwall panel, 8 ft of coal was mined, limited by the maximum support height, leaving 1 ft of coal for the immediate roof below the sandstone strata above the seam. This roof was fairly competent in front of the canopy tips and caved readily at the rear of the supports. The assumed compressive strength of the coal roof was 650 psi. The floor was a hard, dry shale and provided a firm surface for the support bases. Overlying this longwall panel was 2,200 ft of overburden composed of sandstones, mudstones, siltstones, shales, and coal seams.

SUPPORTS

The supports used at longwalls G and H were similar in design. Supports at longwall G were two-legged lemniscate shields with a 57.6-ft^2 canopy bearing area. The setting pressures and yield loads of the supports were 4,350 psig and 472 tons, respectively. Longwall H also had two-legged lemniscate shields, but the canopy bearing area was 54.0 ft^2, the setting pressure was 4,500 psig, and the yield load was 440 tons. At both longwalls, the side seals on the flushing shields were spring-activated with hydraulic override. The supports could be moved in the contact-advance mode from a bidirectional adjacent control.

Since the immediate roof at both longwalls was coal, it was assumed that the roof at both mines had a compressive strength of 650 psi. Load densities exerted on the roof by the supports at longwalls G and H were 73.6 and 80.6 psi, yielding roof loading factors of 8.8 and 8.1, respectively, indicating a tendency of the roof to crush and grind under setting loads.

OPERATIONAL PROCEDURES

Longwalls G and H used a unidirectional cutting sequence with contact advance of supports during the head-to-tail pass. Horizon control was maintained fairly well. Ventilation at G and H was head-to-tail, with average face airflows of 650 and 355 ft/min, respectively. Mining conditions at these longwalls were fairly good. The large amounts of roof support dust seemed to be generated by the easy crushing and grinding of the coal roof during advance and setting of the supports. The airflow at longwall G was quite high, which could have contributed to the entrainment of support-generated dust.

FACTORS AFFECTING DUST GENERATED BY SUPPORTS

Eight longwalls were surveyed and categorized according to the amount of respirable dust generated by roof supports (low, moderate, and high). Within these categories, similarities were observed, mainly with respect to mining conditions (geology). Mining conditions determined by the coalbed geology seemed to be the main factors affecting support dust generation.

ROOF STRENGTH

Strong shale roof seemed to generate the least amount of dust during support movement (< 0.5 mg/m^3). The weaker shale and siltstone roofs generated moderate amounts of dust during support movement (> 0.5 mg/m^3 and < 2.0 mg/m^3). Longwalls that left an immediate coal roof (lowest compressive strength) because of weak strata above the coal or limits of the longwall equipment had the highest amounts of support-generated dust (> 2.0 mg/m^3). Thus, there appears to be an inverse relationship between roof strength and support-generated dust. Figure 5 shows the relationship of the roof loading factor to dust concentration. Usually, the lower the roof-loading factor (roof compressive strength/load density exerted on roof by canopy), the weaker the roof. The dust concentrations plotted in figure 5 were the average RAM measurements of support dust at each longwall; using the gravimetric dust data instead of the RAM measurements yielded the same relationship.

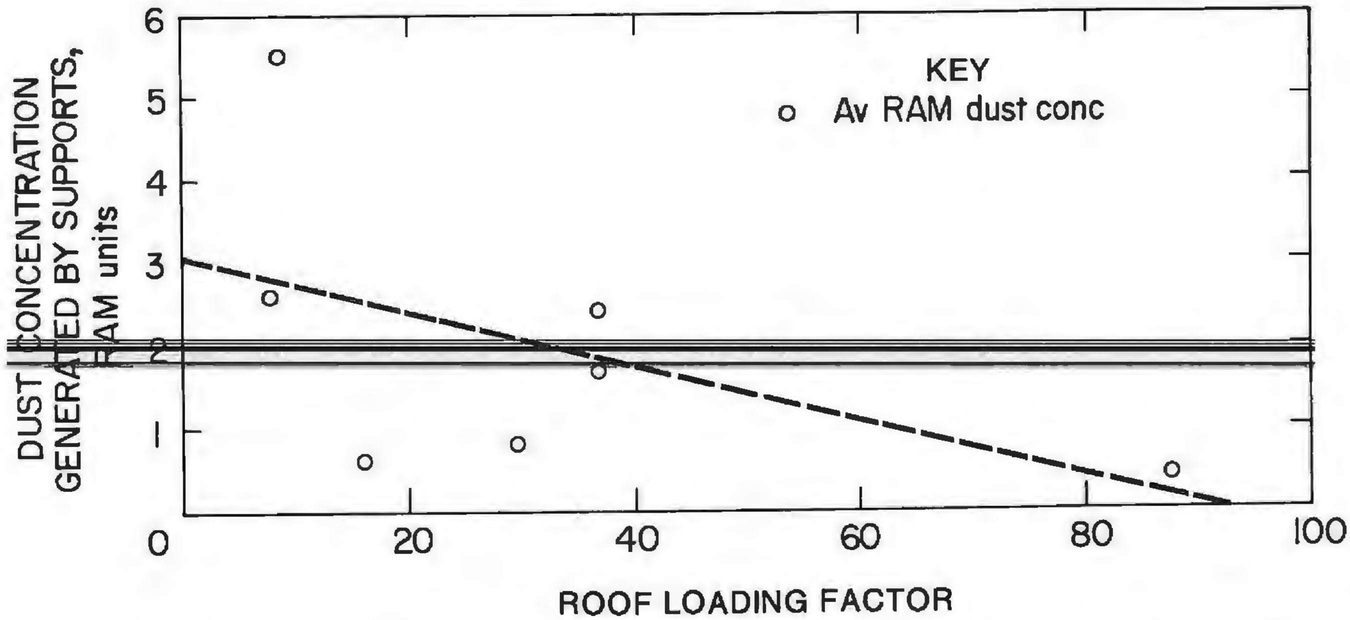

FIGURE 5. - Relationship between roof loading factor and average support dust concentration at surveyed longwall faces.

DEPTH OF COVER

Another geologic factor that seemed to affect the amount of support-generated dust was the depth of cover over the coal seam. At the eight longwalls studied, the support-generated dust seemed to increase as overburden above the seam increased. In figure 6, seam depth is plotted against average RAM concentrations of the support dust at each longwall. The gravimetric data for these longwalls showed the same trend. As depth of cover increases, vertical and horizontal stresses in the strata increase, usually producing more pronounced fracturing of the strata. Also, deeper strata usually have more in situ stresses in all directions. Generally, fractured and highly stressed rock strata are weaker and less competent during mining, which may make them more susceptible to crushing and grinding by longwall roof supports.

SHIELD DESIGN

The longwall roof supports at the eight longwalls were either two- or four-legged lemniscate shields. Their designs did not seem to be as strong a factor in dust generation as roof strength. The only major difference between the two-legged and four-legged shields was that the four-legged shields distributed floor loads more evenly throughout the bases. Other differences between the shields were their prop sizes and canopy areas, which produced different load densities exerted on the roof with approximately the same setting pressures. However, there seemed to be no relationship between the load densities alone and support-generated dust. A relationship did appear when the load densities exerted on the roof and the roof strength were utilized together to determine the roof-loading factor.

OTHER FACTORS

Other factors that may influence the generation of support dust are horizon control, contact advance, water application, and face airflow. Good horizon control should be maintained by the shearer or plow. When irregularities occur in the roof and floor, the bearing areas of the supports make contact with only a portion of the roof or floor and will crush out these areas due to high stress. All the longwalls included in this study maintained good horizon control. However, at longwalls C, D, E, and

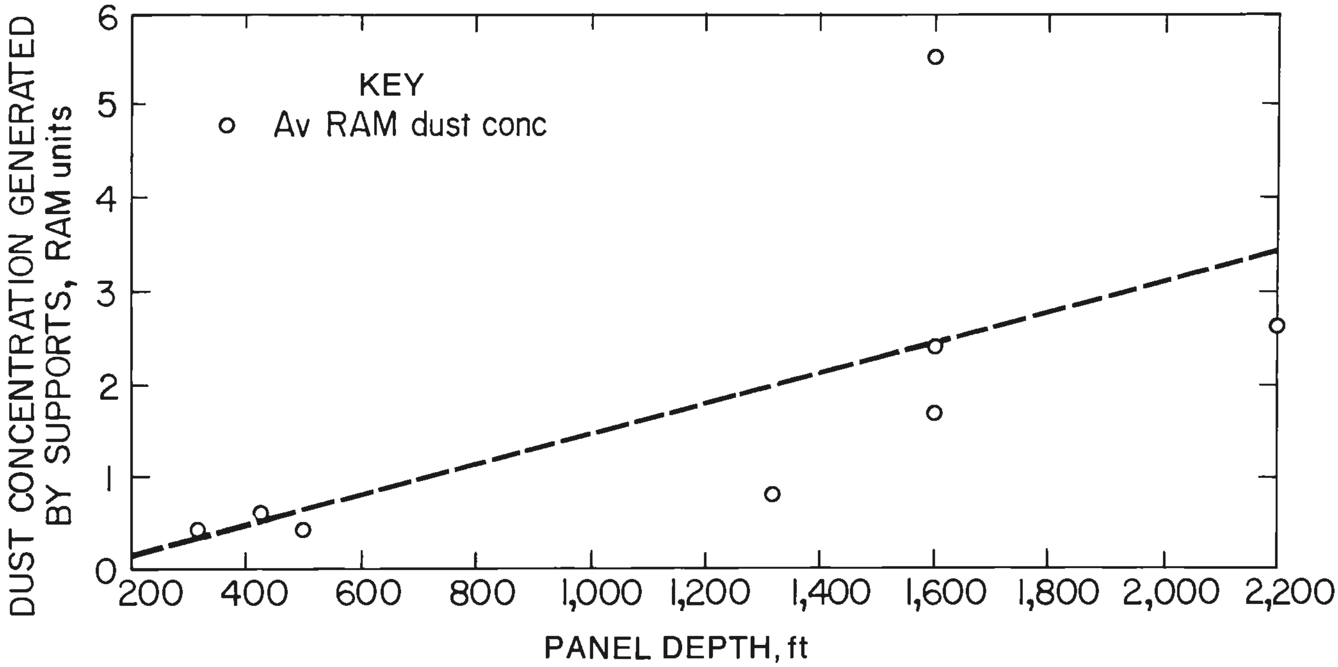

FIGURE 6. - Relationship between panel depth and average support dust concentration at surveyed longwall faces.

F, the roof broke off in front of the canopies, leaving cavities in the roof and above the support canopies after they were advanced. The smaller contact area between the roof and support canopies was highly stressed and fractured. When the support was lowered to be moved, debris accumulated on the canopy and was further crushed under setting loads, producing respirable dust. To reduce debris buildup, contact advancement of the supports should be utilized to scrape the debris off the canopies as the supports are advanced.

Water application on the immediate roof may also help reduce support-generated dust. The residual moisture on the roof should suppress some of the dust during the crushing and grinding action of roof supports. At longwalls A and B, which had the least support-generated dust, the roof was wet with the shearer. However, it was difficult to determine what effect the water had on the roof support dust because these longwalls had the strongest roofs and the best mining conditions.

Airflow can also affect dust concentrations. If the air velocity along the face is maintained in a moderate range, from 350 to 600 ft/min, good dust diffusion and dilution can be achieved some distance downwind from the generating source, as shown in figure 7 (3). Below this range, dust levels can be significantly higher because of inadequate dilution and diffusion. Above this range, dust levels can also be significantly higher because of dust entrainment at higher airflows. However, this trend was not observed in the present study because support dust measurements were made adjacent to support movement, not allowing sufficient time for diffusion and dilution.

SUPPORT DUST CONTROL TECHNOLOGY USED IN THE UNITED STATES

Several support dust control techniques were observed to be in use or on trial in the United States. These techniques involve water application and/or support movement practices. The effectiveness of some of these techniques is unknown, and some of them may be impractical for certain longwall operations.

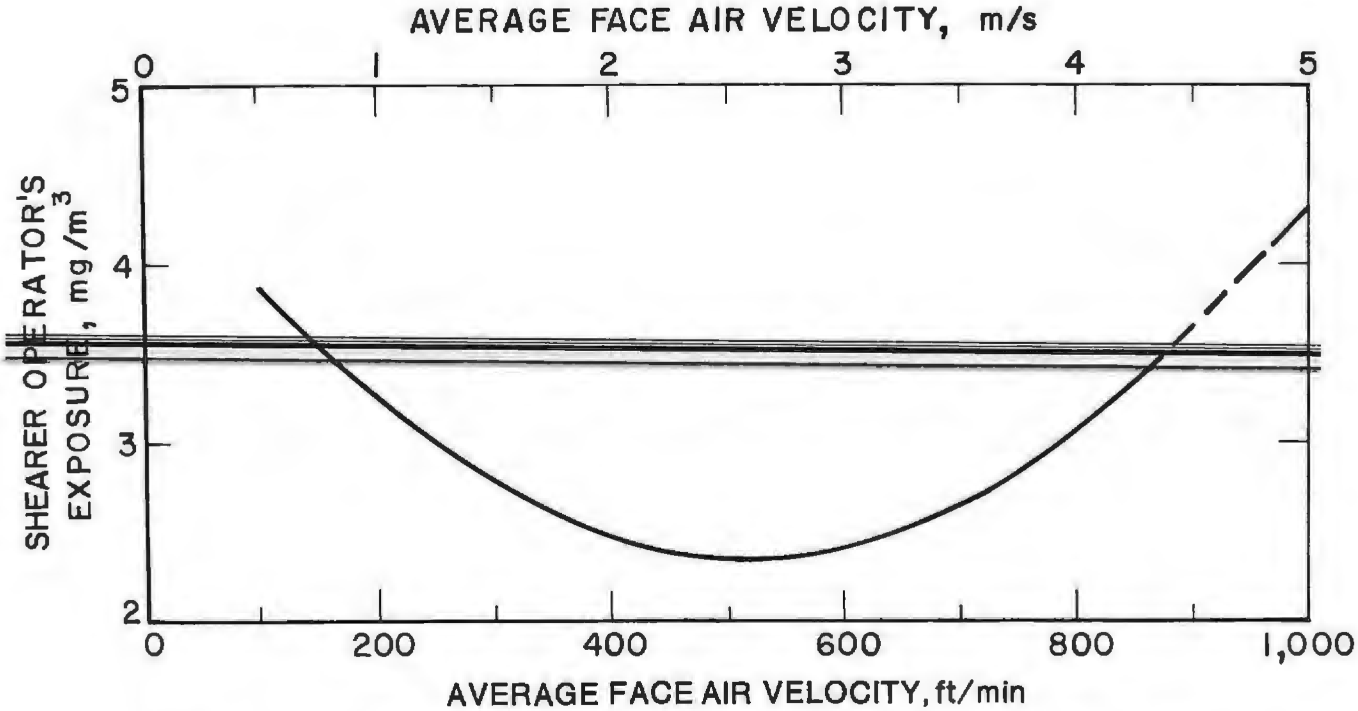

FIGURE 7. - Relationship between face air velocity and dust levels at the face (3).

WATER APPLICATION

Several water application techniques for longwall support dust control currently practiced in U.S. coal mines are discussed briefly below.

Support Washdown. - One shearer operator uses a shearer water hose to hose down the supports and roof during the head-to-tail or tail-to-head pass. The residual moisture reduces dust entrainment when the supports are moved. For this procedure to be effective, sufficient water must be supplied to the shearer so that its internal and external water systems are not affected during washdown.

Wetting Immediate Roof With Shearer Water. - This can be done in several ways. One way is to maintain sufficient water pressure at the drum sprays to wet the roof while it is being cut. Also, during the cleanup pass in a unidirectional operation, the lead drum, which typically will not be cutting much material, can be freewheeled near the roof, allowing the water sprays to wet the roof. Another alternative is to spray the unsupported roof using one or several water sprays mounted on top of the shearer body, directing the water with the airflow and upward at an angle of approximately 45°.

Mounting Water Sprays on Support Canopies Over Panline. - Water sprays can be mounted on the support canopies in several ways. Usually several sprays are directed down at the face and in the direction of the airflow from a manifold at every tenth support (fig. 8). Their purpose is to humidify the face area to suppress support dust generation. The suppression effectiveness of these sprays has not been documented; however, studies indicate that they actually move air and help diffuse and dilute the dust from supports. Drawbacks are that these sprays are difficult to maintain and tend to wet the face personnel.

OTHER DUST CONTROL PRACTICES

Where water application might deteriorate the roof and floor, the practices described below are employed during support movement to reduce the dust exposure of face workers; these practices can also be used in conjunction with water.

FIGURE 8. - Spray manifold located on support canopy.

Minimizing Debris on Top of Canopies. - Debris on top of shield canopies can be minimized by contact advancing supports (shields) so that the debris can be scraped off the canopies into the gob. This avoids crushing and grinding of debris during support movement and thereby generally reduces respirable dust generation (fig. 9) (4). Also, maintaining good horizon control during mining yields more contact area between the support canopy and the roof, which reduces highly stressed areas on the roof and minimizes spaces or cavities where debris can build up.

Advancing Supports During Pass Cycle Against Airflow. - This practice can be employed on unidirectional operations, allowing all face personnel to work on the intake-air side of support advance. When the pass cycle against airflow is used as a cleanup pass, dust levels generated by the shearer are low, and although the support movers are on the return-air side of the shearer, the dust exposure levels they are subjected to can be kept low. When the primary cut is taken against the airflow, a properly designed external shearer water-spray system (shear clearer) can confine shearer-generated dust against the face for approximately 40 ft (fig. 10), thus maintaining an acceptable dust-exposure level for the support movers immediately downwind of the shearer (5).

Diluting and Diffusing Support Dust When Supports Are Advanced With Airflow. - It is not always possible to advance supports only on the return-air side of the shearer. Roof conditions may necessitate support advance immediately after the shearer cuts the face.

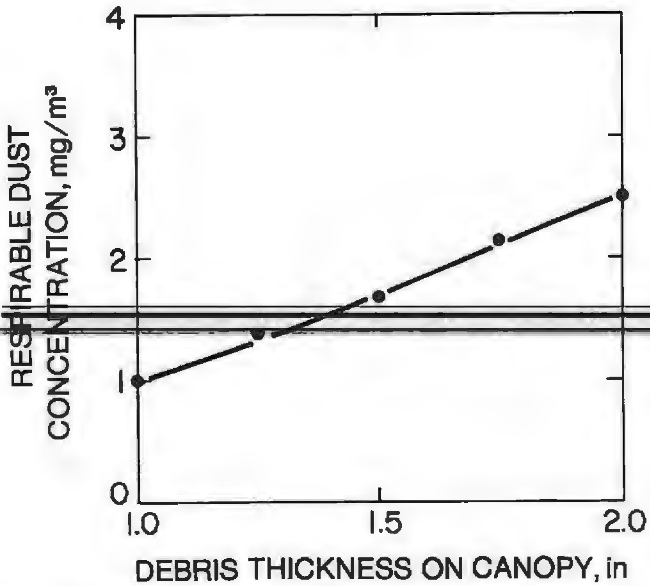

FIGURE 9. - Relationship between debris thickness on shield canopy and dust generated (4).

Bidirectional cutting requires support advance during both directional passes. In some operations, it may not be possible to install an external water-spray system capable of confining the dust against the face for any substantial distance downwind of the shearer. Under these circumstances, the most feasible method of dust control is to dilute and diffuse the dust by increasing the distance between support movement and the shearer. Figure 11 shows how dust levels in the walkway decrease with increases in distance downwind from support movement. Based on the walkway dust levels shown in figure 11, it is recommended that a distance of at least 50 ft be maintained between support movement and the shearer. Increasing the face airflow also promotes dilution and diffusion (6). However, face velocities should not exceed 600 ft/min, to prevent dust entrainment.

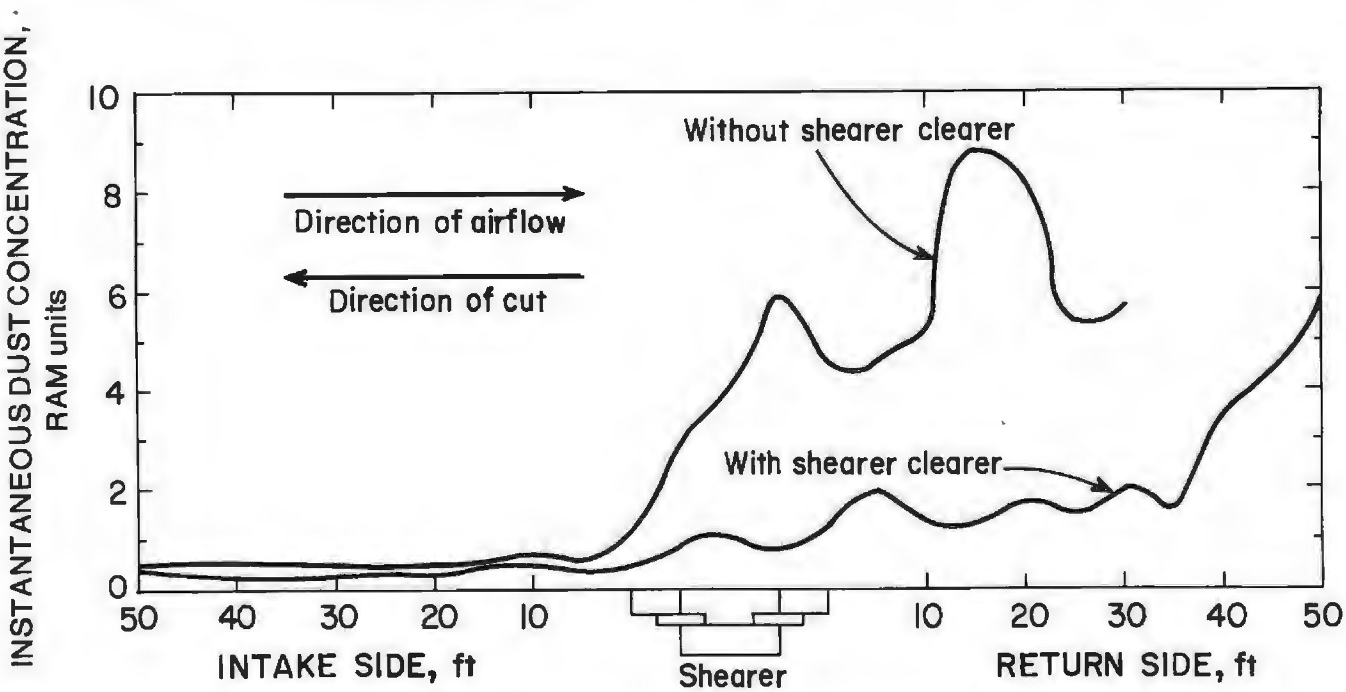

FIGURE 10. - Effectiveness of shearer-clearer system.

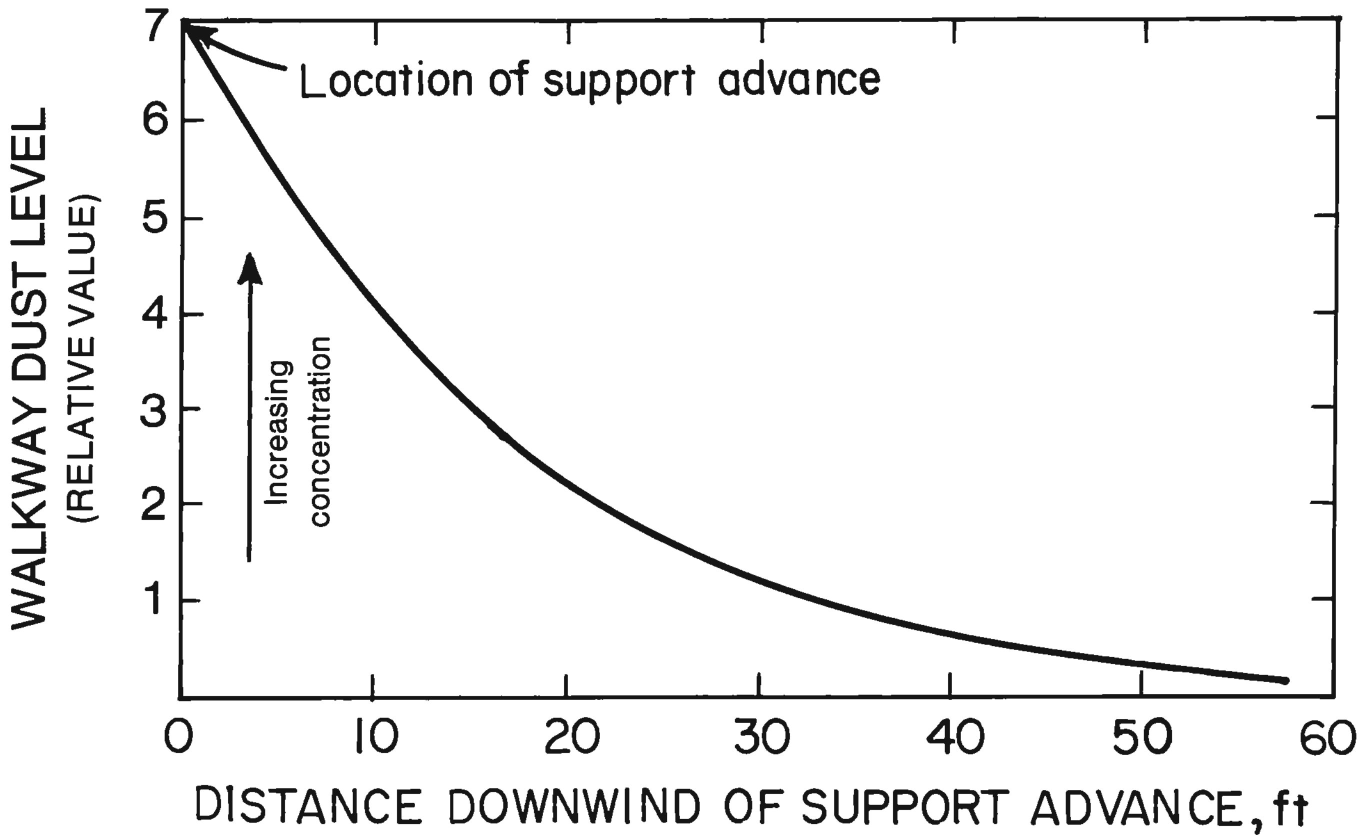

FIGURE 11. - Relationship between distance downwind of support movement and dust level.

CONCLUSIONS

Although several factors can affect the amount of respirable dust generated by longwall supports, this study indicates that geologic conditions (roof conditions and depth of cover) are the most significant factors. The amount of support dust generated was inversely related to roof strength and directly related to depth of cover over the longwall panel. Some techniques for controlling support dust generations are currently in use. Although some of these techniques have limitations, they should be applied if support-generated dust makes up a significant portion of the face personnel's overall dust exposure.

Further research and development are needed to advance longwall support dust control technology, to improving efficiency and to overcome the limitations of the existing techniques. The objective of this research should be improved support design. One area that needs to be addressed is reducing stresses on host strata from supports while maintaining acceptable roof convergence. Certain roof types are more susceptible to crushing and grinding from longwall roof supports, and therefore they generate more dust during support movement. An improved seal between supports needs to be developed to prevent the dust from the roof and gob areas from entering the face area. It appears that the side seals presently used on supports allow a significant amount of dust to seep into the face area from the gob and roof. Finally, a reliable automated support advance system would allow all face personnel to be positioned upwind of the dust generated by support movement.

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7. _____. Improved Respirable Dust Monitor. Technol. News 72, Oct. 1979.

APPENDIX A.--DATA FROM LONGWALL SURVEY

TABLE A-1. - Numerical data from survey

	Longwall[1]							
	A	B	C	D	E	F	G	H
Seam thickness................ft..	5	6	6	6	9	9	8	8
Seam depth....................ft..	320	500	1,320	430	1,600	1,600	1,600	2,200
Roof strength (est)..........psi..	10,000	10,000	4,000	650	4,000	4,000	650	650
Canopy area.................ft^2..	55.0	55.0	42.0	50.7	42.8	42.8	57.6	54.0
Setting pressure............psig..	4,350	4,350	4,350	4,000	4,350	4,350	4,350	4,500
Av set load density on roof								
tons/ft^2..	8.2	8.2	9.7	2.9	7.8	7.8	5.3	5.8
psi..	113.9	113.9	134.7	40.3	108.3	108.3	73.6	80.6
Roof loading factor[2].............	87.7	87.7	29.7	16.1	36.9	36.9	8.8	8.1
Yield pressure..............psig..	5,440	5,440	4,570	9,580	6,150	6,150	6,730	6,300
Yield load..................tons..	564	564	426	352	472	472	472	440
Av face air velocity......ft/min..	580	289	167	402	184	179	650	355
Av support dust conc along face:								
RAM.................RAM units..	0.4	0.4	0.8	0.6	2.4	1.7	5.5	2.6
Gravimetric.............mg/m^3..	0.3	0.1	1.7	1.0	1.3	1.5	10.7	3.0

Av Average. conc Concentration. est Estimated.

[1]See table A-2 for description of longwalls.

[2]Average roof strength/average set load density.

TABLE A-2. - Descriptive data from survey

Longwall	Coal seam	Roof type	Floor type	Shearer horizon control	Support type	Support advance procedure	Support dust control practices
A.......	Lower Kittanning.	48 ft hard shale.	Hard, dry clay.	Good...	4-legged shield.	Contact advance, tail-to-head cleanup.	Wet roof with free-wheeling head drum, head to tail.
B.......	Campbell Creek.	5 ft hard shale..	Dry sand-stone.	...do..	...do...	Contact advance, head-to-tail cut.	Wet roof with drums and venturi.
C.......	Eagle.......	1/2 ft soft shale; 9 ft hard shale above.	Soft, wet shale.	Fair...	2-legged shield.	Semicontact advance, head-to-tail cleanup.	None.
D.......	Pittsburgh..	1 ft coal; 4 ft soft shale above.	...do....	Good...	...do...	Semicontact advance, head-to-tail cut.	Do.
E.......	Blind Canyon	4 ft soft silt-stone; bottom carbonaceous.	Soft, wet mudstone.	Fair...	...do...	Noncontact advance, head-to-tail cleanup.	Do.
F.......	...do.......	...do...........	...do.....	...do..	...do...	...do..........	Spray manifold on canopy every 5th shield.
G.......	Hiawatha....	1 ft coal, 10 ft sandstone above.	Hard, dry sand-stone.	Good...	...do...	Contact advance, head-to-tail cleanup.	None.
H.......	E-Seam......	1 ft coal; sand-stone above.	...do....	...do..	...do...	...do..........	Do.

APPENDIX B.--DUST-SAMPLING STRATEGY[1]

Support-generated dust was sampled with both instantaneous and gravimetric samplers. The instantaneous sampler used was the GCA Real-Time Aerosol Monitor (RAM). This is a light-scattering instrument that measures the volume of respirable dust in a volume of air instantaneously (7). Its numerical output is in RAM units, which approximate respirable dust concentrations in milligrams per cubic meter. The gravimetric samplers consisted of a pump, cylone, and filter: A Dupont model P-2500 pump drew 2 L/min of air through a 10-mm Dorr-Oliver nylon cyclone and deposited the respirable dust on a 5-μm MSA preweighed cassette filter. This sampler gave an average weight per unit volume of air in milligrams per cubic meter.

The amount of respirable dust generated by support movement was measured by two people, each using one RAM and two gravimetric samplers. Samples were taken on the immediate upwind side of each support moved and on the immediate downwind side of each support moved. Sampling followed support movement along the face, with gravimetric samplers continuously running and RAM measurements taken at every other support. The difference between the downwind concentrations and the upwind concentrations indicated the amount of dust generated by supports (shaded areas between curves in figures 2, 3, and 4).

RAM measurements were also made at some faces to determine the effect of ventilation on the diffusion and dilution of support dust. These measurements were made in an area of the face during movement of about 12 supports. Sampling was conducted from a stationary position downwind of all the supports to be moved. During the advance of each support, the dust concentration at the stationary position was measured and the distance from the support moved was recorded. The concentrations measured at various distances from the supports were used to show how support-generated dust is diluted and diffused by face ventilation, yielding lower dust concentrations at greater distances downwind of support movement.

[1]Dust concentrations were measured only during support movement and cannot be directly related to an 8-h average exposure for compliance purposes.

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No.	Records	Request
1	1	pb85107241*
2	1	pb84182088*
3	2	pb85107241* or pb84182088*
4	627	respirable
5	6727	dust
6	425	longwall
7	1998	roof
* 8	1	(respirable dust in ti) and (longwall roof in ti)

Record 1 of 1 - NTIS 1985(#14-26), 1986-1990(#1-21)

TI: Factors Affecting <u>Respirable</u> <u>Dust</u> Generation from <u>Longwall</u> <u>Roof</u> Supports. Information circular/ 1985.
AN: PB85236453XSP
AU: Organiscak-J.A.; Listak-J.M.; Jankowski-R.A.
CS: Performer: Bureau of Mines, Pittsburgh, PA. Pittsburgh Research Center.
RD: 1985. 27p.
PY: 1985
CI: UNITED-STATES
LA: ENGLISH
PR: PC A03/MF A01
DE: Coal-mining; Dust-control; Geology-; Mining-equipment; Air-pollution; Cutting-; Shields-; Roofs-; Supports-; Concentration-Composition.
DE: *Coal-dust; *Caving-mining.
ID: *Pollution-control.
SC: Earth-sciences-and-oceanography-Mining-engineering (8I); Natural-resources-and-earth-sciences-Mineral-industries (48A); Environmental-pollution-and-control-Air-pollution-and-control (68A)
CC: 8I, 48A, 68A, 8, 48, 68
AB: The Bureau of Mines conducted a survey of eight shearer longwall operations to identify factors that affect respirable dust generation from longwall roof supports. The longwalls surveyed were in coal seams located in different geographic regions of the United States. Data were collected on mining (geologic) conditions, support design, operational characteristics, and amount of respirable dust generated from roof supports. Several practices are currently employed to effectively control roof support dust.
AG: DIBM
CA: 004993027
RN: BUMINESIC9019
UD: 8524

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