Impact of control parameters on shearer-generated dust levels

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Abstract
Previous research on continuous mining operations has shown that significant interactions exist between dust-control parameter application and the resulting respirable dust levels. However, simply increasing the level of the controls does not guarantee a reduction in respirable dust levels. Full-scale laboratory tests are being conducted to provide information to longwall operators that would assist them in selecting control parameters to reduce dust levels for mine-specific conditions. The interactions between face air velocity, shearer water quantity, drum water spray pressure, external water spray pressure and spray system design were evaluated in a simulated 2.13-m (7-ft) coal seam for two cutting directions. Locations around and downwind of the shearer were monitored to evaluate relative changes in respirable dust levels as a function of each control parameter.

Introduction
During the past 15 years, there have been dramatic improvements in longwall mining operations. In 1999, the average horsepower used on the shearer was 1,180 hp compared to 381 hp in 1984. Today, approximately 75% of longwall mines operate with shearer horsepower ≥1,000 hp. One-third of the longwall faces have face widths greater than 305-m (1,000-ft) and panels that measure 3,050-m (10,000-ft) or longer (*Coal Age*, 2000). Longwall mining now accounts for approximately 50% of the coal produced in underground US coal mines. The increase in longwall coal-extraction rates has resulted in far more dust being generated. Consequently, more dust must be controlled.

During the period 1995 through 1999, mine operators and Mine Safety and Health Administration (MSHA) inspectors collected 9,968 and 1,365 dust samples respectively, from longwall designated occupation (DO) personnel. The samples showed that 1,970 (20%) of the mine operator samples and 258 (19%) of the MSHA samples (Niewiadomski, 1999) exceeded the 2 mg/m^3 dust standard. Pneumoconiosis continues to be a very serious health threat to underground coal mine workers. The results of a recent (1992 through 1996) Coal Worker's X-ray Surveillance Program (NIOSH, Department of Health and Human Services, 1999) indicated that approximately 8% of the miners that were examined with at least 25 years of mining experience were diagnosed with coal worker pneumoconiosis (CWP) (category 1/0+). Furthermore, the majority of the workers examined in the study have been employed since the passage of the Federal Coal Mine Health and Safety Act of 1969. The continued development of CWP in coal mine workers and the magnitude of respirable dust over exposures in longwall mining occupations illustrate the need for improved dust-control technology in underground coal mines.

The control of respirable coal dust provides an ongoing challenge for coal mine operators. Ventilation and water sprays remain the primary methods used to control dust generated during longwall mining. To compensate for ever-increasing production, mine operators have increased face air velocities and water quantities in an attempt to protect mine workers from excessive dust exposures. Unfortunately, increasing ventilation and water spray pressure does not guarantee reductions in dust levels; conversely, misapplication of increased air and water quantities may adversely escalate worker exposure to higher levels of dust.

Laboratory tests are now being conducted at a full-scale longwall test gallery at the National Institute for Occupational Safety and Health's (NIOSH) Pittsburgh Research Laboratory to evaluate the interactions among different longwall dust-control parameters and the impact that altering these parameters has on respirable dust levels along the longwall face. This paper describes an ongoing research effort that makes use of an experimental design program to identify relative differences in dust levels on longwalls for changes in control parameters and/or operating conditions.

Experimental design
A face-centered-cube experimental design test program (DuPont Quality Management Services, 1988) was used to maximize the amount of information gained concerning the impact of each test parameter and to minimize the number of required tests. The requirements of a face-centered-cube designed test program necessitate that each parameter be evaluated at three different levels (low, midrange and high). Four control parameters (face air velocity, drum spray pressure, external spray pressure and shearer water quantity) are being tested to show the effect that different parameters have on dust generation as well as to determine the interaction

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between each other. The experimental design protocol calls for the completion of 468 tests to evaluate the four control parameters at three seam heights of 1.52, 2.13 and 2.74 m (5, 7 and 9 ft), two external water spray configurations ("shearer clearer" and "basic"), two cutting directions (head-to-tail and tail-to-head) with three replicates for each test combination. Upon completion of the experimental design protocol, a comprehensive statistical analysis to determine the significant effectiveness of each evaluated parameter will be performed. Results from 132 tests conducted at a 2.13-m (7-ft) seam height are presented. Dust-control parameters were analyzed in two cutting directions for two external water spray configurations ("shearer clearer" and "basic" spray systems).

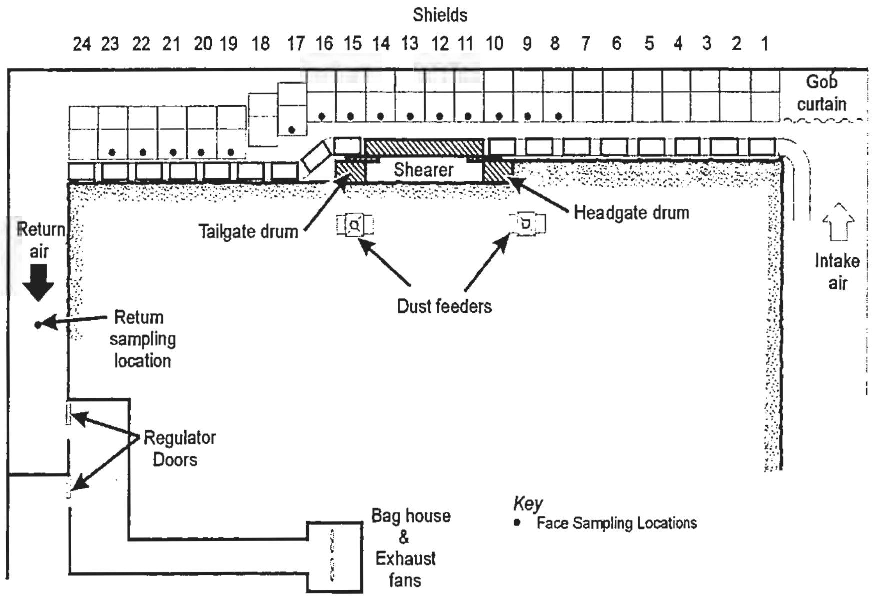

Figure 1 — Diagram of longwall test facility at the Pittsburgh Research Laboratory.

Surface test facility

Tests were conducted at the simulated longwall test facility located at the Pittsburgh Research Laboratory. The simulated face is 38.13-m (125-ft) long and the height from floor to roof is 2.13-m (7-ft), as shown in Fig. 1. The distance from the face to the center of the panline is 1.52-m (5-ft), the simulated hydraulic supports are 3.96-m (13-ft) from the face, and the center of the shield-line is 2.44-m (8-ft) from the face. Twenty-four simulated shield supports (1.52-m or 5-ft wide) cover the length of the test facility. A full-scale wooden mock-up of a Joy 4LS double ranging arm shearer was located approximately one-half of the distance from the headgate to the tailgate. A 76.2-mm (3-in.) water line along with a booster pump supplied water to both shearer cutting drums and the two external water spray systems to attain the quantity and pressure requirements.

Each cutting drum was equipped with 33 water sprays that produced a uniform and consistent full-cone spray pattern for dust suppression. Pressure regulators and flow meters were installed to regulate and measure the flow and pressure of the drum-mounted water sprays along with the two external water-spray systems. Ventilation for the simulated longwall gallery was provided by two exhaust fans that were capable of supplying approximately 19.17 m^3/s (40,500 cfm) of air along the face. The return entry was equipped with an adjustable regulator to control the quantity and velocity of air reaching the face.

Respirable coal dust was introduced into the gallery at the head and tail drum locations. Dust was generated by using a screw-type feeder system that funneled respirable coal dust into mini-eductors. Using compressed air, these mini-eductors carried the dust through hoses and into the longwall gallery. Two mini-eductors and accompanying hoses transported coal dust from the screw-feeder system into the gallery at the leading drum location. The discharge hoses were mounted in the coal seam at approximately 25% and 75% of the cutting drum height. Simulating lower dust levels at the trailing drum location was accomplished by using one mini-eductor and a corresponding discharge hose. A "Y" connector was attached to the discharge hose to disperse the coal dust uniformly. Two discharge hoses entered the gallery and were mounted in the coal seam at the trailing drum location. Pressure gauges and regulators were installed in both sets of compressed air supply lines to monitor and control the amount of air that fed the mini-eductors. A commercially available 50-μm coal dust (Keystone Filler & Mfg. Co., Nancy, Pennsylvania) was used throughout the testing sequence.

Sampling methodology

Gravimetric samplers, along with real-time aerosol monitors (RAM), for instantaneous dust measurements were used to collect the dust samples during testing. Constant-flow gravimetric sampling pumps, operating at 2 L/min, pulled dust-laden air through a 10-mm nylon cyclone preseparator. The cyclone separated the respirable dust from nonrespirable dust and deposited the respirable dust onto preweighed 37-mm filters.

After each test, the net dust weight on each filter was calculated and used in subsequent analysis. The RAM instrument was used to supplement the gravimetric samplers. The RAM is a portable dust-measurement device where dust-laden air was pulled at 2 L/min through a 10-mm cyclone that separated the respirable dust and passed it through a light source. The amount of light deflection in the chamber was considered to be representative of the dust concentration (GCA/Environmental Instruments, 1979). The instantaneous dust concentrations were downloaded to a multichannel data-acquisition system for monitoring throughout the test and for subsequent analysis.

Sampling packages, each consisting of a RAM monitor adjacent to two gravimetric samplers, were used to collect dust samples at typical headgate and tailgate operator positions along the face. In addition, a sampling package was used to collect dust samples approximately 15.24-m (50-ft) downwind of the shearer in an area simulating the approximate breathing zone of the jacksetter operator. The samplers were suspended from the shield supports at the approximate breathing zone of the shearer operators. At each sampling location, the sampling package was moved across a five-shield sampling area in an effort to simulate the relative work area for each occupation on the face. In addition to the sampling packages along the face, three sampling packages were located in the return entry at 25%, 50% and 75% of the height between the floor and the roof.

Table 1 — Test conditions at 2.13-m (7-ft) seam height.

Test conditions	Number of tests	Air velocity, m/s (fpm)	Water quantity, L/min (gpm)	Drum pressure, kPa (psi)	External pressure, kPa (psi)
A	3	1.27 (250)	378.5 (100)	689.5 (100)	965.3 (140)
B	9	1.78 (350)	378.5 (100)	689.5 (100)	965.3 (140)
C	3	2.29 (450)	378.5 (100)	689.5 (100)	965.3 (140)
D	3	1.78 (350)	302.8 (80)	689.5 (100)	965.3 (140)
E	3	1.78 (350)	454.3 (120)	689.5 (100)	965.3 (140)
F	3	1.78 (350)	378.5 (100)	413.7 (60)	965.3 (140)
G	3	1.78 (350)	378.5 (100)	965.3 (140)	965.3 (140)
H	3	1.78 (350)	378.5 (100)	689.5 (100)	689.5 (100)
I	3	1.78 (350)	378.5 (100)	689.5 (100)	1,241.1 (180)

Test procedure

Tests were conducted to evaluate the effect of changing air velocity, drum water-spray pressure, external water-spray pressure and water quantity on the respirable dust levels generated at typical headgate, tailgate and jacksetter operator positions and in the return entry. Based on the face-cubed experimental design protocol, nine test conditions were examined at the 2.13-m (7-ft) seam height with air velocities ranging from 1.27 to 2.29 m/s (250 to 450 fpm), drum water-spray pressures ranging from 413.7 to 965.3 kPa (60 to 140 psi), external water-spray pressures ranging from 689.5 to 1,241.1 kPa (100 to 180 psi) and water quantity delivered to the shearer ranging from 302.8 to 454.3 L/min (80 to 120 gpm), as shown in Table 1. Two external spray configurations were evaluated. The first spray system was the standard "shearer clearer" configuration developed by the US Bureau of Mines (Jayaraman et al., 1985). This spray system consisted of 11 hollow cone sprays installed on the shearer. Installation was based on guidelines provided in the Bureau of Mines publication. The other spray configuration, referred to as the "basic" spray system, had the external sprays oriented perpendicular to the face. Tests were conducted simulating a head-to-tail cutting sequence followed by the tail-to-head cutting sequence at the low, midrange and high levels for each control parameter.

A test cycle consisted of a 10-minute baseline period and a test period of 1.5 hours. Prior to the start of the baseline period, the test parameters were set, face ventilation was established, shearer drums started rotating, the dust injection system was energized, and the dust cloud was allowed to stabilize. The RAM samplers in the return entry were then turned on to record dust concentrations for the 10-minute baseline period, as a means of monitoring fluctuations in the dust feed. The completion of the baseline dust-sampling period triggered the activation of the drum and external spray systems. RAM samplers along the face and all the gravimetric samplers were activated, and the 1.5-hour test cycle started. Each dust sampling package was operated for 18 minutes or 20% of the total test time at each of the five shield locations in the designated sampling areas along the face (i.e., headgate operator = Shields 8 through 12; tailgate operator = Shields 13 through 17; and jacksetter = Shields 19 through 23). The sampling packages were moved across the five shield sampling area in an effort to simulate the relative work area for each occupation on the face.

Data analysis

Using a data acquisition software package, dust levels recorded by the RAM samplers at the locations along the face and in the return entry were captured and downloaded every two seconds for the duration of the test. In addition, sensors measured water pressure to the shearer drums, external sprays and average air velocity along the face. A real-time monitoring software program displayed dust levels along with pertinent control parameter data for each test. Dust concentrations at the headgate, tailgate and jacksetter sampling areas were calculated by averaging dust levels obtained from the two gravimetric sampling filters at each face sampling location. The dust concentrations for the six return entry samples were combined to calculate an average return-entry concentration for each test. Average gravimetric dust concentrations at the four sampling locations (headgate, tailgate, jacksetter and return entry) were then normalized for fluctuations in the dust feed.

Dust concentrations that were recorded during the 10-minute baseline test period from the three RAM return entry samplers were averaged together to obtain a single baseline return entry concentration. A normalizing ratio was calculated by dividing the average baseline return entry dust level from all tests performed at the same airflow by the RAM return-entry dust level from the test being normalized. An 18-minute time weighted average of RAM dust concentrations was calculated at the 15 shield locations to create a profile of dust levels along the longwall face. Average gravimetric concentrations from each sampling location and specific airflow parameter were multiplied by the normalizing ratio. A summary of the average normalized gravimetric concentrations for the four sampling locations and test conditions is provided in Table 2 and Fig. 2. All subsequent data analysis utilized normalized dust concentrations.

Gravimetric data results

Gravimetric dust concentrations measured for each cutting direction were averaged to formulate a dust concentration representing a complete pass at the headgate, tailgate and jacksetter sampling locations. Test results showed that the lowest dust levels were observed at test condition C (2.29 m/s or 450 fpm), followed by test condition H (689.5 kPa or 100 psi external pressure) for both the shearer clearer and basic spray systems. Higher face air velocities provide greater air quantities for better dilution of ventilating air across the face, help confine shearer dust to the face and lower contamination in the walkway (Jankowski and Colinet, 2000).

Analyzing cutting direction data, i.e., head-to-tail (H to T) and tail-to-head (T to H), showed that increasing the airflow consistently reduced dust levels at the tailgate operator and jacksetter locations for both the shearer clearer and basic spray systems. While testing the shearer clearer spray configuration, significant increases in dust levels at the face sampling locations were observed when cutting in the Head-to-tail direction compared to the tail-to-head direction. Dust levels ranged between 53% (test condition A) and 104% (test condition I) higher when cutting head-to-tail. Specifically, dust concentrations observed at the tailgate sampling locations were two to five times higher, while locations downwind of the shearer showed increases of 42% during the head-to-tail cutting cycle.

Tests conducted with the basic spray system showed dust levels increased significantly when cutting in the tail-to-head direction for test conditions C (2.29 m/s or 450 fpm) and E (454.3 L/min or 120 gpm) when compared to the head-to-tail cutting cycle. Conversely, dust levels were substantially higher during the head-to-tail cutting sequence for test conditions G (965.3 kPa or 140 psi drum spray pressure) and I (1,241 kPa or 180 psi external spray pressure) compared to the tail-to-head cutting sequence. When examining cutting direction and the basic external-spray system, differences in dust levels were insignificant for the remaining test conditions.

The relative effectiveness of each control parameter was examined by comparing respirable dust levels at the base or center-point test condition B (1.78 m/s or 350 fpm, 378.5 L/min or 100 gpm, 689.5 kPa or 100 psi drum spay pressure and 965.3 kPa or 140 psi external spray pressure) to respirable dust levels at a high and low test limits for each of the four control parameters (Fig. 2).

The impacts that varying the control parameters had on respirable dust levels along the longwall face are as follows:

- Varying airflow caused the greatest fluctuation in respirable dust levels. Concentrations at the face sampling locations substantially increased when airflow was reduced.
- Increases in air velocity reduced respirable dust levels from 12% to 26% for the shearer clearer and basic spray system.
- Decreasing the amount of water directed to the shearer had little effect on shearer-generated airborne respirable dust levels across the face. It should be noted, however, that the testing conducted in the gallery could not simulate the potential benefit of increasing moisture content in the coal product.
- When shearer water quantity (test condition E) was increased to 454.3 L/min (120 gpm), face sampling dust levels were elevated 13% when the external sprays were oriented perpendicular to the face (basic spray system) and decreased 7% when the shearer clearer spray system was used.
- A substantial increase in dust levels (16%) was observed when the drum spray water pressure was increased to 965.3 kPa (140 psi) (test condition G) and the basic spray system was tested.
- Minimal fluctuations in dust levels were observed for the other test conditions associated with the drum spray pressure parameter.
- When the external spray pressure was lowered to 689.5 kPa (100 psi) (test condition H), dust levels were reduced by 10% for tests conducted with the shearer clearer system and 18% when the basic spray system was used.
- Increases in respirable dust levels were observed along the face when the water pressure was increased to 1,241 kPa (180 psi) for both external spray systems. Average dust levels increased approximately 10% when mining in the head-to-tail direction.

Table 2 — Summary of test results at the 2.13-m (7-ft) seam height.

Test condition	Average respirable dust levels (mg/m³)							
	Headgate operator		Tailgate operator		Jacksetter		Return entry	
	H to T	T to H	H to T	T to H	H to T	T to H	H to T	T to H
Shearer clearer spray system:								
A	0.07	0.25	8.42	4.16	7.83	6.26	9.46	7.98
B	0.03	0.17	6.38	3.01	5.22	3.87	7.15	5.73
C	0.07	0.10	5.17	2.57	4.95	3.57	5.53	5.35
D	0.13	0.13	6.84	2.81	5.63	3.77	7.79	6.60
E	0.12	0.24	6.20	2.88	5.55	2.82	7.38	6.06
F	0.08	0.18	7.01	2.07	5.57	5.01	7.68	8.01
G	0.06	0.24	6.69	2.62	5.69	3.32	6.90	5.50
H	0.07	0.15	5.51	2.86	4.47	3.56	6.83	5.72
I	0.12	0.15	7.37	1.59	6.06	4.92	7.63	5.92
Basic spray system:								
A	0.05	0.11	5.90	7.46	6.99	4.51	9.94	6.95
B	0.03	0.02	4.28	4.88	4.24	2.80	7.24	5.01
C	0.05	0.36	2.64	3.60	2.43	2.85	5.02	4.98
D	0.13	0.08	4.18	4.62	4.31	3.35	7.43	5.88
E	0.06	0.50	3.82	6.13	4.35	3.71	7.64	5.36
F	0.05	0.25	4.21	4.84	3.96	3.42	7.52	6.74
G	0.04	0.20	4.96	5.27	5.42	3.14	7.14	5.28
H	0.07	0.00	2.66	4.03	3.70	2.69	7.32	5.32
I	0.04	0.17	4.79	3.36	4.63	3.00	7.11	5.20

RAM data results

Profiles of dust levels measured by RAM data loggers at the 15 sampling locations (Fig. 1) along the face are presented in Fig. 3 for the test conditions with the shearer cutting in the tail-to-head (T to H) direction. The low, midrange and high levels for control parameters are displayed for both the shearer clearer and basic external-spray systems.

For the various conditions tested, the shearer clearer spray system appears to provide greater control of the shearer-generated dust. Examining the tests conducted with the shearer clearer spray system shows that the dust cloud was contained against the face until it was influenced by the tailgate drum (Shield 14/15).

Turbulence created by the tailgate drum cutting action and drum sprays seems to overwhelm the system and forces the dust cloud out away from the face. Dust levels dramatically increase and peak 1.52 to 3.04 m (5 to10 ft) downwind of the tailgate drum. Once the cloud moves away from the face, it becomes diluted and mixes with ventilating air, resulting in constant but elevated levels throughout the entire cross-sectional volume of the longwall face downwind of the shearer.

Tests using external sprays that were oriented perpendicular to the face (basic spray system) showed that the dust cloud moved away from the face at the shearer midpoint 4.57-m (15-ft) upwind of the tailgate drum (Shield 12). Concentrations were elevated over a 9.15-m (30-ft) area (Shields 12 through 18) and peaked 1.52-m (5-ft) upwind of the tailgate drum. Downwind of the shearer, the dust levels stabilize close to or slightly lower than levels observed with the shearer clearer external-spray system. When comparing the shearer clearer external-spray system to the basic system, the dust cloud was contained against the face for a greater distance and dust concentrations were lower.

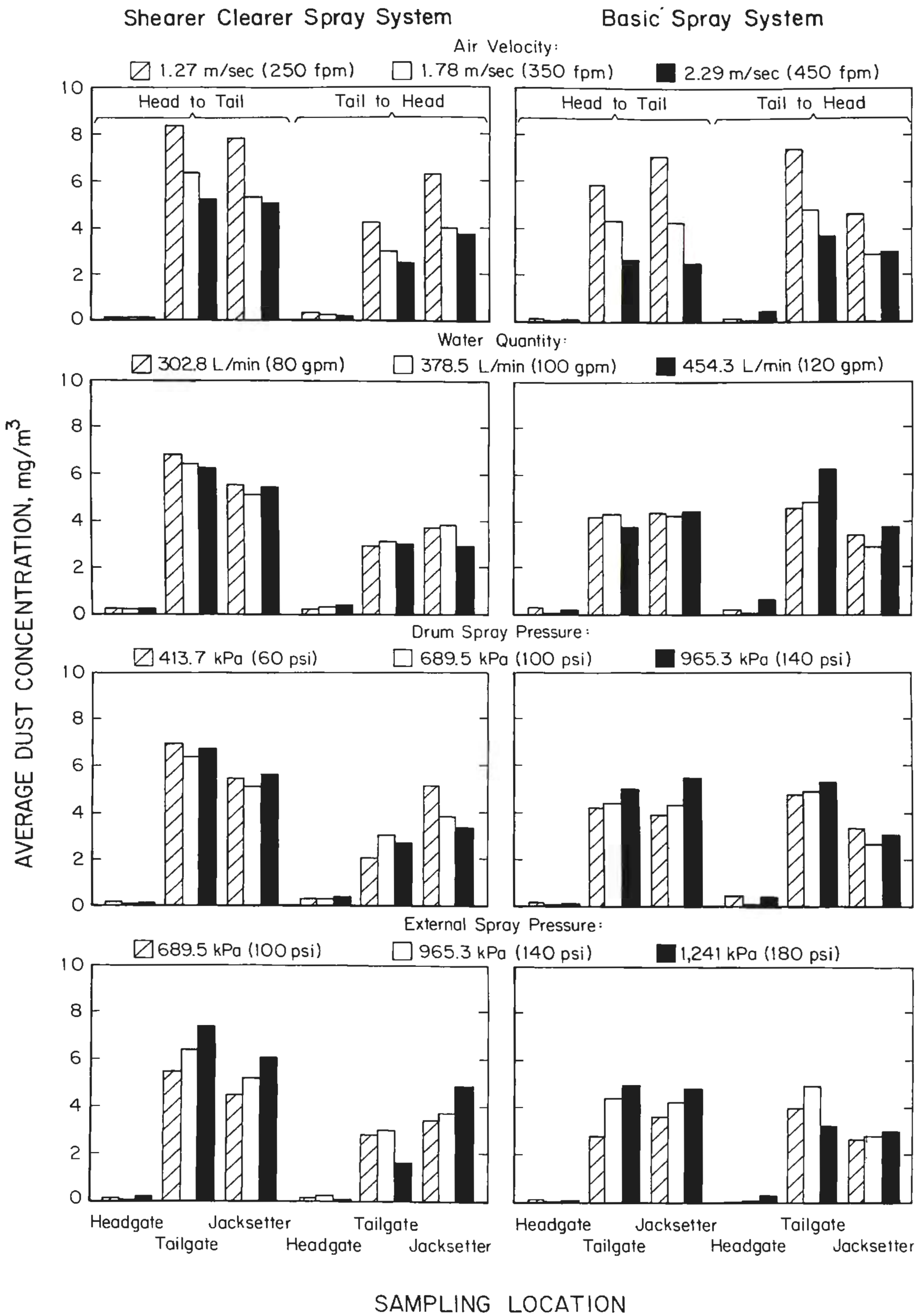

Figure 2 — Summary of gravimetric sampling units.

The following is an assessment of the relative effectiveness of each control parameter:

- Airflow had a significant impact on dust levels along the face, especially when the external sprays were oriented perpendicular to the face (basic spray system).
- Increases in face air velocity, resulting in higher airflow, held the dust cloud against the face for a greater distance with lowered peak concentrations.
- Substantial reductions in respirable dust levels were observed at the sampling locations downwind of the shearer at the higher air velocities.
- Increasing the quantity of water to the shearer had adverse effects on dust levels at the tailgate sampling locations.
- Dust levels were observed at their lowest levels for tests conducted with the water quantity at 302.8 L/min (80 gpm) (test condition D).

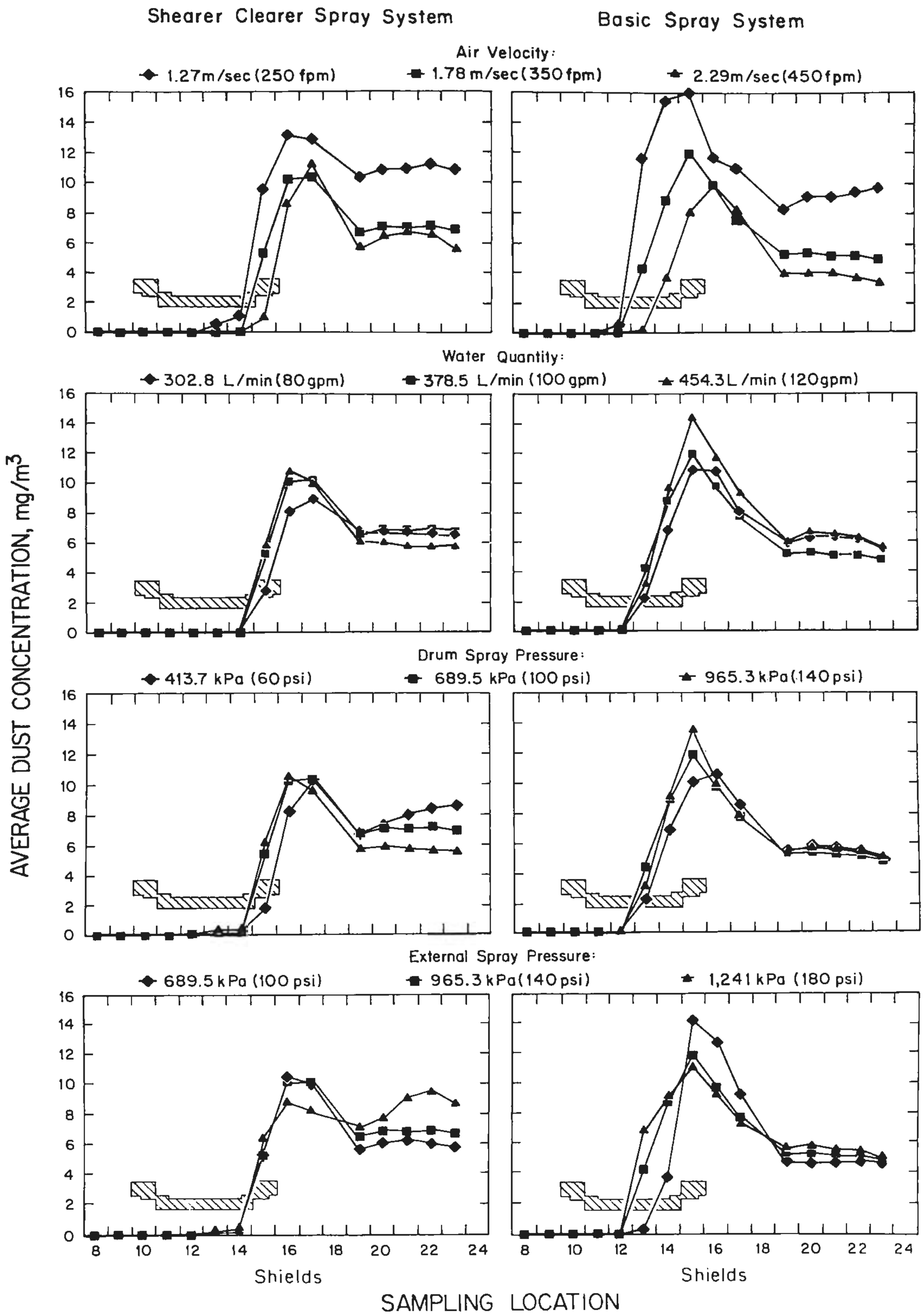

Figure 3 — Dust profiles to test conditions with shearer cutting in the tail-to-head direction.

- Tests with lower drum spray pressure (test condition F) showed that the dust cloud was held against the face for a greater distance but concentrations downwind of the shearer were elevated when compared to high drum spray pressures for tests conducted with the shearer clearer spray system.
- Significant reductions in dust levels were observed at the tailgate sampling locations for tests conducted with drum-mounted water spray pressure at the 413.7 kPa (60 psi level) (test condition F) when compared with higher drum spray pressures when the external water sprays were oriented perpendicular to the face (basic spray system). Dust levels downwind of the shearer were not effected.
- Examining the external spray pressure variable shows that increasing spray pressure (test condition I) reduced dust levels at the tailgate sampling locations but significantly increased dust levels downwind of the

shearer when the shearer clearer spray system was tested.

- Dust levels observed when the basic spray system was tested at lower external spray pressures (test condition H) showed that the dust cloud was held close to the face for a longer distance, but peak concentrations ranged from 18% to 29% higher at the lower pressure when compared to higher spray pressures. Varying the external spray pressure had no effect on dust levels downwind of the shearer.

Summary

Longwall mining accounts for approximately 50% of the coal produced in underground mines in the United States. While longwalls are highly productive, controlling respirable dust continues to be an ongoing challenge for coal mine operators. Research to evaluate the interactions of different longwall dust control parameters and the impact that altering these parameters have on dust levels is being conducted at NIOSH's Pittsburgh Research Laboratory. A face-centered-cube experimental design test program is being used to study the impacts that face air velocity, drum water spray pressure, external water spray pressure, shearer water quantity and seam height have on dust levels at typical headgate, tailgate and jacksetter operator positions along the face.

A full-scale model of a Joy 4LS double ranging arm shearer located in a simulated longwall test facility was used for testing. The cutting drums were equipped with 33 drum-mounted sprays. Pressure regulators and flow meters were installed to monitor flow and pressure to the cutting drums along with the external sprays. A shearer clearer external-spray system and basic spray system where the external sprays are oriented perpendicular to the face were evaluated during testing. Ventilation for the longwall test facility was provided by exhaust fans capable of supplying approximately 19.17 m^3/s (40,500 cfm) of air along the face.

Gravimetric samplers along with RAM monitors were employed to collect dust samples for all tests. The samplers were suspended from shield supports at the approximate breathing zone of the shearer operators. Test were conducted at a 2.13-m (7-ft) seam height with air velocities ranging from 1.27 to 2.29 m/s (250 to 450 fpm), drum water spray pressure varied from 413.7 to 965.3 kPa (60 to 140 psi), external water spray pressure varied from 689.5 to 1,241.1 kPa (100 to 180 psi) and the flow of water delivered to the shearer ranging from 302.8 to 454.3 L/min (80 to 120 gpm).

Varying face airflow had the greatest impact on dust levels at the sampling locations along the face. Gravimetric sampling results showed that dust levels were reduced for all test conditions when the air velocity was increased to 2.29 m/s (450 fpm) across the face. Dust levels were reduced by 55% when compared to tests conducted with the air velocity at 1.3 m/s (250 fpm). Results from the gravimetric sampling showed that changes in the flow of water to the shearer had minimal effect on shearer-generated airborne dust levels. The potential benefits from increasing the moisture content of the coal as it traveled along the conveyor belt or through the stageloader/crusher could not be simulated.

Increasing the drum spray pressure had a minimal but adverse effect on dust levels when the shearer was cutting in the head-to-tail direction for both the shearer clearer and basic external-spray systems. Lower drum spray pressure impacted respirable dust levels when the shearer clearer spray system was tested and the cutting sequence was in the tail-to-head direction. Dust levels at the tailgate position were reduced, while levels downwind of the shearer increased when compared to higher drum spray pressures. Dust concentrations obtained from the gravimetric sampling results increased substantially at the tailgate and jacksetter operator positions when the external water spray pressure was increased while the shearer was cutting head-to-tail and the shearer clearer spray system was operational.

Dust levels for test conditions that used the shearer clearer external spray system showed elevated dust levels along the face while cutting head-to-tail compared to tail-to-head. The elevated dust levels may be a result of ventilating air being forced by the shearer clearer sprays toward the face where it impacts the tailgate drum cowl, creating turbulent eddies of air that force the dust cloud into the walkway. Cutting direction did not significantly influence dust levels when the external sprays were oriented perpendicular to the face (basic spray system).

Dust profiles along the longwall face for tests conducted with the shearer cutting in the tail-to-head direction showed the dust cloud was contained against the face at a distance of 3.05 to 4.57 m (10 to 15 ft) further downwind when the shearer clearer external spray configuration was used. In addition, the dilution of the dust cloud occurred faster and peak dust concentrations were not as severe with the shearer clearer external sprays. The type of external spray configuration had minimal impact on dust levels downwind of the shearer. When the dust cloud mixed with the ventilating air, it seemed to stabilize and remained reasonably constant. Once again, variations in airflow caused by changes in face air velocity had significant impact on the dust levels along the face. While reducing face air velocity had the greatest impact on dust levels, increasing the air velocity from 1.78 to 2.29 m/s (350 to 450 fpm) had minimal impact on dust levels when the shearer clearer external sprays were tested.

Research to determine if changes in control parameters and/or operating conditions significantly alter respirable dust levels along the face is continuing at the Pittsburgh Research Laboratory. The dust control parameter data identified in this paper could be used to assist the mine operator in the selecting the appropriate dust control approach for the unique conditions that exist at their longwall mining operation.

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