# 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, but 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 which would assist them in selecting control parameters that would 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

The past 15 years have seen dramatic improvements in longwall mining operations. In 1999, the average horsepower used on the shearer was 880 kw (1,180 hp) compared to 284 kw (381 hp) in 1984. Today, approximately 75% of longwall mines operate with shearer horsepower at 745.7 kw (1000 hp) or greater. One-third of the longwall faces have face widths greater than 305-m (1000-ft) and panels that measure 3050-m (10,000-ft) or longer (Anon., 2000). Longwall mining now accounts for approximately 50% of the coal produced in underground U.S. coal mines. The increase in longwall coal-extraction rates has resulted in far more dust being generated, and consequently, more dust must be controlled.

During the period of 1995 through1999, mine operators and Mine Safety and Health Administration (MSHA) inspectors collected 9,968 and 1,365 dust samples respectively, from longwall designated occupation [D.O.] 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 (1992-1996) Coal Worker's X-ray Surveillance Program (Anon.,1999) indicated 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 utilized to control dust generated during longwall mining. To compensate for ever-increasing production, mine operators have increased face airflow 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 being conducted at a full-scale longwall test gallery at the National Institute for Occupational Safety and Health (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. Results from 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).

## EXPERIMENTAL DESIGN

A face-centered-cube experimental design test program (Strategy ..., 1988) was used to maximize the amount of information gained about the impact of each test parameter and minimize the number of required tests. Five control parameters (face air velocity, drum spray pressure, external spray pressure, shearer water quantity, and seam height) will be tested to show the effect different parameters have on dust generation as well as determine the interaction between each other. The requirements of a face-centered-cube designed test program necessitate that each parameter be evaluated at three different levels (low, mid-range, and high). A total of 468 tests will be required to complete the evaluation of two external water spray configurations for two cutting directions and 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.

Two external spray configurations were evaluated during the current test program. The first spray configuration was the standard "shearer clearer" spray system developed by the U.S. Bureau of Mines (Jayaraman, 1985). The spray system consisted of 11 hollow cone sprays that were installed on the shearer based upon guidelines provided in the Bureau of Mines publication. The other spray configuration refered to as the "basic" spray system had the external sprays oriented perpendicular to the face. Each spray configuration was evaluated for cuts made in the head-to-tail direction and the tail-to-head directions.

## 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 Figure 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 (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 7.62-cm (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 which 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 system. Ventilation for the simulated longwall gallery was provided by two exhaust fans that were capable of supplying approximately 19.17 $m^3$ /sec (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, which funneled respirable coal dust into mini-eductors. Utilizing 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 1/4 and 3/4 of cutting drum height. Simulating lower dust levels at the trailing drum location was accomplished by utilizing 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 minus-50 micron coal dust ( Keystone) was used throughout the testing sequence.

## SAMPLING METHODOLOGY

Gravimetric samplers, along with real-time aerosol monitors (RAM), for instantaneous dust measurements were employed 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 pre-separator. The cyclone separated the respirable dust from non-respirable dust, then deposited the respirable dust onto pre-weighed 37-mm filters. After each test, the net weight for 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 which 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 ,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. The samplers were suspended from the shield supports at the approximate breathing zone of the shearer operators. Also, a sampling package was used to collect dust samples approximately 9.14 m (30 ft) downwind of the shearer in an area simulating the approximate breathing zone of the jacksetter operator. 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 1/4,1/2, and 3/4 of the height between the floor and the roof.

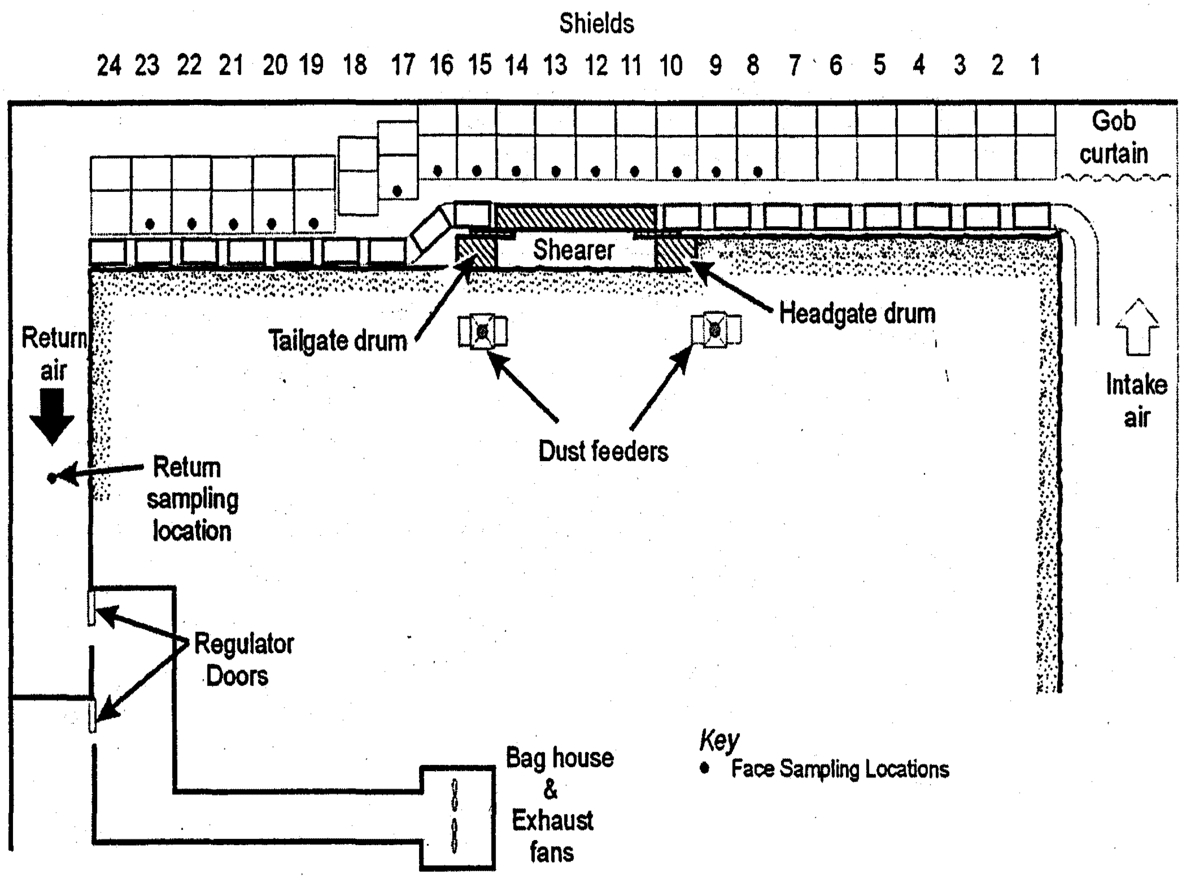


**Figure 1.** Diagram of longwall test facility at the Pittsburgh Research Laboratory.

## 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 respirable dust levels generated at typical headgate, tailgate, and jacksetter operator positions and in the return entry. A total of 132 tests with 9 different test conditions were examined at the 2.13-m (7-ft) seam height with air velocities ranging between 1.27 and 2.29 m/s (250 and 450 fpm), drum water spray pressure ranging between 413.7 and 965.3 kPa (60 and 140 psi), external water spray pressure between 689.5 and 1241.1 kPa (100 and 180 psi), and the quantity of water delivered to the shearer ranging between 302.8 and 454.3 L/min (80 and 120 gpm) as shown in Table I. 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. Tests were replicated three times at each control parameter.

**Table I.** Test Conditions at 7-ft Seam Height.

| Test Condition | Air Velocity m/sec (fpm) | Water Quantity L/min (gpm) | Drum Pressure kPa (psi) | External Pressure kPa (psi) |
|---|---|---|---|---|
| A | 1.27 (250) | 378.5 (100) | 689.5 (100) | 965.3 (140) |
| B | 1.78 (350) | 378.5 (100) | 689.5 (100) | 965.3 (140) |
| C | 2.29 (450) | 378.5 (100) | 689.5 (100) | 965.3 (140) |
| D | 1.78 (350) | 302.8 (80) | 689.5 (100) | 965.3 (140) |
| E | 1.78 (350) | 454.3 (120) | 689.5 (100) | 965.3 (140) |
| F | 1.78 (350) | 378.5 (100) | 413.7 (60) | 965.3 (140) |
| G | 1.78 (350) | 378.5 (100) | 965.3 (140) | 965.3 (140) |
| H | 1.78 (350) | 378.5 (100) | 689.5 (100) | 689.5 (100) |
| I | 1.78 (350) | 378.5 (100) | 689.5 (100) | 1241.1 (180) |

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 8-12; tailgate operator - shields 13-17; jacksetter - shields 19-23). 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

Utilizing 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. Also, 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 levels from the two gravimetric samplers at the three sampling locations along the face were combined, resulting in an average dust concentration at each face location. The individual dust concentrations for the six return entry samples were combined to calculate an average return entry concentration for each test. The 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. 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 II and Figure 2. All subsequent data analysis utilized normalized dust concentrations.

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/sec (450 fpm)] followed by test condition H [689.5 kPa (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, 2000).

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/sec (350 fpm), 378.5 L/min (100 gpm), 689.5 kPa (100 psi) drum spay pressure, and 965.3 kPa (140 psi) external spray pressure] to respirable dust levels at a high and low test limits for each of the four control parameters (Figure 2).

The following description assess the impact that varying the control parameters had on respirable dust levels along the longwall face:

- 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 between 12 and 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 utilized.

Table II - Summary of Test Results at the 2.13-m (7-ft) Seam Height.

SHEARER CLEARER SPRAY SYSTEM

| | Average Respirable Dust Levels [mg/m$^3$] | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Test | Headgate Operator | | Tailgate Operator | | Jacksetter | | Return Entry | |
| Condition | H to T | T to H | H to T | T to H | H to T | T to H | H to T | T to H |
| 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

| | Average Respirable Dust Levels [mg/m$^3$] | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Test | Headgate Operator | | Tailgate Operator | | Jacksetter | | Return Entry | |
| Condition | H to T | T to H | H to T | T to H | H to T | T to H | H to T | T to H |
| 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 |

- 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 for both external spray systems when the spray pressure was increased to 1,241 kPa (180 psi). Average dust levels increased approximately 10% when mining in the head-to-tail direction.

Analyzing cutting direction data (H to T and 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 tail-to-head. 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 2 to 5 times higher, while locations downwind of the shearer showed increases of 42% during the head-to-tail cutting cycle.

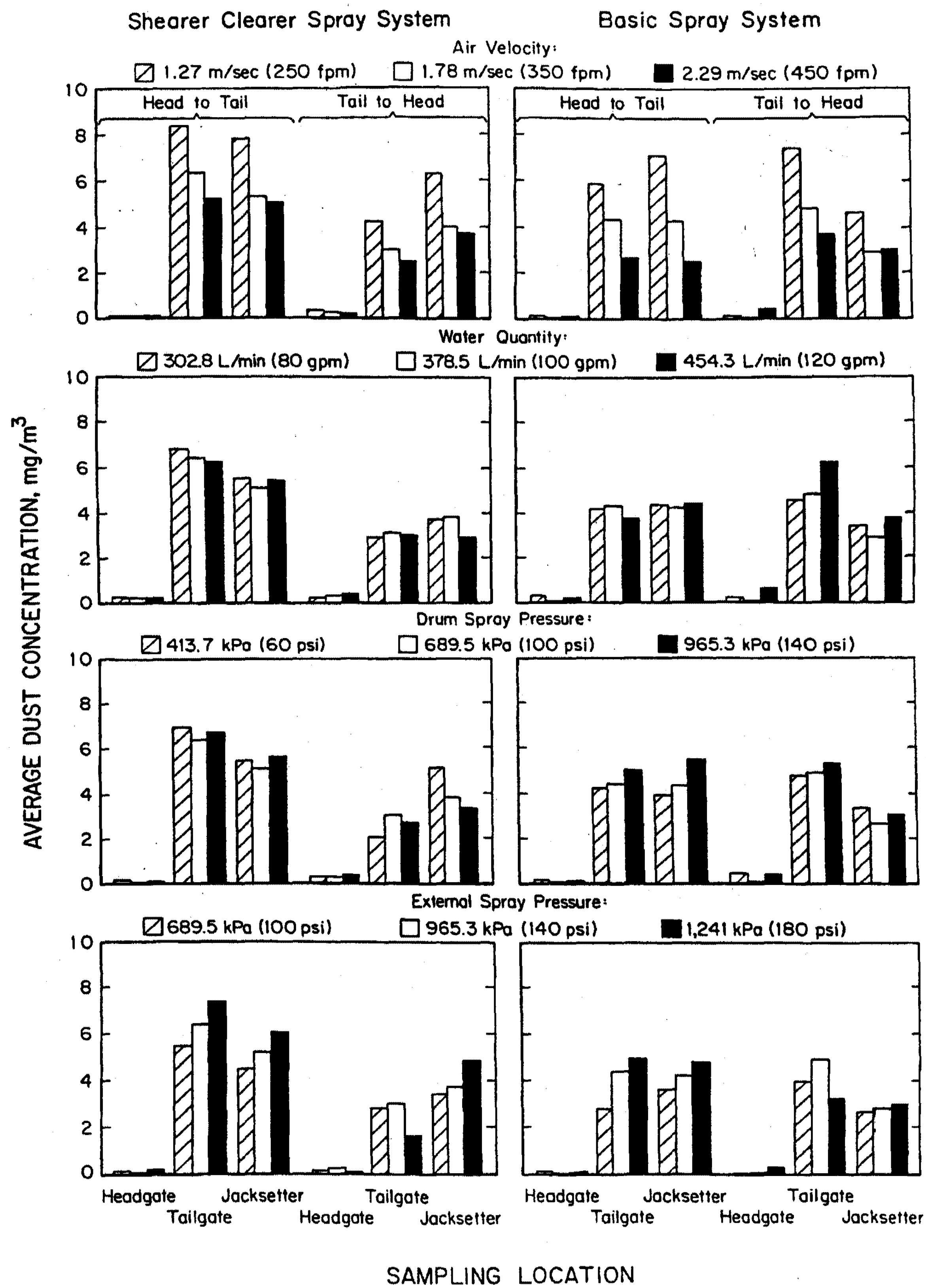


**Figure 2.** Summary of gravimetric sampling results.

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/sec (450 fpm)] and E [454.3 L/min (120 gpm)] when compared with 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 (140 psi) drum spray pressure] and I [1241 kPa (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.

Profiles of dust levels measured by RAM data loggers at the 15 sampling locations (Figure 1) along the face are presented in Figure 3 for the test conditions with the shearer cutting in the tail-to-head direction. The low, mid-range, 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 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 to 10 ft) downwind of the tailgate drum. Once the cloud detaches 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 utilizing external sprays that were oriented perpendicular to the face (basic spray system) showed that the dust cloud detached from the face at the shearer mid-point 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 - 18) and peaked 1.52-m (5-ft) upwind of the tailgate drum. Downwind of the shearer the dust levels stabilize close to 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.

The following explanations assess 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 higher airflow, held the dust cloud against the face for a greater distance with lowered peak concentrations.
- A substantial reductions in respirable dust levels was 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].
- 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 between 18 and 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 U.S. mines. While longwalls are highly productive, controlling respirable dust continues to be an on-going challenge for coal mine operators. Research to evaluate the interactions of different longwall dust control parameters and the impact

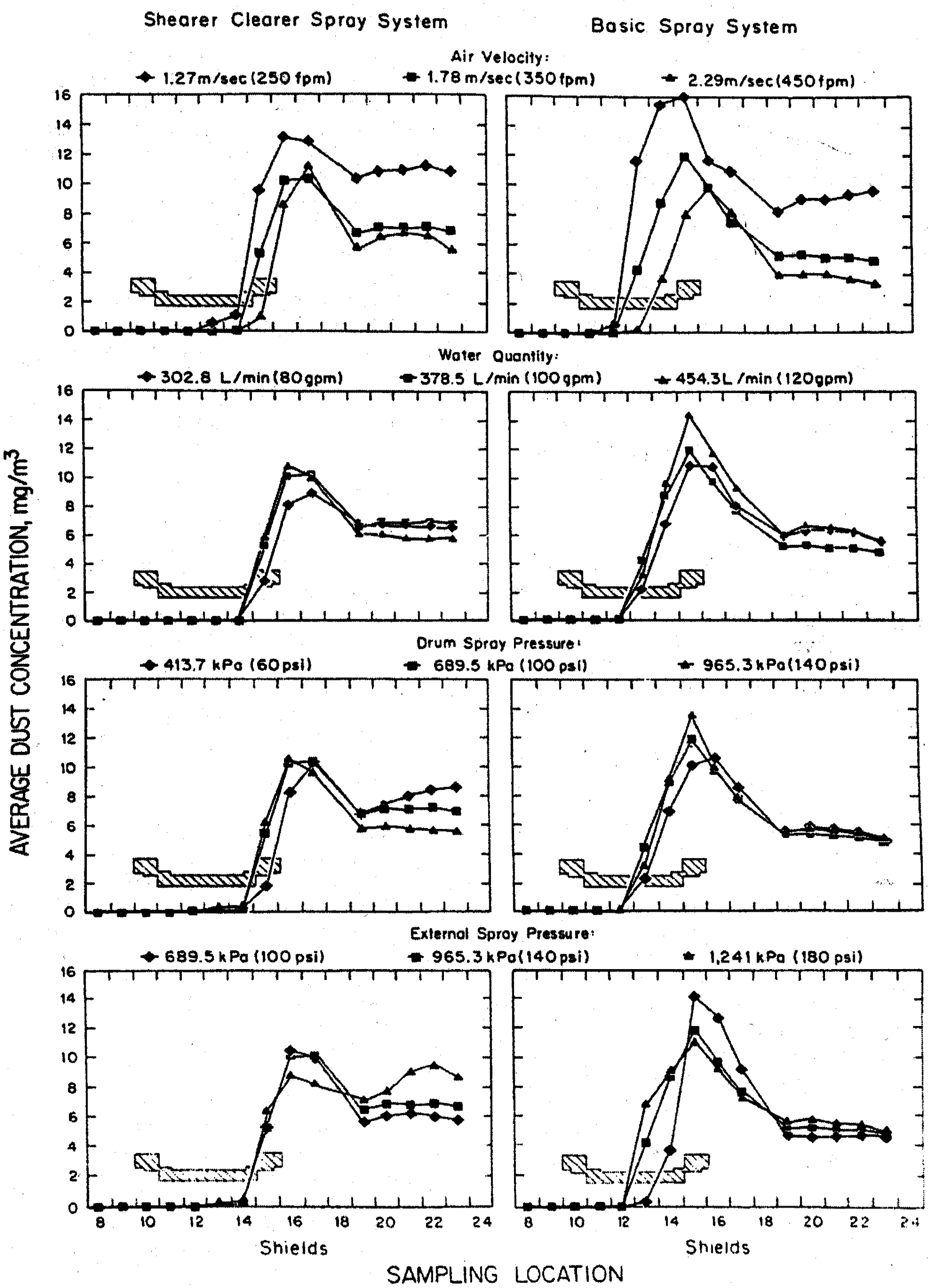


**Figure 3.** Dust profiles fo test conditions with the shearer cutting in the tail-to-head direction.

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 utilized to study the impact 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 $m^3$/sec (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 between 1.27 and 2.29 m/s (250 and 450 fpm), drum water spray pressure varied between 413.7 and 965.3 kPa (60 and 140 psi), external water spray pressure between 689.5 and 1,241.1 kPa (100 and 180 psi), and the flow of water delivered to the shearer ranging between 302.8 and 454.3 L/min (80 and 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/sec (450 fpm) across the face. Dust levels were reduced by 55% when compared to tests conducted with the air velocity at 1.3 m/sec (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.

Increases in drum spray pressure had 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 utilized 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 a distance of 3.05 to 4.57- m (10 to 15-ft) further downwind when the shearer clearer external spray configuration was utilized. Also, 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/sec (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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