DOE/FE/00016--T164

A Final Report
MAY 1990

EVALUATE FUNDAMENTAL APPROACHES TO LONGWALL DUST CONTROL SUBPROGRAM C - STAGELOADER DUST CONTROL

Contract J0318097
Foster-Miller, Inc.

BUREAU OF MINES
UNITED STATES DEPARTMENT OF THE INTERIOR

50272-101

REPORT DOCUMENTATION PAGE	1. REPORT NO.	2.	3. Recipient's Accession No.

4. Title and Subtitle Evaluate Fundamental Approaches to Longwall Dust Control Subprogram C - Stageloader Dust Control	5. Report Date May 1990
	6.
7. Author(s) J. Kelly, S. Ruggieri	8. Performing Organization Rept. No. BMI-8148
9. Performing Organization Name and Address Foster-Miller, Inc. 350 Second Avenue Waltham, MA 02254	10. Project/Task/Work Unit No.
	11. Contract(C) or Grant(G) No. (C) J0318097 (G)
12. Sponsoring Organization Name and Address U.S Bureau of Mines/Pittsburgh Research Center Bldg. 20, P.O. Box 18070 Cochrans Mill Road Pittsburgh, PA 15236	13. Type of Report & Period Covered Final Report
	14.

15. Supplementary Notes

DOE/FE/00016--T164

DE90 015510

16. Abstract (Limit: 200 words)

The contamination of intake air is a significant dust control problem, often overlooked on many longwall faces, that can add to the full shift dust exposure of all face personnel. Several sources can contribute to intake air contamination; however, the stageloader (particularly with a crusher) is the single largest source.

The objective of this subprogram was to design and evaluate a stageloader dust control system. This was accomplished through a manufacturer's survey to document existing dust controls and determine design parameters for the new systems, laboratory investigations of potential system components, and three underground evaluations of different prototype ideas.

Ultimately a series of simple, practical and mineworthy recommendation evolved for optimized stageloader dust control. These included enclosing the entire stageloader with brattice or conveyor belting and installing three auxiliary spraybars at strategic locations along the enclosed stageloader. A field test of these techniques reduced dust levels by 80 percent in the headgate and by 45 percent along the face.

17. Document Analysis a. Descriptors

Dust Control	Water Sprays
Longwall Dust	Stageloader
Intake Contamination	Crusher
Scrubber (Water-Powered)	Underground Coal Mine Health

b. Identifiers/Open-Ended Terms

MASTER

c. COSATI Field/Group

18. Availability Statement	19. Security Class (This Report) Unclassified	21. No. of Pages
	20. Security Class (This Page) Unclassified	22. Price

(See ANSI—Z39.18) See Instructions on Reverse

OPTIONAL FORM 272 (4-77)
(Formerly NTIS-35)
Department of Commerce

FOREWORD

This report was prepared by Foster-Miller, Inc. (FMI), Waltham, MA under United States Bureau of Mines Contract No. J0318097. This contract was initiated under the Health and Safety Technology Program. It was administered under the technical direction of the Pittsburgh Research Center with Mr. Robert Jankowski acting as Technical Project Officer. Mr. Louis Summers was the Contract Officer for the Bureau. This report summarizes the work completed on Subprogram A of the contract during the period July 1981 to March 1983. This report was submitted by the authors in February 1990.

The technical effort was performed by the Mining Division of the Engineering Systems Group under the direction of Mr. Terry L. Muldoon, with Mr. Steven K. Ruggieri as Program Manager and Mr. Charles Babbitt as Subprogram A Principal Investigator.

The authors would like to extend their special appreciation and acknowledgment to the numerous mining industry representatives who provided valuable input to the program and who provided valuable assistance during the underground evaluations. The assistance, guidance, and cooperation extended by Dr. Frederick Kissell and his staff are especially appreciated.

CONTENTS

ILLUSTRATIONS

ILLUSTRATIONS--Continued

TABLES

EXECUTIVE SUMMARY

Intake dust is a significant contributor to the dust exposure level of all longwall face personnel and thus can significantly affect compliance with Federal Regulations. While the shearer is cutting, intake dust levels will frequently increase to a concentration level of 2 mg/m^3 or above. Intake dust levels, however, can remain high even during periods of little activity.

Intake dust is generated from several sources, the most significant of which is the stageloader crusher. The breaking action of the crusher generates a tremendous quantity of respirable dust. Another contributor to intake contamination, for many mines, is dust from the belt entry. Both of these dust sources mix with the primary ventilation in the headgate, resulting in a high level of contamination which is carried down the entire length of the face.

Intake contamination has been shown to represent as much as 50% of the 8 hour time weighted respirable dust exposure for face personnel. An important goal of dust control research on longwalls, therefore, is to reduce intake contamination levels originating from the stage-loader crusher and transfer points.

Foster-Miller, Inc., (FMI) under the United States Bureau of Mines Contract No. J0318097 has designed, developed, and evaluated a system to control airborne respirable dust generated by headgate equipment.

System Description

The system consists of a brattice cover installed over the stageloader as shown in figures 1 and 2, together with three additional spraybars located at the mouth of the crusher, crusher discharge, and stageloader to belt transfer point.

As shown in the illustration figure 3, the first spraybar is located in the mouth of the crusher. Its purpose is to block airflow through the crusher and wet the coal entering the crusher, thereby containing the crusher-generated dust. Only two hollow cone sprays are required utilizing 2 gpm. Most crushers have a built-in internal spraybar located above the crusher's hammers. Tests have determined that this location is less effective, and, if used at all, the water flow should be limited to a maximum of 8 to 10 gpm.

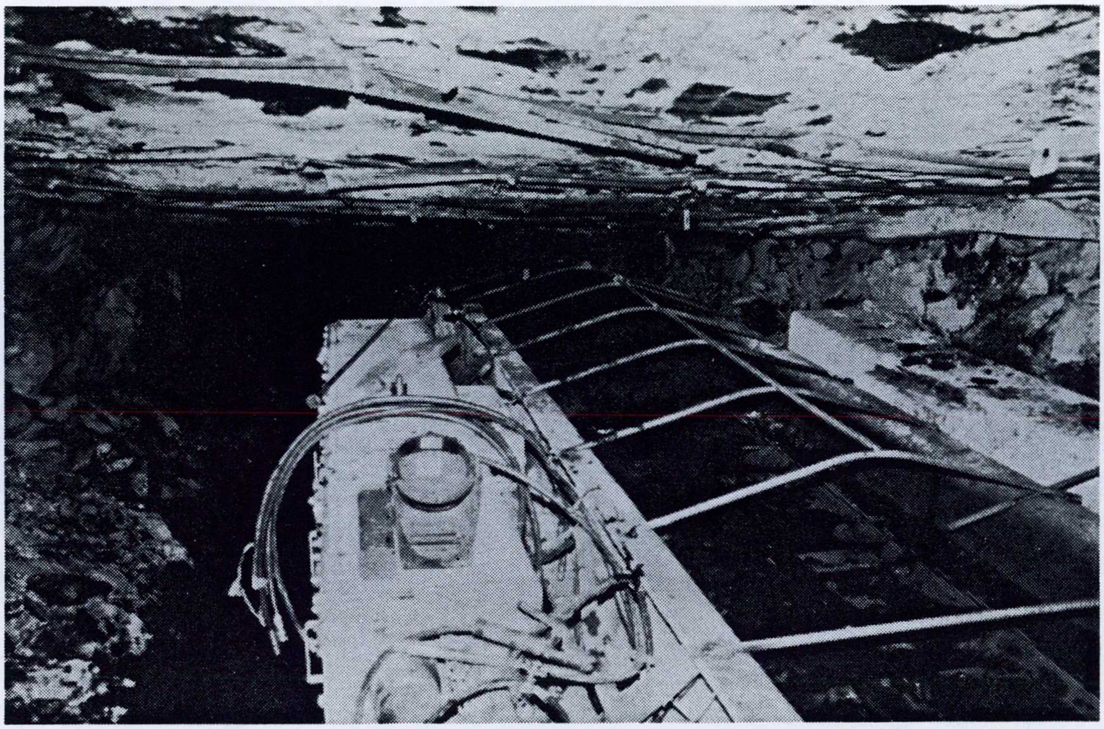


FIGURE 1. - Photo of open stageloader with cover support structure.

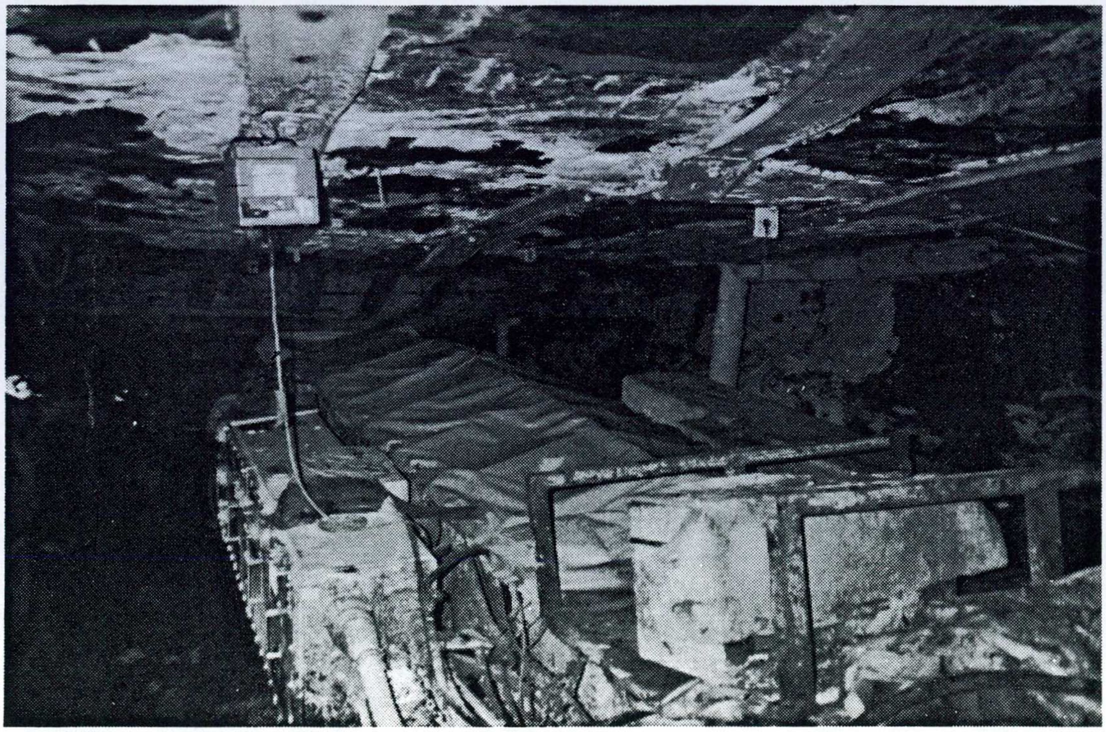


FIGURE 2. - Photo of covered stageloader.

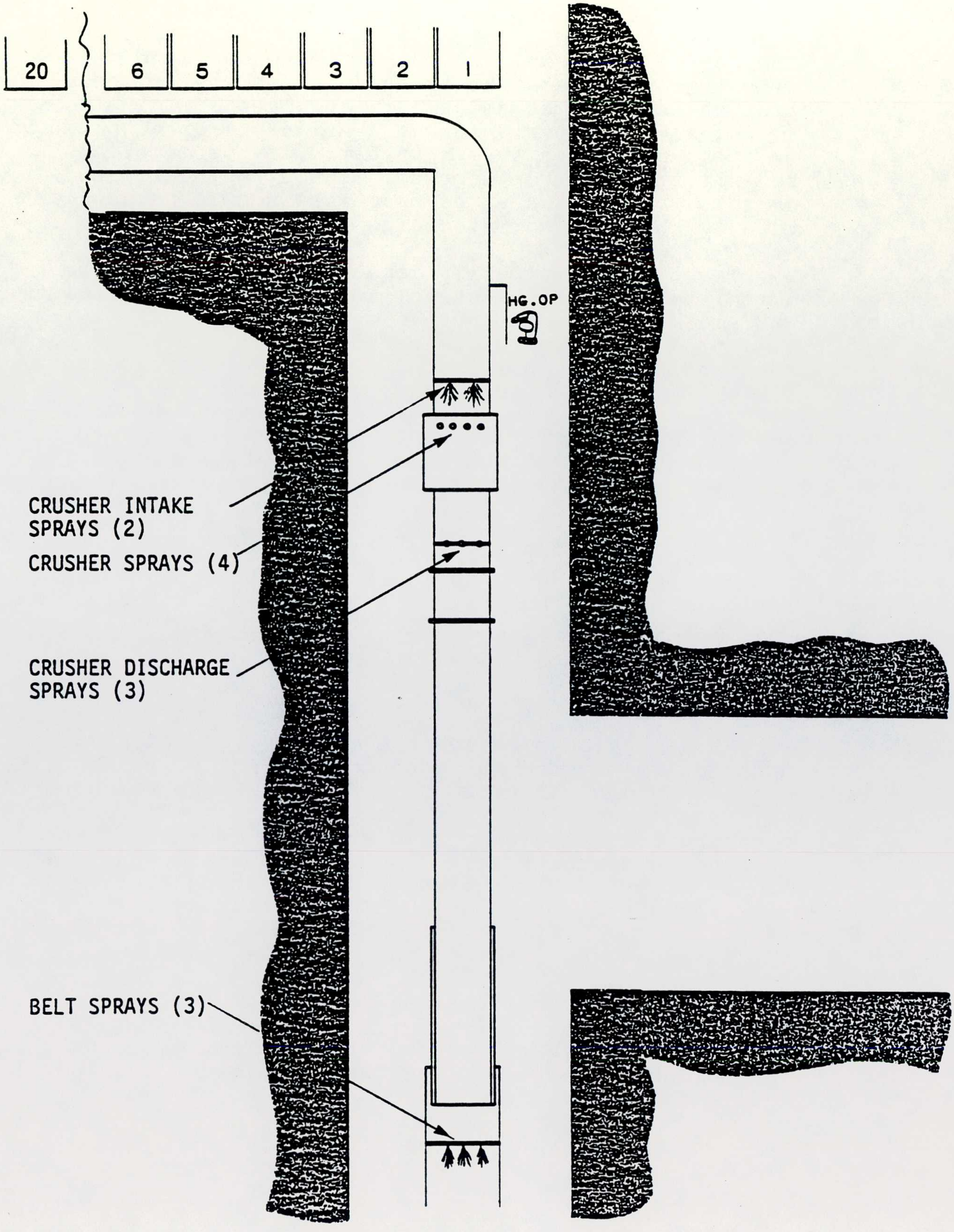


FIGURE 3. - Location of spraybars.

The _most effective_ spraybar for reducing the crusher-generated dust is located on the discharge to the crusher. It knocks down the airborne dust and simultaneously wets the freshly broken coal. These sprays fill the covered stageloader with a dense mist allowing it to act similar to a scrubber. A minimum of 5 gpm should be applied through this spraybar. If the material can benefit from further wetting, without any detrimental effects, as much water as practical should be applied through this crusher discharge spraybar.

The final spraybar is located above the belt immediately after the stageloader/belt transfer point. Two small hollow cone sprays are required. The sprays will produce a fine mist that dampens the surface of the coal and wets the belt. Only 3 gpm of water is required, but this produces a dramatic reduction in the contamination of the belt air. The sprays should be angled into the airflow to block air movement into the covered stageloader.

The total control system, therefore, requires only three additional spraybars and the covering of the entire stageloader. The total water flow for the new system is approximately 18 gpm, which is typical of many existing installations. The system is a simple, cost effective, easily installed modification requiring minimal maintenance.

Test Results

An underground evaluation of the improved stageloader dust control system was conducted by FMI. The baseline evaluation was conducted by applying 10 gpm through the internal crusher sprays. The improved system consisted of covering the stageloader and applying additional water through three spraybars. The results are illustrated in figure 4. With all the controls operating, the mean improvements from the evaluation were:

a. 80% reduction in the headgate

b. 45% reduction along the face (shield No. 20).

Figure 4 illustrates the dramatic improvements that can be achieved by covering the stageloader and installing additional spraybars.

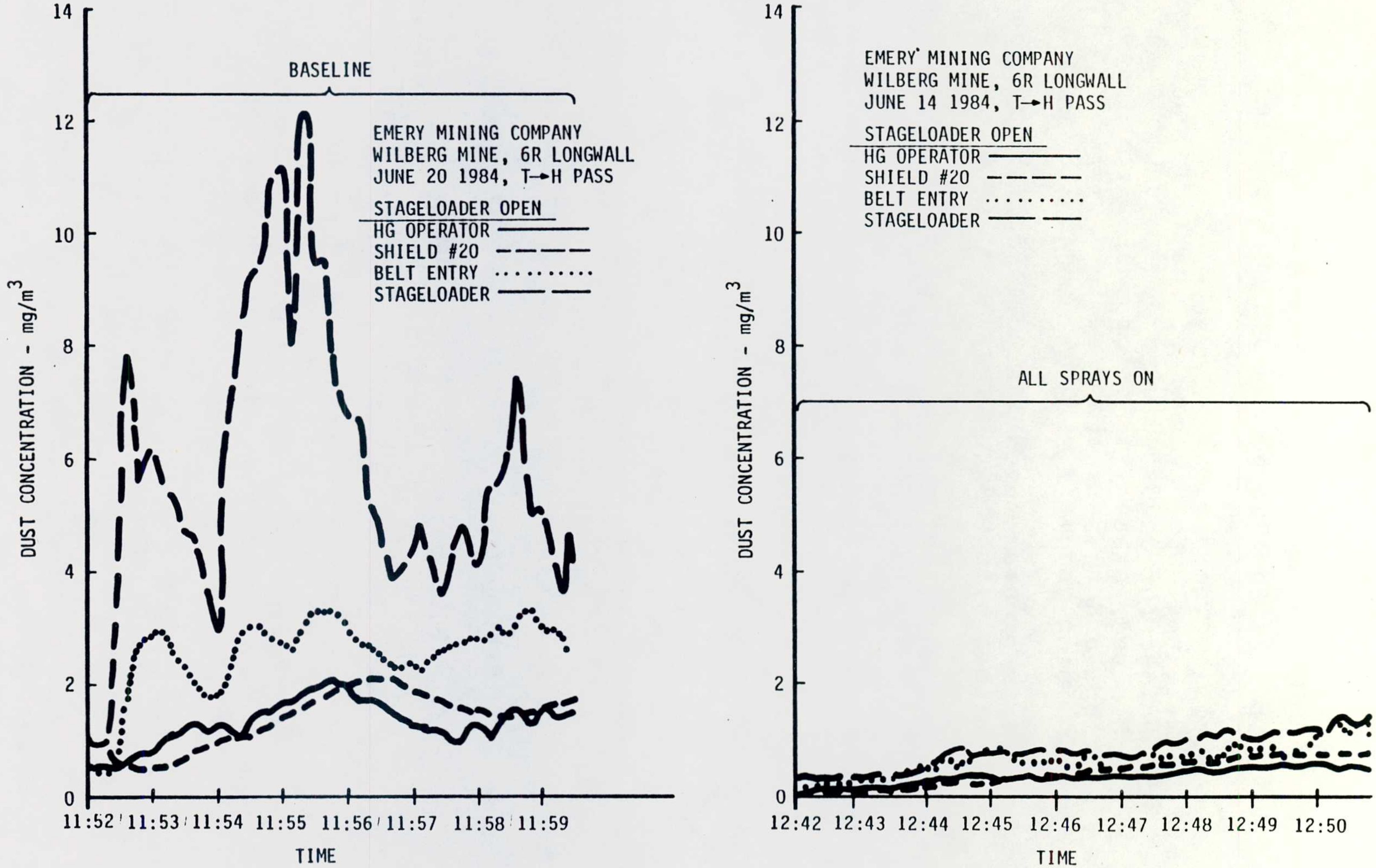


FIGURE 4. - Comparison of worst and best operating conditions.

1. INTRODUCTION

In 1981 the Bureau awarded FMI Contract J0318097 - "Evaluate Fundamental Approaches to Longwall Dust Control." The overall objective of the contract was to evaluate the effectiveness of available dust control technology for double-drum shearer longwall sections in a coordinated, systematic program at a few longwall test sections and to make the results available to the entire coal mining industry.

This program investigated 10 different dust control techniques within 9 subprograms. The subprograms included:

a. Subprogram A - Passive Barriers/Spray Air Movers for Dust Control

b. Subprogram B - Practical Aspects of Deep Cutting

c. Subprogram C - Stageloader Dust Control

d. Subprogram D - Longwall Automation Technology

e. Subprogram E - Longwall Application of Ventilation Curtains

f. Subprogram F - Reversed Drum Rotation

g. Subprogram G - Reduction of Shield Generated Dust

h. Subprogram H - Air Canopies for Longwalls

i. Subprogram I - Mining Practices
   Division I - Homotropal Ventilation
   Division II - Ventilation Parameters

These 9 subprograms encompassed a broad range of dust control techniques ranging from administrative controls to new hardware. They spanned not only presently employed methods but also those recently adopted in the United States and those proposed for the future.

The report constitutes the Final Technical Report for Subprogram C "Stageloader Dust Control," summarizing the effort expended and the results obtained.

Companion volumes document the results of the other subprograms.

1.1 BACKGROUND

Mechanized longwall mining has been the primary technique for underground coal extraction in Europe for more than 20 yr. With the impetus for increased coal production, the trend to high production longwall techniques has firmly taken root in the United States. Increased levels of coal production on longwalls has brought with it higher levels of dust generation and most United States longwalls have difficulty complying with federal dust standards.

The contamination of intake air is a significant dust control problem often overlooked on many longwall faces. This dust source contributes to the full shift dust exposure of <u>all</u> face personnel, and thus can significantly affect compliance with federal regulations.

Several sources can contribute to intake air contamination; however, the stageloader crusher is the single largest source. The breaking action of the crusher on the coal or rock generates tremendous quantities of dust, which mixes with the primary airstream and is carried down the entire length of the longwall face.

1.2 SUBPROGRAM OBJECTIVE

The objective of this subprogram was to design and evaluate a stageloader dust control system. The system was to utilize both water-powered scrubbers and water sprays to control dust sources at the stageloader and crusher. Subsequent field tests would evaluate the effectiveness of the entire dust control system and each separate control in reducing intake air contamination. These objectives were to be accomplished through the following tasks:

a. <u>Field Evaluations</u> of various dust control measures at <u>three</u> mine sites to quantify the effectiveness of a total stageloader dust control system

b. <u>Laboratory Investigations</u> of system components which appeared to be practical and effective after the first two in-mine evaluations. This study would result in an optimized dust control package for the third and final field trial

c. <u>Manufacturer's Survey</u> to determine design parameters for the control system components and to document dust control features (current and future) being designed into and supplied with stageloader equipment packages.

2. FIELD EVALUATION OF A STAGELOADER DUST CONTROL SYSTEM AT EMERY MINING COMPANY'S DEER CREEK MINE

The first installation and evaluation of a stageloader dust control system was conducted at Emery Mining Company's Deer Creek Mine in November, 1981.

The field evaluation was divided into the following three phases:

a. Preliminary mine evaluation

b. Dust control system installation

c. Dust control system evaluation.

Each of these phases is discussed in the following subsections.

2.1 PRELIMINARY EVALUATION

The original scope of effort for this task called for:

a. Conducting preliminary surveys of potential mine sites

b. Selecting the mine demonstration site

c. Designing the scrubber and dust control system for the selected site.

While conducting another Bureau field evaluation at Emery's Deer Creek Mine, dust surveys indicated that intake contamination contributed a significant portion of the full shift dust exposure of face personnel. Dust levels (instantaneous) averaged 1.0 mg/m^3 on the headgate end of the face while coal was being loaded. Tests, designed to locate the source of the intake contamination, indicated that the stageloader crusher was the major contributor. Given these conditions, Deer Creek's 7th East longwall seemed an appropriate site for the initial stageloader dust control field installation and evaluation.

During this evaluation, it was learned that Donaldson Co., a manufacturer of dust control systems had submitted a proposal to Emery for a scrubber installation on the stageloader. FMI immediately interfaced with Donaldson and Emery and confirmed that an intake dust problem did exist and that the crusher was the major source of the contamination. All of the necessary ingredients for the planned evaluation of stageloader dust controls were at hand:

a. A scrubber designed by Donaldson ready for application

b. A cooperative mine with an intake contamination problem.

After a series of discussions the following decisions were reached by all parties involved:

a. Emery Mining would purchase a "J-SAM"[1] water-powered scrubber from Donaldson (see figure 5)

b. Donaldson and FMI would cooperate in the installation of the scrubber to control crusher and stageloader generated dust

c. FMI would conduct a 2-week evaluation of the stageloader dust controls to determine their effectiveness in reducing intake contamination

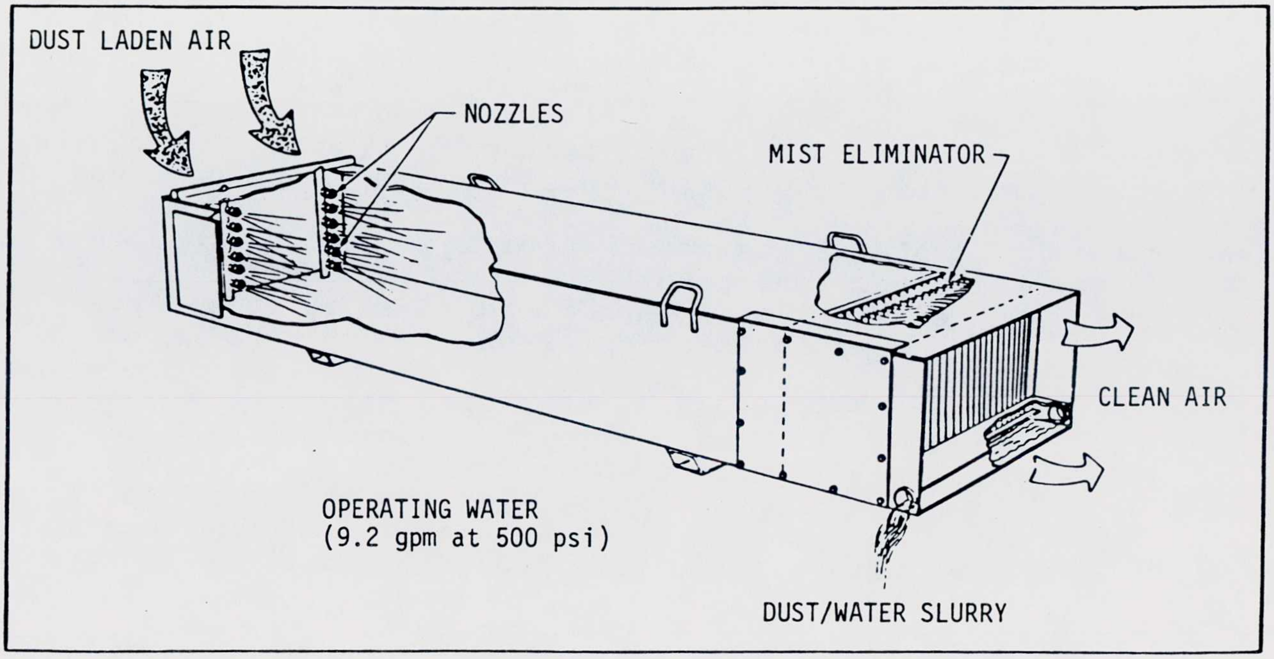


FIGURE 5. - Donaldson water-powered scrubber.

[1]Reference to specific equipment ("J-SAM" water-powered scrubber) does not imply endorsement by the Bureau of Mines.

d. During the evaluation FMI would install additional dust controls as determined from dust sampling surveys (to further reduce intake contamination levels).

2.2 SYSTEM INSTALLATION

The installation of the Donaldson scrubber and the refurbishment of the existing controls were performed with both Donaldson and FMI personnel on November 14, 1981. As shown in figure 6 the inlet of the Klockner (Type SB63) crusher was covered with a flap fabricated from conveyor belt. Mounted vertically in an opening in the crusher top was a bank of four Conflow swivel tip sprays. The outlet of the crusher was enclosed in a 4-ft square steel tunnel ending in a vertically mounted hinged steel plate. Two Conflow swivel tip sprays were attached to the outby side of the hinged plate aimed into the stage loader panline. A 4-ft section of panline from the enclosed tunnel to the manbridge was covered with brattice.

Due to the enclosed steel tunnel and inadequate clearance between the tunnel and manbridge, the scrubber was installed immediately outby the manbridge on the inclined section of the stageloader. Its inlet and exhaust was transitioned with belting into the panline, then the entire unit was covered with brattice creating a duct around the unit (as shown in figure 7). The entire length of the stageloader panline outby the crusher was covered in brattice which continued the duct effect.

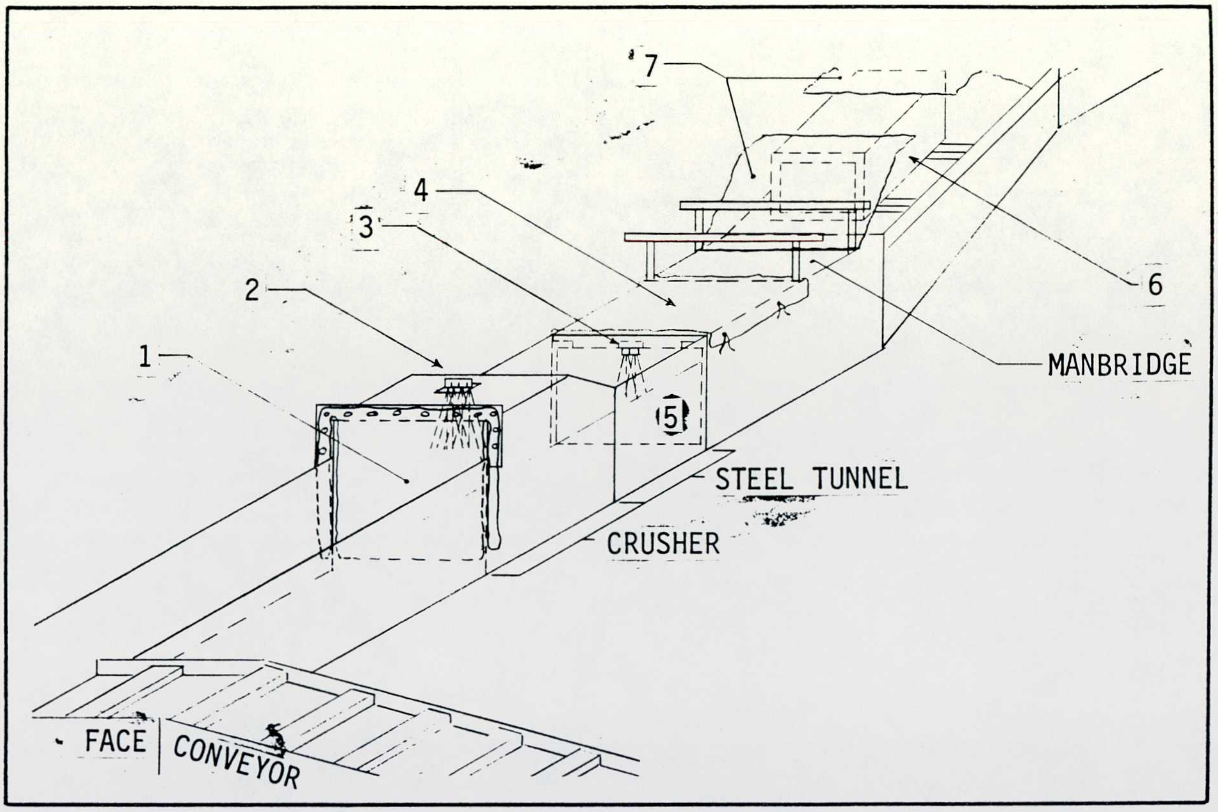
All of the water supplying the Conflow sprays and scrubber passed through a Conflow reverse flushing strainer. The scrubber had an additional stage of filtration - a Donaldson screw-on element type filter.

After installing the scrubber and other controls, preliminary dust control evaluations took place from November 16 through November 18, 1981. Figure 8 shows the headgate area with dust averages indicated at various sampling points. Careful analysis of the data indicated that with all controls (scrubber plus Conflow sprays) operating:

a. Dust levels measured along the initial face shields dropped approximately 50%

b. Dust levels measured at the operator and manbridge were substantially reduced

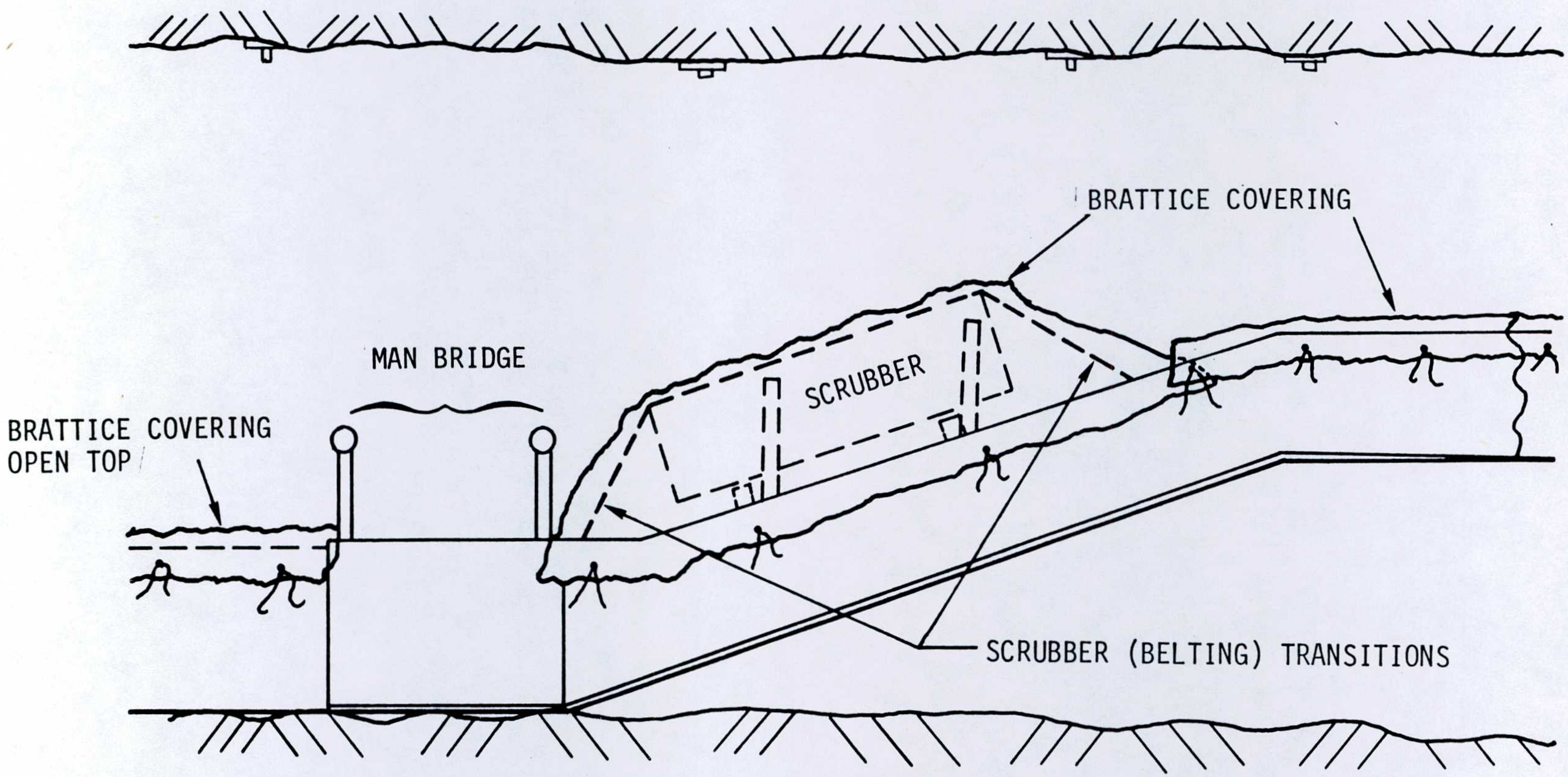
c. Dust levels measured in the immediate area of the crusher intake increased.



CONTROLS EXISTING DURING PRE-EVALUATION AND
FOR FIRST WEEK OF SYSTEM EVALUATION TESTING

1. CRUSHER THROAT FLAP (BELTING)
2. 4-CONFLOW SWIVEL TIP SPRAYS
3. 2-CONFLOW SWIVEL TIP SPRAYS
4. BRATTICE COVERING OPEN TOP
5. HINGED STEEL PLATE
6. DONALDSON WATER POWERED SCRUBBER
7. SCRUBBER TRANSITIONS* (BELTING)

FIGURE 6. - Scrubber and existing controls.



BRATTICE WAS SECURED TO ONE SIDE OF THE STAGE LOADER, PASSED OVER THE SCRUBBER AND TRANSITIONS, THEN SECURED ON THE OTHER SIDE. THIS CREATED A DUCT AROUND THE SCRUBBER.

FIGURE 7. - Scrubber installation.

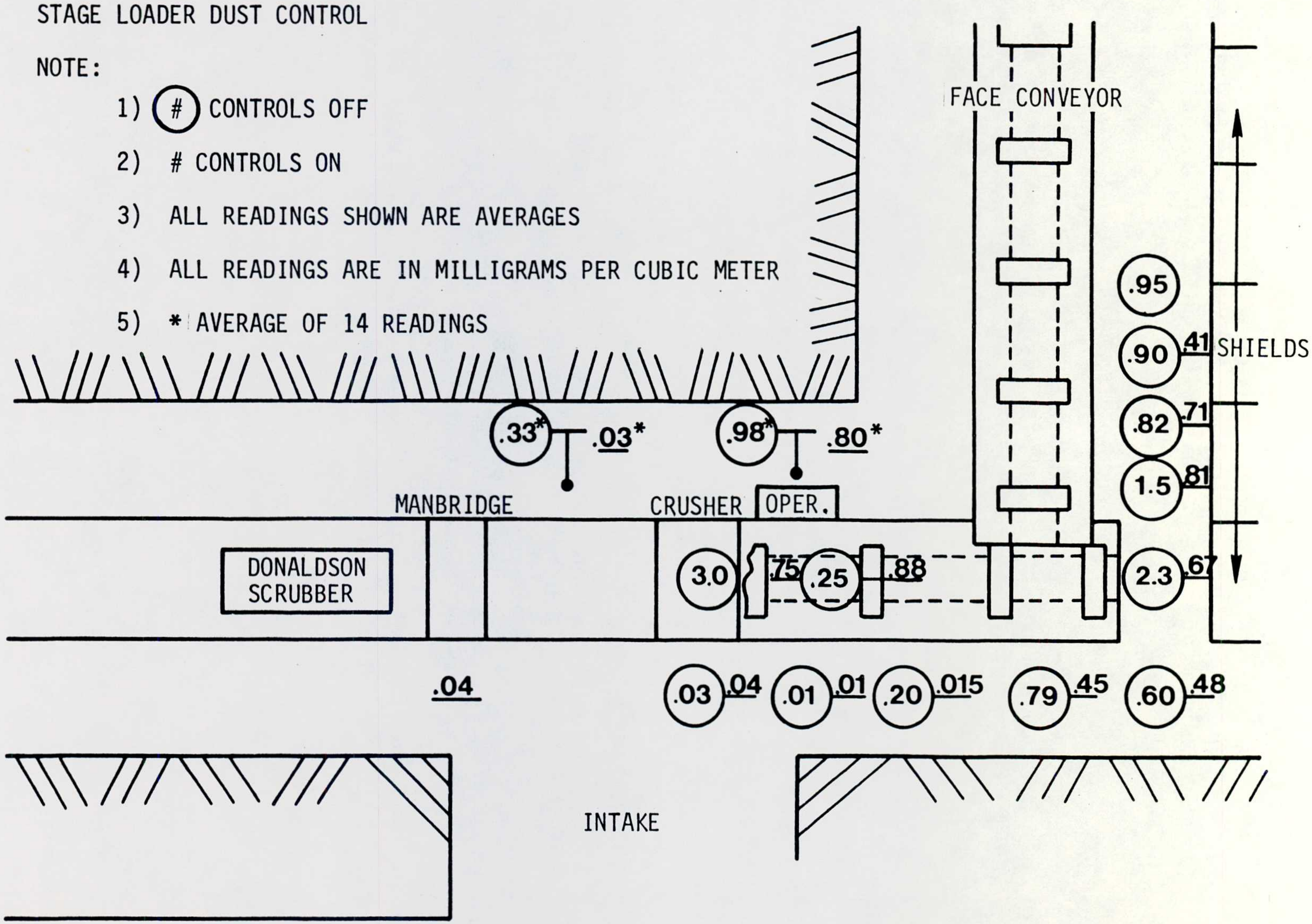


FIGURE 8. - Preliminary headgate dust data.

These initial observations were encouraging with the exception of the dust increase inby the crusher. Visual observations indicated that the crusher sprays (Item 2 in figure 6) seemed to boil dust out of the crusher intake possibly causing the increase in dust levels. This observation was investigated in future system evaluation tests.

2.3 SYSTEM EVALUATION

Early in December, FMI returned to Emery's Deer Creek Mine for the complete evaluation of the crusher and stageloader dust control system. Included in the 2-week test plan was the evaluation of the following dust controls:

a. Existing stageloader dust controls

b. The Donaldson water-powered scrubber

c. Additional dust controls installed during the evaluation.

Dust sampling and ventilation mapping were performed with the scrubber and existing water sprays in operation during the first week of the evaluation. Analysis of the data shown in figures 9 and 10 indicated a significant reduction in dust levels at the headgate operator's position and in overall intake contamination. However, dust was still escaping from the mouth of the crusher.

This was apparently due to the "boiling out" effect created by the top mounted crusher sprays and the lack of scrubber air suction through the crusher. It was decided that by creating an airflow through the crusher, the scrubber's effectiveness in controlling escaping dust would be improved. Therefore, the top mounted crusher sprays were removed and the following controls were added to induce a flow of air through the crusher intake:

a. <u>Venturi crusher sprays</u> - Two air moving sprays were mounted at a 45-deg angle into the crusher to create an airflow through the crusher toward the scrubber

b. <u>Outboard crusher sprays</u> - Two hollow cone sprays were directed at the crusher inlet to create an airflow toward the crusher intake capturing the "boil out"

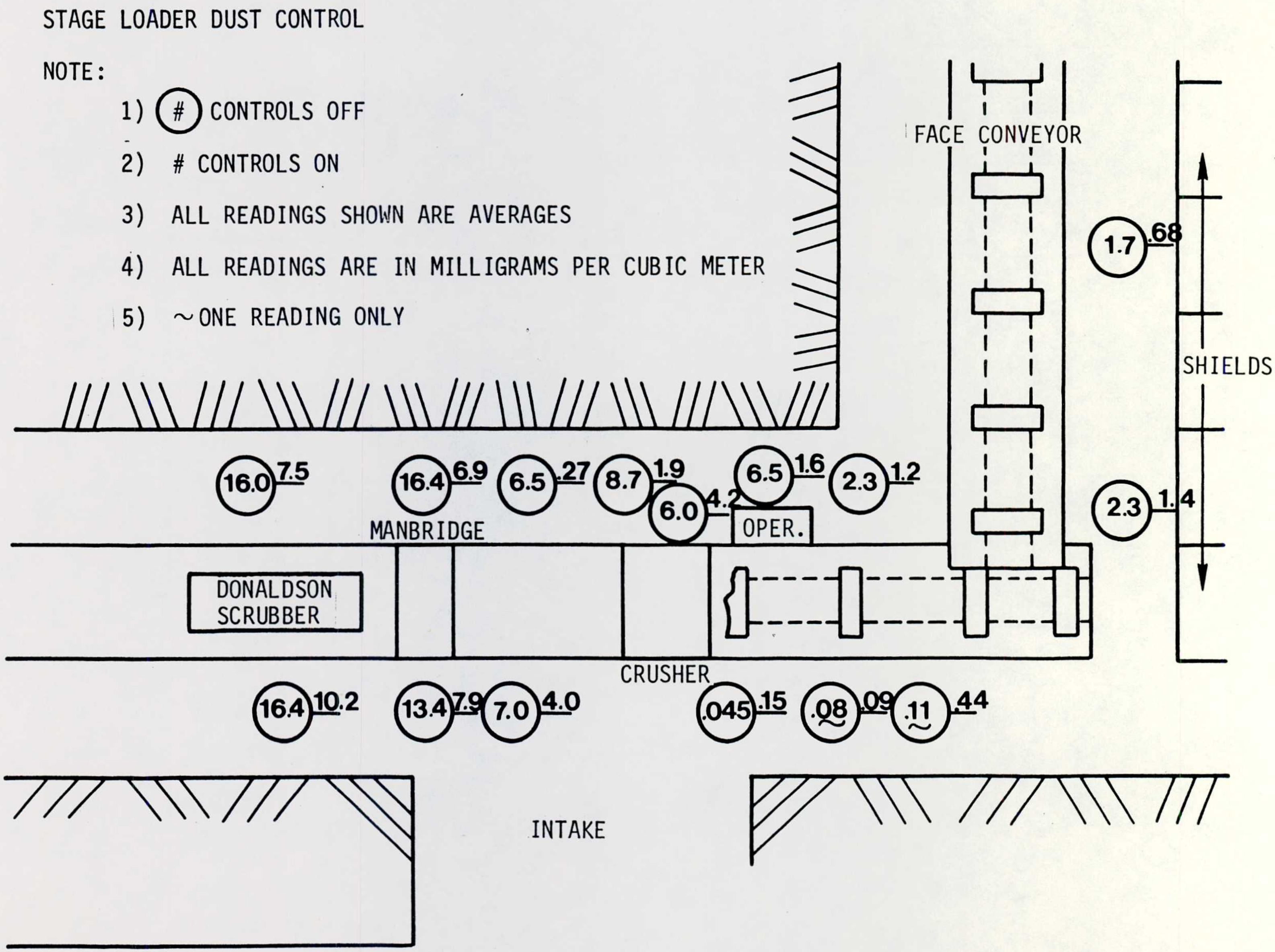


FIGURE 9. - Week 1 headgate dust data.

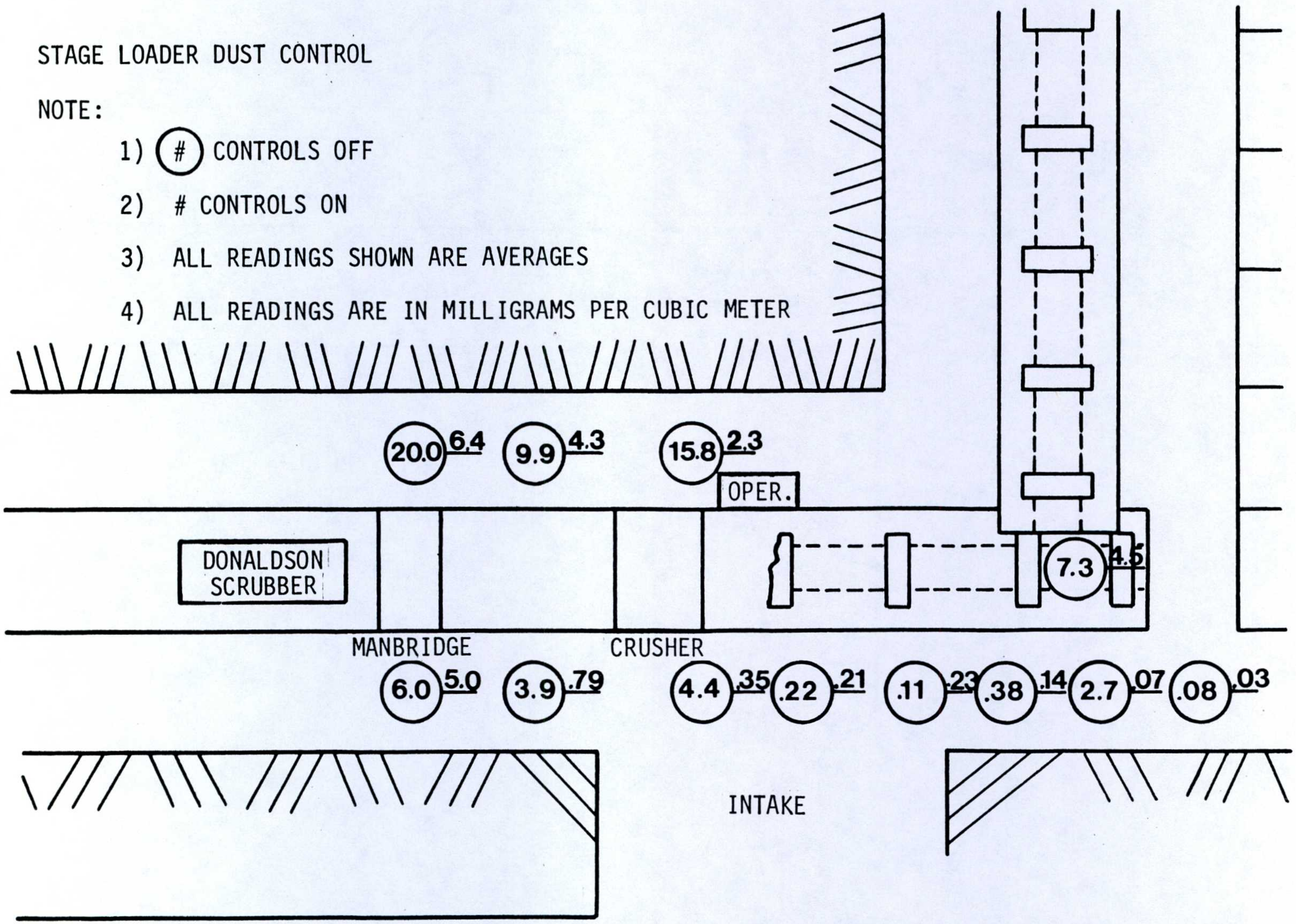


FIGURE 10. - Additional week 1 headgate dust data.

c. Crusher intake hood - This brattice cloth hood was secured to the crusher and vertical spill-plate extensions. It was installed to contain escaping crusher dust and allowed the airflow, induced by the outboard sprays, to be established without ventilation air disturbance.

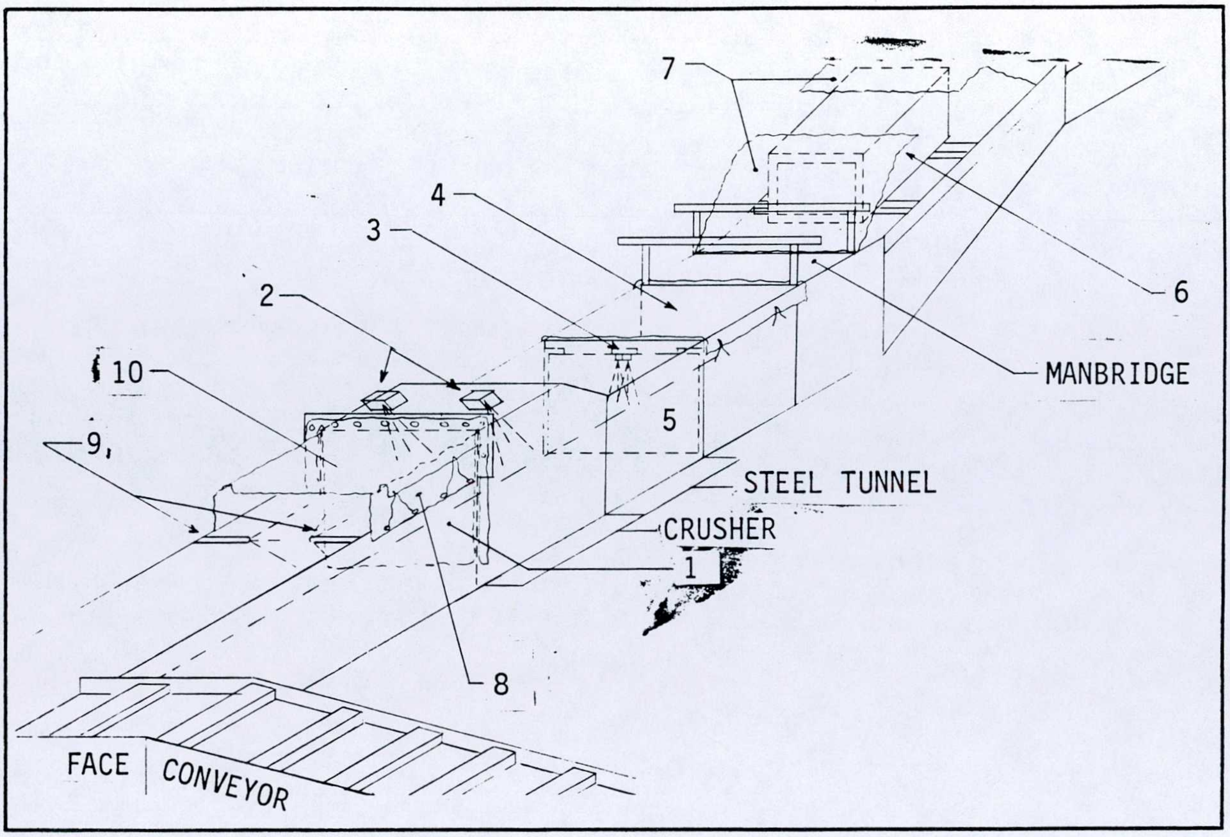
The additional controls together with those already existing are shown in figure 11.

Evaluation testing resumed on December 7, 1981. Deteriorating roof conditions, however, forced the abandoning of the entire headgate grid sampling pattern. Therefore, a test was designed aimed at evaluating the effect that all the controls had on headgate operator dust levels. The test involved continuously sampling operator dust levels while all the controls were turned ON and OFF sequentially. Table 1 contains the average concentrations measured during testing. The data shows reductions approaching 85% with the controls ON versus OFF.

TABLE 1. - Operator dust levels

Status of controls	Coal loading rate	Average concentrations (mg/m^3)
All ON	Full pan	0.26
All OFF	Full pan	11.50
All ON	Full pan	0.38
All OFF	Full pan	2.62
All ON	Full pan	0.39

The system was well received by Emery personnel for its practicality and effectiveness. The results obtained clearly indicated that stageloader induced dust - a significant contributor to face contamination - could be successfully controlled and reduced with the proper application of a water-powered scrubber supplemented by additional dust control techniques.



ADDITIONAL CONTROLS ADDED DURING 2ND WEEK OF TESTING

1. CRUSHER THROAT FLAP (BELTING)
2.* 2-VENTURI SPRAYS MOUNTED AT 45 deg
3. 2-CONFLOW SWIVEL TIP SPRAYS
4. BRATTICE COVERING OPEN TOP
5. HINGED STEEL PLATE
6. DONALDSON WATER POWERED SCRUBBER
7. SCRUBBER TRANSITIONS (BELTING)
8.* SPILL PLATE VERTICAL EXTENSIONS 3 ft × 1 ft (BELTING SECURED TO BOTH RIGHT AND LEFT SPILL PLATES
9.* OUTBOARD SPRAYS (FLEXIBLY MOUNTED BD 3 SPRAYS)
10.* BRATTICE COVER - SECURED TO CRUSHER AND VERTICAL SPILL PLATE EXTENSIONS

*ADDITIONAL CONTROLS

FIGURE 11. - Complete dust control system including existing and additional controls.

3. SECOND IN-MINE EVALUATION OF A STAGELOADER DUST CONTROL SYSTEM AT PRICE RIVER COAL COMPANY'S NO. 5 MINE

The second installation and evaluation of a stageloader dust control system was conducted at Price River Coal Company's No. 5 Mine in July and August 1982. Details of this evaluation are presented in the following subsections.

3.1 PRELIMINARY INVESTIGATIONS

Two preliminary visits were made to the No. 5 Mine. The first visit to the 8th West Longwall in March, 1982 showed face concentrations near the headgate of 1 to 2 mg/m^3. During this visit the stageloader was open. Water sprays were mounted in the crusher housing, but no spraybar was used.

When a second visit was made on May 19 and 20, 1982, a new crusher and a partially enclosed stageloader with a spraybar had been installed on the 9th West Longwall as shown in figure 12. Intake dust concentrations from limited measurements taken on the face during the May visit ranged from 0.5 to 0.6 mg/m^3. Although a different longwall panel and crusher were measured and preliminary survey data were limited, it was possible that at least a 50% reduction in respirable dust concentrations in the headgate area of the face had been achieved by partially enclosing the stageloader as shown in figure 12.

The stageloader configuration included a 10-ft section of open top inby the manbridge, and an approximate 10 ft section covered with belting outby the manbridge. The remainder of the stageloader inby the crusher had a steel top. The section outby the crusher, which contained the leveling plate, was also covered with steel plate. Coal was leveled by the plate, transferred to a chain conveyor stage, which was partially covered with belting, and then transferred to the main belt. Dust control measures included:

a. Belting covers for 10 ft outby the manbridge and over a portion of the chain conveyor stage outby the leveling plate

b. Steel plate covers on top of the stageloader at the crusher and tunnel discharge

c. Spraybar with 3 spray nozzles at the outby edge of the belting beside the manbridge (spray oriented towards oncoming material flow)

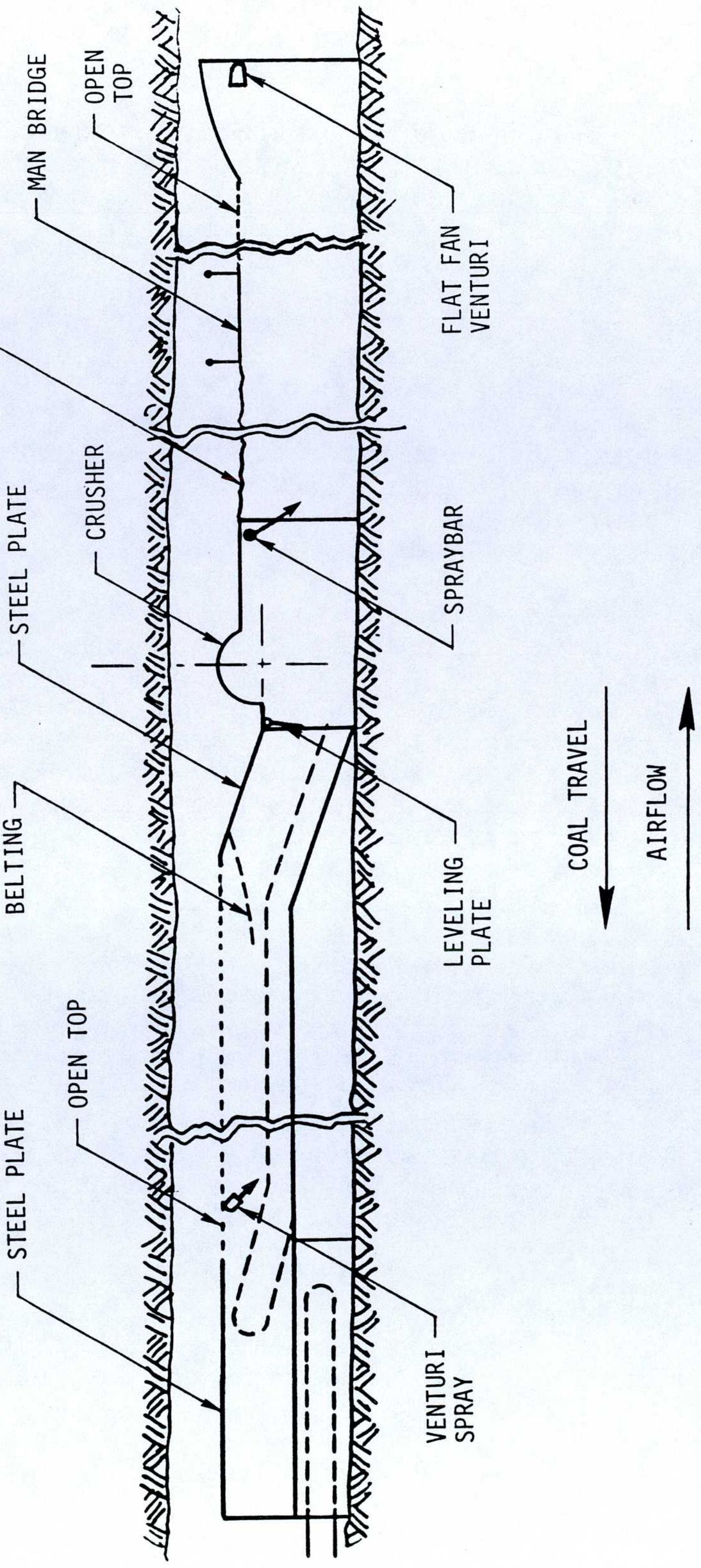


FIGURE 12. - Price River stageloader before scrubber installation.

d. Flat fan venturi at the face conveyor transfer point to the stageloader (oriented with material flow to crusher)

e. Flat fan venturi at the stageloader transfer point to the main belt (oriented towards oncoming material flow).

The preliminary data resulted in an initial recommendation to the mine for a preferred scrubber installation that is shown in figure 13. Specific recommendation included:

a. Cutting a hole in the steel top plate immediately inby the crusher to serve as a scrubber inlet

b. Resting the scrubber on the steel top inby the crusher

c. Installing brattice cloth or belting to form an inlet "duct" for the scrubber

d. Orienting the scrubber so the discharge was towards the manbridge.

3.2 STAGELOADER DUST CONTROL EVALUATION

Figure 14 illustrates the stageloader configuration that was actually installed by the mine and evaluated in July and August 1982. A photograph of the installation is shown in figure 15. The stageloader side plates had been raised about 12 in. and the following dust control measures had been taken:

a. A steel plate had been welded to the top of the stageloader for its entire length inby and outby the crusher except for a 7-ft open section at the transfer point to the main belt

b. A hinged steel gate was installed at the material entrance to the stageloader

c. A Donaldson "J-SAM" scrubber was installed outby the leveling plate with the scrubber exhaust towards the face (not as recommended and shown in figure 13)

d. The flat fan venturi at the face conveyor transfer point was removed because of damage from transported coal.

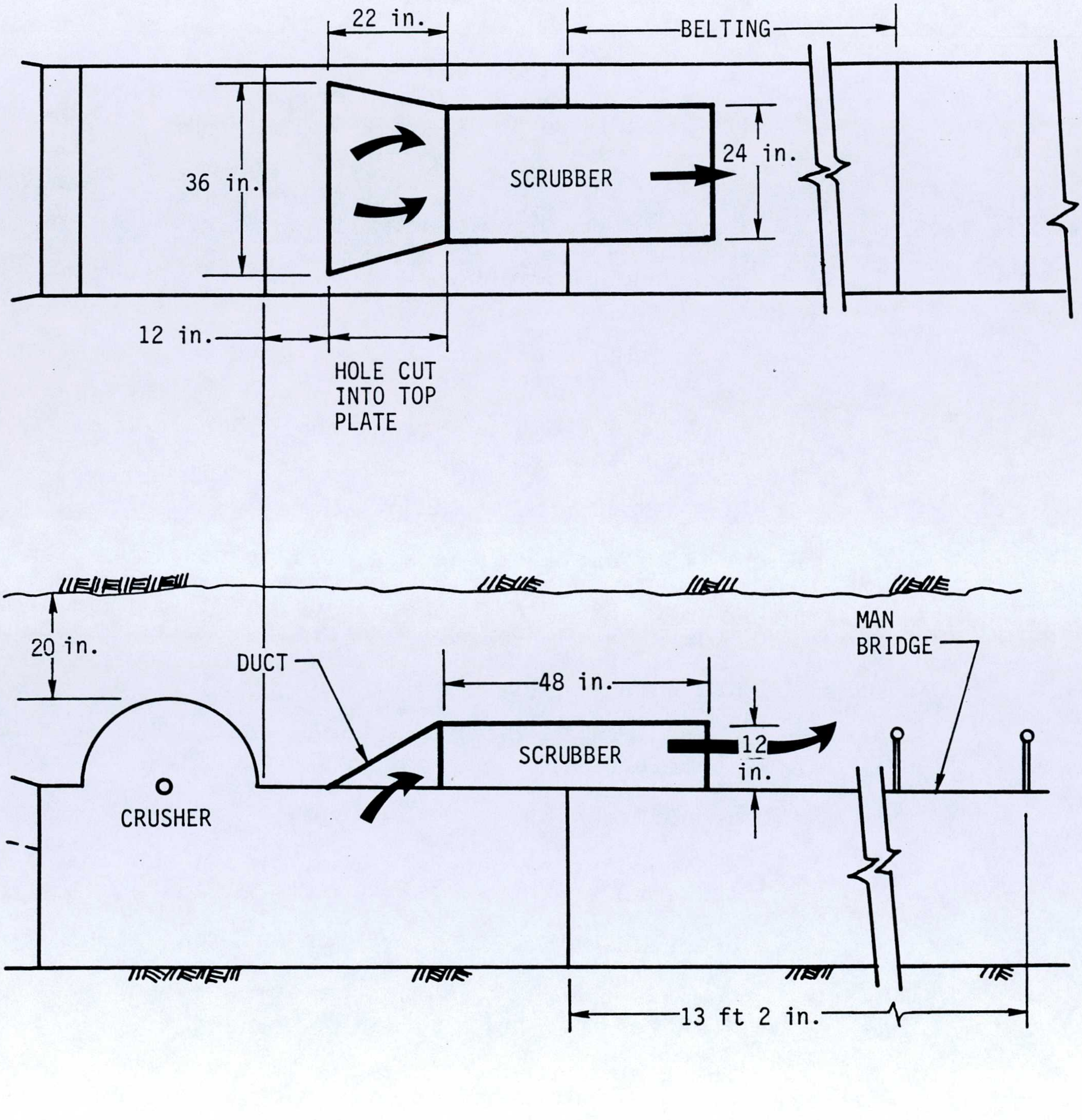


FIGURE 13. - Recommended stageloader scrubber (crusher inlet) Price River installation.

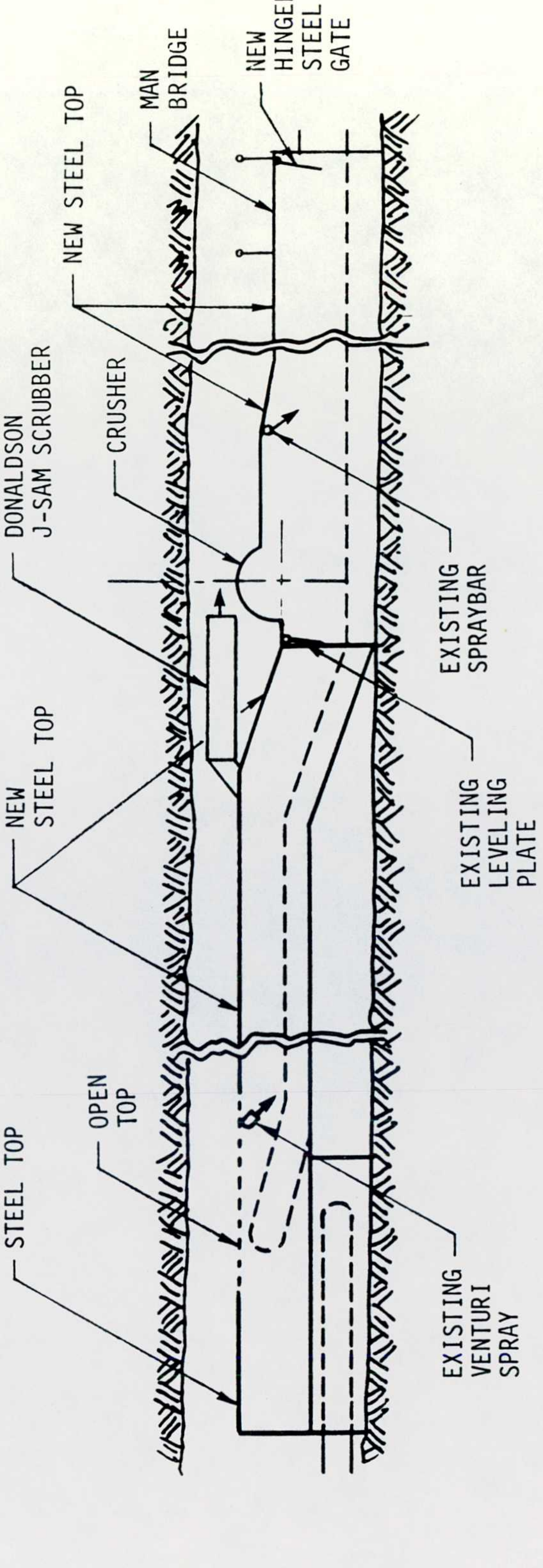


FIGURE 14. - Actual scrubber installation - Price River coal stageloader.

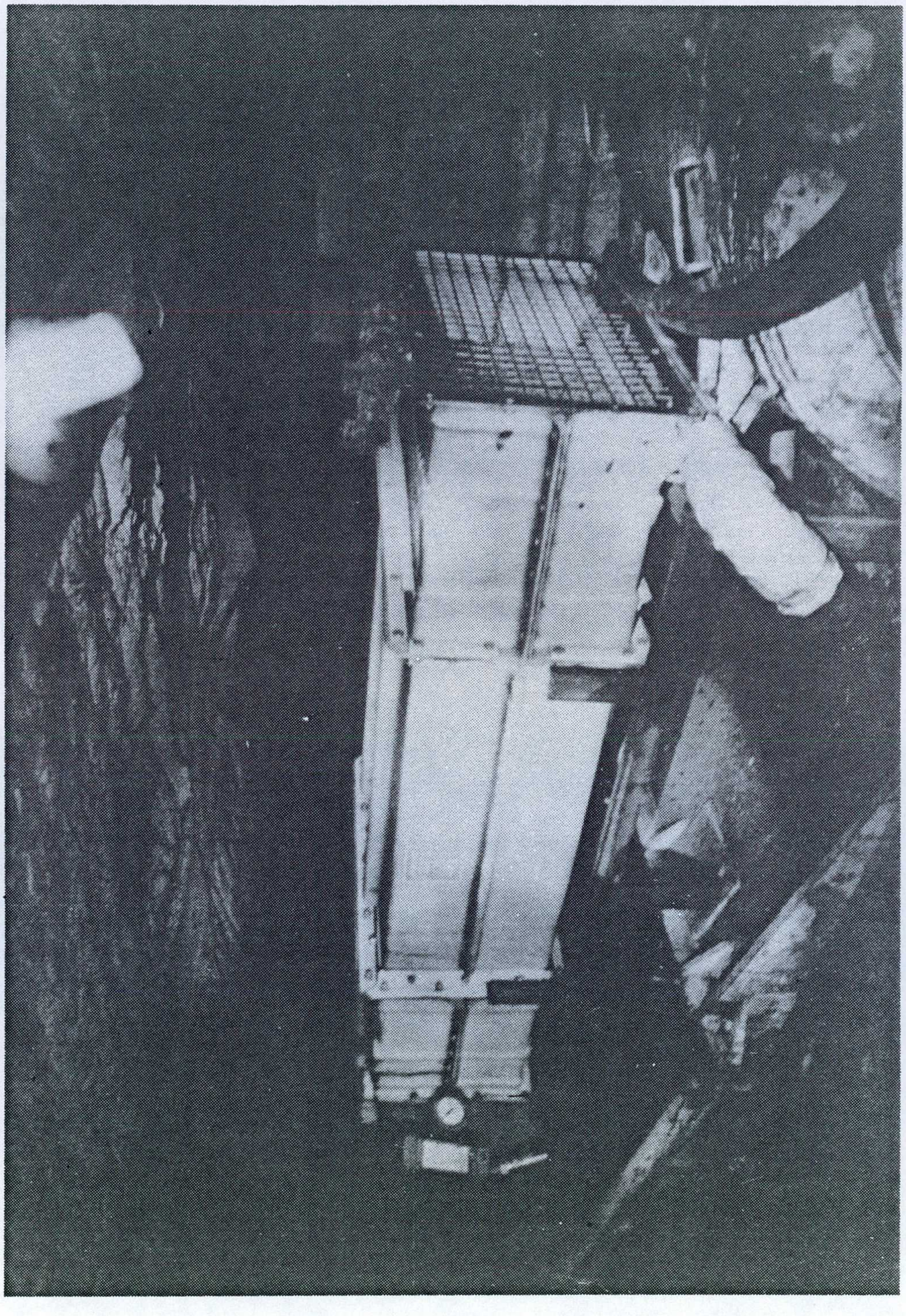


FIGURE 15. - "J-SAM" scrubber installed on enclosed stageloader at Price River.

The water supply system was valved so the existing spraybar and the "J-SAM" scrubber could be evaluated separately or in combination with each other. Water pressure to the scrubber and spraybar was typically 400 psi.

The stageloader area investigation included:

a. Respirable dust concentration surveys for the following configurations:

   1. Baseline - the stageloader enclosure and the existing venturi spray at the transfer point to the main belt

   2. Spraybar - located 10 ft outby the manbridge

   3. "J-SAM" scrubber - installed with its inlet outby the leveling plate (scrubber discharging towards the face)

   4. <u>All</u> of the above controls combined

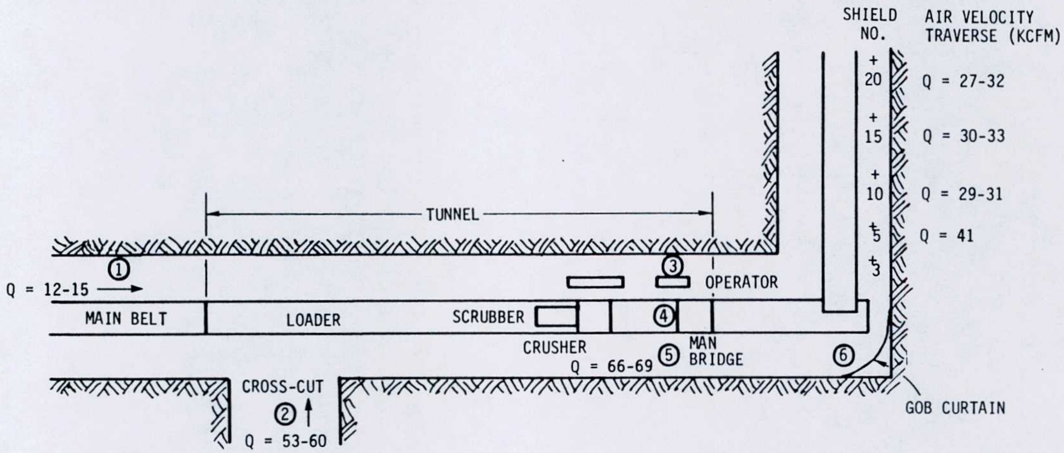
b. Airflow measurements

c. Dust source evaluation within the stageloader enclosure.

3.2.1 <u>Respirable Dust Concentration and Airflow Surveys</u>

From our visual observations of the stageloader during the 30 July to 13 August, 1982 tests, a pan loading of only one-quarter resulted in a slurry being transported due to the large water quantities that were used on the face. A pan loading of only one-half resulted in a very wet coal being transported. In both cases, differences in dust levels generated for various controls were very difficult to determine unless large lumps were passing through the crusher. Table 2, therefore, presents a combined summary of tests conducted when production levels ranged between one-quarter and three-quarter pan (or full pan during certain tests). Unfortunately, tests with the scrubber on and the spray bar off were only conducted during pan loads between one-quarter and one-half. Nonetheless, these results were included in Table 2 for comparison purposes.

TABLE 2. - Summary of dust survey measurements



Dates	Stageloader operating conditions				Pan load	Average respirable dust concentrations, mg/m³											
						① Intake ②		Stageloader operator ③ ④ ⑤			At gob curtain ⑥	By shield number					
	Scrubber		Spraybar			10 ft outby stage loader exit (operator side)	Last open crosscut	At operator	On stage loader	Outby side							
	On	Off	On	Off								20	15	10	5	3	Average
1982																	
8/11 (one test)		x		x	1/4 to full	2.41	0.31	0.55	1.50	0.35	0.31	1.63	1.96	6.56	2.56	2.68	3.08
8/4, 8/5, 8/11, 8/12 (four tests)		x	x		1/4 to 3/4	0.43	0.25	0.96	0.65	0.23	0.25	0.58	0.59	0.48	0.58	0.67	0.58
7/30, 8/2, 8/4, 8/11, 8/12 (five tests)	x		x		1/4 to 3/4	0.49	0.17	0.62	8.71	0.21	0.21	0.64	0.66	0.67	0.80	0.72	0.70
8/4, 8/6 (two tests)	x			x	1/4 to 1/2	1.41	0.20	0.74	2.10	0.30	0.17	0.60	0.45	0.75	0.52	0.55	0.57
Diagram positions						1	2	3	4	5	6						

Notes: 1. All dust measurements with GCA RAM-1 Respirable Aerosol Monitor.
2. All air velocity measurements J-TEC Anemometer.

All dust concentrations were measured with a GCA RAM-1 Respirable Aerosol Monitor, and all air velocity measurements were made with a J-TEC anemometer. Two dust controls remained constant throughout the survey:

a. The stageloader was enclosed (as shown in figure 10)

b. The existing venturi spray, at the transfer point to the main belt, remained on since it was on a cooling water circuit.

The average background dust concentration (scrubber and spraybar off) ranged from 1.63 to 6.56 mg/m^3 (Avg. = 3.08 mg/m^3) for the first 20 shields.

With the scrubber <u>on</u> and the spraybar <u>off</u>, the average dust concentration dropped to 0.57 mg/m^3 over two tests for the first 20 shields. This is a <u>reduction of approximately 81% from background levels</u> (enclosed tunnel, venturi spray only). As previously discussed, production levels were lower during the scrubber only tests than the remaining test configurations.

With the spraybar <u>on</u> and the scrubber <u>off</u>, the average dust concentration dropped from background levels to 0.58 mg/m^3 over four tests that were at a higher production rate than the two scrubber tests. This was also an <u>81% reduction from background levels</u> for the first 20 shields.

A comparison can now be made between the <u>partially enclosed</u> stageloader with some belting/steel-top and spraybar (fig. 12) which was observed during the preliminary visit, and an <u>enclosed</u> stageloader with steel-top and spraybar (fig. 14). The former had measured face concentrations of approximately 0.5 to 0.6 mg/m^3 and the latter had average face concentrations of 0.58 mg/m^3.

<u>It therefore appeared that dust levels at the face were not significantly reduced by the simple change from a belted-top enclosure (fig. 12) to a steel-top enclosure (fig. 14).</u>

With both the scrubber and spraybar <u>on</u>, the average dust concentration increased slightly to 0.70 mg/m^3 over five tests for the first 20 shields. This can be partially explained by referring to Table 2 and the data for position 4.

There were always some dust emissions from the scrubber discharge when the scrubber was operated. The emissions were especially high (typically 20 to 40 mg/m^3 at 2000 ft^3/min) when large lumps entered the crusher. Position 4 therefore recorded substantially higher dust concentrations when the scrubber was in operation (2.1 mg/m^3 with spraybar off and 8.71 mg/m^3 with spraybar on) as compared to the conditions when the scrubber was not operating:

a. Background test (1.5 mg/m^3)

b. Spraybar tests (0.65 mg/m^3).

The scrubber discharge was covered when the scrubber was not operated to prevent dust emissions from the enclosed tunnel escaping to the face.

Two reasons can therefore be given for why the tested spraybar was as effective as the scrubber in an enclosed stageloader:

a. Dust emissions from the scrubber were directed towards and in close proximity to the face. Although a scrubber may appear to be efficient because it is removing 80% of the respirable dust from its induced airflow, 20% of the respirable dust entrained is being discharged. The scrubber in this application was producing a large number of airflow changes per minute within the stageloader enclosure. Hence, the dust within its discharge was significant.

b. The scrubber was not installed at the optimum location for effective dust control and a fair evaluation had, therefore, not been performed (as discussed in the next subsection).

3.2.2 Dust Source Analysis within Stageloader Enclosure

As the dust survey was being performed, the preliminary results made us suspect that the scrubber may not have been installed at the source of highest dust concentrations. Our prior experience from the first mine evaluation at Emery had also indicated that the preferred scrubber location for optimum effectiveness was the crusher inlet if physically possible. The crusher inlet location had been recommended prior to the scrubber's installation.

On August 11, we ran simultaneous dust concentration tests within the tunnel at the crusher inlet and discharge to resolve which location was preferred for effective

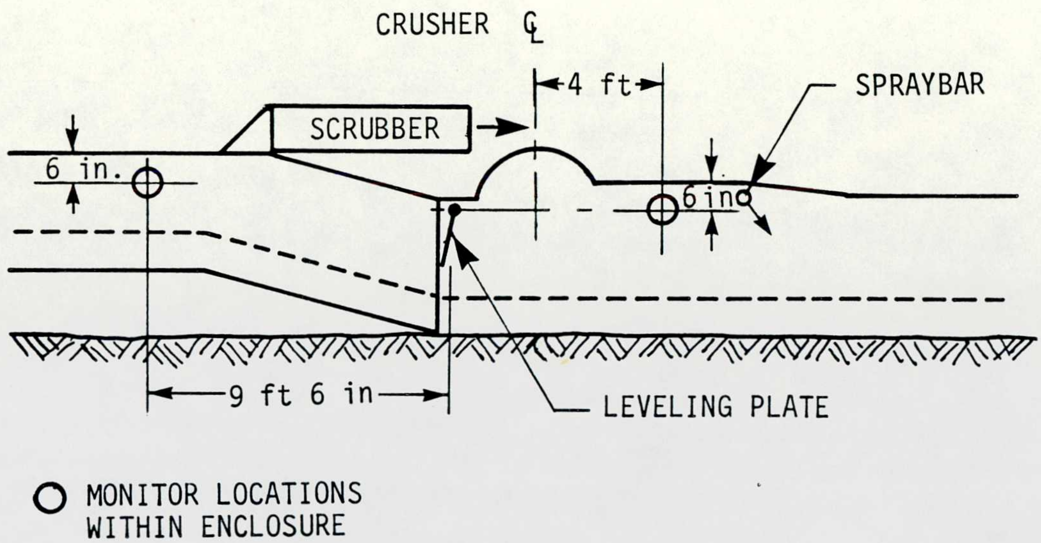


FIGURE 16. - Monitoring locations within enclosure.

scrubber application. Two GCA-RAM-1 Respirable Aerosol Monitors were used. The cyclones were detached from the units and each was mounted to a probe which included a 4-ft section of tygon tubing. The probes were inserted at the crusher inlet and discharge at the locations shown in figure 16, and the cyclone inlets were oriented towards the oncoming flow. Periodic cyclone backflushing and simultaneous tests of less than 10 min were performed to minimize line fouling which otherwise would have been a problem.

Respirable dust concentrations were found to be significantly higher at the crusher inlet.

Table 3 presents a summary of the simultaneous dust concentration tests within the tunnel. Crusher inlet concentrations were about 46 mg/m^3 with the spraybar and scrubber off versus about 4 mg/m^3 at the discharge, an order of magnitude lower. When the spraybar and scrubber were turned on, inlet concentrations dropped to 1.7 mg/m^3 (96% reduction) and discharge concentrations dropped to 0.7 mg/m^3 (81% reduction). Outlet levels were less due to the leveling plate acting as a barrier between the crusher outlet measurement location and the source of major dust concentrations, the crusher inlet.

TABLE 3. - Dust concentrations within enclosed stageloader

Operating conditions	Average respirable dust concentration, mg/m^3 At crusher inlet	At crusher discharge
Scrubber on Spraybar on Production: 1/2 PAN	1.7	0.7
Scrubber off Spraybar off Production: 1/2 to 3/4 PAN	45.5	3.7

3.3 SUMMARY OF SYSTEM EVALUATION

Based on the dust survey results and the dust source analysis within the enclosure, we recommended the configuration shown in figure 17 to Price River. The recommended configuration included:

a. Installing the scrubber at the crusher inlet

b. Turning the scrubber around (discharge away from face)

c. Duct the discharge back into the tunnel outby the leveling plate.

Item a. was a result of the analysis within the enclosure, and items b. and c. were a result of high dust levels measured at position 4 near the scrubber discharge (see table 2).

Because of equipment failures and production problems, we were unable to install and test the recommended configuration. The field evaluation had demonstrated, however, that it was important to determine the relative effectiveness of the spraybar and scrubber in an enclosed volume and under conditions that represented a fair evaluation for each component. We therefore designed and performed a laboratory evaluation for this purpose, as discussed in the next section.

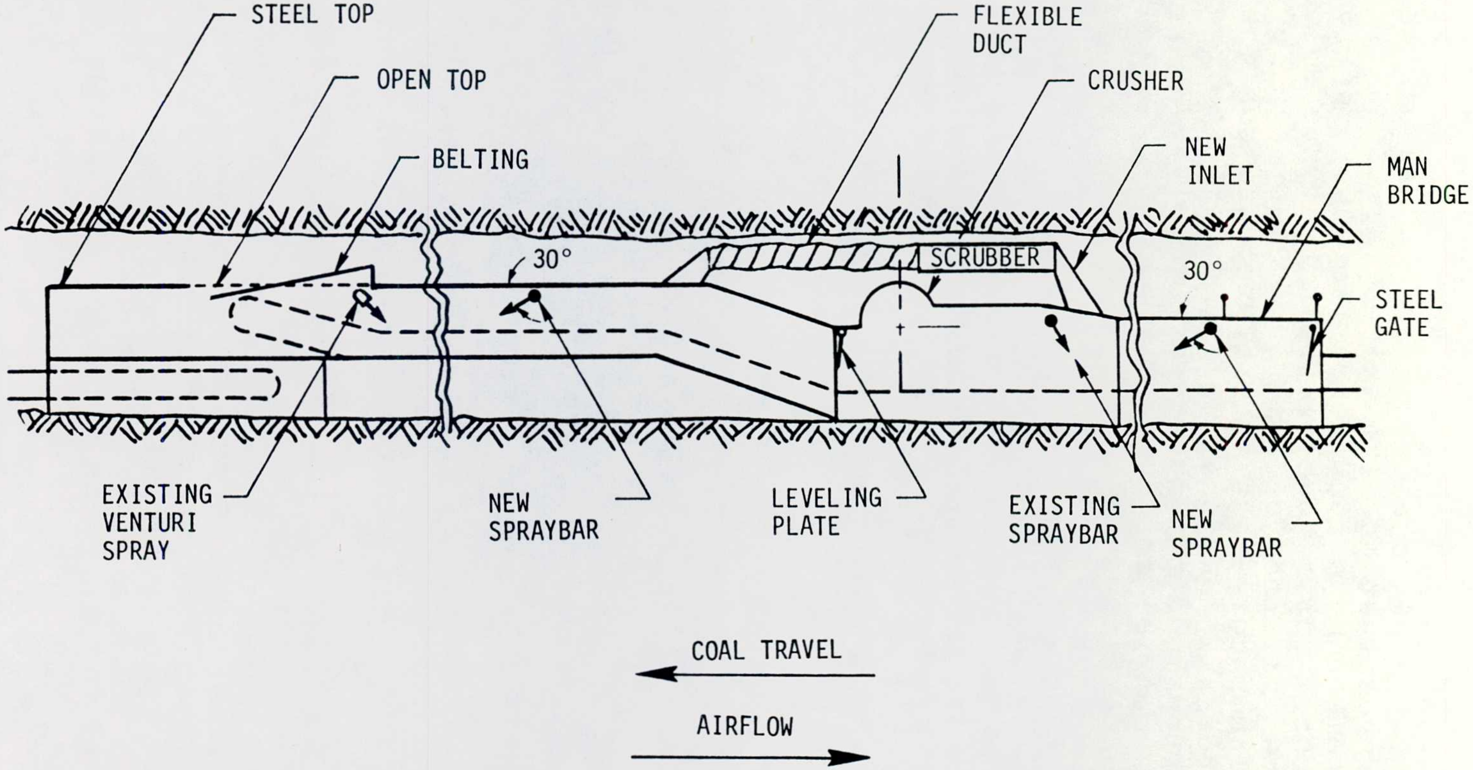


FIGURE 17. - Recommended scrubber installation - Price River Coal Company.

4. LABORATORY EVALUATION

The fundamental result of the Emery and Price River evaluations was that individual components of the stage-loader dust control system must be applied with discretion so the package of components can operate effectively. The investigation also raised questions regarding relative component effectiveness for dust control. Production conditions, however, do not always allow testing opportunities for determining relative effectiveness. A laboratory task, therefore, was designed into the program for this purpose. Field experience from the two evaluations and the laboratory results could then be applied to a control system that would be optimized during a final underground test.

The laboratory evaluation included brief dust control performance tests of:

a. Scrubber configuration with:

   1. Variable spray nozzle pressures and flows with 1/4 VV4002 nozzles (to optimize water use)

   2. Variable scrubber lengths (to package scrubber more compactly)

   3. With and without demister (to evaluate effectiveness when scrubber is discharged into an enclosure and demister is not required)

b. Spraybar with 4 equally spaced nozzles with:

   1. Variable nozzle types

   2. Variable spray pressures and flows

c. Combination of scrubber and spraybar.

Figure 18 illustrates the dust booth setup for the stageloader dust control program. An NBS dust feeder injected dust into the air-tight booth until the concentration was in excess of 200 mg/m^3 (a fan uniformly mixed the dust). The dust feeder was then turned off and a GCA RAM-1 monitored the respirable dust decay beginning at 200 mg/m^3. When the concentration decayed to 180 mg/m^3 the scrubber or spraybar was turned on and monitoring continued for dust concentrations versus time (seconds) until a 30 mg/m^3 concentration was reached. Decay rates were then compared for the configurations listed above.

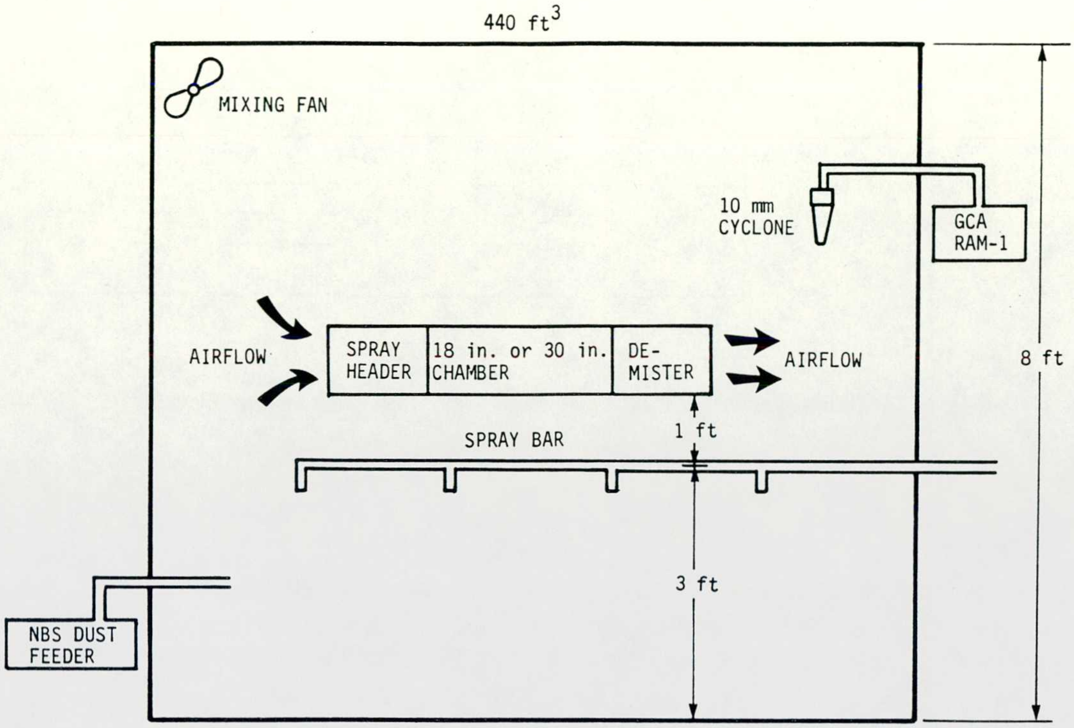


FIGURE 18. - Dust booth setup for stageloader dust control program.

Field conditions were duplicated to the extent possible by the laboratory tests. The dust booth volume is approximately the same as the volume for the enclosed stageloader evaluated at Price River. The dust injection approximates a surge of dust being generated by a large lump passing through the crusher, both in terms of injection duration and approximate dust concentration. The spraybar and scrubber airflow rates are analogous to field conditions.

Dust reduction efficiency as a function of airflow and normalized for water flow was plotted versus spray pressure.

Figure 19 presents a summary of the results. The following conclusions can be drawn from the results:

a. Dust control efficiency shows a strong dependence on spray pressure and whether or not a demister was used for the scrubber

b. The spraybar with four BD8-1 spray nozzles is the most effective component that was tested for the dust control system

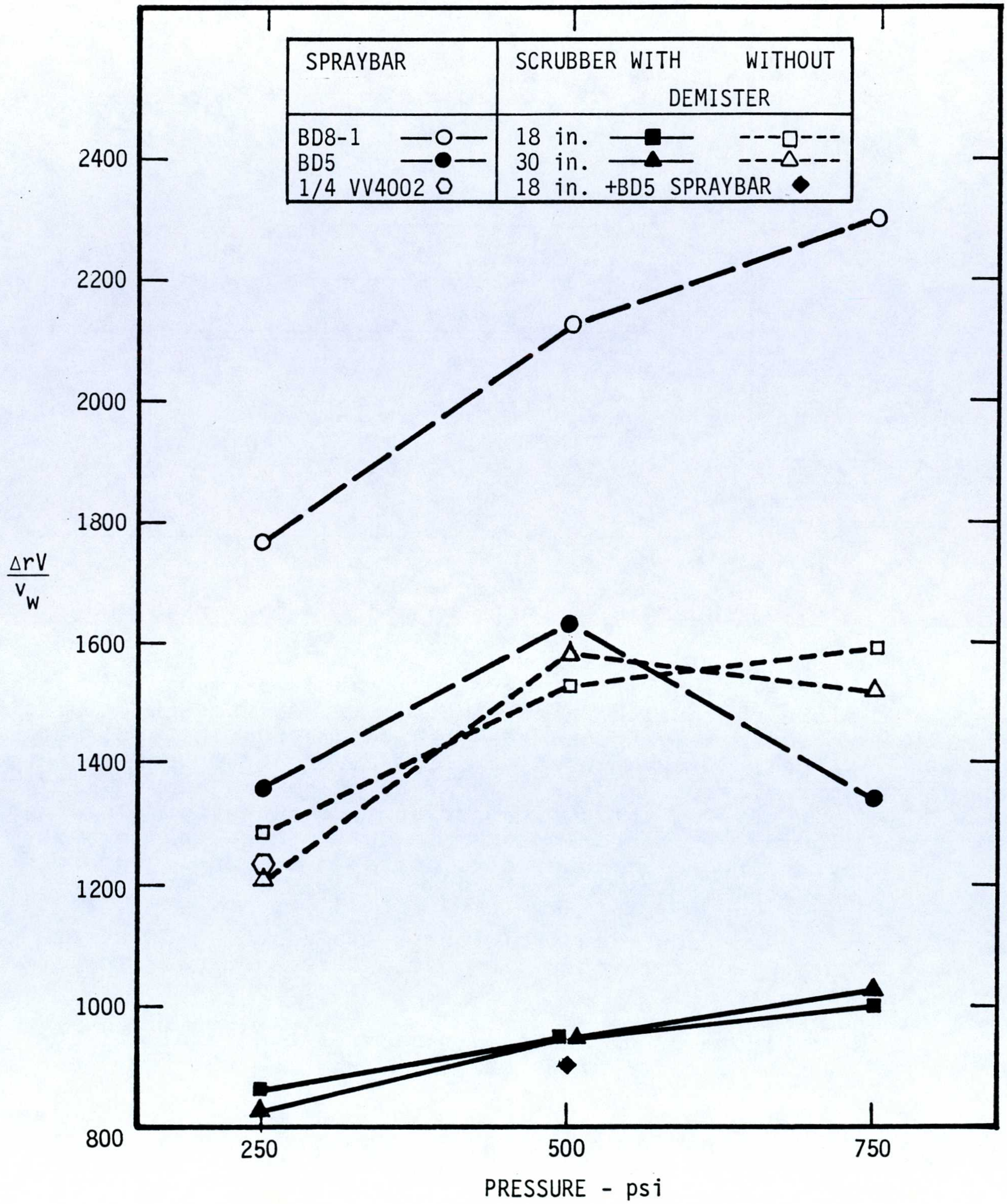


FIGURE 19. - Laboratory Evaluation Results.
(Δr = decay rate due to water spray
V = Volume of test booth
v_w = volume of water)

c. The BD8-1 spray is very fine and may not be suitable for field applications where mine water quality is a problem, although it is worth a trial. If the nozzle is not suitable, four BD-5 nozzles are recommended

d. The laboratory results confirmed the field results at Price River where the spraybar was also found to be the most effective component of the dust control system for an enclosed stageloader.

The results, coupled with the results of the underground evaluation showed that:

a. Within an enclosed space such as a stageloader, a spraybar with BD8-1 or BD-5 nozzles was more effective for reducing respirable dust concentrations than a "J-SAM" scrubber with 1/4 VV4002 nozzles at comparable water pressures

b. Enclosing a stageloader requires a minimal investment and effort.

This simple approach, therefore, would be easier to maintain, cost less, and be equally as effective as a scrubber. The use of spray bars for dust control were tested further during the final evaluation (see Section 6).

5. STAGELOADER MANUFACTURERS' SURVEY

Suppliers and manufacturers of face conveyors, stageloaders, and crushers for longwalls were contacted via a telephone survey to determine which dust control features, if any, were being offered on headgate equipment. During the survey the manufacturers were also informed of the current research on the subject program. Additional information, including literature and blueprints, was sought to ensure that the control techniques being investigated on the program could be incorporated into existing equipment without posing any operational difficulties.

A total of 12 suppliers and manufacturers were contacted late in 1982. Those that responded with pertinent information are included in table 4. Table 4 summarizes all <u>passive</u> (e.g., peripheral pick speeds, tunnels, flappers) and <u>active</u> (e.g., dust suppression sprays, sprays built into crusher hammer) dust control techniques currently being offered by equipment suppliers.

European manufacturers, such as Mining Supplies International, Dowty, Halbach & Braun, and Klockner-Becorit, generally provided an in-line crusher as part of the stageloader package. These manufacturers also typically supply dust suppression water sprays directed at the crusher's inlet and discharge. Some European suppliers provide a tunnel to enclose the stageloader up to 15 ft inby and outby the crusher. The presence of such a tunnel makes the installation of curtains and sprays much easier. Totally enclosed stageloaders (with or without sprays) have not been provided to an appreciable extent in the United States, but such systems are gaining acceptance as more longwall equipment is being sold to American mines. Enclosed stageloaders are common on European longwalls since they provide an extra measure of safety in their low seam conditions.

Three of the techniques presented in table 4 are of particular interest. One manufacturer offers dust suppression sprays built into the rotating crusher cylinder. The sprays are directed at the crusher heads, or hammers, much like pick-point flushing sprays on a shearer drum. The other two techniques are intended to <u>reduce the amount of dust generated</u>. They include:

a. Tangential picks designed to impact perpendicularly to the pan

b. Peripheral pick speed 2.3 x stageloader chain speed.

TABLE 4. - Dust control techniques - headgate equipment (from manufacturer survey completed in December 1982)

Dust Control Technique	Representative/Manufacturer Who Recommended Technique	Reference
1. Crusher		
a. Inlet/outlet tunnel, 15 ft inby and outby crusher	Joe Kuti, Mining Progress, WV 304-343-5593 Klöckner-Becorit	 Brochure: Impact Roll Sizer, Type U Drawing No.: 0915-00003 00001
	Brieden	Brochures: Einwalzen-Brecher UWB Durchlauf-Brecher DLB
	Terry Allerton, American Longwall Mining, VA 703-628-4141	Technical Specs being mailed
	Don Shaw, Dowty Corp., PA 412-776-3693 MMD	Brochure: S108 In-Line Heavy Duty Mineral Sizer
b. Sprays within stage loader tunnel, directed at crusher inlet and outlet	Joe Kuti, Mining Progress Terry Allerton, American Longwall Mining	
c. Sprays directed onto crusher heads rotating with cylinder	Paul Bruland, Halbach & Braun, PA 412-225-7850	Brochures: Continuous Flow Crusher Impact Head Crusher Drawing No.: (0.02)71.900.054.00
	Terry Allerton, American Longwall Mining Don Shaw, Dowty Corp.	
d. Inlet/outlet curtains or "flappers" (levelling plates)	George L. Sidney, Jr., McLanahan Corp., PA 814-695-9807	Brochure: Stage Loader Crusher
	Paul Bruland, Halbach & Braun Terry Allerton, American Longwall Mining	
e. All sprays ganged to solenoid valve & stage loader power	Terry Allerton, American Longwall Mining	
f. Crusher cylinder design: (1) Tangential picks for impact ⊥ to pan (2) Peripheral pick speed 2.3 × stage loader chain speed	Don Shaw, Dowty Corp.	
2. Transfer Point		
a. Side discharge instead of T-Discharge	Joe Kuti, Mining Progress Don Shaw, Dowty Corp.	Brochure: Klöckner-Becorit, "Chain Conveyor"
b. 90 deg roller curve	Joe Kuti, Mining Progress	Brochure: MP/Westfalia, "Roller Curve Conveyor 2.30 Klöckner-Becorit, "Multi-Roller Curve with Single Tree Chain

Two passive dust control measures for the face conveyor to stageloader transfer point included:

a. Side discharge instead of T-discharge

b. Elimination of the transfer point by using a 90 deg roller curve.

These techniques transfer the coal to the stageloader in a less turbulent manner, thereby reducing secondary generation.

6. FINAL EVALUATION OF A STAGELOADER DUST CONTROL SYSTEM AT EMERY MINING COMPANY'S WILBERG MINE

The third and final installation and evaluation of a stageloader dust control system was conducted at Emery Mining Company's Wilberg Mine in June 1984. Details of this evaluation are presented in the following subsections.

6.1 PRELIMINARY SITE VISITS

To locate a site for the third evaluation, visits were made to two mines:

a. Florence No. 1 Mine - North American Coal Co.

b. Wilberg Mine - Emery Mining Co.

The results of these visits are presented in the following subsections. Test planning for the third evaluation is also discussed.

6.1.1 Florence Mine - Preliminary Visit

On June 8 and 9, 1983 a preliminary visit was made to the Florence No. 1 Mine, North American Coal Corp. During the visit dust concentrations were sampled within the headgate and along the face to establish the contribution of the stageloader to intake contamination of the face. The stageloader was fully covered and fitted with spraybars. Sprays were also fitted on all the transfer points.

Dust levels measured close to the crusher averaged approximately 1.5 mg/m^3. Intake dust levels measured over the first 20 shields on the face averaged 1.6 mg/m^3. The ventilation in the headgate, however, was only 12,000 cfm. This ventilation rate was half the airflow normally on the face and was considered only temporary. It was concluded, therefore, that when the full ventilation airflow was restored dust concentration within the headgate and in the face would be approximately 1/2 of these measured.

The predicted lower levels of dust within the headgate and on the face made this site marginal for the evaluation.

6.1.2 Wilberg Mine - Preliminary Visit

On February 2, 1984, a preliminary visit was made to Emery Mining Company's, Wilberg Mine. The face was equipped with an Eickhoff EDW 400 double ended ranging drum shearer that cut approximately 9 ft. The primary cutting pass was from tailgate to headgate, with cleanup on the headgate to tailgate pass. Every other shield was pulled up on the cutting pass with the remainder advanced during the clean-up pass. During normal operation the shearer cut with the leading drum lowered and the trailing drum raised.

During the survey, two cutting passes were monitored. Dust levels upstream of the shearer and at the shearer operator's position were measured. The results showed low intake dust levels as the shearer began its cutting pass from the tailgate. By the time the shearer had cut to shield 20, however, the intake dust was above 2 mg/m^3.

Figure 20 shows dust levels measured in the intake, (upwind of the shearer) and at the shearer operator's position as a function of shield number for the cutting pass. Intake dust levels were contributing up to 75% of the dust concentration measured at the operator. In a meeting after the underground visit, mine management expressed interest in cooperating with FMI in a stageloader dust control evaluation.

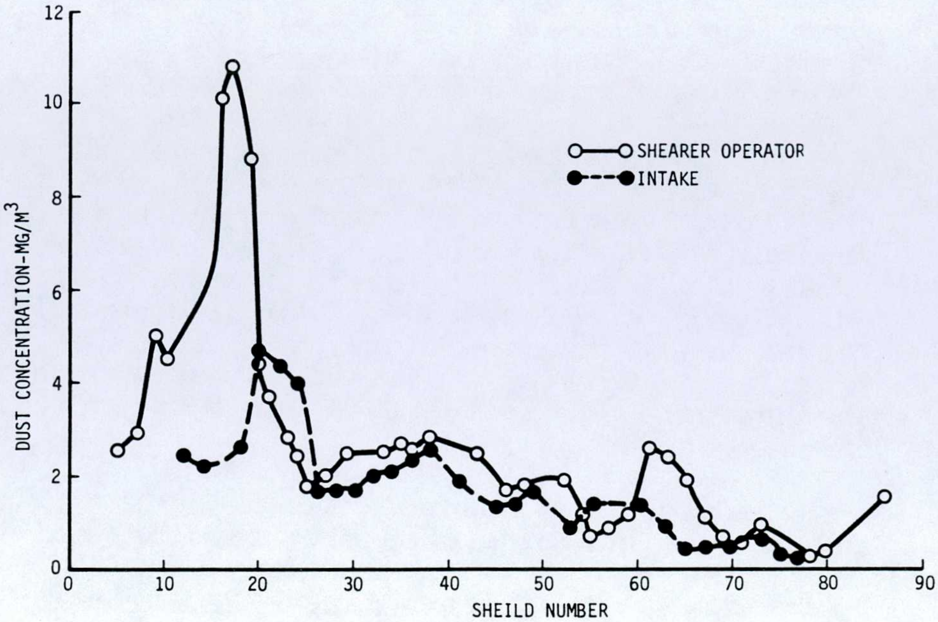


FIGURE 20. - Dust concentrations, shearer cutting from tailgate-to-headgate - Emery Mining Company's, Wilberg Mine.

6.2 TEST PLAN FOR THIRD STAGELOADER EVALUATION

Previous stageloader evaluations had been conducted by mapping the headgate and intake regions using instantaneous dust monitors. This technique was the best available approach when the previous evaluations were performed. The problem with this method, however, is that conditions within a headgate are dynamic. Manual sampling takes 20 min to completely measure all points within the headgate. During this time conditions can change, impacting the test results. To minimize the effects requires simultaneous sampling and recording at each test point.

Since the last survey, FMI had been granted MSHA approval for an instrumentation system using a multichannel data logger. This system would allow the placing of continuous monitors in strategic locations within the headgate and the face. Using this system it would be possible to characterize the dust levels under changing conditions.

The test program was designed to determine the effect of a number of selected variables on stageloader dust:

a. Baseline testing, to establish headgate dust concentration (no controls)

b. Open stageloader (with controls)

c. Enclosed stageloader (with partial controls)

d. Enclosed stageloader (with controls).

The "no control" condition used 10 gpm of water applied through built-in crusher sprays located directly above the crusher hammers. The "with controls" condition used three additional spraybars which were located at the:

a. Entrance to the crusher

b. Exit from the crusher

c. Transfer point from the stageloader onto the belt.

These three spraybars, together with the internal crusher sprays, utilized a total of 20 gpm of water.

During the evaluation, which was conducted from June 11 to June 22, 1984, a range of permutations of spraybars and water flow rates were examined.

6.3 SITE DESCRIPTION

The headgate selected for the evaluation at Emery Mining Company's, Wilberg Mine, was 6th right longwall. The longwall operated in the Hiawatha seam at a cover depth of approximately 1200 ft. The salient features of the longwall are given below. Table 5 gives the face specifications.

6.3.1 Ventilation

The face was ventilated using antitropal (headgate to tailgate) ventilation. The mean face air quantity during the period of the survey was 15,200 ft^3/min. The ventilation data obtained during the survey is recorded in Appendix A. At times, there appeared to be a small amount

TABLE 5. - Stageloader evaluation site description

Wilberg Mine, 6th Right Longwall	
Panel depth	1200 ft
Panel length	600 ft
Extraction height	
face	102 in.
face ends	129 in.
Ventilation direction	Head to tail
Ventilation quantity	15,200 cfm (typical)
Face cross section	68 ft^2
Roof support type	Hemscheidt, 2-leg lemniscate shield (IFS canopies)
Mining cycle	Unidirectional, tail-to-head
Shearer type	Eickhoff EDW 300L DERDS
Face Conveyor	H&B, 2 x 26 mm inboard chain
Stageloader	Klockner-Becorit DMK 26 x 92, with crusher

of leakage into the gob along the length of the face, but this was considered negligible. The majority of air entered the face through the intake crosscut. Occasionally, there was belt air entering the headgate. The belt air movement was at times caused by holes in the stoppings through which cables and hoses were routed. To reduce this effect, a brattice curtain was hung across the belt entry to restrict airflow. The mean air velocity within the headgate was 194 ft/min with the intake air flowing over the stageloader. The velocity increased to 210 ft/min on the face.

6.3.2 Mining Cycle

The mining cycle applied at Wilberg was unidirectional cutting. The snake was performed at the tailgate. The shearer cutting pass was from tailgate to headgate, with the clean-up pass taken from headgate to tailgate. Under poor roof conditions, alternate supports were advanced during the cutting pass. When possible, however, the shield operators advanced the supports on the clean-up pass. Delays on the face generally only occurred at the tailgate. Once the shearer began either a cutting or clean-up pass, it usually maintained a constant speed without any stoppages.

6.3.3 Face Equipment

The roof supports were Hemscheidt two leg lemniscate "one web back" shields, fitted with canopy extensions of conventional design. The shearer was an Eickhoff EDW 300L double ended ranger, which extracted 550 tons/pass. The face conveyor was fitted with a side discharge and delivered onto a K.B. stageloader, fitted with an integral crusher.

6.4 DATA ACQUISITION

The layout of the instrumentation, to monitor conditions within the headgate, is shown in figure 21. The data was recorded on an A.D. Data Systems, Inc. portable data logger. The instrument was capable of monitoring up to 10 channels, but only 5 were utilized for the survey. The instrument was set up with a scan interval of 10 s. The instrument, at a preselected time interval, recorded the input from all five channels with real-time, and stored the information on a cassette tape. The data logger was battery powered and protected with MSHA approved, intrinsically safe barriers.

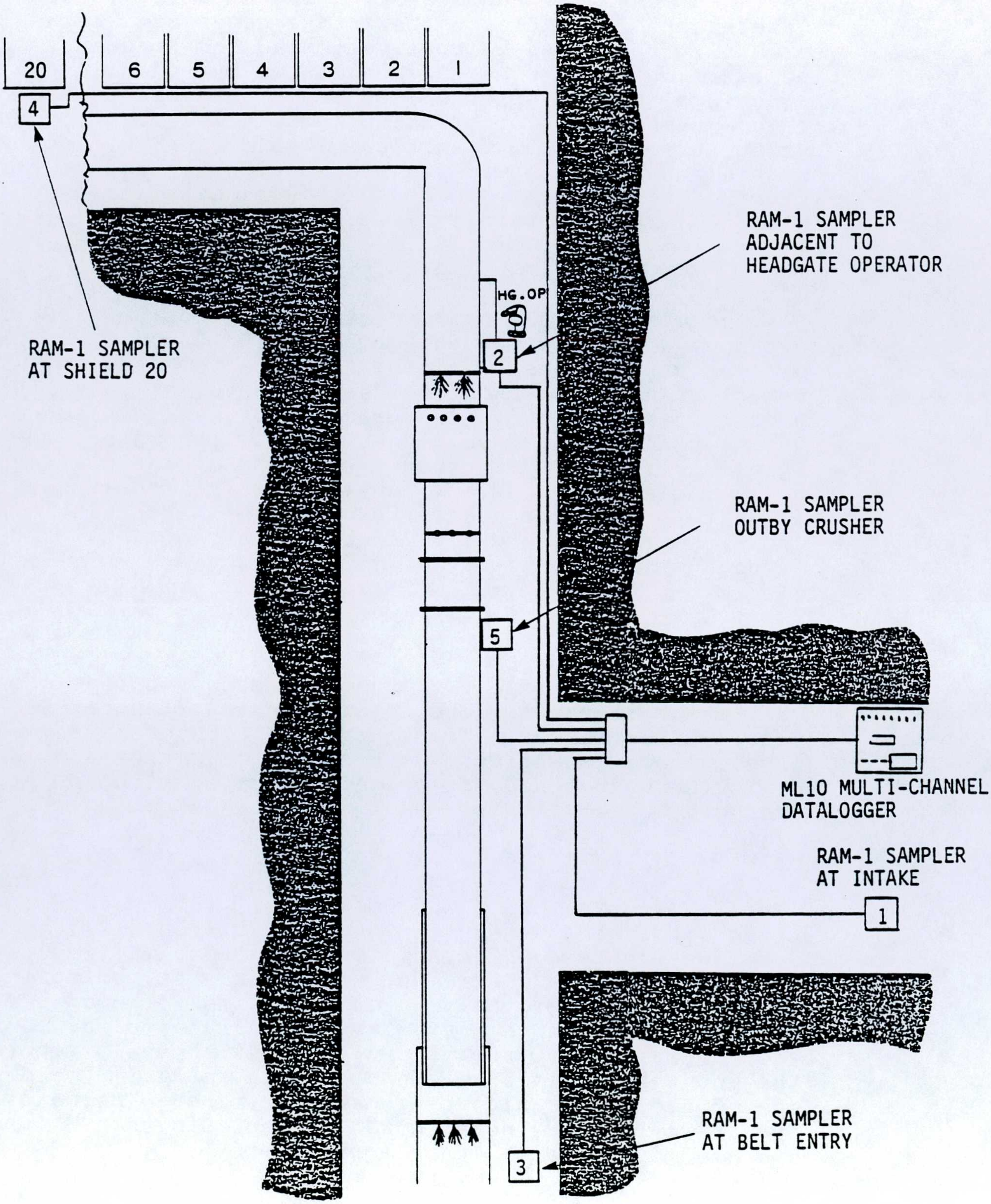


FIGURE 21. - Instrumentation layout.

The data logger was always located in the last open crosscut and connected via multicore cable to a connection box in the headgate entry.

Five GCA RAM-1 respirable dust monitors were positioned in strategic locations within the headgate region. For this survey, the voltage output from the RAMs was trans- mitted by hard wires to the connection box and then to the data logger.

The locations of the RAM-1 samplers shown in figure 21 include:

1. Face intake crosscut

2. Headgate operator

3. Belt entry

4. Shield No. 20

5. Discharge from the crusher.

The No. 1 and No. 3 locations were monitored to determine the levels of contaminant in the air splits before they reached the headgate. Instruments No. 2 and No. 5 monitored conditions at the headgate operator and crusher discharge, respectively. In practice at Wilberg Mine, the headgate operator was not permanently located at the control panel. In most mines, however, the operator is required to remain in close proximity to this location, and therefore, this was an important data point. The crusher discharge was suspected of being a major source of contamination and for this reason, instrument No. 5 was positioned close to this location. Instrument No. 4 was located at shield No. 20 to record how changes in headgate conditions impacted the contamination of the intake air that was routed down the face.

A computer was used to convert the stored data and to calculate cumulative concentration values. To obtain the mean concentration over the duration of a test period, the initial cumulative value was deducted from the final cumulative value, and the result divided by time. By this method, mean values were quickly obtained for each test. The results of the testing were then tabulated into a format so that mean values for tests under the same conditions could be evaluated.

6.5 TEST METHODOLOGY

The evaluation was conducted over a 2-week period. The testing was designed to determine the benefits of the various control measures for reducing respirable dust. The weekend prior to the evaluation, the mine, with assistance from FMI, fitted a framework over the stageloader to accommodate a brattice cloth cover to conduct a series of covered stageloader tests. The mine, with FMI's direction, fitted 3 additional spraybars (fig. 22). The spraybars were located at the:

a. Intake to the crusher

b. Discharge from the crusher

c. Belt/stageloader transfer point.

The spraybar at the intake to the crusher (a), was directed into the mouth of the crusher to block ventilation and dust from discharging. A small amount of brattice was used to bridge between the spraybar and the crusher so that the sprays could contain the dust in an enclosure without causing boilout. Only 2 hollowcone sprays, utilizing 2 gpm of water, were required to give complete coverage and control.

The majority of dust is usually emitted from the crusher discharge. For this reason, three hollowcone sprays, utilizing 5 gpm, were incorporated into the crusher discharge spraybar (b). The area from the spraybar to the crusher was covered for all testing. A manbridge was located immediately after the spraybar, which produced an enclosed tunnel for 3 ft on the discharge side. Even during the open stageloader testing, no mist was emitted by this spraybar.

The last spraybar (c) was located at the transfer point from the stageloader onto the belt. Its purpose, like that of the spraybar at the crusher inlet (a), was to both wet the material and block the ventilation. The spraybar (c) contained 3 hollowcone nozzles that utilized 3 gpm of water and produced a fine mist that wet the belt and material.

Each of the spraybars was fitted with an individual valve so it could be isolated. The hose line supplying all the spraybars was fitted with a flowmeter which enabled the recording of the water flowrate.

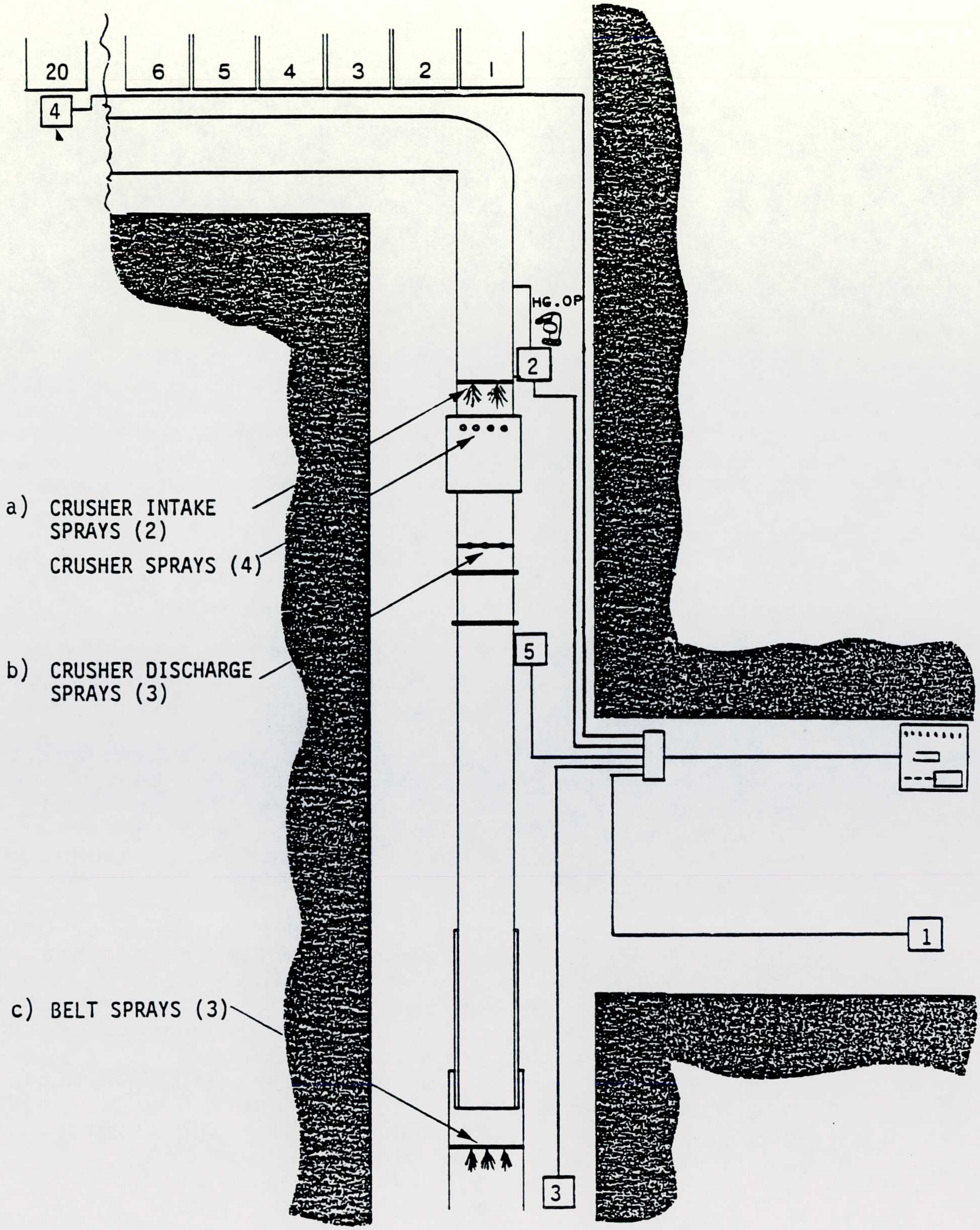


FIGURE 22. - Location of spraybars.

In addition to the 3 spraybars added for the evaluation, the crusher was equipped with 4 sprays built into the crusher frame. The four major conditions tested during the evaluation included:

a. Baseline testing - Open stageloader with only crusher sprays operating, 10 gpm

b. Open stageloader with the full spray system operating (i.e., crusher sprays with 3 additional spraybars), 20 gpm

c. Total enclosure of the stageloader with only crusher sprays operating, 10 gpm

d. Total enclosure of stageloader with the full spray system operating, 20 gpm.

The enclosure of the stageloader was achieved using brattice cloth stretched over a steel framework and tensioned with cable ties. The covering of the stageloader was very effectively performed up to the raised section over the belt tail-piece. Over this section, there were belting side pieces fitted to the stageloader to reduce spillage. The side pieces over this short section prevented a perfect enclosure; however, the two gaps that remained uncovered amounted to only a few square inches. The advantage of using brattice cloth for the covering was that it could be readily removed during the evaluation to return to the open stageloader condition.

During the course of the evaluation, the stageloader's condition was continuously monitored, together with the level and size of material on the stageloader. The information was recorded on a permissible tape recorder and later synchronized with the results and times recorded by the data logger.

Intake dust has often been shown to be related to the cutting sequence. Intake dust usually increases almost linearly with time during the cutting pass. To minimize the effects of dust sources related to time and variations in strata conditions through the face, changes in the test parameters were made when the shearer was at midface. Thus, a change from condition 1 to condition 2 would occur on one cutting pass. On the next cutting pass, the change was from condition 2 to condition 1. The same approach was used to evaluate the clean-up passes.

In addition to sampling the data automatically, by means of the data logger, a "floating" RAM-1 sampler was used to:

a. Check the accuracy of the dust monitors wired to the data logger

b. Identify dust sources within the headgate

c. Determine the effect of shield movement in the headgate on the dust monitor at shield No. 20.

6.6 EVALUATION RESULTS

As described earlier, the four major conditions evaluated were:

a. Baseline: open stageloader, crusher sprays, 10 gpm

b. Open stageloader: full spray system, 20 gpm

c. Covered stageloader: crusher sprays, 10 gpm

d. Covered stageloader: full spray system, 20 gpm.

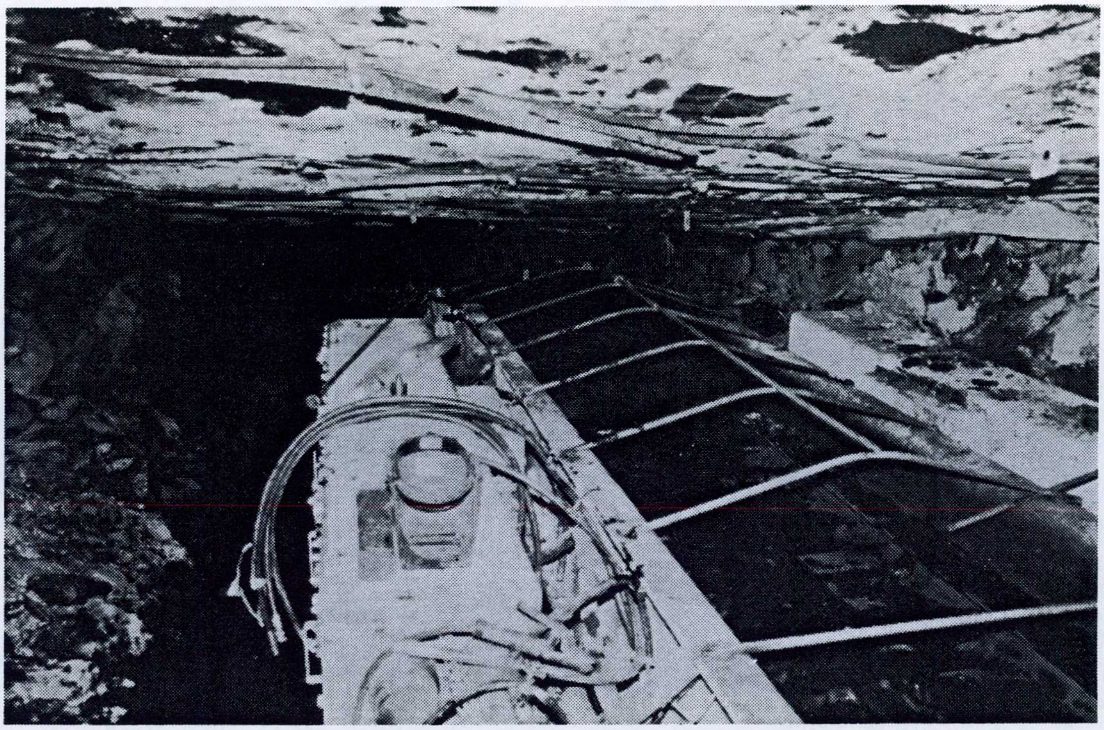
In figure 23 are photographs of the stageloader both uncovered and covered. In the following evaluation of data, no further reference will be made to the intake dust levels or the face ventilation. Both these potential variables were virtually constant throughout the evaluation. The mean intake dust concentration in the crosscut was 0.26 mg/m^3.

No attempt was made to quantify any benefits from improved stageloader dust control on the head to tail cleanup pass. Although a considerable quantity of data was collected, the dust levels were always low on this pass and any possible improvements were difficult to detect. The average values recorded during cleanup at the four locations are shown in table 6.

TABLE 6. - Average dust concentration during the cleanup pass

Dust concentration, mg/m^3			
Belt entry	Stageloader operator	Headgate	Shield 20
0.5	0.5	0.3	0.5

It is of interest, however, to note that even during the cleanup pass, when the crusher was not contributing to headgate dust, dust concentrations entering the face averaged 0.5 mg/m^3.



a) PHOTO OF OPEN STAGELOADER

b) PHOTO OF COVERED STAGELOADER

FIGURE 23. - Stageloader both uncovered and covered.

6.6.1 Graphical Data

The following sets of data, plotted in graphical form, have been included for discussion because they typify the characteristics of the various conditions. These particular sets were also chosen for illustration, because their mean values are almost identical to the mean values of the complete sets of data and can, therefore, be considered extremely representative. Each of the graphs illustrate the data obtained at the four sampling locations:

a. Headgate operator

b. Shield No. 20

c. Belt entry

d. Stageloader.

The first two are the most important sampling locations. The headgate operator data will reflect the levels of exposure experienced by this operator. The data at shield No. 20 should also be regarded as critical, since it is this dust which affects the majority of face personnel.

The first set of data has been plotted in figure 24 and illustrates a cutting pass. The conditions were changed from "baseline" to "all sprays on" for an open stageloader. The highest values recorded are for the stageloader location. This sampling location was close to the discharge from the crusher. It would appear that this zone is a major source of respirable dust within the headgate. The change in conditions from baseline to "all sprays on" more than halves the dust levels. It is also of interest to note that in going from the "baseline" to "all sprays on" by activating the 3 additional spraybars, there appears to be a 45 s delay before the sprays take effect.

Seventeen feet downwind from the stageloader sampling point was the headgate operator's location. It is of interest to note that his concentration was a factor of 5 less than the stageloader location, which illustrates that considerable dilution has taken place over this relatively short disance. The magnitude of improvement obtained by going from "baseline" to "all sprays on" is approximately 2:1 for the majority of the locations sampled.

The location of the sampler in the belt entry was outby the stageloader. The doubling of the total water flow from 10 gpm to 20 gpm obviously resulted in wetter material on the stageloader. It is, however, difficult to see how such a sudden improvement could have occurred right after the additional spraybars were turned on. A possible explanation is that dust pickup had been reduced, but the relative velocity of ventilation over the coal was only 300 to 400 ft/min. A more plausible explanation is that the 3 gpm of water applied by the belt spraybar (c) was very effective. The sprays produced a fine mist which not only thoroughly wet the top belt but also partially wet the bottom belt. The graph in figure 24 shows an immediate improvement upon activation of the sprays.

The data recorded at shield 20 was not time shifted in figure 24 to compensate for the 1 min required for the ventilation/dust to flow from the headgate to shield No. 20. The effect of the additional water was, therefore, slightly delayed before the improvement took effect.

The data illustrated in figure 25 was recorded on the next cutting pass after figure 24. The difference between the data sets is that the second set is a mirror image of the first set, changing <u>from</u> "all sprays on" <u>to</u> "baseline" conditions.

Once again, there was a time delay after the water flow was reduced from 20 gpm to 10 gpm before conditions deteriorated; as expected, shield No. 20 had the longest lag time. It is again quite clear that the sprays effectively reduce the quantity of respirable dust generated by an open stageloader.

The graph in figure 26 depicts data gathered when the stageloader was covered. In figure 26, at the start of the pass, all the sprays were on, which reduced dust levels at all sample points to below 1 mg/m^3. Levels showed some slight increase during cutting up to the point where the shearer reached mid-face. On initiating the "baseline" condition, there was a dramatic rise in dust levels. Generally, the increase in dust concentrations was of a similar order of magnitude to those achieved by applying "all sprays on" to the open stage-loader. Comparing figures 24, 25, and 26 <u>shows that the dust levels for both spray conditions were greatly reduced when the stageloader was covered</u>. In the uncovered state (fig. 24), the data at the stageloader location reached a peak of 12 mg/m^3. In figure 26 (covered stageloader) the peak value is 4.5 mg/m^3. It is interesting to note that towards the end of the pass, the shearer cut past the instrument located at shield No. 20. This is reflected in

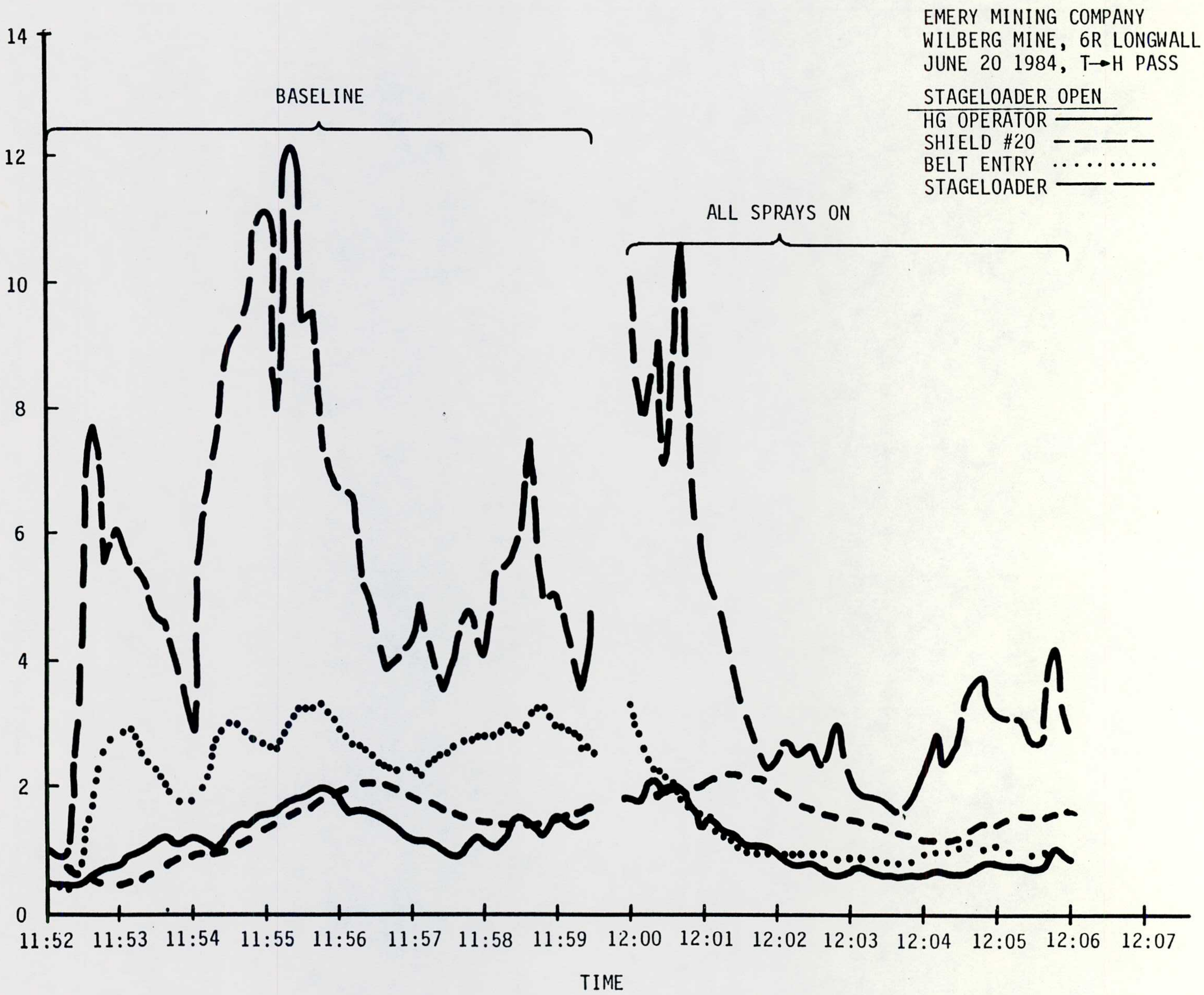


FIGURE 24. - Open stageloader, "baseline" to all sprays on.

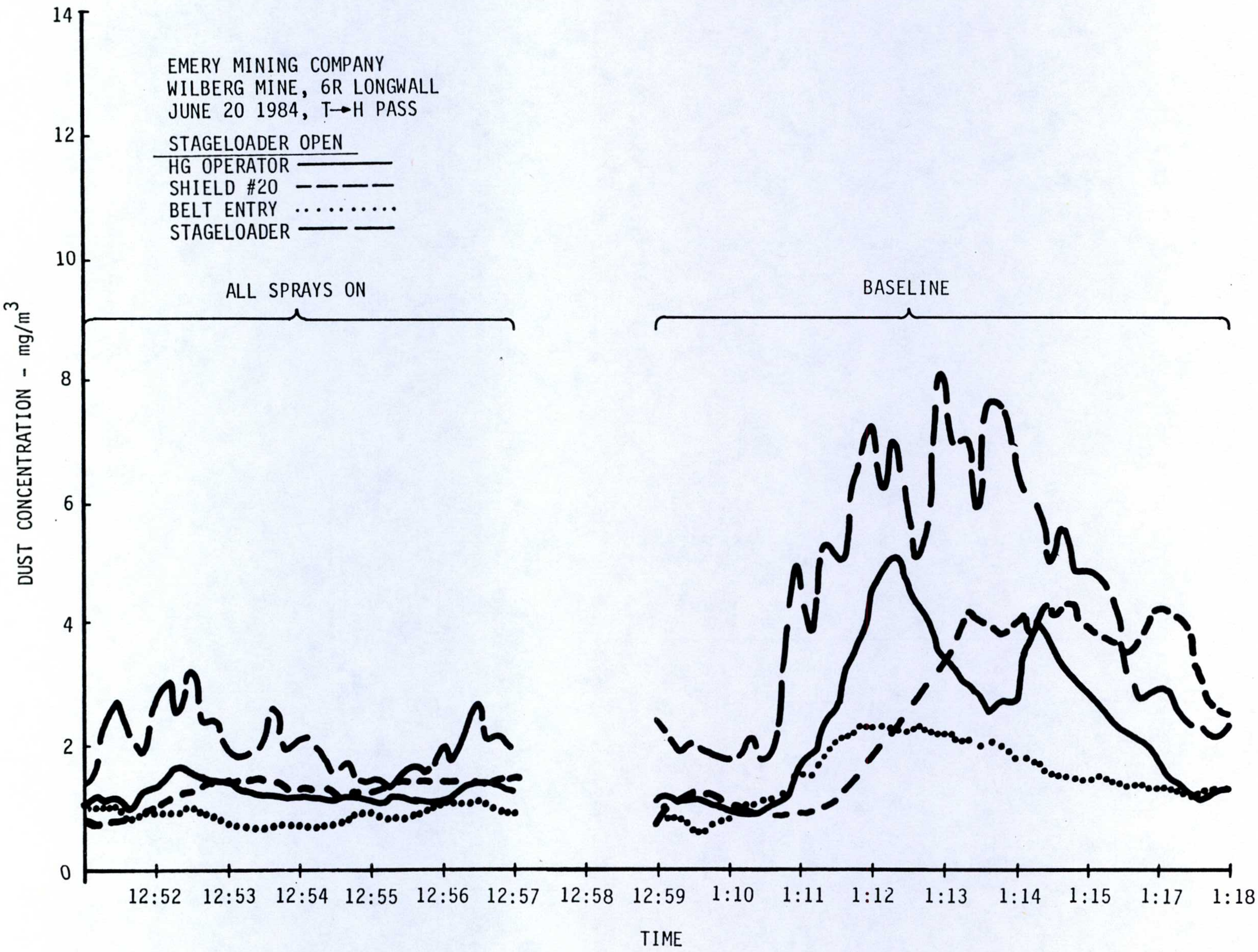


FIGURE 25. - Open stageloader, "all sprays on" to "baseline."

figure 26 at 1:01 p.m. by a sudden rise in the dust levels as the instrument began to record the shearer generated dust.

To emphasize the total improvement that took place through the combined effects of the covered stageloader and the extra spraybars, figure 27 compares "baseline" to the "all sprays on" covered stageloader condition. The improvement between the two extremes demonstrates clearly the advantages of a good spray system and the enclosure of the stageloader.

6.6.2 Tabular Data

The graphical data in the previous section depicts both the magnitude and characteristics of the dust levels within the headgate. Another method of evaluating the data is to display it in tabular form. In table 7 the mean values for the four major conditions that were evaluated are displayed. As expected, the data obtained with an open stageloader under baseline conditions had the highest dust concentration. The covered stageloader with all the spraybars operating had the lowest. But even under these almost ideal conditions, the concentration at shield No. 20 was 1 mg/m^3 during cutting.

Another method of displaying the data is to express the change from one condition to another in terms of percentage improvements (table 8). As expected, the major improvement occurred when the open, baseline stageloader is compared with the covered, "all sprays on" stageloader. A negative set of data, indicating deteriorating conditions, arose at the belt entry when the results of open stageloader testing were compared with covered stageloader testing under baseline spray conditions. Covering the stageloader contains the dust, but without the additional spraybars little dust knockdown is achieved. Consequently, when the material is loaded onto the belt, the respirable dust contained by the covering is released into the ventilation.

6.6.3 Additional Test Results

Having completed the tasks required for the major evaluation, some additional tests were conducted to identify the effects of other incremental changes. The number of tests conducted for each condition was limited and, therefore, the degree of certainty for this data has been reduced and it should be treated with caution.

Testing was conducted with the total water flow increased from 20 gpm to 30 gpm. The majority of the additional water was applied through the crusher sprays.

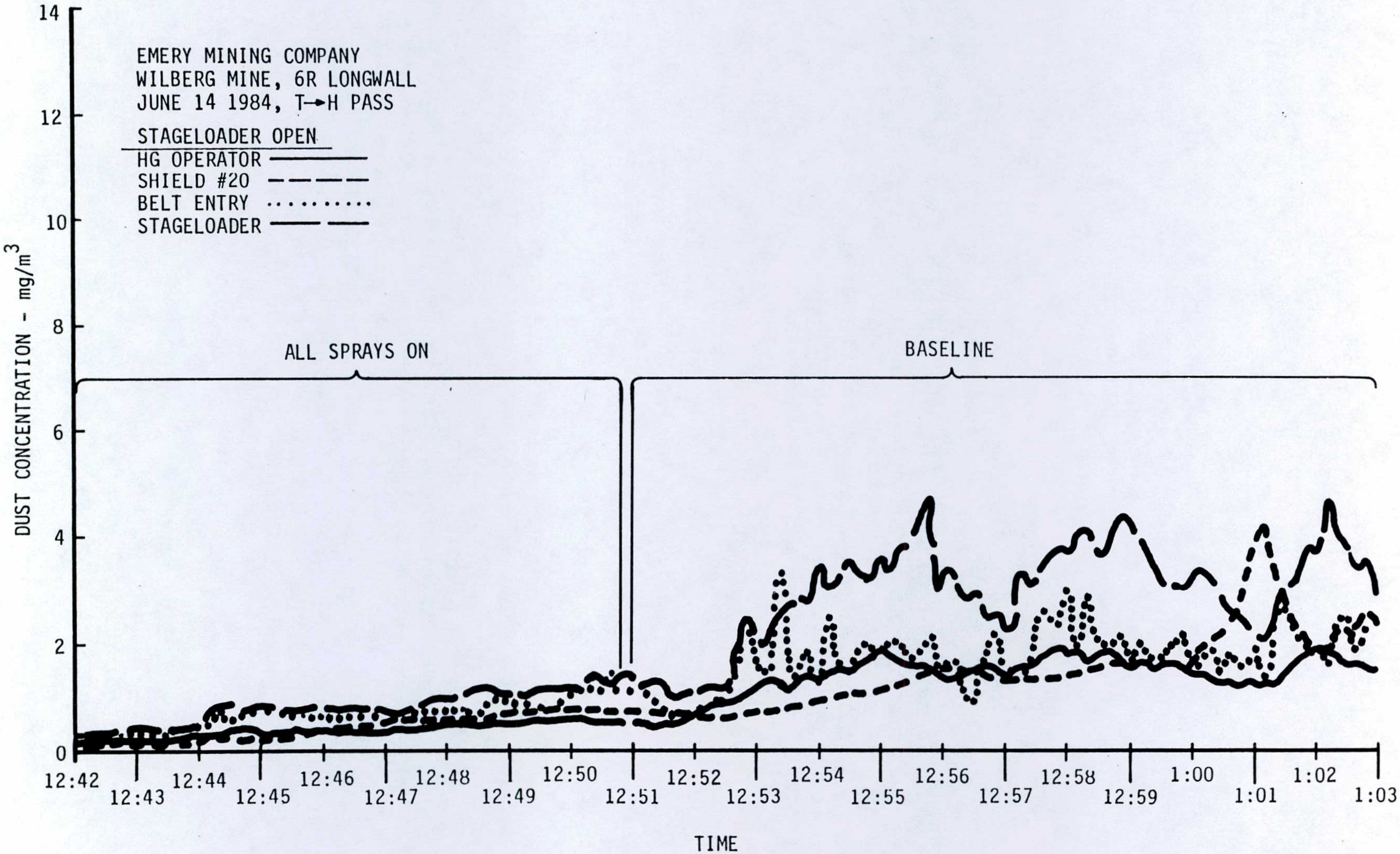


FIGURE 26. - Covered stageloader, "all sprays on" to "baseline."

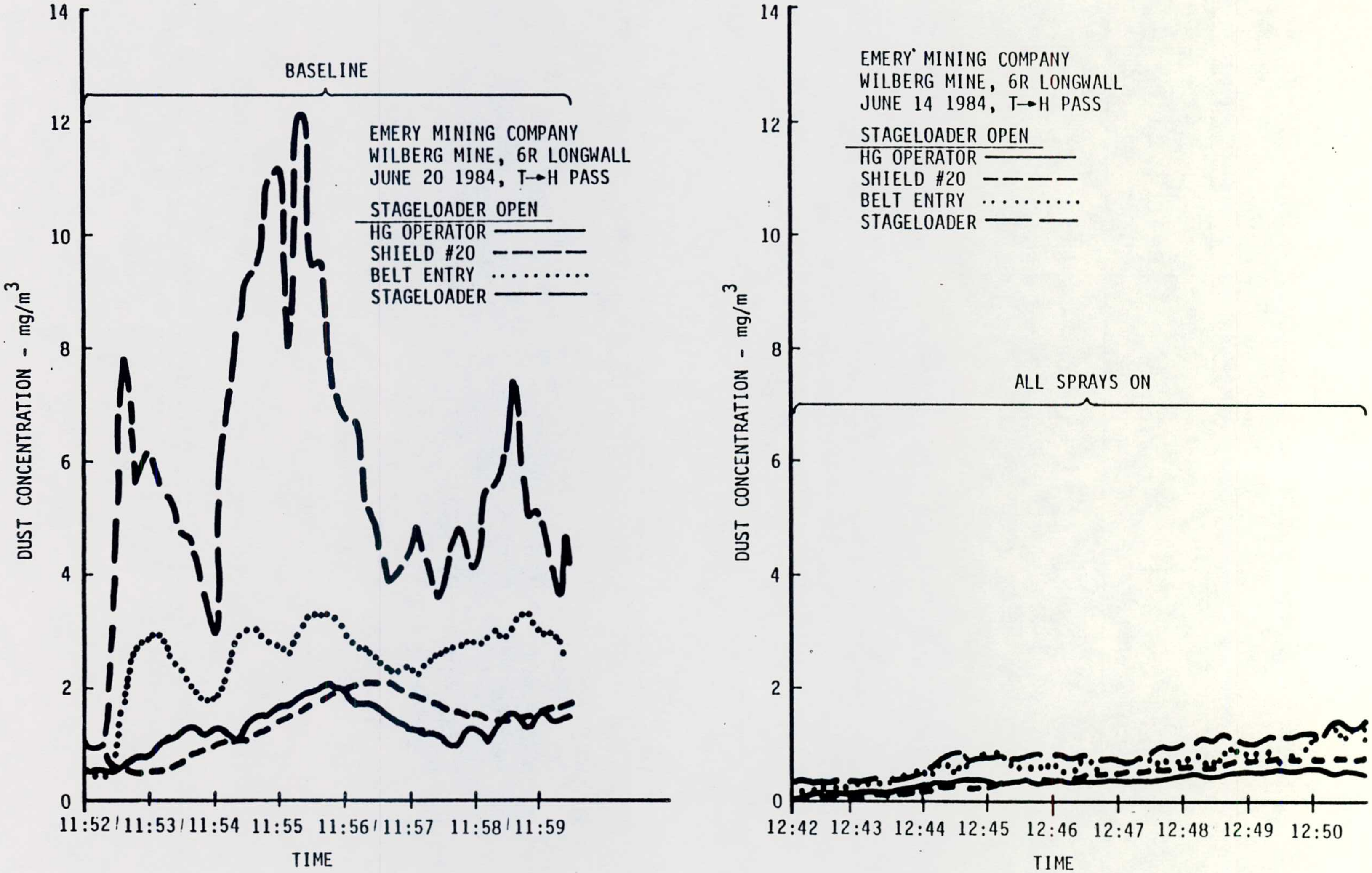


FIGURE 27. - Comparison of worst and best operating condition.

TABLE 7. - Tabulation of data

Stageloader		Baseline (10 gpm)	All sprays (20 gpm)	Average dust concentration - mg/m^3			
Open	Covered			Belt entry	Stage-loader	HG. opera-tor	Shield 20
X		X		1.2	2.7	2.4	1.7
X			X	0.9	2.4	1.0	1.4
	X	X		1.5	2.8	0.9	1.3
	X		X	1.0	0.7	0.5	1.0

TABLE 8. - Effect of changing conditions on dust control

Change in Condition	Belt entry	Stage-loader	HG. opera-tor	Shield 20
<u>From</u> open, baseline <u>to</u> covered, all sprays	17	74	79	43
<u>From</u> open, baseline <u>to</u> open, all sprays	25	11	58	20
<u>From</u> open, baseline <u>to</u> covered, baseline	-25	0	61	26
<u>From</u> covered, baseline <u>to</u> covered, all sprays	33	75	47	23

A 30% improvement was achieved at the headgate operator's position and at shield No. 20. No improvement was recorded at the belt entry, which helps substantiate that the belt sprays are responsible for the majority of the decrease in belt dust.

A series of tests was also conducted to determine the contribution of the various spraybars to the improved headgate conditions. This series of supplementary tests was limited. The trends observed from the data show that for an open stageloader, improvements at the headgate operator and shield No. 20 are dependent on the spraybars in the following order of effectiveness:

a. Crusher discharge sprays (5 gpm)

b. Baseline (crusher) sprays (10 gpm)

c. Crusher intake sprays (2 gpm)

d. Belt entry sprays (3 gpm).

It is interesting to note that although the internal crusher sprays (baseline condition) are ranked No. 2 in effectiveness, they required 10 gpm to achieve that level of control.

With the covered stageloader, the effectiveness of the various spraybars was improved. The stageloader became a covered chamber, which contained dust and spray mist and, therefore, achieved greatly enhanced dust knockdown. The effectiveness of each spraybar was observed by systematically isolating each one. The test results ranked the spraybars in the following order of effectiveness:

a. Belt entry sprays (3 gpm)

b. Crusher discharge sprays (5 gpm)

c. Baseline (crusher) sprays (10 gpm)

d. Crusher intake sprays (2 gpm).

The belt sprays were external to the covered crusher. Even with only a small percentage of air entering the headgate from the belt entry, the elimination of belt sprays resulted in greatly deteriorated conditions through the headgate and downwind to shield No. 20. It should also be noted that the crusher discharge sprays are important for producing good control. Although they use 10 gpm, the crusher (baseline) sprays are ranked second to last, indicating that they do not appear to be effective once the stageloader is covered.

A short test was also conducted with all the sprays turned off (0 gpm). The results with the stageloader covered and uncovered showed that conditions deteriorated rapidly, particularly in the belt entry. The high dust levels generated in the belt entry dominated all locations, resulting in increased dust exposure of 100% at shield No. 20.

6.7 CONCLUSIONS

The results of this final evaluation show quite clearly that large reductions of intake dust can be achieved by an improved spray system and the covering of the stageloader. The results showed a 79% reduction in respirable dust levels at the headgate operator and a 43% reduction at shield No. 20.

The reductions achieved were comparable or better than those obtained with the water powered scrubber during the first two underground evaluations. The enclosure with spraybars had the additional benefits of:

a. Not requiring high pressure water

b. Creating no overhead clearance problems in the headgate

c. Being easily fabricated from available materials.

The cost to the mine operator for covering the stageloader and adding the additional spraybar is minimal. Maintenance costs are also expected to be minimal if the spray water supply is provided with adequate filtration.

7. SUMMARY OF GENERAL RECOMMENDATIONS

The following paragraphs provide a general synopsis of recommendations for mines with an intake dust problem.

For some mines, the problem of intake dust arises due to the use of belt air. Belt air is difficult to control and its flow into the headgate region is often unintentional. From the many site visits conducted on this program, the belt entry was frequently identified as a major dust problem, but there appeared to be very little effort to control it. Following are several recommended control techniques to reduce the impact of belt air dust:

a. For those faces not permitted to use belt air, properly install a check curtain outby the stageloader to regulate the belt entry air. Provide a neutral split with the perceptible airflow <u>away</u> from the face.

b. Install a spray bar to wet the coal immediately as it discharges onto the belt from the stageloader. The spray bar should use two or three solid cone sprays at a water flow of about 2 gpm to obtain sufficient control. The low water flow rate will not present any water problems in the entry. The water control valve for the spray bar should be plumbed into the stageloader circuit and be easily accessed by the stageloader operator.

c. Install or ensure that the top and bottom belt scrapers are operating effectively. Ensure that a system of wetting the bottom return belt is provided. Minimize any spillage and ensure it is clear of the belt.

Although contaminated belt entry air can dominate the conditions in the headgate, the stageloader is also a major contributor to the intake dust onto the face. Because of their low cost and ease of installation, it is recommended that all the following stageloader dust controls be applied simultaneously:

a. Totally cover the stageloader and ensure that there are no gaps in the covering.

b. Install four spraybars at the following locations:

   1. At the entry to the crusher, to block dusty air from flowing back out of the stageloader.

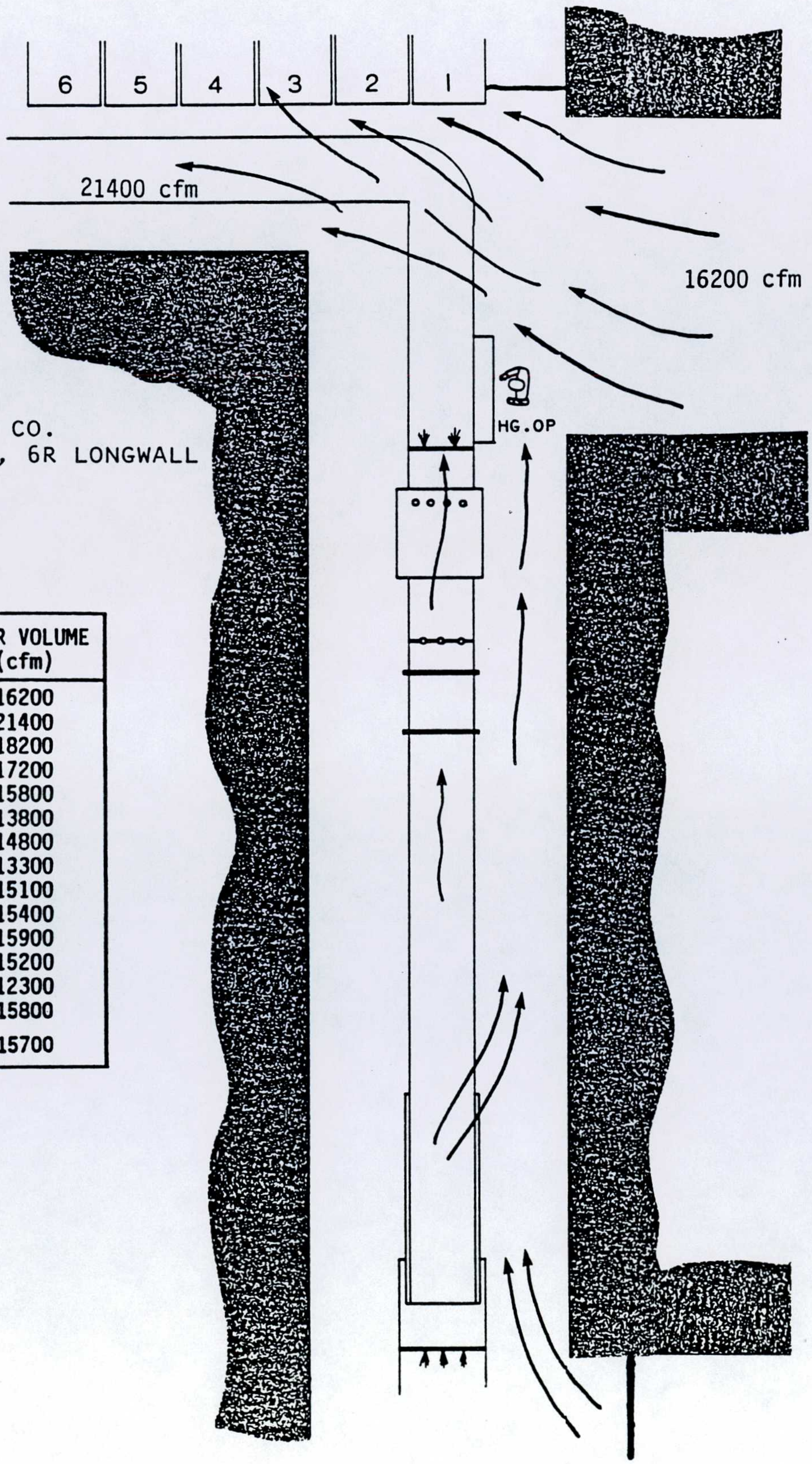
2. Above the crusher's hammers (this spray bar is typically already supplied by the stageloader manufacturer).

3. At the discharge from the crusher, to scrub the enclosed dusty air and fill the covered stageloader with a dense mist to knock-down any remaining airborne dust.

4. In the belt entry to wet the surface of the coal during conveying to minimize dust entrainment by the ventilation.

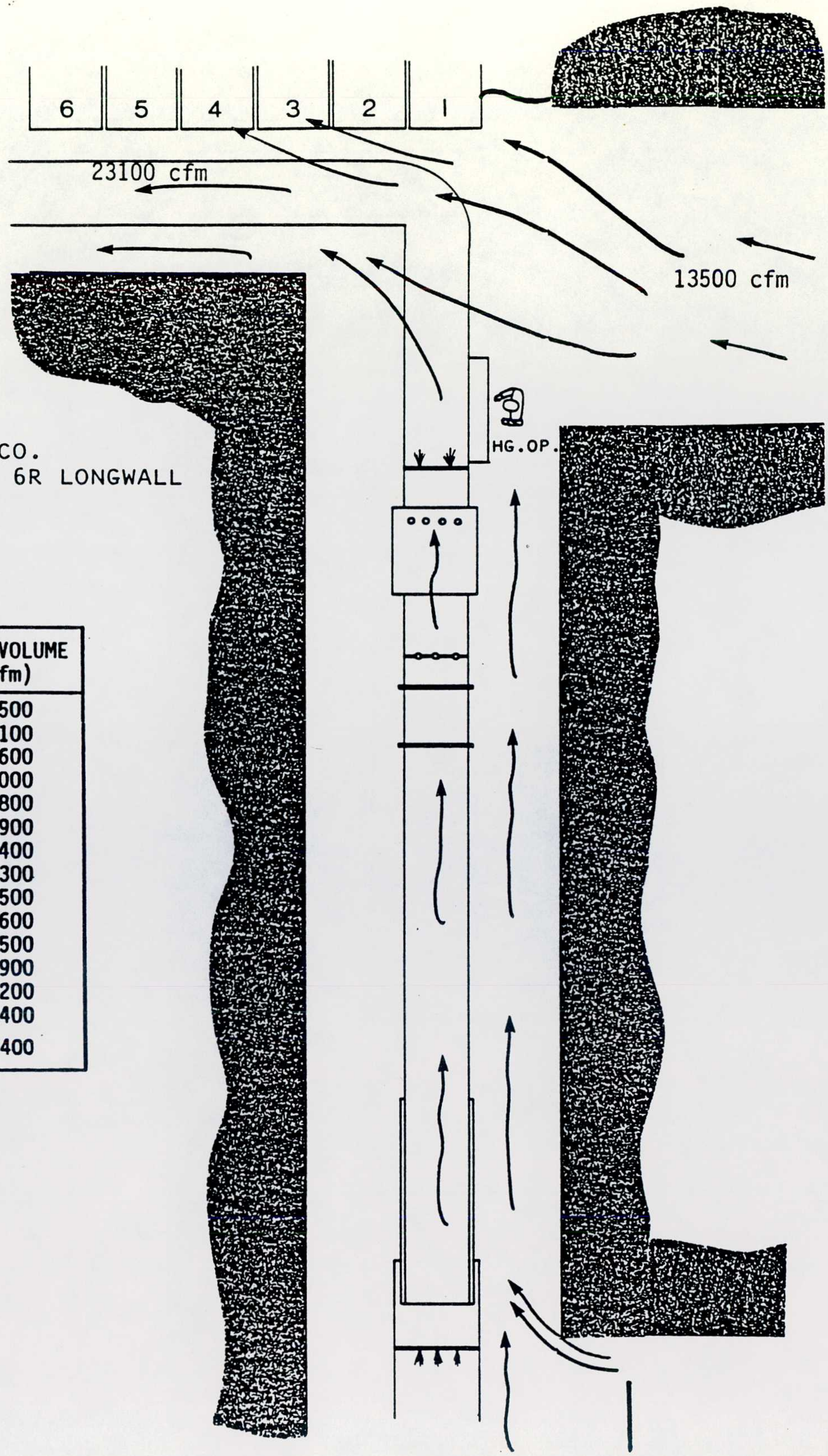
When installing the spray systems described above, special attention should be paid to the existing sprays routinely supplied by crusher manufacturers above the crusher's hammers. Manufacturers will frequently fit these sprays with extremely large orifice nozzles which will rob the auxiliary spraybar system of pressure and flow. A throttling valve should be used to limit the flow to the crusher sprays to about 10 gpm, allowing for adequate water flow and pressure to the remainder of the systems. The water control valve for the entire system should be located conveniently close to the stageloader operator and the water pressure under full flow conditions should be a minimum of 100 psi.

APPENDIX A.--VENTILATION DATA FOR THE STAGELOADER DUST CONTROL EVALUATION AT EMERY MINING CO., WILBERG MINE



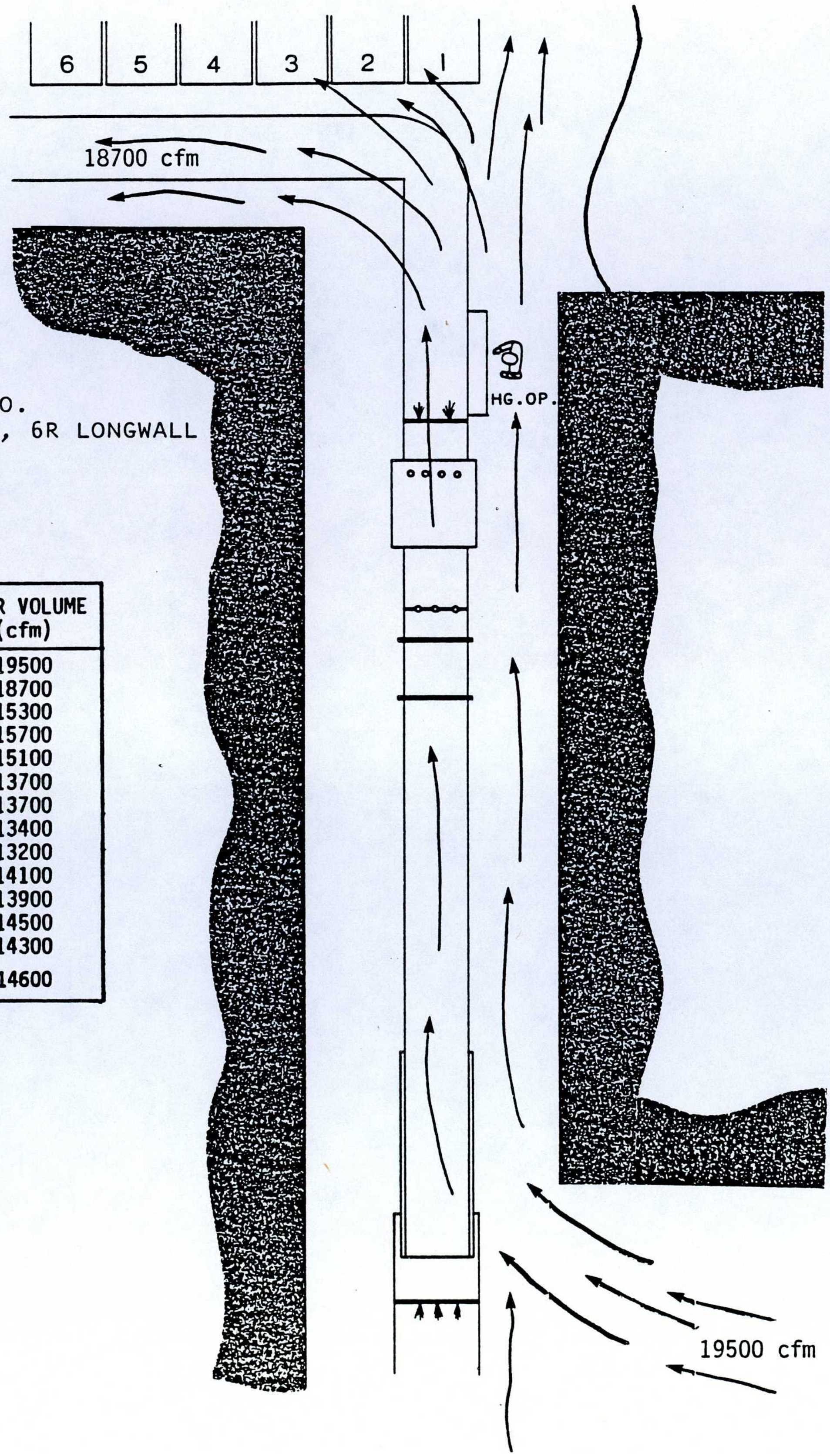
EMERY MINING CO.
WILBERG MINE, 6R LONGWALL
JUNE 11 1984

LOCATION	AIR VOLUME (cfm)
INTAKE	16200
SHIELD #5	21400
SHIELD #10	18200
SHIELD #20	17200
SHIELD #30	15800
SHIELD #40	13800
SHIELD #50	14800
SHIELD #60	13300
SHILED #70	15100
SHIELD #80	15400
SHIELD #90	15900
SHIELD #100	15200
SHIELD #110	12300
SHIELD #120	15800
FACE AVERAGE	15700



EMERY MINING CO.
WILBERG MINE, 6R LONGWALL
JUNE 12 1984

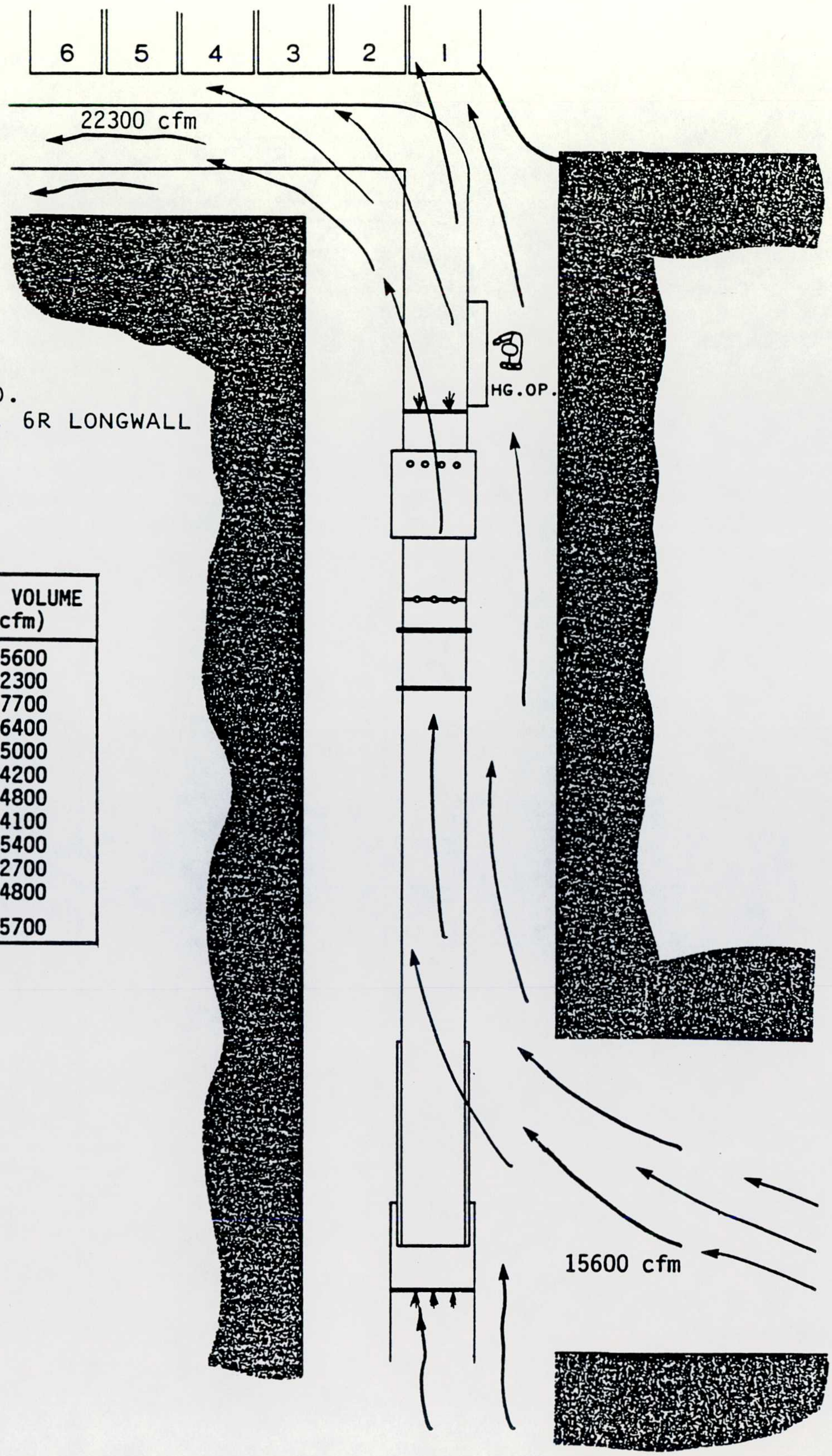
LOCATION	AIR VOLUME (cfm)
INTAKE	13500
SHIELD #5	23100
SHIELD #10	21600
SHIELD #20	20000
SHIELD #30	15800
SHIELD #40	15900
SHIELD #50	14400
SHIELD #60	14300
SHIELD #70	16500
SHIELD #80	16600
SHIELD #90	12500
SHIELD #100	12900
SHIELD #110	14200
SHIELD #120	15400
FACE AVERAGE	16400



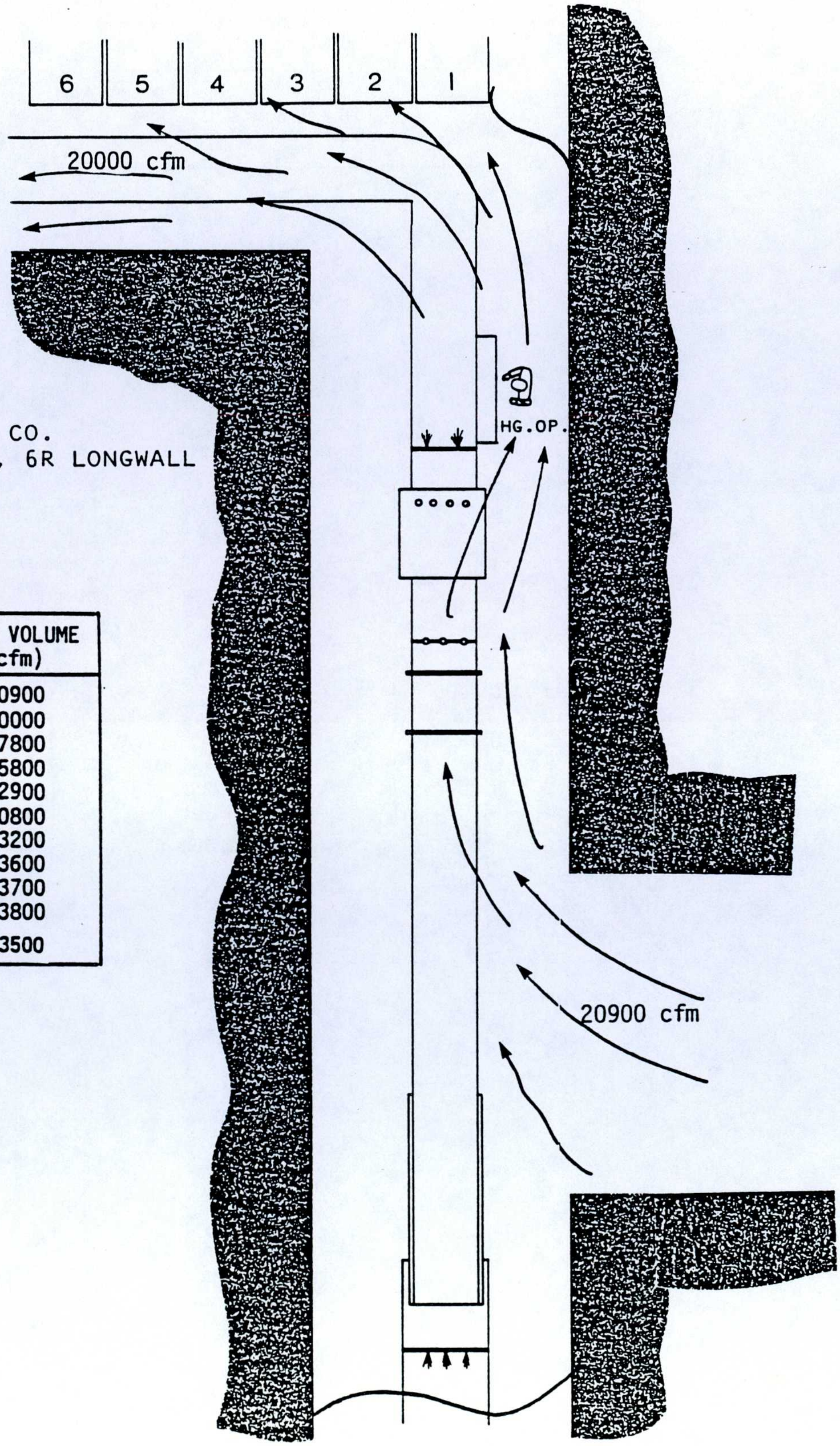
EMERY MINE CO.
WILBERG MINE, 6R LONGWALL
JUNE 13 1984

LOCATION	AIR VOLUME (cfm)
INTAKE	19500
SHIELD #5	18700
SHIELD #10	15300
SHIELD #20	15700
SHIELD #30	15100
SHIELD #40	13700
SHIELD #50	13700
SHIELD #60	13400
SHIELD #70	13200
SHIELD #80	14100
SHIELD #90	13900
SHIELD #100	14500
SHIELD #110	14300
FACE AVERAGE	14600

EMERY MINE CO.
WILBERG MINE, 6R LONGWALL
JUNE 14 1984

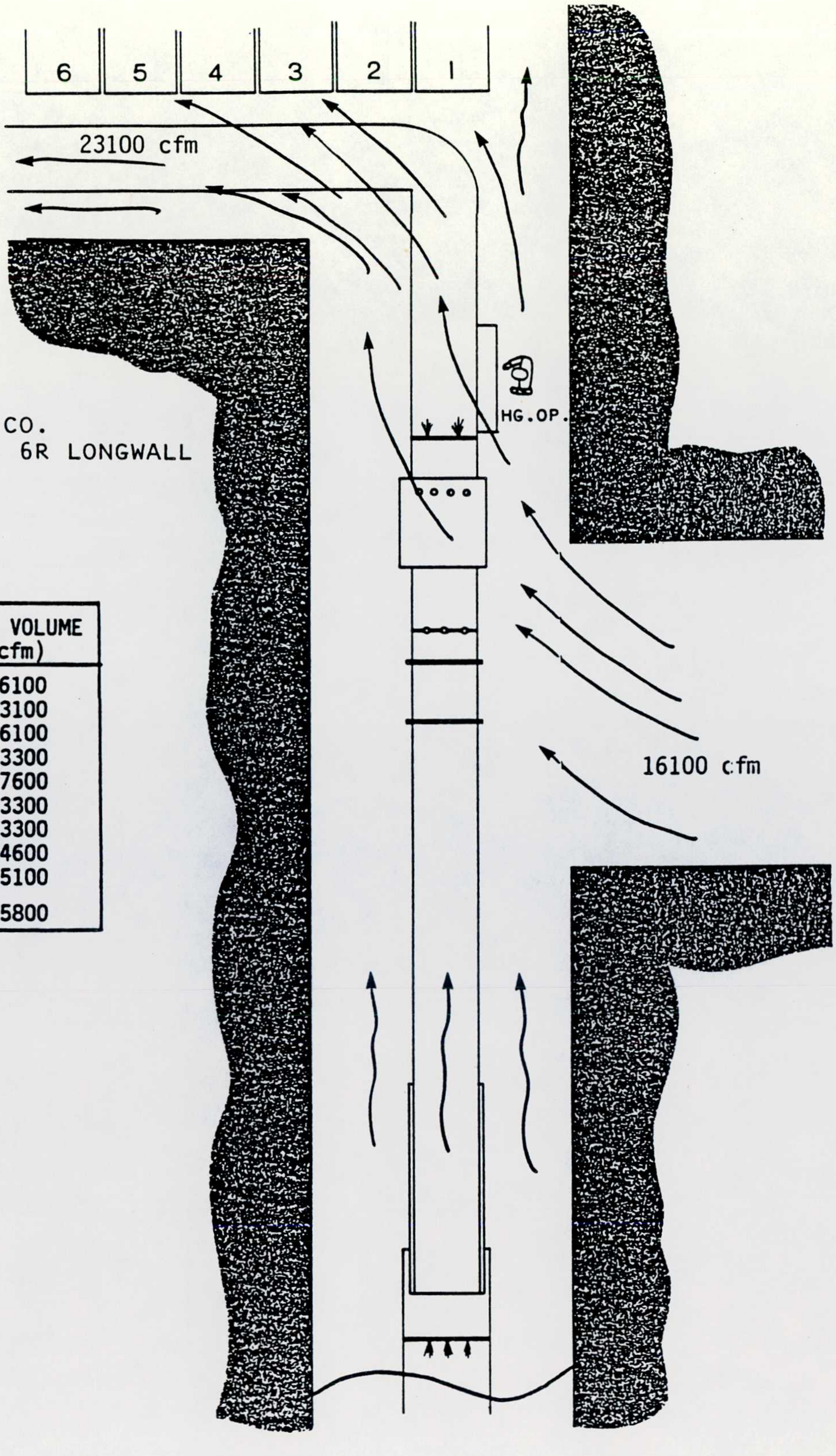


LOCATION	AIR VOLUME (cfm)
INTAKE	15600
SHIELD #5	22300
SHIELD #10	17700
SHIELD #20	16400
SHIELD #30	15000
SHIELD #40	14200
SHIELD #50	14800
SHIELD #60	14100
SHIELD #70	15400
SHIELD #80	12700
SHIELD #90	14800
FACE AVERAGE	15700



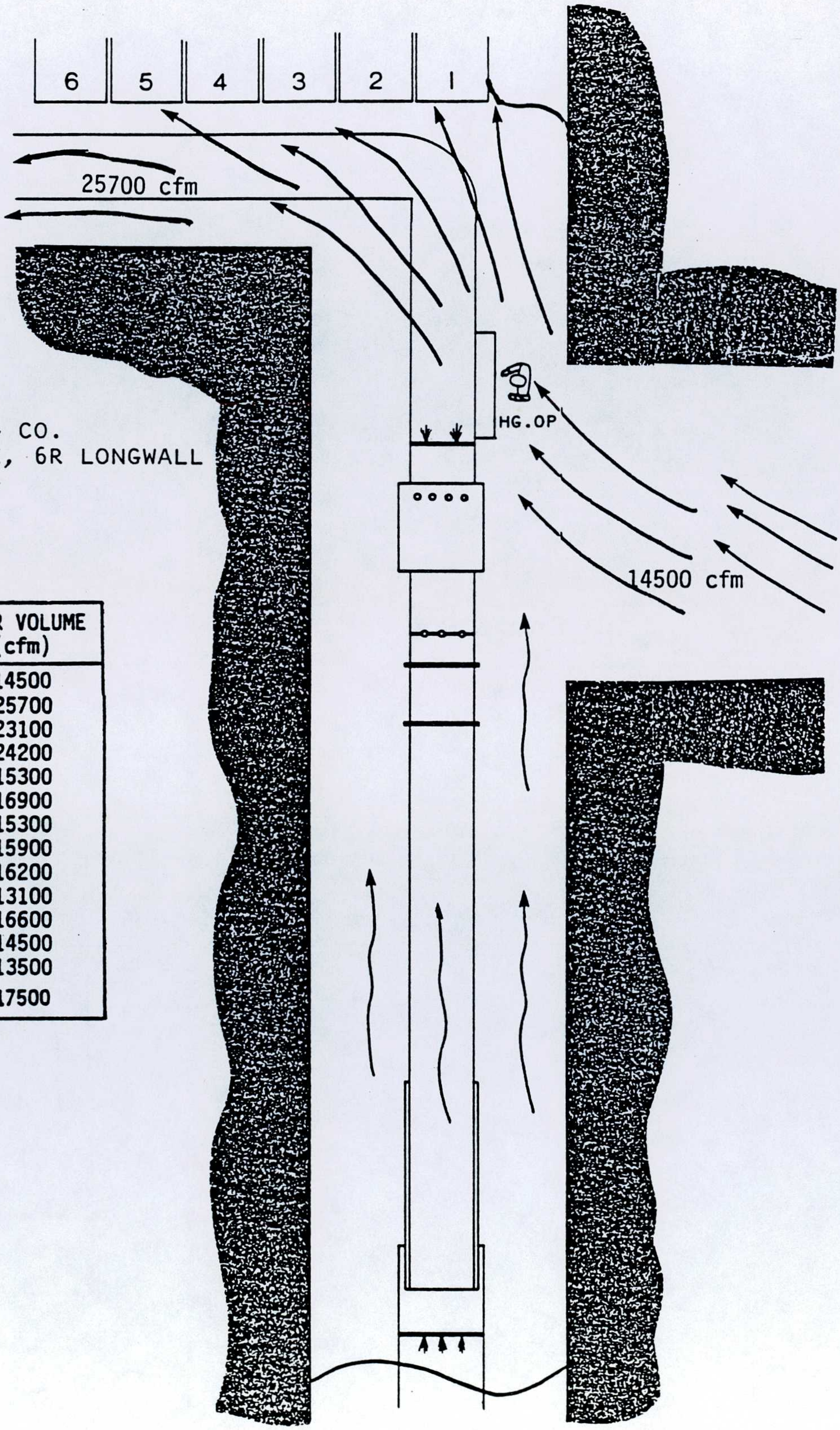
EMERY MINING CO.
WILBERG MINE, 6R LONGWALL
JUNE 15 1984

LOCATION	AIR VOLUME (cfm)
INTAKE	20900
SHIELD #5	20000
SHIELD #10	17800
SHIELD #20	15800
SHIELD #30	12900
SHIELD #40	10800
SHIELD #50	13200
SHIELD #60	13600
SHIELD #70	13700
SHIELD #80	13800
FACE AVERAGE	13500



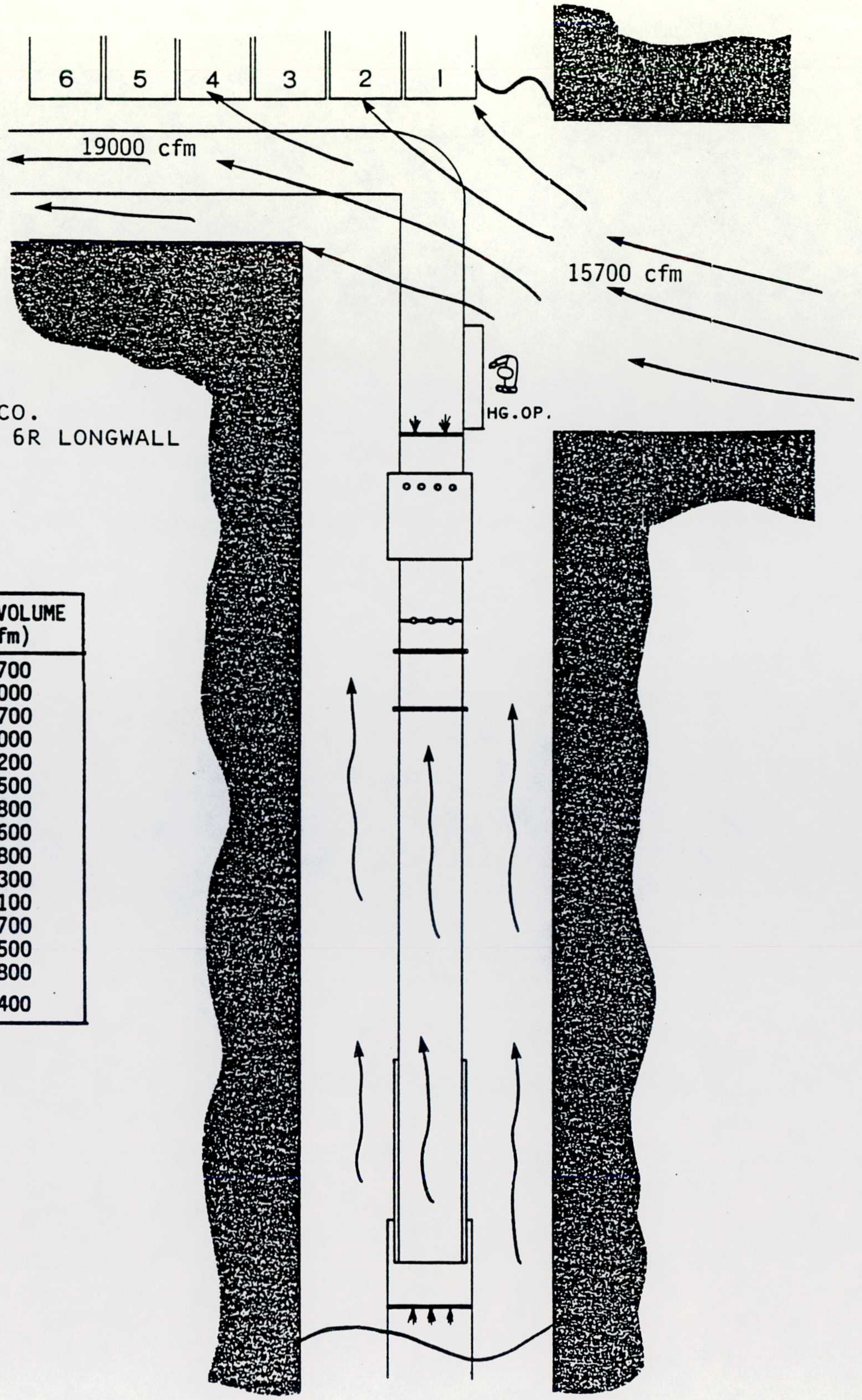
EMERY MINING CO.
WILBERG MINE, 6R LONGWALL
JUNE 18 1984

LOCATION	AIR VOLUME (cfm)
INTAKE	16100
SHIELD #5	23100
SHIELD #10	16100
SHIELD #20	13300
SHIELD #30	17600
SHIELD #40	13300
SHIELD #50	13300
SHIELD #60	14600
SHIELD #70	15100
FACE AVERAGE	15800



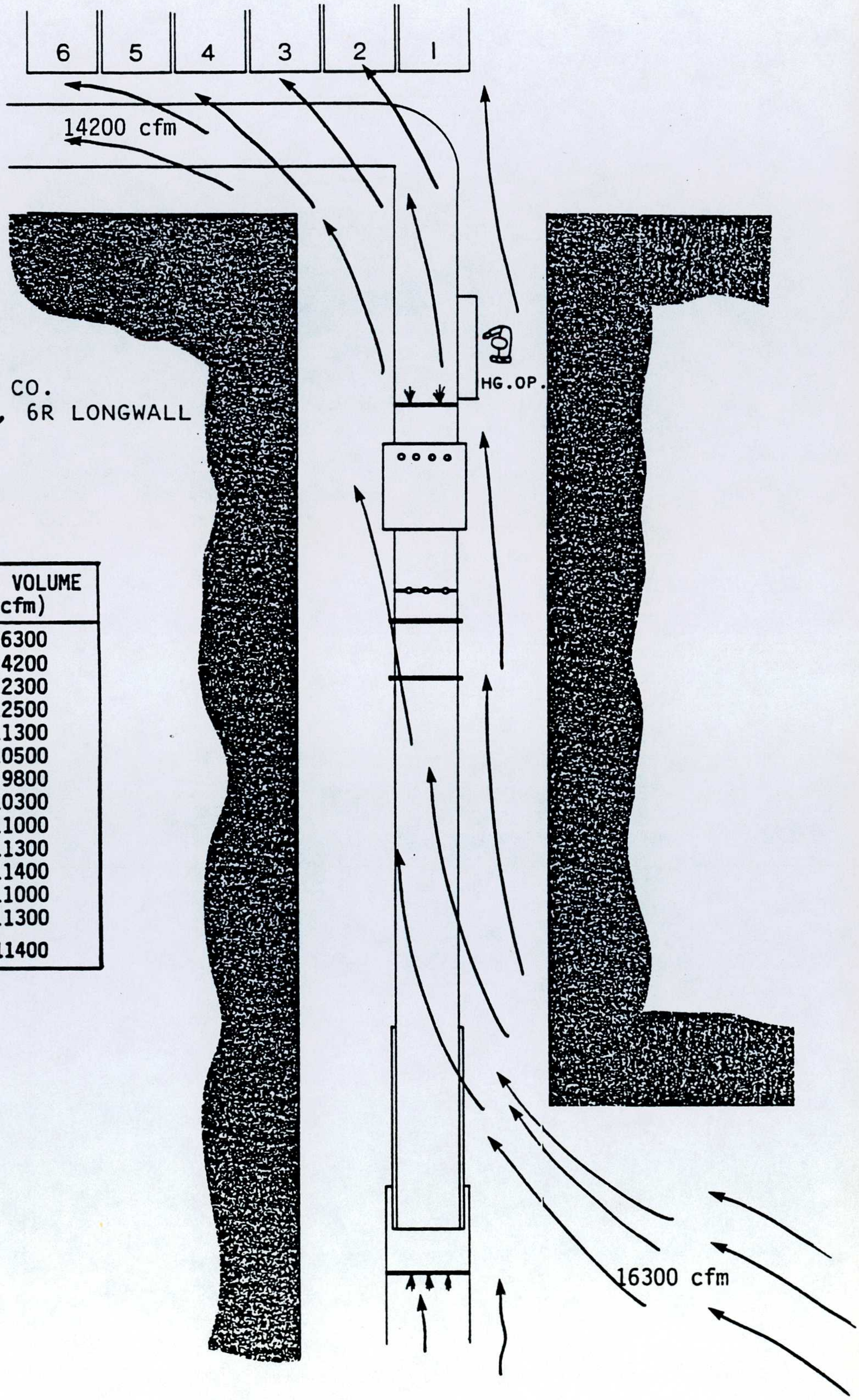
EMERY MINING CO.
WILBERG MINE, 6R LONGWALL
JUNE 19 1984

LOCATION	AIR VOLUME (cfm)
INTAKE	14500
SHIELD #5	25700
SHIELD #10	23100
SHIELD #20	24200
SHIELD #30	15300
SHIELD #40	16900
SHIELD #50	15300
SHIELD #60	15900
SHIELD #70	16200
SHIELD #80	13100
SHIELD #90	16600
SHIELD #100	14500
SHIELD #110	13500
FACE AVERAGE	17500



EMERY MINING CO.
WILBERG MINE, 6R LONGWALL
JUNE 20 1984

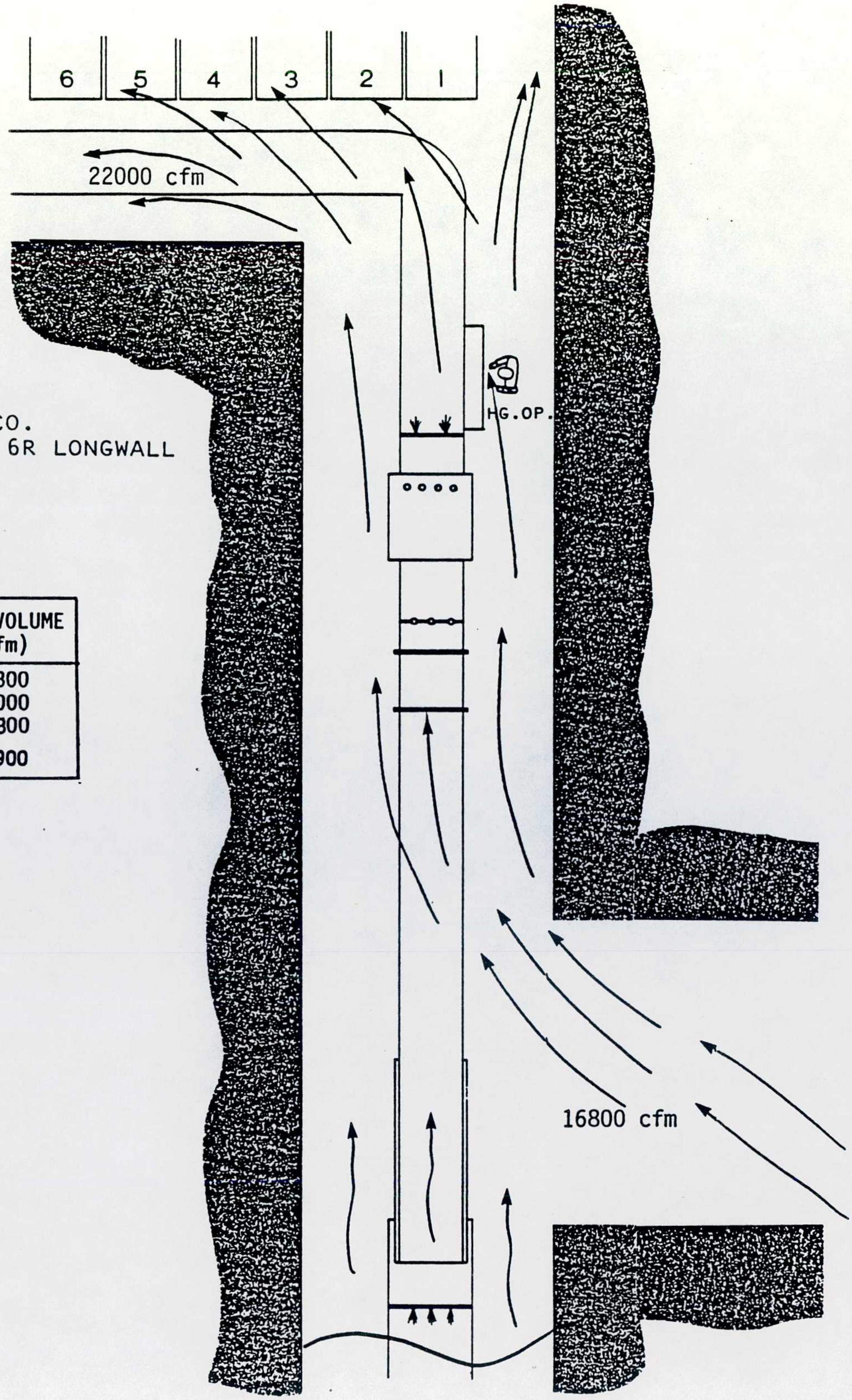
LOCATION	AIR VOLUME (cfm)
INTAKE	15700
SHIELD #5	19000
SHIELD #10	14700
SHIELD #20	11000
SHIELD #30	11200
SHIELD #40	11500
SHIELD #50	12800
SHIELD #60	12600
SHIELD #70	13800
SHIELD #80	14300
SHIELD #90	13100
SHIELD #100	13700
SHIELD #110	12500
SHIELD #120	13800
FACE AVERAGE	13400



EMERY MINING CO.
WILBERG MINE, 6R LONGWALL
JUNE 21 1984

LOCATION	AIR VOLUME (cfm)
INTAKE	16300
SHIELD #5	14200
SHIELD #10	12300
SHIELD #20	12500
SHIELD #30	11300
SHIELD #40	10500
SHIELD #50	9800
SHIELD #60	10300
SHIELD #70	11000
SHIELD #80	11300
SHIELD #90	11400
SHIELD #100	11000
SHIELD #110	11300
FACE AVERAGE	11400

EMERY MINING CO.
WILBERG MINE, 6R LONGWALL
JUNE 22 1984



LOCATION	AIR VOLUME (cfm)
INTAKE	16800
SHIELD #5	22000
SHIELD #10	15800
AVERAGE	18900