MESA - IR - - 1037

MESA-IR--1037

DE83 902962

Informational Report 1037

Determining the Feasibility of Area Sampling To Enforce the Respirable-Dust Standard in Underground Coal Mines

By Thomas F. Tomb and Robert S. Ondrey
Pittsburgh Technical Support Center, Pittsburgh, Pa.

UNITED STATES DEPARTMENT OF THE INTERIOR
Thomas S. Kleppe, Secretary

Mining Enforcement and Safety Administration
Robert E. Barrett, Administrator

PREFACE

This paper was also presented at the NCA/BCR Coal Conference and EXPO II in Louisville, Ky., October 21-23, 1975, and published in the proceedings.

CONTENTS

ILLUSTRATIONS

TABLES

DETERMINING THE FEASIBILITY OF AREA SAMPLING TO ENFORCE THE RESPIRABLE DUST STANDARD IN UNDERGROUND COAL MINES

by

Thomas F. Tomb[1] and Robert S. Ondrey[2]

ABSTRACT

New regulations are being prepared to enforce the mandatory health standard established in the Federal Coal Mine Health and Safety Act of 1969 (ACT). A program based on an "area sampling concept" rather than on the collection of personal samples is being proposed. This paper describes the field study conducted in an underground coal mine to evaluate the feasibility of employing the "area sampling concept."

Environmental respirable dust levels and co-dependent engineering parameters were measured in underground shop areas, haulage entries and at key transfer points. In addition, personal respirable dust samples were obtained on personnel required to work in any of the respective areas for an entire shift.

The results of the study depicted that although the dust concentration of the high-risk occupation (that occupation generally considered to be exposed to the highest respirable dust concentration) may comply with the mandatory health standard, dust generated at other locations in the mine may present a significant health hazard to personnel working in these areas.

It was concluded from this study that the "area sampling concept" could more viably insure that the intent of the 1969 ACT is fulfilled.

INTRODUCTION

Mandatory dust sampling of coal mine environments, required by the 1969 Federal Coal Mine Health and Safety Act (ACT), was initiated by coal mine operators in 1970. The regulatory program established to enforce the requirement that

> ". . . each operator shall continuously maintain the average concentration of respirable dust in the mine atmosphere during each shift to which each miner in the active workings of such mine is exposed at or below . . ."

---

[1]Chief, Dust Group.
[2]Mining engineer, Dust Group.

the applicable standard, is based on portal-to-portal sampling of each individual miner's environment.

Although compliance with mandatory standards is determined by the respirable dust exposure of the high-risk occupation for each section, the program required that all underground miners be sampled at least twice a year; and those assigned to a working section[3] three times a year. A high-risk occupation is that occupation that previous information had shown to have the highest respirable dust exposure.

The original intent of the data obtained from sampling all individuals working in the mining industry was to build a data bank that could eventually be used to establish a dose-response relationship between dust levels and the incidence of pneumoconiosis for the mining population. However, because of the mandatory requirements of the ACT, the range in underground environmental dust exposures was greatly reduced. Prior to 1970, environmental surveys[4] conducted in 29 underground coal mines showed that occupational exposures to respirable dust ranged from less than 1 mg/m^3 to greater than 10 mg/m^3. By the end of 1973, the average exposure for all occupations was less than 2 mg/m^3. Therefore, because of this limited range in occupational exposures, the necessary type of data required to establish the dose-response relationship was not being acquired, it was concluded that many of the dust samples presently required to be collected could be eliminated.

Consequently, in the current rewriting of Part 70, Title 30, CFR, a program has been proposed that will eliminate the mandatory collection of samples that are not germane to determining compliance with the health standards set forth in the ACT. The proposed program is based on an "area sampling concept" that eliminates the collection of personal samples on every underground coal miner.

The philosophy behind the "area sampling concept" as proposed is to establish a program that assures that the amount of respirable dust in the environment of all areas of the active workings of a mine is at or below the applicable standard, thus assuring that the average concentration of respirable dust during each shift to which each miner could be exposed is at or below 2 milligrams per cubic meter.

Compared to the present dust sampling program, the "area sampling concept" has the following advantages:

1. Reduces the number of samples required to be collected by coal mine operators.

2. Relieves mine personnel from wearing sampling equipment.

---

[3]Code of Federal Regulations, Title 30, Mineral Resources, Part 70, revised July 1, 1974, Office of Federal Register, National Archives and Records Service, General Services Administration, Washington, D.C.

[4]Parobeck, P. S. Effect of the 2.0 mg/m^3 Coal Mine Dust Standard on Underground Environmental Dust Levels. Presented at the American Conference of Governmental Industrial Hygienists, Miami, Fla., 1974.

3. Simplifies the enforcement of dust program regulations.

4. Will cause the environment in other dusty areas of the mine where men work to meet the applicable standard.

To determine if the "area sampling concept" would provide a viable means for insuring that the intent of the 1969 ACT is fulfilled, an extensive underground survey employing the concept was conducted. This paper describes in detail the methods and rationale used in conducting that survey and discusses the results with respect to the feasibility of employing the "area sampling concept."

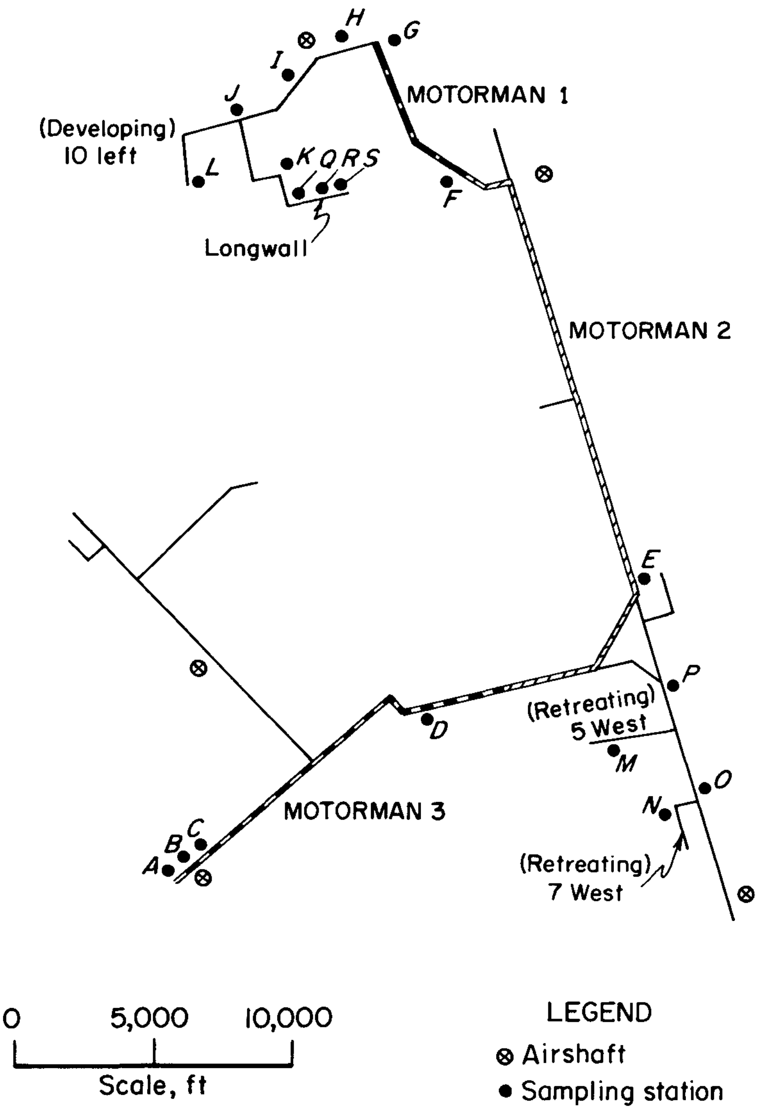

FIGURE 1. - Schematic depicting relative location of areas sampled.

Procedures

A large, 10 section mine utilizing mining methods, equipment and haulage systems typical of those most widely used throughout the industry was selected for the survey. The mine produced approximately 3,000 tons per production shift. Nine sections were being mined with continuous miners (five retreating and four advancing) and one section with a longwall plow. Shuttle car, belt and rail haulage systems were used, resulting in a variety of loading and transfer points (shuttle car to belt, shuttle car to mine car, belt to belt, belt to mine car, and a rotary dump).

The line drawing shown in figure 1 depicts the general layout of the mine. Because of manpower and equipment limitations, only four of the 10 sections were sampled during the survey. Of these sections, two were continuous retreating operations, one was a continuous developing operation and one was a longwall operation.

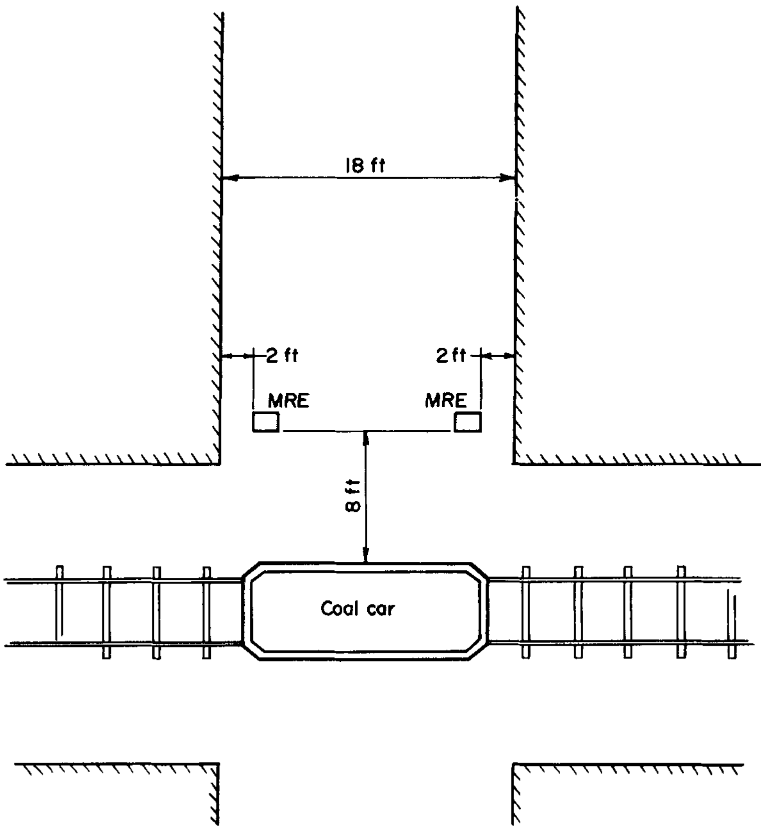

FIGURE 2. - Location of sampling instruments at the shuttle to mine car transfer point.

On the continuous mining sections, respirable dust samples were collected from the environment of the continuous mining machine operator, the shuttle car operators (two per section), and the dumping or loading point. At the loading points, sampling devices were situated so that samples were collected from areas on each side of the shuttle car. The positioning of these instruments is depicted in figures 2 and 3, respectively.

On the longwall plow section, respirable dust samples were collected at the head, midpoint and tail of the longwall face. In addition, samples were collected at two transfer points (belt to belt) between the head of the longwall face and the main haulage belt. The latter locations were sampled because personnel were required to work at these locations during a major portion of the work shift. Personal respirable dust samples were also collected on personnel working in these areas. Other major mine areas sampled included the underground shop (including one of the motor barns) and main haulage routes. In the shop, the environment of the return escapeway was sampled; in the motorbarn, the return air was sampled. Personal samples were also collected on a mechanic working in each of the respective areas.

The sampling locations selected along the haulage entries are depicted in figure 1. Sampling instruments were located on the clearance side (opposite the trolley wire) of the mainline haulage within 4 feet of the track. The instruments were distributed so that measurements were obtained "upstream" and "downstream" of selected dust generating sources. In addition, personal samples were collected on the motorman. The routes over which the respective motormen samples were collected are also depicted in figure 1.

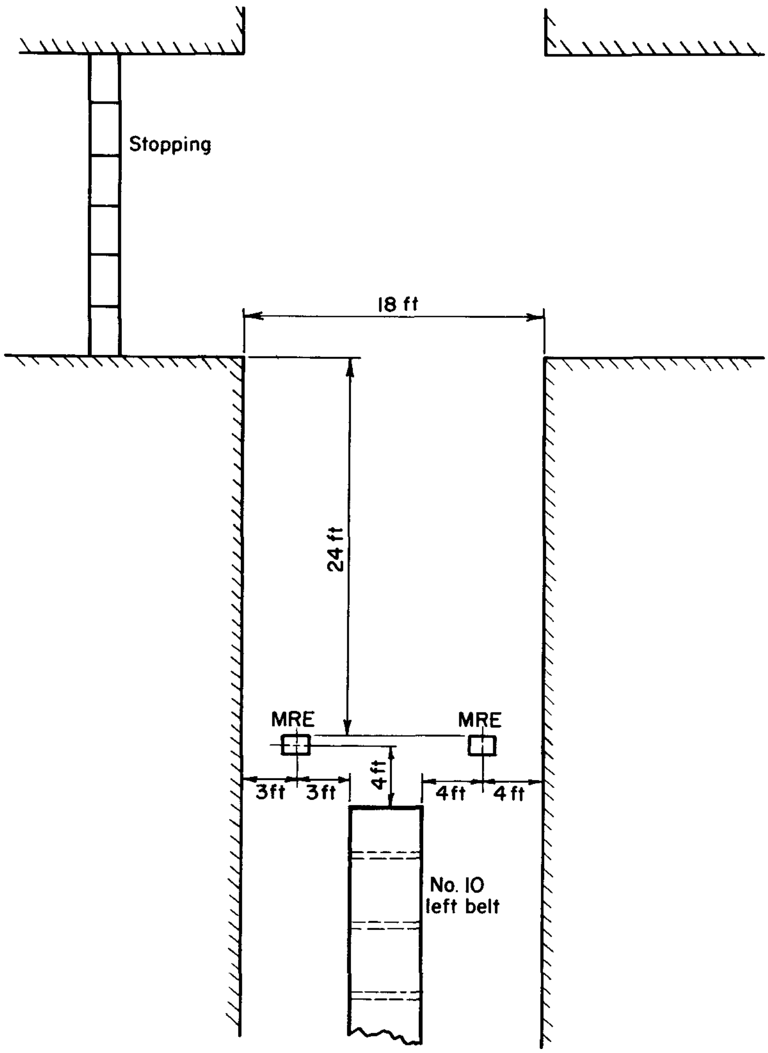

FIGURE 3. - Location of sampling instruments at the shuttle car to belt transfer points.

All area samples were obtained using the Isleworth[5] gravimetric dust sampler (MRE). In nearly all instances, the instruments were positioned midway between the roof and floor with the inlet perpendicular to entry airflow. The instruments were operated for the working shift, excluding travel time between the portal and sampling location.

Personal samples were obtained with currently approved personal respirable dust samplers operated at a flow rate of 2 liters per minute. Personal samplers were operated for the entire shift (portal to portal). All personal measurements were converted to equivalent MRE concentrations by multiplying by the constant factor 1.38. Twelve work shifts of samples were collected.

In this study, no attempt was made to establish a location that would be representative of the highest respirable dust concentration for the source of dust generation selected. Instruments were subjectively placed at locations of high dust concentrations based on:

1. Visual observation of the dust generating area.

2. Utilization of smoke tubes to determine the direction of airflow.

3. A study of the mine ventilation system using available mine maps.

4. Physical limitations of the location.

[5]Reference to specific brands, equipment, or trade names in this report is made to facilitate understanding and does not imply endorsement by the Mining Enforcement and Safety Administration.

5. The data obtained at similar sampling locations from previous underground respirable dust surveys.

The area sampling procedure consisted of the following:

1. Transporting the sampling instruments to the sampling location.

2. Securing the instrument at the sampling location.

3. Monitoring the instrument at least twice during the shift.

4. Transporting the instruments to the mine portal at the end of the shift.

Data

Table 1 lists the location sampled, the designated map location, the type of sample, the number of samples collected at that location, the average concentration determined and the variability(s) about the average value. The personal dust samples were collected on personnel that were assigned to work in the designated areas for the entire shift. The area designated G is depicted twice because it is compared to two different personal exposures--the motorman and the clean-up man assigned to that location.

All area measurements were converted to equivalent portal to portal measurements. For those areas where the travel time between the mine portal and sampling locations was less than 1 hour, the measurements were multiplied by a factor determined by dividing actual sampling time by 480 minutes (portal to portal sampling time). Where the travel time between the mine portal and sampling location was significant (locations G, K, J, L, Q, R, S), the equivalent portal to portal concentration was determined using the equation:

$$P\text{-}P = \frac{\text{measured concentration} \times \text{actual sampling time} + 0.8\ \text{mg/m}^3 \times \text{travel time}}{\text{portal to portal sampling time}}$$

This, in effect, gives the time-weighted average concentration based on a travel time exposure of 0.8 mg/m^3 (the average intake air concentration measured during this study).

Table 2 shows a comparison of the measurements obtained at the continuous miner operator's position, the shuttle car operator's position, and at the dumping point for the respective sections using continuous mining machines.

TABLE 1. - Summary of survey data

Area	Map location	Area samples			Personal samples		
		N	Average[1] concen. (mg/m³)	Standard deviation (mg/m³)	N	Average[2] concen. (mg/m³)	Standard deviation (mg/m³)
Rotary dump.........	A...........	10	0.2	0.11	-	-	-
Motorbarn...........	B...........	10	0.3	0.14	6	0.1	0.12
Car shop............	C...........	12	0.3	0.14	10	0.3	0.5
Haulage entry.......	D...........	11	0.2	0.10	12	[3]0.8	0.48
Do................	E...........	10	0.3	0.13	11	[4]1.6	0.35
Do................	F...........	11	0.9	0.36	11	[5]1.2	0.54
Transfer point (B-C)	G...........	12	1.02	0.28	11	[5]1.2	0.54
Haulage entry.......	H...........	11	0.2	0.22	-	-	-
Do................	I...........	12	0.2	0.18	-	-	-
Do................	O...........	11	0.3	0.13	-	-	-
Do................	P...........	11	0.3	0.15	-	-	-
Section loading point	L--on side..	12	2.4	1.89	9	3.0	2.09
Do................	L--off side.	12	2.7	1.75	9	3.4	1.77
Do................	M--on side..	11	0.6	0.30	12	1.2	0.81
Do................	M--off side.	11	0.4	0.22	12	1.4	1.08
Do................	N--on side..	12	0.2	0.51	11	0.4	0.40
Do................	N--off side.	11	0.2	0.10	9	0.4	0.36
Transfer point (B-C)	G...........	12	1.2	0.28	11	2.9	2.11
Transfer point (B-B)	J...........	12	3.0	1.19	-	-	-
Do................	K...........	10	2.8	0.91	5	4.5	1.17
Head longwall face..	Q...........	12	2.3	0.45	-	-	-
Midpoint longwall face.	R...........	12	2.7	0.80	-	-	-
Tail longwall face..	S...........	12	3.4	0.63	6	3.9	1.12

[1]Calculated equivalent portal-to-portal measurement.
[2]MRE equivalent concentrations.
[3]Motorman No. 3.
[4]Motorman No. 2.
[5]Motorman No. 1.

TABLE 2. - Average respirable dust concentrations (mg/m³ MRE equivalent) of miner operators, shuttle car operators and section dump points

	High-risk position	Section dump point	
		On-side	Off-side
Location L:			
Miner operator....................	2.0	-	-
Shuttle car operator..............	-	3.0	3.4
Area sampling instrument..........	-	2.4	2.7
Location M:			
Miner operator....................	3.8	-	-
Shuttle car operator..............	-	1.2	1.4
Area sampling instrument..........	-	0.6	0.4
Location N:			
Shuttle car operator..............	-	0.4	0.4
Area sampling instrument..........	-	0.2	0.2

Discussion of Results

The results of this study show that the main areas of concern outby the "working place" are loading and transfer points. Or, more generally, those areas where coal is undergoing secondary handling. It was evident from the engineering data collected during this study that at those locations, for example, N and M, where adequate ventilation and water were employed, dust levels were well below those required by the law; while those at locations (K, J, L, Q, R and S) where inadequate ventilation and water were employed, the levels exceeded the applicable standard.

In general, the personal samples collected at the motorman's location were considerably higher than the respective area samples to which they were compared. This was attributed to dust placed into suspension by movement of the locomotive. Although all of the motormen's personal respirable dust levels were below the 2.0 mg/m^3 standard, it is important to realize that for any operation, of which this is typical, the primary source of dust generation must be appropriately considered when preparing an area sampling plan for a mine.

The average respirable dust measurements obtained at the shuttle car operator's position for the respective continuous miner sections were in close agreement with those obtained at the dumping points. However, a comparison of the shuttle car and continuous miner operator's dust levels (table 2) showed that at location M, the continuous miner operator's concentration (3.8 mg/m^3) was approximately three times that of the shuttle car operators; and at location L (2 mg/m^3) approximately 0.6 times that of the shuttle car operators. Although the engineering data showed that essentially the same quantity of air and water was supplied to each of the respective sections, it was observed that at location M the exhaust tubing was not maintained to within 10 feet of the face, whereas at location L, it was continuously maintained to within 10 feet.

A comparison of the personal and area measurements obtained at the belt to belt (B-B) and belt to car (B-C) transfer points (locations K and G, respectively) showed that the personal measurements tended to be greater than the area measurements. The higher personal measurements could be attributed to:

1. The location of the area sampling device did not represent the point of highest dust concentration within the dust generation area.

2. The local dust concentration around a man may be increased because of his work activity.[6]

[6]Knight, G., R. Kowalchuk, and R. Youst. Development of a Dust Sampling System for Hardrock Mines Based on Gravimetric and Quartz Assessment. Amer. Indust. Hyg. Assoc. J., v. 35, November 1974, p. 671.

SUMMARY AND CONCLUSIONS

The program established to enforce the health standards of the Federal Coal Mine Health and Safety Act of 1969 (ACT) has recently been reviewed. The purpose of this review was to revolutionize the present dust sampling program based on the experience gained from the past 5 years. As a result of this review, a program is being proposed that will eliminate the collection of a large number of respirable dust samples that are not germane to determining compliance with the health standards set forth by the ACT. The program, based on an "area sampling concept" rather than on the collection of personal samples, is mainly designed to improve environmental conditions throughout a mine and to reduce the amount and the cost of dust sampling to the coal mining industry.

To evaluate the feasibility of employing the "area sampling concept," an extensive underground survey was conducted in a mine utilizing mining methods typical of those widely used throughout the industry. Environmental respirable dust levels and co-dependent engineering parameters were measured in the underground shop areas, haulage entries and at key transfer points. In addition, personal respirable dust samples were obtained on personnel required to work in any of the respective areas for the entire shift.

Measurements obtained in the respective areas sampled showed that whereever secondary handling of the coal occurred, such as at dumping points or belt transfer points, environmental dust levels could exceed the applicable standard if adequate dust control procedures were not employed. In all areas where the applicable standard was exceeded, dust control procedures were found to be inadequate.

Although personal measurements were not always less than their respective area counterparts, the data showed that in most cases, the person on which the sample was collected worked in or around an area where the dust was not adequately controlled; had the dust been adequately controlled, both the area and respective personal measurements would have shown the environment to be in compliance with the mandatory standard.

If at the time of sampling all of the areas sampled in this study had been in compliance with the mandatory health standard, the total environmental climate throughout the mine would have been improved. The results of this study depict that although the average respirable dust concentration of the high-risk occupation may comply with the mandatory health standard, dust generated at other locations in the mine may present a significant health hazard to personnel whose duties require working in these areas. Therefore, based on these results, the "area sampling concept" does provide a more viable means of insuring that the intent of the 1969 ACT is fulfilled; that is,

> ". . . that the average concentration of respirable dust in the mine atmosphere to which each miner in the active workings of such mine is exposed. . ."

is at or below 2 milligrams per cubic meter of air.

In conducting this study, there was some difficulty experienced with transporting, securing and monitoring the instruments. Instruments located at section transfer points can be transported and monitored by section personnel. However, care must be taken to insure that instruments are located at the point of highest dust concentration without hindering the movement of personnel or equipment. Several of the instruments positioned in the mainline haulage entries were not monitored because personnel could not travel in the haulage entries while coal trips were moving. This exemplifies the fact that in large mining operations, the sampling program will have to be well planned and organized for the "area sampling concept" to be applicable.

INT.-BU.OF MINES,PGH.,PA. 21068/248