RESPIRABLE DUST IN THE MINE ENVIRONMENT

by

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INTRODUCTION

The mandatory health standards of the Federal Coal Mine Health and Safety Act of 1969 pertaining to respirable dust have been in effect since June 30, 1970. The provisions established strict repirable dust standards for the coal mining industry for the first time in its history. The effort leading up to the establishment and enforcement of the standards and some of the findings at the end of the first and second years are presented.

The environmental dust survey was initiated early in 1968, and 29 underground coal mines were evaluated by early 1969. The mines selected fulfilled the following criteria:

1. The bituminous coal mines selected had a minimum operational expectance of 10 years and employed at least 20 men underground.

2. Ten consecutive days were required to be spent at each mine to obtain statistically valid data.

3. The mines selected had productivities ranging from less than 5 to greater than 50 tons per man shift.

4. The mines selected had seam thicknesses from less than 30 inches to greater than 121 inches and covered 19 different coal seams.

5. The types of sections sampled were continuous, conventional, a combination of continuous and conventional, and handloading. The selection of the sections to be sampled in the mines was dependent on the number and types of sections in the mine, and the results were used in determining the average exposure of the miners employed in specific operations over the entire work shift.

6. The number of mines selected in each of the Coal Mine Health and Safety Districts in the continental United States was based on the percentage of underground bituminous mines in the respective districts.

Each miner on the selected section crew was equipped with a personal gravimetric sampler operated for the entire shift. In addition, three sampling packages, each containing personal, MRE, total airborne, and midget impinger samplers, were employed on each section. One package was placed on or near the coal-cutting equipment adjacent to the operator; the second

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package was in the immediate vicinity of the workers who were indirectly involved with the coal-cutting operation, primarily the roof bolters; and the third package was placed in the intake air entry to the section. These samplers operated the entire time the working crew was on the section.

Data obtained were used to determine the occupations exposed to the highest concentrations of respirable dust in the face areas of the mines. In addition, a linear relationship was derived between data collected with the personal samplers and with the MRE. The average ratio of individual MRE to personal sampler data is approximately 1.6. The importance of this relationship must be emphasized. The regulations of the Federal Coal Mine Health and Safety Act of 1969 state that respirable coal mine dust samples are to be collected with the MRE or any other equivalent device approved by the Secretary of the Interior and the Secretary of Health, Education, and Welfare. The empirical relationship of 1.6 permits the use of the personal sampler and the reporting of data in terms of equivalent MRE concentrations.

FEDERAL COAL MINE HEALTH AND SAFETY ACT

Requirements

The Federal Coal Mine Health and Safety Act of 1969 provides for the protection of the health and safety of persons working in the coal-mining industry of the United States. It is also known as Public Law 91-173.

As specified in Section 203(a), Title II of the Act, each operator of a coal mine shall take accurate samples of the amount of respirable dust in the mine atmosphere. Beginning June 30, 1970, the operator of each coal mine was required to maintain the average concentration of respirable coal mine dust at or below 3.0 milligrams of dust per cubic meter of air. The standard is to be reduced to 2.0 milligrams per cubic meter after December 30, 1972.

The Act requires frequent sampling by the mine operator in accordance with the regulations prescribed by the Secretary of the Interior and the Secretary of Health, Education, and Welfare. Every coal mine operator is required to take monthly samples of the "high-risk" occupation in each coal-producing section. The high-risk occupation is one in which, as indicated by previous information, the worker is exposed to the highest concentration of respirable dust. Therefore, if the high-risk occupation is in compliance with the dust standard, then all other occupations in the area are assumed to be in compliance.

In addition to those "high-risk" samples required in coal-producing sections, a sample of the intake air is required monthly, and all underground workers must be sampled periodically. All samples are taken portal-to-portal, and the respirable dust concentrations are computed based on the worker's total time underground.

Processing

All samples collected by the mine operators are analyzed at the controlled environment laboratory of the Bureau of Mines in Pittsburgh, Pa. The laboratory and procedures followed in processing respirable dust samples are described in Bureau of Mines Information Circular 8520, Respirable Mine Dust Sample Processing Laboratory.

A flow diagram of the mine dust monitoring system is shown in figure 1. As of June 30, 1972, a total of 673,468 samples have been processed in the laboratory, which equates to approximately 30,000 samples per month, or 1,600 per day. The laboratory has a planned peak capacity of about 3,000 to 3,500 samples per day; however, since the health standards for surface operations became effective, peak loads of 50,000 plus and daily inputs of over 3,500 were encountered. Upon completion of the analysis, the information is transmitted to the Bureau of Mines automatic data processing center in Denver, Colo., where dust concentrations are determined and stored for calculation and comparison against existing dust standards. This facility is linked with the various Coal Mine Health and Safety District and Subdistrict Offices to provide reliable and rapid printouts of respirable dust data within hours after receipt of the sample in Pittsburgh.

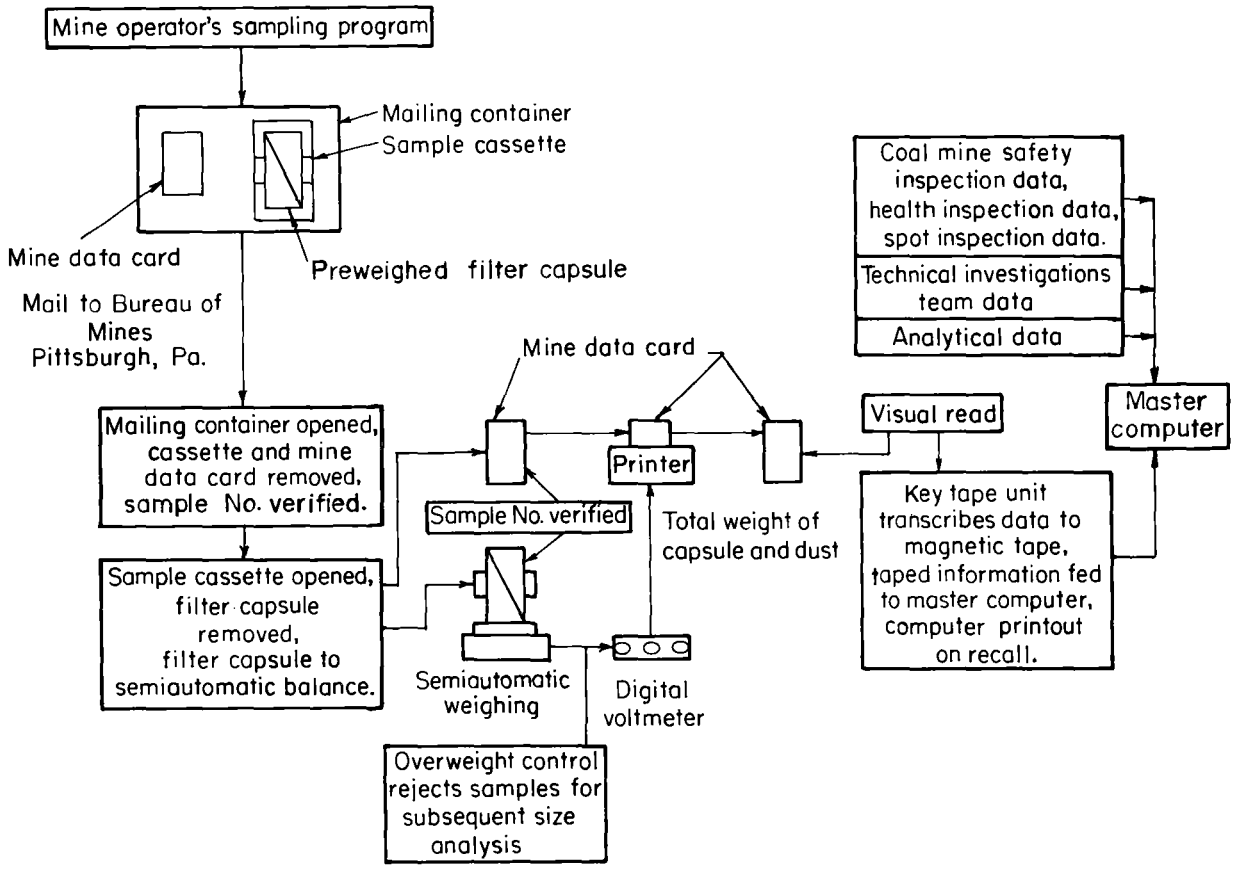

FIGURE 1. - Mine Dust Monitoring System.

RESULTS

To study the effect of the mandatory dust program on the reduction of the respirable dust exposure of the miners, a comparative evaluation of dustiness for high-risk occupations by sections in the 29 previously surveyed mines was conducted. In the 1968-69 survey, 155 sections were sampled. The data are reported as the cumulative percent of the sections whose MRE equivalent dust concentrations fall in the following categories: equal to or less than 1.0 mg/m^3; 2.0 mg/m^3; 3.0 mg/m^3; and 4.5 mg/m^3. These data appear in table 1.

TABLE 1. - Comparison between mean dust concentration of "high-risk" samples, original 29 mines versus all mines

Respirable dust	<1 mg/m^3	<2 mg/m^3	<3 mg/m^3	<4.5 mg/m^3
Survey data 1968-69, 155 sections.....	6.5	20.6	28.4	49.0
Sampling program 1970-71, 288 sections..	13.2	35.4	59.4	84.7
Sampling program 1971-72, 305 sections..	14.8	49.8	74.1	94.1
Sampling program, June 1971.....	21.3	63.2	88.9	99.9
Sampling program, June 1972.....	33.0	76.9	94.9	99.9

Data obtained from the coal mine operators' sampling program of the Federal Coal Mine Health and Safety Act of 1969 are similarly presented for the period of July 1, 1971, to June 30, 1972, for these 29 selected mines. These results represent the average of total data available for the sections in the 29 mines, and not the average of 10 samples. It must be remembered that specific section comparisons cannot be determined owing to the relatively short life of a coal mine working section.

Comparing the data, it is evident that the percentage of sections complying with a 3.0 mg/m^3 standard is approximately three times what it was prior to the law--74 percent as opposed to 28 percent. Increases are likewise evident for the other concentration levels. It further shows that about 50 percent of the sections in these 29 mines will now meet a 2.0 mg/m^3 standard limit.

It is also shown that the distribution of respirable dust concentrations for high-risk occupations for all mine sections, from which data was available at the end of the first and second years of the Federal Coal Mine Health and Safety Act of 1969, is considerably higher than results obtained from the original survey in the 29 mines. These data are for active mine sections which had a complete sampling cycle as of June 30, 1972. They indicate that approximately 95 percent of these sections were in compliance with the 3.0 mg/m^3 standard, and 77 percent were at or below a level of 2.0 mg/m^3.

A further comparative evaluation of the dust concentrations was performed for certain occupations where comparative data were present between original survey data and data obtained under the Act. These data are shown in table 2.

TABLE 2. - Comparison of mean dust exposures, selected occupations

Occupation	Survey data 1968-69, 29 mines	Dust program July 1970 to June 1971, 29 mines	Dust program July 1971 to June 1972, 29 mines	Dust program July 1971 to June 1972, all mines
Continuous miner operator..	6.5	3.1	2.6	2.1
Loading machine operator...	6.0	2.7	2.2	1.7
Cutting machine operator...	5.9	2.9	2.2	1.7
Shuttle car operator.....	2.3	1.6	1.5	1.4
Laborer.....	10.4	2.9	1.2	1.7
Timberman.....	3.9	1.7	1.7	2.2
Roof bolter.....	3.9	2.3	1.9	2.1

Of the original 21 occupations studied, eight had average dust levels below 3.0 mg/m^3, whereas three occupations sampled below 2.0 mg/m^3 at the time of the original survey. Current data indicate that all occupations have average dust concentrations of less than 3.0 mg/m^3. Of the 21 occupations initially surveyed, only four have average concentrations exceeding 2.0 mg/m^3 and these only range to 2.5 mg/m^3.

When the respirable dust in the mine atmosphere contains more than 5 percent quartz, the operator must maintain the average concentration at or below a concentration computed by dividing the percent of quartz into the number 10. The result of this calculation may not result in a concentration in excess of any standard previously established by the Act.

Approximately 99 percent of the samples collected in the face areas of the mines contain 5 percent quartz or less; 79 percent contain less than 2 percent quartz. This corroborates the previous estimate of approximately 2 percent of quartz in the respirable dust encountered in the working areas of operating coal mines.

The data presented clearly indicate that the first level of the Federal respirable dust standards is attainable at this time. Many mines are now demonstrating that coal can be mined without exposing the workers to excess concentrations of respirable dust and that there is real promise for achieving the 2.0 mg/m^3 standard when it becomes effective after December 30, 1972.

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