

## MONITORING AND CONTROLLING QUARTZ DUST EXPOSURE IN U.S. COAL MINES: CURRENT MSHA PROGRAM AND EXPERIENCE

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### ABSTRACT

On December 1, 1985, the U.S. Department of Labor's Mines Safety and Health Administration (MSHA) implemented a fully computerized, revised quartz exposure monitoring program that among other features, enables coal mine operators to participate for the first time in the coal dust standard-setting process when more than 5 percent quartz is found in active workings. In addition, the improved program also provides for automatic reevaluation of work areas or occupations on a reduced dust standard on a biannual basis.

In the 22 months since its inception, 7418 MSHA, 1349 operator, and 455 operator 6-mo. samples were analyzed for respirable quartz. As a result, 1740 areas or occupations were identified as having excessive quartz dust and thus were required to comply with a reduced respirable dust standard. An additional 304 operations on reduced respirable dust standards continued to operate under stricter dust standards because of quartz reevaluations.

During this period, approximately 42 percent of the coal mining operations given the opportunity to participate in the dust standard-setting process elected to do so. Despite the lower than expected participation rate, the improved program has enabled more effective identification and more frequent monitoring of areas or occupations experiencing high levels of quartz dust exposure.

This paper will discuss the key features of the improved MSHA quartz dust exposure monitoring program, how reduced respirable dust standards are currently set, and the performance of the program since its inception.

### INTRODUCTION

During the seventeen years following passage of the Federal Coal Mine Health and Safety Act of 1969, exposure to airborne quartz dust has been controlled by reducing the allowable dust standard when coal mine dust contains more than 5 percent quartz. One of the significant milestones in the Federal quartz enforcement process occurred in early 1981, when MSHA began to use the low-temperature ashing, infrared (IR) method for the determination of quartz in coal mine dust samples.

Unlike the earlier direct IR procedure, which required a number of samples to be combined to obtain a sample containing sufficient dust for analysis,<sup>1,2</sup> the upgraded IR method allows individual samples weighing as little as 0.5 mg to be analyzed for quartz. By using this method, the number of quartz determinations per year increased dramatically as illustrated in Table I. Consequently, this has resulted in a corresponding rise in the number of designated entities on a reduced respirable dust standard (entities that are required to be sampled bimonthly by coal mine operators), from 155 in 1980 to over 1360 in 1985.

The increase in the number of reduced standards, especially on roof bolters, coupled with growing operator concern about MSHA's longstanding policy of establishing a dust standard

Table I

History of Inspector Coal Mine Dust Samples Analyzed for Quartz, FY 1978–FY 1987

Fiscal Year	Number of Analyses	Number with >5% Quartz
1978*	876	311
1979*	1257	528
1980*	1619	721
1981*	3937	2188
1982*	4342	1881
1983	4774	1896
1984	5134	2135
1985	4380	1712
1986	4484	1482
1987	3848	1181

\* Calendar Year

based on the analysis of a single inspector sample prompted the agency to reexamine its quartz enforcement strategy. In December of 1985, MSHA instituted the current quartz program, one that not only provides for more frequent monitoring of quartz dust exposure, but, for the very first time, enables coal mine operators to participate in the dust standard-setting process.

### MSHA's CURRENT QUARTZ PROGRAM

The implementation of the revised quartz enforcement program marked the successful culmination of three years of effort to make the dust standard-setting process more effec-

tive. Its aim was to expand the level of health protection of the miner through more frequent monitoring and timely dust-standard adjustments.

### Specific Features

The current quartz enforcement program was designed to achieve these objectives:

1. Consider day-to-day variations in environmental quartz levels.
2. Allow use of limited number of operator dust samples to set the dust standard when over 5 percent quartz is found.
3. Provide for subsequent monitoring of entities (i.e., jobs, areas, or work positions) placed on a reduced standard.
4. Provide for automatic biannual reevaluation of entities placed on a reduced standard.

As before, the sample that triggers the dust standard-setting process is an MSHA sample. However, the resulting dust standard is now based on up to three samples, a combination of MSHA and operator samples. The background and development of this dust standard-setting strategy will not be discussed as it is beyond the scope of the paper.<sup>3,4</sup>

### Adjusting a Dust Exposure Standard

The specific procedures for setting a respirable dust standard differ somewhat depending on whether an entity is (a) on the normal 2.0 milligrams per cu. meter of air ( $\text{mg}/\text{m}^3$ ) dust standard; (b) already on a reduced respirable dust standard; or (c) on a reduced standard and being automatically reevaluated.

### Entities on the Normal Dust Standard

Whenever an MSHA dust sample from an entity is found to contain over 5 percent quartz (or more than 10 percent quartz from a Part 90 miner already on a  $1.0 \text{ mg}/\text{m}^3$  dust standard), the mine operator is notified by computer message of the option to collect a sample from the entity in question and submit it to MSHA for quartz analysis within a prescribed time frame. Since optional samples require minimum weight of 0.5 mg for analysis, dust collection over several shifts is permitted to obtain the required weight gain. These optional samples are used for quartz analysis only—not for compliance determination.

If the percentage of quartz found in the optional sample is within  $\pm 2\%$  of the MSHA sample, the two values are averaged, and the result is used to determine the allowable standard by dividing it into the number 10. Should the percentage of quartz differ by more than 2%, the operator is asked to collect a second sample. The three quartz values, MSHA plus two operator, are then averaged, and the result determines the standard for the entity. All quartz percentages are truncated to a whole percent. If the hundredths position in the calculated standard is greater than 0, the standard is raised to the next highest 0.1 mg.

In the event the operator fails to submit an optional sample containing enough dust for analysis within the prescribed time frame, the standard is based on the MSHA sample alone. If the first optional sample is sent in, but not the second,

the sample with the highest quartz percentage—be it MSHA's or the operator's—is used to set the standard.

### Entities on a Reduced Respirable Dust Standard

When an MSHA sample is collected from an entity already on a reduced respirable dust standard, the percentage of quartz in the MSHA sample is compared to the quartz value that was used to set the standard currently in place. If the two values differ by 2% or less, they are averaged and the standard adjusted accordingly. If the difference exceeds  $\pm 2\%$ , the operator is notified of the option to collect a sample from the entity in question. The same procedures used for entities on a normal dust standard are then followed.

Whenever a second optional sample is requested, submitted, and utilized, the preestablished quartz value is no longer used; only the three most recent samples (MSHA's plus two operator samples) are used to determine the average percentage of quartz and the applicable standard.

### Automatic Reevaluations

Once an entity is placed on a reduced respirable dust standard, approximately every six months the Information System Center's computer, in Denver, CO, selects the first valid operator bimonthly sample taken on that entity. The entity, however, must be in compliance, and the sample must have sufficient weight for quartz analysis. If no valid sample can be found, the computer continues searching the incoming bimonthly samples until it finds one. This sample is retrieved and analyzed for quartz.

If the percentage of quartz in this sample is within  $\pm 2\%$  of the quartz value used to set the current standard, the two values are averaged and the standard adjusted accordingly. If the difference exceeds 2%, the operator is notified of the option to collect another sample; the three values are then averaged to determine the standard. Should the operator not submit an optional sample with sufficient dust for analysis, the previously established standard stays in effect until the next automatic reevaluation or until an MSHA sample is submitted for quartz analysis.

Once a dust standard has been established, the operator is notified about whether bimonthly sampling will be required, the date of the first sampling cycle, and the applicable dust standard for the entity.

### PROGRAM STATUS

As of the end of FY 1987 (Sept. 30, 1987), 7418 MSHA, 1349 operator optional and 455 operator 6-month samples have been analyzed for respirable quartz dust. Thirty-three percent of the MSHA, 36% of the operator optional, and 31% of the 6-month samples were found to contain more than 5 percent quartz. Roof bolter and surface highwall drill operators continue to have the highest quartz exposure. Over 23% of the roof bolter and 55% of the highwall drill samples that were submitted for analysis contained more than 10 percent quartz. Some 22% of the highwall drill samples had more than 20 percent quartz.

Of the entities given the opportunity to submit the first optional sample, only 42% elected to do so. The data appear to suggest that the operator's decision may be influenced,

in part, by the amount of quartz found in the MSHA sample. This is most apparent when the MSHA sample contains less than 8 percent quartz, a level below which an operator, if given the option, is less likely to participate in the program. The data also show that, when submitted, 33% of the samples were found to contain insufficient weight for analysis and, therefore, had to be voided. As a result, the majority of the reduced dust standards established during this period were solely based on the quartz content of the MSHA samples.

Some 1740 separate entities were required to comply with more stringent standards during part of the period. An additional 304 established entities already on a reduced standard continued to operate under such standards as a result of biannual reevaluations. Of the 2044 entities, 42% were roof bolters. At the end of FY 1987, there were 1526 or 12% more established entities (in producing status) on a reduced standard than in FY 1985, before the current program took effect. However, the number of standards at or below 1.0 mg/m<sup>3</sup> declined by 18%, while the mean of the reduced standards remained relatively unchanged at 1.2 mg/m<sup>3</sup> (Table II).

Table II  
Number and (Pct) of Producing Entities  
on Reduced Standard

Fiscal Year	Range of Reduced Standards, mg/m <sup>3</sup>				Avg
	1.8-1.5	1.4-1.1	1.0-0.7	0.6-0.1	
1985	227 (31)	218 (30)	199 (27)	90 (12)	1.1
1987	304 (42)	180 (25)	186 (26)	50 (7)	1.2

According to the quartz data, over 70% of the time the MSHA samples contained more quartz than operator first-optional samples for the same entity. And only in 31% of the instances, the quartz content of first-optional samples was within  $\pm 2\%$  of the MSHA value (Table III). This is considerably lower than the 58% found in an earlier study which looked only at operator samples.<sup>4</sup>

In 74% of the biannual reevaluations, the quartz content of the 6-month sample was lower than the previous quartz percentage used to set the standard. The difference in % quartz between the previous value and the 6-month sample exceeded 5 percent 38% of the time. As shown in Table IV, only 25% of the 6-month samples were found to contain percentage of quartz that was within  $\pm 2\%$  of the previous quartz value.

Finally, to determine the level of impact, if any, of operator participation in the program, a comparison was made of the percentage quartz in the MSHA sample and the final quartz value used to set the allowable dust standard. These show (Table V) that 77% of final quartz values were within  $\pm 2\%$  of the MSHA value. Specifically, 56% of the time the two values were found to be equal, 31% of the time the MSHA quartz value was greater, and 13% of the time it was less than the value used to set the standard. This appears to sug-

gest that selective operator participation can influence the final outcome of the dust standard-setting process.

Table III  
Cumulative Distribution of Differences in % Quartz:  
MSHA\* vs. Operator 1st Optional Samples

Diff. (+) % Quartz	Cumulative % $\leq$ Stated Diff.
0	5
1	17
2	31
3	41
4	53
5	62
>5	100

\* 71% of the time MSHA samples contained more quartz.

Table IV  
Cumulative Distribution of Differences in % Quartz:  
Previous Value\* vs. 6-Month Samples

Diff. (+) % Quartz	Cumulative % $\leq$ Stated Diff.
0	7
1	17
2	25
3	38
4	47
5	56
>5	100

\* 74% of the time Previous quartz value exceeds the 6-mo. value.

Table V  
Cumulative Distribution of Differences in % Quartz:  
MSHA\* vs. Final Value Used to Set Std.

Diff. (+) % Quartz	Cumulative % $\leq$ Stated Diff.
0	56
1	73
2	77
3	82
4	87
5	90
>5	100

\* MSHA % quartz vs. Final % value  
(=) 56% of the time  
(>) 31% of the time  
(<) 13% of the time

## SUMMARY

Since early 1970, exposure to airborne quartz dust has been controlled by reducing the allowable dust standard when coal mine dust contains more than 5 percent.

The rise in the number of reduced standards, especially on roof bolters, and operator concerns about the use of a single MSHA sample to adjust the standard has led to the development and implementation on December 1, 1985, of a fully computerized, revised quartz enforcement program. The pro-

gram not only speeds up the dust standard-setting process to control exposure to quartz dust, but enables coal mine operators to be actively involved in this important process.

During the first 22 months of the program's operation, only 42% of the coal mining operations elected to participate in the standard-setting process. As a result, the reduced standards on the majority of the 2044 separate entities, that were found to contain more than 5 percent quartz during this period, were established based on the quartz content of the MSHA sample only.

When operator samples were submitted, over 70% of the time MSHA samples contained more quartz, and only 31% of the samples had a quartz content that was within  $\pm 2\%$  of the MSHA value. In 74% of the biannual reevaluations, the quartz content of the 6-month sample was lower than the previous quartz percentage used to set the standard.

A comparison of the percentage quartz in the MSHA sample and the final quartz value used to set the allowable standard, revealed that in 56% of the instances the values are equal, in 31% the inspector quartz value was greater, and

in 13% the inspector quartz value was less. This appears to suggest that the final outcome of the standard-setting process may be influenced by selective operator participation.

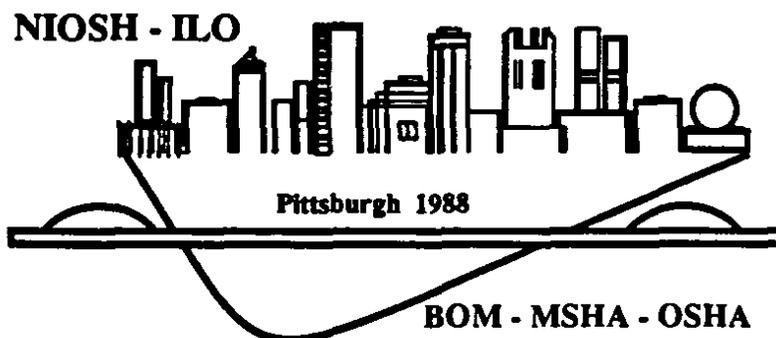
Through more frequent monitoring of exposure to airborne quartz dust, the current quartz enforcement program has had a positive impact on enhancing the level of health protection of U.S. coal miners.

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