Dust Sampling Roof Bolting Operations

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The Dust Division, Pittsburgh Health Technology Center, has conducted environmental dust studies on various roof bolting operations. The Mine Safety and Health Administration (MSHA) has determined that it may be necessary to collect respirable dust samples on roof bolting operations to assure the health of the miner is being protected. When the quartz content of the dust is greater than five percent, the respirable dust standard is based on the amount of quartz in the dust. Analysis of dust samples collected by mine inspectors have shown that many roof bolting operations have quartz levels greater than five percent. The purpose of this study was to determine locations where dust samples could be collected to assess the roof bolter's occupational exposure to respirable dust. Gravimetric dust samples were collected in order to determine the most appropriate location to collect respirable dust samples to assess the environment of the roof bolter. All samples were collected full shift (8 hours) using approved coal mine respirable dust sampling equipment. Personal samples were collected on the roof bolter and helper as well as fixed point samples at various locations on the roof bolting machine. Analysis of the results of these samples indicate that fixed point dust samples collected on a roof bolting machine in general are not representative of the roof bolter's personal exposure. The results of this study show that if a personal sample cannot be collected on the roof bolter operator, the most appropriate alternative sampling location is near the roof bolter drill controls.

Introduction

In 1980 Federal Regulations for assessing employees' exposures to respirable dust were changed. Prior to 1980 all employees were sampled. After 1980 only the designated occupation on each section was sampled. "Designated occupation" means the occupation on a mechanized mining unit that has been determined by results of respirable dust samples to have the greatest respirable dust concentration.

There is evidence that the respirable dust standard for the designated occupation may not adequately protect some occupations on the mechanized mining unit (mechanized mining unit means a unit of mining equipment including hand loading equipment used for production of material) specifically, the roof bolter(s) and/or roof bolter helper. One situation where this may occur is when the roof bolter is working on the return air side of the continuous miner on a section using a single split of air. In this situation the roof bolter(s) will be exposed to the dust generated by the continuous miner in addition to the dust generated by the roof bolting machine.

Another situation is when there is quartz present in the roof bolter's working environment resulting in a respirable dust standard significantly lower than that required by the designated occupation. Section 70.101, Title 30, of the Code of Federal Regulations provides that respirable dust samples with a quartz content exceeding five percent will result in a lower respirable dust standard. This reduced respirable dust standard is computed by dividing the number 10 by the percent quartz. There have been roof bolters on a reduced respirable dust standard since the beginning of the respirable dust sampling program. However, the number of roof bolters going on a reduced respirable dust standard has greatly increased since 1981.

In 1981 the Mine Safety and Health Administration's (MSHAs) analytical procedure for determining the quartz percentage of a respirable dust sample was changed. This change enabled a quartz determination to be made on nearly all samples collected by enforcement personnel. Analysis of quartz data showed that approximately 50 percent of all roof bolter samples analyzed contained greater than five percent quartz, and that 63 percent of the time the quartz percentage of the roof bolter exceeded that of the designated occupation on the same Mechanized Mining Unit. At the present time approximately 1000 roof bolter occupations are on reduced respirable dust standard. Hence, the necessity for making the roof bolter a designated area. "Designated area" means the active areas of a mine identified by the operator in the plan required under ~75.316 (Ventilation System and Methane and Dust Control Plan) where bimonthly samples will be collected to measure the dust generation sources.[1]

Once an area has been designated the operator must take one valid respirable dust sample from the designated area on a normal production shift each bimonthly period. If the sample fails to meet the requirements of CFR 70.100 or 70.101 the operator must take five valid respirable dust samples from that designated area within 15 calendar days. The operator shall begin such sampling on the first day on which there is a production shift following the day of receipt of notification by MSHA.

After an area has been made a designated area, the question arises as to the selection of the sampling point within the designated area. The placement of the respirable dust sampling instrument within a designated area is critical in order to obtain a representative measurement of respirable dust within the designated area so that its measurement is indicative of the highest dust exposure to personnel who are required to work or travel in that area. As required by 30 CFR 70.208(e), the methane and dust control plan shall show the specific location where designated area samples will be collected. Some guidelines for the selection of this position are:

1. Generally, within 10 to 20 feet downwind of the dust generating source. (Hard to do on a roof bolter since the sampling location would be in the return behind the canvas.)

TABLE I

Single Arm Roof Bolters Concentration (mg/m^3) and Percent Quartz (%)

	Mine 1											
	Section A						Section B					
	Shift 1-1		Shift 2-2		Shift 3-3		Shift 1-4		Shift 2-5		Shift 3-6	
	mg/m^3	%Qtz	mg/m^3	%Qtz	mg/m^3	%Qtz	mg/m^3	%Qtz	mg/m^3	%Qtz	mg/m^3	% Qtz
Bolter	2.0	7	1.1	6	1.6	6	3.3	8	2.5	7	2.3	7
Helper	2.8	7	1.0	6	1.1	3	2.0	6	0.9	4	1.9	5
Bolter Controls	1.7	6	0.3	4	1.3	6	2.4	6	1.2	5	2.4	6
Dust Box Side	1.7	5	0.5	3	1.4	6	1.6	5	*	*	1.4	5
Immediate Intake	1.4	4	0.0	0	0.7	3	*	*	0.5	5	1.7	5
Immediate Return	1.3	4	0.3	4	0.8	2	*	*	*	*	*	*
Opposite Dust Box	*	*	*	*	*	*	1.9	5	0.9	6	0.5	3

	Mine 2				Mine 5					
	Section A				Section A		Section B		Section C	
	Shift 1-7		Shift 2-8		Shift 1-9		Shift 1-10		Shift 1-11	
	mg/m^3	%Qtz	mg/m^3	%Qtz	mg/m^3	%Qtz	mg/m^3	%Qtz	mg/m^3	%Qtz
Bolter	1.4	0	1.1	6	1.2	7	1.5	1	1.6	5
Helper	0.6	4	1.0	5	1.3	7	1.3	8	1.8	12
Bolter Controls	0.3	17	0.5	4	0.6	*	1.2	*	1.6	5
Dust Box Side	0.4	1	0.5	3	*	*	*	*	*	*
Immediate Intake	0.2	0	0.4	2	0.6	5	0.5	22	0.7	2
Immediate Return	0.4	1	0.5	4	0.8	6	*	*	*	*
Opposite Dust Box	*	*	*	*	*	*	*	*	*	*

* no sample collected or no analysis

2. At normal breathing level, but not less than one foot from the roof or rib.
3. More than two feet from any obstruction and placed where it will not be directly behind an obstruction which would affect the airflow around the sampling device.
4. Within 36 inches inby of the operator's control station or normal work station.

Because these guidelines do not exactly fit the roof bolter as a designated area; a study was undertaken to determine the best location for the roof bolter designated area sample. The purpose of this study was to determine locations where dust samples could be collected to assess the roof bolter's occupational exposure to respirable dust.

Sampling Strategy and Procedures

A variety of roof bolters representing typical mining applications were selected to be studied. Single and double arm bolters operating in both blowing and exhausting ventilation systems were sampled. Also, bolters were sampled using single and double air split face ventilation systems. However, all roof bolters selected to be studied were on a reduced respirable dust standard (less than 2.0 mg/m^3) due to a high quartz level in the environment.

There were two reasons for choosing roof bolting operations with a high environmental quartz content. First, one of the guidelines proposed was to make the roof bolter a designated area when the quartz percentage of the sample is greater than five percent. Secondly, a sufficient amount of quartz was necessary to obtain a profile of the quartz distribution in the vicinity of the roof bolting operation.

Approved Mine Safety Appliances (MSA) personal respirable coal mine dust sampling instruments were positioned in several locations on and in the immediate area of the roof bolter. The locations consisted of sampling the single arm roof bolter operator, helper and bolting controls or on both bolter operators and their bolting controls on a double arm roof bolter. For both single and double arm roof bolters a dust sampling instrument was located on the tram controls, dust box and, for one sampling shift, the automatic temporary roof support. The fixed-point samples located on the machine were collected to determine the best alternate location(s) for collecting the designated area sample in case the personal sample could not be collected on the operator. Also, it was desired to compare the different respirable dust concentrations from different sampling locations to determine the sources of dust on these operations.

A dust sample was collected on the immediate intake and return of the roof bolter. These samples were moved and relocated in each place the bolter moved to bolt. The immediate intake and return samples were collected in order to determine the amount of respirable dust the roof bolting operation generated. This was accomplished by subtracting the intake dust concentration from the return dust concentrations for each sampled shift.

All fixed-point sampling instruments were operated while on section. All personal sampling instruments were operated portal-to-portal (480 minutes) and at a flow rate of 2.0 liters per minute (lpm). The filter cassettes were pre- and post-weighed on an analytical balance to a hundredth of a milligram and dust concentrations were calculated. All respirable dust concentrations were then converted to MRE equivalent concentrations by multiplying by the constant factor of 1.38. In addition, all respirable dust samples were analyzed for quartz content using infrared spectroscopy.

During the shift, different system parameters pertaining to each roof bolting machine were noted or measured. The different parameters noted were: type of drill bit, type of dust collector, the number of bolts per working place and the number of working places bolted per shift. The parameters measured were the air velocity and quantity in the entry the bolting machine was operating and the vacuum pressure at the drill chuck. Also, a time study was done to determine the amount of time the roof bolting machine operated in each place bolted. The objective in noting these parameters was to see what effect, if any, they had on respirable dust levels measured in the vicinity of the roof bolter.

Sampling Results and Discussion

Single Arm Roof Bolters

Respirable dust sampling was conducted on a total of 13 sections at five different mines. Initially multiple shifts were sampled on each section. However, once it was determined that large shift to shift variation in data was not occuring the study ended with only one shift being sampled on each section at Mine No. 5. A total of 23 shifts were sampled. Eleven of these shifts were on sections employing single arm roof bolters and the remaining 12 shifts were on sections employing double arm roof bolters.

All gravimetric respirable dust sampling data for single arm roof bolters is shown on Table I. Examination of this data shows that respirable dust concentrations and/or quartz percentages measured at the dust box and opposite the dust box were lower than either personal concentrations measured on the bolter operator and bolter helper or the concentration measured at the bolter controls. Therefore, these were determined to be poor locations to collect an area sample and no further discussion will be made of data from those two locations.

Individual respirable dust concentrations of the bolter operator, bolter helper and bolter controls from Table I are graphically shown on Figure 1. Figure 1 shows the roof bolter operators respirable dust concentrations are greater than the respirable dust concentrations measured at the roof bolter controls. For the 11 shifts sampled on single arm bolters, average respirable dust concentrations for the bolter operator bolter helper and bolter controls are 1.7 mg/m^3, 1.4 mg/m^3, and 1.0 mg/m^3, respectively. Statistical analysis of the data shows that the difference between respirable dust concentration measured on the bolter operator and on the bolter controls is significant at a 95 percent confidence level. Therefore the most appropriate location to collect a roof bolter designated area sample is on the roof bolter operator.

The quartz data for the bolter operator, bolter helper and bolter controls for single arm roof bolters is shown in Figure 2. Eight of the 11 bolter operator samples had a quartz content greater than five percent. This would result in a reduced respirable dust standard for those eight sections. In all but one case the bolter operator had a higher quartz content than the sample collected at the bolter controls. This is

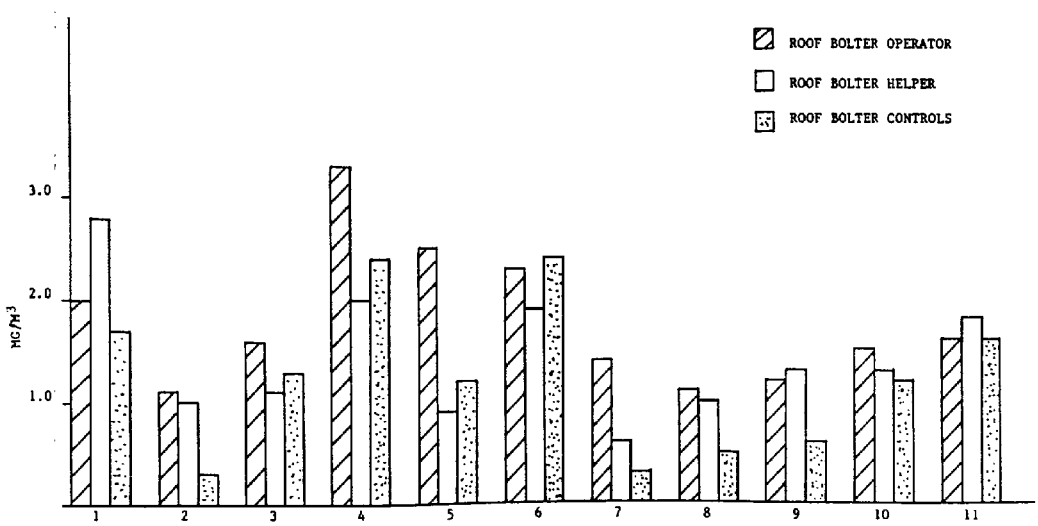

FIGURE 1. Single arm roof bolters.

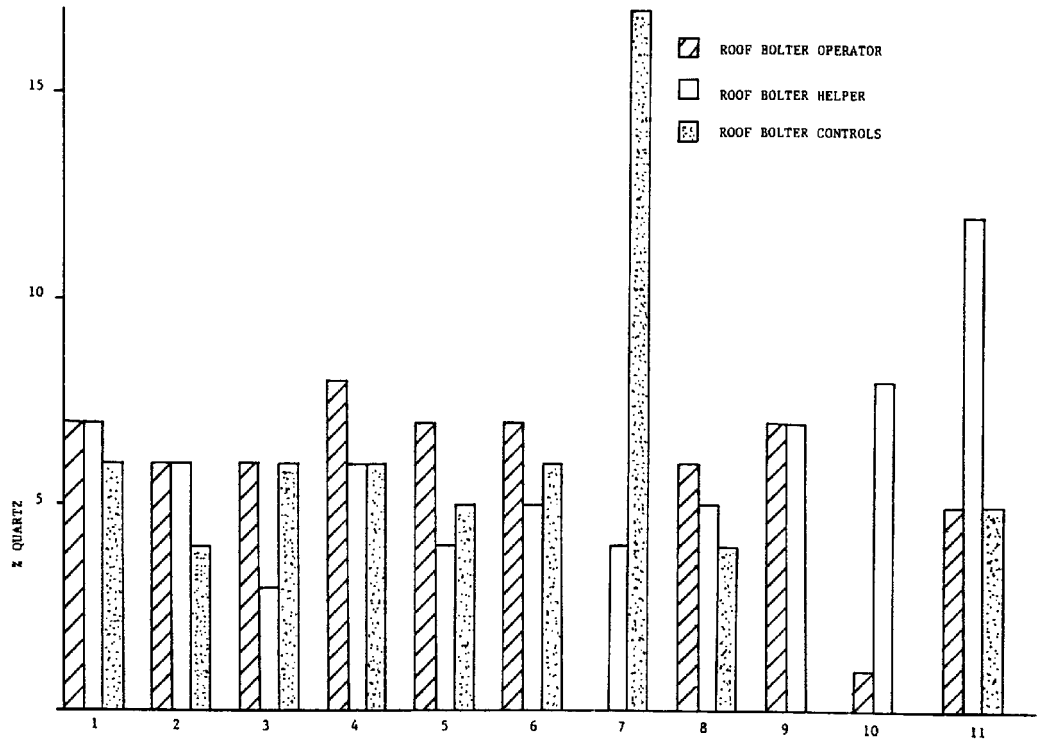

FIGURE 2. Single arm roof bolters percent quartz.

another reason for choosing to sample the roof bolter operator as the designated area.

Double Arm Roof Bolters

All of the gravimetric respirable dust sampling data for double arm roof bolters is shown on Table II. Examination of this data shows that respirable dust concentrations and/or quartz percentages measured at the dust box and tram controls were lower than personal concentrations measured on the right and left bolter operator. Therefore, these were determined to be poor locations to collect an area sample and no further discussion will be made of data from those two locations. Although the concentrations measured on the ATRS are more representative of the concentration measured on the left and right bolter operator; sampling at this location was stopped after only one shift due to the difficulty on collecting a sample at this location.

Statistical analysis of the double arm roof bolter data indicated the following: 1) there is no significant difference at the 95 percent confidence level between the right and left bolter operator's concentrations, 2) there is no significant difference at the 95 percent confidence level between the concentration measured at the right and left bolter controls, 3) there is no significant difference at the 95 percent confidence level between the concentrations measured at the right bolter operator and right bolter controls, 4) there is no significant difference at the 95 percent confidence level between the concentrations measured at the left bolter operator and the left bolter controls. Therefore, on double arm roof bolters any one of the above four sampling locations would be suitable for collecting a designated area sample. However, to make the designated area policy uniform, it is recommended that the bolter operator should be sampled.

Of the system parameters observed and measured during the survey, the only system parameter that had a noticeable effect on respirable dust exposures was the amount of time the roof bolter spent downwind of the continuous mining machine. As the amount of time the roof bolter spent downwind of the continuous mining machine increased, the respirable dust concentrations measured at the immediate intake and on the bolter operators increased. Subtracting the immediate intake concentration from the roof bolter operator's concentration would have resulted in all of the roof bolter operator concentrations being at or below 2.0 mg/m^3. The difference between the immediate intake and immediate return concentrations indicated the roof bolting operation was not generating a significant amount of dust (up to 0.3 mg/m^3).

Summary

The results of this study show that the most appropriate manner in which to sample the roof bolter DA is to collect a personal sample on the roof bolter operator. In situations

TABLE II

Double Arm Roof Bolters Concentration (mg/m^3) and Percent Quartz (%)

	Mine 2				Mine 3							
	Section B				Section A				Section B			
	Shift 1-1		Shift 2-2		Shift 1-3		Shift 2-4		Shift 1-5		Shift 2-6	
	mg/m^3	%Qtz	mg/m^3	%Qtz	mg/m^3	%Qtz	mg/m^3	%Qtz	mg/m^3	%Qtz	mg/m^3	%Qtz
Right Bolter	1.0	7	0.6	9	1.1	8	0.9	7	3.9	9	1.6	13
Left Bolter	0.7	9	0.6	4	1.1	9	1.7	9	3.5	9	3.0	12
Right Bolter Controls	0.3	2	0.3	4	0.9	8	1.2	8	2.9	8	1.2	12
Left Bolter Controls	0.4	5	0.5	6	1.0	7	3.3	*	3.9	*	1.5	*
Tram Controls	0.2	4	0.5	6	*	*	*	*	2.6	8	0.8	9
Dust Box	*	*	*	*	0.8	8	0.7	10	*	*	*	*
Immediate Intake	0.1	2	0.2	0	0.7	7	1.1	7	2.7	8	0.7	8
Immediate Return	0.4	3	0.3	5	0.7	8	1.0	6	3.0	7	0.7	10
Right ATRS	*	*	*	*	*	*	*	*	*	*	*	*
Left ATRS	*	*	*	*	*	*	*	*	*	*	*	*

	Mine 3				Mine 4						Mine 5	
	Section C				Section A				Section B		Section D	
	Shift 1-7		Shift 2-8		Shift 1-9		Shift 2-10		Shift 1-11		Shift 1-12	
	mg/m^3	%Qtz	mg/m^3	%Qtz	mg/m^3	%Qtz	mg/m^3	%Qtz	mg/m^3	%Qtz	mg/m^3	%Qtz
Right Bolter	0.5	10	1.4	11	0.2	14	0.4	6	0.3	7	2.0	7
Left Bolter	0.4	11	1.5	4	0.2	24	0.1	18	0.5	5	2.9	8
Right Bolter Controls	0.1	9	1.3	*	0.2	27	0.1	14	0.3	7	2.4	7
Left Bolter Controls	0.1	*	0.7	10	0.2	33	0.2	29	0.2	3	3.0	8
Tram Controls	0.0	7	0.6	11	0.4	8	0.1	14	*	*	*	*
Dust Box	0.1	9	0.6	11	0.2	*	0.1	14	0.4	3	*	*
Immediate Intake	0.0	5	0.5	8	*	*	0.0	27	0.1	6	1.6	5
Immediate Return	*	*	*	*	*	*	*	*	0.3	5	*	*
Right ATRS	*	*	*	*	*	*	*	*	*	*	2.6	7
Left ATRS	*	*	*	*	*	*	*	*	*	*	2.7	*

* no sample collected or no quartz analysis.

where a personal sample cannot be collected on the roof bolter operator, the best alternate sampling location is near the roof bolter drill controls. The data also shows that location of the roof bolting machine with respect to the continuous mining machine noticeably affects the respirable dust exposure of the roof bolter operator.

References

1. Code of Federal Regulations, Title 30, Mineral Resources, Part 70, revised July 1, 1985, Office of Federal Register, National Archives and Records Service, General Services Administration, Washington, D. C.