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Dust Exposures at U.S. Surface Coal Mines in 1982–1983

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ABSTRACT. Exposures to British Mining Research Establishment corrected respirable dust and respirable quartz at U.S. surface coal mines during 1982–1983 were evaluated from coal mine operator and Mine Safety and Health Administration (MSHA) inspector samples. The average respirable quartz concentration from inspector samples ranged from .34–.49 mg/m³ for drilling jobs and .18 mg/m³ for bulldozer operators. For most other surface coal mine jobs, the average respirable quartz concentration was less than .1 mg/m³, and the average respirable dust concentration was less than 2 mg/m³. The results from the analysis of quartz exposures are consistent with epidemiological results for an increased silicosis risk among drillers. It is unclear, however, whether the MSHA samples provide a representative estimate of the average annual quartz concentration for drillers. Results suggest the need for a greater number of quartz samples to be taken on strip coal miners, particularly on drillers and bulldozer operators.

IN 1972–1973 Fairman et al.[1] examined 1,438 workers employed at eight strip coal mines. They reported only a slight prevalence (2–3%) of radiographic small opacities among workers who had never been employed at an underground coal mine, and concluded that this was expected because of the low dust exposure reported at surface coal mines.

Dust levels at surface coal mines have been reported to be low since 1972. In 1974, Parobeck and Tomb[2] reported that 91% of 66,138 samples of airborne respirable dust submitted to the Mine Safety and Health Administration (MSHA) by surface coal mine operators were below the federal standard of 2.0 mg of coal mine dust/m³ of air. In 1979, Parobeck and Jankowski[3] reported that 95% of 126,498 samples submitted were below the standard. They also reported that mean dust levels were below 1.0 mg/m³ for 72 of 74 surface coal mine jobs.

Based on the exposure-response results in British coal miners,[4] coal mine dust containing less than 5% quartz would not be associated with a significantly increased risk of category 2 or higher pneumoconiosis at exposures less than 1 mg/m.[3] Thus, from the Parobeck et al. reports, a low risk of pneumoconiosis would be expected for most surface coal mine jobs where the quartz content is less than 5%.

In more recent years, however, the prevalence of silicosis has been reported to be increased among highwall drillers at some U.S. strip coal mines.[5-7] These results suggest that the quartz exposure may have been increased for drillers at these mines.

The purpose of this paper is to estimate the average respirable dust and quartz concentrations at U.S. surface coal mines in order to identify jobs with a potentially high risk of pneumoconiosis.

Methods

The Mine Safety and Health Act of 1969 requires that respirable dust sampling be carried out for compliance purposes by surface coal mine operators. Respirable dust, as defined by MSHA, is that dust measured with a device approved by the secretaries of labor and health and human services, and is typically a 10 mm cyclone operated at a flow rate of 2.0 L/min. However, a generally accepted definition for respirable dust (e.g., Atomic Energy Commission, British Medical Research Council, or American Conference of Governmental Industrial Hygienists) is not cited in the law or MSHA regulations.[8] Also, since the U.S. coal mine dust standard is based on the British dose-response curve derived from exposure data collected using the horizontal elutriator, the resultant MSHA respirable dust concentration is multiplied by a factor of 1.38 to convert the results to the British Mining Research Establishment (MRE) equivalent concentration.[8] The MSHA enforces a 2 mg/m^3 respirable dust standard (calculated as MRE equivalent), with a reduction based on the quartz content of the dust (computed by dividing the number 10 by the percent quartz, if the percent quartz is greater than 5).[8] Thus, the effective MSHA quartz standard is .1 mg/m^3 based on an MRE conversion (which is comparable to .072 mg/m^3 based on the ACGIH respirable dust criterion).

The MSHA requires that each surface coal mine operator collect respirable dust samples at "designated work positions" as selected by MSHA district managers. These samples are obtained from a sampler which is worn by the miner or which is placed in the immediate vicinity of the miner's normal working position. Samples are to be taken on a normal work shift when the mine is in production. If a sample concentration is in excess of the applicable standard, additional sampling will be required. If further sampling indicates noncompliance, a citation may be issued. Dust sampling requirements subsequent to a citation issuance are then specified by MSHA.[8]

The dust samples which are collected by MSHA inspectors during routine mine inspections for the determination of respirable dust concentrations are analyzed for quartz content by infrared spectroscopy. The MSHA specifies that samples with sufficient weight gain (greater than .5 mg) be submitted for quartz analysis from each designated work position sampled, each 'Part 90' miner sampled, and each nondesignated work position where excessive quartz is suspected.[9] Prior to 1985, inspector samples were used for evaluating the quartz content and for determination of a reduced respirable coal mine dust standard. Since 1985, a mix of inspector and operator samples may be used on setting a reduced standard, and the standard may be reassessed at 6-month intervals using samples submitted by the operator.

Three sources of surface coal mine dust data taken during 1982–1983 were made available by MSHA for this paper:

(1). **Quartz file.** All samples of respirable airborne dust which were collected by MSHA inspectors in 1982–1983, and analyzed for respirable quartz content. (Note: Only samples with greater than 0.5 mg weight gain are included in this data file.)

(2). **Inspector dust samples.** All samples of respirable airborne dust which were collected by MSHA inspectors in 1982–1983 during routine mine inspections. Samples in the quartz file were a subset of these inspector samples.

(3). **Operator dust samples.** All samples of respirable dust which were collected by surface coal mine operators in 1982–1983 for compliance with MSHA regulations.[8]

The three sources of samples will be referred to in this paper as the 'quartz file,' 'inspector samples,' and 'operator samples, respectively. For the purpose of this paper, only samples taken on surface coal miners who were employed in nonadministrative or nonmanagerial jobs were considered for analysis.

Results

Estimates of the average MRE corrected respirable dust concentration are presented in Table 1 for nonadministrative surface coal mine job categories on which samples were available. Samples "voided" by MSHA (Table 3) were excluded. Jobs were categorized as those in strip mines or quarrying operations, preparation plants or cleaning facilities, maintenance, and miscellaneous. The average quartz and MRE corrected respirable dust concentrations for 1,409 samples from 627 mines in the quartz file were .13 and 1.9 mg/m^3, respectively. The average respirable dust concentration for 17,884 inspector samples from 2,964 mines was .6 mg/m^3, and for 36,679 operator samples from 1,537 mines was .6 mg/m^3.

The average respirable quartz concentration for coal drill operators, rock drill operators, highwall drill helpers, and highwall drill operators was .39, .34, .49, and .39 mg/m^3, respectively. Correspondingly, the proportion of samples with a quartz concentration greater than .072 mg/m^3 (.1 mg/m^3 on the MRE scale) was 50, 100, 81, and 88% respectively. The average respirable dust concentration for drilling jobs ranged from 2.5 to 3.5 mg/m^3 for samples in the quartz file, and ranged from .8–1.5 mg/m^3 for inspector samples. Highwall drill operators and helpers had a higher average respirable quartz concentration and a higher average respirable dust concentration (inspector samples) than all jobs except sweepers, dispatchers, and carpenters on whom few samples were taken.

Bulldozer operators, pan scraper operators, coal shovel operators, and shotfirers had an average quartz exposure greater than .1 mg/m^3. The average quartz concentration was .18 mg/m^3 for bulldozer operators, and the quartz concentration exceeded .072 mg/m^3 in 59% of the samples. The average quartz concentrations

Table 1.—The Distribution, Average, and Standard Deviation of Respirable Dust (MRE Corrected) and Quartz Concentration (mg/m^3) for Samples Collected in 1982–1983 by Operators and MSHA Inspectors on Workers Employed in Nonadministrative Jobs

	Quartz file							Inspector dust samples				Operator dust samples			
		Quartz			Dust										
Job category	No. samples	%>.072*	Avg.	*SD*	%>2.0	Avg.	*SD*	No. samples	%>2.0	Avg.	*SD*	No. samples	%>2.0	Avg.	*SD*
Strip mine															
Shotfirer	6	67	.11	.12	17	1.5	.7	89	6	.7	1.3	268	4	.5	.9
Pan scraper opr.	21	52	.10	.11	19	1.8	2.1	461	2	.4	.6	481	1	.4	.4
Coal drill. hlpr.	—	—	—	—	—	—	—	8	0	.3	.2	45	4	.6	.6
Coal drill. opr.	6	50	.39	.71	33	3.4	4.3	51	4	.8	1.7	388	9	.7	.9
Rock drill. opr.	13	100	.34	.21	46	2.5	1.9	42	14	1.3	2.4	276	13	.9	1.5
Coal shovel opr.	5	20	.11	.16	0	1.1	.3	161	1	.4	1.3	129	0	.3	.3
Bull dozer opr.	227	59	.18	.23	13	1.4	1.3	3,560	2	.5	1.0	5,880	4	.5	.8
Road grader opr.	3	33	.07	.09	0	.9	.2	149	0	.3	.2	225	3	.4	.8
Coal truck drv.	11	36	.05	.04	0	1.0	.3	358	1	.6	3.2	1,198	2	.4	.6
Drag line opr.	8	0	.02	.02	0	.8	.1	492	1	.3	.4	202	1	.3	.4
High lift opr.	96	19	.05	.06	11	1.3	.9	3,177	1	.4	1.5	1,849	2	.4	.5
H.W. drill. hlpr.	26	81	.49	1.31	38	3.5	7.5	187	13	1.3	3.9	733	5	.7	1.0
H.W. drill. opr.	250	88	.39	.58	48	3.2	3.7	1,406	20	1.5	2.9	4,149	12	.9	1.7
Refuse truck drv.	105	36	.06	.07	10	1.1	.6	1,257	2	0.6	1.4	2,095	3	.5	.7
Rot. bucket opr.	—	—	—	—	—	—	—	9	0	.2	.2	29	10	.7	1.4
Str. shov. opr.	1	100	.14	—	0	1.6	—	81	0	.2	.2	57	2	.4	.5
Water trk opr.	—	—	—	—	—	—	—	25	0	.3	.3	62	0	.3	.3
Groundman	2	0	.03	.01	0	1.2	.3	36	3	1.0	3.5	94	1	.3	.4
Rotary dump opr.	—	—	—	—	—	—	—	9	0	.2	.1	3	0	.2	.2
Scoop opr.	—	—	—	—	—	—	—	2	0	.4	—	—	—	—	—
Sweeper opr.	—	—	—	—	—	—	—	1	100	3.5	—	—	—	—	—
Auger opr.	3	0	.02	.00	0	1.3	.1	102	1	.4	.4	19	0	.4	.4
Auger hlpr.	5	20	.04	.05	20	1.4	.5	82	1	.4	.4	32	0	.4	.3
Clam opr.	—	—	—	—	—	—	—	6	0	.1	.0	—	—	—	—
Prep facility															
Coal sampler	22	9	.03	.04	32	1.6	1.2	133	14	.8	.9	365	5	.7	.7
Crusher attndt.	9	33	.16	.34	33	3.1	3.4	76	3	.7	1.4	40	13	1.1	1.3
Dispatcher	—	—	—	—	—	—	—	12	8	4.2	13.7	148	2	.3	.4
Motorman	—	—	—	—	—	—	—	7	0	.1	.0	35	0	.2	.2
Car dropper	5	0	.03	.02	40	1.9	1.1	218	1	.3	.4	563	3	.5	.7
Cln. plant opr.	76	4	.01	.02	8	1.4	.5	444	4	1.0	3.9	1,451	7	.8	.8
Dryer opr.	10	10	.02	.06	10	1.6	1.3	87	7	.8	.8	288	6	.7	.7
Fine Cl. plt. opr.	66	0	.01	.01	20	1.8	2.0	325	15	1.2	1.4	1,107	13	1.1	1.0
Scalp scrn. opr.	34	12	.03	.03	26	2.4	3.7	215	13	1.2	1.8	626	10	.9	.8
Silo opr.	2	0	.00	—	0	.8	.4	13	0	.7	.6	49	8	.8	.8
Tipple opr.	67	1	.01	.01	22	1.5	.8	824	5	.7	2.9	1,848	7	.7	.8
Weighman	—	—	—	—	—	—	—	83	1	.3	.5	18	0	.2	.2
Yard eng. opr.	1	0	.02	—	0	1.3	—	15	0	.2	.3	27	0	.3	.3

Table 1.—continued.

Job category	Quartz file							Inspector dust samples				Operator dust samples			
		Quartz			Dust										
	No. samples	%>.072*	Avg.	*SD*	%>2.0	Avg.	*SD*	No. samples	%>2.0	Avg.	*SD*	No. samples	%>2.0	Avg.	*SD*
Brakeman	—	—	—	—	—	—	—	4	0	.2	.2	—	—	—	—
Steel workers	—	—	—	—	—	—	—	1	0	.7	—	—	—	—	—
Washer opr.	3	0	.02	.03	33	1.9	.7	48	2	.7	.5	41	7	1.0	.7
Barge attendant	—	—	—	—	—	—	—	29	0	.3	.3	27	4	.3	.5
Car trimmer/ldr.	—	—	—	—	—	—	—	50	0	.2	.2	22	0	.3	.2
Car shake-out	—	—	—	—	—	—	—	10	0	.3	.2	3	0	.1	.0
Froth cell opr.	2	0	.03	.04	50	1.7	.4	35	17	1.2	.8	25	4	.9	1.0
Shop/maint.															
Electrician	12	0	.00	.01	0	1.0	.3	193	1	.4	.4	721	4	.6	.8
Elect. helper	—	—	—	—	—	—	—	4	0	.3	.1	70	1	.4	.9
Mechanic	65	3	.01	.05	28	1.6	.9	836	5	.6	.8	3,086	5	.6	.8
Mechanic helper	2	0	.00	—	0	1.0	—	38	0	.4	.4	149	4	.5	1.0
Supplyman	2	0	.00	—	50	1.7	1.0	37	3	.3	.5	186	2	.4	.5
Laborer	112	6	.02	.05	21	1.6	1.8	1,072	5	.7	1.0	4,043	6	.6	.7
Greaser/oiler	30	0	.01	.02	17	1.6	1.6	391	3	.4	.6	767	2	.4	.6
Welder	24	4	.01	.02	58	2.6	1.8	258	20	1.2	1.6	188	5	.5	.7
Shopman	2	0	.01	.01	0	1.4	.1	16	0	.3	.3	108	1	.3	.3
Carpenter	—	—	—	—	—	—	—	3	33	1.5	2.4	17	0	.2	.1
Mason	—	—	—	—	—	—	—	3	0	.2	.2	3	0	.1	.1
Bit sharpener	4	0	.00	—	75	10.6	9.3	2	0	.5	.5	18	22	1.4	2.1
Machinist	—	—	—	—	—	—	—	31	0	.3	.2	—	—	—	—
Miscellaneous															
Conveyor opr.	2	0	.01	.02	0	1.2	.6	67	0	.5	.5	143	4	.5	.5
Belt vul.†	—	—	—	—	—	—	—	3	0	.4	.3	24	4	.4	.6
Clean-up	44	2	.01	.02	23	1.5	1.2	317	10	.9	.9	1,388	10	.8	.9
Transitman	—	—	—	—	—	—	—	2	0	.8	.5	13	0	.3	.4
Beltman†	14	7	.01	.04	50	3.6	5.8	63	17	1.0	1.2	81	27	1.2	1.2
Waterboy	—	—	—	—	—	—	—	2	0	.1	—	—	—	—	—
Hoist hlpr.†	—	—	—	—	—	—	—	4	0	.4	.2	2	0	.1	—
Lampman†	1	0	.02	—	0	.1	—	39	0	.3	.2	365	1	.3	.3
Rodman/surveyor	—	—	—	—	—	—	—	—	—	—	—	9	0	.4	.4
Cage attendant†	—	—	—	—	—	—	—	1	0	0.0	—	—	—	—	—
Watchman	—	—	—	—	—	—	—	1	0	.1	—	—	—	—	—
Other‡	10	0	.00	—	10	1.6	.3	67	6	.7	.6	259	8	.8	1.0
Fan attendant	—	—	—	—	—	—	—	1	0	1.0	—	—	—	—	—
Hoist opr.	—	—	—	—	—	—	—	36	0	.2	.1	64	0	.2	.2
Coal strip opr.	—	—	—	—	—	—	—	17	0	.4	.3	78	4	.5	.6
All samples	1,409	35	.13	.40	24	1.9	2.5	17,884	5	.6	1.8	36,679	6	.6	.9
Number mines			627			2,964				1,537					

*Percentage of samples that had a concentration less than .072 mg/m^3.
†Jobs only at surface areas of underground coal mines.
‡Possible error in job listing.

Table 2.—Weighted Average Quartz Concentration by State for Highwall Drill Operators and Bulldozer Operators*

State	Highwall drill operators No. mines	Highwall drill operators Weighted average	Highwall drill operators SD	Bulldozer operators No. mines	Bulldozer operators Weighted average	Bulldozer operators SD
Alabama	1	0.2	—	3	.1	0
Colorado	1	1.2	—	—	—	—
Illinois	1	.7	—	—	—	—
Indiana	7	.3	.4	5	.2	.2
Kentucky	25	.3	.3	29	.3	.3
New Mexico	—	—	—	1	.0	—
Ohio	20	.2	.2	22	.2	.2
Oklahoma	6	.3	.2	2	.3	.2
Pennsylvania	23	.5	.6	48	.1	.1
Tennessee	4	.3	.2	5	.2	.1
Texas	—	—	—	2	.2	.1
Virginia	33	.5	.7	29	.2	.2
West Virginia	28	.3	.3	19	.2	.3
Wyoming	—	—	—	4	.1	.1

*Average quartz concentration (mg/m^3) from quartz file, weighted by the number of samples at a mine.

for coal and strip shovel operators, shotfirers, and panscraper operators were based on a small number of samples ($N = 5$, 1, 6, and 21, respectively).

For all surface coal mine jobs, except dispatchers and sweeper operators, the average respirable dust concentration was less than 1.5 mg/m^3 from inspector samples and was less than 1.4 mg/m^3 from operator samples. With the exception of crusher attendants, the average quartz concentration was less than 0.1 mg/m^3 for all nonstrip mine jobs and was less than .02 mg/m^3 for all preparation plant jobs.

The average quartz concentration (weighted by the number of samples at a mine) was computed for highwall drillers and bulldozer operators by state to determine whether the average quartz exposure varied with geographic area (Table 2). A significant geographical difference was not observed. The average was greater than 0.2 mg/m^3 for drillers in all states, and exceeded 0.1 mg/m^3 for bulldozer operators in 9 of 12 states.

Discussion

The average quartz concentration ranged from .3 - .5 mg/m^3 for coal, rock, and highwall drill operators and helpers, and for bulldozer operators. For most jobs other than drillers and bulldozer operators, the average quartz concentration was less than .1 mg/m^3 and the average respirable dust concentration was less than 1.5 mg/m^3.

The National Institute for Occupational Safety and Health (NIOSH) has concluded that silicosis risk is negligible at quartz exposures less than .05 mg/m^3; this conclusion was based primarily upon studies of Vermont granite shed workers.[10] Additionally, from the results of studies of British underground coal miners,[4] the risk of category 2 or higher coal workers' pneumoniosis is negligible at coal mine dust exposures less than 1 mg/m^3 (for percent silica less than 5%).

Therefore, if the MSHA respirable quartz and respirable dust samples provide an accurate estimate of long-term average quartz exposure during 1982–1983, then quartz exposures for drillers and bulldozer operators may have been associated with an increased risk of silicosis. Additionally, respirable dust exposures for jobs other than drillers and bulldozer operators would have a slight risk of radiographic category 2 or higher coal workers' pneumoconiosis (CWP) and a negligible risk of silicosis.

However, conclusions about the level of pneumoconiosis risk in the surface coal mine industry based on

Table 3.—MSHA Criteria for Voiding Samples

MSHA code	Description
OCC	Invalid occupation code
SAM*	Invalid sample type
TME	Invalid or missing sampling time
PRO	Invalid estimate of production
OSP*	Sample indicated evidence of oversized particles
CON	Sample contaminated
EXC*	Excess sample
INW*	Invalid initial weight
ABD	Status is abandoned
BRK	Cassette broken
MFP	Malfunction in pump
OVP*	Operator void; production
OVR*	Operator void; rain
OVT*	Operator void; time
OVM*	Operator void; miscellaneous reasons

*Void samples selected for reanalysis (Table 4).

MSHA data are still unclear. Risk depends on the particle size distribution, the average and duration of exposure, the representativeness of the samples, and the precision of the estimate of average exposure, which is related to the number of samples taken. The particle size distribution of respirable dust for surface coal mine drillers may be different from that for Vermont granite shed workers, and if so, the NIOSH recommended standard of .05 mg/m^3 quartz may be inappropriate for surface coal mine drillers. Additionally, silicosis risk will be low at mines with moderately increased exposure for workers with short tenure drilling and at mines with very low exposures for workers with long tenure. Thus, risk assessment must be based, in part, on a work history and on an estimate of long term (e.g., annual) average exposure.

Whether MSHA inspector samples which were collected for quartz analyses provide a representative estimate of long-term average exposure is questionnable. A comparison of the respirable dust concentration between quartz, inspector, and operator samples indicate that quartz samples have possibly overestimated the average respirable dust exposure. Inspectors collected samples at 2,964 mines, and for only 627 mines were samples evaluated for quartz content (Table 1). The average respirable dust exposure was higher for quartz samples (1.9 mg/m^3) than for inspector (.6 mg/m^3) and operator samples (.6 mg/m^3).

One possible explanation for the difference in the average respirable dust concentration between quartz and inspector samples is that MSHA inspectors may have selected the dustier mines and jobs to evaluate the quartz content of the airborne respirable dust. However, the main reason for the difference is that MSHA only analyzed samples for quartz if the respirable dust weight gain was at least 0.5 mg.

On the other hand, there is no reason to assume that the average quartz exposure for drillers and bulldozer operators at all mines has been markedly overestimated due to the .5 mg restriction. This would depend on the frequency of samples with a weight gain of less than .5 mg and their quartz content.

Samples with a weight gain of less than .5 mg could have a quartz concentration greater than .1 mg/m^3 if the quartz content exceeds 20%. For highwall drillers, the average percent respirable quartz, weighted by the number of samples at a mine, exceeded 20% in 38% of all mines sampled from 1972–1979.[11] Additionally, Tomb et al.[12] reviewed samples which were collected by inspectors in 1983 and reported that "although exposure levels for surface personnel were very low, the quartz content of the samples that were analyzed was typically high." Additionally, they analyzed 719 samples which were collected by surface coal mine operators in 1984, including samples with less than .5 mg weight gain. The average quartz concentration exceeded 0.1 mg/m^3 in approximately 40% of the samples for highwall drill operators, 45% for highwall drill helpers, and 35% for bulldozer operators.

The hypothesis that the quartz samples may have overestimated the average quartz concentration appears to be possible because of the higher average respirable dust concentration from quartz samples than from inspector and operator samples. This comparison, however, must consider the criteria used by MSHA to void samples. Subsequent to collection, an inspector sample may be voided by either the inspector or the lab analyst according to MSHA criteria. These criteria include both technical (e.g., malfunctioning pump, contamination, etc.) and recordkeeping (e.g., invalid or missing sample type, initial weight measured by inspector in the field rather than in the laboratory, etc.) considerations (Table 3).

Since many of the recordkeeping errors do not affect the estimate of the concentration or the identification of the worker's occupation, selected void samples were considered (Table 3), and the average respirable dust concentration for each occupation was recalculated. The inclusion of void samples made little difference in the average respirable dust concentration for all occupations except for highwall drill operators (Table 4). For highwall drill operators, the average respirable dust concentration was 1.5 mg/m^3 for nonvoid samples, 1.6 mg/m^3 for samples which included selected void samples except those voided for containing oversized particles (OSP), and 2.0 mg/m^3 for samples, including all selected void samples, including those containing OSP. Thus, if the presence of OSP is not considered a valid restriction, then the average respirable dust concentration for highwall drill operators appears to be extremely high at a few mines (2% of the samples and 5% of the mines). A similar analysis could not be conducted for operator samples because void sample information was not available to NIOSH and all void samples were deleted from the operator file.

Presently, MSHA examines any inspector sample for OSP which has a weight gain in excess of 1.8 mg. If 30 or more particles greater than 10 μm in diameter are counted in 10 microscopic fields of the filter, the sample is declared void. This criteria may be unduly restrictive, because the 30 particle control limit may be invalidating samples which may only have a small fraction of their total mass due to OSP. Also, OSPs could appear in any sample regardless of their weight gain. Therefore, since the true respirable dust concentration in a 1.8 mg sample may exceed the dust standard, invalidating these samples makes it difficult to detect and to control the worst cases of high dust concentrations.

Whether the average quartz exposure estimates are representative of long-term average exposure is also questionable due to the small number of quartz samples collected per mine and job. The number of inspector samples which were analyzed for quartz ranged

Table 4.—Average and Standard Deviation of Respirable Dust Concentration (MRE Corrected) for Inspector Samples with and without Selected Void Samples Included

Job	Void samples excluded			Void samples included					
				A†			B‡		
	No.	Avg.	*SD*	No.	Avg.	*SD*	No.	Avg.	*SD*
Rock drill opr.	42	1.3	2.4	45	1.3	2.4	46	1.6	3.1
Highwall drill hlpr.	187	1.3	3.9	188	1.4	4.1	188	1.4	4.1
Highwall drill opr.	1,406	1.5	2.9	1,417	1.6	3.9	1,446	2.0	5.7
Groundman	36	1.0	3.5	36	1.0	3.5	36	1.0	3.5
Sweeper opr.	1	3.5	—	1	3.5	—	1	3.5	—
Dispatcher	12	4.2	13.7	12	4.2	13.7	12	4.2	13.7
Cleaning plant opr.	444	1.0	3.9	445	1.1	5.4	449	1.2	5.4
Fine coal plant opr.	325	1.2	1.4	325	1.2	1.4	327	1.2	1.4
Scalp screen opr.	215	1.2	1.8	216	1.5	5.5	216	1.5	5.5
Froth cell opr.	35	1.2	.8	35	1.2	.8	35	1.2	.8
Welder	258	1.2	1.6	258	1.2	1.6	259	1.2	1.7
Carpenter	3	1.5	2.4	3	1.5	2.4	3	1.5	2.4
Beltman	63	1.0	1.2	63	1.0	1.2	64	1.3	3.0
Fan attendant	1	1.0	—	1	1.0	—	1	1.0	—

Note: Results presented only for job categories with an average respirable dust concentration greater than 1 mg/m^3.
†A: Samples were included if MSHA void code was one of following reasons: SAM, EXC, INW, OVP, OVR, OVT, OVM.
‡B: Samples were included if MSHA void code was one of reasons in group A, or OSP.

from 2–3 samples per mine in 1982–1983 (1,409 samples/627 mines). Tomb et al.[12] noted that a single sample taken in a year is a poor estimate of the annual quartz exposure at a mine.

NIOSH found that a driller who was employed at a West Virginia strip mine had developed acute silicosis and died within 5 yr.[5] The respirable coal mine dust concentrations from MSHA samples taken on drillers at the West Virginia strip mine were low and within compliance, and no samples were analyzed for quartz content. Similarly, in a more recent study,[7] NIOSH reported that a 25-yr-old man who was employed as a driller at a Pennsylvania anthracite strip coal mine developed ILO radiographic category 2 small rounded opàcities within 3 yr from 1980–1983. There were no quartz samples taken at the mine from 1980–1985.

The results of the NIOSH studies[5,7] indicate that MSHA's compliance system has not prevented silicosis among highwall drillers. One explanation may be that the number of samples which were collected at the mines where cases of silicosis were found were not sufficient to obtain a valid estimate of the worker's average long-term quartz exposure. This was certainly true for the two cases described above. Another explanation may be that samples high in quartz frequently have less than .5 mg weight gain or have too many over-sized particles, and are not evaluated for quartz by MSHA.

Whether MSHA's quartz samples provide a representative estimate of the average long-term quartz exposure for surface coal mine jobs can not be evaluated from their data. However, the quartz samples provide an accurate estimate of an 8-hr time-weighted average quartz exposure on those days sampled. Coupled with the epidemiological observation of an increased silicosis prevalence among drillers[5-7], the possibility of an increased silicosis risk among drillers and bulldozer operators based on evidence from 1982–1983 samples at U.S. surface coal mines should be of concern to MSHA, NIOSH, surface coal mine companies, and surface coal miners. There is a need for a greater number of quartz samples on surface coal miners, particularly for drillers and bulldozer operators, in order to provide a more accurate basis for control of silicosis than 1–2 samples/yr.

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