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EVALUATION OF DUST CONTROL TECHNOLOGIES IN CONSTRUCTION TASKS

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Abstract:
Significantly elevated exposures to silica dust have been widely documented in construction activities, especially concrete cutting and grinding. Although application of water streams or spays to the cutting surface can substantially control exposures, many construction situations make the use of water infeasible. In order to evaluate the effectiveness of local exhaust ventilation (LEV) as an alternative approach to silica dust control in constructions, a series of three studies were done The study proceeded by first testing the effectiveness of LEV controls on four different types of tools in an experimental setting, then characterizing exposures occurring in eight common masonry activities in the field, and finally, considering the effectiveness of LEV on surface grinders used in field conditions.

In each study, measurements were made with and without the use of LEV, and personal respirable dust and silica exposures were measured during the activity. Measurements were obtained with an inline respirable dust cyclone and filter, and with a direct reading instrument (pDR) allowing for the quantification of peak levels, and adjustment of the data for task-specific time periods.

Very high silica concentrations were observed in field conditions. The overall geometric mean (GM) quartz concentration was 0.10 mg/m^3 (GSD=4.88) for all samples, with 71% exceeding the TLV. Activities with the highest (GM $\pm$ GSD) exposures were surface grinding (0.63 $\pm$ 4.12), tuckpoint grinding (0.22 $\pm$ 1.94), and concrete demolition (0.10 $\pm$ 2.60). In both controlled experimental conditions and field conditions, the use of LEV on several types of tools resulted in an over 90% reduction in dust concentrations. However, even after application of LEV, a significant portion of the dust concentrations exceeded relevant guidelines: 22% greater than the OSHA PEL, and 25% over the ACGIH TLV for respirable silica.

The results of these studies clearly show the large degree of effectiveness of LEV applied to typical masonry cutting and grinding tasks. However, some tools (e.g., hand held power ('Quickee' saw) were not controlled by LEV, and even with effective control, some exposures continue to exceed recommended levels of silica exposure. In these conditions, it remains important for workers to participate in effective respiratory protection programs.

Significant Findings: A series of three studies were done to address the effectiveness of local exhaust ventilation (LEV) on the control of silica dust exposures during various masonry grinding activities. The study proceeded by first testing the effectiveness of LEV controls on four different types of tools in an experimental setting, then characterizing exposures occurring in eight common masonry activities in the field, and finally, considering the effectiveness of LEV on surface grinders used in field conditions. Summary documents for each of the three studies are attached as appendices to this report.

The first study assessed the effectiveness of commercially available local exhaust ventilation (LEV) systems for controlling respirable dust and crystalline silica exposures during concrete cutting and grinding activities in controlled experimental conditions. Work activities were performed by union-sponsored apprentices and included tuck point grinding a brick wall (angle grinder), surface grinding a concrete wall (surface grinder), pave block and brick cutting (masonry saw) and concrete block cutting (hand-held saw). Three ventilation rates (0, 30 and 75 CFM) were tested for each tool. With the exception of the hand-held saw, the use of LEV resulted in a significant ($p<0.05$) reduction in respirable dust exposure. The mean exposure levels for the 75 CFM treatments were less than that of the 30 CFM treatments; however, differences between these two treatments were only significant for tuck point grinding ($p<0.1$) and paver block cutting ($p<0.01$). Although exposure reduction was significant (70 - 90% at the low ventilation rate and 80 - 95% reduction at the high ventilation rate), personal respirable quartz exposures remained very high (1.5 - 2.5 x PEL at the low ventilation rate and 0.5 to 1.5 x PEL at the high ventilation rate). Nonetheless, this dust control alternative would reduce the risk of workers developing disease, allow workers to use a lower level of respiratory protection, protect workers during short duration work episodes, potentially allow the effective use of administrative controls, reduce exposure to nearby workers and reduce clean-up associated dust exposures. Furthermore, the actual exposure levels during this study are not representative of the exposures that might occur in actual field conditions because of the experimental apparatus used.

The second study characterized respirable dust exposure under normal field conditions. Eight common construction tasks (clean up, demolition with hand-held tools, concrete cutting, concrete mixing, tuckpoint grinding, surface grinding, sacking and patching concrete, and concrete floor sanding) were evaluated for quartz and respirable dust exposure with 113 personal task period samples. Sampling methods included standard time-integrating filter samples in conjunction with direct-reading respirable dust monitors. The overall geometric mean (GM) quartz concentration was 0.10 mg/m^3 (GSD=4.88) for all samples, with 71% exceeding the TLV. Activities with the highest (GM $\pm$ GSD) exposures were surface grinding (0.63 $\pm$ 4.12), tuckpoint grinding (0.22 $\pm$ 1.94), and concrete demolition (0.10 $\pm$ 2.60).

Factors recorded each minute were task, tool, work area, respiratory protection and controls used, estimated cross draft, and whether anyone nearby was making dust. The factors important to exposure included tool used, work area configuration, controls employed, cross draft, and, in some cases, nearby dust. More protective respirators were employed as quartz concentration increased, although respiratory protection was found to be inadequate for 42% of exposures. Controls were employed for only 12% of samples. Exposures were reduced with three controls: box fan for surface grinding, box fan for floor sanding, and vacuum/shroud for surface grinding, with reductions of 57%, 50%, and 71% respectively, while exposures were higher for sweeping compound, box fan for clean up, ducted fan dilution, and wetted substrate. This study concluded that construction masons and laborers are frequently overexposed to silica. The most common method of protecting individuals from exposure, personal respirators, is not always adequate and engineering control use was infrequent and often ineffective.

Finally, we combined the attributes of the experimental and observational approach, and tested the effectiveness of LEV in field conditions. For this part of the study, we focused on the effectiveness of commercially available local exhaust ventilation (LEV) systems for controlling respirable dust and crystalline silica exposures during concrete grinding. Surface grinding was conducted at six commercial building construction sites by cement masons working on the selected sites. As in the second study, monitoring was done using standard time-integrating filter samples and direct reading respirable dust monitors. Personal exposure levels were determined with and without ventilation during the same task, one sample directly after the other, allowing for the direct comparison of the two control conditions. A total of 28 paired samples were collected in which three different dust collection shroud configurations were tested. The application of LEV resulted in the reduction of the overall geometric mean respirable dust exposure from 4.53 to 0.14 mg/m^3, an over 90% overall reduction. Despite the effective control of dust, 22.2 percent of the samples collected while ventilation was being used were greater than the OSHA permissible exposure limit.

Usefulness of findings

In combination, these three studies demonstrate the high degree of exposure to respirable crystalline silica during a variety of common masonry-related tasks in construction, and the high degree of effectiveness of local exhaust ventilation in both controlled experimental conditions, and in normal field working conditions. Despite the large degree of effectiveness of LEV, some exposure levels continue to pose a significant risk of silica-related lung disease. The reductions achieved by LEV, however, do significantly control the risk to the worker doing the task, make the use of half-face air purifying respirators adequate in most conditions, help control exposures to workers in the vicinity, and largely limit problems with accumulation of settled dust on site, and releases of dust to the ambient environment. However, some challenges remain concerning the cost and logistics of providing effective vacuum systems to masonry grinders, and maintaining the vacuums at a high level of effectiveness.

The results of this study can be used to recommend to contractors that when wet methods are infeasible, silica dust exposure can be substantially controlled by the use of local exhaust ventilation. The ventilation system must be run with sufficient duct velocity to avoid build-up of dust in the vacuum hose – in our tests, greater than 75 cfm through a 2 inch diameter hose. This high ventilation rate also reduces the frequency with which the hose must be cleaned. The findings also suggest that with the use of LEV, a properly configured respiratory protection program can be used to adequately protect workers from silica exposure. In many conditions, the combination of LEV and a half-face respirator can be used to achieve excellent protection. A brief guidance document for contractors and workers was developed to suggest these guidelines (attached in the appendix).

List of publications

Croteau GA, Guffey SE, Flanagan ME and Seixas NS. The effect of local exhaust ventilation controls on dust exposures during masonry activities. Am Indus Hyg Assoc J 63:458-467, 2002.

Croteau GA, Flanagan ME Camp J, Seixas NS. The effect of local exhaust ventilation controls on silica dust exposures on construction sites. manuscript in preparation, 2003.

Croteau GA. "The effect of local exhaust ventilation controls on dust exposures during masonry activities. MS thesis. University of Washington, Seattle, WA 2000.

Flanagan ME, Seixas NS, Majar M, Camp J, Morgan M. Silica dust exposures during selected construction activities. Accepted: Am Ind Hyg Assoc J. June, 2003.

Majar MK. Respirable dust and silica exposure during construction activities. MS Thesis, University of Washington, Seattle, WA, 2001.

Relationship of findings to specific aims

Specific Aim 1: Identify a set of 6-12 tools or activities used in masonry and concrete-related trades that high the potential for generating significant silica dust exposures and that control techniques are commercially available.

We identified eight common construction tasks (clean up, demolition with hand-held tools, concrete cutting, concrete mixing, tuckpoint grinding, surface grinding, sacking and patching concrete, and concrete floor sanding) used in our assessment of exposures in the field. These activities were identified through a focus group meeting with local contractor safety directors and evaluated as part of the second study (Majar, 2001; Flanagan, et al, 2003). These activities were narrowed down to four representative tools (tuck point (angle) grinder, surface grinder, masonry saw and hand-held (Quickee) saw) for detailed evaluation under controlled conditions in the first study (Croteau, 2000; Croteau et al, 2002). Finally, three different LEV configurations were evaluated on the most common dust generating tool/task, surface grinding, in the third study (Croteau, et al, 2003).

Specific Aim 2: Conduct a series of semi-controlled experiments to measure the effectiveness of these control techniques. The experiments will be developed at the training facilities of the Western Washington Cement Masons Training Institute and

International Masonry Institute. Experiments will test differences in exposure levels produced by the application of available controls while keeping experimental conditions constant.

This aim was primarily addressed in the first study (Croteau, 2000; Croteau et al, 2002). Additional testing of the effectiveness of LEV were conducted in the second study through multivariate modeling (Majar, 2001; Flanagan, et al, 2003), and by specifically testing the use of LEV configurations in field conditions in the third study (Croteau, et al., 2003).

Specific Aim 3: Test the effectiveness of the same tool/control combinations during application in 'real world' construction site conditions to evaluate how non-ideal conditions affect performance, to measure degradation of performance over time, and to assess worker and management acceptance and perception of the effectiveness of these control techniques.

Testing of the effectiveness of LEV under normal construction site conditions was conducted in the second study through multivariate modeling (Majar, 2001; Flanagan, et al, 2003), and by specifically testing the use of LEV configurations in field conditions in the third study (Croteau, et al., 2003).

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APPENDICES

I. Project 1 Summary: The effect of local exhaust ventilation controls on dust exposures during masonry activities

II. Silica dust exposures during common construction tasks

III. The efficacy of local exhaust ventilation for controlling dust exposures during concrete surface grinding in the field.

IV. Brochure. "Silica Exposures: What Workers Need to Know"

Project 1
EXECUTIVE SUMMARY

The Effect of Local Exhaust Ventilation Controls on Dust Exposures During Masonry Activities

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Background

Respirable Crystalline Silica Exposures in Construction

Exposures to crystalline silica can occur during construction activities in which dust is generated during the cutting, grinding or drilling of concrete, brick, stone and similar building materials. This occupational exposure can result in silicosis, a debilitating lung disease. Silica has also recently been classified as a Type 1 carcinogen. Effective treatments for silicosis are non-existent, placing a high priority and importance on prevention through the reduction and elimination of respirable crystalline silica exposure.

Exposure assessment and regulatory monitoring results indicate crystalline silica exposure levels for a large number of construction workers are very high. Using OSHA inspection data, it has been estimated that 2.6 percent of masonry workers, 2.1 percent of heavy construction workers, and 1.3 percent of nonresidential construction workers (36,000 workers total) are exposed to at least twice the NIOSH recommended exposure limit (REL = 0.05 mg/m^3) for crystalline silica. In addition, several epidemiology studies have shown an increased prevalence and incidence of silicosis among construction workers.

Current Occupational Exposure Limits

The U.S. Occupational Safety and Health Administration (OSHA) 8-hour Time Weighted Average Permissible Exposure Limit (TWA-PEL) for crystalline silica is based on the following equation.

$$\text{OSHA PEL} = 10\ \text{mg/m}^3/(\%\ \text{respirable quartz} + 2)$$

A more stringent 8-hour TWA of 0.05 mg/m^3 has been adopted as a threshold limit value by the American Conference of Governmental Industrial Hygienists and as an REL by NIOSH.

Research Needs and Study Objective

Given the constraints and limited effectiveness of administrative, process and PPE controls, engineering controls provide the best means of reducing crystalline silica exposures. Despite the commercial availability of local exhaust ventilation (LEV) systems for selected masonry tools, few studies have evaluated their effectiveness. The primary objective of this study was to assess the effectiveness of four tools equipped with commercially available LEV systems for reducing respirable dust and crystalline silica exposure.

Methods

Dust control evaluations were conducted at the training site of the local brick and cement masons union apprenticeship programs. All tools were evaluated in a vinyl tent, which reduced the effects of wind and rain while preventing dust exposure to nearby personnel (Figure 1).

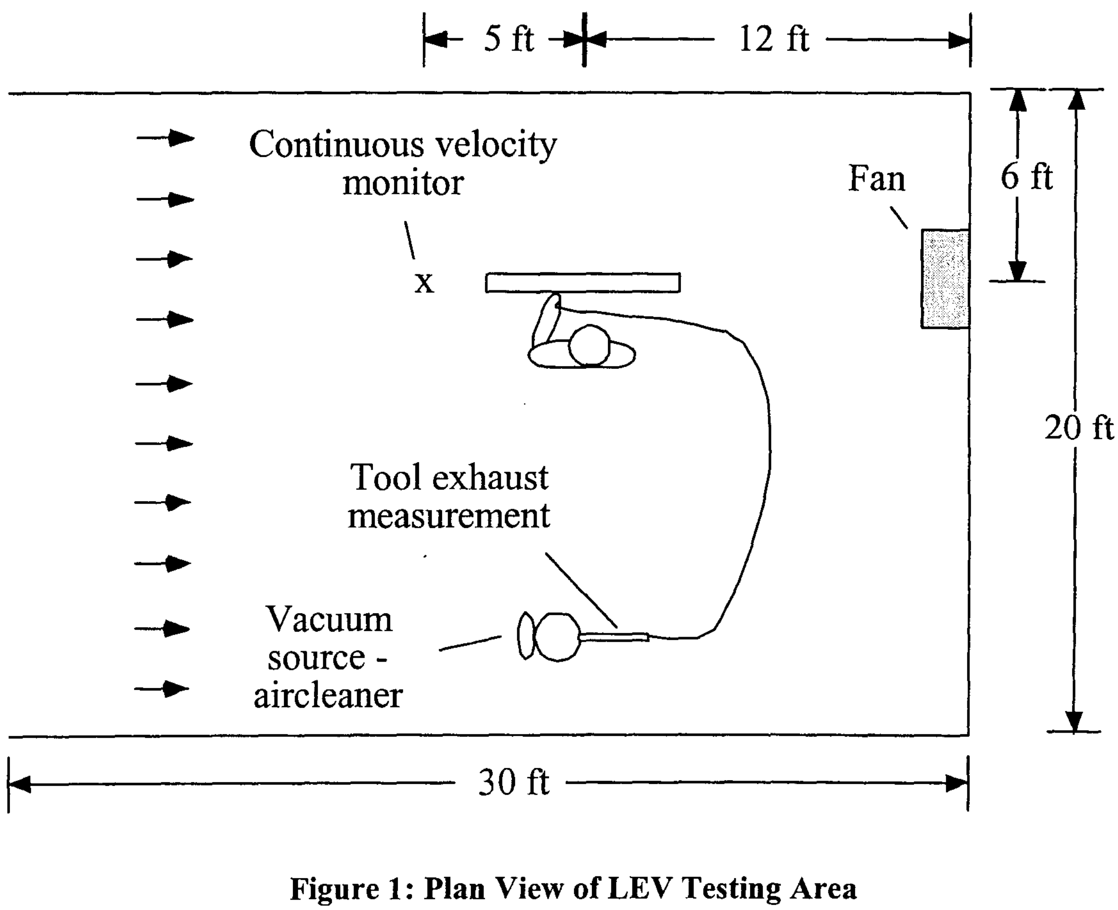


Figure 1: Plan View of LEV Testing Area

Ventilation through the tent was provided by a fan placed in a ground level opening. The study assessed three levels of exhaust ventilation (0, 30 and 70 cubic feet per minute [cfm] of airflow) provided to each tool's LEV system. Each subject used a single tool over the course of a day. Each of the three ventilation treatments was replicated three times in random order for a total of nine 15 minute work sessions per study subject. An industrial vacuum equipped with a cyclone and HEPA filter was used to provide ventilation airflow for the tools evaluated.

Dust control effectiveness was assessed by collecting personal and "downstream" respirable dust samples during each work session. Collected samples were analyzed to determine the respirable dust mass and crystalline silica concentration. Statistical analyses were conducted to assess the effectiveness of LEV for reducing respirable dust and crystalline silica exposures. The four tools selected for evaluation and the construction materials used for testing them are described as follows. Pictures of the tools evaluated are presented in Appendix A.

Angle Grinder

The hand-held, electric powered angle grinder is commonly used in a restorative function to remove worn and dilapidated mortar in walls constructed of bricks, blocks, stones or similar building materials. To complete the restoration process, new mortar is placed in the resulting groove in a process called "tuck pointing". The angle grinder was equipped with a shroud that covered most of the grinding blade, with the portion protruding being equivalent to the grinding depth. Tuck point grinding was performed on portable brick walls.

Surface Grinder

This hand-held electric powered tool is used to produce a smooth finish on poured concrete surfaces. The surface grinder shroud covered the grinding cup completely, allowing for a seal between the working surface and the shroud. Surface grinding was performed on concrete walls. Apprentices were instructed to work for 11.5 minutes on the wall, one minute on the four inch wide horizontal top section, two minutes putting a 45° chamfer on a vertical side edge, and 0.5 minutes putting a 45° chamfer on a horizontal edge. The latter three exercises were included to mimic real working situations in which there is no seal between the shroud and working surface, and dust capture is compromised.

Masonry Saw

The gasoline powered masonry saw was specifically designed for cutting paver blocks -- 5 – 10 cm thick blocks used in the construction of walkways, patios, and other similar surfaces.

Cuts are made by pushing the object on a sliding tray into a fixed blade. The saw's LEV system consists of a 2.5 cm (1 inch) square tube running the length of the saw immediately below the blade. Exhaust ventilation is connected to the open end of the tube, located at the rear of the saw, and dust is captured through a slot in the tube near the point of contact between the blade and material being cut.

Hand-held Saw

The gasoline powered hand-held saw's configuration and operation is similar to that of a chain saw, with the engine and controls located near the operator. This tool has numerous applications in the construction industry due to its high power, portability and ability to cut a variety of different materials. Dust control for the hand-held saw was facilitated by a port near the back end of the guard to which the exhaust ventilation was connected. Concrete blocks (C-90) were used to assess the effectiveness of the hand-held saw's LEV system.

Results

Personal respirable dust measurements were used to assess the efficacy of the LEV systems (Table 1). The LEV system for the hand held saw was not effective, as the personal respirable dust exposures for the high ventilation rate and no ventilation were similar. However, the other three LEV equipped tools significantly reduced personal respirable dust exposure for both the low and high ventilation rates tested as compared to the no ventilation treatment (Table 1).

Table 1. Geometric Mean Personal Respirable Dust and Quartz Exposure Levels (mg/m^3)

Work Activity	No Ventilation		Low Ventilation		High Ventilation	
	Dust	Quartz	Dust	Quartz	Dust	Quartz
Tuck point grinding (k = 5)	22.2 (n = 14)	3.0	6.1^{A} (n = 14)	1.0	3.0^{B} (n = 13)	0.5
Surface grinding (k = 2)	165.3 (n = 5)	29.2	11.2^{A} (n = 6)	2.4	8.0^{B} (n = 5)	1.7
Paver block cutting^{F} (k = 2)	89.9 (n = 6)	22.5	13.1^{A} (n = 6)	3.3	4.3^{BC} (n = 6)	1.0
Brick cutting^{F} (k = 1)	26.7 (n = 3)	4.2	7.3^{A} (n = 3)	1.0	3.7^{B} (n = 3)	0.6
Block cutting^{G} (k = 1)	2.4 (n = 3)				2.4 (n = 3)	

^{A}Comparison (t-test) of low ventilation to no ventilation, $p<0.05$
^{B}Comparison (t-test) of high ventilation to no ventilation, $p<0.05$
^{C}Comparison (t-test) of low and high ventilation rates, $p<0.05$
^{F}Masonry saw, ^{G}Hand-held saw, k = number of study subjects

The effectiveness of LEV in reducing personal dust exposure levels for the tuck point grinding, surface grinding and paver block and brick cutting work activities is demonstrated in Figure 2. Despite the very large reduction in respirable dust exposures (70 - 90% reduction at the low ventilation rate and 80 - 95% at the high ventilation rate), personal respirable dust exposures remained very high: 1.5 - 2.5 times the PEL at the low ventilation rate and 0.5 - 1.5 times the PEL at the high ventilation rate (Figure 3). LEV at the high ventilation rate reduced average respirable dust exposure levels to just below the PEL for tuck point grinding and paver block and brick cutting. Figure 4 shows these same data in comparison with the respirable crystalline silica PEL. The application of LEV reduced exposures considerably; however, even at the high ventilation rate, the respirable quartz PEL was exceeded by a factor of 5 to 20 for all tools. Note that this comparison of the study results to the OSHA 8 hour TWA-PEL assumes the concentrations observed during the 15 minute work sessions would be maintained for an eight hour work shift.

Discussion

The use of LEV reduced occupational dust exposures for all tools evaluated, with the exception of the hand-held saw. Despite the large reduction in personal dust exposure levels, some respirable dust exposures and all respirable quartz exposures exceeded the OSHA 8 hour TWA-PEL by more than an order of magnitude, even at the highest ventilation rate tested. Although the LEV systems evaluated did not reduce crystalline silica exposures below the PEL, this dust control alternative decreases the risk of workers developing disease by reducing exposures. The large exposure reduction could allow a worker to use a less expensive and more readily available mode of personal respiratory protection, such as a half face air purifying respirator, instead of a supplied air or powered air purifying respirator. In addition, exposures to nearby workers would be considerably reduced. Finally, dust exposures resulting from clean-up activities would be reduced substantially.

Increasing the ventilation rate from 30 to 75 cfm improved dust capture and reduced personal exposure levels. A comparison of the low and high ventilation rate treatments indicated a significant ($p<0.05$) reduction in respirable dust exposure for the paver block cutting work activity and a non-significant decrease in personal exposure for tuck point grinding and surface

Figure 2: Respirable Dust Exposure Reduction as Compared to Control

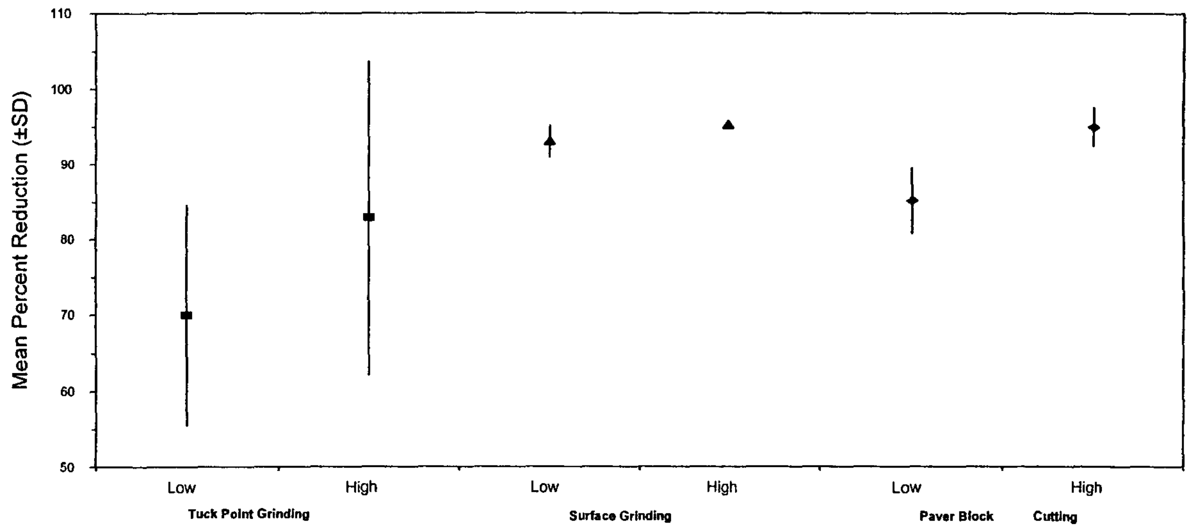


Figure 3: Comparison of Respirable Dust Exposures to OSHA 8 hr TWA-PEL

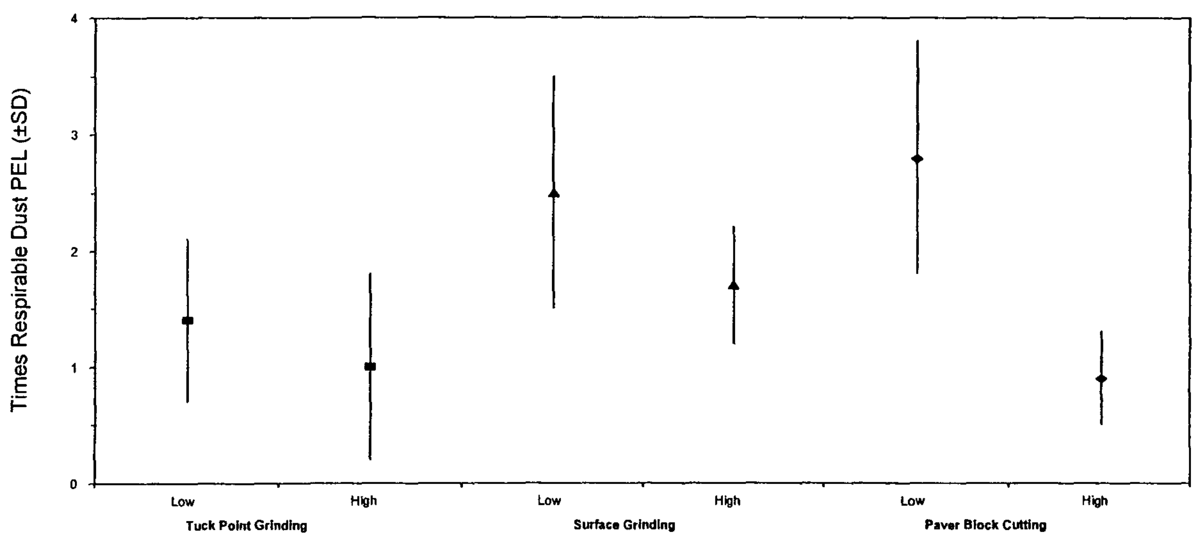
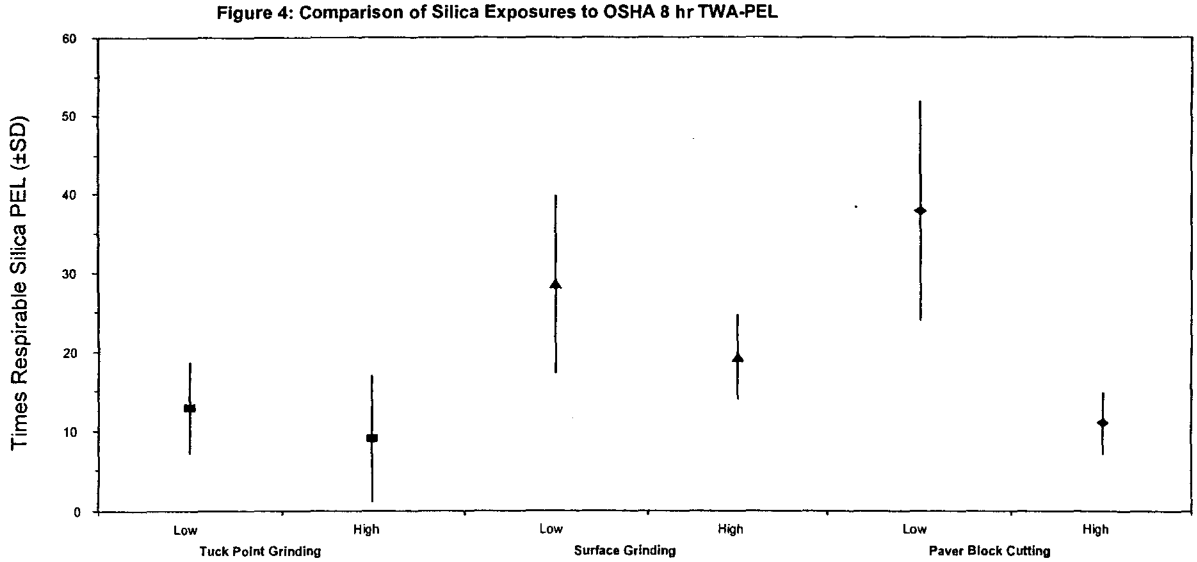


Figure 4: Comparison of Silica Exposures to OSHA 8 hr TWA-PEL



grinding. Compared to the low ventilation rate, the high ventilation rate reduced respirable dust exposures by about an additional ten percent.

The rate of dust settling in the ventilation conveyance system is another factor that needs to be considered in the determination of a minimal ventilation rate. Observations made during the study suggest that dust would need to be cleared from the system every 30 minutes when operated at the low ventilation rate, as opposed to only twice a day at the high ventilation rate. For industrial ventilation systems, a minimum transport velocity of 3,500 to 4,000 feet/min is recommended by the American Congress of Governmental Industrial Hygienists in order to limit the settling of concrete dust in the conveyance system. Based on this recommended dust conveyance velocity, 30 cfm (1,375 feet/min) is inadequate and a ventilation rate of 75 cfm (3,440 feet/min) should be considered the minimum ventilation rate for the system tested (assuming a 2 inch hose is used).

During the study, the performance of the tools, LEV systems and vacuum source was assessed through observations and comments solicited from the study subjects. Both the hand-held saw and masonry saw performed their intended tasks as expected and no comments were made regarding their performance. However, study subjects indicated that the angle and surface grinder shrouds completely obstructed their view of the working surface and the vacuum line restricted their mobility. Another operational issue of note regarding the angle grinder was the build-up of dust within the shroud resulting from the small 1 inch diameter exhaust port and the 90° bend in the exhaust port take-off. Industrial vacuum performance was contingent on maintaining the filter. As the filter became loaded with dust and static pressure increased, there was a corresponding decrease in ventilation rate. In addition to periodic use of the reverse flow cleaning system, the filter had to be removed and cleaned manually in order to achieve the high ventilation rate of 75 cfm. The filter also needed to be replaced after approximately 50 hours of use.

Conclusions

This study demonstrated that LEV can substantially reduce respirable dust and crystalline silica exposures during concrete cutting and grinding activities in a controlled field setting. Due to the variable conditions encountered at construction sites, further research is needed to address LEV effectiveness under actual field conditions. Successful implementation of this engineering control in the field will require diligence on the part of the operator to ensure an adequate tool ventilation rate is provided and that the LEV system is operating as intended. To this end, manufacturers of industrial vacuums and LEV systems need to provide operating and maintenance guidelines. Manufacturers should also engage in product testing to provide the user with information regarding exposure reduction potential and minimum tool ventilation rates. This testing would best be conducted using a standard procedure, the basis for which is provided in this study.

Acknowledgements

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Project 2
EXECUTIVE SUMMARY

Silica Dust Exposures during Common Construction Tasks

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Introduction

Silica exposure is a primary hazard for the construction industry but it has not been well characterized due to factors including frequent turnover of personnel, and continually changing workplaces, tasks, and environmental conditions.

Silica exposure has been associated with excess disease for construction populations. Silicosis, tuberculosis (known to be more prevalent among silicotics), and lung cancer are all elevated in studies of construction populations. Reduced lung function has been reported with exposure to low levels of concrete dust containing silica.

Highly elevated quartz exposures have been reported for several construction activities although levels appear to be conflicting from one study to the next. For most activities the sample size is small or focusing on only one or two activities. Some studies measured short term and/or concentrated dust-producing activities while other studies sampled full shift or when the target activity was only one of several activities occurring during the sampling period. A range of environmental conditions and process differences could also contribute to variability seen in previous studies.

The purpose of this study was to provide a more comprehensive evaluation of exposure to silica during common dust-producing construction activities, to identify factors that are important in affecting exposure levels, and to characterize exposure for non-continuous tasks.

Methods

Quartz and respirable dust exposures were measured using two types of sampling devices to characterize eight silica dust-producing construction activities.

After consultation with a group of construction contractor safety directors, a list of eight activities common to many large construction projects was selected, based on frequency of occurrence and expected level of dust produced. These activities included clean up, demolition using hand tools, concrete cutting with hand-held or table mount saws, concrete and mortar mixing, tuck point grinding, surface grinding, sacking and patching concrete, and concrete floor sanding.

Sampling occurred for 42 on-site days at nine large construction sites representing six contractors. Site days were selected primarily at the convenience of researchers, usually without advance knowledge of that day's scheduled construction activities. Volunteer subjects were recruited at the start of the shift by a referral from the foreman or during the shift, as workers were observed conducting target tasks.

Sample and Data Collection. Sampling was conducted for the entire period a worker was engaged in the target task or doing activities to support additional target task work. At times, there were large time gaps between target task occurrences when set up, clean up, or other activities were completed in support of the target task.

Two types of sampling devices employed to monitor target activities included a nylon cyclone to measure average concentrations and a personal pDR dust monitor to assess peak exposures as well as run time averages.

A subject was fitted with either a nylon cyclone or a pDR sampling device. Subjects monitored with a nylon cyclone were asked to record their activities on a task card that delineated task, tool, respiratory protection used, work area (enclosed, inside, partially enclosed, or outside), whether anyone nearby was making dust (Y/N). Subjects monitored with a pDR were observed by a researcher who recorded the following variables for each minute: task, tool, work area, respiratory protection used, controls employed, estimated cross draft and whether anyone nearby was making dust.

Work area was categorized as outside, partially enclosed (not all walls and windows in place), inside, or enclosed. Examples of enclosed areas are stairwells and confined plastic enclosures. Respirators encountered included dust masks and half-face cartridge respirators. At some sites respirator protection was mandated by management during dusty operations, while it was a matter of worker choice at other sites. The control strategies employed varied among sites, with some sites having a much greater emphasis on controls for dust reduction than other sites. Cross draft was estimated (none, low, medium, high) using prior researcher experience and observation of visible dust as a guide.

Sample Analysis. Respirable dust samples were analyzed following NIOSH method 600. The laboratory's limit of detection was 0.005 mg. Quartz analysis followed NIOSH method 7602. The quartz limit of detection was 5.5ug.

Activities Monitored

Clean up

Demolition with hand-held tools

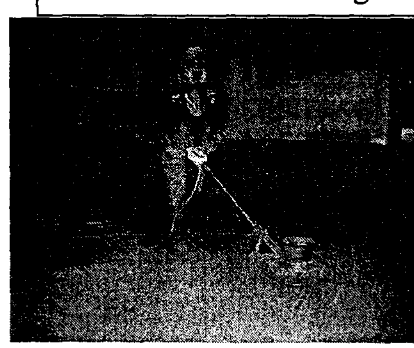
Mortar and cement mixing

Surface grinding

Tuckpoint grinding

Concrete saw cutting

Sacking and patching



Concrete floor sanding

Findings

Run Time Averages. Respirable dust and quartz run time average concentrations are presented in Table 1. There were 113 samples collected, representing eight activities and one "mixed" activity category with a mean sample duration of 202 minutes (SD=97). The highest exposures were to surface grinding and tuckpoint grinding and the lowest exposures were to clean up, and sacking/patching concrete. Mixed samples may be elevated due to amount of surface grinding represented in these samples. Although concentrations for respirable dust were substantially less than the ACGIH TLV of 3.0 mg/m^3, 34% of the sample distribution exceeded the respirable dust TLV.

Quartz exceeded the TLV 75% of the time. For five of the eight activities, over half the sample distribution exceeded the quartz TLV. Mean quartz percent ranged from 2.2 to 21.0% depending on activity. Cyclone and pDR samplers reported similar results with the GM (GSD) respirable dust concentrations being 1.32 (4.25) for cyclones and 1.12 (3.38) for pDRs.

Table 1: Respirable Dust and Quartz Averages (mg/m^3)

Usual Trade	*Activity*	*n*	*Respirable Dust*		*Quartz*	
			GM (GSD)	*%ExceedingTLV*	*GM (GSD)*	*% ExceedingTLV*
Laborer	Clean up	11	0.55 (1.82)	5	0.03 (2.79)	50
Laborer	Hand demolition	14	0.96 (2.18)	21	0.10 (2.60)	88
Brick Mason	Concrete cutting	15	0.76 (2.14)	14	0.07 (2.78)	77
Brick Mason	Concrete mixing	9	0.91 (1.70)	13	0.02 (1.99)	20
Brick Mason	Tuck point grinding	12	2.25 (2.10)	54	0.22 (1.94)	100
Cement Finisher	Surface grinding	23	6.17 (3.16)	84	0.63 (4.12)	100
Cement Finisher	Sack and patch concrete	13	0.40 (2.01)	3	0.03 (2.22)	40
Cement Finisher	Concrete floor sanding	9	0.63 (1.73)	7	0.07 (2.62)	80
Cement Finisher	Mixed	7	2.66 (5.47)	72	0.22 (3.93)	97
Total		113	1.25 (3.95)	34	0.11 (5.21)	75

TLV = 0.05 mg/m^3

Respiratory protection use was assessed with quartz data since respirator decisions would normally be based on quartz exposure.

- As quartz exposure increased, greater respiratory protection was employed, with concentrations of 0.03, 0.12, and 0.21 mg/m3 respectively for no respirator, dust mask, and cartridge respirator (Table 2).
- For higher exposure activities (tuckpoint grinding and surface grinding) respirators were always used, with a preference for cartridge respirators.
- Laborers and brick masons tended to favor no respirators or dust masks, while cartridge respirators were more common among cement finishers.
- Concentrations exceeded the protection factor of the respirator approximately half of the time.

Table 2: Quartz Runtime Concentrations by Activity and Respirator Use (mg/m^3)

Activity	*No Respirator*			*Dust Mask*			*Half Mask Cartridge*		
	N	GM(GSD)	Exceed PF - %	N	GM(GSD)	Exceed PF - %	N	GM(GSD)	Exceed PF - %
Clean up	9	0.03(2.14)	57	1	0.04(-)	*	1	0.01(-)	*
Hand demolition	3	0.07(3.07)	90	6	0.07(2.40)	35	5	0.19(2.27)	65
Concrete cutting	10	0.05(2.19)	72	4	0.09(3.74)	59	1	0.39(-)	*
Concrete mixing	6	0.01(1.80)	17	3	0.02(2.18)	32	0	-	-
Tuckpoint grinding	0	-	-	3	0.30(2.49)	87	9	0.20(1.81)	61
Surface grinding	0	-	-	7	0.48(7.45)	95	16	0.70(3.10)	92
Sack and patch	4	0.03(1.78)	54	4	0.03(1.54)	5	5	0.02(3.39)	29
Floor sand concrete	1	0.06(-)	*	2	0.10(1.11)	<43	6	0.06(3.24)	40
Mixed activities	1	0.03(-)	*	5	0.26(3.32)	78	1	0.69(-)	*
Total	34	0.03(2.50)	46	35	0.12(4.67)	43	44	0.20(5.00)	57

* Not enough information to calculate this

PF – protection factor of respirator; no respirator PF=1; dust mask and half mask cartridge PF=5

Surface grinding was the activity with the highest exposures (Table 1). Two grinder diameter sizes and two grinder wheel styles were monitored in this study. Surface grinders come in two common diameters: 4.5-inch and 7-inch. Quartz exposures for the 4.5-inch grinders were 67% of exposures for 7-inch grinders.
The two grinder wheel styles observed were abrasive, used for fine finishing, and diamond, used for rougher, more aggressive grinding. Quartz exposures for abrasive wheels were only 40% of exposures for diamond wheels.

One-minute Averages. The one-minute average data set offers the opportunity to look at exposures during only the target task or during the full sample period, including non-target task activity. There were 39 sampling sessions conducted to collect 6,365 minutes of data with a respirable dust geometric mean of 0.66 mg/m^3 (GSD=3.07).

- The highest levels: **tuckpoint grinding** and **surface grinding**
- The lowest levels: sacking/patching and floor sanding
- Activities with least interruptions: tuckpoint grinding, clean up, demolition
- Activities with most interruptions: concrete mixing, concrete cutting, floor sanding
- For clean up, tool producing highest exposure– the **backpack blower**
- For demolition, the **rivet buster and sledgehammer** produced the highest exposures
- For concrete cutting the **hand-held and table saws** were higher than the slab saw with water control.

Several measures to control dust levels were observed during sampling for the one-minute data set including using sweeping compound, a box fan to create a cross draft, a fan with ducting to the outside to ventilate an interior space, local exhaust ventilation (LEV) on a power tool, and wetting a surface prior to grinding. A task without controls was compared to the same task with controls in the same type of work area. The box fan appeared to reduce exposure during surface grinding and floor sanding inside, while higher exposures were observed using the box fan for clean up activities. LEV reduced exposures for surface grinding while sweeping compound, ducted fan dilution, and the wetted substrate were associated with higher exposures, compared to the same activity without the control applied.

Discussion

Using traditional respirable sampling techniques, elevated quartz exposures were documented for most activities for the period sampled. Through the use of data logging monitors, non-continuous tasks could be evaluated both for the task exposure and the larger period containing non-target tasks. It also offered the ability to characterize the portion of time a target task occurred for specific activities.

The percentage of time spent performing the target task varied among activities, from 11% for hod carriers doing concrete mixing to 69% for restoration masons doing tuckpoint grinding. Some activities with relatively low concentrations, such as concrete cutting and mixing (0.88 and 0.57 mg/m^3 respectively), had task specific concentrations that were two times higher (1.71 and 1.19 mg/m^3 respectively). If a job required continuous cutting or mixing, exposures could be considerably higher than suggested by the activity concentration.

Quartz concentrations reported in this study were in general agreement with concentrations found in other U.S. construction studies but were lower than those found in European studies. Some of this difference may be due to differences in methods used.

There were several limitations in our methods. Since sampling was not full-shift, comparison to any full-shift standard may over estimate standard exceedances. It was assumed that respirators, when used, were used continually over the course of the sampling period. Respirators may sometimes have been used intermittently, producing an overestimation of respiratory protection. On the other hand, it was assumed that respirators all fit properly. Respirator fit was probably variable, particularly for dust masks, which are notoriously difficult to achieve a good fit. When respirators do not fit well, protection would be underestimated. The comparison of dust exposure with and without control strategies in a variety of circumstances is a crude comparison method. Exposures, which warrant control application, may initially be more elevated than exposures where control treatments were not employed.

For surface grinding, both grinder diameter and grinder wheel type were important exposure factors. The choice of grinder size and wheel could be part of a plan to limit quartz exposure especially when the space is enclosed or other workers are positioned near grinding operations.

Since protection was inadequate with use of respiratory protection nearly half of the time and higher levels of respiratory protection involve respirators that are more expensive and require greater maintenance (powered air-purifying or supplied air) the argument for greater use of engineering controls is bolstered.

Conclusions

Quartz exposure was elevated in some cases for all eight activities with grinding and demolition producing the highest exposures. Some activities with high but infrequent exposure (saw cutting and cement mixing) had relatively low runtime averages but could produce high time-weighted average exposures if the task occurred for a large portion of the shift. Controls employed sometimes reduced exposures, but this study design could not assess their effectiveness. The degree of enclosure for the work area was an important predictor of exposure. For surface grinding the wheel size and type effected exposure. Respiratory protection was inadequate for protecting from quartz exposure approximately half of the time.

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Project 3
EXECUTIVE SUMMARY

The Efficacy of Local Exhaust Ventilation for Controlling Dust Exposures During Concrete Surface Grinding in the Field

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BACKGROUND

Engineering controls such as water spray and local exhaust ventilation (LEV) have considerable potential for reducing silica dust exposures at construction sites. For some construction activities, such as concrete grinding, the use of water spray for controlling silica dust exposures is not practical, as the use of water spray can result in material discoloration and expansion, building damage, and wastewater disposal problems. Other factors that favor the use of LEV during surface grinding are the high dust exposures that result from this activity and its prevalence at construction sites. Furthermore, site observations and conversations with construction industry professionals, suggest that the surface grinding of concrete surfaces is common to most commercial structures that use concrete as a building material.

Although LEV systems for surface grinders and other dust generating tools are commercially available, there have been very few studies in which their effectiveness has been evaluated. In a previous study conducted under controlled field conditions, by this research team, the use of LEV resulted in a 95 percent reduction in respirable dust exposures during surface grinding. In spite of the high reduction in dust exposure, respirable crystalline silica exposure levels were still 34 times the American Conference of Governmental Hygienists Threshold Limit Value. However, the researchers also suggested that the level of exposure reduction observed in the field study would likely be achieved under actual field conditions.

A controlled field study environment is very desirable for assessing LEV effectiveness as conditions continually change at construction sites. Changes in wind speed and direction, non-work task time during monitoring, other dust sources, level of enclosure and type of surface being prepared among other conditions, all can have a substantial effect on personal dust exposures, which compromises the ability to accurately assess the efficacy of LEV. However, testing the LEV system under actual field conditions is also essential and can be looked at as second tier in the testing process. Therefore, the primary objective of this study was to assess the efficacy of LEV for controlling dust exposures during surface grinding under actual field conditions.

Methods

Dust control evaluations were conducted from February 2001 to July 2002 at six large construction sites in Seattle, WA. All of the construction sites, each of which was managed by a different prime contractor, were commercial building projects and were covered, but not completely enclosed. Most surface preparation work was focused on vertical walls, with some ceiling grinding at one site and some vertical column grinding at another. The study utilized a paired samples design, in which dust exposures for a given study subject were determined, in sequence, with and without local exhaust ventilation for a sampling duration of approximately 20 to 40 minutes. The collection of paired samples, over a relatively short timeframe, minimizes the effect of variable conditions, such as wind, type of concrete, degree of enclosure, and the surface preparation objective.

A Flex LD 1509 FR and Metabo WE 9-125 Quick hand-held, electric powered flat grinders, equipped with abrasive grinding wheels, were used in this study. Both surface grinders were equipped with shrouds that covered the grinding wheel completely, allowing for a seal between the working surface and the shroud. The Flex grinder was equipped with a shroud that was manufactured by Flex and constructed of rubber. The Metabo grinder was equipped with a Sawtec (Costa Mesa, CA) shroud, which is constructed of polyurethane. In addition to having a smaller diameter than the Flex shroud, the Sawtec shroud is more flexible than the Flex shroud. Consequently, the Flex shroud is referred to as the "Rigid Shroud" and the Sawtec shroud is referred to as the "Flexible Shroud" from here on. A third tool/shroud configuration, which entailed cutting the tip of a Flexible (Sawtec) Shroud on a Metabo grinder, was also assessed and is referred to as the Cut Shroud. This modification allows the tip of the grinding wheel to access corners and inside edges, which otherwise is not possible, as the shroud encloses the grinding wheel. For the "no ventilation treatment", workers were provided with a second grinder, identical to the grinder used for the "ventilation treatment, except it was not equipped with a ventilation shroud, but was equipped with a safety guard. An industrial vacuum equipped with a cyclone and filter was used to provide ventilation airflow for the tools evaluated.

Dust control effectiveness was assessed by determining personal exposure levels to respirable dust during surface grinding with and without the use of local exhaust ventilation. Both real time and gravimetric respirable dust exposure levels were determined with a light scattering photometer fitted with a BGI cyclone pre-selector (Waltham, MA) and PVC filter. The filter samples were used to describe actual exposure levels to respirable dust and crystalline silica, assess regulatory compliance and compare conditions between work sites. The pDR data, after limiting to those minutes in which grinding work was actually being performed, were used to evaluate the effectiveness of the LEV controls.

All work sessions were observed by a researcher who recorded the following variables on a one minute basis: whether the worker was actively engaged in the work task (surface grinding) or not, if the working surface was an edge or flat surface, the presence of other dust sources, and the observed orientation of the wind to the worker. It was anticipated that the actual task time spent surface grinding during a work session could change appreciably between different work sessions. Consequently, to provide a better estimate of dust exposure during the actual surface grinding work task, exposure levels were determined, using one minute pDR data, during periods when the worker was actively engaged in the surface grinding work task. The resulting exposure metric is referred to as the "task pDR exposure level" as opposed to the "total pDR exposure level"

The respirable dust mass of all samples collected was determined gravimetrically using NIOSH Method 0600 (NIOSH, 1994). After the dust mass was determined, individual filters were placed in a crucible, ashed and subsequently analyzed for quartz and cristobalite by infrared spectrometry using NIOSH Method 7602 (NIOSH, 1994). Exposure reduction was based on a comparison of the task pDR exposure levels for each pair of matched samples, which were collected with and without local exhaust ventilation (Equation 1):

$$\% \text{ Reduction} = [(C_{nv} - C_v)/C_{nv}] * 100 \quad \textbf{(1)}$$

Where C_{nv} and C_v are the task pDR exposure levels, as determined with the pDR, for a matched sample pair, under the no ventilation treatment and ventilation treatments, respectively.

RESULTS

A total of 28 paired personal air monitoring samples were collected at six different construction sites, over 11 monitoring days, using nine different study subjects. A total of nine paired samples were collected in which the Rigid Shroud was being used, with 8 and 11 paired samples being collected while the Flexible and Cut Shrouds were being used, respectively. The overall mean (±SD) ventilation rate of 69.6 (±3.6) did not vary considerably from the target ventilation rate of 70 CFM. The percent quartz content of each of the five different materials used ranged from 3.1 to 9.8 %.

Personal respirable dust (gravimetric) and crystalline silica measurements were used to assess exposure levels and were compared to the ACGIH TLV of 0.05 mg/m^3. The overall geometric mean respirable dust exposure without ventilation was 4.53 mg/m^3 compared to an overall geometric mean of 0.14 mg/m^3 with ventilation (Table 1). Similar results were observed with respect to respirable crystalline silica where the exposure was reduced from 0.250 mg/m^3 to 0.034 mg/m^3 with the introduction of local exhaust ventilation (Table 2).

Without ventilation, the overall geometric mean respirable dust exposure level was 0.91 times the OSHA PEL (5 mg/m^3) and 1.51 times the ACGIH 8-hour time weighted average TLV of 3 mg/m^3 (Table 3). With ventilation the respirable dust exposure level declined to 0.03 and 0.05 times the OSHA PEL and ACGIH TLV. Similar results were observed with respect to respirable crystalline silica exposures. Without ventilation the mean respirable crystalline exposure levels were 3.4 and 5.0 times the OSHA PEL and ACGIH TLV (0.05 mg/m^3), respectively. In contrast, the respirable crystalline silica exposure levels with ventilation were 0.37 and 0.68 times the OSHA PEL and ACGIH TLV, respectively.

For respirable dust exposure levels determined during the no ventilation treatment, 29.6 percent of the samples (n=27) exceeded the OSHA PEL and 70.4 percent exceeded the ACGIH TLV, whereas, none of the with ventilation treatment samples exceeded the OSHA PEL or ACGIH TLV (Table 3). With respect to respirable crystalline silica exposures, 85.2 percent of the samples exceeded both the OSHA PEL and the ACGIH TLV. With ventilation, 22.2 percent of the samples exceeded the OSHA PEL and 25.9 percent of the samples exceeded the ACGIH TLV for respirable crystalline silica.

Light scattering photometer data were used to assess the efficacy of local exhaust ventilation as a method for controlling dust exposures. To provide for a better estimate of a workers respirable dust exposure during the actual work task, a metric referred to as a "task pDR exposure level", was calculated by excluding all non-work task dust exposures. The resulting task pDR exposure level data were used to determine exposure reduction resulting from the use of LEV. The overall geometric mean (±SD) task pDR exposure level without ventilation was 5.46 (±2.10) mg/m^3 and 0.14 mg/m^3 (±10.5) with ventilation. Based on an arithmetic mean of the exposure reduction determined for each paired sample (Equation 1), the use of LEV resulted in an overall mean exposure reduction of 92 percent.

DISCUSSION AND CONCLUSIONS

Local exhaust ventilation was very effective at reducing both respirable dust and crystalline silica exposures during surface grinding. The geometric mean respirable dust concentration was reduced from 0.91 to 0.03 times the OSHA PEL and the geometric mean respirable crystalline silica exposure was reduced from 3.41 to 0.37 times the OSHA PEL, as a result of using LEV to control dust emissions. With respect to respirable dust exposures only, the use of LEV would not require respiratory protection or any other control measure as none of the personal exposure samples obtained in the LEV treatment were greater than the OSHA PEL or ACGIH TLV. The control of personal respirable crystalline exposures was not quite as effective, as 22.2 and 25.9 percent of the samples exceeded the OSHA PEL and ACGIH TLV, respectively.

These results indicate that in general, workers will need to use respiratory protection with a protection factor between 5 and 10 when they are using a hand-held grinder to prepare concrete surfaces. However, without LEV, the worker would need to use a respirator that has a protection factor that is greater than 10, as 15 percent of the samples were more than 10 times the OSHA PEL for respirable crystalline silica.

The use of local exhaust ventilation resulted in an overall exposure reduction of 92 percent. This is comparable to the 95 percent reduction in respirable dust exposure that was observed in a controlled field study in which LEV was used to control dust during surface grinding. This is noteworthy, as the respirable dust exposure levels in the controlled field study, under both the LEV and no LEV treatments, were more than 35 times greater than the dust exposure levels observed in this study. When examining the results by construction site, four of the six sites are noted to attain an exposure reduction of greater than 92 percent, despite a 3.7 fold difference in the task pDR exposure levels between the sites with the highest and lowest exposure levels.

Comparison of the exposure reduction obtained with the three different tool/shroud configurations used is tenuous, as there was minimal crossover of tool use at a given site. The use of different tool types on a given day was minimized in order to maintain productivity and minimize disruptions. With this experimental limitation in mind, the results suggest that the Cut Shroud is slightly less effective than the other two shrouds assessed. This is probably a result of dust escaping from the opening at the tip of the Cut Shroud. A comparison of different shrouds and other parameters such as ventilation rate is probably best implemented under controlled field conditions.

Table 1: Geometric Mean (GSD) Personal Gravimetric Respirable Dust Exposure Levels (mg/m^3)

Independent Variable		n	No LEV Samples < DL[a]	No LEV GM (GSD)	With LEV Samples < DL	With LEV GM (GSD)
All Data		27	1	4.53 (3.93)	11	0.14 (7.83)
Site	1	5	0	7.33 (3.54)	1	0.25 (11.16)
	2	6	0	3.74 (1.55)	3	0.07 (5.35)
	3	5	0	7.77 (1.64)	0	1.33 (2.24)
	4	5	1	0.78 (7.20)	5	0.02 (1.24)
	5	2	0	6.57 (2.41)	0	0.55 (9.79)
	6	4	0	12.70 (1.86)	2	0.04 (2.83)
Shroud	Rigid	9	0	9.17 (1.91)	4	0.11 (7.55)
	Flexible	8	1	1.72 (6.51)	5	0.08 (7.30)
	Cut	10	0	5.22 (2.65)	2	0.32 (8.12)
Activity	Walls	22	1	4.18 (4.43)	11	0.10 (7.81)
	Ceiling & walls	2	0	6.57 (2.41)	0	0.55 (9.79)
	Columns & walls	3	0	6.41 (1.76)	0	0.81 (1.87)

a - Number of samples with a respirable dust mass that was less than the detection limit

Table 2: Geometric Mean (GSD) Personal Gravimetric Respirable Quartz Exposure Levels (mg/m^3)

Independent Variable		n	No LEV		With LEV	
			Samples < DL[a]	GM (GSD)	Samples < DL	GM (GSD)
All Data		27	4	0.250 (3.397)	17	0.034 (2.323)
Site	1	5	0	0.474 (3.098)	2	0.065 (3.234)
	2	6	1	0.126 (2.368)	6	0.020 (1.248)
	3	5	0	0.400 (1.585)	1	0.058 (1.936)
	4	5	3	0.073 (2.613)	5	0.020 (1.199)
	5	2	0	0.414 (1.601)	0	0.083 (2.891)
	6	4	0	0.640 (2.014)	3	0.022 (1.685)
Shroud	Rigid	9	0	0.464 (1.962)	6	0.030 (2.141)
	Flexible	8	3	0.139 (3.311)	5	0.031 (1.816)
	Cut	10	1	0.229 (3.296)	6	0.042 (2.965)
Activity	Walls	22	4	0.223 (3.322)	17	0.029 (2.270)
	Ceiling & walls	2	0	0.414 (1.601)	0	0.083 (2.891)
	Columns & walls	3	0	0.410 (1.828)	0	0.060 (1.338)

a - Number of samples with a respirable crystalline silica mass that was less than the detection limit

Table 3: Comparison of Respirable Dust and Quartz Exposures to OSHA PELs and ACGIH TLVs

Exposure Criteria	Respirable Dust		Respirable Quartz	
	No LEV	LEV	No LEV	LEV
Fraction of OSHA PEL	0.91	0.03	3.41	0.37
Fraction of ACGIH TLV	1.51	0.05	5.00	0.68
Percent of Samples > OSHA PEL	51.9	0	85.2	22.2
Percent of Samples > ACGIH TLV	70.4	0	85.2	25.9

Table 4: Geometric Mean (GSD) for Total and Task pDR Respirable Dust Exposures (mg/m³)

Independent Variable		n	Total pDR Exposure Level		Task pDR Exposure Level		
			No LEV	LEV	No LEV	LEV	Reduction (%)
All Data		25	4.95 (2.13)	0.16 (8.60)	5.46 (2.10)	0.14 (10.5)	92 (9.6)
Site	1	3	4.41 (1.79)	0.98 (3.04)	5.64 (2.25)	1.03 (3.25)	78 (16.8)
	2	6	4.45 (1.75)	0.01 (21.8)	5.31 (1.76)	0.01 (23.7)	97 (4.9)
	3	5	7.73 (1.70)	0.38 (1.36)	8.26 (1.72)	0.40 (1.32)	94 (4.4)
	4	5	2.02 (2.21)	0.15 (1.14)	2.25 (2.18)	0.14 (1.12)	92 (5.0)
	5	2	7.97 (1.42)	1.38 (1.86)	8.89 (1.31)	1.37 (1.88)	81 (14.9)
	6	4	8.77 (1.68)	0.19 (1.31)	7.83 (1.64)	0.19 (1.54)	97 (2.4)
Shroud	Rigid	9	8.81 (1.59)	0.10 (15.3)	8.95 (1.52)	0.10 (15.3)	94 (9.2)
	Flexible	8	3.05 (2.37)	0.21 (1.76)	3.40 (2.40)	0.21 (1.76)	93 (4.7)
	Cut	8	4.20 (1.64)	0.14 (22.8)	5.01 (1.77)	0.14 (22.8)	89 (13.2)
Activity	Walls	20	4.58 (2.25)	0.11 (9.51)	5.03 (2.19)	0.09 (11.7)	93 (9.4)
	Ceiling and walls	2	7.97 (1.42)	1.38 (1.86)	8.89 (1.31)	1.37 (1.88)	81 (14.9)
	Columns and walls	3	6.06 (1.60)	0.37 (1.26)	6.78 (1.75)	0.41 (1.13)	93 (5.2)

a - Cut shroud

Respirator types

Disposable
dust mask
NIOSH approved

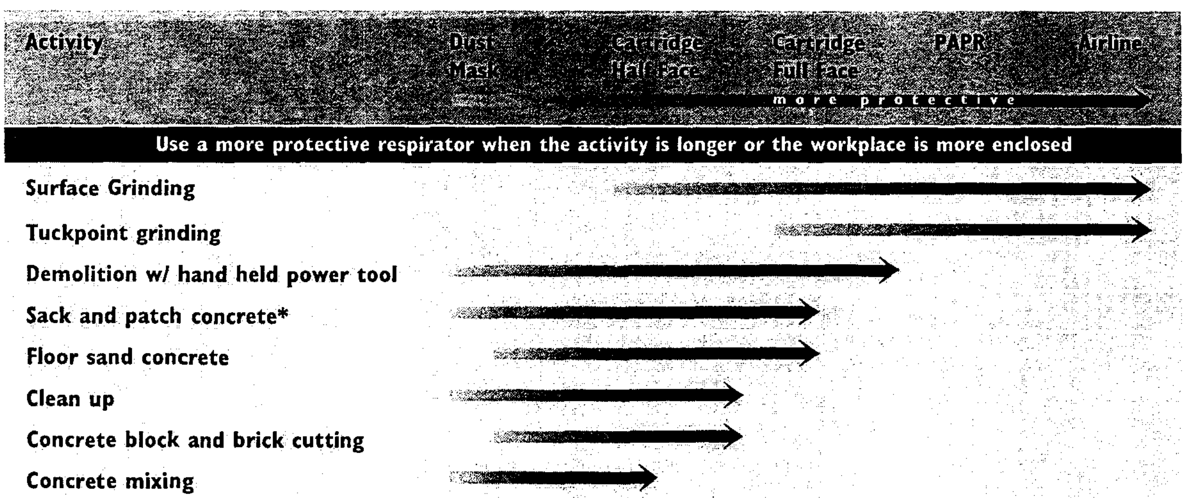
Half face
cartridge
with P-100 filter

Full face
cartridge
with P-100 filter

PAPR (Power Air
Purifying Respirator)
*P-100 filter/blower
worn at belt*

Airline
respirator
air supply from tank

The right respirator for the job



*More protection needed when sack and patch includes grinding

Avoid reliance on respirators alone for protection. More information on the use of respirators can be found at: http://www.osha.gov/SLTC/respiratory_advisor/mainpage.html

University of Washington
School of Public Health
and Community Medicine

Field Research & Consultation Group, Department of Environmental Health

Silica exposures in construction

What workers need to know

Field Research & Consultation Group
University of Washington
206-543-9711
http://depts.washington.edu/frcg/

Silica

Exposures for common construction tasks

A study at seven construction sites in Washington State found at least some construction tasks were over silica exposure limits.

Why worry about silica exposure?

When silica dust is breathed into the lungs frequently or in high concentration, it can damage the lungs causing silicosis. Silicosis is an irreversible scaring of the lungs that leads to breathing problems, and in some cases, death.

Silica exposure has also been linked to increased risk of lung cancer.

To learn more about silicosis visit this website:

http://www.osha-slc.gov/Training/Silicosis.html

Percent of samples over the American Conference of Governmental Industrial Hygienists Threshold Limit Value (TLV*) if task is done for a full shift.

100%

Surface Grinding

100%

Tuckpoint Grinding

88%

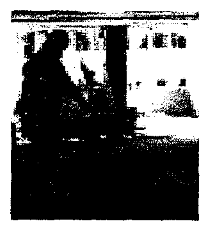
Concrete Demolition

80%

Floor sanding

77%

Concrete Cutting

50%

Clean Up

40%

Sack and Patch Concrete

20%

Cement/Mortar Mixing

*TLV is 0.05 mg/m³, based on lung cancer studies.

Getting control of concrete dust

Use ventilated tools

Spray water at point of dust emission

Do dusty work outside if possible

Keep tool's dust control apparatus intact

Dust levels can remain high for a time even after cutting, grinding, or sweeping stops

Air sampling is needed to verify dust levels

What makes a difference in dust levels and dust exposures

How much of the work space is enclosed

How long the dusty activity occurs

Whether the dusty activity is continuous or occasional

Whether dust controls installed really work