

October 15, 2019

VIA REGULATIONS.GOV

Loren Sweatt
Principal Deputy Assistant Secretary of Labor
Occupational Safety and Health Administration
U.S. Department of Labor
200 Constitution Avenue, NW
Washington, D.C. 20210

Re: Construction Industry Safety Coalition
Comments to Request for Information; Occupational Exposure to Respirable
Crystalline Silica – Specified Exposure Control Methods
Docket No. OSHA-2010-0034; RIN 1218-AD18

Dear Ms. Sweatt:

I write on behalf of the Construction Industry Safety Coalition (“CISC”). The CISC respectfully files the enclosed written comments to OSHA’s Request for Information on Occupational Exposure to Respirable Crystalline Silica – Specified Exposure Control Methods, 84 Fed. Reg. 41667 (August 15, 2019). The CISC appreciates OSHA’s consideration of the information and data presented in these comments.

Sincerely,

LITTLER MENDELSON, P.C.



Bradford T. Hammock
Melissa Harclerode

Enclosures

Construction Industry Safety Coalition

Response to OSHA's Respirable Crystalline Silica Request for Information

Docket No. OSHA-2010-0034

1. Introduction.

The Construction Industry Safety Coalition ("CISC") respectfully submits these comments in response to the Occupational Safety and Health Administration's ("OSHA") Request for Information ("RFI") on "Occupational Exposure to Respirable Crystalline Silica – Specified Exposure Control Methods," 84 Fed. Reg. 41667 (Aug. 15, 2019). The CISC appreciates OSHA's consideration of the information and data presented in these comments.

The CISC is comprised of 26 trade associations representing virtually every aspect of the construction industry. The CISC was formed several years ago to provide OSHA thoughtful, data-driven comments on regulatory initiatives. By pooling resources and members from the wide range of trades affected by OSHA regulatory actions, the participating construction industry trade associations believe that stronger and more detailed information can be submitted to OSHA during the rulemaking process. The CISC speaks for small, medium, and large contractors; general contractors; subcontractors; union contractors; etc.

The CISC was an active participant during OSHA's initial rulemaking on respirable crystalline silica. The CISC submitted extensive pre-hearing written comments, participated in the public hearing, and submitted post-hearing comments and briefs.

Following publication of the final rule, the CISC worked closely with OSHA and organized labor in the development of numerous Frequently Asked Questions ("FAQs") designed to improve compliance with the rule in the construction industry and address some of the difficult interpretive issues that arose after the rule was finalized. The CISC appreciates the opportunity to work with OSHA to improve compliance with the respirable crystalline silica rule, which touches almost every trade in the construction industry.

The CISC applauds the Agency for issuing this RFI and has been pushing the Agency to do so for over two years. Expanding Table 1 and otherwise improving compliance with the rule is of paramount importance to CISC member associations and contractors across the country. Based upon the feedback the CISC has received from contractors – both large and small – compliance with the rule remains challenging. The CISC encourages OSHA to move quickly with rulemaking to permit contractors additional compliance options and tools.

2. Executive Summary.

OSHA has issued this RFI primarily to gather additional information on engineering and work practice control methods that should be added to Table 1 and other equipment/tasks that might be included, as well. This effort is important to the construction industry and construction workers across the country. While well-intentioned, Table 1 as currently

constituted does not provide contractors a viable compliance option. The allowed controls included in the table are too limiting and the tasks included do not represent the wide range of activities that are commonplace on construction worksites. Expanding Table 1 will result in improved compliance throughout the construction industry.

The CISC recommends that OSHA quickly proceed to rulemaking to improve Table 1 and the overall functioning of the standard. Specifically, the CISC recommends that OSHA consider the following improvements to the respirable crystalline silica rule:

- *First*, OSHA should specifically exclude from coverage of the standard two common construction tasks where the data shows that exposures are consistently and reliably below the action level: mortar mixing and drywall installation/finishing. Requiring contractors to focus compliance resources in these areas given the very low exposures detracts from focusing those same resources where exposures to respirable crystalline silica are apparent and potentially significant.
- *Second*, OSHA should expand Table 1 in three different ways. OSHA should consider adding an “under one hour” column/row or an “under one hour” table that provides for equipment/tasks and controls for short term activities. Such an allowance would provide contractors more flexibility and increase the number and types of control options available. OSHA should also add dry cutting with vacuum attachments to Table 1 for stationary masonry saws and handheld power saws, as the data shows that exposures for this equipment with these controls are under the PEL. OSHA should also allow for the use of standard shop vacuums as part of engineering controls, based on recent data from the National Institute for Occupational Safety and Health (“NIOSH”). In addition, OSHA should explore the use of floor and pedestal fans and air scrubbers as simple compliance solutions either on their own or in conjunction with other control measures. Finally, OSHA should add masonry scrubbers, wire saws, and wall saws to Table 1 based on data showing low exposures when using this equipment.
- *Third*, OSHA should examine additional changes to the standard that will ease compliance while maintaining employee safety and health. This includes an exception to the hierarchy of controls for tile cutting on steep slope roofs, given the greater hazards posed by using engineering controls in this environment. In addition, OSHA should permit the use of respiratory protection in lieu of engineering and work practice controls for very short duration work (under 30 minutes) when isolated from other employees. Similarly, OSHA should consider an exception to the prohibition on dry sweeping and dry brushing for employees performing that work for less than 30 minutes and where the employees do not have any other exposure to respirable crystalline silica.

- *Fourth*, the CISC recommends that the Agency standardize a process, which establishes set criteria and relies on interim final rulemaking, to update and expand Table 1 in the future. This proposed process will allow for expeditious changes to the table so as to continue to push and recognize technological improvements.
- *And finally*, the CISC discusses feedback received on the costs and impacts of the current rule and how the recommendations included in this response will result in significant cost savings without compromising employee health.

3. Background on RFI.

In this RFI OSHA is “requesting information on the effectiveness of engineering and work practice control methods not currently included for the tasks and equipment listed on Table 1 of the Respirable Crystalline Silica standard for construction.” 84 Fed. Reg. at 41667. In addition, the RFI seeks “information on tasks and equipment involving exposure to respirable crystalline silica that are not currently listed on Table 1, along with information on the effectiveness of engineering and work practice control methods in limiting worker exposure to respirable crystalline silica when performing those tasks.” *Id.*

The RFI includes over 30 questions regarding types of control methods about which the Agency is specifically interested in receiving information, a variety of tasks that could potentially be added to Table 1, and other miscellaneous information, including information related to the costs and benefits of the respirable crystalline silica rule and Table 1.

From the outset of OSHA’s initial rulemaking on respirable crystalline silica, the CISC has been generally supportive of the Table 1 approach. Listing specified control measures for contractors to use to be in compliance with the monitoring requirements and the permissible exposure limit (“PEL”) is – in theory – very useful to contractors and should result in improved compliance. As the CISC stated in its very first comments to OSHA on the respirable crystalline rule:

At the outset, the CISC wants to emphasize that it appreciates OSHA’s attempt in Table 1 to craft a performance-based tool for use in the construction industry. The associations participating in the CISC have for some time urged OSHA to consider the unique aspects of construction work *vis-à-vis* silica exposures and, certainly, applauds OSHA for including Table 1 in the proposal.

Unfortunately, for several reasons the use of Table 1 is not as pervasive as it could or should be. First, several tasks on the table do not allow for multiple control options. For example, with respect to five of the first six tasks on the table, an integrated water delivery system is the only option provided. 29 C.F.R. § 1926.1153(c)(1)(i)-(vi). When performing those tasks in conditions that do not permit the introduction of water to the work environment, use of the table is not possible. Similarly, for handheld and stand-mounted drills and dowel drilling rigs for concrete, the use of wet methods is not permitted for those following Table 1.

29 C.F.R. § 1926.1153(c)(1)(vii), (viii). The failure to include multiple control options for compliance with Table 1 significantly restricts its use.

CISC member companies have repeatedly described the limitations on the use of wet methods. For example, in very cold work environments wet methods can often not be used. Introducing water at heights (when working on scaffolds or on steep slope roofs) can introduce greater hazards to employees performing the work. Work in health care environments often prohibit the use of wet methods. Many state and local governments also prohibit the use of wet methods when performing road construction and maintenance. And these are just a few of the limitations on the use of wet methods.

Expanding Table 1 to provide for both a wet and a dry control option for as many equipment/tasks as possible would significantly improve the utility of the table.

Second, there are several common construction tasks that are not included on Table 1. During the initial rulemaking, OSHA predicted that virtually all construction operations would be covered by tasks listed on Table 1, with very few exceptions. Unfortunately, there are several tasks/equipment that were not included on the Table. This limits the utility of the table. As one member stated to a CISC-participating trade association: “The current Table 1 is exclusive to a select few tasks that do not encompass the broader numerous equipment and task-related exposure in the construction environment. My communication with other contracting companies is that Table 1 is their “bible” for controls, but there is not enough tasks on the list.”

Third, many owners and developers in commercial construction are requiring contractors to comply with the PEL or even ensure that any exposure to respirable crystalline silica is below the action level of 25 $\mu\text{g}/\text{m}^3$, irrespective of whether they are able to comply with Table 1. This is obviously not a specific requirement from the standard, but many stakeholders predicted this would occur when OSHA was developing the final rule. As a result, many contractors do not even attempt to comply with Table 1, instead they are following – or attempting to follow – the “Alternative Exposure Control Methods” portion of the rule. This significantly hinders compliance as compliance with the Alternative Exposure Control Methods section of the rule is very difficult in construction, given the wide variety of tasks and the unpredictability of silica exposure in the industry.

The current obstacles to the use of Table 1 are hampering overall compliance with the standard. Construction tasks are often of short duration and are highly variable, as the rulemaking record made clear while OSHA was promulgating the initial rule. Attempting to monitor exposures for these short duration tasks on multiple jobsites and on a regular basis simply does not make sense. But the limited utility of Table 1 is causing contractors to comply in that way. Expanding Table 1 with more tasks and more options will improve compliance with the rule.

The CISC understands that virtually all stakeholders support an expanded Table 1, from industry, to organized labor, to the public health community. Furthermore, OSHA has stated

repeatedly that its determination as to whether to proceed to revise and expand Table 1 should be based on good data. The CISC supports OSHA making a data-based decision in this regard. However, the CISC was extremely disappointed that OSHA did not grant an extension of time to submit these comments to the record, instead only providing stakeholders with 60 days to draft comments, develop and organize data, and submit it to the Agency.

The CISC and many individual member associations submitted requests to the Agency to extend the comment period. The period of time set to submit comments was less than other RFIs put forward by the Agency, including the recent RFI for lockout/tagout that included a 90-day comment period. 84 Fed. Reg. 22756 (May 20, 2019). As a result of the Agency's decisionmaking, the data that is gathered and submitted will not be as robust as it should and the Agency will be forced to make important decisions about whether to proceed with rulemaking in this area without the best information. That is unfortunate, as this is an incredibly important issue to employee safety and health in the construction industry. The CISC, however, reserves the right to submit further data to the Agency after the comment period ends and hopes that the Agency will consider that information in its decisionmaking process.

4. Tasks that Should be Specifically Exempt from the Respirable Crystalline Silica Standard.

Before discussing an expanded Table 1 and the data supporting it, the CISC believes that certain activities should be exempt from coverage of the standard altogether. These activities have been shown consistently to result in *de minimis* exposure to respirable crystalline silica. The CISC believes that the standard, as currently configured, takes resources away from contractors focusing on where silica exposures *actually are* and instead forces them to devote resources to assessing tasks where the data shows consistently that exposure is not a problem. This simply does not make sense.

In an FAQ issued after publication of the final rule, OSHA stated as follows:

Has OSHA identified specific tasks that are likely to be outside the scope of the standard because they typically generate exposures below the AL of 25 $\mu\text{g}/\text{m}^3$ as an 8-hour TWA under all foreseeable conditions?

Yes. When the following tasks are performed in isolation from other silica-generating tasks, they typically do not generate silica at or above the AL of 25 $\mu\text{g}/\text{m}^3$ as an 8-hour TWA under any foreseeable conditions: mixing small amounts of mortar; mixing small amounts of concrete; mixing bagged, drywall compound containing trace amounts of silica; mixing bagged exterior insulation finishing system (EIFS) base and finish coat; and removing concrete formwork. In addition, tasks where employees are working with silica-containing products that are, and are intended to be, handled while wet, are likely to generate exposures below the AL under any foreseeable conditions (examples include

finishing and hand wiping block walls to remove excess wet mortar, pouring concrete, and grouting floor and wall tiles).

The CISC appreciates this guidance from OSHA and many contractors have used it to help inform their own silica control efforts. However, there is still ambiguity with the FAQ. It states that performing this work will *likely* be outside the scope of the standard, but it does not state so definitively. These tasks also are not on Table 1. Thus, many contractors are required to devote resources assessing this type of work to determine exposures, approach to engineering controls, personal protective equipment (“PPE”), etc. In at least two areas – mortar mixing and drywall installation/finishing – the CISC believes that data is sufficient for OSHA to exempt the tasks altogether. The CISC discusses this below.

a. Mortar Mixing

One of the most common tasks on construction sites is the mixing of mortar. Frequently this task is performed in silos of differing sizes and dimensions. These silos are at least partially enclosed and provided with various mechanisms to limit any dust generated by adding the mortar to the water in order to mix the product. When this task is performed in a silo under certain conditions, the data demonstrates that exposures are reliably under the action level. As a result, the CISC believes that this task should be excluded from the standard when performed in this manner.

Attached as Exhibit 1 is data from three industrial hygiene assessments of employee exposure to respirable crystalline silica when performing mortar mixing in an enclosed or partially-enclosed silo. Assessments were conducted in three states: Illinois; Arizona; and Georgia and the work performed was representative of standard masonry job site mortar mixing conditions. The two-day average exposure for each project was well below the action level. The highest average exposure was below 13 $\mu\text{g}/\text{m}^3$.

In performing the work, the employees had been trained on how to properly mix the mortar and use the equipment. In addition, they were directed to stay upwind of the mortar-mixing process. The CISC believes that these parameters could be incorporated into the scope section of the rule, as appropriate, and for contractors that do not follow these parameters, exclusion from the standard would not be provided.

Furthermore, OSHA could consider combining the mortar mixing process with a workstation that uses a floor fan or pedestal fan to disperse any respirable crystalline silica away from the employee mixing the mortar. (*See* below for a broader discussion of the use of floor fans or pedestal fans.). Provided the workstation was not situated near other employees performing construction tasks, such a practice could further ensure that exposures to employees are safely below the action level.

Excluding mortar mixing from the standard altogether would allow contractors to shift resources from this task – which is incredibly common in both residential and commercial construction – to other tasks that involve silica exposure. It would also provide contractors

certainty that if they are mixing mortar according to certain specifications, they are *not* covered by the standard.

b. Drywall Installation/Finishing

Another task that the CISC believes should be specifically excluded from the standard relates to drywall installation and finishing with drywall joint compound containing trace amounts of silica. This again, is a common task in residential and commercial construction.

In a letter of interpretation, OSHA addressed coverage of the respirable crystalline silica standard for work on or with drywall and drywall compound containing trace amounts of silica:

Drywall and drywall joint compound frequently contain only trace amounts of silica (frequently less than 1 percent). Is work on or with such materials covered by the standard?

The RCS standard does not include an exemption based on the silica content of materials used. However, OSHA anticipates that employee exposures will typically remain below $25 \mu\text{g}/\text{m}^3$ as an 8-hour TWA when working with drywall or sanding joint compound that contains crystalline silica only as a trace contaminant, provided that the sanding is performed in isolation from other silica-generating tasks. Therefore, these tasks will generally be excluded from the scope of the standard per 29 CFR 1926.1153(a). However, employers should be aware that exposures *could* reach or exceed $25 \mu\text{g}/\text{m}^3$ as an 8-hour TWA in situations where employees are working with drywall or sanding joint compound for long periods of time in very dusty conditions. In such cases, employers must comply with the silica standard, including paragraph (d) (“alternative exposure control methods”), which requires employers to assess and limit the silica exposures of affected employees. See 29 CFR 1926.1153(d). Letter from Kapust to Day, July 25, 2019.

Attached as Exhibit 2 is data demonstrating that when work on or with drywall occurs under various conditions, exposures are well below the action level. This data includes the following:

- Drywall installation
28 samples
Average exposure of $15 \mu\text{g}/\text{m}^3$
- Drywall finishing with vacuum equipped tool
4 samples

- Average exposure of 10 $\mu\text{g}/\text{m}^3$
- Drywall finishing with pole sander
 - 4 samples
 - Average exposure of 22 $\mu\text{g}/\text{m}^3$
- Drywall finishing with hand sander
 - 2 samples
 - Average exposure of 5 $\mu\text{g}/\text{m}^3$
- Drywall finishing with combination of pole, vacuum throughout the test time
 - 13 samples
 - Average exposure of 19 $\mu\text{g}/\text{m}^3$
- Applying joint compound
 - 3 samples
 - Average exposure of 12 $\mu\text{g}/\text{m}^3$

As with mixing mortar, the data shows that when performing work with drywall and drywall joint compound containing trace amounts of silica, exposures are consistently below the action level. The CISC recommends that OSHA exclude drywall installation and finishing from coverage of the standard, provided the following criteria are met: (1) the work is performed with drywall joint compound containing trace amounts of silica; (2) the work is performed apart from other silica generating tasks; and (3) the work is performed in combination with the control measures set forth in the data included in Exhibit 2.

Shifting compliance resources from assessing and controlling for drywall installation and finishing to other areas of significant respirable crystalline silica exposure will help further employee safety and health. In the areas of mortar mixing and drywall installation/finishing, exposures are *de minimis* and when performed under certain conditions are reliably under the action level. OSHA should move to exclude these tasks, thereby helping employees and providing compliance certainty to employers.

5. Additions to Table 1.

As currently configured, Table 1 includes 18 types of equipment or tasks with specified engineering controls and any required respiratory protection. The 18 equipment/tasks are stationary masonry saws; handheld power saws (any blade diameter); handheld power saws

for cutting fiber-cement board (with blade diameter of 8 inches or less); walk-behind saws; drivable saws; rig-mounted core saws or drills; handheld and stand-mounted drills (including impact and rotary hammer drills); dowel drilling rigs for concrete; vehicle-mounted drilling rigs for rock and concrete; jackhammers and handheld powered chipping tools; handheld grinders for mortar removal (i.e., tuckpointing); handheld grinders for uses other than mortar removal; walk-behind milling machines and floor grinders; small drivable milling machines (less than half-lane); large drivable milling machines (half-lane and larger); crushing machines; heavy equipment and utility vehicles used to abrade or fracture silica-containing materials (e.g., hoe-ramming, rock ripping) or used during demolition activities involving silica-containing materials; and heavy equipment and utility vehicles for tasks such as grading and excavating but not including: demolishing, abrading, or fracturing silica-containing materials.

Depending upon the task, contractors may be able to choose from multiple control options (for example, handheld grinders for uses other than mortar removal) or in some instances only one control option (e.g., stationary masonry saws). The table also is bifurcated into two time periods, 4 hours or less and greater than 4 hours to dictate the need for respiratory protection.

The CISC recommends that the Agency expand Table 1 in three separate ways. First, the CISC recommends that OSHA consider adding an “under one hour” column/row to the table (or a separate table) that lists the tasks and control measures to be followed if a contractor only performs the task for less than one hour a day. Expanding the table in this way would open up the possibility of numerous additional control measures that are not currently allowed for contractors to utilize when performing very short duration work. Second, the CISC recommends the addition of other control measures for equipment/tasks currently on the table to integrate into the table as it is now configured. For example, the CISC has data demonstrating that exposures for stationary masonry saws are well below the PEL when cutting dry with a vacuum system. And third, the CISC recommends that additional tasks be added to the table to include as many tasks as possible for contractor compliance.

a. One Hour Exposure Option

The CISC recommends that OSHA consider adding an additional column/row to Table 1 that lists equipment/tasks and control measures that are allowable when the tasks are performed for less than one hour a day. Alternatively, OSHA could develop a “Table 2” or some other supplement to Table 1 that sets forth required controls for tasks when performing the work for less than one hour a day.

This would substantially improve compliance while maintaining employee safety. The CISC believes that it would also provide contractors with several additional compliance options. OSHA developed Table 1 initially considering the revised PEL. The PEL is based on a time-weighted average, and in analyzing the data submitted to the original rulemaking record, the sampling duration varied considerably. The extent to which an employee is

performing a silica-generating activity during the course of a day will have a significant impact on exposure and the effectiveness of controls.

Allowing employers another option of limiting the performance of a task to an hour could dramatically expand the controls available. For example, OSHA may not have data indicating that use of a shroud and vacuum system for a particular task would result in exposures below the PEL when performed for four hours. However, that same data may demonstrate that performing the task for one hour would be well below the PEL and even the action level. Providing employers the option of using the shroud and vacuum system for even just one hour a day will improve compliance flexibility.

In addition, since the respirable crystalline silica rule was finalized, equipment manufacturers have assembled “objective” data for various types of control measures for silica generating equipment/tasks. *See, e.g.*, objective data included in Exhibit 3. This objective data is helpful to employers attempting to comply with the Alternative Exposure Control Method option of the standard or even meet the action level for Table 1 tasks if otherwise required by a third party. Often, however, this data is based on sampling of approximately an hour with an assumption of no additional silica exposure after the period sampled. In these circumstances, if OSHA allowed for use of the equipment/task as a column/row or alternative table for short duration activities, that data could be used and – more importantly – additional compliance options provided for contractors.

b. Additional Exposure Control Methods for Equipment or Tasks Listed on Table 1

OSHA specifically seeks information and data regarding additional exposure control methods that could be added for equipment/tasks listed on Table 1. This is critically important to provide contractors more flexibility to use Table 1 on their jobsites.

i. *Commercially available dust collection systems for stationary masonry saws*

Table 1 currently only provides for an integrated water delivery system when attempting to use a stationary masonry saw. The CISC has obtained data demonstrating the effectiveness of dry cutting several different types of material with a stationary masonry saw attached to a vacuum system. (*See Exhibit 4.*) In one instance, work was performed at a garage worksite and the sampling was representative of the shift and representative of the employees’ regular work. Sampling was performed for three hours total for both saw cutting and rod drilling. The personal air samples were collected with a flow rate of 2.7 liters per minutes and a total volume of 486 liters. The monitoring performed for the employee cutting and the area next to the employee cutting were both below the action level, at $< 10 \mu\text{g}/\text{m}^3$ and $21 \mu\text{g}/\text{m}^3$, respectively.

In another air sampling report, several masonry saws were evaluated under testing laboratory conditions. The saws were equipped with integrated vacuums and dust collection

equipment. Personal breathing zone samples were collected and sampling was performed for 480 minutes. Different masonry units were evaluated. In every instance, the data showed exposures reliably below the PEL, and in one instance below the action level. Adding control measures mirroring the equipment used in these reports would be appropriate for Table 1 and significantly improve contractor compliance.

- ii. *Commercially available dust collection systems for handheld power saws (any blade diameter), including handheld masonry saws*

Table 1 also currently only provides for integrated water delivery systems for employees using handheld power saws (any blade diameter). Handheld power saws are frequently used in both residential and commercial construction. The fact that only wet methods can be used to provide protection to employees under Table 1 is very limiting for a number of contractors.

As with stationary masonry saws, the CISC has obtained data showing that use of vacuum systems can effectively control for exposures to respirable crystalline silica, when dry cutting even in indoor environments. *See Exhibit 5 and the “Air Sampling Report: Respirable Dust and Crystalline Silica Exposure while Dry Cutting Concrete, Masonry, & Ceramic Tile Materials Utilizing Engineered Controls for Dust Collection” included in Exhibit 4.*

- iii. *Commercially available dust collection systems with general purpose filters instead of filters with 99% or greater efficiency*

One of the more expensive aspects of the respirable crystalline silica rule relates to the requirement that dust collection systems and vacuums have a filter with 99% or greater efficiency. These can be very expensive, considering the significant usage on construction sites in very difficult environmental conditions. The ability to use a regular shop vacuum in lieu of a vacuum with filters with 99% or greater efficiency would be extremely helpful for contractors in terms of compliance.

NIOSH recently studied the effectiveness of controlling silica when cutting fiber-cement siding using a regular shop vacuum cleaner. The analyses are attached in Exhibit 6. In one description, “a regular shop vacuum, which had a high efficiency disposable filter bag as a pre-filter and a cartridge filter (not HEPA), was used in these surveys. The survey results showed that the 10-hour time weighted average (TWA) exposure to respirable crystalline silica for workers who mainly cut fiber-cement siding on the job sites was controlled to well below the NIOSH REL.” NIOSH states: “This engineering control measure has the potential to provide an effective, simple and low cost (comparing to HEPA vacuums) solution for workers cutting fiber-cement siding.”

NIOSH also noted the overall ease of use in this situation: “The shop vacuum and the circular saw can be plugged into an intelligent vacuum switch. This eliminates the distraction for the operator of turning on and off a dust collection system and ensures the vacuum is running while operating the saw, avoiding uncontrolled dust release.”

This is important research, which could potentially allow for the use of common shop vacuums as part of engineering control solutions. OSHA should explore this further with an eye toward revising Table 1 to permit the use of shop vacuums to be used as part of dust collection systems.

- iv. Floor fans or pedestal fans positioned to disperse dust away from workers when using handheld power tools*

One of the challenges to increasing compliance with the standard and Table 1 relates to the complexity of some of the control measures included. For several control measures there must be an “integrated water delivery system.” For others, the dust collection systems must “provide the air flow recommended by the tool manufacturer, or greater, and have a filter with 99% or greater efficiency.”

In addition, for all equipment/tasks, employees must follow the manufacturer’s instructions to minimize dust emissions. This, of course, makes sense in theory. However, manufacturers’ instructions are often lengthy and include a lot of information that is irrelevant and confusing to the use of the tool to minimize dust emissions.

Recognizing this, OSHA attempted through its FAQs to help clarify the requirement in a way that would streamline compliance. In FAQ No. 9, OSHA provided the following examples of manufacturer instructions for minimizing dust emissions:

- Instructions on the use of water, water supply, flow rates, etc., including installation and maintenance of integrated water delivery systems;
- Instructions on when to change water, where water supply is reused;
- Instructions on the use, installation, and maintenance of dust collectors or vacuums, including recommended flow rate (cubic feet per minute (CFM)), HEPA filters, and capacity;
- Instructions on the maintenance and replacement of blades; and
- Instructions on the rotation (e.g., speed, direction) of blades.

OSHA also provided manufacturer instructions that are not generally related to minimizing dust emissions:

- Warnings related to electrical hazards, guarding hazards, and noise hazards;
- Instructions regarding the use of personal protective equipment (including respiratory protection);
- Instructions on fueling and refueling; and

- Instructions on transporting the tool from worksite to worksite.

The combination of the complexity of the requirements directly included in Table 1, along with the additional requirements included in manufacturers' instructions, makes compliance difficult, particularly for very small contractors without in-house safety or industrial hygiene support.

Given this, the CISC recommends that OSHA carefully examine control measures to add to the table – either directly or indirectly – to make compliance simpler. Use of shop vacuums attached to tools is one method. Another is the use of floor or pedestal fans that disperse dust away from workers when using power tools. This would be a very simple control measure that would be readily available to contractors. It would also be inexpensive.

James Hardie has examined the effectiveness of the use of a floor fan or pedestal fan in reducing respirable crystalline silica exposures. This analysis involved sampling for respirable crystalline silica in the breathing zone of employees cutting fiber cement board containing crystalline silica, as well as sampling in the general area around the cutting station. The analysis also involved examining multiple styles of fans.

James Hardie concluded that the use of certain fans to disperse the respirable crystalline silica away from the cutting employees was very effective in providing protection to the cutting employees, with results consistently below the PEL. James Hardie also found that when using certain fans the dust would quickly disperse after being blown out of the employee's breathing zone, so that employees outside of the immediate work area would not be significantly exposed.

The CISC urges OSHA to fully consider this evidence and information from James Hardie. The CISC would also welcome the opportunity to meet with OSHA to discuss the findings and any further research needed in this area. This type of control measure – if shown to be effective for even a few of the tasks on Table 1 – would provide a simple, low cost solution for contractors and would significantly improve compliance.

v. *Air scrubbers*

Finally, the CISC urges OSHA to evaluate air scrubbers for use in conjunction with other control measures to further reduce exposures for interior work, perhaps obviating the need for respiratory protection in some circumstances.

Air scrubbers are pieces of equipment that suck air through the machine, where it passes through a filter that collects dust. The scrubber then recirculates the "filtered" air. Air scrubbers vary in size and are frequently used to reduce visible dust in interior work environments.

CISC member companies report that use of air scrubbers for interior work is increasing. As noted above, the scrubbers help reduce visible dust and some initial sampling suggests that they are also effective at reducing exposure to respirable crystalline silica.

Most of the use, however, has been in conjunction with other control measures, either the use of wet methods or dust collection systems. The air scrubbers serve as another layer of protection to reduce exposures as much as possible.

The CISC has not been able to obtain data on the effectiveness of air scrubbers, despite the positive reports received from some member companies. The CISC will continue to try to obtain the data but encourages the Agency to explore the use of air scrubbers in combination with other control measures for interior work. Table 1 is currently configured to require respiratory protection for much of the work that is performed indoors. Air scrubbers may be a means to reduce exposures during interior work to such an extent that, when combined with other control measures, respiratory protection may not be required. This is certainly worth exploring and the CISC encourages OSHA to examine this.

c. Equipment/Tasks to Add to Table 1

In addition to expanding Table 1 to allow for tasks performed for no more than an hour and expanding the controls available to contractors for tasks currently on Table 1, the CISC strongly supports adding other equipment/tasks to the table. As stated above, CISC member companies have routinely informed the CISC that Table 1 is helpful, but it does not include certain equipment/tasks that are frequently used on construction sites.

i. *Masonry Wall Scrubbers*

One common piece of equipment used in construction is a masonry scrubber. Masonry scrubbers involve rotating discs that scrub masonry walls as part of the finishing process. Masonry scrubbers are not currently listed on Table 1.

Given the frequency that masonry scrubbers are used, the CISC believes that they should be added to Table 1. Attached as Exhibit 7 is data from sampling performed with masonry scrubbers with the application of two types of vacuum systems. Exhibit 7 also includes sampling without the application of controls.

The sampling involved a full shift survey with the work performed indoors. Three employees were sampled. Two of the employees had vacuum systems attached to the scrubbers, with one vacuum involving a HEPA filter. One employee performed the task with no control measures.

According to the data, the employees that used the vacuum systems with the scrubbers were both under the action level. The vacuum system using the HEPA filter had results of “non-detect.” The results for the employee performing the work with no controls was exposed

at 110 $\mu\text{g}/\text{m}^3$, significantly over the PEL. This data shows the effectiveness of using a masonry scrubber with an attached vacuum system.

ii. Wire Saws

Yet another common piece of equipment is a wire saw. These saws are typically used for complicated projects where a traditional diamond handheld saw cannot be used. In addition, most wire saws are equipped with an integrated water delivery system and the operation of the machine is *via* remote control away from the point of operation.

When a wire saw is used in this manner, data shows that it is at or below the PEL and even below the action level. Attached as Exhibit 8 is data collected showing the results from the use of wire saws under these conditions. The data supports including wire saws in Table 1 with the listed controls, including an integrated water delivery system and remote operation.

iii. Wall Saws

Wall saws are also frequently used for larger and more complicated concrete sawing operations. As with wire saws, the operation of the wall saws are often remote with the operator located away from the point of operation.

Exhibit 8 also includes data regarding the use of wall saws. The assessment was performed using the saws with wet methods and an air mover (fan) in an enclosed garage. The operator was positioned remotely. Under these circumstances, the data shows exposures reliably below the PEL. As with wire saws, this data supports adding wall saws into Table 1 under the conditions sampled.

6. Other Recommendations.

In addition to the above comments, data, and suggestions, the CISC wishes to make several additional recommendations to ease compliance while maintaining worker safety and health. While OSHA looks to expand Table 1, the CISC strongly encourages it to consider these other recommended changes.

a. Greater Hazard Exception for Steep Slope Roofing

The CISC requests that OSHA implement a specific exception to the PEL and exposure monitoring provisions for work on steep slope roofs.

There are times where tile roofing contractors must cut tiles while working on steep slope roofs (typically during residential construction). This work presents significant fall hazards to those employees. Work on steep slope roofs is hazardous and contractors must take steps to avoid introducing additional hazards into the work that could increase the risk of falling.

Due to the silica exposures and application of the standard to the work, tile roofing contractors must either use wet methods when cutting tile, along with respiratory protection in certain instances, or adopt an alternative exposure control method, presumably a shroud and vacuum system with respiratory protection.

Installing concrete and clay tiles involves occasional cutting for the hips and valleys on the roofs. This task cannot be performed on the ground, as the cuts must be precise for the roof tiles. Using wet methods introduces slip hazards into this work and the hoses also create tripping hazards. Similarly, vacuum systems introduce the same type of trip hazard for these workers on steep slope roofs.

Falls remain the leading cause of fatalities in the construction industry and fall protection in construction constitutes the most frequently cited standard. The construction industry focuses significant resources on fall prevention and protection. Unfortunately, the respirable crystalline silica standard directly increases fall hazards for roofers performing cutting on steep slope roofs.

Given this, the CISC urges the Agency to consider a specific exception to compliance with the PEL and the exposure monitoring provisions for tile cutting on steep slope roofs. Such an exception would be based on the greater hazard from falls created by the use of current silica control technology for tile cutting.

Under the exception, the CISC recommends that OSHA require the use of respiratory protection when cutting tile to ensure that employees are protected from exposure during this work task. Use of respiratory protection does not create the slip and trip hazards inherent in the use of silica control technology.

The CISC emphasizes that this exception would be very limited, i.e., only when cutting tile on steep slope roofs. Cutting tile on other types of roofs would not be impacted by the exception.

b. Permit Use of Respiratory Protection in Lieu of Engineering, Work practice Controls When Performing Tasks for Less than 30 Minutes a Day in Isolation

As set forth above, the CISC believes that the standard, as currently drafted, presents numerous compliance challenges for contractors. The limits of Table 1 combined with the variable nature of construction work has made compliance extremely challenging. Making compliance simpler will result in a safer and more healthful work environment.

To that end, the CISC urges the Agency to provide an alternative approach to protection for very short duration exposures. Rather than rely on engineering controls and work practice controls when performing very short duration tasks, OSHA encourages the Agency to consider the use of respiratory protection for these tasks when they are performed in isolation.

Under this approach, when an employee is expected to perform a task that will take under 30 minutes in the course of a day and performs that task in isolation (i.e., not around other employees) the employee would be allowed to perform the task with respiratory protection only.

This furthers the Agency's position as set forth in FAQ No. 2 that very short duration tasks will typically not be an issue with respect to problematic exposures. FAQ No. 2 provides:

Does the standard cover employees who perform silica-generating tasks for only 15 minutes or less a day?

The standard does not include a specific exemption for tasks with only short-term exposures (e.g., tasks with exposures for 15 minutes a day or less). However, in many cases, employees who perform construction tasks for very short periods of time, in isolation from activities that generate significant exposures to silica (e.g., some tasks listed on Table 1, abrasive blasting), will be exposed below the AL of $25 \mu\text{g}/\text{m}^3$ as an 8-hour TWA under any foreseeable conditions. Short-term silica exposures must be very high in order for those exposures to reach or exceed $25 \mu\text{g}/\text{m}^3$ as an 8-hour TWA; for example, if an employee is exposed for only 15 minutes, his or her exposure would have to be higher than $800 \mu\text{g}/\text{m}^3$ for that 15-minute period before the 8-hour TWA exposure would be at or above $25 \mu\text{g}/\text{m}^3$. See 81 Fed. Reg. at 16706. Some examples of tasks that could generate very high short-term exposures include abrasive blasting and grinding, which are typically associated with high levels of visible dust. OSHA has identified carpenters, plumbers, and electricians as types of workers who may perform tasks (e.g., drilling with a handheld drill) involving occasional, brief exposures to silica that are incidental to their primary work. See 81 Fed. Reg. at 16706. Provided that these employees perform these tasks in isolation from activities that generate significant exposures to silica, and perform them for no more than 15 minutes throughout the work day, their exposures will usually fall below the AL of $25 \mu\text{g}/\text{m}^3$ as an 8-hour TWA under all foreseeable conditions; when that is the case, these employees will not be covered by the standard.

The CISC's approach here builds upon this FAQ. For short duration tasks – under 30 minutes – where an employee is performing those tasks in isolation, an employee could use respiratory protection, rather than engineering and work practice controls.

The CISC recommends that should an employer choose to adopt such a compliance approach for short duration tasks, the approach be set forth in the employer's Written Exposure Control Plan, so that employees are familiar with the approach, trained in it, and that respiratory protection is available and provided in accordance with OSHA's respiratory protection standard.

c. Permit Dry Sweeping and Dry Brushing When Performing Task for Less than 30 Minutes a Day in Isolation and Where Person Performing the Sweeping/Brushing has had no other Silica Exposure during the Day

One of the more difficult provisions in the respirable crystalline silica rule from a compliance perspective is the prohibition on dry sweeping and dry brushing. Sweeping and brushing is a common occurrence on construction worksites. Particularly in residential construction, sweeping and brushing is commonplace at the end of the day or shift.

OSHA initially included the prohibition because it had evidence that dry sweeping and dry brushing contributed to employee crystalline silica exposure. OSHA allows for wet sweeping or the use of vacuums as an alternative when performing housekeeping, unless the employer can demonstrate that wet sweeping or vacuuming is infeasible.

OSHA has issued some FAQs regarding the prohibition to provide some additional clarity to contractors regarding compliance. FAQ No. 25 states:

Under the standard, an employer may not allow the use of dry sweeping or dry brushing where such activity could contribute to employee exposure to silica unless wet sweeping, HEPA-filtered vacuuming, or other methods that minimize the likelihood of exposure are not “feasible.” 29 C.F.R. § 1926.1153(f)(1). The standard contains a similar prohibition on the use of compressed air to clean clothing or surfaces; such use is prohibited unless the compressed air is used in conjunction with a ventilation system that effectively captures the dust cloud created by the compressed air or “[n]o alternative method is feasible.” 29 C.F.R. § 1926.1153(f)(2). What is the definition of “feasible” in this context?

The standard does not require employers to demonstrate that wet methods, a HEPA-filtered vacuum, or other methods are impossible to use in order to establish “infeasibility” for purposes of paragraph (f). As explained in the preamble to the standard, the limited “infeasibility” exceptions included in these housekeeping provisions are intended to encompass situations where wet methods, HEPA-filtered vacuuming, and other exposure-minimizing methods are not effective, would cause damage, or would create a hazard in the workplace. *See* 81 Fed. Reg. at 16795-96. For example, an employer can establish infeasibility for these purposes by demonstrating that wet sweeping, using a HEPA-filtered vacuum, and other methods that minimize the likelihood of exposure would negatively impact the quality of the work being done. However, even in cases where one of the acceptable cleaning methods may not be feasible, employers may be able to use another acceptable cleaning method.

In another FAQ, OSHA clarifies that the prohibition does not apply when there are just *de minimis* exposures, those below the action level:

If employee exposure will remain below the AL of 25 µg/m³ as an 8-hour TWA under any foreseeable conditions, does the prohibition on dry sweeping, dry brushing, and the use of compressed air for cleaning clothing and surfaces apply?

No, none of the standard's requirements apply if, without implementing any controls, exposures will remain below the AL under any foreseeable conditions. Employers should note, however, that dry sweeping, dry brushing, and the use of compressed air, either alone or in combination with other tasks, can result in exposures at or above the AL, and thus coverage under the standard. Employers should consider the duration of the dry sweeping, dry brushing, or use of compressed air; the location and frequency of the tasks; and other factors in determining whether employee exposures will remain below the AL under any foreseeable conditions. (Note that the standard's housekeeping provisions apply in areas where dry sweeping, dry brushing, or the use of compressed air could contribute to the exposures of any employees who are covered by the standard.)

This FAQ, while interpreting the scope of the standard, also recognizes that the prohibition does not apply where exposures to crystalline silica are *de minimis* and isolated. The CISC believes that this should be explicitly recognized in a revised standard. Specifically, the CISC recommends that the prohibition should not apply in those instances where the dry sweeping and dry brushing is limited to 30 minutes, is performed in isolation, and the employee performing the sweeping has had no other respirable crystalline silica exposure throughout the day.

Such a rule would ease compliance burdens without sacrificing employee protection. It would allow for a common practice, particularly in residential construction, of sweeping and brushing at the end of the day, provided the contractor can do so consistent with the work practices outlined. It also reflects what is implicit in FAQ No. 23, that where exposures are very low, the prohibition on dry sweeping and dry brushing is not necessary.

The CISC is NOT recommending that OSHA re-examine the entire prohibition at this time. However, this easing of the requirement where exposures are *de minimis* is appropriate and will not sacrifice workplace safety.

7. Adopt "Expanded" Table 1 for Tasks Supported by Adequate Data through Interim Final Rulemaking.

The CISC has consistently noted the significance of the respirable crystalline silica standard to the construction industry. Unlike all other health hazards regulated by OSHA, crystalline silica is everywhere on construction worksites and is present in virtually all foundational construction materials.

Table 1 also constituted a first-of-its-kind approach to regulating a health hazard, by prescribing for contractors specific controls and respiratory protection to use when performing

common construction tasks. As noted above, however, Table 1 is too limiting at this time and contractors, thus, cannot always follow it. It needs to be expanded – and quickly – to improve overall compliance with the standard.

Furthermore, technology continues to improve and manufacturers of equipment develop new control measures, vacuum systems, shrouds, and water delivery methods that protect employees. Without a quick and easy method to continue to update Table 1, OSHA may end up stifling the type of innovation that it seeks to create. The development of Table 1 demonstrated the creativity of the Agency. The CISC encourages the Agency to continue that creativity by developing a process to quickly and efficiently “update” Table 1.

To that end, the CISC strongly recommends that OSHA commit to updating Table 1 on an ongoing basis through the interim final rulemaking process. This would involve two steps.

- *First*, the Agency would develop set criteria for data submission for new control technology on a going-forward basis. The characteristics of the data that OSHA set forth in this RFI could be used as a starting point; however, for this ongoing update project, we recommend that the Agency specifically seek comment or hold stakeholder meetings on the parameters of the data needed. Parameters such as number of samples for a task, variety of conditions to be examined, worst-case conditions evaluated, etc. should be part of the overall criteria.
- *Second*, once the criteria is established, OSHA should publish it and allow the submission of information to the Agency on an ongoing basis for the Agency’s consideration. If the Agency determines that the submission satisfies the criteria established, the Agency will issue an interim final rule permitting use of the control measure, along with an identical proposed rule providing the public an opportunity to comment on it. Should OSHA receive significant negative comment on allowing the control measure – something that should be rare given the criteria established by the Agency – the Agency could rescind the interim final rule and proceed with rulemaking on the proposed rule. However, if no negative comment is received, OSHA could simply withdraw the proposed rule and the final rule would already be in place.

Provided the Agency adopts criteria that is widely accepted by stakeholders, the likelihood of significant negative comment on a particular control measure is low. The interim final rule procedure, however, is designed to allow for that possibility while streamlining the rulemaking process and contributing to the “market place of ideas” with respect to engineering controls for respirable crystalline silica.

8. Economic Considerations.

The RFI also requests information on any economic impacts that should be considered in determining whether to update Table 1, along with information about how small entities could be affected if OSHA decides to revise Table 1.

As described above, member company feedback has been almost universal in noting the difficulties in compliance with Table 1. For all of the reasons described above, Table 1 is too limiting for it to be an effective compliance option. As a result, contractors are being forced to spend additional resources on trying to follow the Alternative Exposure Control Method for compliance. This involves exposure assessment and application of uncertain engineering or work practice controls in a wide variety of environments and workplace conditions.

Furthermore, while industry and equipment manufacturers are working to provide objective data for contractor use when following the Alternative Exposure Control Method, some of that data is not universally applicable to the wide variety of construction worksites and conditions. The limitations of Table 1 result in significant costs to contractors and, as a result, also diminish overall compliance with the rule.

The CISC firmly believes that implementing the recommended adjustments to the rule that are set forth here will result in improved compliance and significant cost savings. Even just allowing a “dry” option for the first several items on Table 1 should result in significant cost savings. Incorporating the use of floor or pedestal fans or air scrubbers will also result in cost savings, when used by themselves or in conjunction with other control measures. The latter two options would be particularly useful for small and very small entities.

During the initial rulemaking, the CISC predicted that the costs of the rule would be significantly greater than what OSHA estimated. Part of this related to some of the underlying assumptions used by OSHA, but part related to the CISC’s view that Table 1 would not be able to be used universally by the construction industry. The feedback that CISC member companies have provided supports the CISC’s initial position.

Notwithstanding this, OSHA has the opportunity to adjust the rule to reduce its costs while not sacrificing employee health. OSHA should proceed to do so promptly.

9. Conclusion.

The CISC appreciates OSHA publishing the RFI and seeking ways to improve compliance with the respirable crystalline silica standard. This is a vitally important initiative for the construction industry. The CISC asks the Agency to seriously consider the recommendations included in this response, along with the data and information provided.

The CISC looks forward to continuing to work with the Agency in this important area.

American Road and Transportation Builders Association
American Society of Concrete Contractors
American Subcontractors Association
Associated Builders and Contractors
Associated General Contractors
Association of the Wall and Ceiling Industry
Concrete Sawing & Drilling Association
Construction & Demolition Recycling Association
Distribution Contractors Association
FCA International
Interlocking Concrete Pavement Institute
International Council of Employers of Bricklayers and Allied Craftworkers
Leading Builders of America
Mason Contractors Association of America
Mechanical Contractors Association of America
National Asphalt Pavement Association
National Association of Home Builders of the United States
National Association of the Remodeling Industry
National Demolition Association
National Electrical Contractors Association
National Roofing Contractors Association
National Utility Contractors Association
Natural Stone Council
Natural Stone Institute
Sheet Metal and Air Conditioning Contractors National Association
The Association of Union Constructors
Tile Roofing Industry Alliance

EXHIBIT 1



September 2, 2016

SPEC MIX, Inc.
1230 Eagan Industrial Road
Suite 160
Eagan, Minnesota 55121

ARS Environmental Health, Inc. performed three industrial hygiene assessments of employee exposure to respirable dust and respirable crystalline silica in Chicago, Illinois; Statesboro Georgia; and Scottsdale, Arizona during June, 2016. The purpose of these assessments was to define exposure risks to respirable crystalline silica, in light of OSHA's new standard for crystalline silica in construction 29CFR1926.1153, when using SPEC MIX silos according to manufacturer's instructions.

CONCLUSIONS

The risk of worker exposure to respirable crystalline silica and respirable particulate, at levels approaching or over the new OSHA Action Level and PEL was found to be low.

This study and these findings provide a good representation of standard masonry job site mortar mixing conditions.

FINDINGS and OBSERVATIONS

Results of Personal Sampling

Results of this assessment may be found in Table I of this report.

Respirable Crystalline Silica - No crystalline silica was found in 5 of the 6 samples collected. Observed work practices for the one sample where measureable levels were found, were judged to be poor and not in keeping with SPEC MIX recommendations. Even so, the observed exposure level was below the OSHA Action Level.

Respirable Dust - Measurable amounts of respirable dust were found in 5 of 6 samples. All levels were below the PEL for respirable dust.



Table I
Airborne Concentrations
Respirable Crystalline Silica and Respirable Dust
Chicago, Illinois Statesboro, Georgia and Scottsdale, Arizona
June, 2016
ARS Report No. 1640-090216

MASONRY PROJECT TEST SITES	RESPIRABLE DUST (8 HOUR AVG)		RESPIRABLE CRYSTALLINE SILICA (8 HOUR AVG)		
	OSHA PEL (mg/m ³)	Project Average (mg/m ³)	OSHA PEL* (µg/m ³)	OSHA Action Level (µg/m ³)	Project Average (µg/m ³)
Illinois: 2 Day Average	5.0	0.28	50	25	<13**
Georgia: 2 Day Average	5.0	0.93	50	25	13
Arizona: 2 Day Average	5.0	0.12	50	25	<10
Project 2 Day Average	5.0	0.44	50	25	12

*OSHA PEL (Construction) limits worker exposure to 50 µg of crystalline silica per cubic meter of air (µg/m³) averaged over an 8 hour day (29 CFR 11926.1153)

** Results are below analytical limit of quantification, therefore, none was found.

mg/m³ – milligrams of contaminant per cubic meter of air
 µg/m³ – micrograms of contaminant per cubic meter of air.

Crystalline silica analyses by X-Ray Diffraction using TIC-XRD-01/NIOSH 7500

Respirable Particulate analyses by Gravimetric analysis using TIC-GRV-01/NIOSH 0600

Analytical services provided by the Travelers' Industrial Hygiene Laboratory which is Accredited by the American Industrial Hygiene Association.



MATERIAL USE GUIDE



As a leader in preblended materials supply and on site delivery systems, SPEC MIX® takes pride in continuing to provide its customers with timely information and solutions to keep projects moving forward in a fashion that addresses worker safety and OSHA Standards. This booklet is designed to inform contractors of certain pertinent information regarding OSHA's New Crystalline Silica Rule for Construction (29 CFR 11926.1153) and to suggest certain controls that should reduce dust exposure when mixing SPEC MIX products at the mix station. For purposes of aiding the overall reduction of dust created from all activities conducted on a jobsite it is important to note that the new OSHA rule is not constrained to any specific construction product and is focused on construction activities that produce large amounts of fine particles, such as sawing, drilling and grinding and not where exposure will remain low under any foreseeable conditions, such as mixing mortar, pouring concrete footers, slab foundation and foundation walls or removing concrete framework.

The information and suggestions set forth in this booklet should not be construed or relied upon as legal advice or as setting forth a comprehensive understanding of the new OSHA rule or compliance with the new rule. Each contractor as an employer in the construction industry should seek the advice of its own professional advisors in understanding the new OSHA rules, its responsibilities under those new rules and the development of a compliance program of workplace controls/methods or other efforts that may be required to satisfy those responsibilities.

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The inserted "Fact Sheet" from OSHA covering the crystalline silica rule for construction is a brief resource to which the contractor may refer for OSHA guidance regarding compliance with the new rule, what activities should be monitored and other related information.)

Industrial Hygiene Assessment 6-8

This section of the booklet contains briefings of assessments obtained by SPEC MIX at certain jobsites where SPEC MIX products and silo systems were on site. SPEC MIX hired ARS Environmental to evaluate four jobsites across the country of different size and with aggregates of different composition to get across section of the average worker's exposure to dust on a jobsite when mixing materials. A contractor may wish to use this information to better understand and evaluate the mixing stations on your projects.

Work Control Practices for SPEC MIX Silo 9-11

SPEC MIX products and silo systems, when used properly and as designed, increase jobsite efficiency and consistency while minimizing exposure to dust. Like any other tool on site, it is of the utmost importance that the user is properly trained on its use to ensure that workers are not putting themselves at risk. This section of the booklet focuses on suggested Work Control Practices Guide intended to help train on-site personnel to use SPEC MIX silo systems and products in a safe way that should reduce unnecessary exposure to dust. Note that not all jobsite conditions are the same and that a contractor will need to assess the conditions at the mixing station to determine what, if any, adjustments need to be made to keep an employee in a position to reduce dust exposure.

Written Control Plan12-13

This section of the booklet contains a suggested Written Control Plan for the SPEC MIX mixing station. Your competent designee may use this form as a template when evaluating the unique mixing conditions on your jobsite to help develop a plan for mixing. This plan can be kept on file and used to educate employees as well as notify safety inspectors to the plan that your company has set in place for mixing materials on site.

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SPEC MIX Preblended Materials15

SPEC MIX products are preblended cement, aggregate and performance admixtures that are specifically designed for the application and consistent from the first to the last batch. This section of the booklet contains a listing of our basic product mixes.

SPEC MIX Silo Systems16

This section of the booklet includes all of the SPEC MIX silo systems that are available for use on construction sites today. Each silo system offers the contractor specific efficiency advantages to help maximize mixing station efficiency.

SPEC MIX Engineering Controls17

Should a jobsite condition make it necessary to incorporate additional protection, SPEC MIX does offer engineering controls that can be implemented at the contractors' option to help additionally reduce exposure to dust. This section of the booklet identifies two controls. It is important to note that proper training on how to use the silo systems and products can often create an on-site environment that reduces exposure to dust.

SPEC MIX hopes the information in this booklet is helpful. This booklet provides information about SPEC MIX products and their applications and invites customers' attention to the OSHA regulation and compliance guide, which customers should use in their work. Those OSHA documents should provide the basis for a customer's compliance program. This booklet is not itself a compliance guide. All SPEC MIX warranties are set forth in the documents accompanying the sale of the product. This booklet makes no additional warranties express or implied and provides no assurance regarding compliance with any third-party patents. SPEC MIX assumes no legal obligation or liability in connection with this booklet.

OSHA[®] FactSheet

OSHA's Crystalline Silica Rule: Construction

OSHA is issuing two standards to protect workers from exposure to respirable crystalline silica—one for construction, and the other for general industry and maritime—in order to allow employers to tailor solutions to the specific conditions in their workplaces.

Who is affected by the construction standard?

About two million construction workers are exposed to respirable crystalline silica in over 600,000 workplaces. OSHA estimates that more than 840,000 of these workers are exposed to silica levels that exceed the new permissible exposure limit (PEL).

Exposure to respirable crystalline silica can cause silicosis, lung cancer, other respiratory diseases, and kidney disease. Exposure can occur during common construction tasks such as using masonry saws, grinders, drills, jackhammers and handheld powered chipping tools; operating vehicle-mounted drilling rigs; milling; operating crushing machines; and using heavy equipment for demolition or certain other tasks.



Without dust controls, using a handheld power saw to cut concrete can expose workers to high levels of respirable crystalline silica.

The construction standard does not apply where exposures will remain low under any foreseeable conditions; for example, when only performing tasks such as mixing mortar; pouring concrete footers, slab foundation and foundation walls; and removing concrete formwork.

What does the standard require?

The standard requires employers to limit worker exposures to respirable crystalline silica and to take other steps to protect workers.

The standard provides flexible alternatives, especially useful for small employers. Employers can either use a control method laid out in Table 1* of the construction standard, or they can measure workers' exposure to silica and independently decide which dust controls work best to limit exposures to the PEL in their workplaces.

Regardless of which exposure control method is used, all construction employers covered by the standard are required to:

- Establish and implement a **written exposure control plan** that identifies tasks that involve exposure and methods used to protect workers, including procedures to restrict access to work areas where high exposures may occur.
- Designate a **competent** person to implement the written exposure control plan.
- Restrict **housekeeping** practices that expose workers to silica where feasible alternatives are available.
- Offer **medical exams**—including chest X-rays and lung function tests—every three years for workers who are required by the standard to wear a respirator for 30 or more days per year.

- **Train workers** on work operations that result in silica exposure and ways to limit exposure.
- **Keep records** of workers' silica exposure and medical exams.

What is Table 1?

Table 1 matches common construction tasks with dust control methods, so employers know exactly what they need to do to limit worker exposures to silica. The dust control measures listed in the table include methods known to be effective, like using water to keep dust from getting into the air or using ventilation to capture dust. In some operations, respirators may also be needed.

Employers who follow Table 1 correctly are not required to measure workers' exposure to silica and are not subject to the PEL.

Table 1 Example: Handheld Power Saws

If workers are sawing silica-containing materials, they can use a saw with a built-in system that applies water to the saw blade. The water limits the amount of respirable crystalline silica that gets into the air.

Table 1: Specified Exposure Control Methods When Working with Materials Containing Crystalline Silica			
Equipment/Task	Engineering and Work Practice Control Methods	Required Respiratory Protection and Minimum Assigned Protection Factor (APF)	
		≤ 4 hrs/shift	> 4 hrs/shift
(ii) Handheld power saws (any blade diameter)	<p>Use saw equipped with integrated water delivery system that continuously feeds water to the blade.</p> <p>Operate and maintain tool in accordance with manufacturer's instructions to minimize dust emissions.</p> <ul style="list-style-type: none"> • When used outdoors. • When used indoors or in an enclosed area. 	None	APF 10
		APF 10	APF 10

Excerpt from Table 1.

*See regulatory text for construction standard, with complete Table 1 at www.osha.gov/silica/SilicaConstructionRegText.pdf.

In this example, if a worker uses the saw outdoors for four hours or less per day, no respirator would be needed. If a worker uses the saw for more than four hours per day or any time indoors, he or she would need to use a respirator with an assigned protection factor (APF) of at least 10. In this case, a NIOSH-certified filtering facepiece respirator that covers the nose and mouth (sometimes referred to as a dust mask) could be used. If a worker needs to use a respirator on 30 or more days a year, he or she would need to be offered a medical exam.

Alternative exposure control methods

Employers who do not use control methods in Table 1 must:

- Measure the amount of silica that workers are exposed to if it may be at or above an **action level of 25 µg/m³** (micrograms of silica per cubic meter of air), averaged over an eight-hour day.
- Protect workers from respirable crystalline silica exposures above the **permissible exposure limit of 50 µg/m³**, averaged over an eight-hour day.
- Use **dust controls** to protect workers from silica exposures above the PEL.
- Provide **respirators** to workers when dust controls cannot limit exposures to the PEL.

When are employers required to comply with the standard?

Construction employers must comply with all requirements of the standard by June 23, 2017, except requirements for laboratory evaluation of exposure samples, which begin on June 23, 2018.

Additional information

Additional information on OSHA's silica rule can be found at www.osha.gov/silica.

OSHA can provide extensive help through a variety of programs, including technical assistance about effective safety and health programs, workplace consultations, and training and education.

OSHA's On-site Consultation Program offers free and confidential occupational safety and health services to small and medium-sized businesses in all states and several territories across the country, with priority given to high-hazard worksites. On-site consultation services are separate from enforcement and do not result in penalties or citations. Consultants from state agencies or universities work with employers to identify

workplace hazards, provide advice on compliance with OSHA standards, and assist in establishing and improving safety and health management systems. To locate the OSHA On-site Consultation Program nearest you, call 1-800-321-OSHA (6742) or visit www.osha.gov/dcsp/smallbusiness .

For more information on this and other health-related issues impacting workers, to report an emergency, fatality, inpatient hospitalization, or to file a confidential complaint, contact your nearest OSHA office, visit www.osha.gov , or call OSHA at 1-800-321-OSHA (6742), TTY 1-877-889-5627.

This is one in a series of informational fact sheets highlighting OSHA programs, policies or standards. It does not impose any new compliance requirements. For a comprehensive list of compliance requirements of OSHA standards or regulations, refer to Title 29 of the Code of Federal Regulations. This information will be made available to sensory-impaired individuals upon request. The voice phone is (202) 693-1999; teletypewriter (TTY) number: (877) 889-5627.

For assistance, contact us. We can help. It's confidential.



www.osha.gov (800) 321-OSHA (6742)



U.S. Department of Labor

DSGFS-3681 03/2016

As OSHA's new crystalline silica rule for construction was being developed, SPEC MIX took a proactive approach to better understanding how this rule will affect its silo systems and material used on site. In 2016, ARS Environmental Health, Inc. was contracted to run a series of three industrial hygiene assessments of workers' exposure to respirable dust and crystalline silica while using SPEC MIX products and silo systems. A follow up test was run in September of 2017 on one additional jobsite.

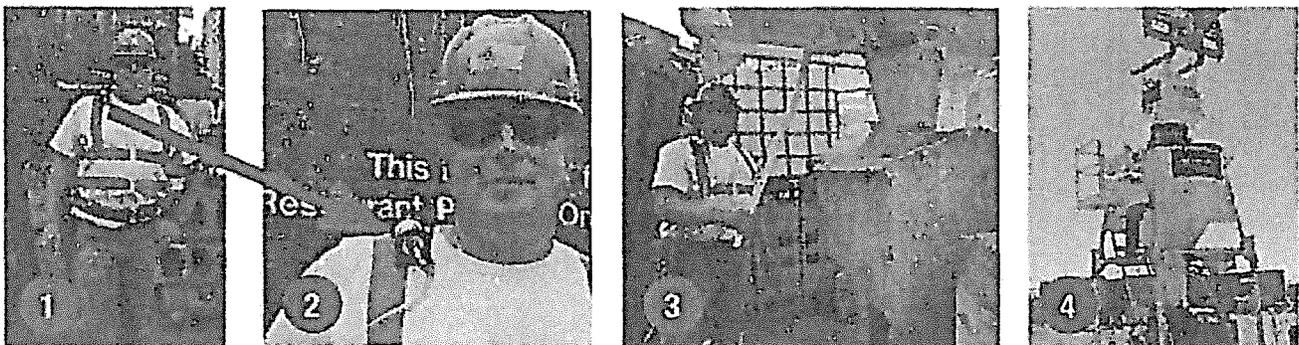
2016 Material Mixing Assessment

In 2016, three jobsites (Chicago, IL; Statesboro, GA; Scottsdale, AZ) were selected for evaluating a workers exposure to respirable dust and crystalline silica when using SPEC MIX silo systems and materials. The employees who were working the mixing stations were fitted with a personal sampling pump with a respirable dust cyclone (pictures 1 & 2) and monitored for two continuous days.

These jobsites had crews of between 8 and 12 workers, mixed between 4 and 7 double batches of material per worker and loaded between 1 and 4 bulk bags per day (pictures 3 & 4). The employees who were mixing the materials also performed other jobsite activities including building scaffold, shoveling mortar and grout, driving the forklift, carrying brick and block, cutting brick and block and laying block. They were generally exposed to all conditions on site.

Prior to the assessment, the workers who performed the mixing tasks were given SPEC MIX Work Control Practices training on how to best approach these tasks in a safe and responsible manner. In some cases the silos did employ an upper silo shroud, but not all silos. There were no engineering controls used between the silo and the mixer beyond the standard material dispensing chute.

The analysis of the samples collected showed that the workers monitored on these jobsites had an exposure level below the PEL (PERMISSIBLE EXPOSURE LIMIT) and below the Action Level of OSHA's New Crystalline Silica Rule for Construction in an 8 hour working day (Table 1).



INDUSTRIAL HYGIENE ASSESSMENT

2017 Material Mixing Assessment

In September of 2017, an additional study was commissioned in Dallas, TX using industrial hygienist ARS Environmental Health, Inc. The Dallas market was specifically selected because the mason sand/aggregate in this part of the country is known to have a high content of silica (quartz). The analysis was performed on a large project employing two masonry subcontractors with over 50 workers onsite. The employees who were working the mixing stations were fitted with a personal sampling pump that included a respirable dust cyclone while monitored for two continuous eight hour days.

The employees at the mixing station on this jobsite mixed between 13 and 52 double batches of material and loaded between 7 and 13 bulk bags per day. The employees who were mixing materials spent the majority of their time at the mixing station, mixing materials, loading silos and performing other tasks related to the mixing of materials. They were generally exposed to all conditions on site.

Prior to the assessment, the workers who performed the mixing tasks were given SPEC MIX Work Control Practices training on how to best approach these tasks in a safe and responsible manner. The silos did have engineering controls installed, specifically, an upper silo shroud and a mixer shroud (pictures 1 & 2).

The analysis of the samples collected showed that the workers monitored on this jobsite had an exposure level below the PEL (PERMISSIBLE EXPOSURE LIMIT) and below the Action Level of OSHA's New Silica Rule for Construction in an 8 hour working day (Table 2).

We note that some jobsites will include other activities, such as sawing concrete, which will produce dust that these assessments did not report. Where those activities occur on the jobsite, contractors will need to consider them in making their own assessments.

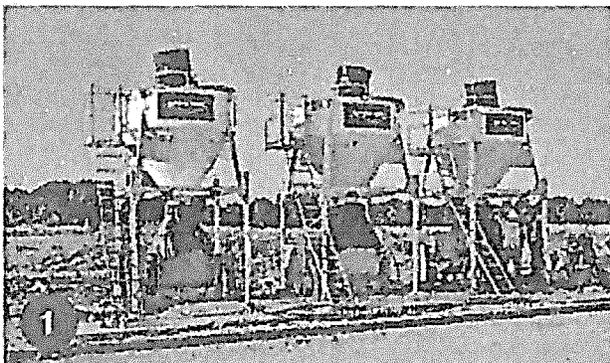




Table 1

Airborne Concentrations
Respirable Crystalline Silica and Respirable Dust
Chicago, Illinois Statesboro, Georgia and Scottsdale, Arizona

June, 2016

ARS Report No. 1640-090216

MASONRY PROJECT TEST SITES	RESPIRABLE DUST (8 HOUR AVG)		RESPIRABLE CRYSTALLINE SILICA (8 HOUR AVG)		
	OSHA PEL (mg/m ³)	Project Average (mg/m ³)	OSHA PEL* (µg/m ³)	OSHA Action Level (µg/m ³)	Project Average (µg/m ³)
Illinois: 2 Day Average	5.0	0.28	50	25	<13**
Georgia: 2 Day Average	5.0	0.93	50	25	13
Arizona: 2 Day Average	5.0	0.12	50	25	<10**
Project 2 Day Average	5.0	0.44	50	25	12

*OSHA PEL (Construction) limits worker exposure to 50 µg of crystalline silica per cubic meter of air (µg/m³) averaged over an 8 hour day (29 CFR 11926.1153)

** Results are below analytical limit of quantification, therefore, none was found.

mg/m³ – milligrams of contaminant per cubic meter of air

µg/m³ – micrograms of contaminant per cubic meter of air.

Crystalline silica analyses by X-Ray Diffraction using TIC-XRD-01/NIOSH 7500

Respirable Particulate analyses by Gravimetric analysis using TIC-GRV-01/NIOSH 0600

Analytical services provided by the Travelers' Industrial Hygiene Laboratory which is Accredited by the American Industrial Hygiene Association.



Table 2

Worker Exposure to
Respirable Dust and Respirable Crystalline Silica
Waxahachie, Texas

August 22 - 23, 2017

ARS Report No. 1725-082317

Date	Description	RESPIRABLE DUST (8 HOUR AVG)		RESPIRABLE CRYSTALLINE SILICA (8 HOUR AVG)		
		OSHA PEL (mg/m ³)	Project Average (mg/m ³)	OSHA PEL* (µg/m ³)	OSHA Action Level (µg/m ³)	Project Average (µg/m ³)
	Texas: 2 Day Average	5.0		50	25	
8/22/17	Masonry Contractor A	5.0	0.57	50	25	<8.2**
	Masonry Contractor B	5.0	0.62	50	25	<8.2**
8/23/17	Masonry Contractor A	5.0	0.22	50	25	19
	Masonry Contractor B	5.0	1.1	50	25	15

*OSHA PEL (Construction) limits worker exposure to 50 µg of crystalline silica per cubic meter of air (µg/m³) averaged over an 8 hour day (29 CFR 11926.1153)

** Results are below analytical limit of quantification, therefore, none was found.

mg/m³ – milligrams of contaminant per cubic meter of air

µg/m³ – micrograms of contaminant per cubic meter of air.

Crystalline silica analyses by X-Ray Diffraction using TIC-XRD-01/NIOSH 7500

Respirable Particulate analyses by Gravimetric analysis using TIC-GRV-01/NIOSH 0600

Analytical services provided by the Travelers' Industrial Hygiene Laboratory which is Accredited by the American Industrial Hygiene Association.

WORK CONTROL PRACTICES

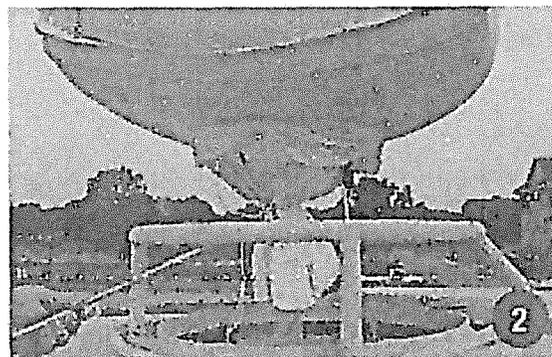
Reducing Unnecessary Exposure to Dust at the Mixing Station

SPEC MIX silo delivery systems are designed to increase productivity on site while adding to job site safety by reducing physical injury with their ergonomically correct design. The standard gravity or mechanical silos should also limit workers exposure to construction site mixing dust when the following best practices are incorporated into everyday use.

Loading the Silo:

1. Position silo in an area of open wind, avoiding enclosed or confined areas. (If silo enclosures are necessary for winter work, provide engineering controls to minimize dust exposure.)
2. Position the bulk bag over the top of the silo centered over the fill port and safety ring.
3. From the loading platform, position yourself so you are not downwind from the filling port to minimize exposure to dust (picture 1).
4. Lower the bulk bag to a position just above the safety ring.
5. Using the safety hook or your hand, reach under the safety ring and open the b-locks on the inner and outer chutes at the bottom of the bulk bag to dispense material into the silo (picture 2).
6. Climb down the ladder as the material dispenses into the silo to minimize exposure to dust while filling the silo (picture 3).
7. Using the forklift, continue to adjust the position of the bulk bag over the silo to keep the chute of the bulk bag as close as possible to the fill port to reduce dust.

If positioning upwind when loading the silo is not possible or if the contractor should want to use additional measures to reduce exposure to dust when loading a SPEC MIX silo system, the contractor should employ its own engineering controls or may contact SPEC MIX to explore additional manufacturer's engineering controls.



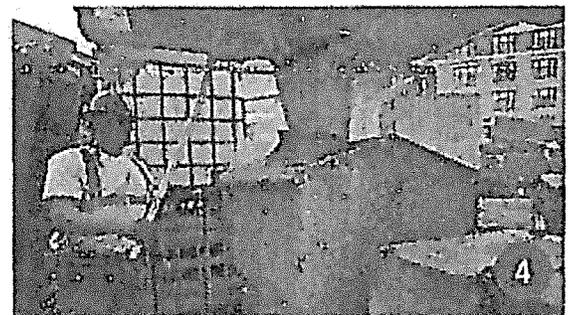
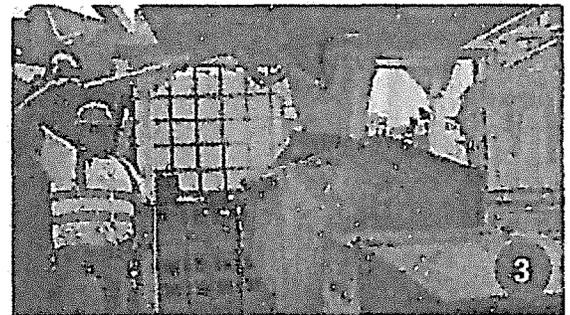
Silo Mixing Procedures:

1. Position silo in an area of open wind, avoiding enclosed or confined areas. (If silo enclosures are necessary for winter work, provide engineering controls to minimize dust exposure.)
2. Position the silo so the mason tender can be positioned with a crosswind over the mixer or upwind to keep dust from blowing into the face of the worker while mixing. Many SPEC MIX silos are equipped with rotating gates that allow for the handle to be moved without moving the silo itself. If necessary, remove the mixer from under the silo and reposition it in a different direction to keep the operator from standing in a downwind position (picture 1).
3. Fill the mixer with sufficient water to receive the material. It is beneficial to keep the initial batch wetter than required for final use to ensure complete hydration of the aggregate, reducing dust when charging the mixer and increasing board life of the final product (picture 2).
4. When opening the gate, take a stance that is away from the discharge of material to limit exposure to dust.
5. Open the gate with even force and only as wide as needed to allow for a good steady flow of material into the silo mixer. Opening at too great of a distance can cause product surges that have the potential to increase airborne particles. When the desired amount of material has been dispensed into the mixer, shut the gate with even force, maintaining distance from the mixer (picture 3).
6. As the wind shifts, make sure to position yourself with a cross wind or upwind to continue to avoid exposure to dust. If necessary, turn the mixer a different direction (picture 4).

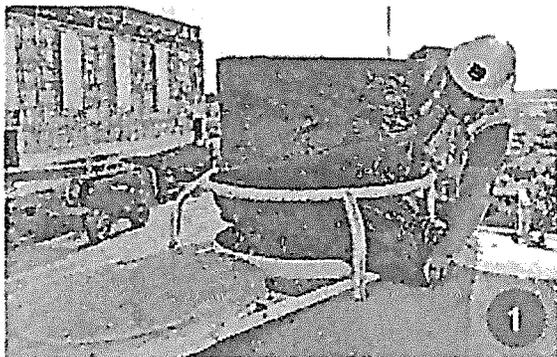
If positioning upwind when mixing is not possible or if the contractor should want to use additional measures to reduce exposure to dust when loading a SPEC MIX silo system, the contractor should employ its own engineering controls or may contact SPEC MIX to explore additional manufacturer's engineering controls.

Mixing 80 Pound Bag Product:

Always position the mixer with either a cross wind or upwind from work to keep dust from blowing into the face of the worker while mixing. This may require a change in the mixer position as the wind direction changes daily (picture 5).



WORK CONTROL PRACTICES



If positioning upwind when loading a silo or mixing is not possible or if the contractor should want to use additional measures to reduce exposure to dust when loading a SPEC MIX silo system, the contractor should employ its own engineering controls or may contact SPEC MIX to explore additional manufacturer's engineering controls.

SPEC MIX Silo Upper Shroud:

1. Install the Silo Upper Shroud into the fill port at the top of the silo. The end of the tube with the skirt should be positioned just above the top of the silo and draped down to close any air gaps between the Upper Dust Shroud and the silo (picture 1).
2. Position the bulk bag over the Silo Upper Shroud and lower the bulk bag so it compresses the upper shroud.
3. Reach under the safety ring, pull the upper dust shroud down from the bulk bag and release the inner and outer b-lock by hand or with the safety hook (picture 2).
4. Release the upper dust shroud to allow it to compress against the bulk bag.
5. Climb down the ladder as the material dispenses into the silo to minimize exposure to dust while filling the silo (picture 3).
6. Reposition the bulk bag as needed to keep a tight seal between the upper dust shroud and the bulk bag.

SPEC MIX Mixer Shroud:

1. Install the Mixer Shroud to the silo slide gate chute ring.
2. Cut the chute of the Mixer Shroud at the desired height to allow the shroud to hang over the mortar mixer so that the shroud falls down over the sides of the mixer drum approximately 2" in every direction (picture 4).
3. Strap the chute of the mixer shroud over the silo chute on the chute ring.

Additional Helpful Mixing Tips:

1. If the mixer cannot be repositioned, the use of a wind screen to block wind direction that is creating an upwind condition can be helpful.
2. When mixing in enclosed areas, the use of an evacuation fan can be helpful.

WRITTEN EXPOSURE CONTROL PLAN

Date: _____

Project: _____

Address: _____

City/State/Zip: _____

Competent Person: _____

Contractor: _____

Address: _____

City/State/Zip: _____

Contact #: _____

I. Description of Task—Mortar Mixing:

- Mixing SPEC MIX materials utilizing a SPEC MIX silo material delivery system.
- Mixing SPEC MIX 80 pound bag materials utilizing a paddle/barrel mixer.

II. SPEC MIX Preblended Materials used on site:

- Masonry Mortar
- Masonry Grout
- Stucco
- Other (description of product(s) used):

III. SPEC MIX Silo Systems in Use:

- G7000 Silo
- Ten Bag Silo
- Split Bell Silo
- Load N Go
- Masons Mix Silo
- PA4000
- PA1000
- D2W Silo Continuous Mixer

IV. SPEC MIX Engineering Controls in Use:

- Silo Shroud
- Mixer Shroud
- Other _____

WRITTEN EXPOSURE CONTROL PLAN

VI. Contractor Administered Engineering/Work Practice Control Plans

- Engineering Controls (ie: Windscreens or Fans, etc.)
- Work Practice Controls (ie: Positioning of worker or worker rotation, etc.)
- Other _____

VII. Respiratory Protection Program (type):

VIII. Housekeeping Measures Implemented on Jobsite:

IX. Restrictive Access Procedures:

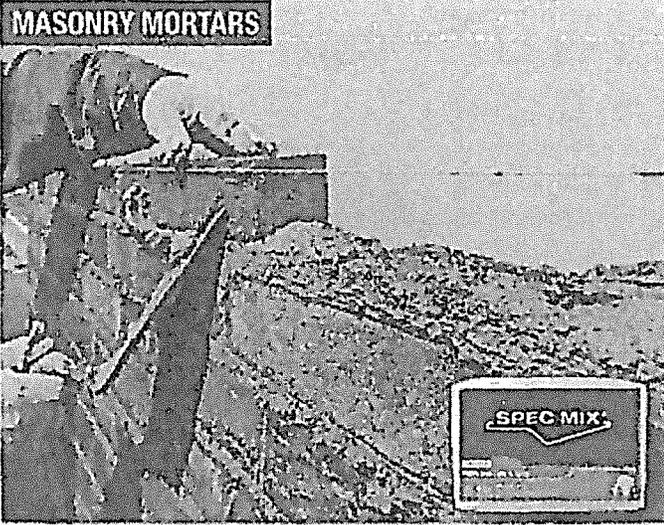
X. Description of Additional Mixing Systems and Procedures:

XI. Employee Exposure Training Program:

- Review SPEC MIX Work Practices Control Guide for Mixing Materials.
- Other _____

PREBLENDED MATERIALS - APPENDIX A

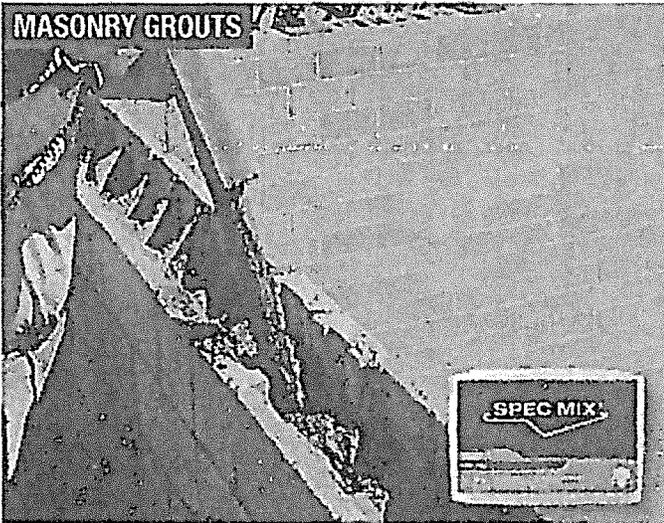
MASONRY MORTARS



PAVING MORTARS



MASONRY GROUTS



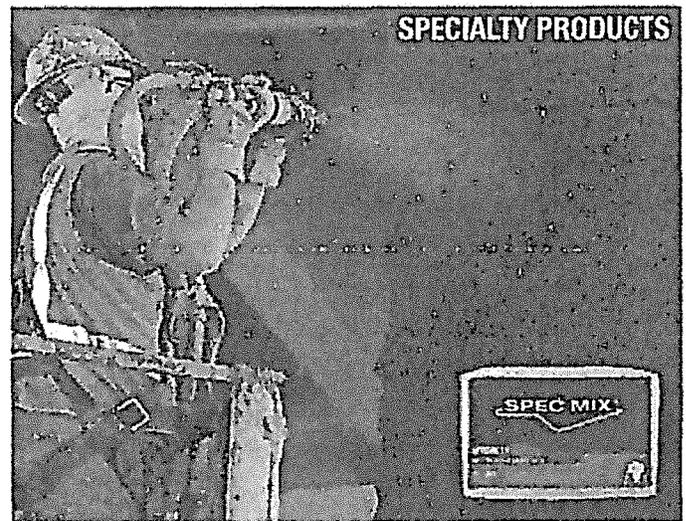
STUCCO BASE COATS



ADHERED VENEER MORTARS



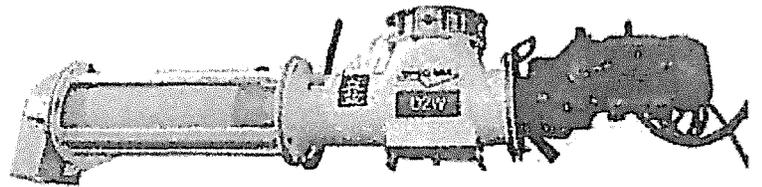
SPECIALTY PRODUCTS



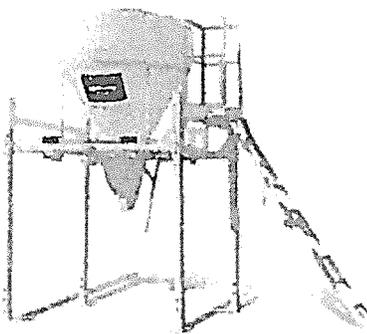
G7000
SILO SYSTEM



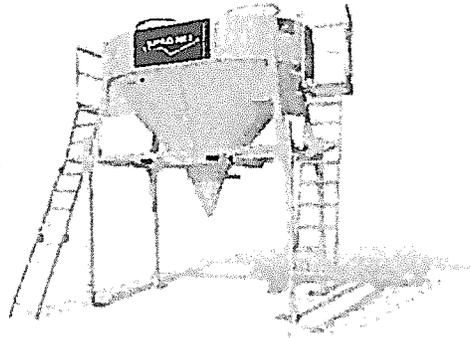
D2W
CONTINUOUS MIXING SYSTEM



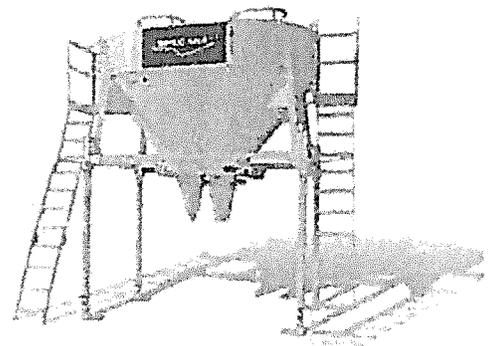
LOAD N GO®
SILO SYSTEM



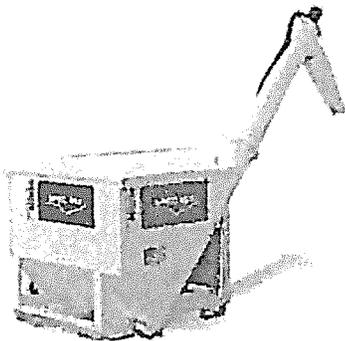
TEN BAGGER
SILO SYSTEM



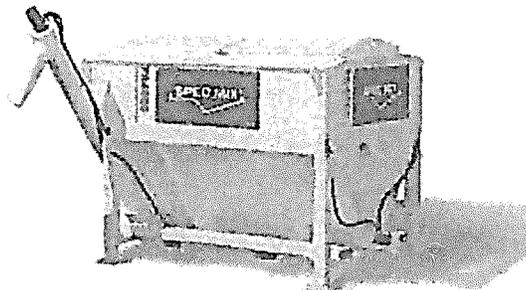
SPLIT SILO
SILO SYSTEM



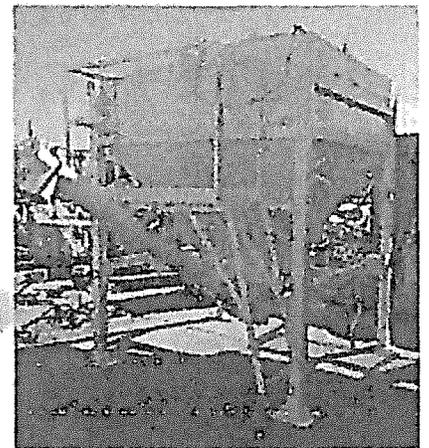
PA1000
POWER AUGER SYSTEM



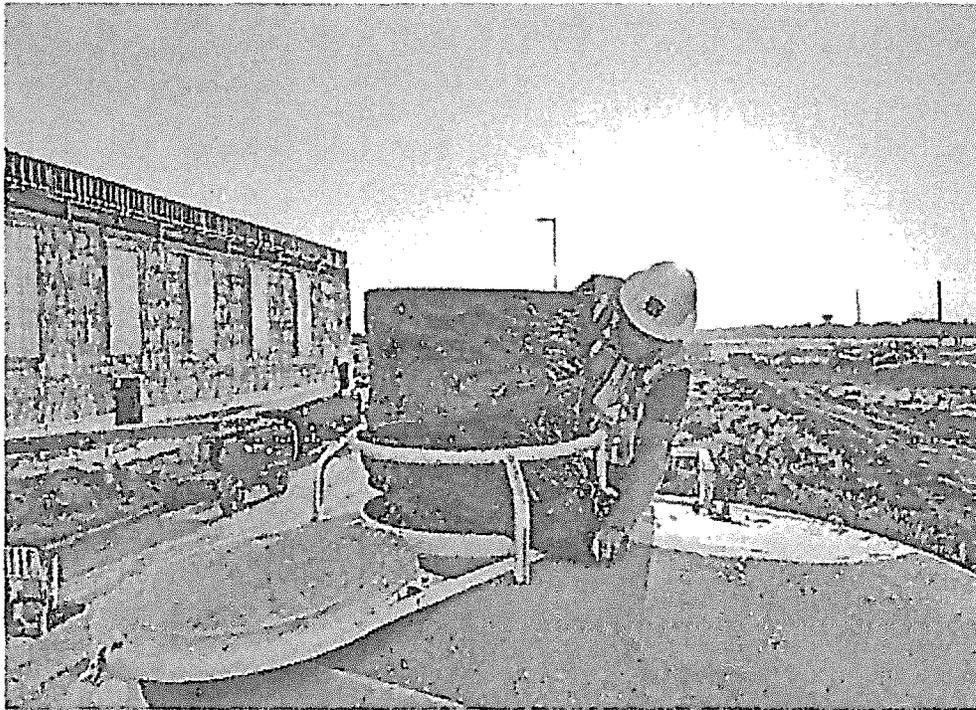
PA4000
POWER AUGER SYSTEM



MASONS MIX
POWER AUGER SYSTEM



UPPER SILO SHROUD



MIXER SHROUD



NOTES

NOTES

PHONE

1-888-SPEC MIX

1230 EAGAN INDUSTRIAL RD. STE 160, EAGAN, MN 55121

FAX 651-454-5315

WWW.SPECMIX.COM

SPEC MIX[™]

The logo for Spec Mix features the text "SPEC MIX" in a bold, sans-serif font. Below the text is a stylized graphic element consisting of a horizontal line that curves downwards at both ends, resembling a wide, shallow 'U' or a bridge-like structure.

EXHIBIT 2

EXHIBIT 3



Makita U.S.A., Inc.

14930 Northam Street, La Mirada, CA 90638, (714) 522-8088, Fax (714) 522-8133 or (714) 522-8194

Objective Data Testing for Concrete Surfacing/Grinding OSHA 29 CFR §1926.1153 Respirable Silica Dust Exposure Makita 7" Grinder (GA7011C) with Dust Extractor (VC4710)

Makita performed testing to determine the operator's exposure level to respirable crystalline silica dust¹. The purpose of the test was to produce "objective data" required for compliance under the exposure assessment performance option of OSHA respirable crystalline silica standard, 29 CFR §1926.1153(d)(2)(ii) when the task is performed under the same conditions tested by Makita.

Testing conditions:

- Test duration: 1 hour
- Room size: 8.4m x 5.1m x 4.9m (210m³)
- Room ventilation: Closed with no ventilation openings
- Base material: Concrete
- Weight of collected dust: 6900 g.
- Grinding orientation: Offset 15° from vertical
- Grinding height: 2' x 6' above floor level
- Applied force: 70-90% of the grinders rated amperage
- Sampler: 10 L/min GSP pump, FSP sampler. ISO 7708-compliant. 5 µm filter
- Volume of air sample collected by sampler during test: 600 liters

Results:

Dust Extractor	VC4710	VC4710	VC4710
Tool Used	GA7011C	GA7040S	GA9040S
Grinding Wheel	A-96425	A-96425	A-96425
Dust Attachment	195386-6	195386-6	195386-6
Connection Adapter	P-70421	P-40421	P-70421
Hose	P-79865	P-79865	P-79865
Time-Weighted Average Respirable Silica Dust Exposure^{2,3}	100 µg/m³	382 µg/m³	172 µg/m³

Interpretation Example: The 1 hour TWA for GA7011C is 100 µg/m³. Assuming no additional silica exposure occurs throughout an 8-hour work shift, the TWA for the 8-hour work shift would be 12.5 µg/m³. See reverse side for details on calculating TWA.

¹ Testing performed in accordance with EN 50632-1 and EN 50632-2-3.

² The silica content of base materials varies. As a result, the silica content in respirable dust samples also varies. The above-published exposure value is based on a 20% silica content applied to the total respirable dust measurement.

³ Exposure value is a representation of the time-weighted average (TWA) over the 1-hour test period. Due to the test being conducted in a closed room with no ventilation, this TWA silica exposure value would increase if the test duration was extended under the same conditions.



29 CFR §1926.1153(d)(2)(ii)
Performance Option
General Interpretation of "Time-Weighted Average"

Permissible Exposure Limit (PEL) is a legal limit for permissible exposure of an employee to respirable silica. The new OSHA statute requires the employer ensure that no employee is exposed to an airborne concentration of respirable crystalline silica in excess of $50 \mu\text{g}/\text{m}^3$, calculated as an 8-hour TWA. (29 CFR § 1926.1153(d)(1)). A TWA (time-weighted average) is the *average* exposure workers have to respirable silica over an eight-hour standardized work period. This means the exposure level as an 8-hour TWA is $\leq 50 \mu\text{g}/\text{m}^3$; a 4-hour TWA is $\leq 100 \mu\text{g}/\text{m}^3$ (assuming no exposure for the remainder of the shift); a 2-hour TWA is $\leq 200 \mu\text{g}/\text{m}^3$ (assuming no exposure for the remainder of the shift) and a 1-hour TWA is $\leq 400 \mu\text{g}/\text{m}^3$ (assuming no exposure for the remainder of the shift).

Calculating the TWA: A TWA is equal to the sum of the time period each task is performed multiplied by the level of silica dust exposure while performing the task, divided by the hours in the workday.

The following formula can be used to determine TWA:

$$\text{TWA} = [t_1c_1 + t_2c_2 + \dots + t_n c_n] / [t_1 + t_2 + \dots + t_n]$$

- "t" represents the time for each task, "c" indicates the concentration of silica exposure during the task and $\mu\text{g}/\text{m}^3$ indicates micrograms per cubic meter.
- The denominator (bottom number) for determining TWA for a workday would equal 8 hours. If exposure is different than 8 hours, the denominator would change to reflect the time period worked.
- **Example:** An employee is exposed to silica on 3 separate occasions in 3 discrete locations during an 8-hour work day. Task 1 was performed for 1 hour with an exposure of $200 \mu\text{g}/\text{m}^3$. Task 2 was performed for 2 hours with an exposure of $60 \mu\text{g}/\text{m}^3$. Task 3 was performed for 1.5 hours with an exposure of $40 \mu\text{g}/\text{m}^3$. The employee had no further silica exposure for the remaining 3.5 hours of his shift.

$$\text{8-hour TWA} = [(1 \text{ hour})(200 \mu\text{g}/\text{m}^3) + (2 \text{ hours})(60 \mu\text{g}/\text{m}^3) + (1.5 \text{ hours})(40 \mu\text{g}/\text{m}^3) + (3.5 \text{ hours})(0 \mu\text{g}/\text{m}^3)] / [1 \text{ hours} + 2 \text{ hours} + 1.5 \text{ hours} + 3.5 \text{ hours}]$$

$$\text{8-hour TWA} = [200 \mu\text{g}/\text{m}^3 + 120 \mu\text{g}/\text{m}^3 + 60 \mu\text{g}/\text{m}^3 + 0 \mu\text{g}/\text{m}^3] / [8 \text{ hours}]$$

$$\text{8-hour TWA} = [380 \mu\text{g}/\text{m}^3] / [8 \text{ hours}]$$

$$\text{8 hour TWA} = 47.5 \mu\text{g}/\text{m}^3$$

In this example, the employee's TWA ($47.5 \mu\text{g}/\text{m}^3$) is below the PEL of $50 \mu\text{g}/\text{m}^3$.



Makita U.S.A., Inc.

14930 Northam Street, La Mirada, CA 90638, (714) 522-8088, Fax: (714) 522-8133 or (714) 522-8194

**Objective Data Testing for Concrete Drilling
OSHA 29 CFR §1926.1153 Respirable Silica Dust Exposure
Makita Rotary Hammers with Dust Extractors DX01, XCV05Z &
HR2661/HR2651**

Makita performed testing to determine the operator's exposure level to respirable crystalline silica dust¹. The purpose of the test was to produce "objective data" required for compliance under the exposure assessment performance option of OSHA respirable crystalline silica standard, 29 CFR §1926.1153(d)(2)(ii) when the task is performed under the same conditions tested by Makita.

Testing conditions:

- Test duration: 1 hour
- Room size: 8.4m x 5.1m x 4.9m (210m³)
- Room ventilation: Closed with no ventilation openings
- Base material: Concrete
- Drilling orientation: Overhead
- Drilled hole dimensions: 5/8" x 2"
- Total holes drilled: 75
- Dust container on dust extractor emptied every 8 holes drilled with DX01 and every 25 holes drilled with XCV05Z
- Sampler: 10 L/min GSP pump, FSP sampler. ISO 7708-compliant. 5 µm filter
- Air sample volume collected by sampler during test: 600 liters

Results:

Dust Extractor	DX01	XCV05Z	XCV05Z	Incorporated
Tool Used	XRH01Z	XRH05Z	HR2641	HR2661/HR2651
Dust Attachment	DX01	193472-7	193472-7	N/A
Connection Adapter	N/A	417765-1	417765-1	N/A
Hose	N/A	143787-2	143787-2	N/A
Time-Weighted Average Respirable Silica Dust Exposure ³	22 µg/m ³	203 µg/m ³	270 µg/m ³	28 µg/m ³

The 1 hour TWA for XRH05Z is 203 µg/m³ and for HR2641 is 270 µg/m³. Assuming no additional silica exposure occurs throughout an 8-hour work shift, the TWA for the 8-hour work shift would be 26 µg/m³ and 34 µg/m³ respectively. See reverse side for details on calculating TWA.

¹ Testing performed in accordance with EN 50632 1 and EN 50632 2 6. Exception: EN 50632 2 6 specifies drilling one hundred twenty ø16mm x 50mm holes at a 15° downward-from-horizontal position; and the monitor be equipped with an 8-micron filter.

² The silica content of base materials varies. As a result, the silica content in respirable dust samples also varies. The above-published exposure value is based on a 20% silica content applied to the total respirable dust measurement.

³ Exposure value is a representation of the time-weighted average (TWA) over the 1-hour test period. Due to the test being conducted in a closed room with no ventilation, this TWA silica exposure value would increase if the test duration was extended under the same conditions.



29 CFR §1926.1153(d)(2)(ii) Performance Option General Interpretation of "Time-Weighted Average"

Permissible Exposure Limit (PEL) is a legal limit for permissible exposure of an employee to respirable silica. The new OSHA statute requires the employer ensure that no employee is exposed to an airborne concentration of respirable crystalline silica in excess of $50 \mu\text{g}/\text{m}^3$, calculated as an 8-hour TWA. (29 CFR § 1926.1153(d)(1)). A TWA (time-weighted average) is the *average* exposure workers have to respirable silica over an eight-hour standardized work period. This means the exposure level as an 8-hour TWA is $\leq 50 \mu\text{g}/\text{m}^3$; a 4-hour TWA is $\leq 100 \mu\text{g}/\text{m}^3$ (assuming no exposure for the remainder of the shift); a 2-hour TWA is $\leq 200 \mu\text{g}/\text{m}^3$ (assuming no exposure for the remainder of the shift) and a 1-hour TWA is $\leq 400 \mu\text{g}/\text{m}^3$ (assuming no exposure for the remainder of the shift).

Calculating the TWA: A TWA is equal to the sum of the time period each task is performed multiplied by the level of silica dust exposure while performing the task, divided by the hours in the workday.

The following formula can be used to determine TWA:

$$\text{TWA} = [t_1c_1 + t_2c_2 + \dots t_n c_n] / [t_1 + t_2 + \dots t_n]$$

- "t" represents the time for each task, "c" indicates the concentration of silica exposure during the task and $\mu\text{g}/\text{m}^3$ indicates micrograms per cubic meter.
- The denominator (bottom number) for determining TWA for a workday would equal 8 hours. If exposure is different than 8 hours, the denominator would change to reflect the time period worked.
- **Example:** An employee is exposed to silica on 3 separate occasions in 3 discrete locations during an 8-hour work day. Task 1 was performed for 1 hour with an exposure of $200 \mu\text{g}/\text{m}^3$. Task 2 was performed for 2 hours with an exposure of $60 \mu\text{g}/\text{m}^3$. Task 3 was performed for 1.5 hours with an exposure of $40 \mu\text{g}/\text{m}^3$. The employee had no further silica exposure for the remaining 3.5 hours of his shift.

$$\text{8-hour TWA} = [(1 \text{ hour})(200 \mu\text{g}/\text{m}^3) + (2 \text{ hours})(60 \mu\text{g}/\text{m}^3) + (1.5 \text{ hours})(40 \mu\text{g}/\text{m}^3) + (3.5 \text{ hours})(0 \mu\text{g}/\text{m}^3)] / [1 \text{ hours} + 2 \text{ hours} + 1.5 \text{ hours} + 3.5 \text{ hours}]$$

$$\text{8-hour TWA} = [200 \mu\text{g}/\text{m}^3 + 120 \mu\text{g}/\text{m}^3 + 60 \mu\text{g}/\text{m}^3 + 0 \mu\text{g}/\text{m}^3] / [8 \text{ hours}]$$

$$\text{8-hour TWA} = [380 \mu\text{g}/\text{m}^3] / [8 \text{ hours}]$$

$$\text{8 hour TWA} = 47.5 \mu\text{g}/\text{m}^3$$

In this example, the employee's TWA ($47.5 \mu\text{g}/\text{m}^3$) is below the PEL of $50 \mu\text{g}/\text{m}^3$.



Makita U.S.A., Inc.

14930 Northam Street, La Mirada, CA 90638, (714) 522-8088, Fax: (714) 522-8133 or (714) 522-8194

Objective Data Testing for Concrete Drilling OSHA 29 CFR §1926.1153 Respirable Silica Dust Exposure Makita Rotary Hammers with Dust Extractor XCV05Z

Makita performed testing to determine the operator's exposure level to respirable crystalline silica dust. The purpose of the test was to produce "objective data" required for compliance under the exposure assessment performance option of OSHA respirable crystalline silica standard, 29 CFR §1926.1153(d)(2)(ii) when the task is performed under the same conditions tested by Makita.

Testing conditions:

- Test duration: 1 hour
- Room size: 8.4m x 5.1m x 4.9m (210m³)
- Room ventilation: Closed with no ventilation openings
- Base material: Concrete
- Drilling orientation: 15° downward-from-horizontal position
- Drilled hole dimensions: 5/8" x 2"
- Total holes drilled: 120
- Dust container on dust extractor emptied every 30 holes drilled with XCV05Z
- Sampler: 10 L/min GSP pump, FSP sampler. ISO 7708-compliant. 5 µm filter
- Air sample volume collected by sampler during test: 600 liters

Results:

Dust Extractor	XCV05	XCV05Z	XCV05Z	XCV05Z	XCV05Z	XCV05Z
Tool Used	XRH03Z	XRH04Z	XRH06Z ¹	RH01 ¹	HR2475	HR2811F
Dust Attachment	193472-7	193472-7	198362-9	198362-9	193472-7	193472-7
Connection Adapter	417765-1	417765-1	417765-1	417765-1	417765-1	417765-1
Hose	143787-2	143787-2	143787-2	143787-2	143787-2	143787-2
Time-Weighted Average Respirable Silica Dust Exposure ^{2,3}	92 µg/m ³	103 µg/m ³	30 µg/m ³	37 µg/m ³	105 µg/m ³	85 µg/m ³

Interpretation Example: The 1 hour TWA for XRH03Z is 92 µg/m³. Assuming no additional silica exposure occurs throughout an 8-hour work shift, the TWA for the 8-hour work shift would be 11.5 µg/m³. See reverse side for details on calculating TWA.

¹ Testing performed in accordance with EN 50632-1 and EN 50632-2-6. Exception: EN 50632-2-6 specifies drilling one hundred twenty ø16mm x 50mm; and rotary hammer models XRH06Z and RH01 have been tested drilling 10mm x 50mm size holes.

² The silica content of base materials varies. As a result, the silica content in respirable dust samples also varies. The above-published exposure value is based on a 20% silica content applied to the total respirable dust measurement.

³ Exposure value is a representation of the time-weighted average (TWA) over the 1-hour test period. Due to the test being conducted in a closed room with no ventilation, this TWA silica exposure value would increase if the test duration was extended under the same conditions.



29 CFR §1926.1153(d)(2)(ii) Performance Option General Interpretation of "Time-Weighted Average"

Permissible Exposure Limit (PEL) is a legal limit for permissible exposure of an employee to respirable silica. The new OSHA statute requires the employer ensure that no employee is exposed to an airborne concentration of respirable crystalline silica in excess of $50 \mu\text{g}/\text{m}^3$, calculated as an 8-hour TWA. (29 CFR § 1926.1153(d)(1)). A TWA (time-weighted average) is the *average* exposure workers have to respirable silica over an eight-hour standardized work period. This means the exposure level as an 8-hour TWA is $\leq 50 \mu\text{g}/\text{m}^3$; a 4-hour TWA is $\leq 100 \mu\text{g}/\text{m}^3$ (assuming no exposure for the remainder of the shift); a 2-hour TWA is $\leq 200 \mu\text{g}/\text{m}^3$ (assuming no exposure for the remainder of the shift) and a 1-hour TWA is $\leq 400 \mu\text{g}/\text{m}^3$ (assuming no exposure for the remainder of the shift).

Calculating the TWA: A TWA is equal to the sum of the time period each task is performed multiplied by the level of silica dust exposure while performing the task, divided by the hours in the workday.

The following formula can be used to determine TWA:

$$\text{TWA} = [t_1c_1 + t_2c_2 + \dots + t_n c_n] / [t_1 + t_2 + \dots + t_n]$$

- "t" represents the time for each task, "c" indicates the concentration of silica exposure during the task and $\mu\text{g}/\text{m}^3$ indicates micrograms per cubic meter.
- The denominator (bottom number) for determining TWA for a workday would equal 8 hours. If exposure is different than 8 hours, the denominator would change to reflect the time period worked.
- **Example:** An employee is exposed to silica on 3 separate occasions in 3 discrete locations during an 8-hour work day. Task 1 was performed for 1 hour with an exposure of $200 \mu\text{g}/\text{m}^3$. Task 2 was performed for 2 hours with an exposure of $60 \mu\text{g}/\text{m}^3$. Task 3 was performed for 1.5 hours with an exposure of $40 \mu\text{g}/\text{m}^3$. The employee had no further silica exposure for the remaining 3.5 hours of his shift.

$$\text{8-hour TWA} = [(1 \text{ hour})(200 \mu\text{g}/\text{m}^3) + (2 \text{ hours})(60 \mu\text{g}/\text{m}^3) + (1.5 \text{ hours})(40 \mu\text{g}/\text{m}^3) + (3.5 \text{ hours})(0 \mu\text{g}/\text{m}^3)] / [1 \text{ hours} + 2 \text{ hours} + 1.5 \text{ hours} + 3.5 \text{ hours}]$$

$$\text{8-hour TWA} = [200 \mu\text{g}/\text{m}^3 + 120 \mu\text{g}/\text{m}^3 + 60 \mu\text{g}/\text{m}^3 + 0 \mu\text{g}/\text{m}^3] / [8 \text{ hours}]$$

$$\text{8-hour TWA} = [380 \mu\text{g}/\text{m}^3] / [8 \text{ hours}]$$

$$\text{8 hour TWA} = 47.5 \mu\text{g}/\text{m}^3$$

In this example, the employee's TWA ($47.5 \mu\text{g}/\text{m}^3$) is below the PEL of $50 \mu\text{g}/\text{m}^3$.

EXHIBIT 4

Silica Sampling Summary

The Occupational Safety and Health Administration (OSHA) has issued a final rule to curb lung cancer, silicosis, chronic obstructive pulmonary disease and kidney disease in American workers by limiting their exposure to respirable crystalline silica by lowering the permissible exposure limit (PEL) for respirable crystalline silica to 50 micrograms per cubic meter of air or 0.050 milligrams per cubic meter of air; averaged over an 8-hour shift.

Personal air monitoring for respirable crystalline silica was performed for simulated dry saw cutting with vacuum and rod drilling tasks for [REDACTED] on October 20, 2017. **The analysis for these tasks resulted in respirable crystalline silica levels as well as total respirable dust levels that are below regulatory limits.** The following paragraphs describe the observed work practices, sampling procedure, analytical methodology and results.

Observed Work Practices

One employee, [REDACTED] was monitored for respirable crystalline silica and total respirable dust during the simulated dry saw cutting with vacuum attachment and dry rod drilling tasks at the [REDACTED] worksite. Usually, the tasks are performed by a work crew of two to three employees who perform their work task in close proximity to each other for about two to three hours at a time. Please note however, that the actual sawing and rod drilling tasks take only a few minutes at a time and other work tasks are performed. The tasks are performed dry and the employee(s) performing this task are required to wear N95 dust masks. A small amount of visible dust was observed but only at the site of saw and/or drill contact which lasted for only a few minutes at a time. Please refer to attached picture file for these tasks.

Employee, [REDACTED] was observed wearing the following personal protective equipment (PPE), in addition to a N95 dust mask:

- Hard hat,
- Safety glasses with side shield,
- Hearing protection (ear plugs),
- Short sleeve work shirt and work type pants,
- Steel toe work boots, and
- Outer heavy cotton or leather work gloves as needed.

Sampling Procedure and Analytical Methodology

Karen Krall, a Certified Industrial Hygienist, performed the personal air monitoring. A total of four (4) personal air samples and two (2) area samples were collected during the saw cutting and rod drilling tasks using 37 millimeter (mm) mixed cellulose ester

(MCE) cassettes. Sampling was performed for 3 hours total for the saw cutting and rod drilling task monitored. Current U.S. method, NIOSH-7500 was used for both sampling and analytical procedures. Air monitoring samples were representative of the shift and representative of the employees' regular work. The personal air samples were collected with a flow rate of 2.7 liters per minute and a total volume of 486 liters. The calibrated air sampling pumps were provided by Field Environmental Services, Inc.

RJ Lee Group provided the sampling cassettes and performed the analysis and is an accredited laboratory participating in the National Institute of Occupational Safety and Health (NIOSH) and National Environmental Lab Accreditation Conference (NELAC) proficiency programs. A copy of the analysis report is attached.

Acceptable respirable crystalline silica dust concentrations for personal monitoring samples are not to exceed the Occupational Safety and Health (OSHA) permissible exposure level (PEL) of 50.0 micrograms per cubic meter of air ($\mu\text{g}/\text{m}^3$) or 0.050 milligrams per cubic meter of air (mg/m^3) averaged over an 8 hour time-weighted average (TWA). The Action Level is 25.0 $\mu\text{g}/\text{m}^3$. The three forms of respirable crystalline silica measured are Quartz, Cristobalite, and Tridymite. Acceptable total respirable dust concentrations are not to exceed the OSHA PEL of 5.0 mg/m^3 or 5000 $\mu\text{g}/\text{m}^3$ averaged over an 8 hour TWA.

Results and Discussion

The results for the analysis (see Table 1) of the personal and area sampling for the employee performing the simulated saw cutting and rod drilling tasks were below the regulatory levels for respirable crystalline silica and total respirable dust as mentioned above. These sampling results should be shared with the respective employee that was monitored as well as other applicable employees.

Under the new OSHA silica standard, employers are required to: use engineering controls (such as water or ventilation) to limit worker exposure to the PEL; provide respirators when engineering controls cannot adequately limit exposure; limit worker access to high exposure areas; develop a written exposure control plan, offer medical exams to highly exposed workers, and train workers on silica risks and how to limit exposures. Wet methods should be used and are highly recommended for all silica work activity.

As a final note, additional personal air samples could be obtained to fully characterize exposure during the saw cutting and rod drilling task and any other tasks where there is the potential for respirable crystalline silica exposure.

Respectfully Submitted,

Karen Krall

Karen Krall, CIH, 8720CP

The findings regarding site conditions and work practices do not constitute a warranty that all areas within the facility/site area are of the same quality or condition as those observed or sampled. If additional data concerning the facility, site, or work practices become available, such information should be provided to SMTC so that the results and conclusions may be reviewed and modified as necessary

Table 1

<u>Sample</u>	<u>Location</u>	<u>Total Respirable Dust</u> <u>PEL=5.0mg/m3 Or 5000.0ug/m3</u>	<u>Quartz mg/m3</u> <u>PEL=0.050 Mg/m3 Or 50.0 ug/m3</u>	<u>Cristobalite mg/m3</u>	<u>Tridymite mg/m3</u>
258655	Employee: [REDACTED] [REDACTED] Dry Saw Cutting Using IQ Saw Attached to Vacuum Cutting Brick	<0.208 mg/m3 <208.0 ug/m3	<0.010 mg/m3 <10.0 ug/m3	<0.010 mg/m3 <10.0 ug/m3	<0.010 mg/m3 <10.0 ug/m3
258651	Employee: [REDACTED] [REDACTED] Wet Saw Cutting Using 14" Table Saw	<0.208 mg/m3 <208.0 ug/m3	<0.010 mg/m3 <10.0 ug/m3	<0.010 mg/m3 <10.0 ug/m3	<0.010 mg/m3 <10.0 ug/m3
258661	Area Next to Dry Saw Cutting Using IQ Saw Attached to Vacuum Cutting Brick	<0.208 mg/m3 <208.0 ug/m3	0.021 mg/m3 21.0 ug/m3	<0.010 mg/m3 <10.0 ug/m3	<0.010 mg/m3 <10.0 ug/m3
258660	Employee: [REDACTED] [REDACTED] Dry Drilling Rods in Vertical	<0.208 mg/m3 <208.0 ug/m3	<0.010 mg/m3 <10.0 ug/m3	<0.010 mg/m3 <10.0 ug/m3	<0.010 mg/m3 <10.0 ug/m3
258650	Employee: [REDACTED] [REDACTED] Dry Drilling Rods in Horizontal	<0.208 mg/m3 <208.0 ug/m3	<0.010 mg/m3 <10.0 ug/m3	<0.010 mg/m3 <10.0 ug/m3	<0.010 mg/m3 <10.0 ug/m3
258658	Area Next to Dry Drilling Rods in Horizontal	<0.208 mg/m3 <208.0 ug/m3	<0.010 mg/m3 <10.0 ug/m3	<0.010 mg/m3 <10.0 ug/m3	<0.010 mg/m3 <10.0 ug/m3
258662	Sample Blank	<0.100 mg <100.0 ug	<0.005 mg <5.0 ug	<0.005 mg <5.0 ug	<0.005 mg <5.0 ug

Air Sampling Report

August 23, 2018

Respirable Dust and Crystalline Silica Exposure While Dry Cutting Concrete, Masonry, & Ceramic Tile Materials Utilizing Engineered Controls for Dust Collection

Air samples collected by:

iQ PowerTools
P.O. Box 7449
Moreno Valley, CA 92552
Telephone: (888) 274-7744
www.iqpowertools.com

Analytical report performed by:

ALS Global Environmental Laboratory
960 West LeVoy Drive, Salt Lake City UT 84123
Telephone 801-268-9992
www.alsglobal.com

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PC912v-030817-125876	iQPC912v	Operator's Breathing Zone for 480 min.	5
TS244-060617-125863	iQTS244	Operator's Breathing Zone for 480 min.	6
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Cutting Concrete Masonry Units with a 20" Stationary Masonry Saw (Air Sampling on the operator)

Test # iQ2000-030917-125844

Test: To measure the tool operators total respirable and crystalline silica dust exposure.

Work Process: Cutting the listed concrete/masonry materials.

Frequency: Typical number of cuts made by a tool operator 25—200 cuts per 8 hour day.

Material: 8x8x16 concrete masonry unit (CMU) ASTM C90 spec. US market > 1 billion annually.

Use: A typical concrete product used throughout the US to construct commercial and industrial buildings, site walls, retaining walls.

Cutting Equipment: MK 5009G 20" gas masonry saw for materials up to 8" high, 8" wide and 24" long.

Dust Collection Equipment: iQ2013G Dust Collection Vacuum 13 hp gas stationary saw and iQT20 20" Saw Dust Collection Table

Number of Cuts Made: 200 thru both the face shells of an 8x8x16 concrete masonry unit (CMU).

Air Sampling Location and Duration: In saw operator's breathing zone for 480 min.

Sample information: Lab Sample ID# 1707204001, March 09, 2017.



Testing Laboratory: ALS Global Environmental Laboratory, 960 West LeVoy Drive, Salt Lake City UT 84123
ALS Analytical Results: Sample ID 1707204001

August 23, 2018

Sample ID: iQ2000-030917-125844		Collected: 03/09/2017			
Lab ID: 1707204001		Received: 03/13/2017			
Method: NIOSH 0600 Mod., MW PVC Filter		Media: PVC Filter	Analyzed: 03/14/2017 (186888)		
		Sampling Info: Air Volume 1320 L			
Analyte	Result (mg/sample)	Result (mg/m ³)	RL (mg/sample)		
Respirable Dust	0.26	0.19	0.020		
Method: NIOSH 7500 Mod.		Media: PVC Filter	Analyzed: 03/15/2017 (186965)		
		Sampling Info: Air Volume 1320 L			
Analyte	Result (mg/sample)	Result (ug/m ³)	Result (%)	LOD (mg/sample)	RL (mg/sample)
Quartz	0.038	29	15	0.010	0.030

Monitoring and Analysis Methods

The air samples were collected at iQ Power Tools, 4635 Wade Avenue, Perris, CA, 92571 on one iQ Power Tools employee on March 9th, 2017 during concrete masonry dry cutting activities. The air samples were collected using SKC Brand of AirCheck Touch air sampling pumps on pre-weighted 3-piece matched weight 37 mm PVC filter media and SKC GS-3 plastic cyclones (SKC Part # 225-100) at a flow rate of 2.75 liters per minute (LPM). The air sampling flow rate was pre-calibrated and post calibrated with a SKC Checkmate calibrator (part # SKC 375-07550N). Analysis was conducted at an AIHA accredited laboratory, ALS Laboratory in Salt Lake City, Utah for the analysis of respirable dust and silica. The test was conducted in accordance with current OSHA regulations. The analysis was completed using National Institute of Occupational Safety and Health (NIOSH) method 0600 and method 7500.

Cutting Concrete Paver with a 14" Masonry Saw (Air Sampling on the operator)**Test # iQ360x-030817-125847****Test:** To measure the tool operator's total respirable and crystalline silica dust exposure.**Work Process:** Cutting the listed concrete/masonry materials.**Frequency:** Typical number of cuts made by a tool operator 25—200 cuts per 8 hour day.**Material:** Manufactured Concrete Paver 4"x8" Unit—US market > 100 million annually.**Use:** A typical concrete product used throughout the US to construct residential and commercial projects.**Cutting Equipment:** iQ360x electric masonry 14" saw for materials up to 5" high, 12" wide and 12" long.**Dust Collection Equipment:** iQ360x 14" masonry saw with integrated vacuum, filter and dust containment system.**Number of Cuts Made:** 200 thru cuts in material size 2.25" thick by 4" wide by 8" long**Air Sampling Location and Duration:** In saw operator's breathing zone for 480 min.**Sample information:** Lab Sample ID# 1707204002 March 08, 2017

Testing Laboratory: ALS Global Environmental Laboratory, 960 West LeVoy Drive, Salt Lake City UT 84123
ALS Analytical Results: Sample ID 1707204002

August 23, 2018

Sample ID: iQ360x-030817-125847		Collected: 03/08/2017			
Lab ID: 1707204002		Received: 03/13/2017			
Method: NIOSH 0600 Mod., MW PVC Filter		Media: PVC Filter	Analyzed: 03/14/2017 (186888)		
		Sampling Info: Air Volume 1320 L			
Analyte	Result (mg/sample)	Result (mg/m ³)	RL (mg/sample)		
Respirable Dust	0.27	0.21	0.020		
Method: NIOSH 7500 Mod.		Media: PVC Filter	Analyzed: 03/15/2017 (186965)		
		Sampling Info: Air Volume 1320 L			
Analyte	Result (mg/sample)	Result (ug/m ³)	Result (%)	LOD (mg/sample)	RL (mg/sample)
Quartz	0.036	27	13	0.010	0.030

Monitoring and Analysis Methods

The air samples were collected at iQ Power Tools, 4635 Wade Avenue, Perris, CA, 92571 on one iQ Power Tools employee on March 8th, 2017 during concrete masonry dry cutting activities. The air samples were collected using SKC Brand of AirCheck Touch air sampling pumps on pre-weighted 3-piece matched weight 37 mm PVC filter media and SKC GS-3 plastic cyclones (SKC Part# 225-100) at a flow rate of 2.75 liters per minute (LPM). The air sampling flow rate was pre-calibrated and post calibrated with a SKC Checkmate calibrator (part # SKC 375-07550N). Analysis was conducted at an AIHA accredited laboratory, ALS Laboratory in Salt Lake City, Utah for the analysis of respirable dust and silica. The test was conducted in accordance with current OSHA regulations. The analysis was completed using National Institute of Occupational Safety and Health (NIOSH) method 0600 and method 7500.

Cutting Concrete Masonry Units with a 12" Hand Held Saw (Air Sampling on the operator)

Test # PC912v-030817-125876

Test: To measure the tool operators total respirable and crystalline silica dust exposure.

Work Process: cutting the listed concrete/masonry materials.

Frequency: Typical number of cuts made by a tool operator 25—100 cuts per 8 hour day.

Material: 8x8x16 concrete masonry unit (CMU) ASTM C90 spec. US market > 1 billion annually.

Use: A typical concrete product used throughout the US to construct commercial and industrial buildings, site walls, retaining walls.

Cutting Equipment: iQPC912v 12" Gasoline power cutter

Dust Collection Equipment: iQPC912v Gasoline power cutter with integrated vacuum, filter, and dust containment system.

Number of Cuts Made: 100 cuts thru the face shells of an 8x8x16 concrete masonry unit (CMU).

Air Sampling Location and Duration: In saw operator's breathing zone for 480 min.

Sample information: Lab Sample ID# 1707204003 March 08, 2017.



Testing Laboratory: ALS Global Environmental Laboratory, 960 West LeVoy Drive, Salt Lake City UT 84123
ALS Analytical Results: Sample ID 1707204003

August 23, 2018

Sample ID: PC912v-030817-125876		Collected: 03/08/2017			
Lab ID: 1707204003		Received: 03/13/2017			
Method: NIOSH 0600 Mod., MW PVC Filter		Media: PVC Filter	Analyzed: 03/14/2017 (186888)		
		Sampling Info: Air Volume 1320 L			
Analyte	Result (mg/sample)	Result (mg/m ³)	RL (mg/sample)		
Respirable Dust	0.058	0.044	0.020		
Method: NIOSH 7500 Mod.		Media: PVC Filter	Analyzed: 03/15/2017 (186965)		
		Sampling Info: Air Volume 1320 L			
Analyte	Result (mg/sample)	Result (ug/m ³)	Result (%)	LOD (mg/sample)	RL (mg/sample)
Quartz	<0.010	<7.6	<17	0.010	0.030

Monitoring and Analysis Methods

The air samples were collected at iQ Power Tools, 4635 Wade Avenue, Perris, CA, 92571 on one iQ Power Tools employee on March 8th, 2017 during concrete masonry dry cutting activities. The air samples were collected using SKC Brand of AirCheck Touch air sampling pumps on pre-weighted 3-piece matched weight 37 mm PVC filter media and SKC GS-3 plastic cyclones (SKC Part # 225-100) at a flow rate of 2.75 liters per minute (LPM). The air sampling flow rate was pre-calibrated and post calibrated with a SKC Checkmate calibrator (part # SKC 375-07550N). Analysis was conducted at an AIHA accredited laboratory, ALS Laboratory in Salt Lake City, Utah for the analysis of respirable dust and silica. The test was conducted in accordance with current OSHA regulations. The analysis was completed using National Institute of Occupational Safety and Health (NIOSH) method 0600 and method 7500.

Cutting Ceramic Tile with a 10" Stationary Tile Saw (Air Sampling on the Operator)

Test # TS244-060617-125863

Test: To measure the tool operator's total respirable and crystalline silica dust exposure.

Work Process: Cutting the listed dry tile materials.

Frequency: Typical number of cuts made by a tool operator: 10—100 cuts per 8 hour day.

Material: Ceramic Tile. US market > 1 billion annually.

Use: A typical tile product used throughout the US in residential, commercial, and industrial buildings.

Cutting Equipment: 10" electric tile saw for materials up to 1" high, 24" wide and 24" long.

Dust Collection Equipment: iQTS244 10" tile saw with integrated vacuum, filter, and dust containment system.

Number of Cuts Made: 50 lineal feet in material size 3/8" thick by 16" wide by 16" long

Air Sampling Location and Duration: In saw operator's breathing zone for 480 min.

Sample information: Lab Sample ID# 1716335002, June 06, 2017



Testing Laboratory: ALS Global Environmental Laboratory, 960 West LeVoy Drive, Salt Lake City UT 84123

ALS Analytical Results: Sample ID 1716335002

August 23, 2018

Sample ID: TS244-060617-125863		Collected: 06/06/2017			
Lab ID: 1716335002		Received: 06/12/2017			
Method: NIOSH 0600 Mod., MW PVC Filter		Media: PVC Filter		Analyzed: 06/12/2017 (192415)	
		Sampling Info: Air Volume 1320 L			
Analyte	Result (mg/sample)	Result (mg/m ³)	RL (mg/sample)		
Respirable Dust	0.40	0.30	0.020		
Method: NIOSH 7500 Mod.		Media: PVC Filter		Analyzed: 06/13/2017 (192464)	
		Sampling Info: Air Volume 1320 L			
Analyte	Result (mg/sample)	Result (ug/m ³)	Result (%)	LOD (mg/sample)	RL (mg/sample)
Quartz	0.044	34	11	0.010	0.030

Monitoring and Analysis Methods

The air samples were collected at iQ Power Tools, 4635 Wade Avenue, Perris, CA, 92571 on one iQ Power Tools employee on June 6th, 2017 during tile dry-cutting activities. The air samples were collected using SKC Brand of AirCheck Touch air sampling pumps on pre-weighted 3-piece matched weight 37 mm PVC filter media and SKC GS-3 plastic cyclones (SKC Part # 225-100) at a flow rate of 2.75 liters per minute (LPM). The air sampling flow rate was pre-calibrated and post calibrated with a SKC Checkmate calibrator (part # SKC 375-07550N). Analysis was conducted at an AIHA accredited laboratory, ALS Laboratory in Salt Lake City, Utah for the analysis of respirable dust and silica. The test was conducted in accordance with current OSHA regulations. The analysis was completed using National Institute of Occupational Safety and Health (NIOSH) method 0600 and method 7500.

Cutting Concrete Paver with a 16.5" Masonry Saw (Air Sampling on the operator)**Test # MS362-080318-125871****Test:** To measure the tool operator's total respirable and crystalline silica dust exposure.**Work Process:** Cutting the listed concrete/masonry materials.**Frequency:** Typical number of cuts made by a tool operator: 25—200 cuts per 8 hour day.**Materials:** Manufactured Concrete Paver 4"x8" Unit—US market > 100 million annually, and Standard Red Face Brick—US Market > 100 million annually.**Use:** A typical concrete product used throughout the US to construct residential and commercial projects.**Cutting Equipment:** iQMS362 electric masonry 16.5" saw for materials up to 5.5" high, 24" wide, and 24" long.**Dust Collection Equipment:** iQMS362 16.5" masonry saw with integrated vacuum, filter and dust containment system.**Number of Cuts Made:** 100 thru cuts of red brick in material size 2.25" thick by 3.625" wide, and 100 thru cuts of concrete paver units in material size 4" wide by 8" long**Air Sampling Location and Duration:** In saw operator's breathing zone for 480 min.**Sample information:** Lab Sample ID# 1822181007 August 03, 2018

Testing Laboratory: ALS Global Environmental Laboratory, 960 West LeVoy Drive, Salt Lake City UT 84123
ALS Analytical Results: Sample ID 1822181007

Sample ID: MS362-080318-125871		Collected: 08/03/2018		
Lab ID: 1822181007		Received: 08/09/2018		
Method: NIOSH 0600 Mod., MW PVC Filter		Media: PVC Filter	Instrument: GRAV02	
		Sampling Info: Air Volume 1320 L	Analyzed: 08/10/2018 (220732)	
Analyte	Result (mg/sample)	Result (mg/m³)	RL (mg/sample)	
Respirable Dust	0.20	0.15	0.020	
Method: NIOSH 7500 Mod.		Media: PVC Filter	Instrument: XRAY01	
		Sampling Info: Air Volume 1320 L	Analyzed: 08/10/2018 (220769)	
Analyte	Result (ug/sample)	Result (ug/m³)	Result (%)	RL (ug/sample)
Quartz	36	27	18	5.0

Monitoring and Analysis Methods

The air samples were collected at iQ Power Tools, 4635 Wade Avenue, Perris, CA, 92571 on one iQ Power Tools employee on August 3rd, 2018 during concrete masonry dry cutting activities. The air samples were collected using SKC Brand of AirCheck Touch air sampling pumps on pre-weighted 3-piece matched weight 37 mm PVC filter media and SKC GS-3 plastic cyclones (SKC Part # 225-100) at a flow rate of 2.75 liters per minute (LPM). The air sampling flow rate was pre-calibrated and post calibrated with a SKC Checkmate calibrator (part # SKC375-07550N). Analysis was conducted at an AIHA accredited laboratory, ALS Laboratory in Salt Lake City, Utah for the analysis of respirable dust and silica. The test was conducted in accordance with current OSHA regulations. The analysis was completed using National Institute of Occupational Safety and Health (NIOSH) method 0600 and method 7500.



ANALYTICAL REPORT

Workorder: **34-1716335**

Client Project ID: TS244-060617-125886 060617

Purchase Order: NA

Project Manager: Paul Pope

Laboratory Contact Information

ALS Environmental
960 W Levoey Drive
Salt Lake City, Utah 84123

Phone: (801) 266-7700
Email: alsit.lab@ALSGlobal.com
Web: www.alssl.com

General Lab Comments

The results provided in this report relate only to the items tested.
Samples were received in acceptable condition unless otherwise noted.
Samples have not been blank corrected unless otherwise noted.
This test report shall not be reproduced, except in full, without written approval of ALS.

ALS provides professional analytical services for all samples submitted. ALS is not in a position to interpret the data and assumes no responsibility for the quality of the samples submitted.

All quality control samples processed with the samples in this report yielded acceptable results unless otherwise noted.

ALS is accredited for specific fields of testing (scopes) in the following testing sectors. The quality system implemented at ALS conforms to accreditation requirements and is applied to all analytical testing performed by ALS. The following table lists testing sector, accreditation body, accreditation number and website. Please contact these accrediting bodies or your ALS project manager for the current scope of accreditation that applies to your analytical testing.

Testing Sector	Accreditation Body (Standard)	Certificate Number	Website
Environmental	ANAB (DoD ELAP)	ADE-1420	http://www.anab.org/accredited-or-organizations/
	Utah (NELAC)	DATA1	http://health.utah.gov/lab/labimp/
	Nevada	UT00009	http://ndep.nv.gov/bsdwlabservice.htm
	Oklahoma	UT00009	http://www.deq.state.ok.us/CSDnew
	Iowa	IA# 376	http://www.iowadnr.gov/InsideDNR/RegulatoryWater.aspx
	Texas (TNI)	T104704456-11-1	http://www.tceq.texas.gov/field/qa/lab_accred_certif.html
	Washington	C596-16	http://www.ecy.wa.gov/programs/eap/labs/index.html
	Kansas	E-10416	http://www.kdheks.gov/lipo/index.html
Industrial Hygiene	AIHA LAP LLC (ISO 17025 & IHLAP ELLAP)	101574	http://www.aihaaccreditedlabs.org
	Washington	C596-16	http://www.ecy.wa.gov/programs/eap/labs/index.html
Lead Testing:			
CPSC	ANAB (ISO 17025 CPSC)	ADE-1420	http://www.anab.org/accredited-or-organizations/
Soil Dust Paint Air	AIHA LAP LLC (ISO 17025 & IHLAP ELLAP)	101574	http://www.aihaaccreditedlabs.org
Dietary Supplements	ACLASS (ISO 17025)	ADE-1420	http://www.aiclasscorp.com

Definitions

LOO = Limit of Detection = MDL = Method Detection Limit, A statistical estimate of method /media/instrument sensitivity.

LOQ = Limit of Quantitation = RL = Reporting Limit, A verified value of method /media/instrument sensitivity.

ND = Not Detected, Testing result not detected above the LOO or LOQ.

NA = Not Applicable.

** No result could be reported. see sample comments for details.

< This testing result is less than the numerical value.

() This testing result is between the LOO and LOQ and has higher analytical uncertainty than values at or above the LOQ.



ANALYTICAL REPORT

Workorder: **34-1822181**

Client Project ID: Tool Testing 080318

Purchase Order: NA

Project Manager: Paul Pope

General Lab Comments

The results provided in this report relate only to the items tested.
 Samples were received in acceptable condition unless otherwise noted.
 Samples have not been blank corrected unless otherwise noted.
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ALS provides professional analytical services for all samples submitted. ALS is not in a position to interpret the data and assumes no responsibility for the quality of the samples submitted.

All quality control samples processed with the samples in this report yielded acceptable results unless otherwise noted.

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Testing Sector	Accreditation Body (Standard)	Certificate Number	Website
Environmental	PJLA (DoD ELAP)	L17-288	http://www.pjlabs.com
	PJLA (ISO 17025)	L17-291	http://www.pjlabs.com
	Utah (TNI)	DATA1	http://health.utah.gov/lab/labimp/
	Nevada	UT00009	http://ndep.nv.gov/bsdwlabservice.htm
	Oklahoma	UT00009	http://www.deq.state.ok.us/CSDnew/
	Iowa	IA= 376	http://www.iowadnr.gov/InsideDNR/RegulatoryWater.aspx
	Florida (TNI)	E871067	http://www.dep.state.fl.us/labs/bars/sas/qa/
Texas (TNI)	T104704456-11-1	http://www.tceq.texas.gov/field/qa/lab_accred_certif.html	
Industrial Hygiene	AIHA (ISO 17025 & AIHA IHLAP ELLAP)	101574	http://www.aihaaccreditedlabs.org
Lead Testing			
CPSC	PJLA (ISO 17025)	L17-291	http://www.pjlabs.com
Soil, Dust, Paint	AIHA (ISO 17025, AIHA ELLAP and NLLAP)	101574	http://www.aihaaccreditedlabs.org
Dietary Supplements	PJLA (ISO 17025)	L17-291	http://www.pjlabs.com

Definitions

LOD = Limit of Detection = MDL = Method Detection Limit. A statistical estimate of method/media/instrument sensitivity.

LOO = Limit of Quantitation = AL = Reporting Limit. A verified value of method/media/instrument sensitivity.

ND = Not Detected, Testing result not detected above the LOD or LOO.

NA = Not Applicable

** No result could be reported, see sample comments for details.

< This testing result is less than the numerical value.

() This testing result is between the LOD and LOO and has higher analytical uncertainty than values at or above the LOO.



ANALYTICAL REPORT

Workorder: **I, 34-1707204 I,**

Client Project ID: Tool Testing 030917

Purchase Order: Tool Testing

Project Manager: Paul Pope

General Lab Comments

The results provided in this report relate only to the items tested.
 Samples were received in acceptable condition unless otherwise noted.
 Samples have not been blank corrected unless otherwise noted.
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ALS provides professional analytical services for all samples submitted. ALS is not in a position to interpret the data and assumes no responsibility for the quality of the samples submitted.

All quality control samples processed with the samples in this report yielded acceptable results unless otherwise noted.

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	Utah (NELAC)	DATA1	http://health.utah.gov/lab/labimp/
	Nevada	UT00009	http://ndep.nv.gov/bsdwlabservice.htm
	Oklahoma	UT00009	http://www.deq.state.ok.us/CSDnew/
	Iowa	IA# 376	http://www.iowadnr.gov/InsideDNR/RegulatoryWater.aspx
	Texas (TNI)	T104704456-11-1	http://www.tceq.texas.gov/field_qa_lab_accred_certif.html
	Washington	C596-16	http://www.ecy.wa.gov/programs/eap/labs/index.html
Industrial Hygiene	Kansas	E-10416	http://www.kdheks.gov/lipo/index.html
	AIHA LAP LLC (ISO 17025 & IHLAP/ELLAP)	101574	http://www.aihaaccreditedlabs.org
Lead Testing CPSC	Washington	C596-16	http://www.ecy.wa.gov/programs/eap/labs/index.html
	ANAB (ISO 17025 CPSC)	ADE-1420	http://www.anab.org/accredited-organizations/
Soil, Dust, Paint, Air	AIHA LAP LLC (ISO 17025 & IHLAP/ELLAP)	101574	http://www.aihaaccreditedlabs.org
Dietary Supplements	ACLASS (ISO 17025)	ADE-1420	http://www.aiclasscorp.com

Definitions

LOO = Limit of Detection = MDL = Method Detection Limit. A statistical estimate of method/media/instrument sensitivity.

LOQ = Limit of Quantitation = RL = Reporting Limit. A verified value of method/media/instrument sensitivity.

ND= Not Detected. Testing result not detected above the LOQ or LOO.

NA= Not Applicable.

** No result could be reported. see sample comments for details.

< This testing result is less than the numerical value.

() This testing result is between the LOQ and LOO and has higher analytical uncertainty than values at or above the LOO.

DUST-FREE WORKING

iQ POWER TOOLS SAW TABLE iQTS244 TILE SAW

IN COMBINATION WITH FOUR CYCLONES AND iQ DURA BOND CARTRIDGE DUST FILTER



iQ Power Tools iQTS244 Tile Saw



More information is available on www.iqpowertools.com

Responsible use: 50 meters per 8-hour working day sawing ceramic tiles



ceramic tile

Responsible use: 50 meters per 8-hour working day sawing natural stone tiles



natural stone tile

CONTACT

For details on the use of this label and its interpretation refer to the TNO website below:

DUSTFREEWORKING.TNO.NL

TNO
Bakemastraat 97K
2628 VK Delft
Postbus 49
2600 AA Delft

T 088 866 33 24
E wegwijzer@tno.nl



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for life

DUST-FREE WORKING

iQ POWER TOOLS SAW TABLE iQ360XR OUTSIDE

IN COMBINATION WITH VACUUM SYSTEM AND iQ DURA BOND CARTRIDGE DUST FILTER



iQ Power Tools Saw Table iQ360XR



More information is available on www.iqpowertools.com

Responsible use: 50 meters per 8-hour working day sawing ceramic tiles



ceramic tile

Responsible use: 50 meters per 8-hour working day sawing stone tiles



natural stone tile

CONTACT

For details on the use of this label and its interpretation refer to the TNO website below:

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2628 VK Delft
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E wegwijzer@tno.nl



› DUST-FREE WORKING

IQ POWER TOOLS SAW TABLE IQMS362 OUTSIDE

IN COMBINATION WITH FOUR CYCLONES AND IQ DURA BOND CARTRIDGE DUST FILTERS



iQ Power Tools Saw Table IQMS362



More information is available on www.iqpowertools.com

Responsible use: 50 meters per 8-hour working day sawing ceramic tiles



ceramic tile

Responsible use: 50 meters per 8-hour working day sawing natural stone tiles



natural stone tile

CONTACT

For details on the use of this label and its interpretation refer to the TNO website below:

DUSTFREEWORKING.TNO.NL

TNO
Bakemastraat 97K
2628 VK Delft
Postbus 49
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For the pdf of this newsletter see download below:

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EXHIBIT 5



Respirable Silica and Dust Exposure

Indoor Concrete Sawing

Husqvarna X150 Soff Cut Saw with a

HEPA Filtered CDC Larue 500 Series Pulse-Bac Vacuum

Monitoring to assess the operator's exposure to respirable silica and dust during indoor operation of a Husqvarna X150 Soff Cut Saw connected to a CDC Larue 500 Series Pulse-Bac Vacuum (Xtractor System). The following results were obtained on the day of monitoring:

Sample Time	Sample Volume	Respirable Dust Result ¹	Quartz Result ²	Cristobalite Result ^{2,3}	Tridymite Result ^{2,4}
290 minutes	495.9 liters	<0.10 mg/m ³	<0.010 mg/m ³	<0.010 mg/m ³	<0.020 mg/m ³
¹ OSHA Standard: 5 mg/m ³ PEL ² OSHA Standard: 0.25 mg/m ³ AL and 0.50 mg/m ³ PEL ³ Cristobalite is high temperature polymorphs of silica and relatively rare ⁴ Tridymite is a high temperature polymorphs of silica, rarely found in nature and rarely reported in the workplace					

The monitoring results were below the respective Occupational Safety and Health Administration (OSHA) Action Level (AL) and OSHA Permissible Exposure Limit (PEL) for silica (quartz, cristobalite, tridymite) and the OSHA PEL for respirable dust. Since the monitoring results are below the AL and PELs, additional sampling to further determine exposure is not required for the tested equipment.

Variations on the job site conditions, weather, vacuum connection, equipment maintenance, and operators experience may affect exposure levels. Adjacent activities may also increase exposure levels.

The OSHA Table 1 of the Respirable Crystalline Silica in Construction Regulation 29 CFR 1926.1153 states when walk-behind saws are operated indoors and an alternative dust control method (rather than water is used to control dust, the contractor must show that worker exposures will remain below the OSHA AL and OSHA PEL under all foreseeable conditions. Though respirable dust is not in the Respirable Crystalline Silica Regulation, the sample was also analyzed for comparison to the OSHA PEL.

Monitoring was conducted in the Construction Labors Training Center located at 2180 Old Hwy 8 NW, New Brighton, MN 55112 on September 2017. The sample was analyzed using NIOSH 7500 (silica) and NIOSH 0600 (respirable dust) analytical methods by Maxxam Analytics, a laboratory accredited by the American Industrial Hygiene Association (AIHA).

If you have any questions or would like to review the third-party objective data report, please contact **Esch Construction Supply, Inc. located 561 Phalen Blvd, in St. Paul, MN 55130**. Information regarding silica exposure is available at <https://www.osha.gov/silica/SilicaConstructionRegText.pdf>.



Esch Construction Supply, Inc.
www.EschSupply.com

ST. PAUL
(651) 487-1880

MILWAUKEE
(262) 888-1300

CHICAGO
(312) 805-1216

DENVER
(303) 945-1899



**OSHA 29 CFR § 1926.1153
RESPIRABLE SILICA DUST EXPOSURE
OBJECTIVE TEST DATA**
**Core Cut™ C14 Hand-Held Electric Saw
with Vacuum and Core Vac™ Skid Plate - Vertical Cut**



The testing simulated real life use of the equipment. The saw with vacuum skid plate and vacuum were tested under conditions that would produce a maximum cut depth of 5 inches. The sampling demonstrated that the equipment, when used according to manufacturer's recommendation, will perform as designed to eliminate respirable dust and respirable crystalline silica.

Narrative:

The Core Cut™ C14 electric hand saw, Core Vac™ vacuum skid plate and 250 CFM HEPA self-cleaning vacuum were tested. A 14-inch Heavy Duty Orange high speed blade was installed on the saw. Vertical sawing was accomplished on a cured concrete wall at a total length of 27-inches, 5-inches deep. The testing was done without water.

Respirator protection is recommended but not required when the equipment is used properly and according to manufacturer's recommendations.

- Product:** C14 Hand-Held electric saw with vacuum skid plate
- Engineering Controls:** 250 CFM HEPA self-cleaning vacuum
- Test Action:** Vertical saw cutting
- Test Material:** Cured Concrete
- Test Method:** Personal sampling; dust track area sampling

Core Cut™ C14 Hand-Held Saw Sample Data							
Sampling Date	Time of Sample	Sampling Duration	Type of Cut	Blade Diameter	Depth of Cut	Length of Cut	Weather Conditions
January 24, 2018	9:53 AM	5 Minutes	Vertical Sawing	14"	5"	27"	Outside, Sunny 68°

SAMPLING RESULTS:	SiO2	Below Detection Limits
	Respirable Dust	Below Detection Limits
	Total Dust	4.22 mg/m3

Testing conducted by SCT, Inc.
For further information, please contact Diamond Products Health and Safety Department.

This Objective Data represents one test per application and the amount of work performed during the Sampling Duration. The results provide the respirable silica dust exposure level based on the specific testing conditions, and in specific case situations.



Diamond Products Limited
333 Prospect Street - Elyria, OH 44035 U.S.A.
Phone: 800-321-5336, Fax: 800-634-4035
diamondproducts.com



SCT
Safety Engineering • Consultation • Training
6993 Pearl Rd. Middleburg Heights, OH 44130
800-204-1729

EXHIBIT 6

WORKPLACE SOLUTIONS

From the National Institute for Occupational Safety and Health

Reducing Hazardous Dust Exposure When Cutting Fiber-Cement Siding

Summary

Construction workers may be exposed to hazardous dust containing silica when cutting fiber-cement siding. The National Institute for Occupational Safety and Health (NIOSH) found that workers' exposures could be reduced by attaching a regular shop vacuum to a dust-collecting circular saw providing a simple low-cost solution.

Description of Exposure

Breathing dust that contains respirable crystalline silica can lead to silicosis, a deadly lung disease. Respirable dust is that fraction of the aerosol that is small enough to reach the deeper, gas-exchange regions of the lungs. No effective treatment exists for silicosis, but it can be prevented by controlling workers' exposures to dust containing crystalline silica. Exposure to crystalline silica has also been linked to lung cancer, kidney disease, reduced lung function, and other disorders [NIOSH 2002]. Crystalline silica is found in several construction materials, such as brick, block, fiber-cement siding,

mortar and concrete. Many construction tasks have been associated with overexposure to dust containing crystalline silica [Chisholm 1999, Flanagan et al. 2003, Rappaport et al. 2003, Qi et al. 2013a]. Among these tasks are tuck-pointing, concrete cutting, concrete grinding, abrasive blasting, and cutting fiber-cement siding.

The use of fiber-cement siding in construction and renovation is undergoing rapid growth. From 1991 to 2010, the market share of fiber-cement siding has climbed from 1% to 13% [U.S. Census Bureau 2013]. In contrast, the market share of wood siding in residential construction has decreased from 38% to 8% [U.S. Census Bureau 2013]. The durability and appearance of fiber-cement siding, which simulates wood without its maintenance issues, is appealing and provides a competitive advantage over other building materials. The number of workers exposed to dust containing crystalline silica will likely increase as the use of fiber-cement siding displaces other siding products [Bosquin 2009].

Fiber-cement board is cut using three methods: (1) scoring and snapping the board, (2) cutting the board using shears, and (3) cutting the board using a power saw. Although the first two methods are relatively dust-free, they

are not appropriate for use with siding mainly because they are slow and not very precise [Bosquin 2009].

Fiber-cement products can contain as much as 50% crystalline silica and cutting this material with a power saw has been shown to cause excessive exposures to respirable crystalline silica. One study by Lofgren et al. [2004] reported that cutters' uncontrolled exposures to respirable crystalline silica ranged between 0.02 to 0.17 milligram per cubic meter (mg/m^3), which was up to 3.4 times the NIOSH recommended exposure limit (REL) for respirable crystalline silica of $0.05 \text{ mg}/\text{m}^3$. In an in-depth field survey, Qi et al. [2013a] reported that a cutter's uncontrolled exposure to respirable crystalline silica resulted in an exposure of between 0.02 to $0.13 \text{ mg}/\text{m}^3$, which was up to 2.6 times the NIOSH REL.

NIOSH Study

Power saws, such as circular saws and compound miter saws, are used to cut fiber-cement siding. These saws are normally used with 4–8 tooth polycrystalline diamond-tipped (PCD) blades specifically designed to cut fiber-cement siding and minimize dust generation. Several commercially available circular saws have dust-collecting

features such as hoods and exhaust take-offs that can be connected to vacuum cleaners or dust-collection bags. These hoods are designed to partially enclose the saw blade.

NIOSH scientists conducted a study to develop practical engineering control recommendations for respirable crystalline silica from cutting fiber-cement siding. The first phase of the study to characterize the dust generated from cutting fiber-cement siding was conducted in a laboratory setting [Qi et al. 2014d]. The three dust-collecting circular saws evaluated in this study featured built-in dust collection containers or shrouds that functioned as a hood and partially enclosed the saw blade. When fiber-cement siding was cut, the air flow induced by the spinning blade caused a large portion of the dust generated to be collected in the container or shroud and also directed the dust to an exhaust port, which was connected to an external vacuum cleaner. The study found that the dust removal efficiency for the circular saws when used in conjunction with the external vacuum cleaner, which had a cyclone pre-separator and a high-efficiency particulate air (HEPA) filter cartridge, was greater than 81% even at a low air flow rate of 0.83 cubic meters per minute (m^3/min) or 29 cubic feet per minute (CFM). It was also found that further increasing the flow rate provided by the external vacuum cleaner did not substantially improve the dust removal efficiency. A regular shop vacuum typically has a flow rate higher than 30 CFM. Thus, the results from the laboratory evaluation suggested that connecting a dust-collecting circular saw to a regular shop vacuum can be a simple and low-cost engineering solution to control the dust generated from cutting fiber-cement siding.

To further validate the effectiveness of the control, four field surveys [Qi et al. 2013b, Qi et al. 2014a, Qi et al. 2014b, Qi et al. 2014c] were conducted at locations where fiber-cement siding was being cut. A regular shop vacuum, which had a high efficiency disposable filter bag as a pre-filter and a cartridge filter (not HEPA), was used in these surveys. The survey results showed that the 10-hour time weighted average (TWA) exposure to respirable crystalline silica for the workers who mainly cut fiber-cement siding on the job sites was controlled to well below the NIOSH REL. These findings indicated that the engineering control measure evaluated, if used properly, was effective in reducing worker exposures to concentrations below the NIOSH REL for respirable crystalline silica. This engineering control measure has the potential to provide an effective, simple and low cost (comparing to HEPA vacuums) solution for workers cutting fiber-cement siding

Recommended Controls

LEV System

- Use a shop vacuum with an air-flow rate of about or higher than 30 CFM. A vacuum hose can be used to attach the circular saw to the shop vacuum. Figures 1 and 2 depict the circular saw with dust collector and how it was connected to the shop vacuum during the NIOSH field evaluation.
- The hose that connects the shop vacuum to the saw should be of sufficient size (1.25-inch or greater inner diameter) to allow adequate airflow for the capture and transport of saw dust. To maximize efficiency, the hose should only be as long as necessary and be kept as straight as possible.
- A high efficiency disposable filter bag can be used as a pre-filter in the shop vacuum to capture most of the dust. This will prolong the life of the filter cartridge that captures the dust that goes through the filter bag.
- The shop vacuum and the circular saw can be plugged into an intelligent vacuum switch. This eliminates the distraction for the operator of turning on and off a dust collection system and ensures the vacuum is running while operating the saw, avoiding uncontrolled dust release. The switch also allows for delay in turning off the shop vacuum when the saw is turned off, removing the remaining dust in the vacuum hose following the cutting of a board. Some shop vacuums have incorporated such an intelligent vacuum switch. For those shop vacuums that don't have it, an aftermarket device with the same feature can be purchased and utilized [Qi et al. 2013b, Qi et al. 2014a, Qi et al. 2014b, Qi et al. 2014c].



Figure 1. Rear view of a worker bent at the waist wearing a helmet while cutting fiber cement boards on trestles. He is using a dust collecting circular saw connected to a vacuum. A blue boom lift and red brick building are in the background.



Figure 2. A dust collecting circular saw sitting on a blue filing cabinet and connected to a shop vacuum that is on the floor.

Circular Saws

- Use only circular saws with a built-in dust collection container or shroud that functions as a hood, partially encloses the saw blade, and can be easily connected to the LEV system.

Circular Saw Blades

- Use polycrystalline diamond-tipped (PCD) blades designed to be used to cut fiber-cement siding. Compared to Carbide-tipped blades, they provide a cleaner cut of the siding, exhibit a longer wear life, and may reduce the dust generated.

Work Practices

- When using a power saw (circular or miter), cut fiber-cement siding outdoors when practical.
- Avoid cleaning up fugitive fiber-cement dust on job site using dry sweeping, and use vacuum instead.
- Provide a covered trash can near the work station for saw operators to dispose of collected dust. Follow local, state and/or Federal regulations when disposing of fiber-cement dust.

- Ensure the shop vacuum is maintained according to manufacturer recommendations.
- Ensure the shop vacuum is inspected daily for defects (new filter bags and cartridges inspected for holes, cuts, etc.) and that filter bag and cartridge filter are changed regularly to prevent restricted air flow.
- Do not clean the cartridge filter, work clothing, or other areas with compressed air. In addition to creating a hazardous dust cloud, compressed air can damage the filter.
- Inspect the saw blade frequently and change as necessary to ensure the blade is not excessively worn.
- Keep nearby workers clear from any dust generating operation.
- Written procedures should be developed and employees trained on the hazards of silica exposure and the proper methods to reduce exposure.

Respirators

The dust controls provided in this document may greatly reduce worker exposure to hazardous dust; however, NIOSH recommends the use of half-facepiece particulate respirators with N95 or better filters for airborne exposures to crystalline silica at concentrations less than or equal to 0.5 mg/m³ [NIOSH 2008]. Employers should consult with an occupational safety and health professional and/or certified industrial hygienist to determine the respirator that would be best suited for the application. Employers should always follow the Occupational Safety and Health Administration (OSHA) Respiratory Protection Standard (29 CFR 1910.134) if respiratory protection is used. (www.osha.gov/SLTC/etools/respiratory/index.html). NIOSH guidance for selecting respirators can be found at <http://www.cdc.gov/niosh/docs/2005-100/default.html>.

Acknowledgments

This document was prepared by Chaolong Qi, NIOSH Division of Applied Research and Technology, and John J. Whalen, formerly with NIOSH.

References

- Bousquin J [2009]. Fiber cement's aesthetics and durability continue to gain fans. *Building Products Magazine*. Publication date: February 13, 2009. <http://www.ebuild.com/articles/875202.hwx>
- Chisholm J [1999]. Respirable dust and respirable silica concentrations from construction activities. *Indoor Built Environ* 8:94-106. <http://www.karger.com/Article/Abstract/24619>

Flanagan ME, Seixas N, Majar M, Camp J, Morgan M [2003]. Silica dust exposures during selected construction activities. *Am Ind Hyg Assoc J* 64:319-328. <http://deohs.washington.edu/sites/default/files/images/general/MajarThesid.pdf>

Lofgren DJ, Johnson DC, Walley TL [2004]. OSHA Compliance issues: silica and noise exposure during installation of fiber-cement siding. *Occup Environ Hyg J* 1:D1-D6. <http://www.tandfonline.com/doi/pdf/10.1080/15459620490264418>

NIOSH [2002]. NIOSH Hazard Review: Health effects of occupational exposure to respirable crystalline silica. DHHS (NIOSH) Publication No. 2002-129. <http://www.cdc.gov/niosh/docs/2002-129/pdfs/2002-129.pdf>

NIOSH [2008]. NIOSH Policy Statement: respiratory protection recommendations for airborne exposures to crystalline silica. By the Respirator Policy Group (BerryAnn R, Lentz TJ, Ahlers H, Barsan M, Hearl F). DHHS (NIOSH) Publication No. 2008-140. <http://www.cdc.gov/niosh/docs/2008-140/pdfs/2008-140.pdf>

Qi C, Echt A, See M [2013a]. In-Depth Survey Report: partnering to control dust from fiber-cement siding. DHHS (NIOSH) Report No. EPHB 358-11a. <http://www.cdc.gov/niosh/surveyreports/pdfs/358-11a.pdf>

Qi C, Hirst DVL, Echt A [2013b]. In-Depth Survey Report: partnering to control dust from fiber-cement siding. DHHS (NIOSH) Report No. EPHB 358-12a. <http://www.cdc.gov/niosh/surveyreports/pdfs/358-12a.pdf>

Qi C, Echt A [2014a]. In-Depth Survey Report: partnering to control dust from fiber-cement siding. DHHS (NIOSH) Report No. EPHB 358-13a. <http://www.cdc.gov/niosh/surveyreports/pdfs/358-13a.pdf>

Qi C, Garcia A, Echt A [2014b]. In-Depth Survey Report: partnering to control dust from fiber-cement siding. DHHS (NIOSH) Report No. EPHB 358-14a. <http://www.cdc.gov/niosh/surveyreports/pdfs/358-14a.pdf>

Qi C, Kratzer J, Echt A [2014c]. In-Depth Survey Report: partnering to control dust from fiber-cement siding. DHHS (NIOSH) Report No. EPHB 358-15a. <http://www.cdc.gov/niosh/surveyreports/pdfs/358-15a.pdf>

Qi C, Echt A, Gressel M [2014d]. Evaluation of the dust generation and engineering control for fiber-cement siding. DHHS (NIOSH) Report No. EPHB 358-16a. <http://www.cdc.gov/niosh/surveyreports/pdfs/358-16a.pdf>

Rappaport SM, Goldberg M, Susi P, Herrick RF [2003]. Excessive exposure to silica in the U.S. construction industry. *Ann Occup Hyg* 47:111-122.

US Census Bureau [2013]. Survey of construction, principle type of exterior wall material of new one-family houses completed. <http://www.census.gov/const/C25Ann/sftotalexwallmat.pdf>

Suggested Citation

NIOSH [2015]. Reducing hazardous dust exposure when cutting fiber-cement siding. By Qi C, Whalen JJ. Cincinnati, OH: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health. DHHS (NIOSH) Publication No. 2015-185.

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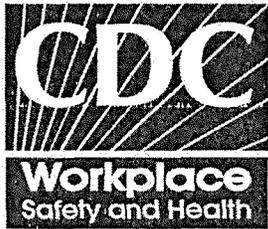
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Reducing Hazardous Dust Exposure When Cutting Fiber-Cement Siding

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DHHS (NIOSH) Publication No. 2015-185



Comprehensive Report

Evaluation of the dust generation and engineering control for cutting fiber-cement siding

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**Division of Applied Research and Technology
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EPHB Report No. 358-16a
October, 2014**

**DEPARTMENT OF HEALTH AND HUMAN SERVICES
Centers for Disease Control and Prevention
National Institute for Occupational Safety and Health**



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Abstract

Workplace exposure to respirable crystalline silica can cause silicosis, a progressive lung disease marked by scarring and thickening of the lung tissue. Quartz is the most common form of crystalline silica. Crystalline silica is found in several construction materials, such as brick, block, mortar and concrete. Construction tasks that cut, break, grind, abrade, or drill those materials have been associated with overexposure to dust containing respirable crystalline silica. Fiber-cement products can contain as much as 50% crystalline silica and cutting this material has been shown to cause excessive exposures to respirable crystalline silica. NIOSH scientists conducted this study to develop engineering control recommendations for respirable crystalline silica from cutting fiber-cement siding.

Detailed characterization of the dust generated from cutting fiber-cement siding was conducted in a laboratory setting. Respirable dust was sampled and analyzed using a variety of instruments based on both a real-time direct reading technique and gravimetric methods. The dust size distribution and the silica distribution in the dust of different sizes were analyzed in detail for cutting fiber-cement siding from four major manufacturers. The generation rate of respirable dust was analyzed and compared for cutting fiber-cement siding using different power tools (a power shear, four miter saws, and three circular saws), different blades, differing the saw cutting feed rate, and cutting different numbers of boards in the stack. It was found that two circular saws with a 4-tooth polycrystalline diamond-tipped (PCD) blade of 18.4 centimeter (cm, 7.25 inch) diameter generated the least amount of dust under the same test conditions. A local exhaust ventilation (LEV) system was also tested for all the power saws used in the laboratory evaluation. The generation rate of respirable dust and dust removal efficiency were recorded for each power saw when used with the LEV operating at different volumetric flow rates. In most test conditions of the miter saws, the dust removal efficiency was about 65% or lower, even at the highest test flow rate of the LEV (3.97 cubic meter per minute, m³/min; or 140 cubic feet per minute, CFM). The three circular saws evaluated in this study featured a built-in dust collection container or shroud, which served as a hood and partially enclosed the saw blade for collecting dust while cutting. The dust removal efficiency for the circular saws was greater than 78% even at a low flow rate of 0.83 m³/min (29 CFM). The results from the laboratory evaluation suggested that connecting a dust-collecting circular saw to a basic shop vacuum with built-in air filters had the potential to provide a simple and low-cost engineering control measure for the dust generated from cutting fiber-cement siding.

Four field surveys were conducted to validate the effectiveness of the engineering control measure suggested from the laboratory evaluation. The survey results showed that the 10-hour time weighted average (TWA) exposure to respirable crystalline silica for the workers who mainly cut fiber-cement siding on the job sites was well under control, with the 95% upper confidence limit being only 24% of the NIOSH Recommended Exposure Limit (REL) of 0.05 milligrams per cubic meter (mg/m³). This engineering control measure effectively reduced occupational silica

exposures, and provided an effective, simple and low cost solution for workers cutting fiber-cement siding.

Introduction

Background for Control Technology Studies

The National Institute for Occupational Safety and Health (NIOSH) is the primary Federal agency engaged in occupational safety and health research. Located in the Department of Health and Human Services, it was established by the Occupational Safety and Health Act of 1970. This legislation mandated NIOSH to conduct a number of research and education programs separate from the standard setting and enforcement functions carried out by the Occupational Safety and Health Administration (OSHA) in the Department of Labor. An important area of NIOSH research deals with methods for controlling occupational exposure to potential chemical and physical hazards. The Engineering and Physical Hazards Branch (EPHB) of the Division of Applied Research and Technology has been given the lead within NIOSH to study the engineering aspects of health hazard prevention and control. Since 1976, EPHB has conducted a number of assessments of health hazard control technologies on the basis of industry, common industrial process, or specific control techniques. Examples of these completed studies include the foundry industry; various chemical manufacturing or processing operations; spray painting; and the recirculation of exhaust air. The objective of each of these studies has been to document and evaluate effective control techniques for potential health hazards in the industry or process of interest, and to create a more general awareness of the need for or availability of an effective system of hazard control measures.

These studies involve a number of steps or phases. Initially, a series of walk-through surveys is conducted to select plants or processes with effective and potentially transferable control concept techniques. Next, in-depth surveys are conducted to determine both the control parameters and the effectiveness of these controls. The reports from these in-depth surveys are then used as a basis for preparing technical reports and journal articles on effective hazard control measures. Ultimately, the information from these research activities builds the data base of publicly available information on hazard control techniques for use by health professionals who are responsible for preventing occupational illness and injury.

Background for this Study

Crystalline silica refers to a group of minerals composed of silicon and oxygen; a crystalline structure is one in which the atoms are arranged in a repeating three-dimensional pattern [Bureau of Mines 1992]. The three major forms of crystalline silica are quartz, cristobalite, and tridymite; quartz is the most common form [Bureau of Mines 1992]. Respirable crystalline silica refers to that portion of airborne crystalline silica dust that is capable of entering the gas-exchange regions of the lungs if inhaled; this includes particles with aerodynamic diameters less than approximately 10 micrometers (μm) [NIOSH 2002]. Silicosis, a fibrotic disease of the lungs, is an occupational respiratory disease caused by the inhalation and

deposition of respirable crystalline silica dust [NIOSH 1986]. Silicosis is irreversible, often progressive (even after exposure has ceased), and potentially fatal. Because no effective treatment exists for silicosis, prevention through exposure control is essential.

Crystalline silica is a constituent of several materials commonly used in construction, including brick, block, and concrete. Many construction tasks have been associated with overexposure to dust containing crystalline silica [Chisholm 1999, Flanagan et al. 2003, Rappaport et al. 2003, Woskie et al. 2002]. Among these tasks are tuckpointing, concrete cutting, concrete grinding, abrasive blasting, and road milling [Nash and Williams 2000, Thorpe et al. 1999, Akbar-Khanzadeh and Brillhart 2002, Glindmeyer and Hammad 1988, Linch 2002, Rappaport et al. 2003]. Fiber-cement products can contain as much as 50% crystalline silica. Cutting this material has been shown to cause excessive exposures to respirable crystalline silica [Lofgren et al. 2004, Qi et al. 2013a].

The use of fiber-cement siding in construction and renovation is undergoing rapid growth. From 1991 to 2010, the market share of fiber-cement siding has climbed from 1% to 13% [US Census Bureau 2013]. In contrast, the market share of wood siding in residential construction has decreased from 38% to 8% [US Census Bureau 2013]. The durability and appearance of fiber-cement siding, which simulates wood without the maintenance issues associated with wood siding, is appealing and reportedly provides a competitive advantage over other building materials [Bousquin 2009]. The use of fiber-cement siding is expected to continue to increase. The number of workers exposed to dust containing crystalline silica as a result can also be expected to increase as the use of fiber-cement siding displaces other siding products. Cellulose fiber, sand or fly ash, cement, and water are the principal ingredients used in the manufacture of fiber-cement products. James Hardie (Mission Viejo, California), CertainTeed (Valley Forge, PA), Maxitile (Houston, TX), GAF (Wayne, NJ), and Nichiha (Norcross, GA) are the major manufacturers of fiber-cement products.

Fiber-cement board is cut using three methods: scoring and snapping the board, cutting the board using shears, and cutting the board using a power saw. When scoring and snapping the board, a knife is used to score the board by scribing a deep line into the board. The board is bent, and it breaks along the scored line. This method should be relatively dust-free. The score and snap method can be used when installing fiber-cement board used for tile underlayment, but is not applicable to siding. Commercially available tools used to shear fiber-cement siding include foot-powered shears and hand-held shears that may be manual or use a power source. These shears are reported to provide a relatively dust-free method of cutting fiber-cement siding. However, slow production rates and low precision limit the use of shears by siding contractors [Bousquin 2009].

Power saws, such as circular saws and compound miter saws, are used to cut fiber-cement siding. These saws are normally used with 4-8 tooth polycrystalline diamond-tipped (PCD) blades specifically designed to cut fiber-cement siding and

minimize dust generation. Several commercially available saws are manufactured with hoods and exhaust take-offs that can be connected to vacuum cleaners or to dust-collection bags. These hoods partially enclose the saw blade. Available blade diameters are 5, 7.25, 10, and 12 inches.

The study by Lofgren et al. [2004] reported that fiber-cement board cutters' uncontrolled exposures to respirable crystalline silica ranged from 0.02 milligrams per cubic meter (mg/m^3) to $0.27 \text{ mg}/\text{m}^3$ during sampling, and 8-hour (hr) time weighted average (TWA) exposure ranged from $0.01 \text{ mg}/\text{m}^3$ to $0.17 \text{ mg}/\text{m}^3$ depending on the length of exposure on the day sampled. The highest result was 3.4 times the NIOSH Recommended Exposure Limit (REL) for respirable crystalline silica of $0.05 \text{ mg}/\text{m}^3$.

In an in-depth field survey, Qi et al. [2013a] reported that a cutter's uncontrolled exposures to respirable crystalline silica ranged from 0.06 to $0.13 \text{ mg}/\text{m}^3$ during sampling, and 8-hr TWA exposure ranged from $0.02 \text{ mg}/\text{m}^3$ to $0.13 \text{ mg}/\text{m}^3$ depending on the time of exposure on the day sampled. The highest result was 2.6 times the NIOSH REL for respirable crystalline silica of $0.05 \text{ mg}/\text{m}^3$.

The data from both field surveys suggested excessive exposures to respirable crystalline silica occurred when an engineering control was not used for cutting fiber-cement siding. In August 2013, OSHA proposed a new Permissible Exposure Limit (PEL) of $0.05 \text{ mg}/\text{m}^3$ for 8-hr TWA exposures to respirable crystalline silica [OSHA 2013]. Thus, the objective of this study was to provide practical recommendations for effective dust controls that will prevent overexposures to respirable crystalline silica while cutting fiber-cement siding. The specific aims of the project were: 1) determine the dust generation rate from cutting fiber-cement siding in the lab; 2) experimentally develop local exhaust ventilation (LEV) recommendations for power saws used to cut fiber-cement siding; 3) validate, at actual construction sites, the recommendations developed from the laboratory studies; and 4) disseminate the information in the form of technical reports, journal articles, a NIOSH Workplace Solutions Document, trade journal articles, home remodeling publications, and other media. The dissemination efforts are directed at the construction and remodeling industries, including the do-it-yourself market, to promote the use of the recommendations. This comprehensive report includes the results from both the laboratory study and field surveys.

Materials and Methods in the Laboratory Evaluation

Laboratory Testing System

A worker's exposure to respirable crystalline silica during construction work can vary due to weather conditions, construction materials involved, work location, type of work performed, task duration and frequency, work practices, personal protective equipment (PPE), and whether or not dust control measures were used. Laboratory evaluation of dust generation and dust controls is an approach to control testing that permits those sources of variation to be controlled. Figure 1 illustrates

a diagram of the laboratory testing system used in this study. The overall dimension and components of the system were similar to those used by Beamer et al. [2005], Heitbrink and Bennett [2006], and Carlo et al. [2010], and they were consistent with European Standard EN 1093-3 [CEN, 2006]. A dust collection air handling unit (PSKB-1440, ProVent LLC, Harbor Springs, MI) was used as an air mover for the system. The air handling unit was connected to an automatic tool testing chamber through a 0.3 meter (m) diameter duct about 6.4 m long. A funnel section connected the duct to the automatic tool testing chamber, which had a square cross section of 1.2 m wide and 1.2 m high. A blast gate upstream of the air handling unit was used to adjust the air flow rate passing through the testing system by allowing the excessive air to enter the air handling unit through the gate. Once turned on, the air handling unit was set to draw room air into the testing system at a flow rate of 0.64 m³/second (m³/sec, equivalent to 1350 cubic feet per minute, CFM). This flow rate was set by manually adjusting the blast gate valve and was monitored by a micromanometer (PVM100 Airflow Developments Ltd., UK) connected to a delta tube (306AM-11-AO, Midwest Instrument, Sterling, MI). The delta tube functioned as an averaging pitot tube and has four pressure-averaging ports on the front and backside of a tear-shaped or circular cylinder [Miller 1989]. The delta tube was mounted on the duct about 2.4 m downstream (8 times of the duct diameter) of the funnel section (not shown in Figure 1 for clarity). The accuracy of the flow rate measured by the Delta tube was verified by comparing the flow rate obtained from its manufacturer's calibration equation [Mid-West Instrument, 2004] and that measured by Heitbrink and Bennett [2006] using a 10-point pitot tube traverse of the duct performed in the horizontal and vertical planes (about 0.8% difference). Two aerosol sampling ports were open on the duct for mounting the sampling probes of all the sampling instruments used in this study. These two ports and the delta tube formed the sampling section of the system. The location of this sampling section on the duct was designed to meet the requirement of European Standard EN 1093-3 [CEN, 2006] for taking representative samples.

The air flow that entered the system first passed through a filter panel, which had the same cross section as the automatic tool testing chamber and was 0.7 m long. The filter panel included one bank of four pre-filters and another bank of four HEPA filters that removed all the particles in the room air so that they did not interfere with the analysis of the dust generated inside the testing system. The filters also helped ensure that the air that entered the system had a uniform velocity profile across the panel's cross section. After the filtration section was the automatic tool testing chamber, which was 4.7 m long and was specifically designed and constructed for this study. Under the operating air flow rate, the flow velocity in the chamber was 0.44 m/sec, which is sufficient to transport respirable dust to the sampling section of the system, according to European Standard EN 1093-3 [CEN, 2006]. The Reynolds numbers for the chamber and duct are 34,000 and 170,000, respectively, indicating turbulent flow, which helped maximize mixing to obtain an appropriately representative sample at the sampling section. The air handling unit collected all the dust generated in the testing system with two filter cartridges

(P25.20, ProVent LLC, Harbor Springs, MI) before the cleaned air was discharged back into the room.

The walls of the automatic tool testing chamber were transparent so the operation inside could be visually observed. The chamber featured automatic control using Programmable Logic Controller (PLC) and Human Machine Interface (HMI). All the power tools evaluated in this study for cutting fiber-cement siding were mounted in the chamber using a variety of fixtures. The operations of these power tools were controlled using a two-dimensional actuator through the PLC. One to six fiber-cement siding boards were mounted on a chain-driven feed plate, and the feed rate was automatically controlled through the PLC. Board feed rate and power tool operation were programmed through the HMI so that automatic and repeatable cuts were achieved.

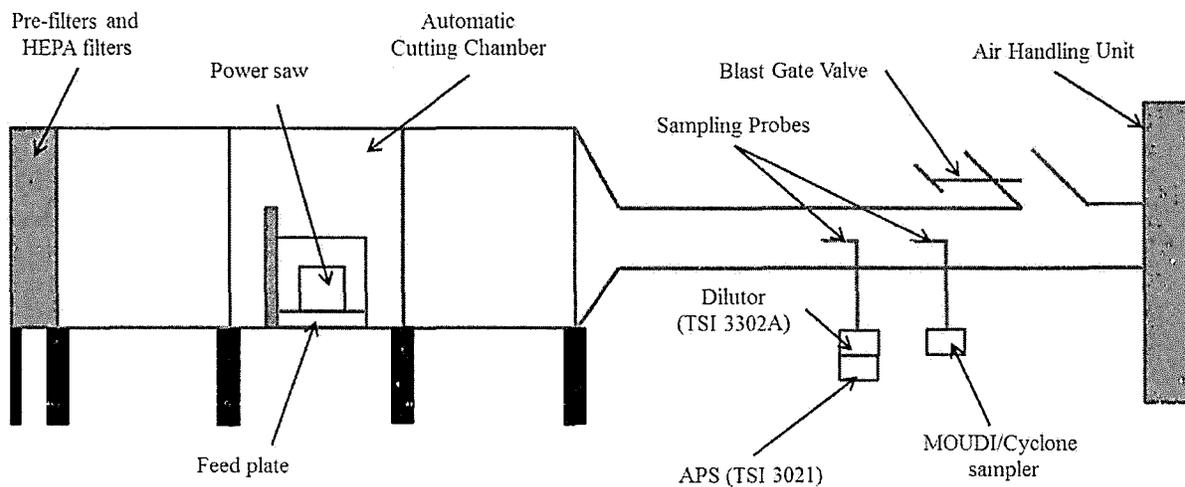


Figure 1. Diagram of the Laboratory Testing System.

Fiber-cement siding

Fiber-cement siding from four different manufacturers was evaluated in this study. Detailed specifications of these products are listed in Table 1. Since they may contain a different amount of silica in their respective formulations, which may also vary from time to time by the manufacturers, the manufacturing dates stamped on the siding boards, were recorded if available. The bulk density of the siding board was obtained by measuring the volume and mass of at least three boards from each manufacturer.

Table 1. Fiber-cement siding evaluated in the study.

Manufacturer	Manufacturing Date	Measured Board Width, W (cm, inch)	Measured Board thickness (cm, inch)	Measured Board Density (g/cm ³)
CertainTeed	05/27/2012	21.0, 8.25	0.76, 0.30	1.31±0.03
James	08/21/2010	21.0, 8.25	0.76, 0.30	1.27±0.01

Manufacturer	Manufacturing Date	Measured Board Width, W (cm, inch)	Measured Board thickness (cm, inch)	Measured Board Density (g/cm ³)
Hardie				
Maxitile	09/30/2010	21.0, 8.25	0.79, 0.31	1.31±0.02
Nichiha	n/a	21.0, 8.25	0.79, 0.31	1.25±0.01

Note: cm — centimeter; g — gram; n/a — “not available”.

Power tools

A variety of power tools for cutting fiber-cement siding were evaluated in this study and their specifications are listed in Table 2. These tools were categorized into three groups: compound miter saw, circular saw and power shear. All four compound miter saws listed in Table 2 used a 12 inch (30.5 cm) diameter blade. Each of these saws had an exhaust port designed to be attached to an external dust collector or shop vacuum, which provided LEV for removing dust while cutting. The dimension and shape of the exhaust port, its location on the miter saw, as well as the overall dimension of the miter saw may all affect the effectiveness of the dust removal efficiency. The three circular saws listed in Table 2 included a dust collecting feature with a built-in dust collection container or shroud, which served as a hood and partially enclosed the saw blade. When fiber-cement siding was cut, the flow induced by the spinning blade caused a large portion of the dust generated to be collected within the container or shroud and also directed the dust to an exhaust port, which could be connected to an external dust collector or shop vacuum. The Ridgid circular saw (Model R3400, Ridge Tool Company, Elyria, OH) had a small built-in blower that pushed air through its exhaust port. This feature may have reduced the requirement of the external LEV. The specified no-load rotating speed listed in Table 2 for each saw was taken from the manufacturer’s technical specification. The actual no-load speed for each saw was measured using a Pocket Tachometer (Model TAC2K, Dwyer Instruments Inc., Michigan City, IN) and is also listed in Table 2. An abbreviation was assigned to each power tool and is listed in Table 2 so that these tools can be more easily referred to in the subsequent text.

Table 2. Power tools used in the study and their specifications

Manufacturer	Model #	Type	Blade Diameter (cm, inch)	Specified No Load Rotating Sped (RPM)	Measured No Load Rotating Sped (RPM)	Abbreviation
Bosch	GCM12SD	Compound Miter	30.5, 12.0	3800	3714	M-B
Dewalt	DW718	Compound Miter	30.5, 12.0	3600	3922	M-D
Makita	LS1216L	Compound Miter	30.5, 12.0	3200	3224	M-M
Hitachi	C12LSH	Compound Miter	30.5, 12.0	3800	4200	M-H
Hitachi	C7YAH	Circular	18.4, 7.25	5500	5663	C-H

Manufacturer	Model #	Type	Blade Diameter (cm, inch)	Specified No Load Rotating Sped (RPM)	Measured No Load Rotating Sped (RPM)	Abbreviation
Makita	5057KB	Circular	18.4, 7.25	5800	5500	C-M
Ridgid	R3400	Circular	12.7, 5.0	9250	9068	C-R
PacTool International	404	Power Shear	DNA	DNA	DNA	SH

Note: RPM — Revolutions Per Minute; DNA — Does Not Apply

Sampling Methods

In this study, the automatic tool testing chamber was set to make a fixed number of repeat cuts of the fiber-cement siding board for each test condition. An Aerodynamic Particle Spectrometer (APS, model 3321, TSI Inc, Shoreview, MN) provided real-time direct reading measurement of the size distribution of the dust generated with a 1 second time resolution. The APS continuously collected an aerosol stream from one of two available duct sampling ports at a 5 Liter per minute (L/min) flow rate. The APS used a time-of-flight technique to measure the aerodynamic diameter of the individually counted particle in the range from 0.5 to 20 micrometers (μm). The APS output connected to a computer and the Aerosol Instrument Manager[®] Software (AIM V8.1, TSI Inc., Shoreview, MN) collected and analyzed the APS data. In this study, an isokinetic sampling probe was designed for the APS with a matching flow velocity for the inlet of the sampling probe and the duct. The sampling probe bent 90 degree and vertically connected to an aerosol dilutor (model 3302A; TSI Inc, Shoreview, MN), which sat on top of the APS. The dilutor was configured to provide a 100 to 1 dilution so that measurement uncertainty caused by high concentration aerosols was minimized. The dust size distribution directly measured by the APS is based on number concentration, and it can be used to derive the mass concentration of respirable dust by the following equation:

$$C_m = \sum_{i=1}^{52} \frac{\rho_p f_i \pi d_{e,i}^3 N_i}{6 \eta_{d,i} \eta_{sp,i}} \quad (1)$$

where,

C_m is the mass concentration of respirable dusts

$d_{e,i}$ is the equivalent volume diameter of channel i in APS and can be calculated by

$$d_{e,i} = d_{a,i} \sqrt{\rho_0 X / \rho_p}$$

$d_{a,i}$ is the aerodynamic diameter of channel i in APS

ρ_0 is the unit density

ρ_p is the density of the dust

χ is the dynamic shape factor of the dust

f_i is the respirable fraction of the dust with $d_{a,i}$

N_i is the number concentration of dust with $d_{a,i}$

$\eta_{dil,i}$ is the the transportation efficiency of dust with $d_{a,i}$ through the diluter

$\eta_{sp,i}$ is the the transportation efficiency of dust with $d_{a,i}$ through the sampling probe

The APS directly measures the aerodynamic diameter of the sampled dusts and it classifies the entire size range into 52 channels with $d_{a,i}$ representing the aerodynamic diameter for each specific channel i ($i = 1-52$). In order to obtain the mass of a dust in each channel, its density (ρ_p) is needed and its equivalent volume diameter needs to be calculated with the knowledge of its density (ρ_p) and dynamic shape factor (χ). In this study, all the dusts generated from cutting fiber-cement siding were assumed to be spherical so their dynamic shape factor was 1. The dust density was also needed for the Stokes correction of the APS data because the APS was calibrated in factory using Polystyrene Latex (PSL) spheres with a density close to 1.05 g/cm^3 . Since the APS measures the aerodynamic diameter in a flow velocity of approximately 150 m/sec instead of a still air, the Reynolds numbers of the sampled dusts are outside the Stokes regime and a sizing inaccuracy is caused when the dust density is different from 1.05 g/cm^3 . The Stokes correction for the APS data can be done by the AIM software with an input of the dust density. However, it is not straightforward to obtain the actual dust density in this study as the bulk material of fiber-cement siding is a mixture of a few different ingredients, and the density might vary depending on the size of the dust. Thus, the measured board density listed in Table 1 was used as the dust density. With the assumed dynamic shape factor and density for the sampled dust, the mass concentration of respirable dusts derived from the APS data and Equation (1) could be different from the actual value. However, this difference should be consistent among all the APS data and should not affect the comparison of the generation rate of respirable dust derived from the APS data under different testing conditions.

In this study, the generation rate of respirable dust (G_{APS}) is defined by the following equation:

$$G_{APS} = \frac{\sum_{t=1}^{T_s} C_{m,t} Q}{n_b W} \quad (2)$$

where,

$C_{m,t}$ is the mass concentration of respirable dusts at time t

Q is the volume flow rate in the testing system, $0.64 \text{ m}^3/\text{sec}$

T_s is the total sampling time of the APS for one cut

n_b is the number of board per cut

W is the board width, listed in Table 1

Since all fiber-cement siding in this study were cut by making cross cuts across the board width, the product of n_b and W represents the total linear length for one cut. The total linear length cut is commonly used in practice to account for cutting productivity. The APS data contains one set of dust size distribution for every second during the test, which leads to a $C_{m,t}$ data point for each second using Equation (1). Thus, the summation of $C_{m,t}Q$ during the sampling time T_s results in the total mass of respirable dust generated for one cut. The generation rate of respirable dust defined in Equation (2) represents the mass of respirable dust generated per unit linear length cut.

In this study, the transportation efficiency of dust with $d_{a,i}$ through the diluter ($\eta_{dil,i}$) was provided by the diluter manufacturer and incorporated within the AIM software. The transportation efficiency through the sampling probe ($\eta_{sp,i}$), however, must be analyzed separately. The loss of dust inside the sampling probe can be attributed to the settling loss in the horizontal part of the probe, the inertial loss at the 90 degree bend, and the diffusion loss throughout the probe. These losses are size dependent so the overall loss of respirable dust depends on the size distribution of the dust generated during cutting fiber-cement siding. The overall loss of respirable dust was calculated using the equations summarized by Brockman [2011] and the size distribution data from the APS, and it was found to be less than 1% combining all three aforementioned losses. Thus, $\eta_{sp,i}$ was assumed to be 1 in this study for simplicity.

In addition to the APS, a GK4.162 RASCAL cyclone sampler (BGI, Waltham, MA) was used to take air samples of respirable dust from the second duct sampling port on the testing system. A Leland Legacy Sample Pump (SKC Inc., Eighty Four, PA) provided a sampling flow rate of 9.5 L/min for the cyclone. The pump connected via Tygon[®] tubing to a pre-weighed, 47-mm diameter, 5- μ m pore-size polyvinyl chloride (PVC) filter supported by a backup pad in a three-piece conductive filter cassette sealed with a cellulose shrink band (in accordance with NIOSH Methods 0600 and 7500) [NIOSH 1998, NIOSH 2003]. The front portion of the cassette was removed and the cassette was attached to the cyclone sampler. The mass of the collected respirable dust on the PVC filters was obtained by post-weighing the filters and subtracting their pre-weights. Compared to the APS, the cyclone sampler offered a direct measurement of the mass of the respirable dust. The performance of the GK4.162 cyclone was characterized experimentally by the Health and Safety Laboratory [2011]. At a flow rate of 9.5 L/min, the cyclone has a 50% cut point (D_{50}) of 3.7 μ m. D_{50} is the aerodynamic diameter of the particle at which penetration into the cyclone declines to 50% [Vincent 2007]. The GK4.162 cyclone conforms to the respirable sampling convention defined in EN481 [1993] by Comite' Europe' en de Normalisation (CEN), American Conference of Industrial

Hygienists [ACGIH, 2013] and the International Organization for Standardization document 7708 [ISO 7708, 1995]. Both the experimental respirable fraction for the GK4.162 cyclone and the respirable convention curve are illustrated in Figure 2, demonstrating a reasonably good agreement between the two. A sampling probe was designed to provide isokinetic sampling for the cyclone at 9.5 L/min. By using the equations from Brockman [2011], the transportation efficiency of respirable dust in this sampling probe was estimated to be very close to 1. The generation rate of respirable dust from the cyclone data (G_{Cyc}) can be described as:

$$G_{Cyc} = \frac{M_{res}}{n_c n_b W} \quad (3)$$

where,

M_{res} is the mass of the respirable dust collected on the filters

n_c is the number of repeating cut during the cyclone sampling

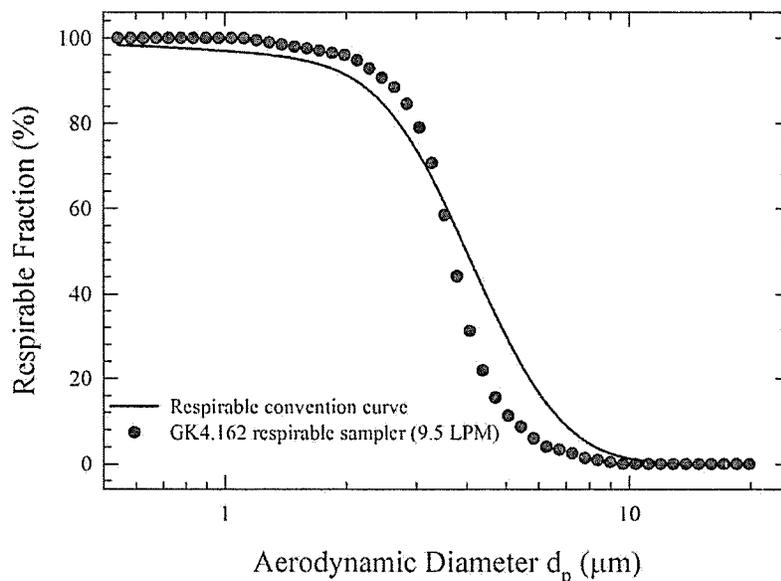


Figure 2. Comparison of the respirable fraction from the convention curve and the GK4.162 cyclone.

A trial test in this current study found that 15-30 repeated cuts using the testing system were optimal to collect sufficient respirable dust without overloading the filter. For the cutting test using the fiber-cement siding from each manufacturer, two bulk dust samples were also collected from the dust settled on the floor of the automatic tool testing chamber in accordance with NIOSH Method 7500 [NIOSH 2003]. Crystalline silica analysis of the air and bulk samples was performed using X-ray diffraction according to NIOSH Method 7500 [NIOSH 2003]. The limit of

detection (LOD) for quartz, cristobalite, and tridymite were 5 µg/sample, 5 µg/sample, and 10 µg/sample, respectively. The limit of quantitation (LOQ) for quartz, cristobalite, and tridymite were 17 µg/sample, 17 µg/sample, and 33 µg/sample, respectively. Quartz was found to be the only form of crystalline silica in the dust in this study.

Sharing the same sampling port on the duct of the testing system as the GK4.162 cyclone sampler, a Micro-Orifice Uniform Deposition Impactors (MOUDI, Model 110, MSP Corp, Shoreview, MN) sampler was used alternatively to collect size-selective filter samples. An isokinetic sampling probe was also designed for the MOUDI with negligible loss of respirable dust at its sampling flow rate of 30 L/min based on the calculations following Brockman [2011]. The MOUDI is an inertial cascade impactor with 10 stages. It collects dusts according to their inertia on the substrates of the ten corresponding impaction plates with the D_{50} ranging from 0.056 µm to 10.0 µm. It has an additional inlet stage with a D_{50} of 18 µm. In this study, 47-mm diameter, 5-µm pore-size PVC filters were used as the substrates. A 37-mm diameter, 5-µm pore-size PVC filter was used as the final filter collecting all the residual dust. By pre-weighing and post-weighing the PVC filters, the mass of dust collected on each stage was obtained and a mass-based size distribution of the sampled dust was derived. Crystalline silica analysis of the filter samples was also performed using X-ray diffraction in accordance with NIOSH Method 7500 [NIOSH 2003]. Thus, the content of crystalline silica in the dust of different sizes was obtained from the MOUDI samples. This additional information helped determine an optimal approach aimed at reducing the generation rate of respirable crystalline silica.

Local Exhaust Ventilation (LEV)

An exhaust port on the bottom of the automatic tool testing chamber allowed connection of the exhaust port on the power saws evaluated in this study to an external vacuum cleaner (Model 3700, Dustcontrol, Sweden) through flexible hoses. The external vacuum cleaner provided LEV of up to 5.0 m³/min (175 CFM) to the power saws. In the Dustcontrol 3700 vacuum cleaner, larger dusts collect in an attached dust bag after running through an internal cyclone collector, and the escaped smaller dusts collect in a HEPA filter cartridge downstream of the cyclone collector. Figure 3 shows how the LEV system was regulated and monitored. A T-shape PVC pipe connected to the vacuum cleaner and a gate valve was installed on the two branches. By adjusting the two gate valves, a ventilation flow rate in the full range of the vacuum cleaner's suction capacity was obtained for the test. The flow rate was monitored by a micromanometer (PVM100 Airflow Developments Ltd., UK) connected to a delta tube (307BZ-11-AO, Midwest Instrument, Sterling, MI).

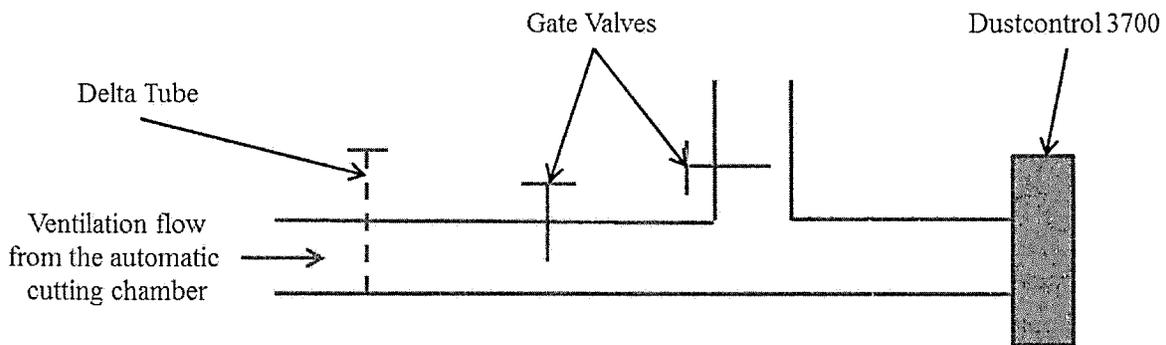


Figure 3. Diagram of the Local Exhaust Ventilation (LEV) system used in this study.

Dust removal efficiency (DRE)

When connected to a power saw, the LEV system removed the generated dust by the ventilation flow. Dust removal efficiency (DRE) was defined in this study as following:

$$DRE = \frac{\overline{G_{APS}(Q_{LEV})}}{\overline{G_{APS,non-LEV}}} \quad (4)$$

where,

$\overline{G_{APS}(Q_{LEV})}$ is the average generation rate of respirable dust when the flow rate of the LEV system is Q_{LEV}

$\overline{G_{APS,non-LEV}}$ is the average generation rate of respirable dust when the LEV system is not connected

Operating procedure for a cutting test

Before conducting a cutting test, the automatic tool testing chamber was programed to perform a pre-determined number of cuts. Each cut included the following steps: 1) the feed plate fed the board; 2) power was supplied to the tool; 3) the 2D actuator moved the tool and made a cut; 4) the tool was turned off; and 5) the 2D actuator moved the tool back to its original position. A waiting time about 5 seconds was programed between steps 2) and 3) to ensure the blades of the power saws reached their designed rotating speed before making a cut. For a circular saw or a power shear, the cut was made only by sliding the tool through a board. A compound miter saw can make a cut by either chopping and/or sliding. In this study, we tested the miter saws with both "chopping only" and "chopping and sliding" modes. The "chopping only" mode cannot make a complete cut of the board with the board width of 30.5 cm (8.25 inch) so the actual length of the cut was measured and used in the place of board width (W) for Equation (2). Due to the size limit of the testing chamber, the "chopping and sliding" mode for the miter saws was configured to cut about 9 cm (3.5 inch) by chopping and cut the rest of

the board by sliding. The sliding speed for all the tools can also be varied and regulated by the PLC, and it is referred to as the cutting feed rate in this report.

For each cutting test, the air handling unit was turned on and the flow rate set to 0.64 m³/sec by adjusting the blast gate valve. For a test involving the LEV system, the Dustcontrol 3700 vacuum cleaner was turned on and the flow rate of the LEV system set to a desired point by adjusting the two gate valves. The flow rates of both the testing system and the LEV were stable throughout each individual test of this study. Once the flow rates in the testing chamber and the LEV system reached the desired values, the sampling instruments began sampling and the automatic tool testing chamber was started. Upon finishing a test, the air handling unit and the vacuum cleaner were turned off and the collected samples were removed from the instruments.

During each cut, a dust cloud was generated, and it was carried downstream by the air flow through the tool testing chamber and measured by the instruments through their respective sampling probes on the duct of the testing system. The APS collected size distribution measurements at 1-second intervals and its data indicated that no dust was detected when no cutting was conducted. The flow rate in the testing chamber (0.64 m³/sec) was optimal so that the APS data with 1-second time resolution captured the entire profile of the dust cloud from each individual cut without overlapping the dust clouds between any two adjacent cuts for all the testing conditions in this study. This ensured the calculation of the respirable dust generation rate (G_{APS}) using Equation (2) for each individual cut.

Experimental Design for the Laboratory Evaluation

Analysis of the APS data from a trial test with at least 15 cuts under the same testing condition revealed that the relative standard deviation (RSD, the ratio of the standard deviation to the mean) for G_{APS} was about only 3.1%, demonstrating excellent repeatability of the test. With the high repeatability, 3 or more repeated cuts under the same testing condition were considered sufficient to provide statistically reliable results. Thus, 5-10 cuts were conducted for the testing conditions when APS was the only instrument used. When the GK4.162 cyclone sampler or the MOUDI was used, 15-30 cuts were conducted to ensure sufficient respirable dust could be collected without overloading the filters.

Cutting fiber-cement siding from different manufacturers

Fiber-cement siding boards from the four manufacturers listed in Table 1 were cut under the same testing condition without the use of the LEV system, and the respectively generated dusts were evaluated. The M-H saw and an 8-tooth PCD blade (Model 18109, Hitachi Power Tools, Valencia, CA) were used to conduct all the cuts for this test. The M-H saw was used under the "chopping and sliding" mode with the cutting feed rate set at 2.54 cm/sec. For the board of each manufacturer, three respirable dust samples were collected by the GK4.162 cyclone sampler, and three sets of MOUDI samples were also collected. APS data were recorded

corresponding to each sample from the GK4.162 cyclone sampler and the MOUDI, with the averaged G_{APS} calculated for each testing condition.

Dust generation from cutting fiber-cement siding using different saw blades

A limited number of saw blades were tested in this study to evaluate their effects on the dust generation. The aforementioned 8-tooth PCD blade and a 60-tooth carbide tipped blade (Model A-93712, Makita U.S.A., Inc., St. La Mirada, CA) were tested on the M-M saw. These two saw blades both have a 12-inch diameter. The M-M saw was used under the "chopping and sliding" mode, and the saw cutting feed rate was set at 2.54 cm/sec. In addition, three saw blades of 7.25 inches diameter, including a 4-tooth PCD blade (Model 18008, Hitachi Power Tools, Valencia, CA), a 28-tooth (Model A-90451, Makita U.S.A., Inc., St. La Mirada, CA) and a 6-tooth (Model D0706CH, Freud Tools, High Point, NC) carbide tipped blades, were tested on the C-M saw. Only one saw blade of 5 inches diameter, i.e., a 6-tooth (Model D0706CH, Freud Tools, High Point, NC) carbide tipped blade, was tested on the C-R saw. A saw cutting feed rate of 2.54 cm/sec was used in the test of the C-M and C-R saws. Only APS data were collected for the saw blade test. An average G_{APS} was calculated and compared for each testing condition. The fiber-cement siding boards used in these tests were from CertainTeed.

Dust generation from cutting fiber-cement siding using different power tools

All the power tools listed in Table 2 were tested to evaluate the dust generation when they were operated under different conditions. During these tests, the four miter saws were tested using the same 8-tooth PCD blade (Model 18109, Hitachi Power Tools, Valencia, CA); the C-M and C-H saws were both tested using the 4-tooth PCD blade (Model 18008, Hitachi Power Tools, Valencia, CA); and the C-R saw was tested using the 6-tooth (Model D0706CH, Freud Tools, High Point, NC) carbide tipped blade. The four miter saws were tested under both "chopping only" and "chopping and sliding" modes. For the three circular saws and the M-H saw when operated under the "chopping and sliding" mode, a saw cutting feed rate in the range of 1.27 to 12.7 cm/sec was tested to evaluate the effect of the saw cutting feed rate on the dust generation. For the test of the power shear and the other three miter saws when operated under the "chopping and sliding" mode, the saw cutting feed rate was fixed at 2.54 cm/sec. Only APS data were collected for these tests, and an average G_{APS} was calculated and compared for each testing condition. The fiber-cement siding boards used in these tests were from CertainTeed.

Dust generation from cutting different number of fiber-cement siding boards at once

If not specified in this study, only one board at a time was cut for each of the tested power tools. In addition, up to six boards were stacked and cut for the M-B, C-H, and C-M saws to evaluate the effect of the number of boards in one cut on the dust generation. During these tests, the 8-tooth PCD blade (Model 18109, Hitachi

Power Tools, Valencia, CA) was used on the M-B saw; and the 4-tooth PCD blade (Model 18008, Hitachi Power Tools, Valencia, CA) was used on the C-H and C-M saws. The M-B saw was tested under the "chopping and sliding" mode only. The saw cutting feed rate for all these tests was fixed at 2.54 cm/sec. Only APS data were collected for these tests, and an average G_{APS} was calculated and compared for each testing condition. The fiber-cement siding boards used in these tests were from CertainTeed.

Testing the effectiveness of the LEV

The effectiveness of the LEV was tested for all the power tools listed in Table 2 except the power shear. The LEV system was connected to each of the tested power tools and its volume flow rate was varied as described earlier. Only APS data were collected for these tests, and an average G_{APS} and the corresponding dust removal efficiency (DRE) were calculated for each testing condition. The fiber-cement siding boards used in these tests were from CertainTeed. During these tests, the 8-tooth PCD blade (Model 18109, Hitachi Power Tools, Valencia, CA) was used for all the four miter saws; the 4-tooth PCD blade (Model 18008, Hitachi Power Tools, Valencia, CA) was used for the C-H and C-M saws; and the 6-tooth (Model D0706CH, Freud Tools, High Point, NC) carbide tipped blade was used for the C-R saw. The M-H saw was tested under the "chopping and sliding" mode only; and the other three miter saws were tested under both "chopping only" and "chopping and sliding" modes. The saw cutting feed rate for the C-R saw and all the miter saws operated under the "chopping and sliding" mode was fixed at 2.54 cm/sec, and it varied in the range of 2.54 to 12.7 cm/sec for the C-H and C-M saws. Both the C-H and C-M saws were also tested when up to six boards were stacked and cut at once.

Results and Data Analysis for the Laboratory Evaluation

Figure 4 shows typical size distributions of the dust generated and observed in one testing condition of this study. The size distributions represent the dust concentration (number or mass) per unit width of size channel at different aerodynamic diameters. The MOUDI data were obtained by using the following equation:

$$\frac{dM}{d\log(d_p)} = \frac{m_i}{Q_M T_M \Delta d_p} \quad (5)$$

where,

m_i is the mass of the dust collected on the filter of stage i of the MOUDI

Q_M is the sampling flow rate of the MOUDI (30 L/min)

T_M is the total sampling time of the MOUDI for one test

Δd_p is the width of the size channel for the MOUDI

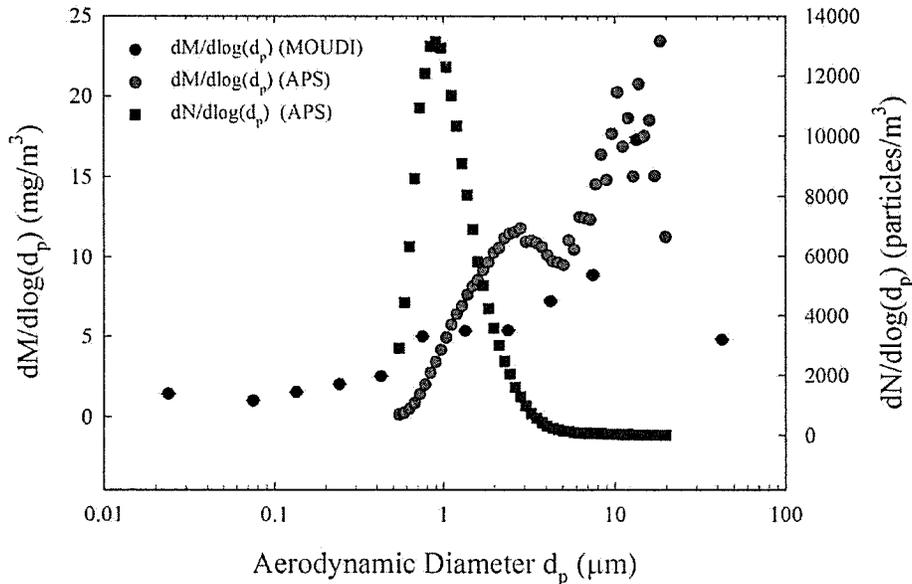


Figure 4. Typical size distribution of the dust from cutting fiber-cement siding. Power tool: M-H; Blade: Hitachi 18109; Saw cutting feed rate: 2.54 cm/sec; Siding: James Hardie.

The MOUDI data illustrated in Figure 4 are the averaged results from three replicate measurements with the small error bars representing the standard deviation of the three measurements. The APS data are also averaged results from all of its data collected concurrently with the MOUDI data. The number-based size distribution obtained from the APS show a lognormal distribution with the geometric mean diameter of 0.97 μm and the geometric standard deviation of 1.5. The mass-based size distributions from the MOUDI and the APS are generally in agreement. They both show a bimodal lognormal distribution with a larger mode around 13 μm , and another mode smaller than 5 μm . The smaller mode is less apparent in the MOUDI data and it shows lower concentrations compared to the APS data for the dust larger than about 1 μm . These observations most likely result from the loss of larger dust inside the MOUDI. Larger inertia for the larger dust particles led to a higher fraction of them bouncing off the substrates where they were supposed to be collected, resulting in a smaller amount of mass collected on the filters. All the size distributions show that an apparent fraction of the airborne dust was respirable (smaller than 10 μm). Note that the concentration level shown in Figure 4 is that monitored in the laboratory setting, which can be very different from those experienced in practice, although the shape of the size distribution is expected to be similar.

Dust generation from cutting fiber-cement siding from different manufacturers

Figure 5 shows the size distribution data obtained from the MOUDI for the dust generated from cutting fiber-cement siding from the four manufacturers listed in Table 1. Since three sets of MOUDI samples were collected for each manufacturer's siding, the data points shown in Figure 5 are the average of the three replicates and the error bars represent the standard deviations of the corresponding data points. In general, the MOUDI data showed reasonably good repeatability and the dust size distributions are very similar among the four manufacturers, except that the one from James Hardie has obviously higher concentrations for the dust in the three stages between 4.2-13.4 μm . All of the data sets show a bimodal lognormal distribution with a larger mode around 13 μm , and another mode between 1-3 μm . Combining the size distribution data shown in Figure 5 and the respirable fraction from the respirable convention curve, the overall respirable fraction of airborne dust was estimated to be 43.1%, 40.9%, 48.8% and 37.8% for cutting fiber-cement siding from CertainTeed, James Hardie, Maxitile, and Nichiha, respectively.

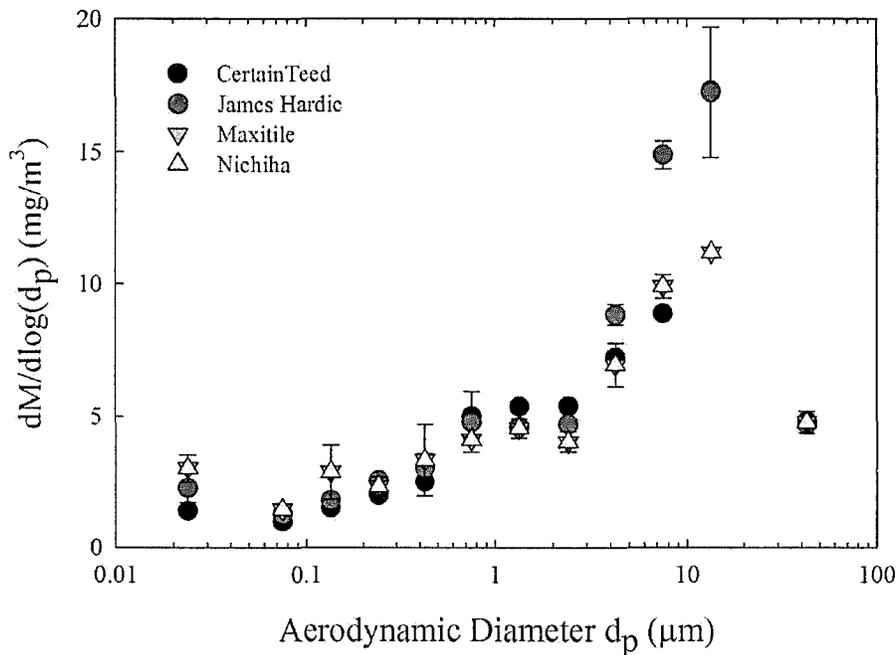


Figure 5. Size distribution obtained from the MOUDI for the dust from cutting fiber-cement siding of different manufacturers. Power tool: M-H; Blade: Hitachi 18109; Saw cutting feed rate: 2.54 cm/sec.

The generation rate (G_{APS} and G_{Cyc}) and the crystalline silica content of the respirable dust for the four siding manufacturers are illustrated in Figure 6. Each data point is the average obtained from either the three respirable samples

collected by the GK4.162 cyclone sampler or the APS data collected simultaneously. The error bars represent the standard deviation of the three replicates.

Besides using the respirable fraction from the respirable convention curve, the APS data was also processed using the experimental respirable fraction (sampling efficiency) for the GK4.162 cyclone sampler (as shown in Figure 2). The G_{APS} based on the respirable fraction from the respirable convention curve was between 0.60 to 0.62 g/m; and the one based on the experimental respirable fraction for the GK4.162 cyclone sampler was between 0.56-0.60 g/m. These results show that the difference of G_{APS} obtained by the two respirable fractions is minimal ($4.4\% \pm 0.8\%$ for the four sets of data in Figure 6). It suggests that the small differences between the two respirable fractions lead to negligible deviation on the respirable dust generation rate for the dusts analyzed in this study. For the analysis of the remaining APS data, only the respirable fraction from the convention curve was used.

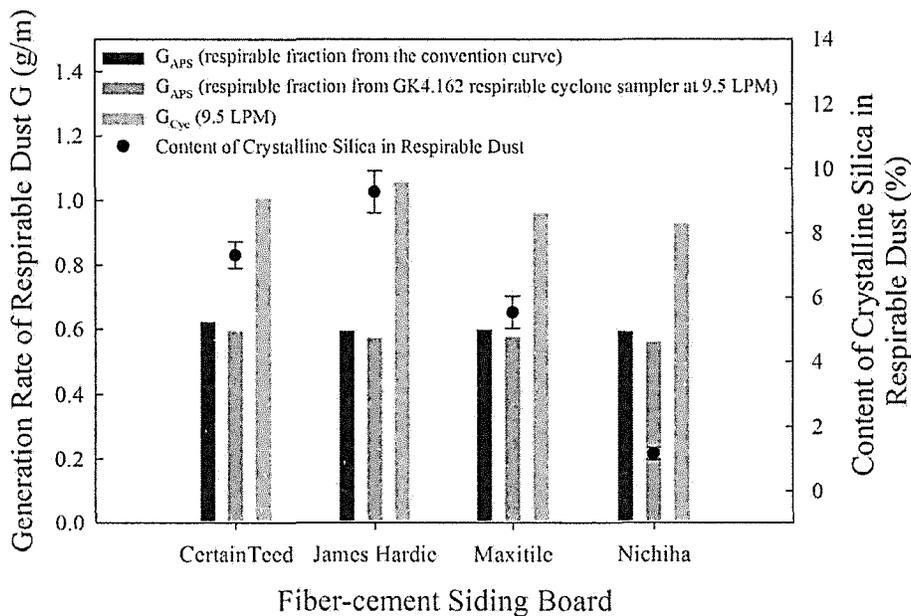


Figure 6. Comparison of the generation rate of respirable dust from cutting fiber-cement siding from different manufacturers. Power tool: M-H; Blade: Hitachi 18109; Saw cutting feed rate: 2.54 cm/sec.

The above analysis also verifies indirectly that the respirable dusts collected by the GK4.162 cyclone sampler were well representative. Compared to the generation rates derived from the APS data (G_{APS}), those obtained from the cyclone sampler (G_{Cyc}) were apparently higher (between 0.93-1.06 g/m). The average of G_{Cyc} was about $63.6\% \pm 9.3\%$ higher than the average of G_{APS} derived based on the convention respirable fraction for the dusts of the four manufacturers. Since the cyclone sampler offers a direct gravimetric measurement of the sampled respirable

dusts, G_{Cyc} should be considered more representative of the actual generation rates. The smaller values for G_{APS} might be attributed to the counting efficiency of the APS being less than 100%, possibly underestimated loss of dust in the sampling line, as well as the bias introduced by the assumptions that the dust density is equal to the board density, and that all the dusts were spherical. Although the difference between G_{Cyc} and G_{APS} is obvious, this difference is consistent among the four cases shown in Figure 6. Thus, the G_{APS} results obtained under different testing conditions should be considered comparable.

The results in Figure 6 also suggest that the respirable dust generation rate for the boards of the four manufacturers are very close to each other, with a maximum difference of 13.8% for G_{Cyc} and 5.9% for G_{APS} among the four sets of data. This result is also consistent with the observation in Figure 5. The content of crystalline silica in respirable dust, however, varied in a relatively wide range of 1.2% to 9.3%, perhaps due to the varied formulations the four manufacturers used in their respective fiber-cement siding boards that were evaluated in this study.

As mentioned earlier, the MOUDI samples offered an additional insight on the content of crystalline silica in the dust of different sizes by analyzing the amount of crystalline silica in the dust collected on each stage of the MOUDI. This information is shown in Figure 7 for the boards from the four manufacturers. The data for bulk samples and respirable dust samples (lab) shown in Figure 7 were obtained by analyzing the silica content in the bulk samples and the respirable dust samples (the same data presented in Figure 6) collected in the laboratory study. In addition, the fiber-cement siding from CertainTeed and James Hardie were used respectively in one [Qi et al., 2013a] and four [Qi et al., 2013b; 2014a, 2014b, 2014c] field surveys conducted as a part of this study. The averaged silica contents in the respirable dust samples (field) collected in these field surveys were also presented in Figure 7 (a) and (b), and they were found very close to the averaged silica content in the corresponding laboratory respirable dust samples. For all four manufacturers, the silica content in the dust showed the same obvious trend of an increase with the aerodynamic diameter of the dust, approaching to the silica content levels found in their respective bulk samples.

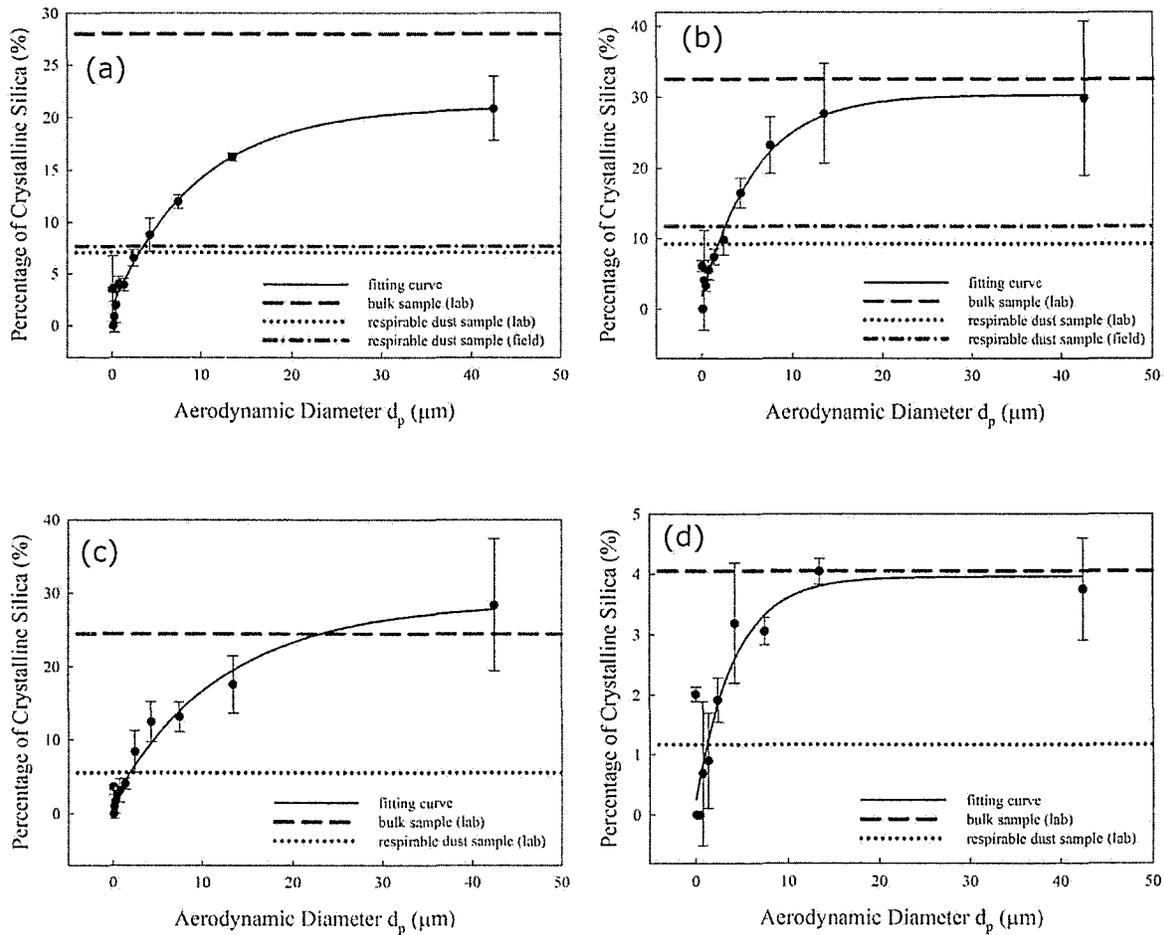


Figure 7. Silica distribution in the dusts of different sizes from cutting fiber-cement siding board of (a) CertainTeed; (b) James Hardie; (c) Maxitile; (d) Nichiha. Power tool: M-H; Blade: Hitachi 18109; Saw cutting feed rate: 2.54 cm/sec.

The MOUDI data, including the dust size distribution and silica distribution in the dust of varying sizes, can also be used to derive the overall silica content in the respirable dust with the knowledge of a respirable fraction based on the convention curve for the aerodynamic diameters of the size channels in MOUDI. Figure 8 compares the silica contents in the respirable dusts derived from the MOUDI data and obtained from the laboratory respirable dust samples. The results from the two methods are reasonably comparable, with those from the MOUDI data consistently lower than those from the laboratory respirable dust samples (ranging from 0.9% to 6.9% compared to ranging from 1.2% to 9.3%). This is possibly due to the low sizing resolution of the MOUDI and the higher fraction of larger dusts with higher contents of silica bouncing off the substrates in the MOUDI.

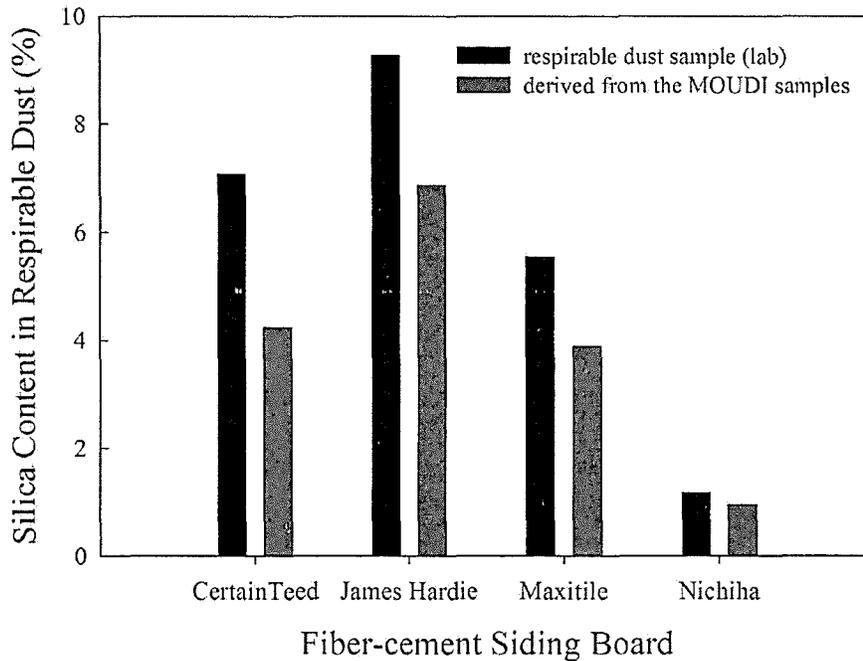


Figure 8. Comparison of the silica content in respirable dust from respirable dust samples and derived from the MOUDI samples. Power tool: M-H; Blade: Hitachi 18109; Saw cutting feed rate: 2.54 cm/sec.

Dust generation from cutting fiber-cement siding using different saw blades

The specifications and respective G_{APS} for the tested saw blades are listed in Table 3. Among the three 7.25-inch diameter blades, the Makita blade with 28 carbide tipped teeth generated significantly more dusts than the other two blades (1.02 g/m vs 0.41 g/m and 0.42 g/m), which have 4 PCD tipped teeth and 6 carbide tipped teeth, respectively. Comparing the two 12-inch diameter blades, the blade with 60 carbide tipped teeth generated 62% more dust than the blade with 8 PCD tipped teeth (0.86 g/m vs 0.53 g/m). The 5-inch diameter Freud blade is the only blade of its size tested in this study and its G_{APS} was the highest among all the blades tested. Specifically, its G_{APS} was 148% higher than the 7.25-inch diameter Freud blade (1.04 g/m vs 0.42 g/m). These two Freud blades both have 6 carbide tipped teeth and a kerf width of 1.7 mm. They were used in two different circular saws with different saw blade diameters (5 inches vs 7.25 inches) and blade rotating speeds (9068 RPM vs 5500 RPM). This resulted in a difference of 13.7% on the linear speed of the blade's tooth cutting through the board (60.3 m/sec vs 53.0 m/sec). Based on the comparisons of these specifications, the higher G_{APS} for the 5-inch diameter blade was likely due to its higher blade rotating speed, as a higher blade rotating speed leads to proportionally more cutting interactions between the blade's teeth and the board during one complete cut, and a higher blade rotating

speed also contributes to a higher linear cutting speed from the blade's teeth. It should be noted that the blades used in these tests were brand new so the G_{APS} results may be different for aged blades. Since the PCD blades were designed to last much longer than the carbide tipped blade, only the PCD blades were used in the rest of this study if not specified otherwise, except for the C-R saw, which only had the 5-inch diameter Freud blade available for it.

Table 3. Saw blade used in the study and their specifications

Manufacturer	Model #	Blade Diameter (inch)	Number of Tooth	Tooth Type	Kerf Width (mm)	Test Saw	Generation Rate of Respirable Dust G_{APS} (g/m)
Hitachi	18109	12	8	PCD Tipped	2.2	M-M	0.53
Makita	A-93712	12	60	Carbide tipped	2.3	M-M	0.86
Hitachi	18008	7.25	4	PCD Tipped	1.8	C-M	0.41
Makita	A-90451	7.25	28	Carbide tipped	2.0	C-M	1.02
Freud	D0706CH	7.25	6	Carbide tipped	1.7	C-M	0.42
Freud	D0506CH	5	6	Carbide tipped	1.7	C-R	1.04

Dust generation from cutting fiber-cement siding using different power tools

Figure 9 shows the G_{APS} for the four miters saws tested in this study. Both the "chopping and sliding" and "chopping only" modes were tested for these miter saws. It was apparent that all the miter saws generated less dust in the "chopping mode" (ranging from 0.23 to 0.34 g/m compared to ranging from 0.53 to 0.77 g/m in the "chopping and sliding" mode), during which the saws were controlled to chop down at a speed of 2.54 cm/sec. Since the test CertainTeed board is only 0.76 cm thick, it took considerably less time to conduct one cut in the "chopping mode" than in the "chopping and sliding mode". Thus, there were fewer cutting interactions between the blade's teeth and the board during one chopping cut, which was likely the reason for a lower dust generation rate. The comparison of the G_{APS} among the four miter saws was consistent for both modes, with the M-H saw having the highest G_{APS} and the M-M saw having the lowest. The differences were likely due to their different specifications, especially the blade rotating speed, which is also presented in Figure 9. Figure 10 plots the G_{APS} against the saws' blade rotating speed and a linear correlation was found with a R^2 of 0.99 for both modes.

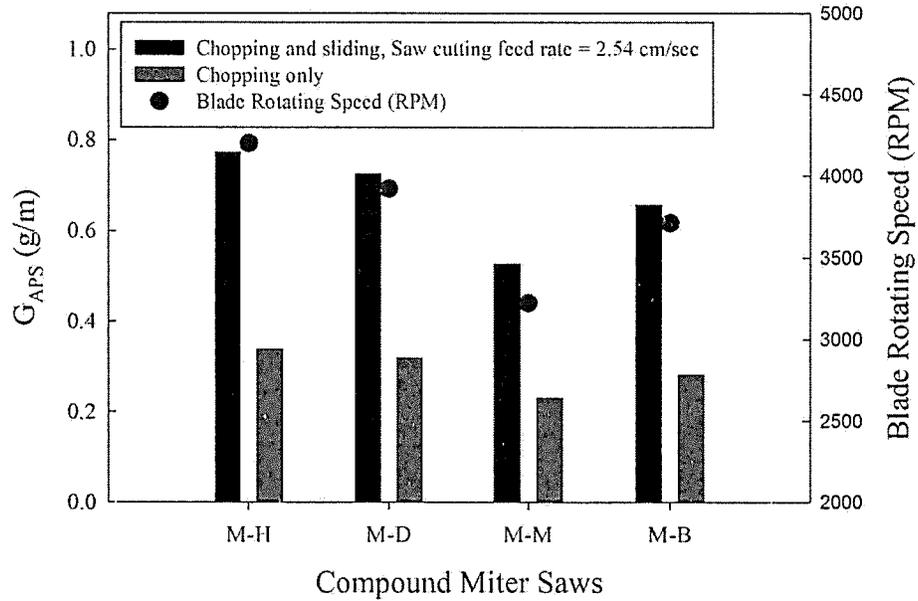


Figure 9. Generation rate of respirable dust for the miter saws. Blade: Hitachi 18109; Siding: CertainTeed.

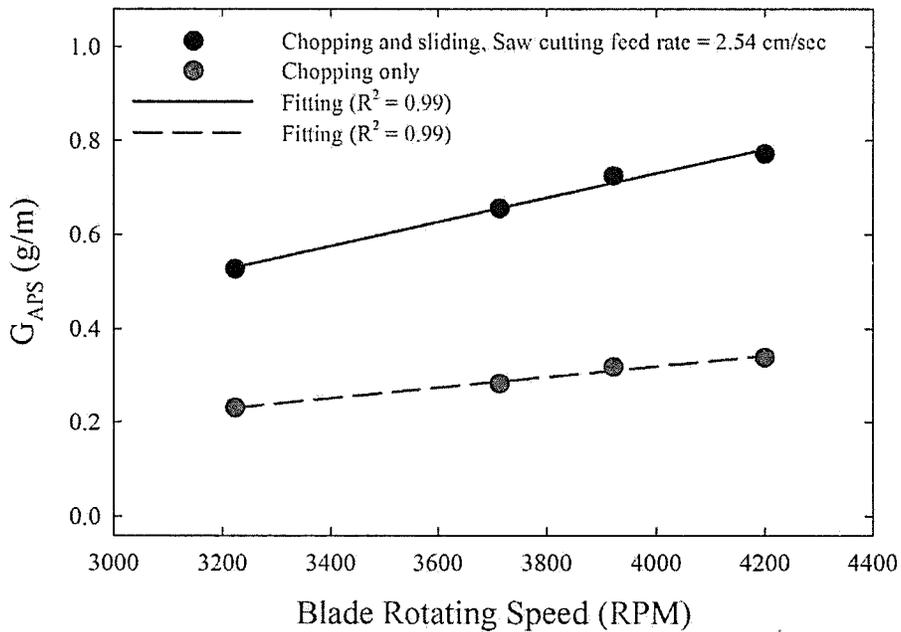


Figure 10. Comparison of the generation rate of respirable dust and the blade rotating speed for the miter saws. Blade: Hitachi 18109; Siding: CertainTeed.

The saw cutting feed rate was varied for the circular saws and miter saws operated under the "chopping and sliding" mode in this study. Figure 11 shows the G_{APS} results for the tested saws under different saw cutting feed rates. It is apparent that the G_{APS} decreased with the saw cutting feed rate for all the tested saws. This was likely due to fewer cutting interactions between the blade's teeth and the board during one cut when the saw cutting feed rate was higher. The circular saw C-R generated the highest amount of dust when it was used with the 5-inch diameter Freud blade running at a higher blade rotating speed at 9068 RPM. The other circular saws, i.e., C-H and C-M, generated the least amount of dust.

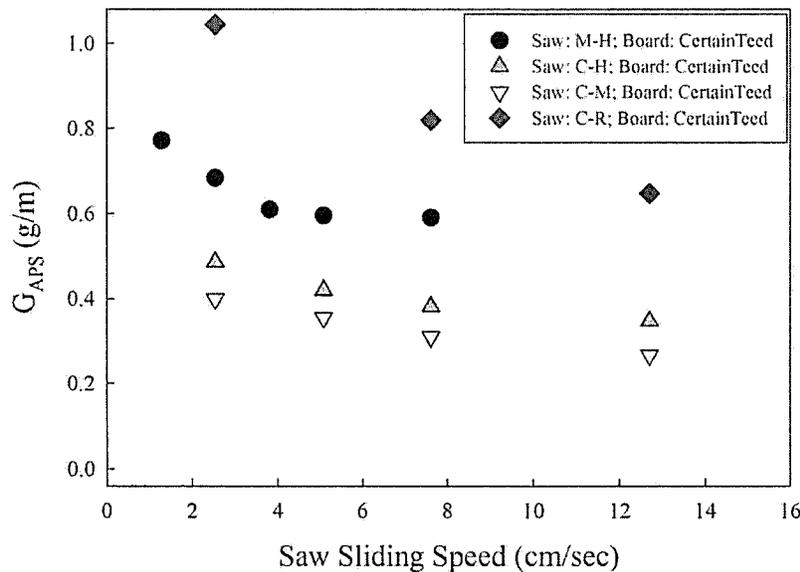


Figure 11. Generation rate of respirable dust at different saw cutting feed rate. Siding: CertainTeed.

Dust generation from cutting different number of fiber-cement siding boards at once

Up to six boards were stacked and cut in this study for the M-B, C-H, and C-M saws, and their G_{APS} results were presented in Figure 12. For all the three saws, the G_{APS} decreased with the number of board in the stack. Since the saw cutting feed rate was fixed at 2.54 cm/sec for these tests, it took about the same amount of time for the same saw to cut the stack of boards no matter how many boards were in the stack. Therefore, fewer cutting interactions occurred between the blade's teeth and the siding material for a unit linear length of cut when a larger number of boards were in the stack, which likely contributed to the lower G_{APS} , which was defined in Equation (2) as the mass of respirable dust generated per unit linear length of cut.

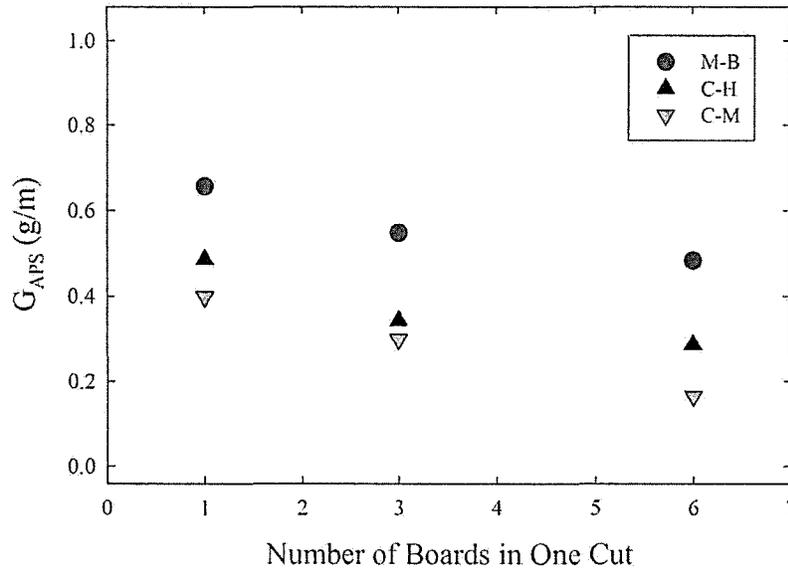


Figure 12. Generation rate of respirable dust when cutting different numbers of siding board in the stack. Saw cutting feed rate 2.54 cm/sec; Siding: CertainTeed.

The effectiveness of the LEV for different power tools

By combing the results of the dust size distribution from the APS data, respirable fraction from the convention curve, and the silica distribution in the dust of different sizes (fitting curves in Figure 7), a size distribution of respirable crystalline silica for the dust from cutting fiber-cement siding can be estimated for the four manufacturers and presented in Figure 13. Since the main objective of this study was to reduce workers' exposure to respirable crystalline silica while cutting fiber-cement siding, the results in Figure 13 are important to consider for choosing and evaluating engineering control measures. As shown in Figure 13, most respirable silica resides in the dust about 2.5 μm in aerodynamic diameter, although the overall concentration level varied among the four manufacturers. These data suggest that if an LEV system can capture the dust larger than about 1.0 μm from where they are generated and remove these dusts by air filtration, about 95% of the respirable silica would be removed. When an LEV system is implemented, it removes the majority of the dust across all the dust sizes with the air flow. This is evident in Figure 14, which shows the number-based size distributions of the generated dust when using the C-M saw with and without an LEV engineering control system. As shown in Figure 14, the dust across the entire size range was removed considerably even at a volumetric flow rate of only 1.18 m^3/min (41.6 CFM). As mentioned earlier, all the power saws tested in this study have a dust collecting feature with an exhaust port that can be connected to an external LEV system. Dust removal efficiency (DRE) defined in Equation (4) was characterized for all the test saws in this study.

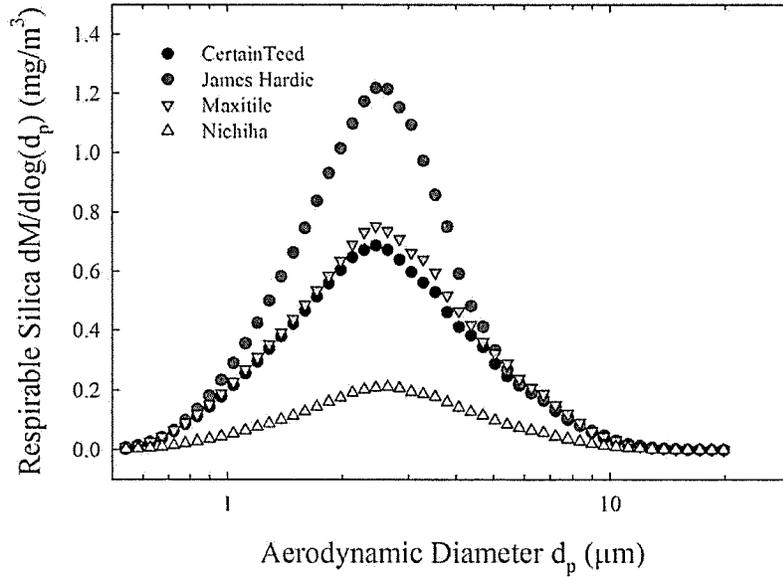


Figure 13. Size distribution of respirable crystalline silica for the dust from cutting fiber-cement siding of different manufacturers.

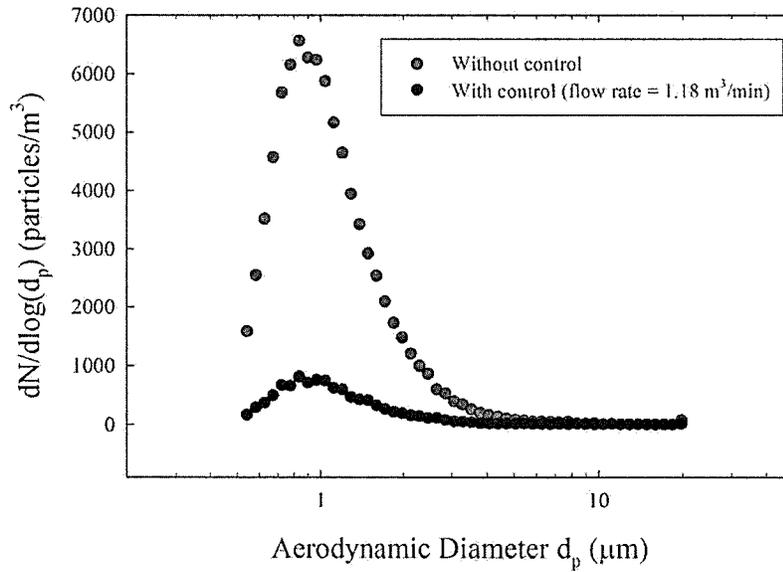
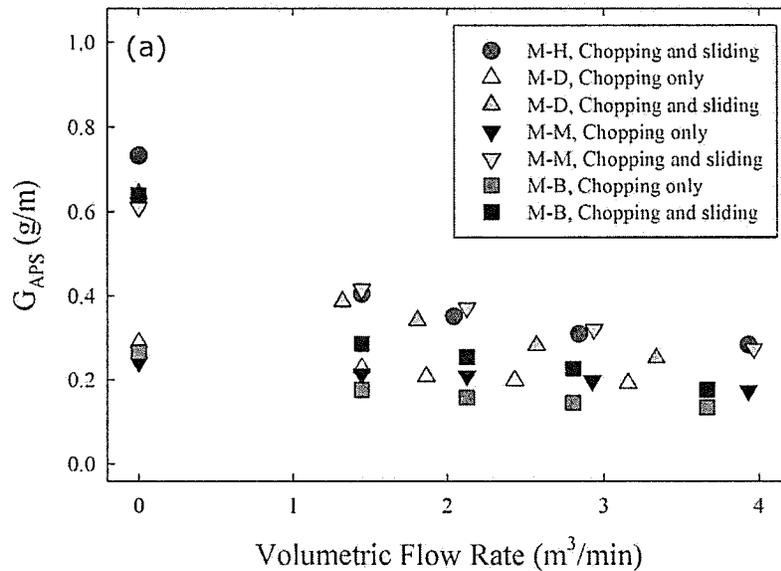


Figure 14. Dust size distributions with and without the LEV control. Power tool: C-M; Blade: Hitachi 18008; Saw cutting feed rate 2.54 cm/sec; Siding: CertainTeed.

Figure 15 illustrates the results of G_{APS} and DRE for the four miter saws under different volumetric flow rates of the LEV. Except for the M-H saw, both the

“chopping and sliding” and “chopping only” modes were tested. The test condition of the volumetric flow rate of zero refers to the case when the LEV system was connected to the test saw without being turned on. The highest tested flow rate was 3.97 m³/min (140 CFM), which was lower than the rating of the Dustcontrol 3700 vacuum cleaner (5.0 m³/min, 175 CFM) due to the extra flow restrictions added by the exhaust port, hose, and connections in the LEV system. As shown in Figure 15, the increased volumetric flow rate of the LEV did lead to a lower G_{APS} and higher DRE, although the increment seemed to diminish with increased flow rate, suggesting that the higher flow rate did not work as efficiently removing the extra amount of dust for these miter saws. This is more apparent in the “chopping only” mode. Similar to the observation in Figure 9, the dust generation in the “chopping only” mode was generally lower than that in the “chopping and sliding” mode when other test conditions were the same. However, the DRE result was higher in the “chopping and sliding” mode. This is possibly because more dust can be captured by the LEV when the blade slides to the far end of the miter saws, where their exhaust ports were located. In most test conditions for the four miter saws, the DRE was about or lower than 65%, even at the highest flow rate of about 3.97 m³/min. Although the M-M saw generated the least amount of dust when the LEV was not connected (Figure 9), the M-B saw demonstrated the lowest G_{APS} and the highest DRE when the LEV was used, possibly due to the design of its exhaust port, which might be able to collect more dust under the the same flow rate of the LEV.



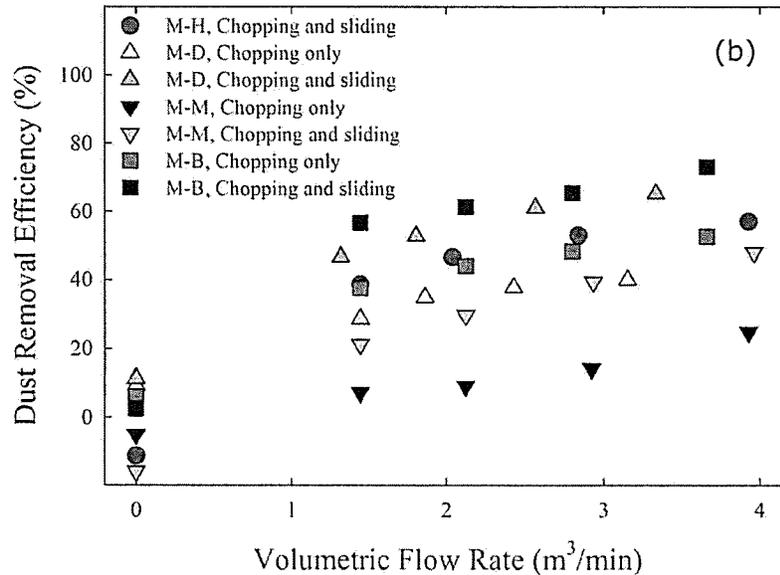


Figure 15. (a) Generation rate of respirable dust; and (b) Dust removal efficiency; for the miter saws cutting one board in the stack under different flow rates of the LEV. Saw cutting feed rate 2.54 cm/sec; Blade: Hitachi 18109; Siding: CertainTeed.

The results of G_{APS} and DRE at different saw cutting feed rate for the C-H saw are shown in Figure 16. Similar to the test of the miter saws, the test condition of the volumetric flow rate of zero refers to the case when the LEV system was connected to the C-H saw without being turned on. The DRE was between about 20% to about 42% even when the flow rate was zero. The C-H saw has a dust-collecting feature with a built-in shroud covering the saw blade and connecting to an exhaust port so that the flow induced by the spinning blade collects in the shroud a large amount of the dust generated while cutting and directs the dust to the exhaust port. When the flow rate of the LEV was zero, the induced flow by the spinning saw blade would still be able to collect and send some dusts into the vacuum cleaner, resulting in the 20% to 40% DRE. The DRE jumped to about 78% when the LEV was turned on, even at a low flow rate of about 1.4 m³/min. However, further increasing the flow rate did not lead to significantly lower G_{APS} and higher DRE as shown in Figure 16. The highest DRE achieved was about 87% at about 2.5 m³/min flow rate. This is possibly limited by the shroud design, whose dust capture efficiency can only reach a certain limit so the increased flow rate would not be able to remove more dust. Figure 16 also shows that a higher saw cutting feed rate in general leads to lower G_{APS} (similar to the observation in Figure 11) and higher DRE when the flow rate was similar. Compared to the DRE results for the miter saws, the DRE for the C-H saw was obviously higher and this higher DRE can be achieved even at low flow rates.

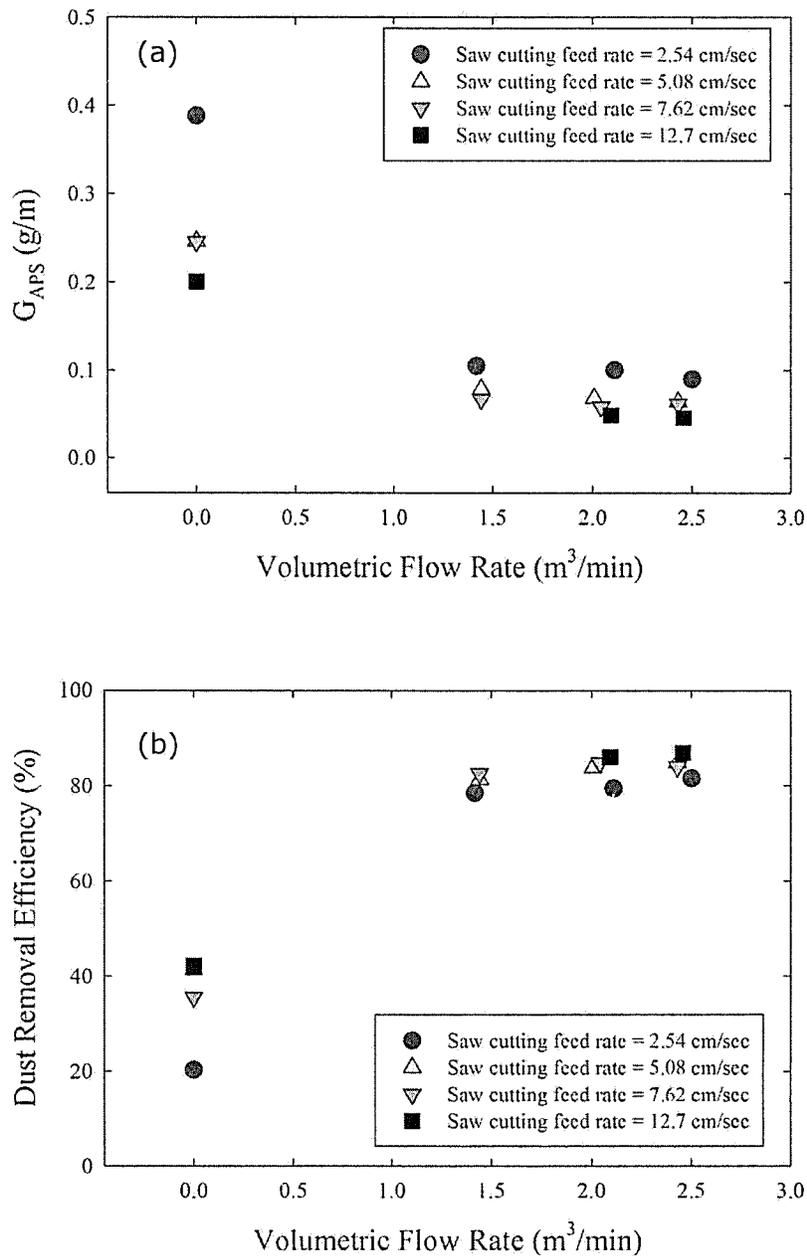
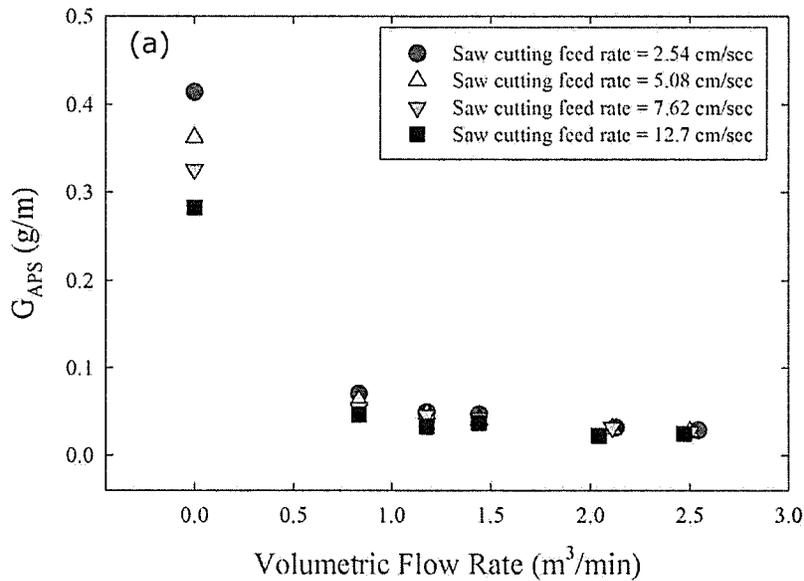


Figure 16. (a) Generation rate of respirable dust; and (b) Dust removal efficiency; for the C-H saw cutting one board in the stack under different flow rates of the LEV. Blade: Hitachi 18008; Siding: CertainTeed.

Unlike the C-H saw, the C-M saw has a removable dust-collecting container, which covers about 69% of the saw blade's surface. Similar to the shroud in the C-H saw, this hood also helps collect dust by the induced flow from the spinning saw blade

and sends the dusts to an exhaust port. The exhaust port can be connected to an external LEV system or capped when it is not in use. The results of G_{APS} and DRE for the C-M saw shown in Figure 17 are largely similar to those shown in Figure 16 for the C-H saw. The DRE jumped to about 82% once the LEV was turned on at a low flow rate of about $0.83 \text{ m}^3/\text{min}$, and the highest DRE achieved was about 93% at a flow rate of about $2.5 \text{ m}^3/\text{min}$. The effect from the saw cutting feed rate is less apparent compared to the observation for the C-H saw. The dust-collecting container of the C-M saw included a cap, which was not available to the C-H and C-R saws, and the test condition of the volumetric flow rate of zero refers to the case when its exhaust port was capped. The capped exhaust port blocked the induced flow so the dust cannot be effectively collected in the container, resulting in an averaged -4% DRE as shown in Figure 17.



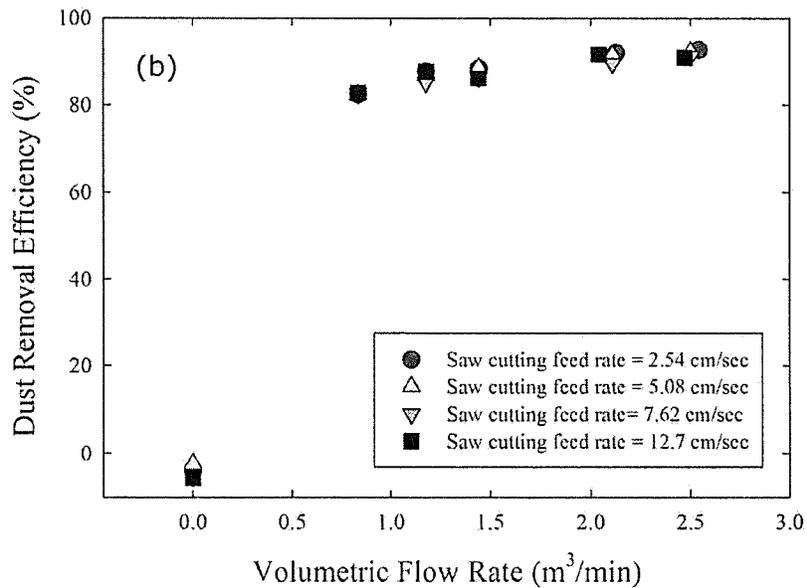


Figure 17. (a) Generation rate of respirable dust; and (b) Dust removal efficiency; for the C-M saw cutting one board in the stack under different flow rates of the LEV. Blade: Hitachi 18008; Siding: CertainTeed.

For both the C-H and C-M saws, tests were conducted with 3 or 6 boards stacked for one cut while the LEV system was activated; the results of G_{APS} and DRE are illustrated in Figure 18. The overall observations in Figure 18 are similar to those in Figure 16 and 17. For the C-H saw, the DRE was about 86% for all the test conditions; and for the C-M saw, the DRE ranged from about 84% to 98%.

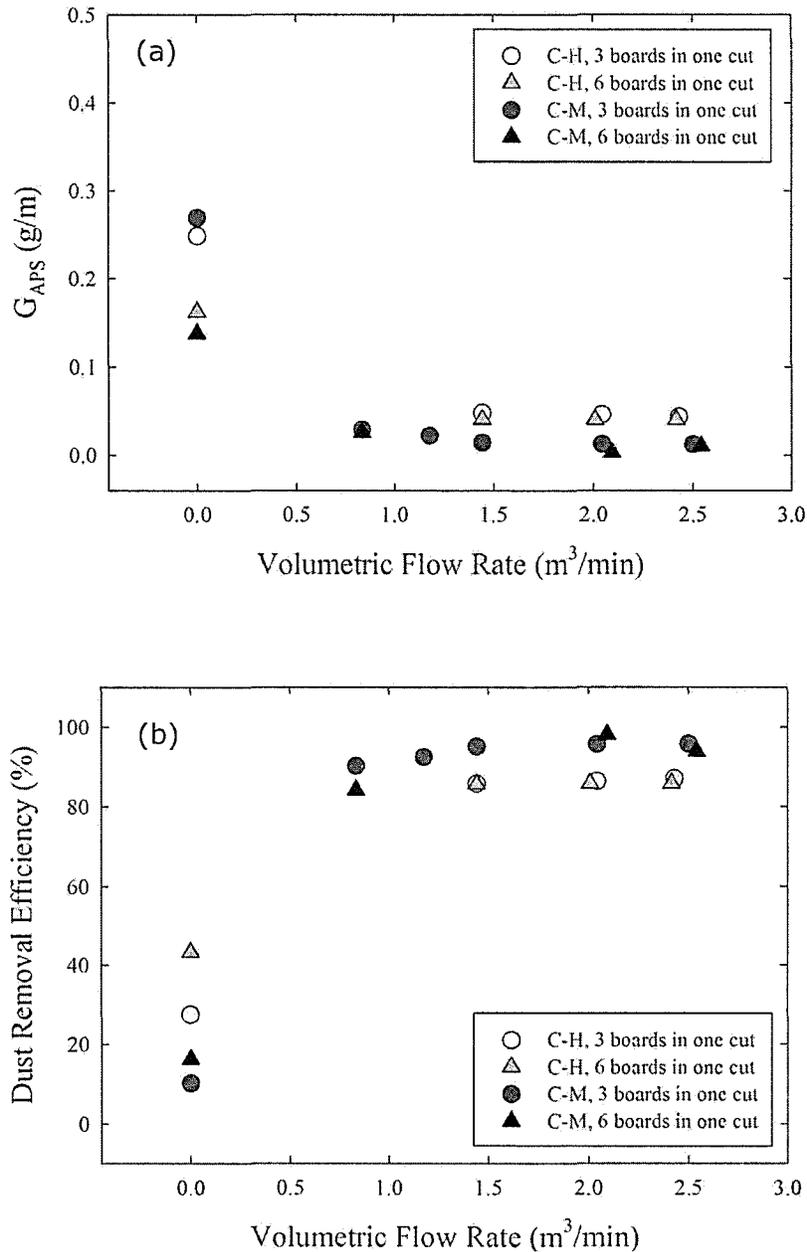


Figure 18. (a) Generation rate of respirable dust; and (b) Dust removal efficiency; for the C-H and C-M saws cutting three or six boards in the stack under different flow rates of the LEV. Saw cutting feed rate 2.54 cm/sec; Blade: Hitachi 18008; Siding: CertainTeed.

As mentioned earlier, the C-R saw has a small built-in blower that pushes air through its exhaust port. Thus, the flow rate of its LEV was about 1.3 m³/min even when the external LEV system was not activated. At this test condition, the DRE

was about 92%. Activating the external LEV and increasing the flow rate led to an increase of the DRE to about 98%.

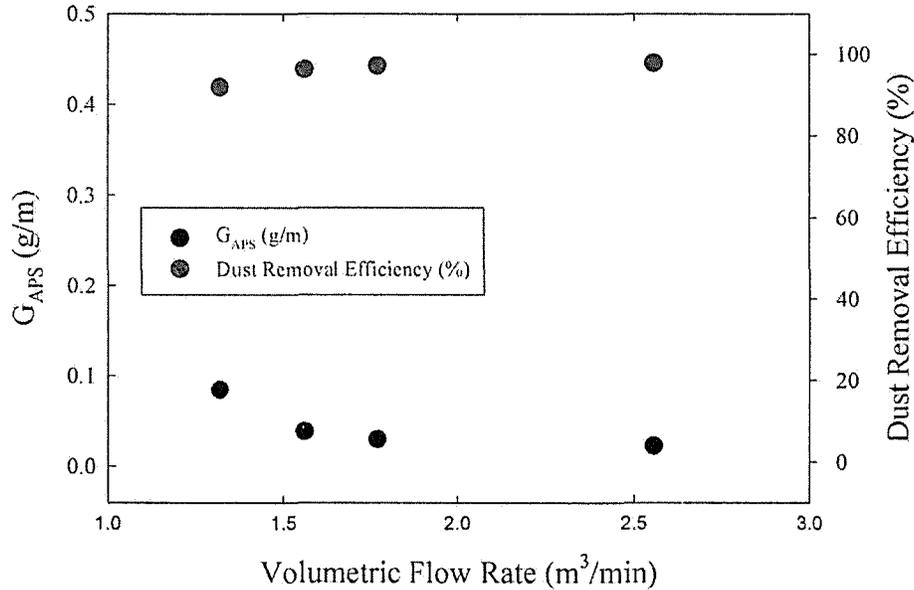


Figure 19. Generation rate of respirable dust and dust removal efficiency for the C-R saw cutting one board in the stack under different flow rates of the LEV. Saw cutting feed rate 2.54 cm/sec; Blade: Freud D0506CH; Siding: CertainTeed.

Discussion of the Laboratory Evaluation

The result of G_{APS} for the power shear was 0.006 g/m at a saw cutting feed rate of 2.54 cm/sec, verifying that it is indeed an almost dust free operation. However, as mentioned earlier, it is limited by slow production rates and low cutting precision.

Under most testing conditions in the laboratory evaluation, the DRE for the four miter saws was about 65% or less, even at the highest tested flow rate of 3.97 m³/min (140 CFM). In addition, increasing the flow rate of the LEV did not lead to an equivalent increase on the DRE. This is mainly due to the design limitations of these miter saws in terms of dust collection. Although all of them were equipped with an exhaust port to be connected to an external LEV system, their exhaust ports were located at a fixed position at the back of the saws and they are not integrated with any other dust collecting apparatus, such as a hood covering the blade to assist in dust collection. Therefore, dusts were scattered from the blade during a cut and the LEV was not able to collect the dust and remove it even at a high flow rate, especially when the cutting point was far away from the exhaust port.

Although all the four miter saws showed a lower dust generation rate in the "chopping only" mode, they cannot complete one crosscut of the lap siding board

used in this study under this mode. In addition, miter saws cannot effectively cut panel siding. Thus, circular saws are the dominant tools used by the siding contractors when cutting fiber-cement siding.

Comparing the four miter saws, all three circular saws had a built-in dust collection container or shroud, which served as a hood and partially enclosed the saw blade. Thus, they were able to collect a considerable amount of dust while cutting and remove it by connecting to an external LEV system even at a low flow rate of 0.83 m³/min (29 CFM). This flow rate can be easily achieved by most basic shop vacuums. The lowest DRE for the three circular saws with an activated LEV was about 78%, demonstrating the effectiveness of the LEV working with these circular saws on removing respirable dust. The C-R saw with a built-in blower has the highest DRE among the three circular saws, providing a 92% DRE even when the LEV system was simply connected but not activated. Activating the LEV increased this DRE to roughly 98%. It should be noted that in the test condition when the LEV was connected but not activated, the air flow induced by the running blade and/or provided by the built-in blower (the C-R saw only) can still capture a certain amount of dust and direct it towards the vacuum cleaner. In practice, if the circular saws were simply connected to a dust bag, which did not have an exhaust, the flow would become blocked and most dust would not be removed, as was the case of the C-M saw when the dust collecting container was capped (Figure 17).

Although the C-R saw demonstrated the highest DRE among the three circular saws, it generated a larger amount of dust when the LEV was not connected (as shown in Table 3), possibly due to its much higher blade rotating speed (9068 RPM compared to 5663 RPM for the C-H saw and 5500 for the C-M saw). So the actual G_{APS} when the LEV was working needs to be compared. At the same saw cutting feed rate of 2.54 cm/sec and cutting one board at a time, the lowest G_{APS} was 0.090 g/m for the C-H saw, 0.029 g/m for the C-M saw, and 0.023 g/m for the C-R saw. The larger blade diameter of the C-H saw and C-M saw (18.4 cm or 7.25 inch, compared to 12.7 cm or 5.0 inch for the C-R saw) make them capable of cutting up to six boards at once. At the saw cutting feed rate of 2.54 cm/sec and cutting six boards at once, the lowest G_{APS} was 0.041 g/m for the C-H saw, and 0.010 g/m for the C-M saw, which was getting close to the G_{APS} of the power shear (0.006 g/m). These results suggest that cutting six boards using the C-M saw with the LEV system results in the lowest generation rate of respirable dust among all the test conditions for power saws in the laboratory evaluation.

Field Validation of the Laboratory Findings

From the two studies by Lofgren et al. [2004] and Qi et al. [2013a], the highest 8-hr TWA exposure to respirable crystalline silica observed without using controls was 0.17 mg/m³. If the DRE for the circular saws equipped with LEV ($\geq 81\%$) obtained in the laboratory evaluation could be translated into the same amount of reduction on workers' exposures, exposures below the NIOSH REL of 0.05 mg/m³ would be achievable. The results from the laboratory evaluation suggested that connecting a dust-collecting circular saw to a basic shop vacuum with built-in air filters, which

normally runs at a higher flow rate than 0.83 m³/min (29 CFM), had the potential to provide a simple and low-cost engineering control for the dust generated from cutting fiber-cement siding. It is referred to as the LEV control in this report. To validate the effectiveness of this engineering control measure, four field surveys were conducted to evaluate workers' exposures at construction sites where it was used to reduce exposure while cutting fiber-cement siding. Detailed information about the four field surveys were published in the survey reports by Qi et al. [2013b, 2014a, 2014b, 2014c].

In the surveys, a 12-gallon shop vacuum (model 586-62-11, Shop-Vac[®] Corporation, Williamsport, PA) was used to provide LEV for the dust-collecting circular saws used by the surveyed cutters. A vacuum hose was used to connect the saw's exhaust port to the shop vacuum. Figure 20 shows C-M saw and its connection to the shop vacuum. The shop vacuum came with a standard disposable filter bag (part number 90662, Shop-Vac[®] Corporation, Williamsport, PA) to trap most of the dust, and a standard Prolong cartridge filter (part number 90304, Shop-Vac[®] Corporation, Williamsport, PA) to capture the dust passing through the filter bag. In order to collect more dust in the filter bag, a high efficiency disposable filter bag (fine filtration bag, part number 90672, Shop-Vac[®] Corporation, Williamsport, PA) was used in this study, replacing the standard disposable filter bag. Since most of the dust was captured in the filter bag rather than in the cartridge filter, the life of the cartridge filter was greatly extended as evidenced in these field surveys [Qi et al., 2013b, 2014a, 2014b, 2014c].

The shop vacuum was rated to provide a 5.66 m³/min (200 CFM) flow rate by the manufacturer, which is sufficient to provide good LEV for the cutting task, based on the laboratory evaluation. However, the actual flow rate can be affected when the shop vacuum is connected to the filters and vacuum hose. More importantly, the flow rate might change due to dust loading on the filter bag and cartridge filter. Thus, a data logging pressure transducer (Smart Reader SRP-004-30G-128K 0-30 PSI-G, ACR Systems, Surrey, BC, Canada) was placed in the tank of the shop vacuum, between the filter bag and the cartridge filter in the flow path, to log the local absolute air pressure. Prior to the field surveys, a laboratory test found that the difference between the absolute air pressure in the shop vacuum tank when the shop vacuum was on and off was linearly correlated with the actual air flow rate, as measured using a Delta tube (model # 307BZ-11-AO, Mid-West Instrument, Sterling Heights, MI). In the laboratory study, the same experimental setup as shown in Figure 3 was used and the gate valves were used to adjust the air flow rate so that the correlation between the actual flow rate read from the Delta tube and the absolute air pressure difference from the data logging pressure transducer in the shop vacuum tank could be obtained. This correlation was used with the pressure data collected from the shop vacuums at the job sites to estimate their actual flow rates during the surveys. The flow rate of the LEV was in the range of 1.95-2.96 m³/min (69-105.8 CFM), which was well above the lowest flow rate tested in the laboratory evaluation of the LEV system. In the field surveys, a battery pack (model # BP-101, ACR Systems, Surrey, BC, Canada) was used

together with the data logging pressure transducer in the shop vacuums in order to obtain the vacuum tank pressure readings every 2 seconds.



Photo by NIOSH

Figure 20. The dust-collecting circular saw and its connection to the shop vacuum used in the field surveys.

In two of these four field surveys, another control measure by using a prototype circular saw with a built-in cyclone dust collector and an air filter was concurrently evaluated [Qi et al., 2014a and 2014b]. This prototype circular saw was developed by James Hardie Industries, and is referred to as the RS saw in this report. The RS saw collects dust in its built-in cyclone dust collector and air filter without using an external shop vacuum. It utilizes a shroud to cover the blade and the flow induced by the spinning blade to direct the dust to a built-in chamber which works as a cyclone dust collector to remove larger dust particles by their inertial effect. The cyclone chamber is inter-connected to another chamber on its side where an air filter is incorporated to remove the residual dust escaping from the cyclone.

Figure 21 shows a surveyed cutter cutting fiber-cement siding on his work bench using the LEV control. Figure 22 shows a picture of the RS saw with its main

components and Figure 23 shows a surveyed cutter cutting fiber-cement siding using the RS saw control.

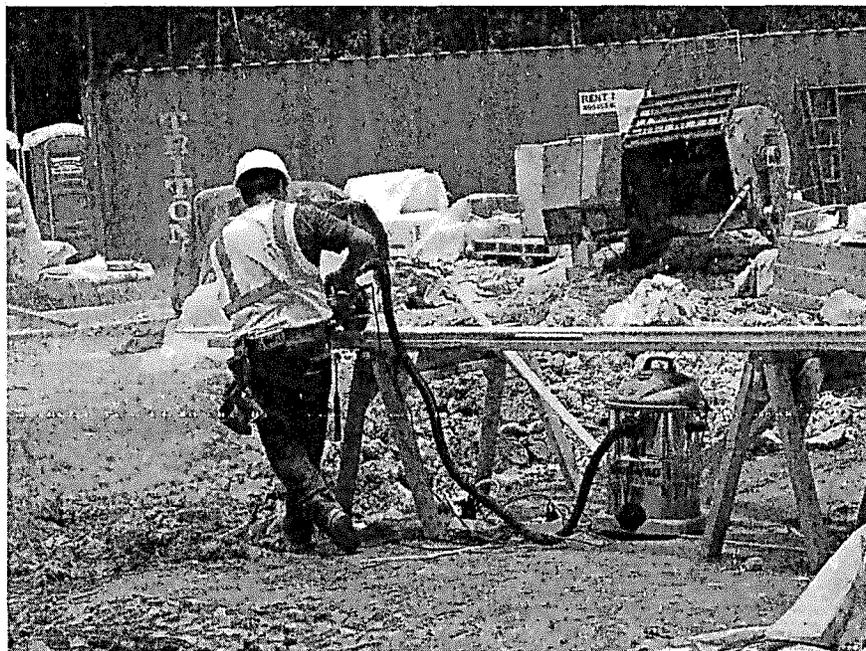


Photo by NIOSH

Figure 21. A worker (cutter) cutting fiber-cement siding using a dust-collecting circular saw that was connected to a shop vacuum.

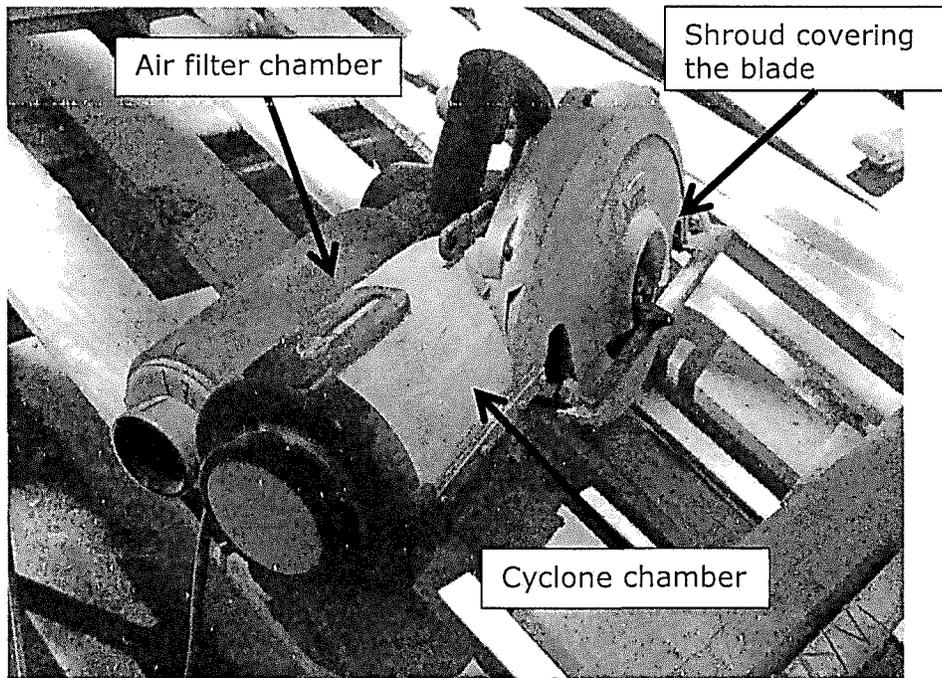


Photo by NIOSH

Figure 22 – The prototype RS saw with its built-in cyclone dust collector and air filter.



Photo by NIOSH

Figure 23 – A worker (cutter) cutting fiber-cement siding using a prototype circular saw with a built-in cyclone dust collector and an air filter (RS saw).

Table 4 provides a summary of the four field surveys. During the surveys, the cutters cut fiber-cement siding using the tested engineering control measures (as shown in Figure 21 and 23), and the installers mainly took the measurements, verbally communicated the size requirement to the cutters, and installed the siding. The fiber-cement siding used in these surveys was from James Hardie.

Table 4. Summary of the field surveys and exposure results

Survey Site	Survey Dates	Power Saw	Number of Cutters Surveyed	Respirable crystalline silica 10-hr/8-hr TWA concentration (mg/m ³) for the surveyed cutter	Number of Installers Surveyed	Respirable crystalline silica 10-hr/8-hr TWA concentration (mg/m ³) for the surveyed installer
Greensboro, GA [Qi et al., 2013b]	06/18/14 to 06/20/14	C-H	2	0.003-0.015/ 0.003-0.018	2	0.001-0.007/ 0.002-0.009
Glenview, IL [Qi et al., 2014a]	07/09/14 to 07/11/14	C-M	2	0.001-0.013/ 0.002-0.016	1	0.004-0.010/ 0.004-0.013
		RS	1	0.024-0.061/ 0.029-0.076		
Woodbury, MN [Qi et al., 2014b]	07/23/14 to 07/25/14	C-M	1	0.013-0.033/ 0.016-0.041	0	n/a
		RS	1	0.016-0.087/ 0.019-0.108		
Huntsville, AL [Qi et al., 2014c]	09/24/14 to 09/26/14	C-M	2	0.007-0.024/ 0.008-0.029	0	n/a

Note: n/a means "not available"

Statistical analyses were performed using SAS v12.1 (SAS Institute Inc.). From the workers participating in the four surveys, we obtained 21 10-hr/8-hr TWA exposure measurements for cutters using the LEV control, 6 measurements for cutters using the RS saw control, and 12 measurements for installers. The exposure data were found to be log-normally distributed (based on the Shapiro-Wilk test) for each group of workers and they were used in the statistical calculation for respirable crystalline silica TWA concentrations. The summary statistics are listed in Table 5.

As listed in Table 5, the exposures for the cutters using the LEV control were well below the NIOSH REL of 0.05 mg/m³ for respirable crystalline silica 10-hr TWA concentration, with the 95% upper confidence limit being only 24% of the NIOSH REL. The 95% upper confidence limit of 8-hr TWA exposures was also only 60% of the ACGIH[®] Threshold Limit Value (TLV[®]) of 0.025 mg/m³. The geometric standard deviation for these cutters' exposure data was 2.06. The exposure level for the installers was about half of that for the cutters using the LEV control, and the

geometric standard deviation for the installers' exposure data was 1.67. However, the exposures for the cutters using the RS saw control were considerably higher, with the geometric mean of the 10-hr TWA concentration being 0.040 mg/m³, which was 5 times of that for the LEV control (0.008 mg/m³). But it was still 20% lower than the NIOSH REL. The 95% lower and higher confidence limits of the 8-hr TWA concentration for these cutters were 0.023 and 0.105 mg/m³, respectively.

Table 5. Summary Statistics for the exposure results from the field surveys

Job Type	Control Type	TWA Type	Number of TWA	Geometric Mean (mg/m ³)	Lower 95% Confidence Limit (mg/m ³)	Upper 95% Confidence Limit (mg/m ³)	Geometric Standard Deviation
cutters	LEV	10-hr TWA	21	0.008	0.006	0.012	2.06
		8-hr TWA	21	0.011	0.008	0.015	2.06
	RS saw	10-hr TWA	6	0.040	0.019	0.084	2.04
		8-hr TWA	6	0.049	0.023	0.105	2.08
installers	n/a	10-hr TWA	12	0.004	0.003	0.006	1.67
		8-hr TWA	12	0.005	0.004	0.007	1.67

Note: n/a means "not available"

In order to statistically validate the effectiveness of the LEV control, further analyses were performed using the combined data set for all the cutters from the above four field surveys as well as from the previous field survey [Qi et al., 2013a], which did not use any control measures. The respirable crystalline silica 10-hr TWA concentrations in the combined data set (31 10-hr TWA exposure measurements) were also log-normally distributed based on the Shapiro-Wilk test. A SAS mixed model procedure followed by the Tukey-Kramer adjusted multiple comparison was used to examine the determinants of exposure. The model set the logarithm of the 10-hr TWA respirable silica concentration as the dependent variable, treated the survey site as a random factor, and included other factors such as control measure, wind speed, wind direction, temperature, relative humidity and workers' productivity as covariance variables. Control measure, as used in the model included three scenarios, i.e., no control, the LEV control, and the RS saw control. During each survey, the NIOSH researchers used a Kestrel model 4500 Weather Meter (Nielsen-Kellerman Co., Boothwyn, PA) to log the wind speed, wind direction, temperature, and relative humidity at the construction site. The averaged data during the sampling period corresponding to each TWA concentration measurement was used in the model. The survey reports [Qi et al., 2013a, 2013b, 2014a, 2014b, and 2014c] described the data processing in detail. The worker's productivity is defined as the mass of crystalline silica in the removed material from cutting fiber-cement siding per unit time during the sampling period corresponding to each TWA concentration measurement. It was measured by using the board density and averaged silica content reported by the siding manufacturers, and counting the

number of cuts, their length, the number of boards stacked and cut, and the thickness of each board cut during each sampling period.

Table 6. The p-value from a mixed model for factors on exposure to respirable crystalline silica 10-hr TWA concentration.

Factor	Control Measure	Wind Speed	Wind Direction	Temperature	Relative Humidity	Worker Productivity
p-value	0.0007	0.0396	0.4094	0.3505	0.3330	0.4163

Table 6 reports the p-value for each factor in the mixed model. Both control measure ($p=0.0007$) and wind speed ($p=0.0396$) were statistically significant in terms of affecting the TWA respirable silica exposure. Since the model treated the survey site as a random factor, the p-value of 0.0007 for control measure confirms that the lower exposure level listed in Table 5 for the workers using the LEV control is statistically significant, and it can be applied to the population of sites from which the random sites were chosen. Therefore, the effectiveness of this control measure is statistically validated. The p-value of 0.0396 for wind speed suggests that wind speed played an important role in reducing worker's exposure to respirable crystalline silica while cutting fiber-cement siding. This is possibly due to the fact that wind could be considered natural ventilation, blowing the dust away from the workers. However, the dust carried away by wind could be a potential hazard for other people working downwind from the source at the construction site. Thus, removing the dust by LEV is preferred. The p-value of the other factors in Table 6 indicates that they did not have a statistically significant effect upon a worker's TWA respirable crystalline silica exposure. This is most likely because the effect from the control measure is so dominant that the effect from these factors becomes insignificant in this particular model.

It should be noted that the respirable dust cyclone sampler used in the field surveys was model GK2.69 from BGI Inc (Waltham, MA) and the sampling flow rate used was 4.2 L/min. Its performance was characterized experimentally in the laboratory by Kenny and Gussman [1997], and more recently by Lee et al. [2010]. At the flow rate of 4.2 L/min, Lee et al. observed a larger sampling efficiency for dust larger than 6 μm comparing to the result from Kenny and Gussman as well as the respirable convention curve. Over sampling of the larger dusts may result in an overestimation of the exposure level. This bias may be particularly apparent for this study as the larger dusts from cutting fiber-cement siding were found containing a larger percentage of silica as shown in Figure 7. Assuming the dust size distribution and the silica distribution in the dust of difference sizes are the same in the laboratory evaluation and the field surveys, we estimated that the bias on the exposure to respirable crystalline silica using the GK2.69 sampler comparing to the exposure level based on the respirable convention curve was +1.5% when using the data from Kenny and Gussman [1997], and +12.3% using the data from Lee et al. [2010].

Limitations of the Control Measure

Both the laboratory evaluation and field surveys suggest that the tested LEV control measure works effectively by removing dust at its source and reducing workers' exposure to respirable crystalline silica while cutting fiber-cement siding. A couple of drawbacks of this engineering control measure were also observed during the field survey. The vacuum hose may collide with the work bench during cutting, especially for long rip cut of lap sidings or cutting panel sidings. Some improvement on this issue may be needed to help workers maintain their productivity while engaging the engineering control measure. Another issue is that the dust-collecting container of the C-M saw often blocks the cutters' view of the blade, which was preferred to be avoided by most workers. The shroud used in the C-H and C-R saws does not have this issue. However, the C-H saw has been discontinued since 2013.

The effectiveness of an air filter is normally rated by its Minimum Efficiency Reporting Value (MERV), which was designed by the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE). However, the manufacturer of the shop vacuum used in the field surveys did not provide such ratings for its filters. The exhaust air of the shop vacuum could potentially still carry some respirable crystalline silica after passing through the filter bag and cartridge filter. If this occurred, it might get inhaled by nearby workers. The exposure levels for the workers using the LEV control in this study included any contributions from this effect. Although evaluating the filtration efficiencies of these air filters and the amount of crystalline silica in the exhaust air of the shop vacuum was beyond the scope of the current study, it is worth noting that using shop vacuums that incorporate filters with lower efficiencies than those used in this study could result in higher exposure levels for the workers.

Conclusions/Recommendations

Controlling exposures to occupational hazards is the fundamental method of protecting workers. Traditionally, a hierarchy of controls has been used as a means of determining how to implement feasible and effective controls. One representation of the hierarchy controls can be summarized as follows:

- Elimination
- Substitution
- Engineering Controls (e.g. ventilation)
- Administrative Controls (e.g. reduced work schedules)
- Personal Protective Equipment (PPE, e.g. respirators)

The idea behind this hierarchy is that the control methods at the top of the list are potentially more effective, protective, and economical (in the long run) than those at the bottom. Following the hierarchy normally leads to the implementation of inherently safer systems, ones where the risk of illness or injury has been substantially reduced.

In the laboratory evaluation of this study, the dust generated by cutting fiber-cement siding from four manufacturers using a variety of power tools was characterized in detail. The overall size distribution and generation rate of respirable dust by cutting fiber-cement siding from the four manufacturers were found very close to each other. The size distribution of the airborne dust showed a bimodal distribution, with a larger mode around 13 μm , and another mode smaller than 5 μm . The overall respirable fraction of the airborne dust from cutting fiber-cement siding of the four manufacturers was estimated to be in the range of 37.8% to 48.8%, and the content of crystalline silica in their respective respirable dusts was estimated to be in the range of 1.2% to 9.3%. Analysis of size-selective samples collected by MOUDI revealed that the dust from cutting fiber-cement siding of the four manufacturers had the same trend of increasing silica content occurring with increases in the aerodynamic diameter of the dust, approaching to the silica content levels found in their respective bulk samples. This result suggested that most crystalline silica distributes in larger dusts, which have less respirable fraction and are likely to be well controlled by LEV equipped with regular air filters instead of high-efficiency particulate air (HEPA) filters.

The results from the laboratory test also suggest that the number of teeth on the saw blade and the blade rotating speed in the tested range are likely two dominant factors affecting the dust generation rate for cutting fiber-cement siding, with the saw blade having fewer number of teeth and the saw running at lower blade rotating speed generating considerably less amount of respirable dust. Miter saws evaluated in this study generated less respirable dust when operated under the "chopping only" mode compared to the "chopping and sliding" mode. For miter saws operated under the "chopping and sliding" mode and all the circular saws evaluated in this study, the generation rate of respirable dust, which was defined in Equation (2) as the total mass of respirable dust generated per unit linear length of cut of fiber-cement siding, was lower when the saw cutting feed rate was higher in the tested range. The generation rate of respirable dust was also found lower when stacking more board to cut at one time.

From the laboratory evaluation of the LEV, the DRE for the four miter saws was about 65% or less, even at the highest tested flow rate of 3.97 m^3/min (140 CFM). In addition, increasing the flow rate of the LEV did not lead to an equivalent increase on the DRE. This is mainly due to the design limitations of these miter saws in terms of dust collection. The test for the three dust-collecting circular saws connected to the laboratory LEV system showed that more than 78% of the respirable dust from cutting fiber-cement siding can be removed, even at a low flow rate of 0.83 m^3/min (29 CFM). The lowest generation rate of respirable dust was achieved by using the C-M saw to cut six boards at once in a stack with the LEV implemented. These results suggested that connecting a dust-collecting circular saw to a basic shop vacuum with built-in air filters, which normally runs at a higher flow rate than 0.83 m^3/min (29 CFM), had the potential to provide a simple and low-cost engineering control for the dust generated from cutting fiber-cement siding. Through four field surveys using a basic shop vacuum, which was equipped

with a high efficiency disposable filter bag and a filter cartridge, to provide the LEV and remove the dust while cutting fiber-cement siding, the effectiveness of this engineering control measure was validated. The statistics from the field survey results showed that the 95% upper confidence limit for 10-hr TWA exposure to respirable crystalline silica was only 24% of the NIOSH REL of 0.05 mg/m³. These results indicate that this engineering control measure effectively controlled the dust emissions, reduced the workers' exposures, and provided an effective, simple and low cost solution for workers cutting fiber-cement siding. The use of this type of engineering control technology for the dust-collecting circular saws is a preferred solution and adheres to the hierarchy of controls.

References

- ACGIH® [2013]. 2013 TLVs® and BEIs®: threshold limit values for chemical substances and physical agents and biological exposure indices. Cincinnati, OH: American Conference of Governmental Industrial Hygienists.
- Akbar-Khanzadeh F, Brillhart RL [2002]. Respirable crystalline silica dust exposure during concrete finishing (grinding) using hand-held grinders in the construction industry. *Ann Occup Hyg* 46:341-346.
- Beamer BR, Shulman S, Maynard A, Williams D, Watkins D [2005]. Evaluation of misting controls to reduce respirable silica exposure for brick cutting. *Ann Occup Hyg.*; 49(6):503-10.
- Bousquin J [2009]. Fiber cement's aesthetics and durability continue to gain fans. *Building Products Magazine*. Publication date: February 13, 2009. [<http://www.prosalesmagazine.com/industry-news.asp?sectionID=0&articleID=875202>] accessed 11/30/2009.
- Brockman [2011]. Aerosol transport in sampling lines and inlets. In: Kulkarni P, Baron PA, Willeke K eds, *Aerosol measurement-principles, techniques, and application*. New Jersey: John Wiley & Sons, pp 69-105.
- Bureau of Mines [1992]. *Crystalline silica primer*. Washington, DC: U.S. Department of the Interior, Bureau of Mines, Branch of Industrial Minerals, Special Publication.
- Carlo RV, Sheehy J, Feng HA, Sieber WK [2010]. Laboratory evaluation to reduce respirable crystalline silica dust when cutting concrete roofing tiles using a masonry saw. *J Occup Environ Hyg.*; 7(4):245-51.
- CEN. [1993]. EN 481, Centre European de Normalisation Workplace atmospheres: Size fraction definitions for measurement of airborne particles in the workplace. Brussels: European Committee for Standardization.

CEN [2006]. EN 1093-3, Safety of machinery-Evaluation of the emission of airborne hazardous substances-Part 3: Test bench method for measurement of the emission rate for a given pollutant. Brussels: European Committee for Standardization.

Chisholm J [1999]. Respirable dust and respirable silica concentrations from construction activities. *Indoor Built Environ* 8:94-106.

Flanagan ME, Seixas N, Majar M, Camp J, Morgan M [2003]. Silica dust exposures during selected construction activities. *AIHA Journal* 64:319-328.

Glindmeyer HW, Hammad YY [1988]. Contributing factors to sandblasters' silicosis: inadequate respiratory protection equipment and standards. *J Occup Med.* 30:917-921.

Health and Safety Laboratory [2011]. Evaluation of the penetration characteristics of a high flow rate personal cyclone sampler for NIOSH. By Thorpe A. Derbyshire, UK: Health and Safety Laboratory, Occupational Hygiene Unit. HSL Contract report prepared for NIOSH, Job Number PE01355.

Heitbrink WA, Bennett J [2006]. A numerical and experimental investigation of crystalline silica exposure control during tuck-pointing. *J Occup Environ Hyg.*; 3: 366-378.

ISO 7708. [1995]. International Organization for Standardization (ISO) 7708 Particle size definitions for health related sampling. Geneva, Switzerland: ISO.

Kenny LC, Gussman RA [1997]. Characterization and modeling of a family of cyclone aerosol preseparators. *J Aerosol Sci*; 28: 677-88.

Lee T, Kim SW, Chisholm WP, Slaven J, Harper M [2010]. Performance of high flow rate samplers for respirable particle collection. *Ann Occup Hyg.*; 54(6):697-709.

Linch, KD [2002]. Respirable concrete dust-silicosis hazard in the construction industry. *Appl Occup Environ Hyg*, 17:209-221.

Lofgren DJ, Johnson DC, Walley TL [2004]. OSHA Compliance issues: silica and noise exposure during installation of fiber-cement siding. *Occup & Env Hyg J* 1:D1-D6.

Mid-West Instrument [2004]. Delta-Tube: application and system design data. Sterling Heights, MI: Mid-West Instruments, Bulletin No. ASDE/04.
<http://www.midwestinstrument.com/pdfs/bulletins/DeltaTubeBulletinNo.ASDE04.pdf>

Miller RW [1989]. Flow measurement engineering handbook. 2nd Edition. New York; McGraw-Hill.

Nash NT, Williams DR [2000]. Occupational exposure to crystalline silica during tuckpointing and the use of engineering controls. *Appl Occup Environ Hyg*, 15:8-10.

NIOSH [1986]. Occupational respiratory diseases. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 86-102.

NIOSH [1998]. Particulates not otherwise regulated, respirable. NIOSH Manual of Analytical Methods (NMAM[®]), 4th ed., 2nd Supplement, Schlecht, P.C. & O'Connor, P.F. Eds. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 98-119.

NIOSH [2002]. NIOSH Hazard Review: Health Effects of Occupational Exposure to Respirable Crystalline Silica. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 2002-129.

NIOSH [2003]. Silica, crystalline, by XRD (filter redeposition). NIOSH Manual of Analytical Methods (NMAM[®]), 4th ed., 3rd Supplement, Schlecht, P.C. & O'Connor, P.F. Eds. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 2003-154.

OSHA [2013]. OSHA Fact Sheet: OSHA's proposed crystalline silica rule: overview. Washington, DC: U.S. Department of Labor, Occupational Safety and Health Administration. https://www.osha.gov/silica/factsheets/OSHA_FS-3683_Silica_Overview.html

Qi C, Echt A, See M [2013a]. In-Depth Survey Report: Partnering to Control Dust from Fiber-Cement Siding. DHHS/CDC/NIOSH Cincinnati, OH. Report No. EPHB 358-11a. <http://www.cdc.gov/niosh/surveyreports/pdfs/358-11a.pdf>

Qi C, Hirst DVL, Echt A [2013b]. In-Depth Survey Report: Partnering to Control Dust from Fiber-Cement Siding. DHHS/CDC/NIOSH Cincinnati, OH. Report No. EPHB 358-12a. <http://www.cdc.gov/niosh/surveyreports/pdfs/358-12a.pdf>

Qi C, Echt A [2014a]. In-Depth Survey Report: Partnering to Control Dust from Fiber-Cement Siding. DHHS/CDC/NIOSH Cincinnati, OH. Report No. EPHB 358-13a. <http://www.cdc.gov/niosh/surveyreports/pdfs/358-13a.pdf>

Qi C, Garcia A, Echt A [2014b]. In-Depth Survey Report: Partnering to Control Dust from Fiber-Cement Siding. DHHS/CDC/NIOSH Cincinnati, OH. Report No. EPHB 358-14a. <http://www.cdc.gov/niosh/surveyreports/pdfs/358-14a.pdf>

Qi C, Kratzer J, Echt A [2014c]. In-Depth Survey Report: Partnering to Control Dust from Fiber-Cement Siding. DHHS/CDC/NIOSH Cincinnati, OH. Report No. EPHB 358-15a. <http://www.cdc.gov/niosh/surveyreports/pdfs/358-15a.pdf>

Rappaport SM, Goldberg M, Susi P, Herrick RF [2003]. Excessive exposure to silica in the U.S. construction industry. *Ann Occup Hyg* 47:111-122.

Thorpe A, Ritchie AS, Gibson MJ, Brown RC [1999]. Measurements of the effectiveness of dust control on cut-off saws used in the construction industry. *Ann Occup Hyg* 43:443-456.

US Census Bureau [2013]. SURVEY OF CONSTRUCTION, Principle Type of Exterior Wall Material of New One-Family Houses Completed. <http://www.census.gov/const/C25Ann/sftotalexwallmat.pdf>. Accessed November 13, 2013.

Vincent JH [2007]. *Aerosol sampling*. Chichester, West Sussex, England: John Wiley & Sons, pp. 203.

Woskie SR, Kalil A, Bello D, Virji MA [2002]. Exposures to quartz, diesel, dust, and welding fumes during heavy and highway construction. *AIHA Journal* 63:447-457.



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EXHIBIT 7



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4/27/2018

[REDACTED]

Re: Policy [REDACTED]

Dear [REDACTED]:

An industrial hygiene (IH) air sampling assessment was conducted at [REDACTED] on 3/27/2018. To accomplish this, three respirable crystalline quartz silica samples were collected according to the methods described in Attachment A. The results are compared to current applicable occupational exposure levels (OELs) such as the OSHA Action Level and Permissible Exposure Limit (PEL), NIOSH Recommended Exposure Limit (REL) and American Conference of Governmental Industrial Hygienists' Threshold Limit Value (ACGIH-TLV®).

RESULTS SUMMARY

Three samples were collected at your construction site [REDACTED] in [REDACTED] on 3/27/2018. The sampling was a full shift survey. Specifically, the process of concern was the operation of three different Booger Bog Systems per the request of [REDACTED] to determine the most effective system as it relates to reducing silica exposure. These three operators did the same process, but with different types of filtration equipment. In addition, all three employees worked in similar atmospheres (indoor areas). Based on laboratory results, one employee was exposed to respirable crystalline quartz silica above occupation standards and guidelines. This employee operated the Booger Hog Diamond Disc with no controls.

For more details and next steps, please see the Observations & Recommendations section of this report.

I would like to thank you and all of the workers who participated in this assessment for the courtesy and cooperation I experienced.

Sincerely,

Devin Keplinger,

OBSERVATIONS & RECOMMENDATIONS

Air Sampling Results

The air sampling results and applicable OELs are summarized in Table 1.

The air monitoring results indicate that one employee ascertained an exposure above the American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Values (TLV) and the Occupational Safety and Health Administrations Permissible Exposure Limits (PEL) for respirable crystalline quartz silica. Exposures at these levels pose a high risk of health issues for most of the population. It is important to continue to observe your workplace for changes that could increase exposures, such as additional sources, increased production or work space environmental changes. The monitoring results only reflect conditions as they existed on the day of the survey. Individual exposures may fluctuate depending on such factors as workload, downtime, and/or individual work practices. Such variability must be considered when interpreting any exposure data.

Exposure limits for air contaminants are developed on a contaminant-specific basis. They do not account for toxic interactions that may occur from exposure to multiple contaminants, and/or employee habits such as smoking. In addition, worker susceptibility may vary greatly, causing some workers to experience adverse health effects at air concentrations lower than the referenced limits. Therefore, it is good practice to maintain exposures as low as possible.

Recommended Next Steps

- Modify your Silica Control Plan to incorporated the most effective filtration systems on your current tools.
- Re-evaluate your Respirator Protection program. An Industrial Hygienist from the BWC (such as myself) can help evaluate and update your respiratory protection program. More information can be found in attachment B.
- Continue to use controls such as a wet saw to cut silica containing material.
- Additional monitoring should be done when a different process is imposed.

TABLE 1 - AIR MONITORING RESULTS

Lang Masonry Contractors Inc 3/27/2018

SAMPLE DESCRIPTION	EXPOSURE MONITORED	TIME SAMPLED (minutes)	EXPOSURE RESULTS	OSHA PEL	ACGIH TLV
Booger Hog/Dust Tech Vac	Respirable Crystalline Silica	360	016 ug/m ³	050 ug/m ³	25 ug/m ³
Booger Hog/Bosch HEPA	Respirable Crystalline Silica	360	N.D.	50 ug/m ³	25 ug/m ³
Booger Hog/Control	Respirable Crystalline Silica	360	110 ug/m ³	50 ug/m ³	25 ug/m ³
<p><i>NOTE: The air sampling results contained in this table are "employee exposure records" as defined in OSHA 29 CFR 1910.1020. This standard requires that air sampling and other employee monitoring data be made available to employees or their representatives upon request. Employees in the areas monitored should be provided with a copy of the information contained in this table. Employers are also required to maintain employee exposure records for 30 years (see 29 CFR 1910.1020(d)(1)(ii))</i></p>					
<p>N.D.= none detected < = less than the lower limit of detection NAS = no applicable standard ug/m³ = micrograms per cubic meter µg/m³ = micrograms per cubic meter ppm = parts per million STEL = short-term exposure limit C = ceiling limit TWA = time-weighted average S = skin notation Sen = sensitizer {See Attachment A for definitions of these footnotes.}</p>					

ATTACHMENT A – SAMPLING AND ANALYTICAL METHODS

Air samples were collected with SKC® model 224-PCXR3 / 222-3R air sampling pumps calibrated before sampling with a NIST-traceable Bios Dry-Cal® primary air flow standard. The same process was used to verify flow rate during and after the sampling period. The air samples were analyzed by an AIHA- & A2LA-accredited laboratory according to the methods listed below.

Analyte	Collection Media	Analytical Method(s)
Total particulate	37 mm pre-weighed 5 µm PVC filter	NIOSH 0500
Respirable particulate	37 mm pre-weighed 5 µm PVC filter / 10 mm nylon cyclone	NIOSH 0600
Silica (quartz, cristobalite, tridymite)	37 mm pre-weighed 5 µm PVC filter / 10 mm nylon cyclone	NIOSH 7500
Metal fume & dust	37 mm 0.8 µm mixed cellulose ester (MCE) filter	OSHA ID-125G / NIOSH 7300
Hydrocarbon vapors (naphthas, esters)	600 mg charcoal tube (Anasorb 2000®)	OSHA 07 / NIOSH 1450 1500 1501
Hydrocarbon vapors (ketones, alcohols)	600 mg charcoal tube (Anasorb 2000®)	OSHA 07 / NIOSH 1300 1400 1403
Acids, inorganic	600 mg washed silica gel tube	NIOSH 7903
Aldehydes	DNPH-coated silica gel tube	NIOSH 2016 / OSHA 1007
Fiber count	25 mm 0.8 µm mixed cellulose ester (MCE) filter with non-conductive cowl	NIOSH 7400
Isocyanates	1-2PP-treated glass fiber filters (open face)	OSHA 42 47
Hexavalent chromium	5 µm PVC filter	OSHA ID-215 rev.2

Metalworking fluid mist	37 mm pre-weighed 5 µm PTFE filter	NIOSH 5524
Nitrogen oxide / Nitrogen dioxide	2 triethanolamine-treated molecular sieve tubes in series w/ oxidizer tube	NIOSH 6014

Sample Description	Flow rate		
	lpm = liters of air per minute cc/min = cubic centimeters of air per minute		
	Pre-shift	Post-shift	Average
██████████ (mixing Station)	1.708	1.665	1.6865
██████████ (Running telescopic loader)	1.696	1.680	1.688
██████████ (Cutting block)	1.709	1.684	1.695
██████████ (Laying block/ some cutting)	1.696	1.637	1.6665
██████████ (Cutting Block)	1.707	1.680	1.6935

The OELs in the air sampling results table refer to airborne concentrations of substances that it is believed that nearly all workers may repeatedly have exposed without adverse health effects. Some workers, especially those who smoke or have pre-existing conditions, may experience symptoms when concentrations are below these levels. These OELs are general guidelines for the control of workplace exposures, and are not fine lines between safe and dangerous conditions. The application of OELs to sampling data to affirm or refute the potential for developing and occupational disease should be done with extreme caution, and then only by someone trained in the occupational health sciences.

Abbreviations & Definitions:

ACGIH - American Conference of Governmental Industrial Hygienists, which develops and publishes Threshold Limit Values® (see below), which are recommended occupational exposure limits for hundreds of chemical substances and physical agents.

ANSI - The American National Standards Institute is a privately-funded, voluntary membership organization that develops consensus standards nationally for a wide variety of devices and procedures

Ceiling limit (C) - An airborne concentration of a toxic substance in the work environment, which should never be exceeded.

Excursion Limit - For many substances with a TLV-TWA, there is no TLV-STEL. Nevertheless, excursions above the TLV-TWA should be controlled, even where the 8-hour TLV-TWA is within recommended limits. Excursion limits apply to those TLV-TWAs that do not have TLV-STELs. *Excursions in worker exposure levels may exceed 3 times the TLV-TWA for no more than a total of 30 minutes during a workday, and under no circumstances should they exceed 5 times the TLV-TWA, provided that the TLV-TWA is not exceeded.*

Fume - Airborne particulate formed by the evaporation & condensation of solid materials, e.g. metal fume emitted during welding. Fumes are typically less than one micron in diameter.

Limit of Quantification (LOQ) - The lowest mass that can be reported with acceptable precision.

NIOSH - The National Institute for Occupational Safety and Health, a federal agency that is part of the Centers for Disease Control (CDC), NIOSH conducts research on health and safety concerns, tests and certifies respirators, and trains occupational health and safety professionals.

OSHA - US Occupational Safety and Health Administration, part of the US Department of Labor.

Permissible exposure limit (PEL) - An occupational exposure limit published and enforced by OSHA as a legal standard.

Respirable particulates - Particulates <10 micrometers aerodynamic diameter; this size range permits them to penetrate deep into the lungs upon inhalation.

Sensitizer (Sen) - The 'Sen' designation refers to the potential for a chemical agent to produce sensitization, as confirmed by human or animal data. The SEN notation *does not imply* that sensitization is necessarily the critical effect on which the occupational exposure limit (OEL) is based, nor does it imply that this effect is the sole basis for that chemical's OEL. If sensitization data exist, they are carefully considered when recommending the OEL for the agent. For those OELs that are based upon sensitization, they are meant to protect workers from induction of this effect. These OELs are not intended to protect those workers who have already become sensitized. In the workplace, respiratory, dermal, or conjunctival exposures to sensitizing agents may occur. Similarly, sensitizers may evoke respiratory, dermal, or conjunctival reactions. At this time, the 'Sen' notation does not distinguish between sensitization involving any of these organ systems.

Short-term exposure limit (STEL) - Maximum concentration to which workers can be exposed for a short period of time (15 minutes) for only four times throughout the day with at least one hour between exposures.

Skin notation (S) - Potential significant contribution of overall exposure by cutaneous route, including mucous membranes and eyes, from airborne exposure to gases, vapor, or liquid or by direct skin contact.

Time-weighted average concentration (TWA) - Refers to concentrations of airborne toxic materials which have been weighted for a certain time duration, usually 8 hours.

Threshold Limit Value (TLV®) - A time-weighted average concentration at which most people can work consistently for 8 hours a day, day after day, with no harmful effects. A table of these values and accompanying precautions is published annually by ACGIH.

ATTACHMENT B – SUPPLEMENTAL INFORMATION
REQUIREMENTS FOR VOLUNTARY USE OF RESPIRATORS

The Occupational Safety and Health Administration's (OSHA) revised respiratory protection standard addresses the voluntary use of respirators. The intent is to allow employers the flexibility to permit employees to use respirators when the hazard/exposure assessment does not indicate the need, without imposing the burden of implementing a full respirator program. The voluntary use requirements are dependent on the type of respirator used.

FILTERING FACEPIECES (DUST MASKS)

Where voluntary use involves only filtering face pieces (dust masks), the employer is not required to implement a written program. The employer does need to ensure that:

- the filtering face piece (dust mask) is not dirty or contaminated,
- the filtering face piece does not interfere with the employee's ability to work safely, and
- A copy of Appendix D of the standard is provided to each voluntary wearer.

ALL OTHER RESPIRATORS

If voluntary use of respirators, other than filtering face pieces, will be permitted, the employers written respiratory protection program must address:

- medical evaluations for employees wearing the respirators,
- the cleaning, storing, and maintenance of the respirators, and
- the distribution of Appendix D of the standard to each voluntary wearer

Medical Evaluation: The medical evaluation must be conducted by a physician or other licensed health care professional whose state license will allow them to perform such an evaluation. The evaluation can consist of using a medical questionnaire or an initial medical examination as long as the evaluation obtains the information requested by Sections 1 and 2, Part A, of the questionnaire found in Appendix C of the standard. If a questionnaire is used it must be filled out by the employee and evaluated by the health care professional. Any employee answering yes to any of the questions 1-8 of Section 2, Part A of the questionnaire must receive a follow-up medical evaluation consisting of any medical tests, consultations, or diagnostic procedures that the health care professional deems necessary. Medical confidentiality must be maintained when administering the questionnaire or examinations.

An annual medical evaluation is not needed but additional evaluations must be provided if:

- an employee reports medical signs or symptoms related to their ability to use a respirator,
- a health care professional, supervisor, or respirator program administrator informs the employer that an employee needs to be reevaluated.
- information obtained during the program evaluation indicates a need, or
- A change occurs in the workplace that may increase the physiological burden placed on the employee.

Cleaning, Storage, & Maintenance

- Respirators used exclusively by one employee shall be cleaned and disinfected as often as necessary to be maintained in a sanitary condition. They must be cleaned and disinfected using the procedures in Appendix B-2 of the standard or the manufacturers recommended method.
- Shared respirators must be cleaned and disinfected after every use.
- Respirators must be stored to protect from damage, contamination, dust, sunlight, extreme temperatures, damaging chemicals, and deformation of the face piece and exhalation valve.

- Respirators must be inspected before each use and during cleaning. The inspection must include a check for proper function, tightness of connections, and the condition of the face piece, head straps, valves, filtering mechanism, and pliability of the elastomeric parts.
- Defective respirators must be discarded or removed from service and repaired according to manufacturer's recommendations by individuals trained to make the repairs.

Information for Employees Using Respirators When Not Required

(Appendix D to the OSHA Respirator Standard 29CFR1910.134)

Respirators are an effective method of protection against designated hazards when properly selected and worn. Respirator use is encouraged, even when exposures are below the exposure limit, to provide an additional level of comfort and protection for workers. However, if a respirator is used improperly or not kept clean, the respirator itself can become a hazard to the worker. Sometimes workers may wear respirators to avoid exposures to hazards even if the amount of hazardous substance does not exceed the limits set by OSHA standards. If your employer provides respirators for your voluntary use, or if you provide your own respirator, you need to take certain precautions to be sure that the respirator itself does not present a hazard.

You should do the following:

1. Read and heed all instructions provided by the manufacturer on use, maintenance, cleaning, and care, and warnings regarding the respirators limitations.
2. Choose respirators certified for use to protect against the contaminant of concern. NIOSH, the National Institute for Occupation Safety and Health of the U.S. Department of Health and Human Services, certifies respirators. A label or statement of certification should appear on the respirator or respirator packaging. It will tell you what the respirator is designed for and how much it will protect you.
3. Do not wear your respirator into atmospheres containing contaminants for which your respirator is not designed to protect against. For example, a respirator designed to filter dust particles will not protect you against gases, vapors, or very small solid particles of fumes or smoke.
4. Keep track of your respirator so that you do not mistakenly use someone else's respirator.

Employee Record of Receiving Appendix D to 1910.134

I understand that respirator use is not required during normal operations. However, I also understand that respirators are provided for voluntary use to provide an additional level of comfort and protection. As a potential voluntary wearer of a respirator I acknowledge that I have received Appendix D of the OSHA respirator standard 1910.134, as required by the standard.

Employee Signature

EXHIBIT 8



June 8, 2017

[REDACTED]
[REDACTED]
[REDACTED]
[REDACTED]

Policy #: [REDACTED]

Dear Mr. [REDACTED]

On May 1, 2017, I conducted industrial hygiene assessments at your facilities. My visit was focused on the evaluation of employees' exposures to respirable crystalline silica (RCS) during diamond wire cutting of poured concrete block. A simulation environment was set up under conditions which represent typical conditions for outdoor diamond wire cutting. Photographs of the simulation set up and equipment may be found in [Appendix D](#).

[Table 1.0](#) presents the results of the exposure assessments conducted during this visit. Exposures were measured **below** the American Conference of Governmental Industrial Hygienists' (ACGIH) Threshold Limit Value for quartz (RCS). Additionally, exposures were **below the revised** Occupational Safety and Health Administration's (OSHA) **Action Level (AL) and Permissible Exposure Limit (PEL)** for RCS as established in [29 CFR 1910.1053 Respirable Crystalline Silica Standard](#). Details on the sampling and analytical methods can be found in [Appendix A](#).

Please note:

- The air monitoring results are representative for the times sampled and may not represent eight-hour time-weighted average concentrations.
- The results only reflect conditions as they existed on the day of the monitoring. Airborne concentrations may fluctuate depending on such factors as products produced, process or material changes, workloads, seasonal variations (doors opened or closed) and/or individual work practices. Such variability must be considered when interpreting any exposure data.
- Exposure limits for air contaminants are developed on a contaminant specific basis. They do not account for toxic interactions that may occur from exposure to multiple chemicals. In addition, worker susceptibility may vary greatly, allowing some workers to experience adverse health effects at air concentrations lower than the referenced limits. Therefore, it is good practice to maintain exposures as low as possible. Additional information pertaining to exposure limits is provided in [Appendix B](#).

Recommendations

- Share exposure assessment results with employees and maintain records in accordance with OSHA's [Access to Employee Exposure and Medical Records](#) standard, 29 CFR 1910.1020.
- Include hazard communication training on silica per the OSHA [Hazard Communication](#) standard 29 CFR 1910.1200. The hazard communication standard was recently revised to align with the Globally Harmonized System of Classification and Labeling of Chemicals (GHS). Additional information on the revisions to the standard may be found at this link: [OSHA Hazard Communication Topic Page](#)
 - BWC's Training Center offers three courses covering Hazard Communication. Information regarding course content, dates, locations, and times may be found on our website: [OBWC Training Center Course Descriptions](#)

- Ensure all personal protective equipment (PPE) used throughout the company is selected and used in accordance with OSHA's *General Requirements* (PPE) standard 29 CFR 1910.132.
 - Additional information on this standard is included in [Appendix C](#). OSHA also has information on their [PPE Topic Page](#).
 - Consider attending our Training Center's course Personal Protective Equipment Selection Criteria. Details on course content, dates, locations and registration may be found at [BWC Learning Center Website](#).
- Based on the measured exposures, no additional controls or PPE are recommended. Employees may utilize filtering face piece respirators on a voluntary use basis. Additional information on Voluntary Use of Respirators is included in [Appendix E](#).
 - Consider attending one of the three courses related to respiratory protection offered at our Training Center. Details on course content, dates, locations and registration may be found at [BWC Learning Center Website](#)
- Re-evaluate exposures following modification of materials or changes to any engineering or work practice controls.

The mission of the Bureau of Workers' Compensation Division of Safety & Hygiene is to protect Ohio's workers and employers through the prevention, care and management of workplace injuries and illnesses at fair rates. I trust this survey will help you to provide a safe and healthy work environment, and potentially reduce your workers' compensation costs.

Sincerely,



Cindy Cooper
Industrial Hygienist

Attachments

- Table 1.0 – Industrial Hygiene Survey Results
- Appendix A - Sampling and Analytical Methods
- Appendix B – Occupational Exposure Limits
- Appendix C - Personal Protective Equipment
- Appendix D - Diamond Wire Cutting Photographs of Simulation Set-Up
- Appendix E – Voluntary Use of Respirators

Table 1.0: Industrial Hygiene Survey Results

Employee Name/ Location	Contaminant	Sample Time (minutes)	Employee Exposure TWA ¹	OSHA PEL ²	ACGIH TLV ³
Wire Saw Operator	PNOC/R, Respirable fraction	242	<0.12 mg/m ³	5 mg/m ³	NAS
	Quartz		ND	NAS	25 µg /m ³
	Cristobalite		ND	NAS	25 µg /m ³
	Tridymite		ND	NAS	NAS
	Respirable Crystalline Silica		ND	50 µg/m ³	NAS
Wire Saw Operator	PNOC/R, Respirable fraction	236	<0.12 mg/m ³	5 mg/m ³	NAS
	Quartz		ND	NAS	25 µg /m ³
	Cristobalite		ND	NAS	25 µg /m ³
	Tridymite		ND	NAS	NAS
	Respirable Crystalline Silica		ND	50 µg/m ³	NAS
Area Sample/ Wire Saw Control Panel	PNOC/R, Respirable fraction	237	<0.12 mg/m ³	5 mg/m ³	NAS
	Quartz		ND	NAS	25 µg /m ³
	Cristobalite		ND	NAS	25 µg /m ³
	Tridymite		ND	NAS	NAS
	Respirable Crystalline Silica		ND	50 µg/m ³	NAS

- 1 Exposures represent time-weighted averages (twa) for the time sampled unless indicated otherwise.
- 2 Occupational Safety & Health Administration's Permissible Exposure Limit.
- 3 American Conference of Governmental Industrial Hygienists' Threshold Limit Value.
- ND Below analytical detection.
- NAS No Applicable Standard/Limit.
- mg/m³ Milligrams of contaminant per cubic meter of air.
- µg/m³ Micrograms of contaminant per cubic meter of air. 1 µg = 0.001 mg.

Note: OSHA's *Respirable Crystalline Silica* standard, 29 CFR 1910.1053 (1926.1153 Construction), has lowered the silica PEL to 50 µg/m³ (0.05 mg/m³) as an 8-hour TWA. And additionally established an Action Level (AL) of 25 µg/m³ (0.025 mg/m³), as 8-hour TWA. The standard takes effect June 23, 2016 with compliance date for general industry of June 23, 2018. OSHA has delayed enforcement of the new standard to September 23, 2018 for construction.

Note: exposures measured during a simulation of typical field conditions of diamond wire cutting in an outdoor environment cutting poured concrete, using water. Control Panel was positioned in general to be upwind from any possible dust plume. Photos included in Appendix D.

4 hours of cutting: first cut 12:20 pm; second cut 2:05 pm. Unsampled time was spent in tasks with no exposure to silica containing materials.

OSHA Standard 29 CFR 1910.1020 provides employees and their designated representatives a right of access to relevant exposure and medical records. Each employee must be informed upon first entering into employment, and annually thereafter, of 1) their right of access to such records, 2) the existence, location, and availability of such records, and 3) the person responsible for maintaining and providing access to such records.

Appendix A: Sampling and Analytical Methods

ANALYTE	METHOD REFERENCE #	SAMPLING MEDIA	ANALYTICAL METHOD
Silica containing particulate / crystalline silica	Modified NIOSH 0600/7500 and modified OSHA ID-142	37 mm Pre-weighed 5 µm Polyvinyl Chloride filter (PW PVC) + 10 mm nylon Dorr Oliver cyclone	Gravimetric analysis and X-Ray Diffraction

OSHA - Occupational Safety and Health Administration
 NIOSH - National Institute for Occupational Safety and Health

All air samples were collected based on the chart above using SKC, Inc. 224-PCXR8 high-flow personal sampling pumps and/or SKC Inc. Model 224 low flow pumps. All sampling pumps were calibrated, pre- and post-sampling, using a Bios DryCal D-C Lite National Institute of Standards and Technology (NIST)-traceable primary flow meter. Sampling was performed by placing the sampling media on the shirt collars, within the breathing zone, of the employees of interest, with the media connected to the sampling pumps using Tygon® tubing. Area samples were placed in locations to represent breathing zones of employees who would potentially be working in the immediate area. All samples were submitted to Galson Laboratories 6601 Kirkwood Road East Syracuse, New York 13057 for analysis. Galson Labs is accredited by the American Industrial Hygiene Association (AIHA).

Sampling Equipment Calibration

Pump Number [Employee] Sample ID	Sampling Media	Pre Survey Flow rate, (lpm)	Post Survey Flow rate, (lpm)
1 [REDACTED]	37-mm, 5 µm PW PVC + cyclone	1.7	1.7
2 [REDACTED]	37-mm, 5 µm PW PVC + cyclone	1.7	1.7
3 [Area Sample] Z2015753	37-mm, 5 µm PW PVC + cyclone	1.7	1.7

lpm Liters of air per minute

Appendix B: Occupational Exposure Limits

OSHA – The Occupational Safety and Health Administration’s permissible exposure limits (OSHA PEL) are found in Tables Z-1, Z-2, and Z-3 of the OSHA General Industry Air Contaminants Standard (29 CFR 1910.1000). They are the legally enforced standards in the United States. Unless noted otherwise, PELs are time-weighted average (TWA) concentrations that must not be exceeded during any 8-hour workshift of a 40-hour workweek. A short-term exposure limit (STEL) is designated by “ST” preceding the value and is measured over a 15-minute period. OSHA ceiling concentrations (designated by “C” preceding the value) must not be exceeded during any part of the workday; if instantaneous monitoring is not feasible, the ceiling is assessed as a 15-minute TWA exposure.

ACGIH - American Conference of Governmental Industrial Hygienists’ Threshold Limit Values (ACGIH TLV), unless noted otherwise, are TWA concentrations for an 8-hour workday and a 40-hour work week and represent conditions under which it is believed that nearly all workers may be repeatedly exposed day after day without adverse health effects. A short-term exposure limit (STEL) is designated by "ST" preceding the value and, unless noted otherwise, is a 15-minute TWA exposure that should not be exceeded at any time during a workday; should not occur more than four times per day; and there should be at least 60 minutes between successive exposures in this range. A ceiling TLV is designated by "C" preceding the value; unless noted otherwise, the ceiling value should not be exceeded at any time. The TLVs are intended for the use in the practice of industrial hygiene as guidelines or recommendations in the control of potential health hazards and no other use such as proof or disproof of an existing disease or physical condition. The TLVs are not fine lines between safe and dangerous concentrations, nor are they a relative index of toxicity.

Typically, concentrations are given in parts per million (ppm) for gases and vapors, and milligrams per cubic meter (mg/m^3) for aerosols. A "skin" designation indicates the potential for dermal absorption; skin exposure should be prevented as necessary using good work practices and gloves, coveralls, goggles, and other appropriate equipment.

Appendix C: Personal Protective Equipment

1910.132 - General requirements

(a) Application.

Protective equipment, including personal protective equipment for eyes, face, head, and extremities, protective clothing, respiratory devices, and protective shields and barriers, shall be provided, used, and maintained in a sanitary and reliable condition wherever it is necessary by reason of hazards of processes or environment, chemical hazards, radiological hazards, or mechanical irritants encountered in a manner capable of causing injury or impairment in the function of any part of the body through absorption, inhalation or physical contact.

(b) Employee-owned equipment.

Where employees provide their own protective equipment, the employer shall be responsible to assure its adequacy, including proper maintenance and sanitation.

(c) Design.

All personal protective equipment shall be of safe design and construction for the work to be performed.

(d) Hazard assessment and equipment selection.

(1) The employer shall assess the workplace to determine if hazards are present, or are likely to be present, which necessitate the use of personal protective equipment (PPE). If such hazards are present, or likely to be present, the employer shall:

- (i) Select, and have each affected employee use, the types of PPE that will protect the affected employee from the hazards identified in the hazard assessment;
- (ii) Communicate selection decisions to each affected employee; and,
- (iii) Select PPE that properly fits each affected employee. Note: Non-mandatory Appendix B contains an example of procedures that would comply with the requirement for a hazard assessment.

(2) **The employer shall verify that the required workplace hazard assessment has been performed through a written certification** that identifies the workplace evaluated; the person certifying that the evaluation has been performed; the date(s) of the hazard assessment; and, which identifies the document as a certification of hazard assessment.

(e) Defective and damaged equipment.

Defective or damaged personal protective equipment shall not be used.

(f) Training.

(1) The employer shall provide training to each employee who is required by this section to use PPE. Each such employee shall be trained to know at least the following:

- (i) When PPE is necessary;
- (ii) What PPE is necessary;
- (iii) How to properly don, doff, adjust, and wear PPE;
- (iv) The limitations of the PPE; and,
- (v) The proper care, maintenance, useful life and disposal of the PPE.

(2) Each affected employee shall demonstrate an understanding of the training specified in paragraph (f)(1) of this section, and the ability to use PPE properly, before being allowed to perform work requiring the use of PPE.

(3) When the employer has reason to believe that any affected employee who has already been trained does not have the understanding and skill required by paragraph (f)(2) of this section, the employer shall retrain each such employee. Circumstances where retraining is required include, but are not limited to, situations where:

- (i) Changes in the workplace render previous training obsolete; or
- (ii) Changes in the types of PPE to be used render previous training obsolete; or
- (iii) Inadequacies in an affected employee's knowledge or use of assigned PPE indicate that the employee has not retained the requisite understanding or skill.

(4) The employer shall verify that each affected employee has received and understood the required training through a written certification that contains the name of each employee trained, the date(s) of training, and that identifies the subject of the certification.

(g) Paragraphs (d) and (f) of this section apply only to 1910.133, 1910.135, 1910.136, and 1910.138. Paragraphs (d) and (f) of this section do not apply to 1910.134 and 1910.137.

PERSONAL PROTECTIVE EQUIPMENT
HAZARD ASSESSMENT DATA

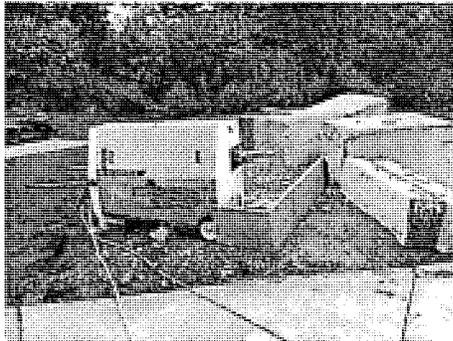
Auditor: _____ Department: _____ Date: _____

Process or Source	Hazard	Risk Level	Affected Body Parts	Required PPE

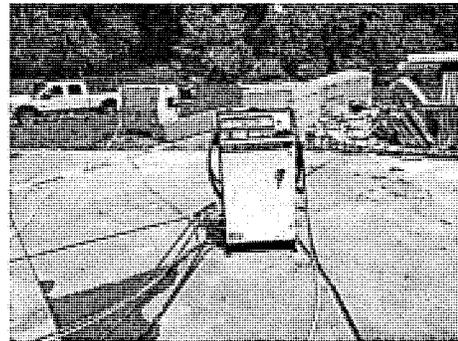
Use the following items to assist you with the assessment.

1. The OSHA 300 Log
2. Material Safety Data Sheets
3. Employee Interviews

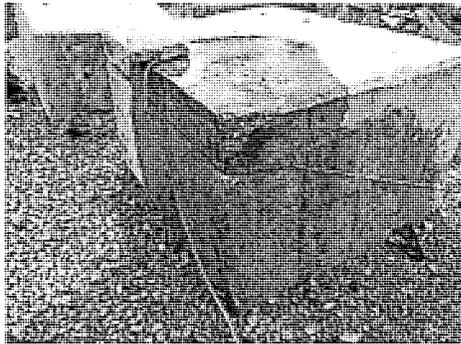
Appendix D: Diamond Wire Cutting Photographs



View of Set-up from Control Panel



View of Cutting Simulation Set-Up



Cutting Site with water applied



Operators wearing sampling equipment

Appendix E: Voluntary Use of Respirators

The Occupational Safety and Health Administration's (OSHA) revised respiratory protection standard now addresses the voluntary use of respirators. The intent is to allow employers the flexibility to permit employees to use respirators when the hazard/exposure assessment does not indicate the need, without imposing the burden of implementing a full respirator program. The voluntary use requirements are dependent on the type of respirator used.

FILTERING FACEPIECES (DUST MASKS)

Where voluntary use involves only filtering face pieces (dust masks), the employer is not required to implement a written program. The employer does need to ensure that:

- the filtering face piece (dust mask) is not dirty or contaminated,
- the filtering face piece does not interfere with the employee's ability to work safely, and
- a copy of Appendix D of the standard is provided to each voluntary wearer.

ALL OTHER RESPIRATORS

If voluntary use of respirators, other than filtering face pieces, will be permitted, the employers written respiratory protection program must address:

- medical evaluations for employees wearing the respirators,
- the cleaning, storing, and maintenance of the respirators, and
- the distribution of Appendix D of the standard to each voluntary wearer

Medical Evaluation: The medical evaluation must be conducted by a physician or other licensed health care professional whose state license will allow them to perform such an evaluation. The evaluation can consist of using a medical questionnaire or an initial medical examination as long as the evaluation obtains the information requested by Sections 1 and 2, Part A, of the questionnaire found in Appendix C of the standard. If a questionnaire is used it must be filled out by the employee and evaluated by the health care professional. Any employee answering yes to any of the questions 1-8 of Section 2, Part A of the questionnaire must receive a follow-up medical evaluation consisting of any medical tests, consultations, or diagnostic procedures that the health care professional deems necessary. Medical confidentiality must be maintained when administering the questionnaire or examinations.

An annual medical evaluation is not needed but additional evaluations must be provided if:

- an employee reports medical signs or symptoms related to their ability to use a respirator,
- a health care professional, supervisor, or respirator program administrator informs the employer that an employee needs to be reevaluated'
- information obtained during the program evaluation indicates a need, or
- a change occurs in the workplace that may increase the physiological burden place on the employee.

Cleaning, Storage, & Maintenance

- Respirators used exclusively by one employee shall be cleaned and disinfected as often as necessary to be maintained in a sanitary condition. They must be cleaned and disinfected using the procedures in Appendix B-2 of the standard or the manufacturers recommended method.
- Shared respirators must be cleaned and disinfected after every use.
- Respirators must be stored to protect from damage, contamination, dust, sunlight, extreme temperatures, damaging chemicals, and deformation of the face piece and exhalation valve.
- Respirators must be inspected before each use and during cleaning. The inspection must include a check for proper function, tightness of connections, and the condition of the face piece, head straps, valves, filtering mechanism, and pliability of the elastomeric parts.
- Defective respirators must be discarded or removed from service and repaired according to manufacturers recommendations by individuals trained to make the repairs.

Information for Employees Using Respirators When Not Required
(Appendix D to the OSHA Respirator Standard 29CFR1910.134)

Respirators are an effective method of protection against designated hazards when properly selected and worn. Respirator use is encouraged, even when exposures are below the exposure limit, to provide an additional level of comfort and protection for workers. However, if a respirator is used improperly or not kept clean, the respirator itself can become a hazard to the worker. Sometimes workers may wear respirators to avoid exposures to hazards even if the amount of hazardous substance does not exceed the limits set by OSHA standards. If your employer provides respirators for your voluntary use, or if you provide your own respirator, you need to take certain precautions to be sure that the respirator itself does not present a hazard.

You should do the following:

1. Read and heed all instructions provided by the manufacturer on use, maintenance, cleaning, and care, and warnings regarding the respirators limitations.
2. Choose respirators certified for use to protect against the contaminant of concern. NIOSH, the National Institute for Occupation Safety and Health of the U.S. Department of Health and Human Services, certifies respirators. A label or statement of certification should appear on the respirator or respirator packaging. It will tell you what the respirator is designed for and how much it will protect you.
3. Do not wear your respirator into atmospheres containing contaminants for which your respirator is not designed to protect against. For example, a respirator designed to filter dust particles will not protect you against gases, vapors, or very small solid particles of fumes or smoke.
4. Keep track of your respirator so that you do not mistakenly use someone else's respirator.

Employee Record of Receiving Appendix D to 1910.134

I understand that respirator use is not required during normal operations. However, I also understand that respirators are provided for voluntary use to provide an additional level of comfort and protection. As a potential voluntary wearer of a respirator I acknowledge that I have received Appendix D of the OSHA respirator standard 1910.134, as required by the standard.

Employee Signature

Employer Signature



Jan Koehn, M.S., CIH, Inc.
8926 Kirby Drive
Houston, TX 77054
(713) 664-1597
FAX (713) 664-6443

PROJECT SUMMARY REPORT

**INDUSTRIAL HYGIENE AIRBORNE MONITORING
FOR RESPIRABLE CRYSTALLINE SILICA EXPOSURES
DURING CONCRETE CUTTING WORK
WITH REMOTE CONTROL SAW EQUIPMENT
USING WET AND OTHER CONTROL METHODS**

[REDACTED]; [REDACTED]

PROJECT LOCATION: [REDACTED] HOUSTON, TEXAS

MARCH 16, 2017



Jan Koehn, M.S., CIH, Inc.
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Houston, TX 77054
(713) 664-1597
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PROJECT SUMMARY REPORT

INDUSTRIAL HYGIENE AIRBORNE MONITORING FOR RESPIRABLE CRYSTALLINE SILICA EXPOSURES DURING CONCRETE CUTTING WORK WITH REMOTE CONTROL SAW EQUIPMENT USING WET AND OTHER CONTROL METHODS

PROJECT LOCATION: [REDACTED]

MARCH 16, 2017

SCOPE OF WORK:

Jan Koehn, M.S., CIH, Inc. or JK, Inc. was contracted to perform industrial hygiene monitoring to document the existing potential for workplace airborne exposures to respirable crystalline silica associated with outlined concrete saw cutting work for [REDACTED]. Representative personal occupational exposure monitoring was completed on January 25, 2017 based on scheduling with the Client during a partial period day shift for observed work activities at a private residence in [REDACTED]. A remote control saw with continuous water application was utilized for specific concrete cutting of the indicated garage floor locations. Comparisons were made of the airborne monitoring results obtained based on laboratory analytical data and requested 8-hour Time Weighted Average (TWA) calculations performed with respect to the current and also recently published workplace exposure standards such as the Permissible Exposure Limit (PEL) and Action Level (AL) promulgated by the Occupational Safety and Health Administration (OSHA) for the construction industry and the Threshold Limit Values (TLVs) published by the American Conference of Governmental Industrial Hygienists (ACGIH) based on two partial period personal samples and an area sample positioned within the segregated garage containing stored materials.

The project work activities were completed as follows:

1. Design a site-specific sampling strategy to perform industrial hygiene monitoring based on collection of airborne personal and area air samples during identified saw use with initial drilling for track installation and subsequent utilization of remote control and wet methods during concrete cutting work,
2. Review the sampling strategy with company personnel and schedule requested representative airborne monitoring for respirable crystalline silica at an identified local residential job site as directed by the Client,
3. Perform specified industrial hygiene monitoring for airborne respirable crystalline silica with direct observation of both Operator and Assistant work activities by [REDACTED] personnel, and documentation of parameters related to occupational airborne exposures during concrete saw cutting,

SCOPE OF WORK: (continued)

4. Complete industrial hygiene routine sample analysis by a local laboratory accredited by the American Industrial Hygiene Association (AIHA), HIH Laboratory in Webster, Texas, and
5. Prepare a final project monitoring report including documentation of existing site conditions, specific work activities, and control measures employed as noted by a Certified Industrial Hygienist (CIH) in the area of Comprehensive Practice.

METHODOLOGY:

A proposed sampling strategy was designed by Jan Koehn, M.S., CIH, Inc. personnel for this specified residential concrete saw cutting project. Based on consultation with [REDACTED], review of both current and recently published OSHA workplace exposure standards and recommended technical guidelines for defined airborne respirable crystalline silica components, investigation of available sampling and analytical methods, discussions of data results with the local accredited laboratory, and good work practices and procedures, a project industrial hygiene airborne sampling strategy was developed and implemented. This sampling strategy addressed representative collection of two personal breathing zone air samples and also a stationary area sample for respirable crystalline silica during use of the identified remote control saw employing wet methods and other observed dust control measures for outlined concrete cuts completed within a garage area.

The scheduled sampling event was addressed by JK, Inc. personnel upon request for a residential site located at [REDACTED] in [REDACTED] on January 25, 2017. Two personal breathing zone samples on an Operator and an Assistant for [REDACTED] and also an area sample inside the rear center of the garage were collected during remote control saw set-up and use for cutting including clean-up operations. The validated industrial hygiene sampling and analytical methods were: NIOSH 0600 for respirable particulates using SKC aluminum cyclones and NIOSH 7500 for crystalline silica (i.e. cristobalite, quartz and tridymite forms). SKC sampling pumps were pre- and post-calibrated with a primary standard and adjusted to the appropriate flow rate recommended for airborne sample collection of identified respirable particulates including 3 forms of crystalline silica. Appropriate sampling media (i.e. pre-weighed PVC 37 mm filter cassettes) was used for airborne industrial hygiene sample collection over a 4-hour work period. A field blank sample was also prepared for laboratory analysis to address standard quality control considerations.

Appropriate field site documentation was prepared for the outlined monitoring project. An overview of job site parameters such as defined scope of work for cutting the indicated garage concrete floor areas, use of remote control saw equipment with continuous water application, and several other control measures involving accepted work practices and procedures were observed. A specific chronology of the activities performed was noted including appropriate documentation of various project site conditions and overall work.

RESULTS AND DISCUSSION:

Appendix 1 presents JK, Inc. project personnel documentation. Appendix 2 contains an overview of job parameters involved with workplace exposure assessment and data interpretation, a specific chronology of the activities performed including site conditions, a diagram of observed concrete saw cutting operations as well as project digital photographs. Appendix 3 contains summary documentation of the industrial hygiene monitoring results for respirable crystalline silica as well as separate presentation of the airborne quartz results including various specified OSHA PEL calculations as 8-hour Time Weighted Average (TWA) occupational exposures for [REDACTED] personnel, and initially completed AGC Silica Monitoring Forms and outlined calculations in addition to the laboratory analytical report.

A total of 3 concrete floor saw cuts were completed within the garage area by [REDACTED] personnel on January 25, 2017 as scheduled. A combination of a narrative document summarizing work activities and site conditions, overview drawing, and digital photographs is presented in Appendix 2 with information utilized for workplace exposure assessment and airborne data interpretation for respirable crystalline silica on behalf of the Client. Some existing natural ventilation and a positioned air mover were employed at the job site during concrete cutting by the Operator using wet methods and remote control saw operation. The Assistant continually employed a wet vacuum for collection of water and generated debris.

The personal and area airborne sampling results for respirable particulates ranged from 0.02 to 0.07 mg/M³ as reported by the laboratory which did not approach the separate OSHA PEL for respirable particulates at 5 mg/M³ as an 8-hour Time Weighted Average (TWA) and the recommended ACGIH TLV of 3 mg/M³. Respirable crystalline silica is further identified in separate forms as Cristobalite, Quartz and Tridymite. Only quartz was detected for this monitoring effort using the validated sampling and analytical methods with respect to the recently promulgated OSHA PEL of 0.050 mg/M³ and an Action Level (AL) of 0.025 mg/M³ as an 8-hour TWA for respirable crystalline silica outlined for the construction industry with an effective date of June 23, 2017. ACGIH recommends a current TLV-TWA of 0.025 mg/M³ for both respirable quartz and cristobalite. Airborne sample results for cristobalite and tridymite forms were reported at the minimum method detection limit of less than 0.02 mg/M³. The personal monitoring results were both reported at 0.03 mg/M³ for respirable quartz, and the area sample was noted at 0.04 mg/M³ for respirable quartz within the enclosed garage. Only the specific form of quartz was detected for the project air samples with a range of quartz content at 50 to 140% reported by the local laboratory accredited by the American Industrial Hygiene Association (AIHA). These results are summarized in Appendix 2 to this project report with separate presentation of OSHA PEL exposure calculations based on an 8-hour TWA as defined by both the previous and also the recently published OSHA regulatory standard for construction. Based on criteria under the current rule that is effective until June 23, 2017, the three airborne results for respirable particulates did not exceed the calculated sample-specific OSHA PEL based only on the presence of the quartz form of crystalline silica. The referenced OSHA exposure calculation using only the detected presence of airborne quartz based on requirements in the recent rule for construction effective June 23, 2017 reported 8-hour TWA results at either 0.014 or 0.018 mg/M³ which did not exceed the recently published OSHA Action Level of 0.025 mg/M³ or the OSHA PEL of 0.050 mg/M³.

CONCLUSIONS:

This report documents results of representative industrial hygiene airborne monitoring for respirable crystalline silica conducted by Jan Koehn, M.S., CIH, Inc. personnel for defined [REDACTED] work activities related to concrete cutting with a remote control saw employing wet methods and other accepted control measures on January 25, 2017 for a scheduled residential project. Personal breathing zone and area monitoring was completed during a partial period work shift to investigate occupational airborne exposures and record pertinent workplace conditions with requested documentation and data interpretation of behalf of the Client. The reported laboratory analytical sample data for airborne quartz, in particular was below the recently published OSHA PEL related to construction activities, but results may have exceeded the OSHA Action Level and ACGIH TLV during the partial period 4-hour time interval for concrete saw cutting work. Control measures involving use of continuous wet methods, remote control saw operation, position of an air mover, and other vacuum collection methods by Holes, Inc. personnel were observed during conduct of specified project work activities to overall effectively decrease airborne exposures.

The personal airborne monitoring results were both reported at 0.03 mg/M³ for respirable quartz, and the area sample was 0.04 mg/M³ for respirable quartz during concrete floor saw cutting within the enclosed garage. Only the specific form of quartz was detected for the project airborne samples with a range of content at 50 to 140% as reported by the local laboratory accredited by the American Industrial Hygiene Association (AIHA).

Based on criteria under the current rule that is effective until June 23, 2017 using the previous OSHA formula calculation, the airborne results for respirable particulates for each of the 3 separate project air samples did not approach the sample-specific calculated OSHA PELs involving only the presence of quartz as respirable crystalline silica. The OSHA PEL-TWA calculations using only the detected presence of quartz based on requirements of the rule effective June 23, 2017 for the construction industry reported 8-hour TWA exposure results at either 0.014 or 0.018 mg/M³ which did not exceed the recently published OSHA Action Level of 0.025 mg/M³ as well as the ACGIH TLV-TWA or the OSHA PEL of 0.050 mg/M³. Appropriate control measures were properly employed by company personnel in order to further decrease airborne exposures to defined respirable crystalline silica as well as other good work practices and procedures.

APPENDICES

APPENDIX 1
PROJECT PERSONNEL DOCUMENTATION

APPENDIX 2

**PROJECT FIELD DOCUMENTATION OF SAW CUTTING ACTIVITIES
AND PREPARED WORK SITE DRAWING OF OBSERVED OPERATIONS
WITH PROJECT DIGITAL PHOTOGRAPHS**

██████████

WORKPLACE EXPOSURE DATA DOCUMENTATION

Date: 01/25/17

Project Type: Residential Construction

Project Purpose: Garage Renovation/Extension

Trade/Job: Machine Operator and Assistant

Task: Cut Interior Concrete Floor to Remove Rear Elevated Section

Tool: Circular Saw with Remote Control

Controls Used: Wet Method with Vacuum to Collect Water and Debris

General Ventilation: Fan Positioned at Edge of Open Garage on Driveway

Nearby Dust: Limited

Environment: Ambient, No Weather Conditions

Sampler: Gilian BDX II Personal Pump with Cyclone and PVC Filter

Sampling Method: NIOSH 0600 and 7500

Time of Testing: Partial Period

Weather Conditions: Clear, hot, humid, limited breeze

PPE Used:

Notes:

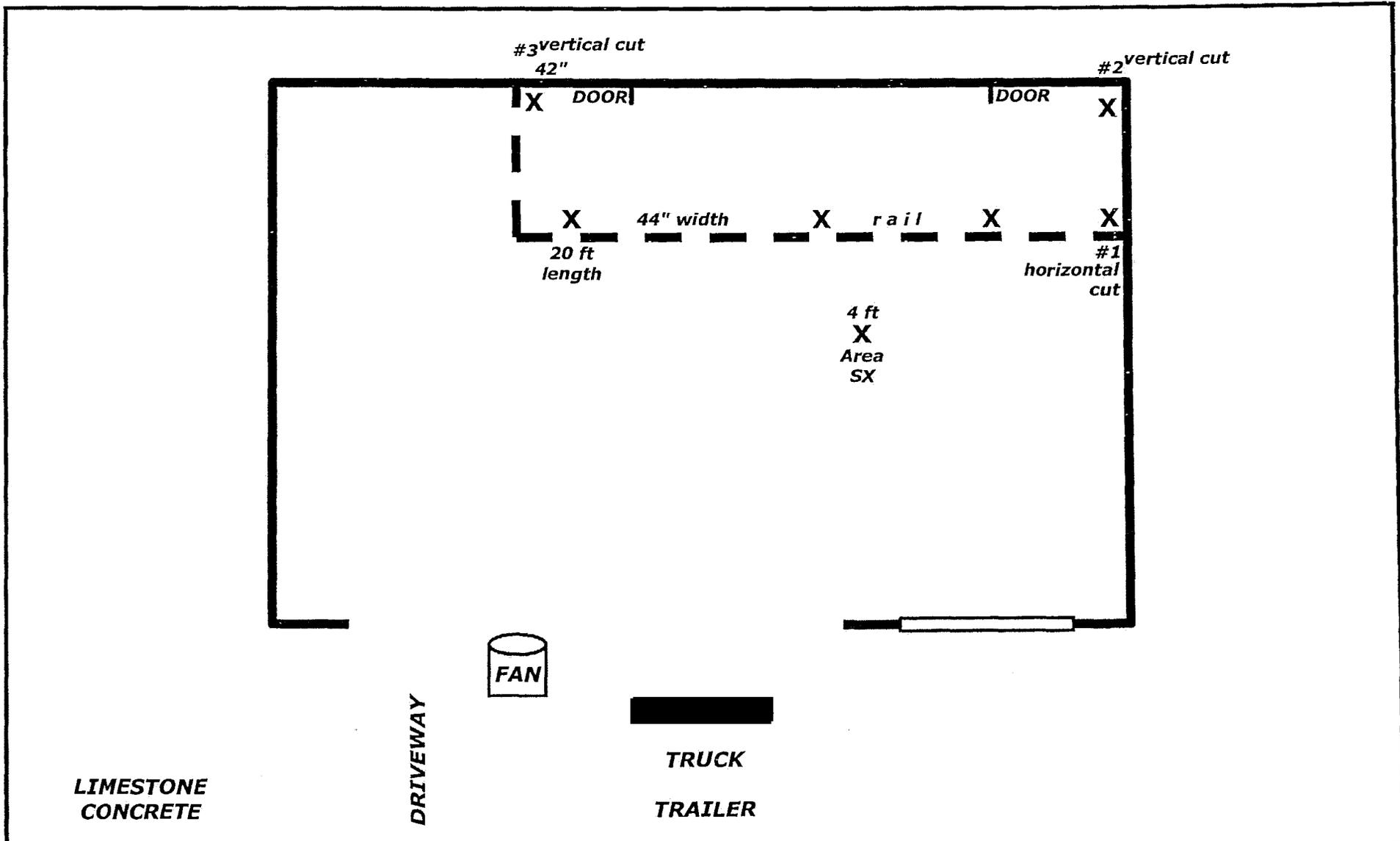
Coordinate with ██████ regarding ██████ request for site air monitoring with remote control saw for respirable crystalline silica. Further confirmation during week of 1/23/17. Mobilize to residential ██████ site from address and call ██████ to communicate regarding arrival. Jan Koehn, M.S., CIH on site after 10 am based on directions. Set up pumps to be positioned and meet ██████ Safety and ██████ and ██████ for Client. Homeowner worked at ██████ and familiar with Industrial Hygiene and setting up air sample pumps.

- 1020: Prepare two personal samples and one area at center rear garage location.
- 1025-1035: Position on personnel and set-up in garage. ██████ outlines position of support brackets for track and saw. Started drawing with measurements. Install track, set up saw blade, and power cords after use of core drill for positioners and installation. Vacuum used during drilling and cutting to collect debris and water from garage floor area.
- 1130: Review set up and prepare remote control for use at rear of garage.
- 1145: Position guard cover on saw blade. Start lengthwise saw cut on concrete floor.

██████████

Notes: (continued)

- 1215: Complete several passes on floor. Exchange vacuum unit for water collection. Saw blade raised and part of guard removed. Empty vacuum and continue water collection. Pumps remain in operation. 5" depth cut made. Fan positioned at edge of garage. Wet methods used with saw and vacuum for liquid collection.
- 1245: Re-position saw on short piece of track on east end. Due to 3" step, depth of side cut will be 8". Thin plastic barrier was further secured with masking tape and then sheetrock from wall used to secure to wall behind saw and separate OSB barrier at south studs at storage area and limit extensive water intrusion. Cut made and saw disassembled. Tracks removed and re-positioned.
- 1310: Outline of final cut at center doorway. Tracks in place and saw to be positioned. Blade marked at 8" and installed. Set in position and verified, and start cut at rear opening. Pumps remain in operation along with fan provided and used by ██████████ personnel. Update log paperwork and prepare chain of custody form. Post calibration will be addressed. Vacuum used to collect liquid and debris at saw cut areas within garage.
- 1330: Start removal and packing of equipment and supplies. Retrieved area sample.
- 1430: Process and label collected samples. Complete paperwork and pack equipment.
- 1500: Load vehicle. Return to office.
- 1600: Post calibrate and address volume calculations and complete chain of custody.
- 1630: Deliver samples for transport to lab. Unpack equipment and file paperwork.



JK Inc.

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Houston, Texas 77054
(713) 664-1597
Email: mail@jkinc.biz

RESPIRABLE DUST & CRYSTALLINE SILICA MONITORING

[REDACTED] - RESIDENTIAL GARAGE

JK, INC. PROJECT NO. 011-17
JANUARY 25, 2017

REVISIONS:

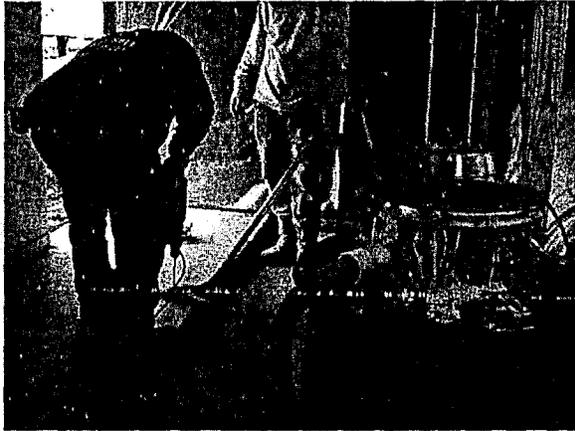
RELEASED:
JANUARY 2017

DWG NO:
SILICA DWG 1

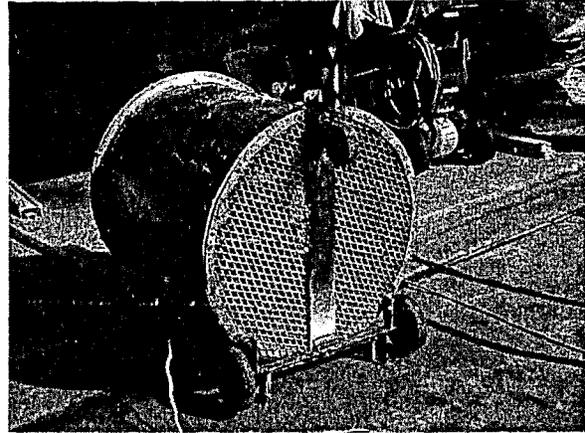
PROJECT ASSESSMENT PHOTOGRAPHS



JANUARY 25, 2017



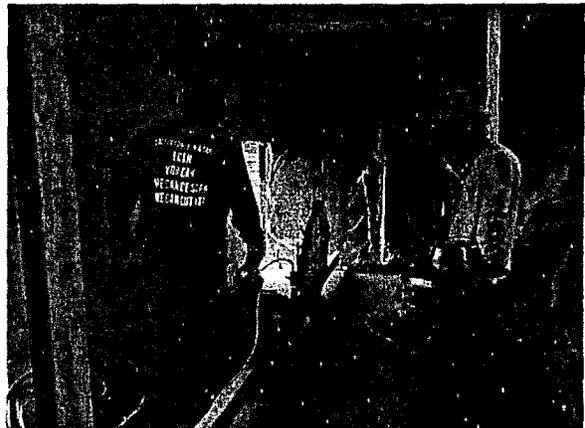
Drill Holes for Saw Track Installation



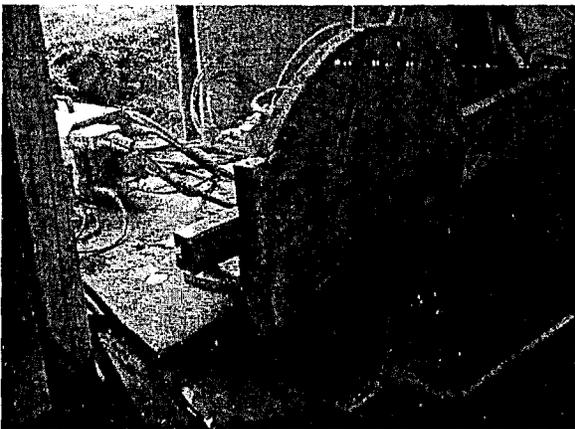
Air Mover Positioned at Garage



Initial Position of Track and Saw



Remote Control Saw and Water Application



Initial Cut and Use of Vacuum for Debris Collection

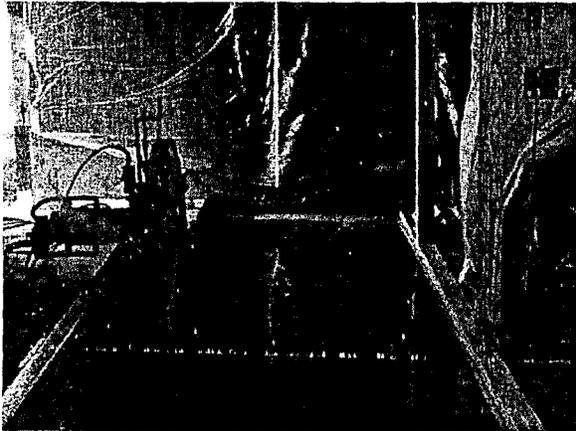


Continued Saw Operation for Initial Cut

PROJECT ASSESSMENT PHOTOGRAPHS



JANUARY 25, 2017



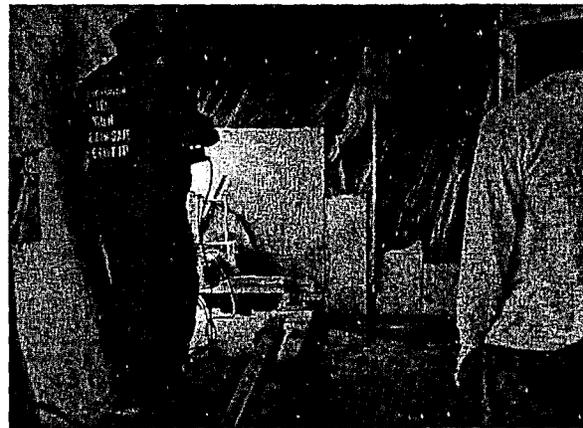
Saw Operation and Area Sample Position in Garage



Operator with Remote and Personal Sample



Assistant with Vacuum and Personal Sample



Second Saw Cut at Garage Perimeter

A P P E N D I X 3

**INDUSTRIAL HYGIENE AIR MONITORING RESULTS
WITH LABORATORY ANALYTICAL DATA REPORT
AND COMPLETION OF AGC SILICA MONITORING FORMS**



Jan Koehn, M.S., CIH, Inc.
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SUMMARY DATA OF REPORTED AIR SAMPLE LABORATORY RESULTS
FOR RESPIRABLE PARTICULATES AND 3 FORMS OF CRYSTALLINE SILICA

██████████ - RESIDENTIAL GARAGE - ██████████
██████████

JANUARY 25, 2017

Sample Number	Type	Sample Description	Time (Min)	Volume (Liters)	RESULTS			
					Respirable Particulates (mg/M ³ *)	RESULTS Cristobalite (mg/M ³)	RESULTS Quartz (mg/M ³)	RESULTS Tridymite (mg/M ³)
01117-01	Personal	██████████ Operator	225	576.0	0.02	< 0.02 [-]	0.03 [140]	< 0.02 [-]
01117-02	Personal	██████████ Assistant	230	591.1	0.07	< 0.02 [-]	0.03 [50]	< 0.02 [-]
01117-03	Area	Inside Garage Center at Rear Wall	216	559.4	0.04	< 0.02 [-]	0.04 [100]	< 0.02 [-]
01117-04	Blank	Field Blank	N/A	N/A	< 0.01 mg**	< 0.01 mg [-]	< 0.01 mg [-]	< 0.01 mg [-]

[-] - Below Detection Limit Result related to silica content, so assumed 0% contribution; or use of specific percentage of silica content reported by lab for calculation.

RESPIRABLE PARTICULATES: OSHA PEL - 5 mg/M³; ACGIH TLV - 3 mg/M³
ACGIH TLV for Respirable Crystalline Silica at 0.025 mg/M³

Note: ██████████ work site activities for concrete floor cutting using remote control saw
with wet methods and vacuum collection of water and generated debris.

*mg/M³ - milligrams per cubic meter

**mg - milligrams

Method: NIOSH 0600 and 7500



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SUMMARY DATA OF AIR SAMPLE RESULTS
FOR RESPIRABLE PARTICULATES AND CRYSTALLINE SILICA AS QUARTZ
AND OSHA PEL - 8-HOUR TIME-WEIGHTED AVERAGE (TWA) CALCULATIONS

██████████ - RESIDENTIAL GARAGE - ██████████
██████████

JANUARY 25, 2017

Sample Number	Type	Sample Description	Time (Min)	Volume (Liters)	RESULTS Respirable Particulates (mg/M ³ *)	OSHA PEL Formula Calculation [with Quartz] (mg/M ³)	SAMPLE ANALYTICAL RESULTS Quartz (mg/M ³)	OSHA 8Hour PEL-TWA Exposure Calculation (mg/M ³ *)
01117-01	Personal	██████████ Operator	225	576.0	0.02	0.070	0.03 [140]	0.014
01117-02	Personal	██████████ Assistant	230	591.1	0.07	0.192	0.03 [50]	0.014
01117-03	Area	Inside Garage Center at Rear Wall	216	559.4	0.04	0.098	0.04 [100]	0.018
01117-04	Blank	Field Blank	N/A	N/A	< 0.01 mg**	N/A	< 0.01 mg [-]	N/A

[#] - Specific percentage of silica content reported by lab utilized for calculation.

OCCUPATIONAL EXPOSURE LIMITS (OELs) AS 8-HOUR TIME WEIGHTED AVERAGE (TWA):

OSHA PEL for Respirable Crystalline Silica at 0.050 mg/M³ and an Action Level of 0.025 mg/M³ as 8-hour TWA.
(Final Rule dated 6/23/16 and effective 6/23/17 for Construction); Formulas outlined on AGC Silica Monitoring Form.

*mg/M³ - milligrams per cubic meter

**mg - milligrams

Method: NIOSH 0600 and 7500

HIH LABORATORY, INC.

Report Number 44754

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 P.O. Box 57727
 Webster, Tx 77598
 (281) 338-9000
 FAX (281) 338-2351

PO Number JK011-17

LABORATORY ANALYSIS REPORT

JK INC.
 8926 KIRBY DRIVE
 HOUSTON TX 77054

Attention:
 Ms. Jan Koehn

Report Number 44754
Client Number: 80

Date Received: 01/26/2017
Date Reported: 01/31/2017

HIH Sample Number:	Client Sample ID	Date Collected	Sample time (min)	Sample Vol. (L) or Area						
Analyte	Result	Units	Actual Exp	Units	Test date:	Reporting Limit	Blank Corrected	Lower 95% Confidence Limit	Upper 95% Confidence Limit	
514385	01117-01	1/25/2017		576						
Particulates, respirable	0.01	mg	0.02	mg/m3	1/27/2017	0.01 mg	N/A			

		1/25/2017		576						
Cristobalite	< 0.01	mg	< 0.02	mg/m3	1/27/2017	0.01 mg	Yes			
Comments: Less than 100 % of Particulates										

		1/25/2017		576						
Quartz	0.02	mg	0.03	mg/m3	1/27/2017	0.01 mg	Yes			
Comments: 140 % of Particulates										

		1/25/2017		576						
Tridymite	< 0.01	mg	< 0.02	mg/m3	1/27/2017	0.01 mg	Yes			
Comments: Less than 100 % of Particulates										

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Analyte	Result	Units	Actual Exp	Units	Test date:	Reporting Limit	Blank Corrected	Lower 95% Confidence Limit	Upper 95% Confidence Limit
514386	01117-02	1/25/2017		591.1					
Particulates, respirable	0.04	mg	0.07	mg/m3	1/27/2017	0.01 mg	N/A		

		1/25/2017		591.1					
Cristobalite	<0.01	mg	<0.02	mg/m3	1/27/2017	0.01 mg	Yes		
Comments: Less than 25 % of Particulates									

		1/25/2017		591.1					
Quartz	0.02	mg	0.03	mg/m3	1/27/2017	0.01 mg	Yes		
Comments: 50 % of Particulates									

		1/25/2017		591.1					
Tridymite	<0.01	mg	<0.02	mg/m3	1/27/2017	0.01 mg	Yes		
Comments: Less than 25 % of Particulates									

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Date Received: 01/26/2017
Date Reported: 01/31/2017

HIH Sample Number:	Client Sample ID	Date Collected	Sample time (min)	Sample Vol. (L) or Area					
Analyte	Result	Units	Actual Exp	Units	Test date:	Reporting Limit	Blank Corrected	Lower 95% Confidence Limit	Upper 95% Confidence Limit
514387	01117-03	1/25/2017		559.4					
Particulates, respirable	0.02	mg	0.04	mg/m3	1/27/2017	0.01 mg	N/A		

		1/25/2017		559.4					
Cristobalite	<0.01	mg	<0.02	mg/m3	1/27/2017	0.01 mg	Yes		
Comments: Less than 50 % of Particulates									

		1/25/2017		559.4					
Quartz	0.02	mg	0.04	mg/m3	1/27/2017	0.01 mg	Yes		
Comments: 100 % of Particulates									

		1/25/2017		559.4					
Tridymite	<0.01	mg	<0.02	mg/m3	1/27/2017	0.01 mg	Yes		
Comments: Less than 50 % of Particulates									

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HOUSTON TX 77054

Attention:
Ms. Jan Koehn

Report Number 44754
Client Number: 80

Date Received: 01/26/2017
Date Reported: 01/31/2017

HIH Sample Number:	Client Sample ID	Date Collected	Sample time (min)	Sample Vol. (L) or Area				Lower 95% Confidence Limit	Upper 95% Confidence Limit
Analyte	Result	Units	Actual Exp	Units	Test date:	Reporting Limit	Blank Corrected		
514388	01117-04	1/25/2017							
Particulates, respirable	< 0.01	mg			1/27/2017	0.01 mg	N/A		

		1/25/2017							
Cristobalite	< 0.01	mg			1/27/2017	0.01 mg	N/A		
Comments: Less than 100 % of Particulates									

		1/25/2017							
Quartz	< 0.01	mg			1/27/2017	0.01 mg	N/A		
Comments: Less than 100 % of Particulates									

		1/25/2017							
Tridymite	< 0.01	mg			1/27/2017	0.01 mg	N/A		
Comments: Less than 100 % of Particulates									

HIH LABORATORY, INC.

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LABORATORY ANALYSIS REPORT

Report Number
44754

SUPPLEMENTARY QUALITY ASSURANCE INFORMATION

Analyte	Method	Media	Test date:	Analyst:	Instrument:	MS % Recovery:	MSD % RECOVERY:	MS/MSD RPD:	LCS % Recovery:	Precision (% Sr)	Blank Result	DUP RPD	Batch No:	Lit Ref	HiH Sample #
Cristobalite	NIOSH 7500	PVC Filter	01/27/2017	LS	XRD1	146	149					2.33	34565	97	514385
Quartz	NIOSH 7500	PVC Filter	01/27/2017	LS	XRD1	120	129		95.3			7.84	34565	97	514385
Tridymite	NIOSH 7500	PVC Filter	01/27/2017	LS	XRD1	121	131					8.32	34565	97	514385
Particulates, respirable	NIOSH 0600	Prewieghed PVC Filter	01/27/2017	LS	001BAL				104		0		34566	97	514385

Method Literature References

97 NIOSH Manual of Analytical Methods, 4th Edition, August, 1994

HIH Laboratory did not collect these samples; therefore, calculations and sampling information are based on client-supplied sampling data.

Samples arrived in good condition unless otherwise noted.

Approved By:

Esteban P. Piña, Technical Manager

Instructions					
<p>1. Use this form to collect information on employee(s) exposure from <u>one</u> product or material or process, task, or activity. The information will be used for recordkeeping purposes and includes information requested in paragraphs (j)(1)(ii) and (j)(2)(ii) of the construction standard (29 CFR 1926.1153).</p> <p>2. Exposure assessment must reflect the exposures of employees on each shift, for each job classification, in each work area.</p> <p>3. Reassess exposures whenever a change in the production, process, control equipment, personnel, or work practices may reasonably be expected to result in new or additional exposures at or above the action level, or when the employer has any reason to believe that new or additional exposures at or above the action level have occurred.</p>					
Purpose					
<input checked="" type="checkbox"/> Air Monitoring Data <input type="checkbox"/> Initial <input type="checkbox"/> Re-sampling			<input checked="" type="checkbox"/> Objective Data, Source: <u>Respirable Particulate & Crystalline Silica</u> <input type="checkbox"/> Reassessment, Change in: _____		
Date	Contractor	Region		Site	
01/25/17	[REDACTED]	<input type="checkbox"/> Northeast (NE) <input type="checkbox"/> Southeast (SE) <input checked="" type="checkbox"/> Southwest (SW) <input type="checkbox"/> West (W) <input type="checkbox"/> Midwest (MW)	[REDACTED]		
Employees Represented by Monitoring					
Name	SSN	Job Class	PPE Used	Monitored (Y/N)	
[REDACTED]	NA	Operator	Gloves, Hard Hat, Glasses, Safety Boots	Y	
[REDACTED]	NA	Assistant	Gloves, Hard Hat, Glasses, Safety Boots	Y	
Area - Inside Garage, Center at Rear Wall		NA	NA	Y	
Job Description					
Residential Garage Renovation/Extension					
Type of Work Being Performed					
Task	Time Performed (%)		Task	Time Performed (%)	
<input checked="" type="checkbox"/> Cutting (C)	<input type="checkbox"/> <25 <input type="checkbox"/> 25-50 <input type="checkbox"/> 50-75 <input checked="" type="checkbox"/> >75		<input type="checkbox"/> Mixing Concrete (MC)	<input type="checkbox"/> <25 <input type="checkbox"/> 25-50 <input type="checkbox"/> 50-75 <input type="checkbox"/> >75	
<input type="checkbox"/> Grinding (G)	<input type="checkbox"/> <25 <input type="checkbox"/> 25-50 <input type="checkbox"/> 50-75 <input type="checkbox"/> >75		<input type="checkbox"/> Mixing Mortar (MM)	<input type="checkbox"/> <25 <input type="checkbox"/> 25-50 <input type="checkbox"/> 50-75 <input type="checkbox"/> >75	
<input checked="" type="checkbox"/> Drilling (D)	<input checked="" type="checkbox"/> <25 <input type="checkbox"/> 25-50 <input type="checkbox"/> 50-75 <input type="checkbox"/> >75		<input type="checkbox"/> Terrazzo Work (TW)	<input type="checkbox"/> <25 <input type="checkbox"/> 25-50 <input type="checkbox"/> 50-75 <input type="checkbox"/> >75	
<input type="checkbox"/> Other:				<input type="checkbox"/> <25 <input type="checkbox"/> 25-50 <input type="checkbox"/> 50-75 <input type="checkbox"/> >75	
Base Material			Silica Content of Base Material		
<input type="checkbox"/> Block (BL) <input type="checkbox"/> Other: _____ <input type="checkbox"/> Brick (BR) <input checked="" type="checkbox"/> Concrete (C)			<input type="checkbox"/> From bulk sample _____ <input type="checkbox"/> From estimate (MSDS or list) _____ <input checked="" type="checkbox"/> Unknown		
Tool(s) Used			PPE Used		
Make: _____ Model: _____			<input type="checkbox"/> Dust Mask (DM) <input type="checkbox"/> Half Face (HF) <input type="checkbox"/> Full Face (FF) <input type="checkbox"/> Protective Clothing (PC) <input checked="" type="checkbox"/> Glove (G) <input type="checkbox"/> Other: _____		

Control Method(s)	
<input type="checkbox"/> None (N) <input type="checkbox"/> Dry (D) <input type="checkbox"/> Natural Ventilation (NV) <input type="checkbox"/> General Mechanical (GM) <input type="checkbox"/> Local Exhaust Ventilation - with HEPA vacuum (LE-HEPA) <input type="checkbox"/> Local Exhaust Ventilation - with shop vac or other vacuum (LE-OTHER) <input type="checkbox"/> Wet Method - Continuous Drip (WM-CD) <input checked="" type="checkbox"/> Wet Method - Continuous Spray (WM-CS) <input type="checkbox"/> Wet Method - Non-continuous Drip (WM-NCD) Frequency: _____ <input type="checkbox"/> Wet Method - Non-continuous Spray (WM-NCS) Frequency: _____ <input type="checkbox"/> Other: _____	
Silica written exposure control plan in effect? <input type="checkbox"/> Yes <input type="checkbox"/> No	
Controls checked during sampling period? <input type="checkbox"/> Yes <input type="checkbox"/> No	
Employee trained and familiar with operation of controls? <input type="checkbox"/> Yes <input type="checkbox"/> No	

Environment	Nearby Visible Dust Sources
<input type="checkbox"/> Outdoors <input type="checkbox"/> Open Sided (Free Flow) <input type="checkbox"/> Enclosed on 1 Side (Limited Flow) <input checked="" type="checkbox"/> Enclosed All Sides (No Flow) <input type="checkbox"/> Other: _____	<input checked="" type="checkbox"/> None <input type="checkbox"/> Other workers doing same task <input type="checkbox"/> Partial from other tasks and sources <input type="checkbox"/> Continuous from other tasks and sources <input type="checkbox"/> Other: _____
Other Possible Interferences in Sampling Area(s)	

Wind Speed (mph)		Source		Temperature (°F)		Humidity (%)	
<input type="checkbox"/> None	<input type="checkbox"/> <5	<input type="checkbox"/> None	<input type="checkbox"/> <40	<input checked="" type="checkbox"/> 40-90	<input type="checkbox"/> <20	<input type="checkbox"/> 20-40	
<input checked="" type="checkbox"/> 5-10	<input type="checkbox"/> >10	<input checked="" type="checkbox"/> Natural	<input type="checkbox"/> >90		<input type="checkbox"/> 40-60	<input checked="" type="checkbox"/> 60-80	
		<input checked="" type="checkbox"/> Artificial			<input type="checkbox"/> >80		

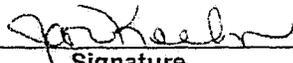
Type & Number of Samples Collected						
<input checked="" type="checkbox"/> Personal (P): <u>2</u> <input checked="" type="checkbox"/> Area (A): <u>1</u> <input type="checkbox"/> Bulk (B): _____						
Agent						
<input type="checkbox"/> Silica (S) <input checked="" type="checkbox"/> Silica w/ Respirable Dust (S/RD) <input type="checkbox"/> Silica w/ Total Dust (S/TD)						
Sample ID	Description	Date Sampled	Collection Medium	Sample Volume, Time, or Area	Sample Units: L, mL, min, in, ft ²	Analysis Requested*
01117-01	██████████	01/25/17	PVC	576.0	L	NIOSH 0600 & 7500
01117-02	██████████	01/25/17	PVC	591.1	L	NIOSH 0600 & 7500
01117-03	Area- inside Garage, Center of Rear Wall	01/25/17	PVC	559.4	L	NIOSH 0600 & 7500
01117-04	Field Blank	01/25/17	PVC	NA	L	NIOSH 0600 & 7500

*Analytical Methods: OSHA ID-142, NMAM 7500, NMAM 7602, NMAM 7603, MSHA P-2, or MSHA P-7.

Laboratory Utilized (Name and Location)		HIH Laboratory, Inc.; Webster, Texas	
Laboratory Results			
Volume of Sample (L) <small>[Average Flow Rate x Duration]</small>		Volume of Sample (m ³) <small>[1000 L = 1 m³]</small>	
576.0 L		0.5760 m ³	
Weight (mg)			
Respirable Dust	α-Quartz	Cristobalite	Tridymite
0.01	0.02	< 0.01	< 0.01
Silica Content (%)			
α-Quartz	Cristobalite	Tridymite	
140			

Exposure Calculations			
Under Old Rule, Effective Until June 23, 2017			
PEL (Respirable Silica) =	$\frac{10}{[\% \alpha\text{-Quartz} + (\% \text{Cristobalite} * 2) + (\% \text{Tridymite} * 2) + 2]}$	= 0.070	mg/m ³
PEL (Total Dust) =	$\frac{30}{[\% \alpha\text{-Quartz} + (\% \text{Cristobalite} * 2) + (\% \text{Tridymite} * 2) + 2]}$	=	mg/m ³
Exposure = (8-hr TWA)	$\frac{[(\text{mg}/\text{m}^3_{(1)} * \text{time}_{(1)}) + \dots + (\text{mg}/\text{m}^3_{(n)} * \text{time}_{(n)})]}{480 \text{ min}}$	= 0.014	mg/m ³
Severity =	$\frac{\text{Exposure}}{\text{PEL}_{(\text{Respirable Silica})}}$	= 0.2	
Under New Rule, Effective June 23, 2017			
Silica Conc. Total =	mg/m ³ α-Quartz + mg/m ³ Cristobalite + mg/m ³ Tridymite	= 0.03	mg/m ³
Exposure = (8-hr TWA)	$\frac{[(\text{mg}/\text{m}^3_{(1)} * \text{time}_{(1)}) + \dots + (\text{mg}/\text{m}^3_{(n)} * \text{time}_{(n)})]}{480 \text{ min}}$	= 0.014	mg/m ³
Severity =	$\frac{\text{Exposure}}{0.050 \text{ mg}/\text{m}^3}$	= 0.28	

Comments
[REDACTED] - Operator Sample #: 01117-01 Sample Time: 225 minutes Sample Type: Personal

Sampled By:
Jan Koehn <hr/> Name (Print)  <hr/> Signature

Laboratory Utilized (Name and Location)		HIH Laboratory, Inc.; Webster, Texas	
Laboratory Results			
Volume of Sample (L) [Average Flow Rate x Duration]		Volume of Sample (m ³) [1000 L = 1 m ³]	
591.1 L		0.5911 m ³	
Weight (mg)			
Respirable Dust	α-Quartz	Cristobalite	Tridymite
0.04	0.02	< 0.01	< 0.01
Silica Content (%)			
α-Quartz	Cristobalite	Tridymite	
50			

Exposure Calculations			
Under Old Rule, Effective Until June 23, 2017			
PEL (Respirable Silica) =	$\frac{10}{[\% \alpha\text{-Quartz} + (\% \text{Cristobalite} * 2) + (\% \text{Tridymite} * 2) + 2]}$	= 0.192	mg/m ³
PEL (Total Dust) =	$\frac{30}{[\% \alpha\text{-Quartz} + (\% \text{Cristobalite} * 2) + (\% \text{Tridymite} * 2) + 2]}$	=	mg/m ³
Exposure = (8-hr TWA)	$\frac{[(\text{mg}/\text{m}^3_{(1)} * \text{time}_{(1)}) + \dots + (\text{mg}/\text{m}^3_{(n)} * \text{time}_{(n)})]}{480 \text{ min}}$	= 0.014	mg/m ³
Severity =	$\frac{\text{Exposure}}{\text{PEL}_{(\text{Respirable Silica})}}$	= 0.073	
Under New Rule, Effective June 23, 2017			
Silica Conc. Total =	mg/m ³ α-Quartz + mg/m ³ Cristobalite + mg/m ³ Tridymite	= 0.03	mg/m ³
Exposure = (8-hr TWA)	$\frac{[(\text{mg}/\text{m}^3_{(1)} * \text{time}_{(1)}) + \dots + (\text{mg}/\text{m}^3_{(n)} * \text{time}_{(n)})]}{480 \text{ min}}$	= 0.014	mg/m ³
Severity =	$\frac{\text{Exposure}}{0.050 \text{ mg}/\text{m}^3}$	= 0.28	

Comments
<p>██████████ - Assistant</p> <p>Sample #: 01117-02 Sample Time: 230 minutes Sample Type: Personal</p>

Sampled By:
<p>Jan Koehn</p> <p style="text-align: center;">Name (Print)</p> <p style="text-align: center;"><i>Jan Koehn</i></p> <p style="text-align: center;">Signature</p>

Laboratory Utilized (Name and Location)		HHH Laboratory, Inc.; Webster, Texas	
Laboratory Results			
Volume of Sample (L) <small>[Average Flow Rate x Duration]</small>		Volume of Sample (m ³) <small>[1000 L = 1 m³]</small>	
559.4 L		0.5594 m ³	
Weight (mg)			
Respirable Dust	α-Quartz	Cristobalite	Tridymite
0.02	0.02	< 0.01	< 0.01
Silica Content (%)			
α-Quartz	Cristobalite	Tridymite	
100			

Exposure Calculations			
Under Old Rule, Effective Until June 23, 2017			
PEL (Respirable Silica) =	$\frac{10}{[\% \alpha\text{-Quartz} + (\% \text{Cristobalite} * 2) + (\% \text{Tridymite} * 2) + 2]}$	= 0.098	mg/m ³
PEL (Total Dust) =	$\frac{30}{[\% \alpha\text{-Quartz} + (\% \text{Cristobalite} * 2) + (\% \text{Tridymite} * 2) + 2]}$	=	mg/m ³
Exposure = (8-hr TWA)	$\frac{[(\text{mg}/\text{m}^3_{(1)} * \text{time}_{(1)}) + \dots + (\text{mg}/\text{m}^3_{(n)} * \text{time}_{(n)})]}{480 \text{ min}}$	= 0.018	mg/m ³
Severity =	$\frac{\text{Exposure}}{\text{PEL}_{(\text{Respirable Silica})}}$	= 0.183	
Under New Rule, Effective June 23, 2017			
Silica Conc. Total =	mg/m ³ α-Quartz + mg/m ³ Cristobalite + mg/m ³ Tridymite	= 0.04	mg/m ³
Exposure = (8-hr TWA)	$\frac{[(\text{mg}/\text{m}^3_{(1)} * \text{time}_{(1)}) + \dots + (\text{mg}/\text{m}^3_{(n)} * \text{time}_{(n)})]}{480 \text{ min}}$	= 0.018	mg/m ³
Severity =	$\frac{\text{Exposure}}{0.050 \text{ mg}/\text{m}^3}$	= 0.36	

Comments

Inside Garage, Center of Rear Wall

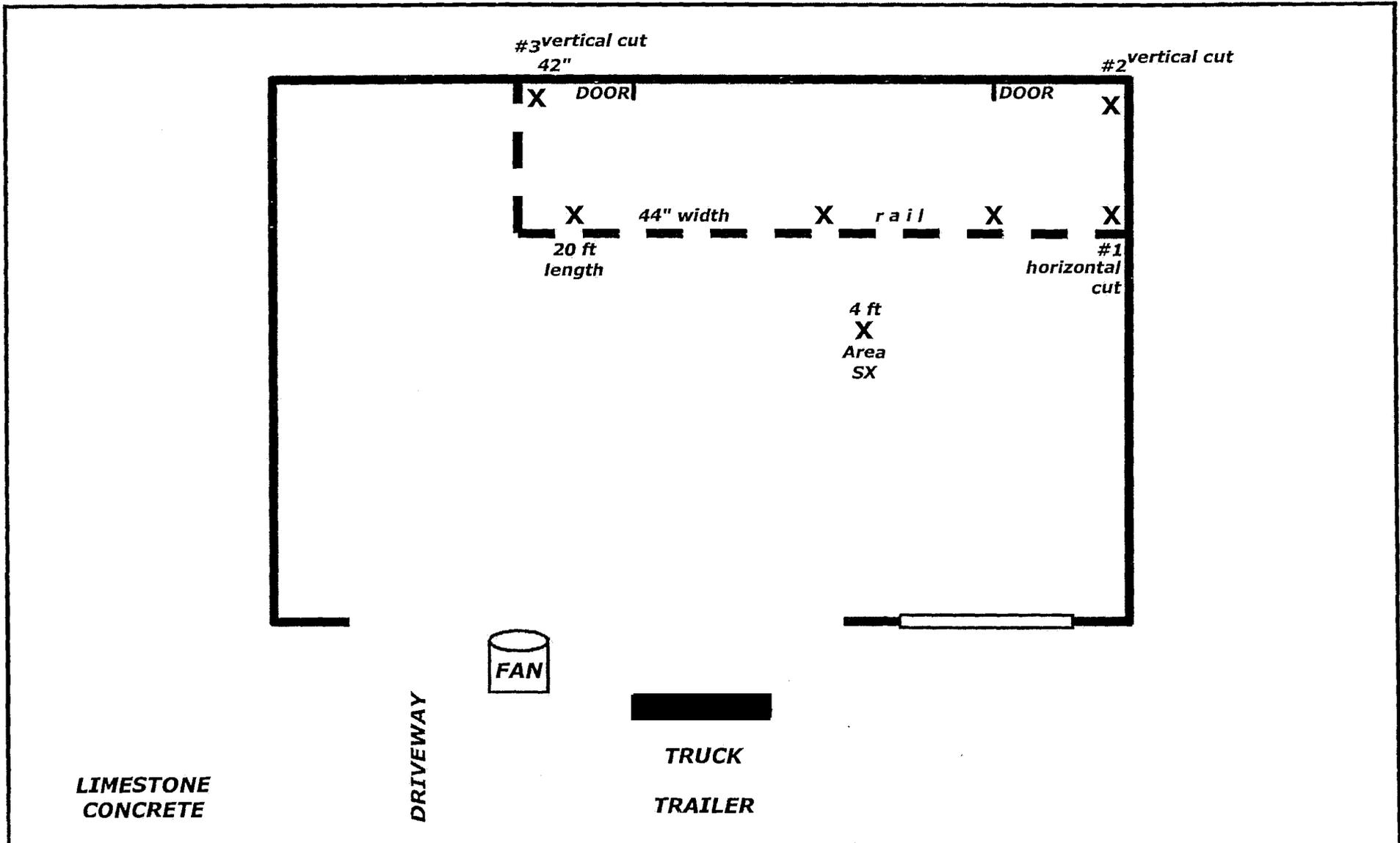
Sample #: 01117-03
 Sample Time: 216 minutes
 Sample Type: Area

Sampled By:

Jan Koehn

Name (Print)


Signature



LIMESTONE
CONCRETE

DRIVEWAY



TRUCK

TRAILER

JK Inc.

8926 Kirby Drive
Houston, Texas 77054
(713) 664-1597
Email: mail@jkinc.biz

RESPIRABLE DUST & CRYSTALLINE SILICA MONITORING

[REDACTED] - RESIDENTIAL GARAGE

JK, INC. PROJECT NO. 011-17
JANUARY 25, 2017

REVISIONS:

RELEASED:
JANUARY
2017

DWG NO:
SILICA
DWG 1

██████████

WORKPLACE EXPOSURE DATA DOCUMENTATION

Date: 01/25/17

Project Type: Residential Construction

Project Purpose: Garage Renovation/Extension

Trade/Job: Machine Operator and Assistant

Task: Cut Interior Concrete Floor to Remove Rear Elevated Section

Tool: Circular Saw with Remote Control

Controls Used: Wet Method with Vacuum to Collect Water and Debris

General Ventilation: Fan Positioned at Edge of Open Garage on Driveway

Nearby Dust: Limited

Environment: Ambient, No Weather Conditions

Sampler: Gilian BDX II Personal Pump with Cyclone and PVC Filter

Sampling Method: NIOSH 0600 and 7500

Time of Testing: Partial Period

Weather Conditions: Clear, hot, humid, limited breeze

PPE Used:

Notes:

Coordinate with ██████ regarding ██████ request for site air monitoring with remote control saw for respirable crystalline silica. Further confirmation during week of 1/23/17. Mobilize to residential ██████ site from address and call ██████ to communicate regarding arrival. Jan Koehn, M.S., CIH on site after 10 am based on directions. Set up pumps to be positioned and meet ██████ Safety and ██████ and ██████ for Client. Homeowner worked at ██████ and familiar with Industrial Hygiene and setting up air sample pumps.

- 1020: Prepare two personal samples and one area at center rear garage location.
- 1025-1035: Position on personnel and set-up in garage. ██████ outlines position of support brackets for track and saw. ██████ outlines position of support brackets for track and saw. Started drawing with measurements. Install track, set up saw blade, and power cords after use of core drill for positioners and installation. Vacuum used during drilling and cutting to collect debris and water from garage floor area.
- 1130: Review set up and prepare remote control for use at rear of garage.
- 1145: Position guard cover on saw blade. Start lengthwise saw cut on concrete floor.

██████████

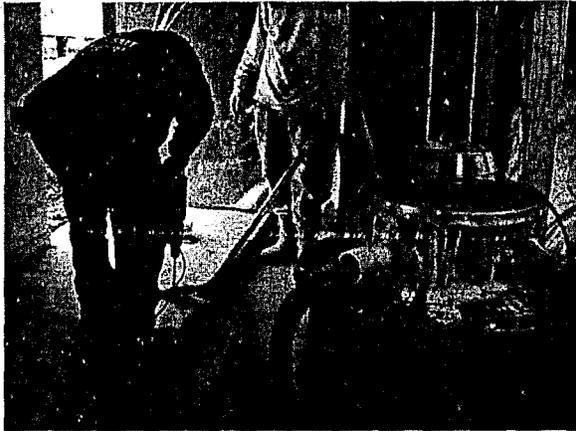
Notes: (continued)

- 1215: Complete several passes on floor. Exchange vacuum unit for water collection. Saw blade raised and part of guard removed. Empty vacuum and continue water collection. Pumps remain in operation. 5" depth cut made. Fan positioned at edge of garage. Wet methods used with saw and vacuum for liquid collection.
- 1245: Re-position saw on short piece of track on east end. Due to 3" step, depth of side cut will be 8". Thin plastic barrier was further secured with masking tape and then sheetrock from wall used to secure to wall behind saw and separate OSB barrier at south studs at storage area and limit extensive water intrusion. Cut made and saw disassembled. Tracks removed and re-positioned.
- 1310: Outline of final cut at center doorway. Tracks in place and saw to be positioned. Blade marked at 8" and installed. Set in position and verified, and start cut at rear opening. Pumps remain in operation along with fan provided and used by ██████████ personnel. Update log paperwork and prepare chain of custody form. Post calibration will be addressed. Vacuum used to collect liquid and debris at saw cut areas within garage.
- 1330: Start removal and packing of equipment and supplies. Retrieved area sample.
- 1430: Process and label collected samples. Complete paperwork and pack equipment.
- 1500: Load vehicle. Return to office.
- 1600: Post calibrate and address volume calculations and complete chain of custody.
- 1630: Deliver samples for transport to lab. Unpack equipment and file paperwork.

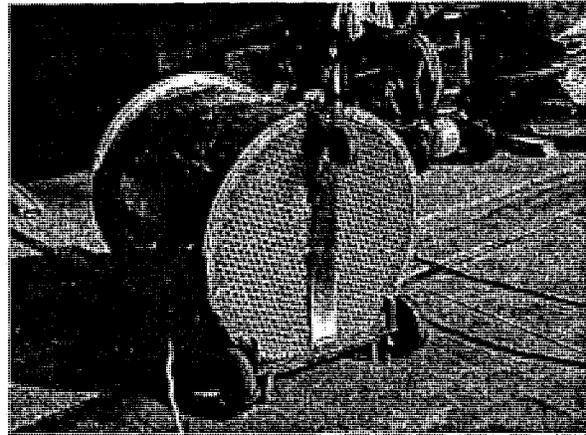
PROJECT ASSESSMENT PHOTOGRAPHS



JANUARY 25, 2017



Drill Holes for Saw Track Installation



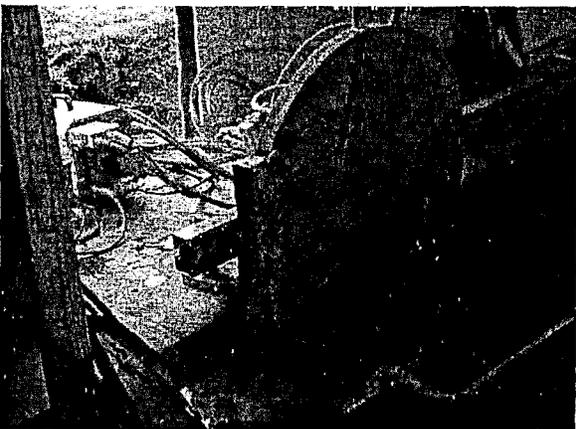
Air Mover Positioned at Garage



Initial Position of Track and Saw



Remote Saw Control and Water Application



Initial Cut and Use of Vacuum for Debris Collection

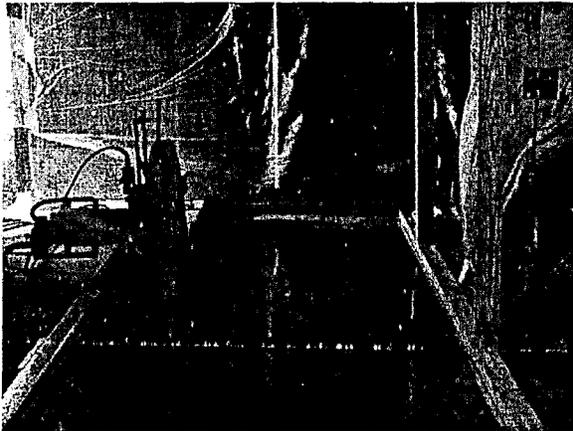


Continued Saw Operation for Initial Cut

PROJECT ASSESSMENT PHOTOGRAPHS



JANUARY 25, 2017



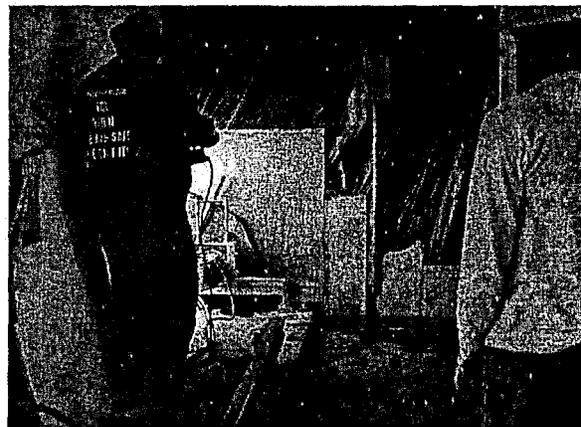
Saw Operation and Area Sample Position in Garage



Operator with Remote and Personal Sample



Assistant with Vacuum and Personal Sample



Second Saw Cut at Garage Perimeter