Appendix A

THE COHEN GROUP

REPORT OF FINDINGS

AIR MONITORING FOR RESPIRABLE DUST AND SILICA

WALL & CEILING CONFERENCE
5690 SONOMA DRIVE
PLEASANTON, CALIFORNIA

Project No. 17183

Survey Dates: October 10-11, November 30, and December 23, 2016
February 26, April 21, and August 25, 2017

Report Date: September 22, 2017

Prepared For: Wall & Ceiling Conference

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REPORT OF FINDINGS

AIR MONITORING FOR RESPIRABLE DUST AND SILICA

WALL & CEILING CONFERENCE 5690 SONOMA DRIVE PLEASANTON, CALIFORNIA

INTRODUCTION

The Cohen Group conducted air monitoring surveys in the San Francisco Bay Area on October 10 and 11, November 30, and December 23, 2016 as well as February 26, April 21, and August 2017. The surveys were conducted by Sarah Llanes and Dustin Christensen, MPH of The Cohen Group. The purpose of the surveys were to characterize and determine the extent of employee exposures to respirable particulates and silica during various drywall and plastering work activities and tasks.

The tasks selected for monitoring to determine respirable dust and silica exposure included:

1. Overhead drilling into metal pan and concrete decking during interior framing work
2. Cutting, rasping and hanging interior drywall
3. Hand and power sanding of joint compound and drywall
4. Use of a powered chop saw to cut metal framing
5. Mixing and hand application of exterior plaster
6. Laborer activities handling trade materials and cleaning up construction debris

The air-monitoring surveys presented in this report were conducted at the construction site of a new healthcare facility in the San Francisco Bay Area. The new facility will be three floors and cover over 200,000 square feet when complete. The drywall and plaster subcontractor for the new facility gave permission to The Cohen Group to perform air-monitoring during their employees work activities and to provide the air-monitoring results to the Wall & Ceiling Conference. Sampled tasks represent typical operations and work methods employed by other drywall contractors

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LIMITATIONS

The Cohen Group has prepared this report for the exclusive use of Wall & Ceiling Conference for this particular project. This report reflects conditions in existence at the jobsite on the survey dates. The findings are based on work site conditions and work activities at the time of the surveys and on information provided by Wall & Ceiling Conference employees and member companies. Findings are limited by the accuracy and precision of the sampling and analytical methodologies and instrumentation employed, as well as by the number of samples collected and the number of measurements taken. However, to the best of our knowledge, the findings constitute a reasonable and accurate assessment of potential worker exposures to airborne concentrations of respirable particulates and silica while performing monitored activities under the conditions encountered. No other representation, warranty or guarantee, expressed or implied, is included or intended.

Measured levels of airborne contaminants will vary during the course of and between individual days of project work. Some of the factors influencing airborne contaminant levels include engineering controls (such as exhaust ventilation), environmental conditions (such as temperature, humidity, wind speed, and direction), and the location and timing of individual measurements.

DESCRIPTION OF WORK ACTIVITIES MONITORED

Overhead Drilling into Concrete Decking

Personal and area air samples were collected over two work shifts (October 10 and December 23, 2016) while an apprentice and a journeyman used rotohammers to drill into the overhead metal pan concrete decking for the installation of soffit tracks as part of interior wall framing activities. The employees monitored used cordless rotary hammers with and without vacuum attachments (local exhaust ventilation). The monitored employees drilled three-eighth inch wide and 4-inch deep holes to install three-eighth inch anchor bolts into the overhead decking. The employees held the rotohammers and impact tools overhead while standing directly beneath the holes they were drilling as well as holding the tool out at arm's length away from their bodies while drilling overhead. The employees were working from scissor lifts in order to access the overhead decking on October 10th and were working on bench walks and scaffolding on December 23rd. When not performing overhead drilling, both workers were observed adjusting the scissor lift (i.e. height, angle, and location to work in), taking measurements, and tightening soffit tracks using hand tools. The work shifts were approximately 7:00AM to 3:00PM.

Two air samples were collected from each worker on each work shift. On October 10th one sample was collected for the full work shift and a second "worst-case" sample was collected on each worker during an approximate two-hour time period when the workers did continuous overhead drilling without taking breaks. On December 23rd sampling cassettes were positioned on the right shoulder and on the left shoulder of each worker in order to observe variation in sampling results depending on sample location. The local exhaust ventilation attachment on the

overhead drilling tools was not in use for the majority of the sampling period on October 10th but were in use the entire shift of December 23rd.

Both workers were observed wearing the following personal protective equipment: hard hat, safety glasses, safety colored clothing (i.e. vest), ear plugs (with a protection factor of 28 dB), N95 disposable particulate respirators, face shields, fall protection harnesses, work gloves, long pants, and work boots.

Interior Drywall Installation

Personal monitoring was conducted on eight workers during interior drywall installation activities on November 30, 2016. Monitoring was conducted from 7:00AM to 3:30PM of which interior drywall installation activities were performed between 7:30AM and 3:00PM.

Samples were collected from four journeymen who worked in two-man teams performing interior drywall installation and from four laborers who worked throughout the jobsite (indoors and outdoors). The laborers were observed performing work as a spotter/flagger for heavy equipment operators, moving metal materials, and sweeping general construction debris with the use of a sweeping compound, vacuuming dust from the previously installed tracks (using wet/dry vac), and applying foam fireproofing. According to the SDS for the drywall, the drywall contained less than six percent silica.

The interior drywall installation process observed can be described as follows:

1) Move drywall from materials pile to rock cart
2) Measure wall and drywall sheets
3) Cut drywall with a hand saw or utility knife and rasp the cut edges
4) Carry/hang drywall to designated spot before drilling into place
5) Cutting portions of hung drywall using a drywall router
6) Securing drywall to framing members with screw fasteners

Equipment, materials, and tools used by workers during the survey included: bench walks, scissor lifts, 12 foot by 4 foot and five-eighth inch thick drywall sheets, measuring tapes, cordless drywall guns with 1¼ inch screws, cordless power drills with 1½ inch rotor baits, hand sanders, hand saws, and box cutters.

Workers were observed wearing the following personal protective equipment: hard hat, safety glasses, safety colored clothing (i.e. vest), ear plugs (with a protection factor of 28 dB), N95 disposable particulate respirators, work gloves, long pants, and work boots.

Drywall Finishing/Sanding Joint Compound and Chopsaw Activities

Samples were collected on three workers sanding drywall joint compound and four workers performing chopsaw activities on February 16, 2017. On the date of the survey, work was

performed from 7:00AM to 3:30PM with set-up activities and safety meetings for the first 30 minutes of the day and clean-up activities taking up the last 45 minutes of the work shift. Sanding of dried joint compound on drywall walls was performed by the three tapers in 10 foot by 12-foot rooms. Sanding was continuous throughout the day. Initial sanding was performed by two of the tapers each using a pole sander and the third taper performed finish sanding using a power sander equipped with a vacuum hose attachment for local exhaust ventilation and angle sponges in areas where the power sander could not access. According to the SDS, the joint compound contained less than six percent silica.

Three journeyman framers and one apprentice worked in two-man teams to install metal framing for interior walls on the survey date. Grinder/chopsaws were used to cut metal framing. The framers were observed cutting and installing metal framing for interior walls, handling materials (i.e. passing/carrying materials to their partners) and taking measurements.

Workers were observed wearing the following personal protective equipment: hard hat, safety glasses, safety colored clothing (i.e. vest; framers), painters' whites (i.e. shirt, jeans; tapers), N95 particulate respirators (tapers), faceshields (framers), long pants, and work boots.

Exterior Plastering

Eight workers performing exterior plastering activities were observed and monitored on April 21, 2017. In addition, upwind and downwind area samples were collected near the plastering work. The scratch coat plaster mix consisted of a fiber base stucco product and a second material used to help ease the spread of the plaster. According to the SDS for the fiber base stucco product, the material contains 40 to 70% "sand, silica, quartz." The SDS for the second material lists silica content at less than six percent. On the survey date, the workers were mixing and hand applying the exterior plaster scratch coat to the penthouse on the roof of the new facility. The plaster scratch coat is the first layer of plaster applied to the exterior of the building. The mixing of the scratch coat plaster was performed outdoors on the roof and the plaster was hand applied by plasterers working on scaffolding. The monitored work day was from 7:00AM to 3:30PM of which exterior plastering activities were performed between 7:30AM and 2:45PM. The weather conditions were clear skies with no precipitation and no measurable wind.

Three hod carriers mixed and/or carried the scratch coat plaster to the plasterers. One hod carrier was observed mixing from 7:30AM to 10:45AM and a second hod carrier was observed mixing from 10:45AM to 2:45PM. Four plasterers performed exterior plastering application by hand-troweling on the plaster. One laborer assisted in materials handling for the plastering process.

The exterior plastering process observed can be described as follows:

1) Turn on the plaster/mortar mixer
2) Each batch of the scratch coat plaster contains six to eight, 80-pound sacks of the fiber base stucco material and one, 7-pound sack of the second material (sacks were opened using a pocketknife and dumped at the top of the mixer), and water (in that order).

3) Allow the materials to mix inside the mixer for 15 minutes with intermittent misting over the mixer using a water hose.
4) Pour mixed plaster scratch coat material from mixer into wheelbarrow.
5) Hod carrier delivered the stucco mixture via a wheelbarrow to each plasterer. The hod carrier then transferred the scratch coat plaster using a shovel directly onto the mudboard or placed the plaster in a 5-gallon bucket which was then hoisted by a rope pully to upper levels of scaffolding.
6) Plasterer obtains mixture from mudboard via hawk and trowel and applies onto wall.
7) After stucco mixture has been evenly applied onto the wall, a "scratcher" is used to create grooves for the scratch coat.
8) A margin trowel is used to even the coat in tight spaces.
9) The laborer assisting in the plastering process moved sacks of stucco from the ground level to the roof.

Equipment, materials, and tools used included: plaster/mortar mixer, water hose, fiber base stucco material, second bagged material to ease the spread of stucco, shovel, pulley, 5-gallon empty bucket, wheel barrow, hawk, trowel, scratcher, margin trowel, pocket knife, and mudboard.

On August 25th three workers were performing mixing and application of the exterior scratch coat on the south exterior wall of the medical facility using the same methods as described above. The plastering work occurred from approximately 7:30AM until 2:00 PM. The plastering crew consisted of one hod carrier who mixed the plaster and carried it to the two plasterers who were working on scaffolding. The weather conditions were clear skies with no precipitation and no measurable wind.

Workers were observed wearing the following personal protective equipment: hard hat, safety glasses, safety colored clothing (i.e. vest; hod carriers), painters' whites (i.e. shirt, jeans; plasterers), faceshield and N95 particulate respirator (worn by the hod carriers when loading materials into the mixer), long pants, and work boots.

MONITORING METHODS

Air Monitoring

Personal and area air sampling for respirable particulates/silica was conducted using three-stage, matched-weight, 37-millimeter diameter, 5 µm pore size PVC membrane filters contained in plastic sampling cassettes fitted with SKC respirable dust (size-selective) aluminum cyclones. The cyclone separates sampled dust particles according to size so that respirable particles (10 microns and smaller) in the sampled air stream will collect on the filter. The sampling media was connected with Tygon tubing to calibrated, battery-operated personal sampling pumps.

Sampling air flow rates were set prior to and checked after monitoring to ensure consistent operation. Sample air volumes were calculated from the average measured flow rate and the duration of the sampling period. The sampling pumps were calibrated at a flowrate of approximately 2.5 liters of sampled air per minute (lpm) and the flowrate was confirmed at the end of the sampling period. Calibration was conducted with a TSI mass flow meter.

During personal sampling, the filter cassettes were attached to the worker's shirt at the shoulder (in the worker's breathing zone). During area sampling, the filter cassettes were positioned at a fixed location within the work area (at approximate breathing zone level, i.e., about 4.5 to five feet above the working surface). Full-shift air monitoring was conducted. In addition, "worst case" personal air samples for respirable particulates and silica were collected for a duration of time shorter than full-shift during overhead drilling activities.

Following sampling, the filter cassettes were sealed, labeled with a unique identifier and sent by courier to an independent American Industrial Hygiene Association-accredited laboratory. The samples were analyzed by National Institute for Occupational Safety and Health (NIOSH) Method 7500 (respirable silica) and Method 0600 (respirable particulates). Silica was analyzed by x-ray diffraction (XRD) and particulates were analyzed by gravimetric means.

Average airborne concentrations were calculated for each sample using the quantity of contaminant detected by the laboratory and the air volume collected for each sample during the survey.

REGULATORY STANDARDS

Airborne Exposure Limits

Under Title 8 CCR 5155, the California Occupational Safety and Health Administration (Cal/OSHA) has established Permissible Exposure Limits (PELs) for employee exposures to airborne contaminants based on an 8-hour, time weighted average exposure. PELs are set at levels where it is believed that nearly all workers can be repeatedly exposed 8-hours a day, 40 hours per week for a working lifetime without adverse health effects.

PEL values are typically expressed as an 8-hour time-weighted average (8-hour TWA); that is, an average airborne concentration for an 8-hour work day. If exposures are found to be in excess of the Cal/OSHA PEL, then the employer is required to implement control measures to reduce the exposures.

The Cal/OSHA PEL is 5 mg/m^3 for respirable particulates (not otherwise regulated) and 0.05 mg/m^3 for the respirable fraction of crystalline silica (quartz). Cal/OSHA has established an Action Level for respirable crystalline silica (quartz) at 0.025 mg/m^3. The Cal/OSHA PELs are the same as the newly adopted Fed/OSHA PELs for Silica in Construction standard.

FINDINGS

Results of the air monitoring are shown in more detail in the tables below but are summarized as follows:

Overhead Drilling in Concrete / Interior Wall Framing

Survey Date: October 10, 2016

- The two employees monitored each wore two sampling trains with one sample on each shoulder. One sample was a full-shift sample and the other was a shorter duration worst-case sample which was collected during an approximately two-hour period when the workers did not take any breaks. The vacuum exhaust attachment for the rotohammers were not in use for most of the sampling period.
- Sample results in mg/m^3 for respirable particulates for full-shift samples were 0.82 for the journeyman and 5.5 for the apprentice. During two-hour sampling under worst-case conditions, results were 0.62 for the apprentice and 5.2 for the journeyman. The full-shift sample results for the journeyman and the worst-case sample results for the apprentice were above the applicable Cal/OSHA PEL with the other sample results below the PEL.
- Sample results in mg/m^3 for respirable silica (quartz) for full-shift samples were 0.11 for the journeyman and 0.39 for the apprentice and 0.058 for the apprentice and 0.47 for the journeyman for the worst-case samples. All sample results were above the Cal/OSHA PEL and Action Level for respirable silica (quartz).

Survey Date: December 23, 2016

- The two employees monitored each wore two sampling trains with one sample on each shoulder in order to measure the variation in airborne concentration across the workers body. In addition, two area samples were collected. The vacuum exhaust attachment for the rotohammers was in use throughout the sampling period.
- Sample results in mg/m^3 for respirable particulates ranged from <0.023 to 1.2. All samples collected were below the applicable Cal/OSHA PEL for respirable particulates.
- Sample results in mg/m^3 for respirable silica (quartz) ranged from <0.011 to 0.094. The sample results from both shoulders of apprentice #1 were above the applicable Cal/OSHA Action Level but only the sample from the right shoulder was also above the Cal/OSHA PEL. The area sample results and sample results from both shoulders of apprentice #2 were below the applicable Cal/OSHA PEL and Action Level for respirable silica (quartz). The difference in sample results was likely due to the continued use of local exhaust ventilation on the rotohammers during the second sampling survey.

Interior Drywall Hanging/Installation

Survey Date: November 30, 2016

- Sample results in mg/m^3 for respirable particulates ranged from 0.15 to 1.0. All samples collected were below the applicable Cal/OSHA PEL for respirable particulates.
- Sample results in mg/m^3 for respirable silica (quartz) ranged from <0.0093 to 0.018. Silica (quartz) was detected above the laboratory limit of detection in just two of eight samples. All samples collected were below the applicable Cal/OSHA PEL and Action Level for respirable silica (quartz).

Sanding Joint Compound and Interior Wall Framing

Survey Date: February 16, 2017

- Sample results in mg/m^3 for respirable particulates ranged from 0.25 to 2.7. All samples collected were below the applicable Cal/OSHA PEL for respirable particulates.
- Sample results in mg/m^3 for respirable silica (quartz) ranged from <0.0090 to 0.018. All samples collected were below the applicable Cal/OSHA PEL and Action Level for respirable silica (quartz).

Mixing and Hand Application of Exterior Plaster

Survey Date: April 21, 2017

- Sample results in mg/m^3 for respirable particulates ranged from <0.050 to 5.4. All but one of the samples collected were below the applicable Cal/OSHA PEL for respirable particulates. The sample collected from one of the hod carriers who performed plaster mixing was above the applicable PEL, however, the second hod carrier who also performed mixing of plaster showed sample results well below the PEL.
- Sample results in mg/m^3 for respirable silica (quartz) ranged from <0.0086 to 0.025. All samples collected were below the applicable Cal/OSHA PEL and all but one sample collected was below the Cal/OSHA Action Level for respirable silica (quartz). A sample collected from one hod carrier showed results of 0.025 or concentration at the Cal/OSHA Action Level.

Survey Date: August 25, 2017

- Sample results in mg/m^3 for respirable particulates ranged from 0.085 to 1.5. All samples collected were below the applicable Cal/OSHA PEL for respirable particulates.
- Sample results in mg/m^3 for respirable silica (quartz) ranged from <0.0057 to 0.014. All samples collected were below the applicable Cal/OSHA PEL and Action Level for respirable silica (quartz).

CONCLUSIONS

1) There was a significant difference in respirable particulates from the first day (October 10) of overhead drilling to the second day (December 23) of overhead drilling. The vacuum attachment on the rotohammer was used on both sampling dates, with the exception of tight spaces (i.e. in between two studs) as encountered during the first overhead drilling date. The differences in concentrations collected from the same breathing zone indicate how handedness (i.e. worker being left-handed or right-handed), position of the drill over the worker, and worst-case (in which the worker's tasks likely produces the greatest exposure) may greatly affect where the concrete debris generated from the overhead drilling falls and the concentration of dust or silica exposure which the worker may potentially experience. That is a right-handed worker would likely have greatest exposure on the right side of the body as opposed to the left.

2) Results from respirable particulate sampling demonstrate that the Cal/OSHA PEL was exceeded for workers involved in overhead drilling and for one hod carrier involved in mixing exterior plaster. However, the sample results for the other hod carrier who performed nearly equal amounts of plaster mixing on the same survey date showed result concentrations well below the PEL. In addition, follow-up sampling of plaster mixing on a second survey date showed a result concentration well below the PEL. This wide variance in sample results may possibly be due to sample placement, a change in work methods such as using less water to suppress dust or possibly sample contamination. The sampling performed on both shoulders during overhead drilling showed that sample placement on the body can result in a significant difference in result concentrations due to concrete debris falling onto the worker or sample location.

3) Results from respirable silica sampling demonstrate that the Cal/OSHA PEL and Action Level was exceeded for workers involved in overhead drilling. Results from one hod carrier mixing plaster showed results at the Cal/OSHA Action Level. However, this sample result (for the hod carrier) did not include the approximate 30 minutes at the start of the shift when the crew did stretching and safety training which, if taken into account, reduces the workers TWA exposure concentration to below the Action Level. In addition, follow-up sampling showed concentrations from mixing exterior plaster outdoors to be below the PEL and Action Level.

4) Results from our sampling survey demonstrate that workers performing interior wall framing (excluding overhead drilling), hanging and sanding of drywall and joint compound, and hand application of exterior plaster are not exposed to respirable dust above the applicable Cal/OSHA PEL or to respirable silica above the Cal/OSHA PEL or Action Level.

RECOMMENDATIONS

1) Additional engineering controls such as water-spray or local exhaust ventilation attached to the equipment should be explored in order to reduce exposures to workers performing overhead drilling with the goal of bringing exposure concentrations below applicable PELs and Action Levels.

2) Air monitoring for particulate matter (including silica) should be repeated periodically to maintain documentation of workplace conditions and whenever a change in operating conditions may result in a significant change in employee exposure levels. Workplace evaluations should be conducted to determine potential operations or tasks where elevated dust levels may be found such as maintenance activities, clean-up operations, or during other work tasks.

3) With regards to workers who exceeded the action level to the new Cal/OSHA silica standard, new requirements that need to be met include: repeat monitoring within six months of the most recent monitoring for employee exposures at or above the AL but at or below the PEL; repeat monitoring within three months of the most recent monitoring for employee exposures above the PEL; and reassess exposures whenever there is a change in the work activities. A written Silica Exposure Control plan should be prepared in order to address employees potential exposures to silica.

4) We recommend performing additional air monitoring for workers performing plaster mixing and overhead drilling into concrete in order to obtain a larger data set to better understand exposure concentrations experienced by those workers. If possible, perform air monitoring with sampling cassettes attached to both shoulders of each worker to better identify the variance in result concentrations across the workers body.

5) We recommend performing air monitoring surveys for respirable dust and silica during plaster mixing if performed indoors and plaster application when performed using a spray-gun and pump.

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Table 1A
Overhead Drilling into Concrete / Interior Framing
Collected/Sampled on: October 10, 2016

Sample Location	Duration (minutes)	Volume (liters)	Percent Quartz	Percent Cristobalite	Percent Tridymite	Respirable Particulates (not otherwise regulated)	Respirable Crystalline Silica (Quartz)	Respirable Crystalline Silica (Cristobalite)	Respirable Crystalline Silica (Tridymite)
						Concentration (mg/m^3)	Concentration (mg/m^3)	Concentration (mg/m^3)	Concentration (mg/m^3)
Personal Carpenter Apprentice Full-shift	390	958.8	7.2	<0.38	<0.38	5.5	0.39	<0.021	<0.021
Personal Journeyman Full-shift	384	855.9	13.0	<2.8	<2.8	0.82	0.11	<0.023	<0.023
Personal Carpenter Apprentice Worse-case	168	427.6	9.4	<7.6	<7.6	0.62	0.058	<0.047	<0.047
Personal Journeyman Worse-case	169	423.6	9.0	<0.91	<0.91	5.2	0.47	<0.047	<0.047
Cal/OSHA 8-Hour TWA Permissible Exposure Limits						5	0.05	0.05	0.05
Cal/OSHA Action Level						NE	0.025	NE	NE

Table 1A Notes:

- "<" indicates "less than"
- NE indicates Not Established
- Representative field blank samples were submitted to the lab with results below the laboratory limit of detection.

Table 1B
Overhead Drilling into Concrete / Interior Framing
Collected/Sampled on: October 10, 2016

Sample Location	Duration (minutes)	Volume (liters)	Percent Quartz	Percent Cristobalite	Percent Tridymite	Respirable Particulates (not otherwise regulated)	Respirable Crystalline Silica (Quartz)	Respirable Crystalline Silica (Cristobalite)	Respirable Crystalline Silica (Tridymite)
						Concentration (mg/m^3)	Concentration (mg/m^3)	Concentration (mg/m^3)	Concentration (mg/m^3)
Person 1/Apprentice *5.5 hour shift* ** left lapel*	339	866.8	(6.9)	<5.3	<5.3	0.44	(0.030)	<0.023	<0.023
Person 1/Apprentice *5.5 hour shift* ** right lapel*	339	847.5	7.6	<1.9	<1.9	1.2	0.094	<0.024	<0.024
Area SE Scaffold *5.5 hour shift*	339	836.0	<35	<69	<69	0.035	<0.012	<0.024	<0.024
Person 2/Apprentice *5.5 hour shift* ** right lapel*	338	852.1	<5.1	<10	<10	0.23	<0.012	<0.023	<0.023
Personal 2/Apprentice ** left lapel*	338	847.2	<4.8	<9.7	<9.7	0.24	<0.012	<0.024	<0.024
Area NE Scaffold *5.5 hour shift*	338	869.8	NE	NE	NE	<0.023	<0.011	<0.023	<0.023
Cal/OSHA 8-Hour TWA Permissible Exposure Limits						5	0.05	0.05	0.05
Cal/OSHA Action Level						NE	0.025	NE	NE

Table 1A Notes:

- "<" indicates "less than"
- "( )" indicates this testing result is between the LOD and LOQ and has higher analytical uncertainty than values at or above the LOQ.
- "NE" indicates "Not Established"
- Representative field blank samples were submitted to the lab with results below the laboratory limit of detection.

Table 2
Interior Drywall Hanging/Installation
Collected/Sampled on: November 30, 2016

Sample Location	Duration (minutes)	Volume (liters)	Percent Quartz	Percent Cristobalite	Percent Tridymite	Respirable Particulates (not otherwise regulated)	Respirable Crystalline Silica (Quartz)	Respirable Crystalline Silica (Cristobalite)	Respirable Crystalline Silica (Tridymite)
						Concentration (mg/m^3)	Concentration (mg/m^3)	Concentration (mg/m^3)	Concentration (mg/m^3)
Personal Journeyman	414	935.0	(2.0)	<2.4	<2.4	0.90	(0.018)	<0.021	<0.021
Personal Journeyman	418	1070.7	<0.90	<1.8	<1.8	1.0	<0.0093	<0.019	<0.019
Personal Journeyman	405	1057.5	<1.2	<2.4	<2.4	0.77	<0.0095	<0.019	<0.019
Personal Journeyman	406	1007.3	<1.2	<2.3	<2.3	0.85	<0.0099	<0.020	<0.020
Personal Laborer	401	1016.9	<12	<23	<23	0.085	<0.0098	<0.020	<0.020
Personal Laborer	408	1024.7	(1.6)	<2.4	<2.4	0.81	(0.013)	<0.020	<0.020
Personal Laborer	409	1025.4	<6.5	<13	<13	0.15	<0.0098	<0.020	<0.020
Personal Laborer	409	1036.2	<3.8	<7.7	<7.7	0.25	<0.0097	<0.019	<0.019
Cal/OSHA 8-Hour TWA Permissible Exposure Limits						5	0.05	0.05	0.05
Cal/OSHA Action Level						NE	0.025	NE	NE

Table 2 Notes:

- "<" indicates "less than"
- "( )" indicates this testing result is between the LOD and LOQ and has higher analytical uncertainty than values at or above the LOQ.
- "NE" indicates "Not Established"
- Representative field blank samples were submitted to the lab with results below the laboratory limit of detection.

Table 3
Drywall Finishing/Sanding Joint Compound/Cutting and Installing Interior Metal Framing
Collected/Sampled on: February 16, 2017

Sample Location	Duration (minutes)	Volume (liters)	Percent Quartz	Percent Cristobalite	Percent Tridymite	Respirable Particulates (not otherwise regulated)	Respirable Crystalline Silica (Quartz)	Respirable Crystalline Silica (Cristobalite)	Respirable Crystalline Silica (Tridymite)
						Concentration (mg/m^3)	Concentration (mg/m^3)	Concentration (mg/m^3)	Concentration (mg/m^3)
Personal-Framer	467	1156.29	(1.9)	<2.3	<2.3	0.76	(0.015)	<0.017	<0.017
Personal-Framer	318	786.73	<4.3	<8.6	<8.6	0.29	<0.013	<0.025	<0.025
Personal-Framer	437	1115.44	<3.6	<7.3	<7.3	0.25	<0.0090	<0.018	<0.018
Personal-Apprentice Framer	431	993.02	<1.7	<3.4	<3.4	0.59	<0.010	<0.020	<0.020
Personal-Taper using power sander	351	900.84	(1.4)	<1.8	<1.8	1.2	(0.018)	<0.022	<0.022
Personal-Taper using pole sander	435	1140.35	(1.1)	<1.3	<1.3	1.4	(0.015)	<0.018	<0.018
Personal-Taper using pole sander	438	1108.58	(0.57)	<0.67	<0.67	2.7	(0.015)	<0.018	<0.018
Cal/OSHA 8-Hour TWA Permissible Exposure Limits						5	0.05	0.05	0.05
Cal/OSHA Action Level						NE	0.025	NE	NE

Table 3 Notes:

- "<" indicates "less than"
- "( )" indicates this testing result is between the LOD and LOQ and has higher analytical uncertainty than values at or above the LOQ.
- "NE" indicates "Not Established"
- Representative field blank samples were submitted to the lab with results below the laboratory limit of detection.

Table 4A
Mixing and Hand Application of Exterior Plaster
Collected/Sampled on: April 21, 2017

Sample Location	Duration (minutes)	Volume (liters)	Percent Quartz	Percent Cristobalite	Percent Tridymite	Respirable Particulates (not otherwise regulated)	Respirable Crystalline Silica (Quartz)	Respirable Crystalline Silica (Cristobalite)	Respirable Crystalline Silica (Tridymite)
						Concentration (mg/m^3)	Concentration (mg/m^3)	Concentration (mg/m^3)	Concentration (mg/m^3)
Personal -Hod Carrier (Mixed Plaster)	417	1098.38	(1.6)	<1.2	<1.2	1.5	(0.024)	<0.018	<0.018
Personal-Hod Carrier (Mixed Plaster)	458	1171.56	0.46	<0.31	<0.31	5.4	0.025	<0.017	<0.017
Personal-Hod Carrier	460	921.84	(2.3)	<3.3	<3.3	0.67	(0.015)	<0.022	<0.022
Personal-Plasterer	456	1139.77	<3.4	<6.7	<6.7	0.26	<0.0088	<0.018	<0.018
Personal-Plasterer	460	1161.04	(5.3)	<8.7	<8.7	0.20	(0.010)	<0.017	<0.017
Personal-Laborer	454	1150.21	<2.7	<5.3	<5.3	0.33	<0.0087	<0.017	<0.017
Personal-Foreman Plasterer	476	1266.87	<2.3	<4.6	<4.6	0.35	<0.0079	<0.016	<0.016
Personal-Plasterer	467	1176.37	(2.9)	<3.6	<3.6	0.47	(0.014)	<0.017	<0.017
Area - 10ft E of Mixer -Downwind	442	1088.65	<5.0	<10	<10	0.18	<0.0092	<0.018	<0.018
Area-10ft N of Mixer -Upwind	442	1161.80	<13	<27	<27	0.065	<0.0086	<0.017	<0.017
Area-10ft E of NE Wall / Moved @ 12:46PM 10ft S of S End	439	1106.28	<19	<39	<39	0.047	<0.0090	<0.018	<0.018
Area-10ft E of SE Wall	149	397.31	NA	NA	NA	<0.050	<0.025	<0.050	<0.050
Cal/OSHA 8-Hour TWA Permissible Exposure Limits						5	0.05	0.05	0.05
Cal/OSHA Action Level						NE	0.025	NE	NE

Table 4A Notes:

- "<" indicates "less than"
- "( )" indicates this testing result is between the LOD and LOQ and has higher analytical uncertainty than values at or above the LOQ.
- "NE" indicates "Not Established"
- "NA" indicates "Not Applicable"
- Representative field blank samples were submitted to the lab with results below the laboratory limit of detection.

Table 4B
Mixing and Hand Application of Exterior Plaster
Collected/Sampled on: August 25, 2017

Sample Location	Duration (minutes)	Volume (liters)	Percent Quartz	Percent Cristobalite	Percent Tridymite	Respirable Particulates (not otherwise regulated	Respirable Silica (Quartz)	Respirable Silica (Cristobalite)	Respirable Silica (Tridymite)
						Concentration (mg/m^3)	Concentration (mg/m^3)	Concentration (mg/m^3)	Concentration (mg/m^3)
Personal-Hod-Carrier (Mixed Plaster)	390	982.8	0.89	<0.34	<2.1	1.5	0.013	<0.0051	<0.031
Personal-Plasterer	364	928.2	1.3	<0.51	<3.1	1.1	0.014	<0.0054	<0.032
Personal-Plasterer	387	971.4	<1.0	<1.0	<6.1	0.51	<0.0051	<0.0051	<0.031
Area – 15 feet west of mixer	351	881.0	<6.7	<6.7	<40	0.085	<0.0057	<0.0057	<0.034
Area – One foot above mixer	354	881.5	1.0	<0.71	<4.3	0.80	0.0082	<0.0057	<0.034
Area – five feet east of mixer	246	620.0	<8.6	<8.6	<52	0.094	<0.0081	<0.0081	<0.048
Cal/OSHA 8-Hour TWA Permissible Exposure Limits						5	0.05	0.05	0.05
Cal/OSHA Action Level						NE	0.025	NE	NE

Table 4B Notes:

- "<" indicates "less than"
- "( )" indicates this testing result is between the LOD and LOQ and has higher analytical uncertainty than values at or above the LOQ.
- "NE" indicates "Not Established"
- Representative field blank samples were submitted to the lab with results below the laboratory limit of detection.

Air Monitoring Strategy and Protocols
September 22, 2017
Prepared by Dustin Christensen, MPH and Tim Bormann, CIH, FAIHA of The Cohen Group

INTRODUCTION

The purpose of this appendix is to provide a brief overview of the purpose, methods and strategies of air monitoring. Air samples provide a means of estimating average airborne contaminant concentrations during the monitored period. There are two basic approaches to air monitoring: personal and area sampling. In personal sampling, the sample collection media is attached to the worker and positioned in the person's breathing zone (e.g., attached to clothing at the shoulder). In area sampling, the sample collection media is positioned at a fixed location within the work area (generally at approximate breathing zone level, i.e., about 4.5 feet above the working surface. Personal samples allow estimation of average personal exposure during the sampled interval, while area samples allow estimation of the average concentration in a given location during the sampled interval. Both personal (at the shoulder) and area (fixed location) air samples are helpful in assessing employee exposures, however, Cal/OSHA requires that personal sampling be conducted to evaluate potential worker exposures to airborne contaminants such as silica. Cal/OSHA regulates occupational exposures to respirable silica in construction in Title 8 California Code of Regulations Section 1532.3 (8 CCR 1532.3) and in dust generating activities involving concrete and masonry materials in 8 CCR 1530.1.

Cal/OSHA requires that "the employer shall ensure that no employee is exposed to an airborne concentration of respirable crystalline silica in excess of 0.05 milligrams per cubic meter of air (mg/m^3) based on an 8-hour time weighted average (See Regulatory Standards section below). Employers are required to assess the exposure of each employee who is or may reasonably be expected to be exposed to respirable silica at or above the action level of 0.025 mg/m^3 by 1) assessing exposure on the basis of air monitoring data or objective data or 2) performing personal breathing zone air sampling that reflect the exposures of employees on each shift, for each job classification, and in each work area. Objective Data means information, such as air monitoring data from industry-wide surveys or calculations based on the composition of a substance, demonstrating employee exposure to respirable crystalline silica associated with a particular product or material or a specific process, task, or activity. The data must reflect workplace conditions closely resembling or with a higher exposure potential than the processes, types of material, control methods, work practices, and environmental conditions in the employer's current operations.

SELECTION OF EMPLOYEES TO SAMPLE

First step in performing an air monitoring survey for silica is to identify employees or job tasks that may result in silica exposures above the action level. Employees or job tasks with the highest potential exposure risk should be placed in highest priority for sampling. Then select a representative number of employees for each job classification on each shift and in each work area. The more employees you monitor the more robust the data, however, cost and time may be prohibitive.

AIR-MONITORING METHODS

Personal and area air sampling for respirable particulates/silica is conducted using three-stage, matched-weight, 37-millimeter diameter, 5 µm pore size PVC membrane filters contained in plastic sampling cassettes fitted with SKC respirable dust (size-selective) aluminum cyclones. The cyclone separates sampled dust particles according to size so that respirable particles (10 microns and smaller) in the sampled air stream will collect on the filter. The sampling media is connected with Tygon tubing to calibrated, battery-operated personal sampling pumps (sampling train). As an alternative to aluminum cyclones, SKC has developed Parallel Particulate Impactor (PPI) samplers which are simpler to use than the traditional cyclones. PPI samplers are impaction-based filter samplers that perform precise size-selection for respirable dust.

Sampling air flow rates are set prior to and checked after monitoring to ensure consistent operation and flow rates. The sampling train and pumps should be checked regularly throughout the survey to ensure proper collection. Sample air volumes are calculated from the average measured flow rate and the duration of the sampling period. The sampling pumps must be calibrated at a flowrate of approximately 2.5 liters of sampled air per minute (lpm) when using aluminum cyclones or 2.0 lpm when using PPI samplers.

Following sampling, seal the sampling cassette and label it with a unique identifier. Samples should be hand delivered to the laboratory for analysis or sent by courier to an independent American Industrial Hygiene Association-accredited laboratory. Samples are analyzed by National Institute for Occupational Safety and Health (NIOSH) Method 7500 (respirable silica) and Method 0600 (respirable particulates). Silica is analyzed by x-ray diffraction (XRD) and particulates are analyzed by gravimetric means. Average airborne concentrations are calculated for each sample using the quantity of particulate and silica detected by the laboratory and the air volume collected for each sample during the survey.

It is important to take detailed notes on environmental (indoor vs. outdoor, weather conditions, ventilation, etc) and workplace conditions, materials used, engineering controls (such as HEPA vacuums), personal protective equipment, and any work taking place adjacent to or in the area where you are performing the survey. An air-monitoring data form is found below. The form should be filled out completely during each sampling survey.

REGULATORY STANDARDS

Airborne Exposure Limits

Under Title 8 CCR 5155, the California Occupational Safety and Health Administration (Cal/OSHA) has established Permissible Exposure Limits (PELs) for employee exposures to airborne contaminants based on an 8-hour, time weighted average exposure. In addition to the Cal/OSHA exposure limits, the American Conference of Governmental Industrial Hygienists (ACGIH) have established Threshold Limit Values (TLVs) which are recommended guidelines to assist in the control of health hazards and are not regulatory standards. Both PELs and TLVs are set at levels where it is believed that nearly all workers can be repeatedly exposed 8-hours a day, 40 hours per week for a working lifetime without adverse health effects.

TLV and PEL values are typically expressed as an 8-hour time-weighted average (8-hour TWA); that is, an average airborne concentration for an 8-hour work day. If exposures are found to be in excess of the Cal/OSHA PEL, then the employer is required to implement control measures to reduce the exposures. In addition, Cal/OSHA has established an 8-hour TWA Action Level for silica which requires to take specific actions if their employees are exposed to silica above the Action Level.

The Cal/OSHA PEL is 5 mg/m^3 for respirable particulates (not otherwise regulated) and 0.05 mg/m^3 for the respirable fraction of crystalline silica (quartz). Cal/OSHA has established an Action Level for respirable crystalline silica (quartz) at 0.025 mg/m^3. The ACGIH TLV is 3 mg/m^3 for respirable particulates and 0.025 mg/m^3 for respirable silica (quartz).

AIR MONITORING DATA FORM

Company: _____ Work Site / Project: _____ Date: _____

Contaminant(s): _____

Method(s) / Media: _____

Sample No. / Media No.	Pump No.	Calibration (lpm)			Worker / Location / Activity (Basic Information)	Time On	Time Off	Total Time (min)	Sample Volume (liters)	Sampling Notes (Pump issues, etc.)
		Pre	Post	Ave						

Sample No. / Media No.	Worker / Location / Activity (Basic Information)	Details of Activity, Conditions, Equipment, Work Practices, PPE, etc.

General notes (work site conditions, weather, etc.):

_____

_____

_____

Samples collected by: _____ _____

(print) (signature)

Current Sampling Data for Silica

September 22, 2017

Created by Dustin Christensen, MPH and Tim Bormann, CIH, FAIHA of The Cohen Group

1. Work Task: Cutting of concrete floor tile with bandsaw

   July 18, 2017 - by Forensic Analytical Consulting Services

   - Results: Simulation study of workers using band saws equipped with HEPA vacuum to cut concrete floor tile. Four workers sampled. Two of four personal samples above PEL at 0.13 and 0.24 mg/m^3. Two area samples above PEL at 0.19 and 0.35 mg/m^3.

2. Work Task: Cutting drywall

   June 3, 2014 - "Evaluation of Airborne Releases from Cutting Gypsum Drywall Using Various Cutting Methods in a Controlled Environment" by RJ Lee Group

   - Results: No measurable levels of respirable silica (126 samples). All levels were below minimum detection limits for silica. Simulation study cutting ½-inch thick gypsum based drywall obtained from seven different USG plants. Samples collected over two-hour time period. One personal sample and two area samples per cutting method. Cutting methods evaluated included score, snap and rasp, rotary saw, and circular saw.

3. Work Task: Overhead drilling into concrete decking

   October 10 and December 23, 2016 by The Cohen Group

   - Results: Two personal samples were above Action Level, PEL and TLV on first day of sampling. Local exhaust ventilation not in use for most of the survey on the first day. On second day of sampling local exhaust ventilation in use and samples collected from one worker were above the Action Limit, PEL, and TLV. On each sampling date, the two workers were fitted with two sampling cassettes. One on each shoulder. Note: Based on limited sampling data, this task may yield sampling results at or above the Cal/OSHA PEL and AL and therefore controls should be implemented.

4. Work Task: Cutting, rasping and hanging drywall

   November 20, 2016 by The Cohen Group

   - Results: Four personal samples on journeyman drywallers and four personal samples on laborers cleaning up general construction debris during the drywall work. All samples were below the PEL, Action Limit and TLV. Joint compound was Westpac brand with <5% or <2% silica as an impurity of other ingredients. Drywall was USG gypsum board.

5. Work Task: Drywall finishing, sanding joint compound, cutting and installing metal framing

February 26, 2017 by The Cohen Group

- Results: Four personal samples from workers installing framing and three tapers sanding joint compound. Two tapers were using pole sanders and one taper was using a power sander equipped with local exhaust ventilation. All sample results were below the PEL, Action Level, and TLV. Joint compound was Westpac brand with <5% or <2% silica as an impurity of other ingredients. Drywall was USG with no silica content.

6. Work Task: Hanging drywall using a router in an enclosed room

   May 24, 2017 by The Hartford

   - Results: Both personal sample results were below the PEL and Action Level. Silica content of drywall was less than 0.18%. A router was used to cut the drywall.

7. Work Task: Mixing and spraying monokote fireproofing

   May 24, 2017 by The Hartford

   - Results: Four-hour samples during mixing and spraying of monokote fireproofing inside a building. All three personal sample results were below the PEL and Action Level.

8. June 21, 2017 by The Hartford

   Work Task: Mixing and spraying monokote fireproofing

   - Results: All three personal samples were below the PEL and Action Level. Samples were collected for approximately 6.5 hours. Work was performed indoors.

Current gaps in data where additional sampling should be conducted:

1. Exterior plaster stucco application by pump and gun (no data)
2. Interior plaster mixing and application by pump and gun or by hand (no data)
3. Drilling into concrete walls or floors during wall framing (no data)
4. Mixing, application and cleanup of fireproofing
5. Cleanup of dried stucco or plaster material overspray

Additional sampling with additional controls should be conducted for the following tasks where sampling data approached or exceeded the Cal/OSHA action limit and/or permissible exposure limit:

1. Cutting concrete floor tiles
2. Overhead drilling into concrete decking
3. Hod carrier – mixing exterior plaster

Construction Task or Equipment Operation	Engineering and Work Practice Control Method or Conditions Monitored	Respirable Dust PEL Exceeded?	Respirable Silica PEL Exceeded?	Respirable Silica Action Level Exceeded?
Cutting concrete floor tiles	Bandsaw equipped with HEPA vacuum (simulation study)	Yes in 1 of 4 personal samples and 2 area samples.	Yes in 2 of 4 personal samples and two area samples	Yes
Cutting USG Drywall	Cut USG drywall using score, snap, rasp, rotary saw, and circular saw. No local exhaust ventilation	No	No – no silica detected in any of 126 samples.	No
Overhead drilling into concrete decking (interior wall framing)	Using rotohammer without local exhaust ventilation attachment for most of the work day.	Yes in 2 of 4 personal samples.	Yes in 4 of 4 personal samples.	Yes in 4 of 4 personal samples.
Overhead drilling into concrete decking (interior wall framing)	Using rotohammer with local exhaust ventilation	No	Yes in 1 of 4 personal samples.	Yes in 2 of 4 personal samples.
Cutting and hanging drywall	Hand saws and power drills	No	No	No
Laborers during interior drywall installation	Sweeping, vacuuming, cleaning up construction debris	No	No	No
Cutting and installing metal wall framing	Using a power chopsaw to cut metal framing and drywall	No	No	No
Drywall finishing / sanding joint compound	Hand sanding with pole sander and power sanding with sander equipped with local exhaust ventilation	No	No	No
Hod carrier - mixing exterior plaster	Performed outdoors using power mixer. Little to no wind.	Yes on 1 of 3 personal samples	No	Yes on 1 of 3 personal samples
Plasterer – hand application (by trowel) of scratch plaster coat	Performed outdoors with little to no wind.	No	No	No
Mixing and Spraying monokote fireproofing	Performed indoors. Workers wore N95 dust masks. Six samples were collected over two sampling days.	No	No	No