AIR SAMPLING

TO MEET THE U.S. OSHA FINAL RULE ON RESPIRABLE CRYSTALLINE SILICA

WHAT'S THE BIG DEAL ABOUT SILICA?

The extremely small respirable silica particles can get deep into the lung producing serious health effects:

- Lung disease including silicosis, tuberculosis, and cancer
- Kidney disease
- Lupus and rheumatoid arthritis

WHAT'S THE BIG DEAL
ABOUT THE 2016 OSHA STANDARD FOR SILICA?

- NEW PERMISSIBLE EXPOSURE LIMIT (PEL):
  - U.S. OSHA significantly reduced (cut in half) the amount of silica that workers can be exposed to over the 8-hour workday. Employers must ensure that no employee is exposed to a concentration of silica in excess of 50 micrograms of silica/cubic meter of air ($\mu g/m^3$) calculated as an 8-hr time-weighted average (TWA).
- An action level of 25 $\mu g/m^3$ was also set by OSHA.
- So how can you comply?

IF YOU WORK IN THE CONSTRUCTION INDUSTRY

Consult the table on the following slide for help with compliance.

- Good news: Allows employers to use specified dust control measures instead of air sampling for defined work tasks.
- Not so good news: Only 18 tasks/control measures are listed as of 2018. OSHA plans to expand.

EXCERPT FROM TABLE 1

§1926.1153 Respirable crystalline silica.

(c) Specified exposure control methods. (1) For each employee engaged in a task identified on Table 1, the employer shall fully and properly implement the engineering controls, work practices, and respiratory protection specified for the task on Table 1, unless the employer assesses and limits the exposure of the employee to respirable crystalline silica in accordance with paragraph (d) of this section.

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 hours /shift	> 4 hours /shift
(i) Stationary masonry saws	Use saw equipped with integrated water delivery system that continuously feeds water to the blade. Operate and maintain tool in accordance with manufacturer's instructions to minimize dust emissions.	None	None
(ii) Handheld power saws (any blade diameter)	Use saw equipped with integrated water delivery system that continuously feeds water to the blade. Operate and maintain tool in accordance with manufacturer's instructions to minimize dust emissions. – When used outdoors. – When used indoors or in an enclosed area.	None APF 10	APF 10 APF 10

FACT SHEETS FROM OSHA

https://goo.gl/pLhJPa

On Controlling Silica Dust for Table 1 Tasks

- Handheld Power Saws Fact Sheet
- Handheld Grinders for Tasks Other Than Mortar Removal Fact Sheet
- Handheld Power Saws Used to Cut Fiber-Cement Board
- Jackhammers or Handheld Powered Chipping Tools Fact Sheet
- Handheld and Stand-Mounted Drills Fact Sheet
- Stationary Masonry Saws Fact Sheet
- Handheld Grinders for Mortar Removal (Tuckpointing) Fact Sheet
- Walk-Behind Saws Fact Sheet
- Drivable Saws Fact Sheet
- Rig-Mounted Core Saws or Drills Fact Sheet
- MORE AVAILABLE

OSHA FactSheet

CONTROL SILICA DUST

CONTROL OF SILICA DUST IN CONSTRUCTION

Jackhammers or Handheld Powered Chipping Tools

The use of a jackhammer or handheld power chipping tools to break or demolish concrete, stone, masonry or other silica-containing materials can generate *respirable crystalline silica* dust. When inhaled over time, the small particles of silica can irreversibly damage the lungs. This fact sheet describes dust controls that can be used to minimize the amount of airborne dust when using jackhammers or handheld powered chipping tools as listed in Table 1 of the Respirable Crystalline Silica Standard for Construction, 29 CFR 1926.1153.

Engineering Control Method: Water applied continuously to the impact point ***OR*** Shroud with Vacuum Dust Collection System

Two methods for controlling dust when using jackhammers or powered chipping tools are: (1) continuously feed water to the point of impact; or (2) use a shroud or cowling with a vacuum dust collection system.

Wet Methods

When jackhammering, wetting must occur with a continuous stream or spray of water at the point where the jackhammer's tip strikes the surface material. Employers may use manual spraying or water- spray systems. Under either approach, water must be applied at a flow rate sufficient to minimize the release of visible dust.

Manual Spraying. One option for applying water when jackhammering is to have one worker direct a stream or spray of water at the impact point while another worker operates the jackhammer or powered chipping tool. A portable sprayer with a nozzle can be used for this job.

Electrical Safety. Where water is used to control dust, electrical safety is a particular concern. Use ground-fault circuit interrupters (GFCIs) and watertight, sealable electrical connectors for electric tools and equipment on construction sites.

One worker applies water using a portable sprayer to suppress dust while the other jackhammers.

Only wetting the surface is not sufficient. Continuous water application either streamed or sprayed at the point where the jackhammer or handheld powered chipping tool breaks the surface is necessary because as the tool breaks through the surface, dry materials below are disturbed, which can produce dust.

Water-Spray Systems. Spray nozzles aimed at the tip of the tool on jackhammers and handheld powered chipping tools can lower silica exposures. Existing equipment can be retrofitted. The

IMPORTANT CONSIDERATION
IF USING TABLE 1 OPTION

- Keep in mind that in 1926.1153(h)(1)(i) OSHA requires medical surveillance for any employee that wears a respirator for more than 30 days per year.

Medical surveillance must include:

- Medical/work history
- Physical exam
- Chest X-ray
- Pulmonary function test
- TB test
- Re-exam at least every 3 years

Air sampling may be less costly for employers.

IMPORTANT CONSIDERATION
FOR ALL EMPLOYERS

- All employers covered by the standard, including employers who fully and properly implement exposure controls in Table 1, must develop and implement a written exposure control plan.

- Employers must also designate a competent person to implement the plan, evaluate its effectiveness, and update it as necessary with new tasks, new tools, and new control measures that are in use.

EXPOSURE CONTROL PLAN

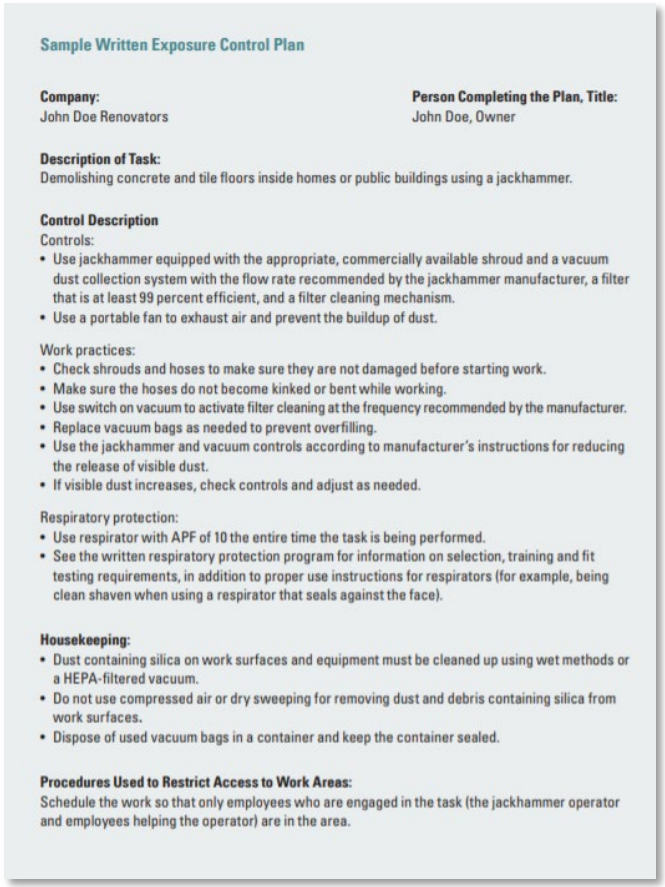
WHAT MUST BE INCLUDED

- Description of workplace tasks where there could be silica exposures including equipment used, materials handled, typical weather conditions, outdoors vs indoor work.
- Description of engineering controls, work practices, and respiratory protection used to limit exposures.
- Instructions from equipment manufacturers on **how to decrease dust and signs that control measures are not working properly** such as an increase in visible dust.

EXPOSURE CONTROL PLAN
WHAT MUST BE INCLUDED

- Acceptable **cleaning methods** that can be used to prevent employees from being exposed to silica dust and any hygiene-related matters such as not using compressed air to clean your clothing.
- Description of **procedures to restrict access** to work areas such as scheduling tasks when others are not around, limiting access to the work area, moving employees to an area where they are not exposed to the dust cloud, posting warning signs.

NEED HELP?



Sample Written Exposure Control Plan

Company:
John Doe Renovators

Person Completing the Plan, Title:
John Doe, Owner

Description of Task:
Demolishing concrete and tile floors inside homes or public buildings using a jackhammer.

Control Description
Controls:
- Use jackhammer equipped with the appropriate, commercially available shroud and a vacuum dust collection system with the flow rate recommended by the jackhammer manufacturer, a filter that is at least 99 percent efficient, and a filter cleaning mechanism.
- Use a portable fan to exhaust air and prevent the buildup of dust.

Work practices:
- Check shrouds and hoses to make sure they are not damaged before starting work.
- Make sure the hoses do not become kinked or bent while working.
- Use switch on vacuum to activate filter cleaning at the frequency recommended by the manufacturer.
- Replace vacuum bags as needed to prevent overfilling.
- Use the jackhammer and vacuum controls according to manufacturer's instructions for reducing the release of visible dust.
- If visible dust increases, check controls and adjust as needed.

Respiratory protection:
- Use respirator with APF of 10 the entire time the task is being performed.
- See the written respiratory protection program for information on selection, training and fit testing requirements, in addition to proper use instructions for respirators (for example, being clean shaven when using a respirator that seals against the face).

Housekeeping:
- Dust containing silica on work surfaces and equipment must be cleaned up using wet methods or a HEPA-filtered vacuum.
- Do not use compressed air or dry sweeping for removing dust and debris containing silica from work surfaces.
- Dispose of used vacuum bags in a container and keep the container sealed.

Procedures Used to Restrict Access to Work Areas:
Schedule the work so that only employees who are engaged in the task (the jackhammer operator and employees helping the operator) are in the area.

Consult the OSHA Small Entity Compliance Guide for a Sample of an Exposure Control Plan at: https://www.osha.gov/Publications/OSHA3902.pdf

IF NOT USING TABLE 1
TO CONTROL EXPOSURES

OSHA requires employers to *assess the exposures* of each employee who is or may be potentially exposed to silica at or above the action level of 25 ug/m^3.

How?

(a) Performance Option or

(b) Scheduled Monitoring Option

DETAILS ON PERFORMANCE OPTION

- Allows employers to assess the 8-hour TWA exposure based on any combination of air monitoring data or so-called objective data.
- Objective data includes typical exposure levels documented in industry-wide surveys, historical data you may have on file, calculations based on chemical composition of a substance in use, etc.
- Objective data must closely reflect the work conditions at your site and the burden is on the employer to demonstrate the objective data being used is applicable to your site/job.

WHERE CAN YOU FIND OBJECTIVE DATA?

Do an internet search:

- Manufacturers of drilling and grinding equipment such as Makita and Hilti provide data for their tools.
- Trade Associations such as the Construction Employers Association and Associated General Contractors (AGC) provide opportunities for members to post and share data.

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

Makita performed testing to determine the operator's exposure level to respirable crystalline silica dust[1]. 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 (210m^3)
- 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
Tool Used	XRH01Z	XRH05Z	HR2641
Dust Attachment	DX01	193472-7	193472-7
Connection Adapter	N/A	417765-1	417765-1
Hose	N/A	143787-2	143787-2
Time-Weighted Average Respirable Silica Dust Exposure[2,3]	22 µg/m3	203 µg/m3	270 µg/m3

The 1 hour TWA for XRH05Z is 203 µg/m^3 and for HR2641 is 270 µg/m^3. Assuming no additional silica exposure occurs throughout an 8-hour work shift, the TWA for the 8-hour work shift would be 26 µg/m^3 and 34 µg/m^3 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.

DETAILS ON
SCHEDULED MONITORING OPTION

- Initial air monitoring must be done unless employers can objectively demonstrate there is no silica released above the action level.
- More monitoring may need to be done to reassess levels:
  - **If above PEL** – Control the hazard; Re-assess every 3 months
  - **If above Action Level** - Re-assess exposures every 6 months
  - **Reassess when there are changes** to production, process, control equipment, personnel, or work practices that could produce exposures greater than the action level.
  - **Discontinue monitoring** when 2 consecutive measurements, 7 days apart are less than the action level.

MORE ON SCHEDULED MONITORING OPTION:

HOW MANY SAMPLES ARE REQUIRED?

- OSHA says to collect one or more personal breathing zone samples that reflect exposures on each shift, each job classification, and each work area.
- If several employees do the same tasks, in the same shift, in the same work area, you can do *representative* sampling, by sampling those with the highest exposures.

MORE ON THE PERMISSIBLE EXPOSURE LIMIT (PEL)

HOW MUCH SILICA DUST IS 50 µg/m^3?

Imagine a pile of dust the size of a standard pencil eraser. This amount of dust in a box 3 ft X 3 ft X 3 ft would be over the current PEL of 50 µg/m3.

WHAT ABOUT ANALYSIS?

- OSHA now requires that the lab analyze for all (3) forms of silica including quartz, cristobalite, and trydymite.
- **Trydymite** is normally only associated with volcanoes. So talk to your lab about analysis of this form of silica.

AIR SAMPLING FOR SILICA

EASY AS 1-2-3

1

2

3

THREE KEY COMPONENTS
FOR SILICA SAMPLING

1. SAMPLING PUMP

Pulls air through the sample collection device

2. FLOWMETER (CALIBRATOR)

Measures the flow rate of the pump with a high degree of accuracy. A readout of the flowrate on the pump itself is not accurate enough without calibration.

3. SAMPLE COLLECTION DEVICE

Separates and collects the small respirable dust particles from the dust cloud onto the filter for lab analysis of silica

FIRST KEY COMPONENT
SAMPLING PUMP

CHOOSING YOUR SAMPLING PUMP

FACTORS TO CONSIDER

1. **FLOWRATE**- Can the pump sample at the flowrates required for respirable dust samplers (typically 2 L/min or higher)?
2. **POWER**- Can the pump continue to sample at a constant flowrate for 8 hours even with high dust load on the filter?
3. **SIZE AND WEIGHT-** Will the pump be acceptable for workers to wear for the full shift?
4. **AUTOMATIC FEATURES-** Do you want a basic pump or are you willing to pay for touchscreen, timers, programming options, PC compatibility?

INEXPENSIVE, BASIC PUMP FROM SKC

AIRCHEK 52

- Flow range up to 3 L/min
- On/off switch and flow adjustment screw
- Maintains constant flow
- Timer keeps track of sample time
- No programmability

Available in a basic silica kit with required accessories.

ADVANCED PUMP
FROM SKC

AIRCHEK TOUCH

- Flow range up to 5 L/min
- Intuitive touch screen to set and monitor pump functions and flowrate.
- Optional software to set up pump functions/flowrate and to document pump history in the field.

Available in a deluxe silica kit with required accessories.

SECOND KEY COMPONENT
CALIBRATOR (FLOWMETER)

PUMP CALIBRATION
CLARIFICATION

- The term *calibration* can be confusing to those who are new to air sampling.
- Calibration of pumps does **not** refer to an annual service that is done by the factory.
- Pump calibration means that you the user set and verify the flowrate of the pump to that required in the sampling procedure.
- **This must be done before and after every sample that you take.**
- The average of the pre- and post- sample flowrates is used to calculate the air volume.

PUMP CALIBRATION:
WHY YOU HAVE TO DO IT

- You must calculate total air volume for each sample and report this to the laboratory when you submit your samples (filters) to them.
- The laboratory will use the total air volume you provided to calculate airborne concentration levels of silica for each sample.

PUMP CALIBRATION:
HOW ITS USED

The pump flow rate measured by your pump calibrator is multiplied by the total sampling time.

Flow rate (L/min) X Time (min)=Air Volume (L of air)

This air volume is sent by you to the laboratory with each one of your samples.

The lab will then measure the amount of silica on the filter and will use the air volume you supplied to calculate micrograms/m^3 of silica in the air.

IT IS IMPORTANT TO HAVE A HIGH ACCURACY CALIBRATOR

- Everyone doing air sampling should have at least one calibrator of high accuracy that is recertified annually to a national standard (NIST) by a ISO calibration laboratory.
- Fee for annual recalibration by SKC Cal Lab is only $195.
- You may also want some less expensive field devices (such as rotameters) that you can calibrate yourself by comparing the flow indication on the rotameter to that of your high accuracy, certified calibrator.

HIGH ACCURACY CALIBRATOR
FROM SKC

CHEK-MATE

- Simple, One-button operation
- Takes a reading once/second and displays a moving average of the flowrates
- Flow range up to 5 L/min covers the range for silica sampling
- Included in the SKC Deluxe Silica Sampling Kit or sold/rented separately

INEXPENSIVE CALIBRATION OPTION
ROTAMETERS

ROTAMETER

- Pump flowrate draws the float ball to a L/min indication on the rotameter scale
- Can be easily transported in the field (or used in the office).
- Included in the SKC Basic Silica Kits
- It is standard practice to check rotameters “regularly” against the high accuracy certified calibrator to ensure the flow indication is accurate.
- Suggestion: Check rotameters once/month.

TECH TIPS ON CALIBRATION

- Remove the pumps from the battery charger and let pumps run about 5 minutes before calibration to let the flow stabilize.
- Attach the sample collection device to the pump with connecting tubing. This sample collection device will be used for calibration only.
- Attach the calibrator to the sample collection device. Turn on the pump and measure the flowrate.
- Attach a clean sample collection device to collect the sample in the field.
- After sampling, recalibrate the pump using the sample collection device for calibration to avoid contaminating the sample from the field.

Some people post-calibrate with the sampler from the field attached to the pump. But this is not necessary if you are using a good quality constant flow pump.

TECH TIPS ON CALIBRATION

5% IS A POPULAR NUMBER

- Ensure the pump flowrate is within ±5% of the specified flowrate for your sample collection device.
- Use the running average from the SKC Chekmate or take at least 3 flow measurements that agree within 5% with other calibrator types and use the average as your flow rate measurement.
- If your pre-and post- sample flowrates differ by more than 5%, your sample is called into question and should be repeated.

TECH TIP IN CALIBRATION

SET-UP

- Don’t get confused.
- Set up the pump and sample media like its ready to place on the worker.
- Then attach the inlet of the sample media to the calibrator to check the flowrate.

THIRD KEY COMPONENT
SAMPLE COLLECTION DEVICE

SO HOW DO WE SAMPLE RESPIRABLE SILICA DUST?

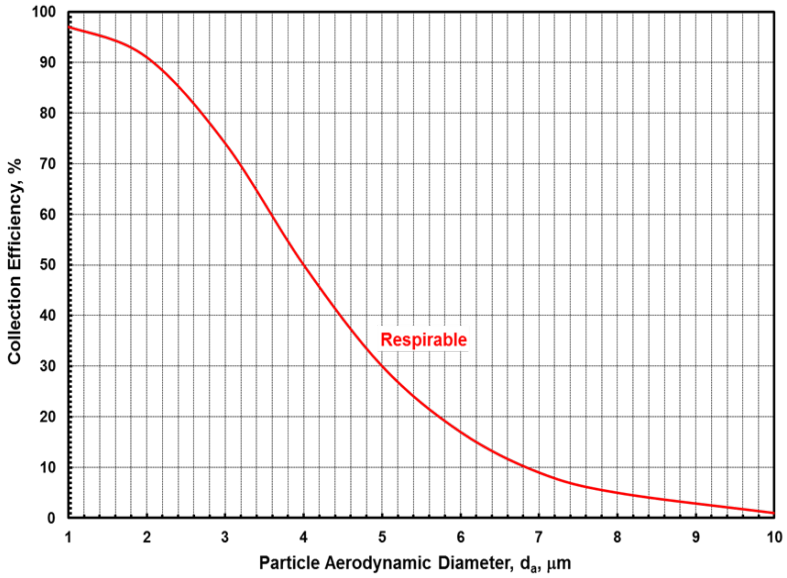
- Respirable silica dust is ultimately collected onto a PVC filter for laboratory analysis.
- Preceding the filter, however, is a particle size-selective device that will separate the smaller, respirable dust particles from the larger, non-respirable dust when connected to a pump sampling at the designated flow rate.

OSHA ADOPTED NEW CRITERIA
FOR RESPIRABLE DUST SAMPLERS

- Respirable crystalline silica samplers must meet the performance criteria specified in ISO 7708.
- ISO 7708 is also referred to in the OSHA silica rule as the ISO/CEN convention.
- ISO=International Standards Organization.
- CEN=Committee for European Normalization.

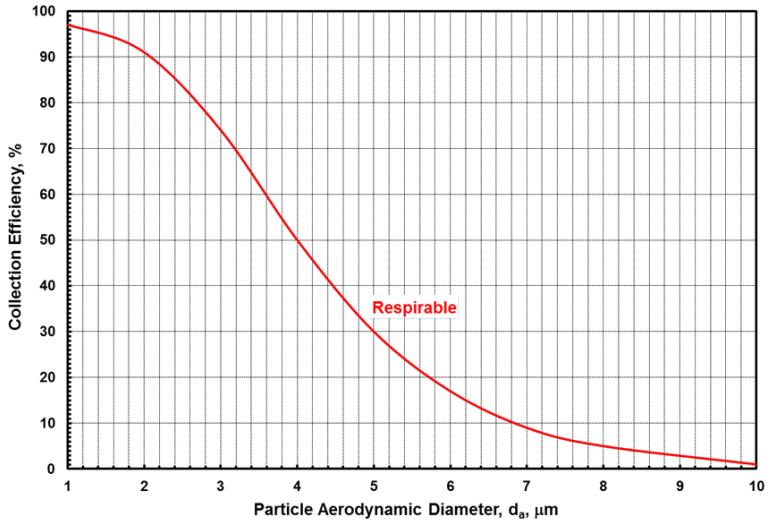
ISO 7708 SPECIFICATIONS
FOR RESPIRABLE DUST SAMPLERS

The ISO 7708 performance criteria is essentially a collection efficiency curve that specifies the efficiency of the sampler for particles of designated sizes.



OF PARTICULAR NOTE:
THE 50% CUT-POINT

- A common term used in sampling.
- This is the particle size that the sampler collects with 50% efficiency.
- ISO 7708 specifies a 50% (median) cut-point of 4 um.



RESPIRABLE DUST SAMPLERS:
TO MEET OSHA CRITERIA IN THE FINAL RULE

Option #1: Cyclones

CYCLONE OPERATION

- Cyclones are inserted into filter cassettes containing PVC filters and are attached to sample pumps.
- Air enters through a slit on the side of the cyclone which creates cyclonic action.
- Through centrifugal force, large particles fall into the cap at the bottom called a “grit pot” and are discarded.
- Small particles are thrown onto the filter for analysis.

Cap must be in place during sampling!

MORE ON CYCLONE OPERATION

- After sampling, the cyclone is removed and the filter is capped and sent to the lab.
- DON'T TURN THE CYCLONE UPSIDE DOWN UNTIL YOU HAVE REMOVED THE FILTER!! If the large particles in the cap at the bottom get dumped onto your filter, your sample is invalid (and the results will look very high).
- Clean the cyclone with soap and water between every use or the dust stuck to the interior walls of the cyclone will affect your results.

OLDER CYCLONE SAMPLERS
TO MEET OSHA CRITERIA

Used at 1.7 L/min

10-mm NYLON DORR-OLIVER CYCLONE

- U.S. OSHA inspectors have been using this cyclone since OSHA began in the 1970s.
- But the new OSHA standard allows employers to use any sampler that meets the OSHA criteria. (ISO 7708)

NEWER CYCLONE SAMPLERS
TO MEET OSHA CRITERIA

SKC ALUMINUM CYCLONE

- Listed in OSHA Final Rule on page 16439 of 29CFR 1910
- Used at 2.5 L/min to meet OSHA criteria

SKC 225-01-02 (37-mm)

SKC ALUMINUM CYCLONE
ADVANTAGES

- **Metal construction** eliminates static electricity concerns.
- **Larger collection area.** The cyclone is inserted into the middle ring of a 3-piece filter cassette.
- **Calibration adapter** offers user convenience.

SKC GS-3 CYCLONE

- Originally designed for coal mines since aluminum (and other alloys) can not be taken into an underground mine
- Conductive plastic construction eliminates static electricity concerns
- Not a spark hazard for coal mines
- Designated flow rate is 2.75 L/min to meet OSHA criteria

SKC 225-100 (37-mm)

IMPORTANT NOTE ON FLOWRATE

- All cyclones are not created equal!
- Each cyclone has different operating specifications to meet the required performance criteria.
- Be sure you know the flow rate specified before using any cyclone.

IF YOU USE THE WRONG FLOWRATE
DATA COLLECTED IS MEANINGLESS

1.7 L/min
Nylon
Dorr-Oliver

2.5 L/min
SKC Aluminum

2.75 L/min
SKC GS-3

RESPIRABLE DUST SAMPLERS
TO MEET ISO 7708 & OSHA CRITERIA

New Options

NEW SAMPLERS
FOR ISO 7708 & OSHA CRITERIA

On Page 16439 of the final rule on silica (29CFR 1910), OSHA notes:

The new silica rule “will permit employers to use ANY sampling device that conforms to the ISO/CEN convention”.

NEW SAMPLERS
FOR ISO 7708 & OSHA CRITERIA

Page 16439 goes on to say that in addition to traditional cyclones:

- “There are also personal impactors available for use at flowrates from 2 to 8 L/min that have been shown to conform closely with the ISO/CEN convention”.
- This data was supplied by SKC to the OSHA docket on new PPI samplers.

HERE'S THE PROOF

For most workplace conditions, the change in the criteria for respirable dust in the final rule would theoretically increase the mass of respirable dust collected over that measured under the previous criteria by an amount that depends on the size distribution of airborne particles in the workplace. Soderholm (1991, Document ID 1661) examined these differences based on 31 aerosol size distributions measured in various industrial workplaces (e.g., coal mine, lead smelter, brass foundry, bakery, shielded metal arc [SMA] welding, spray painting, pistol range) and determined the percentage increase in the mass of respirable dust that would be collected under the ISO/CEN convention over that which would be collected under the 1968 ACGIH criteria. Soderholm concluded that, for all but three of the 31 size distributions that were evaluated, the increased respirable dust mass that would be collected using the ISO/CEN convention for respirable dust instead of the 1968 ACGIH criteria would be less than 30 percent, with most size distributions (25 out of the 31 examined, or 80 percent) resulting in a difference of between 0 and 20 percent (Document ID 1661, pp. 248–249, Figure 1). In the PEA, OSHA stated its belief that the magnitude of this effect does not outweigh the advantages of adopting the ISO/CEN convention. In particular, most respirable dust samplers on the market today are designed and calibrated to perform in a manner that closely conforms to the international ISO/CEN convention.

Incorporating the ISO/CEN convention in the definition of cyclone samplers on the market, such as the Dorr-Oliver, Higgins-Dewell (HD), GK2.69, SIMPEDS, and SKC aluminum. In the PEA, OSHA reviewed several studies demonstrating that these samplers collect respirable particles with efficiencies that closely match the ISO/CEN convention (Document ID 1720, pp. IV–21—IV–24). In addition to cyclone samplers, there are also personal impactors available for use at flow rates from 2 to 8 L/min that have been shown to conform closely with the ISO/CEN convention (Document ID 1834, Attachment 1). Cyclones and impactors both separate particles by size based on inertia. When an airstream containing particles changes direction, smaller particles remain suspended in the airstream and larger ones impact a surface and are removed from the airstream. Cyclones employ a vortex to separate particles centrifugally, while impactors use a laminar airflow around a flat surface such that particles in the desired size range impact onto the surface.

The current OSHA sampling method for crystalline silica, ID–142, is the method used by OSHA to enforce the silica PELs and is used by some employers as well. It specifies that a respirable sample be collected by drawing air at 1.7 ± 0.2 liters/minute (L/min) through a Dorr-Oliver 10 millimeter (mm) nylon cyclone attached to a cassette containing a 5-µm pore-size, 37-mm diameter polyvinyl chloride (PVC) filter (Document ID 0946). NIOSH sampling and analysis methods for crystalline silica (Method 7500, Method 7602, Method 7603) have also adopted the ISO/CEN convention Method 7500 also allows for the use of an aluminum cyclone at 2.5 L/min. NIOSH is revising its respirable dust method to include any sampler designed to meet the ISO/CEN criteria (Document ID 3579, Tr. 218).

The devices discussed above, when used at the appropriate flow rates, are capable of collecting a quantity of respirable crystalline silica that exceeds the quantitative detection limit for quartz (the principle form of crystalline silica) of 10 µg for OSHA's XRD method (Document ID 0946). For several scenarios based on using various devices and sampling times (8-hour, 4-hour, and 1-hour samples), OSHA calculated the amount of respirable quartz that would be collected at quartz concentrations equal to the existing general industry PEL, the proposed (and now final) rule's PEL, and the proposed (and now final) rule's action level. As seen in Table IV.3–A, computations show that the 10-mm nylon Dorr-Oliver operated at an optimized flow rate of 1.7 L/min, the aluminum cyclone operated at 2.5 L/min, the HD cyclone operated at 2.2 L/min, and the GK2.69 operated at 4.2 L/min will all collect enough quartz during an 8-hour or 4-hour sampling period to meet or exceed the 10 µg quartz limit of quantification for OSHA Method ID–142. Therefore, each of the commercially available cyclones is capable of collecting a sufficient quantity of quartz to exceed the limit of quantification when airborne concentrations are at or below the action level, provided that at least 4-hour air samples are taken. Table VII–7 also shows that the samplers can collect enough silica to meet the limit of

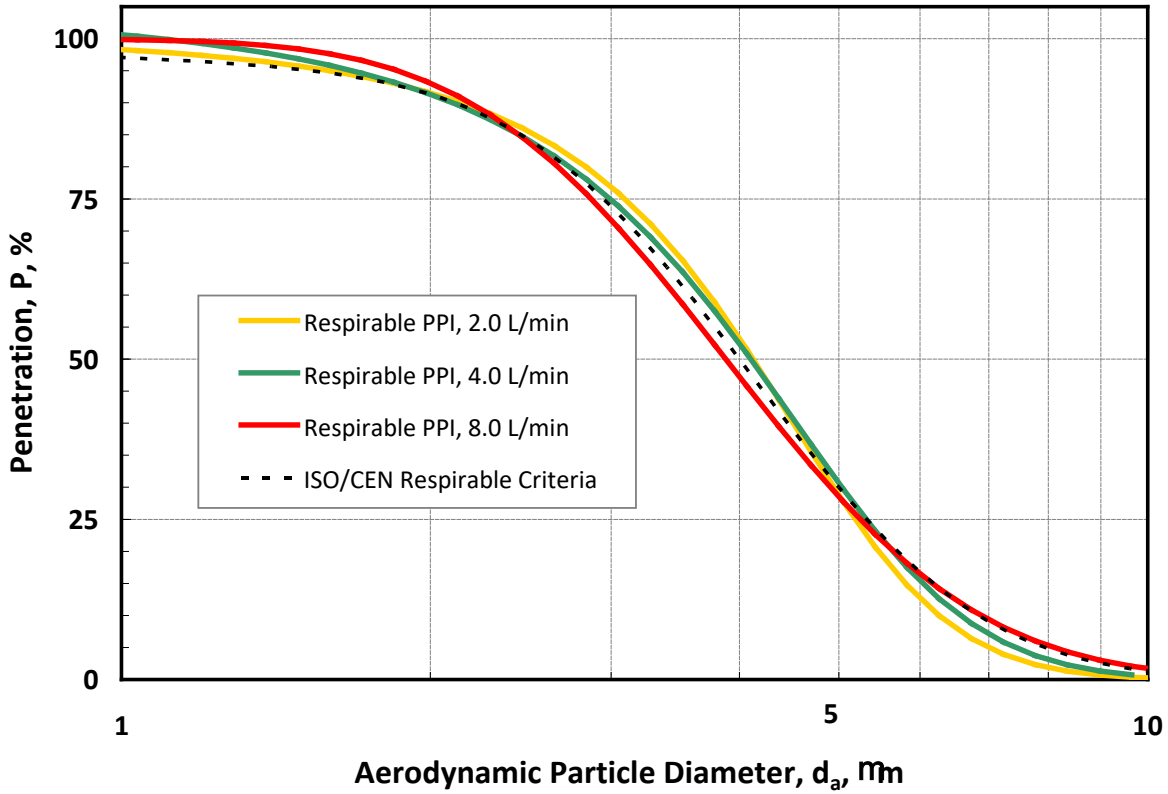
DISPOSABLE IMPACTORS

SKC PPI SAMPLERS

Same filter and same analysis as with cyclones. ONE TIME USE.

- Instead of a cyclone, PPI impactors have 4 internal, pre-oiled plates that scrub out larger particles. The impactor plates are sonically welded into place by SKC and require no assembly.
- The pump draws the air into the PPI. Larger particles are scrubbed out onto the plates and the smaller respirable dust is collected onto the PVC filter for analysis as usual.

PPI SAMPLER PERFORMANCE
COMPARED TO ISO/OSHA CRITERIA



Perfect Match!

MORE PPI ADVANTAGES

CONVENIENCE

- A handy calibration adapter is available to attach the PPI to the calibrator (flowmeter).
- No calibration jar is needed.

MORE PPI ADVANTAGES

SAMPLE INTEGRITY

- No tipping hazard. You can invert the sampler without causing large particles to land on the filter invalidating the sample.
- Assembly. Let's look at cyclones versus the PPI.

SKC RESPIRABLE PPI
FLOWRATE OPTIONS

2 L/min

8 L/min

4 L/min

- Single-use, disposable PPI models are available for use at either 2, 4, or 8 L/min.
- This allows some flexibility in sample duration.

PPI
FLOWRATE OPTIONS

- By far, the number one most popular PPI model is the one designed for use at 2 L/min.
- If you want to sample a shorter duration, you could consider the option of using the 4 L/min PPI (SKC 225-3871) or 8 L/min PPI.
- Keep in mind, you will need sampling pumps that can achieve these flowrates.

PPI: NOT JUST FOR SILICA
FOR ANY RESPIRABLE DUST

- Like a cyclone, the PPI can be used for sampling any type of respirable dust.
- For sampling respirable dust followed by gravimetric analysis (weighing the filter), you will need to use a PPI with PRE-WEIGHED filters now available from SKC or your lab.

IMPORTANT CONSIDERATIONS
FOR SAMPLE DURATION

Full-shift sampling is the best option since the PEL is an 8-hr limit. But listed below are some considerations for shorter term sampling.

- In OSHA's general industry standard for silica, OSHA provides some guidance on how long to collect the sample so the lab will have enough silica on the filter to actually measure it.
- Table VII-7 on page 16440 suggests a minimum sample time of **4 hours using a sampler at 2 L/min** in dust concentrations near the action level.

LABORATORY RECOMMENDATIONS
ON SAMPLE DURATION

- Even though OSHA feels 4 hours may be the minimum sample time for adequate detection of silica on the filter, most commercial labs can provide lower detection.
- Some IH labs have advised SKC that they can detect silica with a minimum sample time of 2 hours using a dust sampler at 2 L/min at silica concentrations near the action level.
- Shorter sampling durations are possible with higher flow dust samplers for use at 4 or 8 L/min. Check with your lab for their recommendations.

HELP TO BEGINNERS ON CALCULATING THE 8-HR TWA EXPOSURE

OPTION #1:

- If you collect one full-shift sample over the entire 8-hour workday, the silica results sent back from the lab represent the 8-hour TWA.
- No calculations necessary. Easy.
- One lab analysis. Less expensive.

Labs do NOT calculate the TWA for you.

MORE ON CALCULATING THE 8-HOUR TWA

OPTION #2:

- Some may choose to collect several separate filter samples throughout the day to document the silica levels of different worker tasks.
- Monitoring a worker's task will help you to choose the correct PPE or to evaluate controls, but the PEL is set as an 8-hour average.
- So if you collect multiple samples throughout the day, you will need to do a calculation to determine the TWA.

TIME-WEIGHTED AVERAGE (TWA)

HOW TO CALCULATE

In every day life, we calculate the AVERAGE of numbers by adding up all the numbers, then dividing by how many numbers there are.

EX: What's the average of 2,4,6?

$\frac{2+4+6}{3}$ = Average of 4

In air sampling, we calculate the 8-hour TIME-WEIGHTED AVERAGE of multiple samples in a day following this basic formula:

$$TWA=\frac{C_1T_1 + C_2T_2 + C_3T_3\ldots}{8}$$

C=µg/m^3 of silica found by lab for the sample

T=sample duration (in hours)

8=represents 8-hour workday

FREQUENT QUESTION

HOW DO YOU COMPARE THE SAMPLING RESULTS TO THE PEL WHEN YOU DON'T SAMPLE THE ENTIRE DAY?

Safety and health professionals must exercise some professional judgement on this matter and be able to answer the question "*Why didn't you sample 8 hours?*"

- Was the concentration expected to be THE SAME CONCENTRATION for the rest of the day? Not a typical scenario for silica exposures.
- Was the concentration ZERO for the rest of the day because the worker went to another task with no silica? Very common scenario.

IF THE SILICA LEVELS WERE ZERO
FOR THE REST OF THE WORKDAY

Then use the standard TWA calculation to determine the 8-hour time-weighted average exposure as below:

$$\frac{(\text{Silica found by the lab in } \mu g/m^3)\,(\text{Time of sample in hours}) + (\text{Zero } \mu g/m^3)\,(\text{Hours left in day})}{8 \text{ Hours}}$$

- Be sure your time is in hours since 8 reflects 8-HOUR workday.
- Be sure to take field notes to document the worker's activities to prove the silica exposure was zero for the rest of the day.

WHAT ABOUT REAL-TIME DETECTION FOR SILICA?

There are no “black boxes” that datalog and provide a direct readout in the field on the levels of silica during various jobs. Laboratory analysis is required to measure silica for OSHA compliance.

There are however direct-reading instruments that can detect and display the levels of dust in general.

DIRECT-READING DUST MONITORS

USEFULNESS IN THE FIELD

- Perimeter sampling of regulated areas; can set up alarms at user-defined levels
- Quick and easy screening of dust levels of worker tasks
- Provide help in choosing PPE and evaluating controls in the field
- Document transient changes in levels with work activities
- Allow for detection of peak exposures
- Record the history of exposures for recordkeeping

SM-4000 MONITOR FROM SKC

SUPPLEMENTS COMPLIANCE SAMPLING

- Sensor is placed in the breathing zone for personal samples
- Can place on a small stand for monitoring regulated areas
- Can measure dust levels down to 1 ug/m^3

ADDITIONAL FEATURES

SM-4000 PERSONAL SILICA MONITOR

1. Displays and data logs dust levels.
2. Has an internal pump that allows users to also collect a filter sample for analysis.
3. Allow for attachment of only the GS-3 respirable dust cyclone.

FINAL THOUGHTS:
WHY BUY PUMPS WHEN FREE PUMP LOANS ARE AVAILABLE FROM LABS?

- You are ready to sample any and all operations at any time with **no waiting for loaner equipment to arrive.**
- You are ready to sample side-by-side with OSHA should they knock on your door.

THANK YOU FOR YOUR INTEREST

www.skcinc.com

Contact skctech@skcinc.com or your local SKC representative with any questions.