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Silica & Dust Exposure Monitoring with Advancements in Sampling Technology

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Silica & Dust Exposure Monitoring

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- Why is Silica a Problem
- Crystalline Silica Rules
  - PEL
  - Action Limit
  - Exposure Control Plans and Regulated Areas
- Industries Impacted
- Sampling Strategies
  - Personal Monitoring
  - Area Monitoring
  - Tips on selecting these devices
- Common issues customers experience
- How Sensidyne equipment and accessories address common problems and concerns
- Live Q&A

Why is Silica a Problem?

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What is Silica?

- Crystalline silica is present in many materials and its use is widespread
  - Silicon Dioxide (SiO_2)-Chemical compound
  - 15% of Earth's Crust
  - Sand, Granite, and Other "Hard Rocks"

- Crystalline Silica (OSHA regulated)
  - Quartz (most common)-Concrete for example
  - Cristobalite, Tridymite (Much less common) - Volcanic rock
  - All Silica forms have diagnostic X-ray diffraction patterns

- Abrasive blasting/crushing
- Drilling concrete
- Masonry and concrete work
- Mining/tunneling
- Cement and asphalt manufacturing
- Jack-hammering
- Brick and concrete block cutting
- Fiber-cement siding work
- Fracking Operations

Why is Silica a Problem?

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Did You Know?

OSHA estimates about 600,000 places of employment and two million construction workers are impacted by the standard. Amongst the most at risk are construction workers, heavy equipment operators and plasterers or drywallers.

What Can I Do To Protect Myself?

Keep dust levels down

There are a several different ways of keeping dust levels down on your construction site, which will keep Silica particles from becoming airborne. Examples include wet cutting, vacuum dust collection systems, intense ventilation or hosing down work sites to keep Silica dust from forming.

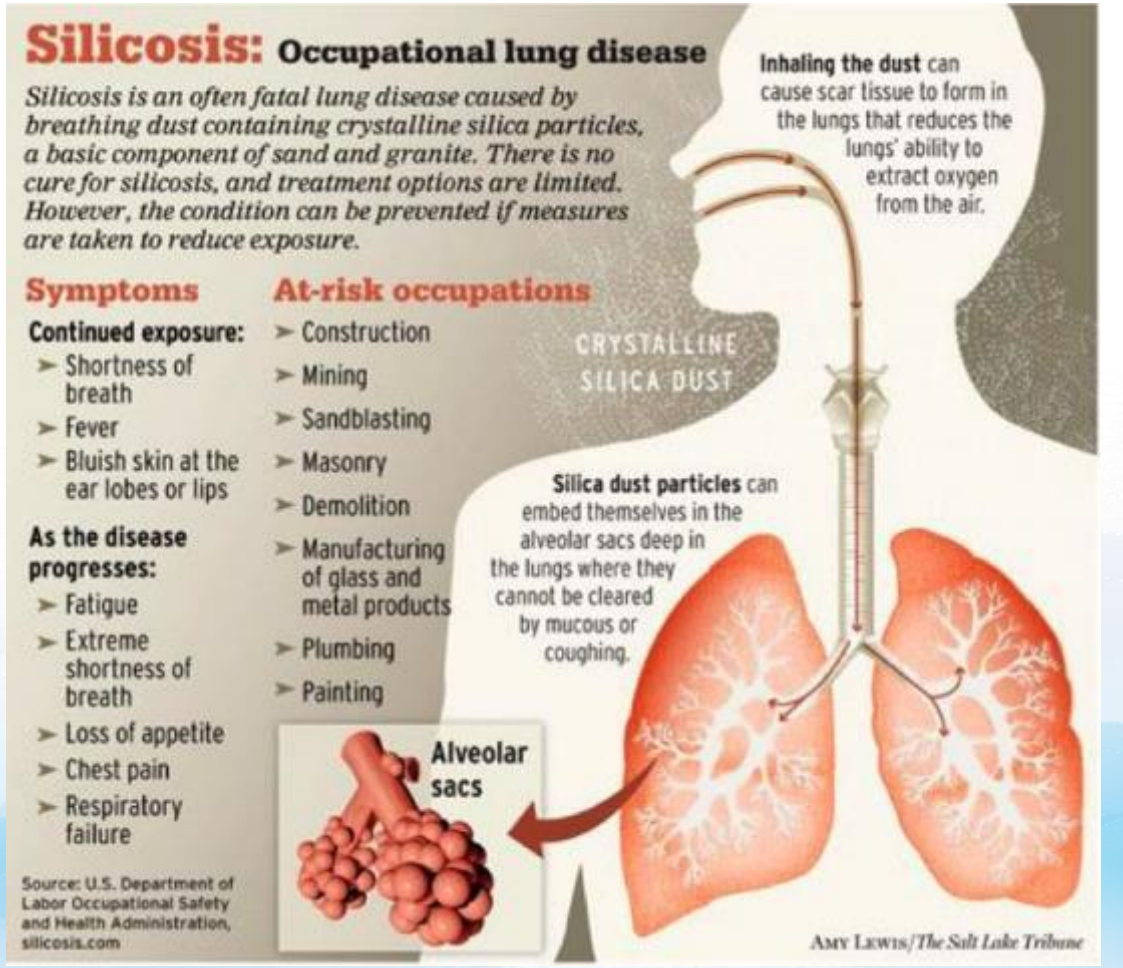
Stay informed

State OSHA programs may have different rules and regulations around managing Silica exposure, it's important to stay up to date with legal limits, testing methods and the latest data on how you can minimize risk.

Why is Silica a Problem?

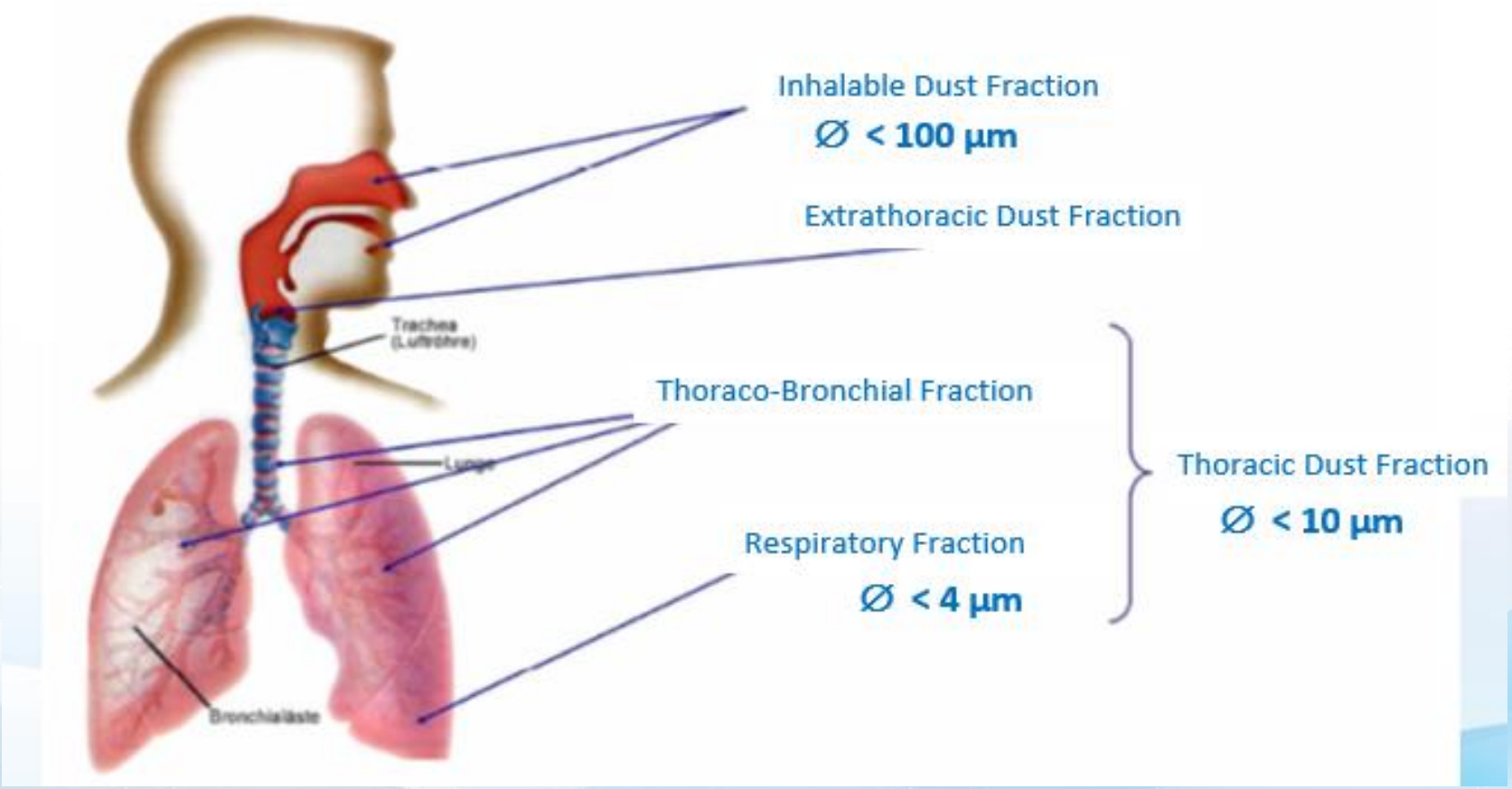
Exposure to respirable crystalline silica has been linked to:

- Silicosis
- Lung cancer
- Chronic obstructive pulmonary disease
- Kidney disease



Dust Deposition

Human Respiratory Tract:



History of Exposure Limits

- Previous permissible exposure limits (PELs) are formulas that many find hard to understand
- Construction/shipyard PELs are obsolete particle count limits
- General industry formula PEL is about equal to 100 µg/m3; Construction/shipyard formulas are about 250 µg/m3
- Previous PELs do not adequately protect workers
- Extensive epidemiologic evidence that lung cancer and silicosis occur at exposure levels below 100 µg/m3

Respirable Crystalline Silica Rule

- Two standards:
  - One for general industry and maritime
  - One for construction

Construction Standard

(a) Scope
(b) Definitions
(c) Specified exposure control methods
OR
(d) Alternative exposure control methods
(1) PEL
(2) Exposure Assessment
(3) Methods of Compliance
(e) Respiratory protection
(f) Housekeeping
(g) Written exposure control plan
(h) Medical surveillance
(i) Communication of silica hazards
(j) Recordkeeping
(k) Dates

Respirable Crystalline Silica Rule

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Construction – Scope

- All occupational exposures to respirable crystalline silica are covered, unless employee exposure will remain below 25 µg/m3 as an 8-hr TWA under any foreseeable conditions.

Specified Exposure Control Methods

- Table 1 in the construction standard matches 18 tasks with effective dust control methods and, in some cases, respirator requirements.
- Employers that fully and properly implement controls on Table 1 do not have to:
  - Comply with the PEL
  - Conduct exposure assessments for employees engaged in those tasks

Example of a Table 1 Entry

Equipment / Task	Engineering and Work Practice Control Methods	Required Respiratory Protection and Minimum APF	
		≤ 4 hr/shift	> 4 hr/shift
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 manufacturers' instruction to minimize dust - When used outdoors - When used indoors or in an enclosed area	None APF 10	APF 10 APF 10

Respirable Crystalline Silica Rule

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List of Table 1 Entries

- Stationary masonry saws
- Handheld power saws
- Handheld power saws for fiber cement board
- Walk-behind saws
- Drivable saws
- Rig-mounted core saws or drills
- Handheld and stand-mounted 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 (tuckpointing)
- Handheld grinders for other than mortar removal
- Walk-behind milling machines and floor grinders
- Small drivable milling machines
- Large drivable milling machines
- Crushing machines
- Heavy equipment and utility vehicles to abrade or fracture silica materials
- Heavy equipment and utility vehicles for grading and excavating

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Example of a Table 1 Entry

Equipment / Task	Engineering and Work Practice Control Methods	Required Respiratory Protection and Minimum APF	
		≤ 4 hr/shift	> 4 hr/shift
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

Respirable Crystalline Silica Rule

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- **Alternative Exposure Control Methods – Permissible Exposure Limit (PEL)**
  - PEL = 50 µg/m3 as an 8-hour TWA
  - Action Level = 25 µg/m3 as an 8-hour TWA
- **Alternative Exposure Control Methods – Exposure Assessment**
  - Required if exposures are or may reasonably be expected to be at or above action level of 25 µg/m3
  - Exposures assessments can be done following:
    - The performance option
    - The scheduled monitoring option
- **Performance Option**
  - Exposures assessed using any combination of air monitoring data or objective data sufficient to accurately characterize employee exposure to respirable crystalline silica
- **Objective Data**
  - Includes air monitoring data from industry-wide surveys or calculations based on the composition of a substance
  - Demonstrates employee exposure associated with a particular product or material or a specific process, task, or activity
  - 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

Respirable Crystalline Silica Rule

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Scheduled Monitoring Option

- Prescribes a schedule for performing initial and periodic personal monitoring
- If monitoring indicates:
  - Initial below the AL: no additional monitoring
  - Most recent at or above the AL: repeat within 6 months
  - Most recent above the PEL: repeat within 3 months
  - When two consecutive non-initial results, taken 7 or more days apart, are below the AL, monitoring can be discontinued
  - Reassess if circumstances change

Appendix A – Methods of Sample Analysis

- Employers must ensure that samples are analyzed by a laboratory that follows the procedures in Appendix A
- Appendix A specifies methods of sample analysis
  - Allows for use of OSHA, NIOSH, or MSHA methods
    - OSHA ID-142
    - NIOSH (7500-XRD, 7602-IR/KBr, 7603-IR)
    - MSHA (P7-IR, P2-XRD)
  - Analysis must be conducted by accredited laboratories that follow specified quality control procedures

Respirable Crystalline Silica Rule

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Written Exposure Control Plan

- The plan must describe:
  - Tasks involving exposure to respirable crystalline silica
  - Engineering controls, work practices, and respiratory protection for each task
  - Housekeeping measures used to limit exposure
  - Procedures used to restrict access, when necessary to limit exposures

Competent Person

- Construction employers must designate a competent person to implement the written exposure control plan
- *Competent person* is an individual capable of identifying existing and foreseeable respirable crystalline silica hazards, who has authorization to take prompt corrective measures
- Makes frequent and regular inspection of job sites, materials, and equipment

Medical Surveillance

- Employers must offer medical examinations to workers who will be required to wear a respirator under the standard for 30 or more days a year.
- Employers must offer examinations every three years to workers who continue to be exposed above the trigger.
- Exam includes medical and work history, physical exam, chest X-ray, and pulmonary function test.

Industries and Operations with Exposures

- Construction
- Glass manufacturing
- Pottery products
- Structural clay products
- Concrete products
- Foundries
- Dental laboratories
- Paintings and coatings
- Jewelry production
- Refractory products
- Asphalt products
- Landscaping
- Ready-mix concrete
- Cut stone and stone products
- Abrasive blasting in:
  - Maritime work
  - Construction
  - General industry
- Refractory furnace installation and repair
- Railroads
- Hydraulic fracturing for gas and oil

Sampling Strategies – Personnel Monitoring

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Air Sampling According to the New OSHA Standard

- Six existing sampling methods are identified in the new OSHA standard with the goal of optimizing the methods to obtain a quantitative limit of detection no higher than 25% of the PEL (based on air volume). A large enough sample is required to reach the detecting limit down to 12.5 micrograms/cubic meter (25% of the new PEL).

- The standard recommends modifying current methods to lower the detection level by taking a larger air sample, this accounts for tasks performed for short periods of time.

- Applying the formula 1.7 LPM x 60 x 8 hours = 816 L = 0.816 CM you can reach the LDL on some of the methods with the traditional 10 mm nylon cyclone at 1.7 LPM in 8 hours. With a four-hour task it is necessary to double the flow rate by using a medium flow cyclone such as our 4.2 LPM cyclone. Tasks performed for only two hours will require higher flow rates to reach the LDL, by using cyclones such as the 9 LPM RASCAL.

Method No.	Analysis	LDL (1.7LPM)
OSHA ID-142	XRD, Redposition	12.0 µg/m3 (qtz)
NIOSH 7500	XRD, Redposition	6.12 µg/m3 (8 hr)
NIOSH 7602	IR, KBr Pellet	6.12 µg/m3 (8 hr)
NIOSH 7603	IR, Redeposition	12.24 µg/m3 (8 hr)
MSHA P-2	XRD, Redposition	24.48 µg/m3 (8 hr)
MSHA P-7	IR, Redeposition	24.48 µg/m3 (8 hr)

Cyclone Model	Part Number	Flow Rate ACGIH Respirable (50% @ 4 µm)
10 mm Dorr-Oliver	800061	1.7 LPM
BGI-4L, HD style (US version)	811-9924-01	2.2 LPM
Medium flow rate GK 2.69 for 37 mm Cassettes	811-9926-01	4.2 LPM
Medium flow rate GK 2.69 for 25 mm Cassettes	811-9926-02	4.2 LPM
High flow rate RASCAL Cyclone with Plastic Filter Holder	811-9925-01	8.5 to 9.5 LPM

37 mm cassette version of the GK 2.69 cyclone is recommended over the 25 mm due to the higher backpressure caused by the smaller cassette.

Sampling Strategies – Personnel Monitoring

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Silica Sampling Best Practices

- Draw a large enough sample to obtain a maximum limit of detection of 12.5 micrograms per cubic meter (i.e., 25% of 50 micrograms per cubic meter)
- Use the analysis by XRD or IR as described in the six listed methods.
- Observe the cyclone flow rate specification for meeting the ACGIH size selection curve (50% at 4 microns).
- Use a constant flow control pump that will keep the flow rate at +/- 5% of set flow.
- A medium flow cyclone can meet the detecting limit in an 8 hour sample and still be comfortable to wear.

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Choosing the right Cyclone

Traditional 10 mm Nylon Cyclone

10 mm nylon cyclone is used in NIOSH & OSHA sampling methods.

The traditional personal air sampling cyclone in the US is the Dorr-Oliver, 10mm nylon cyclone. It was first utilized in US coal mines in the early 1960's, and it continues to be the most commonly used model in the US. It will follow the US ACGIH size distribution curve (50% cut at 4 microns) closely when used at 1.7 LPM. This cyclone is specified in numerous NIOSH and OSHA Test Methods for use with 37mm, 5 micron, PVC, 3-piece filter cassettes. The GilAir Plus and Gilian 5000 pump models are recommended for use with this cyclone. Calibration jar P/N 7013376 (2 Liter size) is also recommended.

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➢ Choosing the right Cyclone

Higgins-Dewell Style BGI-4L Cyclone (US Version)

HD style cyclone with US style cassette is specified in numerous NIOSH protocols

The Gilian BGI-4L is a Higgins-Dewell style aluminum cyclone that operates at 2.2 LPM to produce a 50% cut at 4 microns per the US-ACGIH size distribution curve. This style cyclone is specified in NIOSH 0600 and other respirable dust methods as an alternative to the 10 mm nylon cyclone. It is used with 37 mm, 5 micron, PVC, 3-piece NIOSH-style filter cassettes. The GilAir Plus and Gilian 5000 pump models are recommended.

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Choosing the right Cyclone

Medium Flow Rate GK 2.69

GK 2.69 Cyclone can be used for respirable or thoracic sampling.

The GK 2.69 respirable dust cyclone operates at 4.2 LPM to follow the US-ACGIH respirable dust size distribution curve with 50% cut at 4 microns. It can also be used at 1.6 LPM to follow convention for thoracic dust sampling with a 50% cut at 10 microns. It also uses 37 mm, 5 micron, PVC, 3-piece NIOSH style cassettes. An alternate version using 25mm cassettes is also available. The Gilian 10i sampling pump is recommended for respirable sampling. The GilAir Plus and Gilian 5000 pump models are recommended for thoracic sampling.

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Choosing the right Cyclone

High Flow RASCAL Cyclone GK 4.162

RASCAL Cyclone with Optional Aluminum Filter Holder

RASCAL Cyclone with standard plastic filter holder

The Gilian RASCAL (Respirable Air Sampling Cyclone, Aluminum, Large), made in the US, follows the ACGIH particle size distribution curve (50% at 4µm) at flow rates between 8.5 and 9.5 LPM, per NIOSH Report ECM/2011/03. It is ideal for use with the Gilian 12 air sampling pump for larger volume sampling per the OSHA silica standard. The high flow rate range optimizes the sensitivity for respirable dust and respirable silica dust measurements. The RASCAL is used in conjunction with a 47 mm diameter, 5 micron pore size, PVC filter membrane.

New Disposable 47mm Pre-weighed Cassettes

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➢ Choosing the right Cyclone

FSP-10 High Flow European Style Cyclone

Gilian FSP-10 cyclone offers a high flow rate alternative for better sensitivity in silica sampling.

The new OSHA standard for silica dust requires larger air samples to attain improved sensitivity for lab analysis, and application of this high flow European cyclone is described in NIOSH Report ECM/2011/03 using a 37mm, 5 micron PVC filter membrane. Developed in Germany for 10 LPM sampling following Europe's 5 micron 50% particle size curve, it also conforms to the traditional US respirable dust curve (50% at 4 microns) at 11.2 LPM. The unit uses a European style 37mm filter holder, and is suggested for use with the Gilian 12 pump.

Sampling Strategies – Personnel Monitoring

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Alternative Sampling Devices – Impactors

- OHSA's adoption of the ISO 7708:1995 performance criteria for respirable samplers in the Final Silica Rule has opened the door for a variety of alternative devices such as impactors.

- Respicon
  - The Respicon TM and Respicon 2 TM, with their real-time particle detection and sizing, unites the best of both worlds in one single instrument. The aerodynamic separation and collection of inhalable, thoracic and respirable dust does not only allow a direct gravimetric but also a subsequent SILICA analysis. Additionally , the scattered-light photometers in every collection stage allow real-time recording of the dust concentrations.

Sampling Strategies – Direct Read Equipment

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➢ Alternative Sampling Devices

❖ Workplace Monitoring

The two dust monitors Respicon TM and Respicon 2 TM were designed as a personal dust monitors to be carried around by a worker during a shift, or suitable for stationary measurements. It can thus be employed in several ways:

- **to record dust exposure over time in a single location;**
- **to determine dust exposure of a worker during a shift;**
- **to find dust emission sources in a workplace environment.**

Respicon TM (3.11 LPM) and Respicon 2 TM (6.22 LPM) allow the collection and monitoring of the three fractions:

- **inhalable dust:** **particles < 100 µm**
- **thoracic dust:** **particles < 10 µm**
- **respirable dust:** **particles < 4 µm**

Due to the fractionizing principle, it is also possible to determine the mass concentrations of sub fractions, e.g. of the extra thoracic fraction (with particles between 10 µm and 100 µm).

Sampling Strategies – Direct Read Equipment

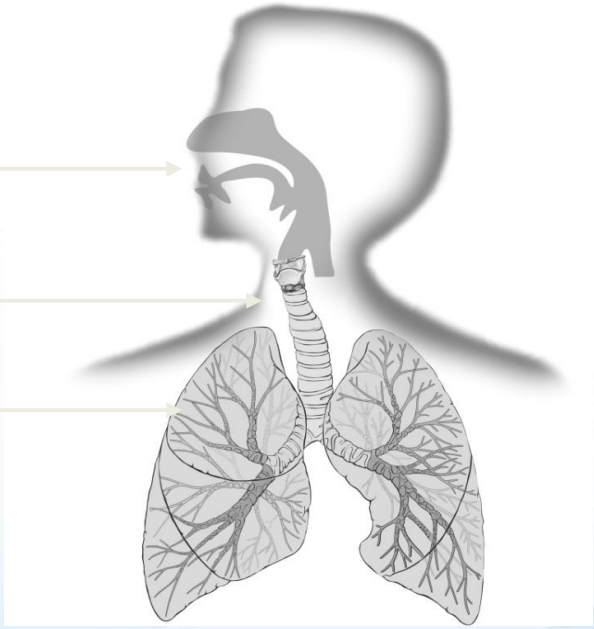
Respicon TM dust measurement system

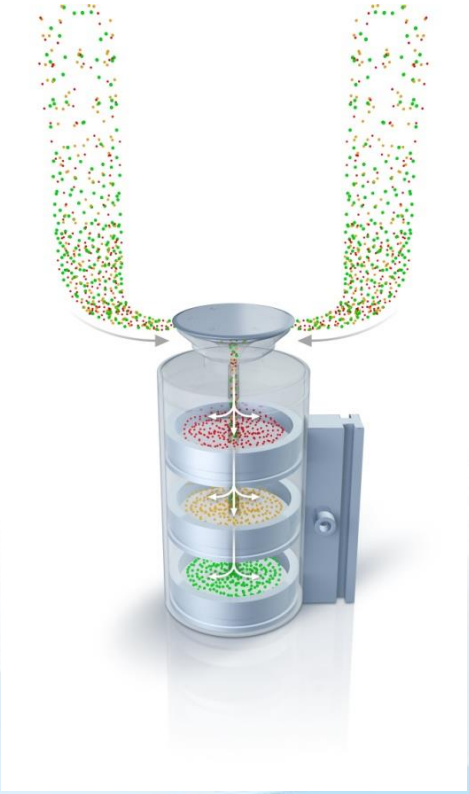
Unique combined gravimetric/photometric system

Inhalable dust fraction
10 -100 µm

Thoracic dust fraction
4 -10 µm

Alveolar dust fraction
< 4 µm





➔ The Respicon system is a simulation of the human breathing tract and measures the three fractions of dust humans are exposed to simultaneously

Sampling Strategies – Direct Read Equipment

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Respicon TM

Feature	Benefit for customer
⊙ One inlet fits for all size of dust particles (1-100µm)	-> Simple to use, no change of inlet needed during collection of dust *(inlet heads of competition units need to be changed*)
⊙ Combined online gravimetric and photometric measurement	-> Easy to calibrate and real time measurements possible
	-> Simultaneously measurement of dust mass and concentration
⊙ Dust is available on filter after the measurement	-> further chemical/Silica analysis of dust possible by means of filter analysis

Sampling Strategies – Direct Read Equipment

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Respicon TM dust measurement system

Unique combined gravimetric/photometric system Respicon TM

Respicon TM utilizes the Gilian 5000 at 3.11 LPM

Complete system on carrying belt

Respicon TM

Data Logger

Respicon 2 TM utilizes the Gilian 10i at 6.22 LPM

Method	Advantage	Disadvantage
Gravimetric	High accuracy	Slow, circumstantial
Photometric	Fast	Difficult calibration
Particle counting	Fast	Results depend on algorithms
Gravimetric/photometric	Fast, easy calibration	…

➔ **Respicon TM overcomes drawbacks of traditional measurement methods**

Sampling Strategies – Direct Read Equipment

Respicon TM dust measurement system

Unique combined gravimetric/photometric system

Respicon TM : Combined gravimetric/photometric system

	Respicon TM	Respicon TM II
Measuring Range	0 – 200 mg/m³	0 – 10 mg/m³
Sensitivity	20 mV/mg/m³	300 mV/mg/m³

Your major benefits

- Simultaneous online measurement
  - Inhalable dust
  - Thoracic dust
  - Respirable dust
- simple calibration of the results
- Comfortable operation and straight forward evaluation with PC SW

Main Application Areas

- Work place monitoring
- Construction sites
- Concrete production
- Wood processing
- Mining (over cut and deep)
- Welding fume
- Venting systems

➔ **Respicon TM combines the advantages of gravimetric and photometric measurement**

Sampling Strategies – Direct Read Equipment

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Sensidyne Nephelometer
Standard & Deluxe Models

Sampling Strategies – Direct Read Equipment

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What is a Nephelometer?

- The Sensidyne Nephelometer is a handheld analytical instrument used to measure airborne dust levels in real time.
- It works by measuring the light-scattering coefficient of aerosols drawn into a darkened chamber. Our Nephelometer incorporates a Laser light source.
- An extremely useful tool, a Nephelometer is lightweight, reliable and quite sensitive.

NOTE – A Nephelometer does *NOT* distinguish Silica from Other Particulates

Sampling Strategies – Direct Read Equipment

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Portable and Affordable

- Handheld
- Light-weight
- Long-life Batteries
- Internal Pump
- Rubber Protective Boot
- Lower Cost Than Other Direct Read Equipment

Sampling Strategies – Direct Read Equipment

Two Models

- The Standard Model is for Total Suspended Particulates (TSP) only.
- The Deluxe Model is for TSP, PM-10, PM-2.5, and PM-4 selectable. It has interchangeable impactors that can be placed at the inlet for size selection.

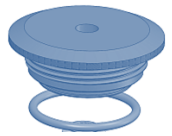
Sampling Strategies – Direct Read Equipment

Deluxe Model

Choose from four inlet options

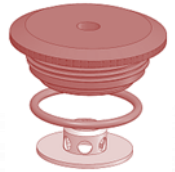
1) TSP (Open)
2) PM-10 Impactor
3) PM-2.5 Impactor
4) PM-4 Impactor

Zero Cap →



TSP

PM 10 Impactor



PM 4.0 Impactor

PM 2.5 Impactor

Sampling Strategies – Direct Read Equipment

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Ease-of-Use

Protective
Iso-kinetic Inlet

Select/Mode
- *1-Minute*
- *15-Minute STEL*
- *Continuous*

ON/OFF / Sample

Flow Adjust

Charging Jack

USB Port

Zero Cap

Two Key Operation

Common Issues Customers Experience

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Representative Sampling

- Workers often perform different tasks for different lengths of time. The PEL = 50 µg/m3 as an 8-hour TWA. However a task duration sample may be used as objective data to illustrate exposures during specific tasks and conditions. It may also be used for the purposes of delineating restricted work areas.
- Sampling may be done using cyclones with higher flow rates to achieve the minimum volume needed for laboratory detection limits. Direct read equipment may also be used to supplement the objective data.

Objective Data

- Includes air monitoring data from industry-wide surveys or calculations based on the composition of a substance
- Demonstrates employee exposure associated with a particular product or material or a specific process, task, or activity
- 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

Common Issues Customers Experience

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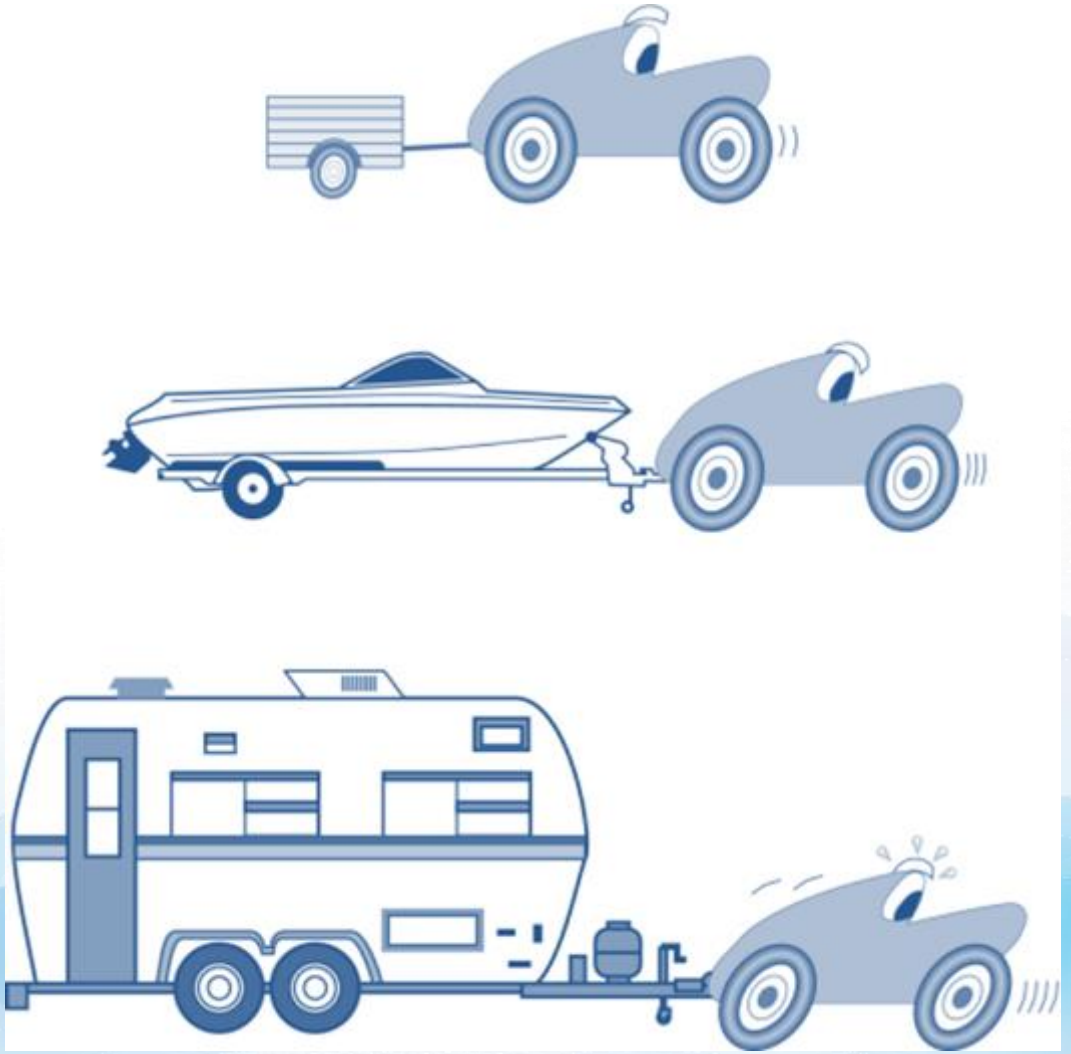
Back Pressure and Pump Faults

- A personal monitoring pump is working to move air against backpressure caused by the resistance of the sample media. The pump is like the car in the adjacent examples. The different types of sampling media with varying resistance to flow are like the trailers. The heavier the trailer, the harder the car has to work. The higher the backpressure, the harder the pump has to work.
- Backpressure can be effected by flow rates, filter pore size, and filter loading. To ensure your sample events do not experience pump faults, select pumps that are larger in size and have higher backpressure capabilities. The Gilian 5000, Gilian 10i, and Gilian 12 offer the highest Back Pressure capabilities.



Common Issues Customers Experience

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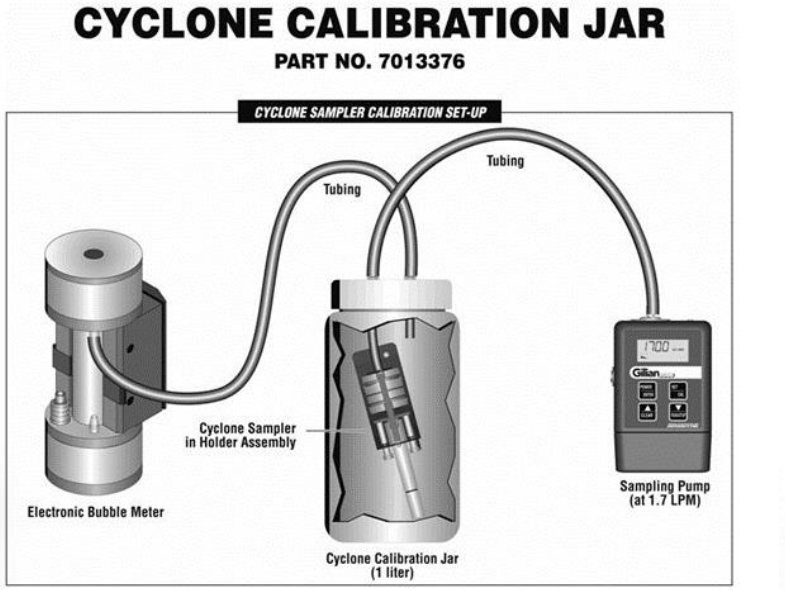
Flow Rates and Calibration

- Setting the correct flow rates are crucial in performing size selective particle sampling (Cyclones and Impactors). Deviations from the appropriate flow rates will cause the sample to misrepresent the concentration (High or Low).
- Post-Cal is used to obtain the final flow rate and to verify that the flow rate stayed within +/- 5% of the set flow. If it is outside the 5%, do not rely on the sample to be accurate.
- Several cyclones do not have an inlet attachment point that can be directly connected to a calibration device.
- Sensidyne has a Cyclone Calibration Jar that allows for calibration of the various cyclones on the market.



Common Issues Customers Experience

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Calibration Reliability

Stability

As sampling heads, like cyclones, rely on a steady flow to maintain a specific size “cut,” it is important for pulsation to be as small as possible. Deviation from the specified airflow for a cyclone will result in the sampled air not accurately reflecting the respirable size fraction.

Common Issues Customers Experience

Calibration Reliability

Advancement In Calibration Technology

The newest piston style calibrators have “pulse free valve technology”, providing low back pressure to the devices being calibrated. This unique patented design equalizes pressure on the pump, regardless of puck travel direction. This feature also allows for minimal disturbance of the airflow generated by the instrument under calibration, providing high calibration accuracy.

Common Issues Customers Experience

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Gravimetric vs Silica Concentration

- Sample analysis may be a combination of Gravimetric Analysis and Silica Analysis (XRD or IR). Take care not to confuse these two concentrations.
- Silica Concentrations will always be less than the total gravimetric concentrations and usually be broken out by Quartz, Cristobalite, and Tridymite
- This also holds true with direct read equipment. The concentrations measured with direct read equipment cannot distinguish between silica and other particle types (i.e. pollen, mold spores, etc.)

FILTER TYPE	MCE		MCE	PURE HOMOPOLYMER PVC	
					
PORE SIZE	0.8um	0.8um	0.8um	5.0um	5.0um
HOUSING STYLE	2PC 37MM	3PC 37MM	FILTER PAIRS ONLY	3PC 37MM	2PC 37MM
WEIGHT TOLERANCE	50ug	50ug	50ug	20ug	20ug
COLOR CODE	BLUE	BLUE	NONE	RED	RED
PACK SIZE	50/BOX	50/BOX	50 PAIRS/BX	50/BOX	50/BOX

QUESTIONS

???

Aaron W. Apostolico, CIH, CSP, CIEC

Product Line Manager – Health and Safety Products

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THANK YOU

Aaron W. Apostolico, CIH, CSP, CIEC

Product Line Manager – Health and Safety Products

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