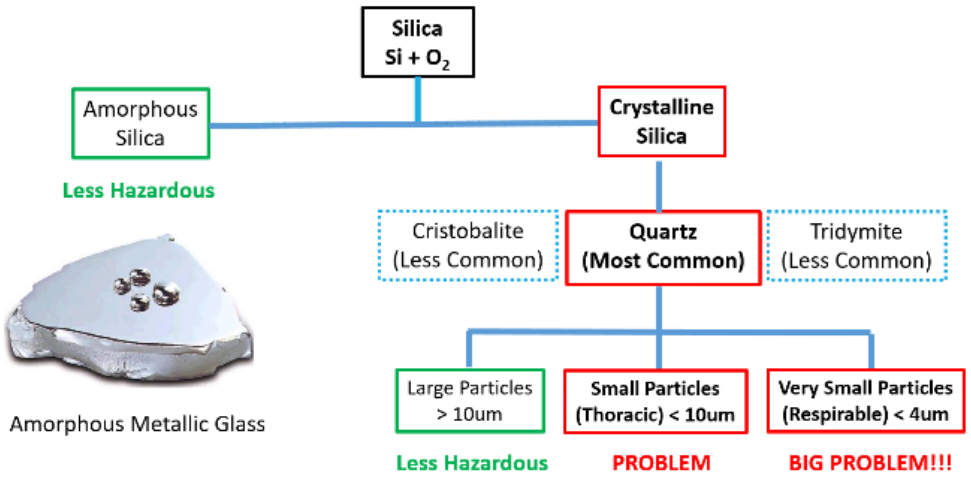
Types of silica dust in air



UK Statistics

How many cases of silicosis are there in the UK?

Results: For the period between 1996 and 2017, there were 216 cases of silicosis reported. The mean (range) age of those reported was 61 years (23-89), with the majority (98%) being male. Across all industries, 65% of cases were diagnosed in individuals of working age (<65 for men and <60 for women).

UK Statistics

An estimated 600,000 workers are exposed to silica each year in the UK.

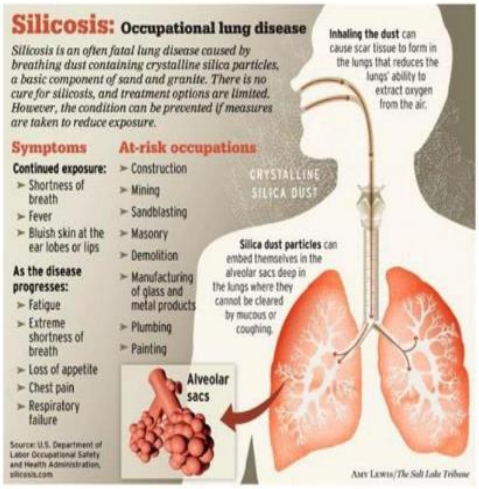
A 2019 Occupational and Environmental Medicine study of UK silica cases co-authored by researchers from HSE's Centre for Workplace Health concluded: "Silicosis remains an important health problem in the UK affecting workers of all ages across a wide range of industries traditionally associated with silica exposure." It added "the majority of workers reported to have silicosis were still of working age."

The authors noted: "Silicosis was reported in young workers across all industry groups, with around one in six of all silicosis cases affecting workers under the age of 46 years."

How Does Silica Affect Us?

Exposure to respirable crystalline silica has been linked to:

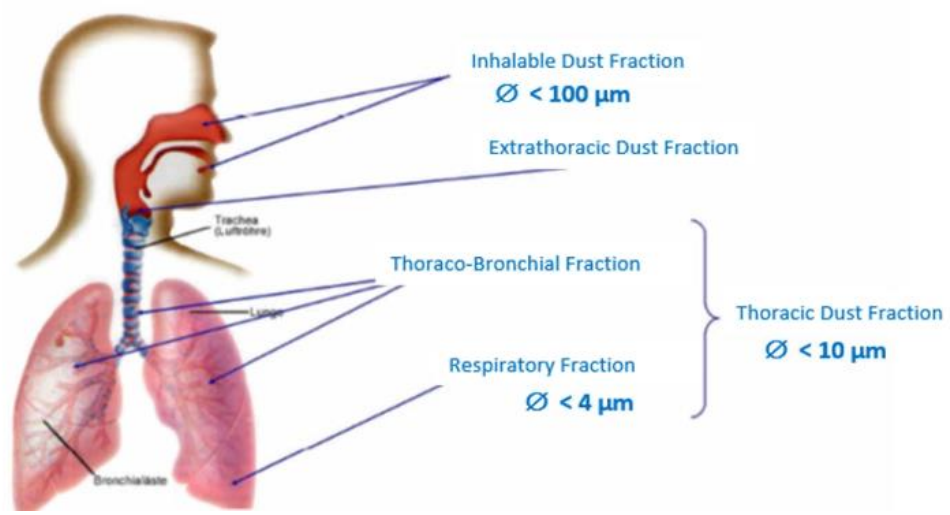
- Silicosis
- Lung Cancer
- Chronic Obstructive Pulmonary Disease
- Kidney Disease
- Autoimmune Diseases
- TB/Silicotuberculosis - Susceptibility



Disease may occur YEARS to DECADES later!!!

Dust Deposition

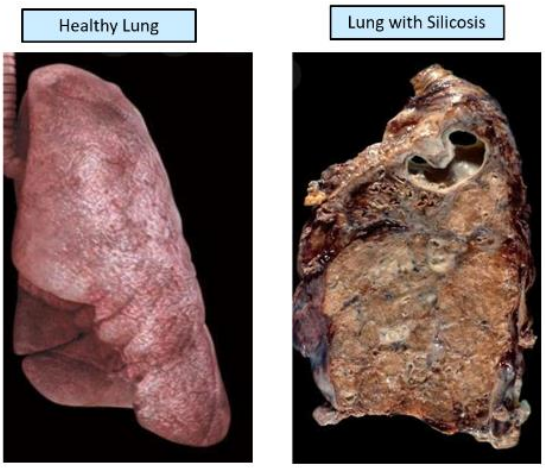
Human Respiratory Tract:



Types of Silicosis

Health Effects

- Three types of Silicosis:
  - Chronic: Problems may not show up until decades after you're exposed to low or moderate amounts of silica. It's the most common type of silicosis. Symptoms may be mild at first and slowly worsen.
  - Accelerated: You'll notice signs about 5 to 10 years after heavy exposure to silica. They'll worsen quickly.
  - Acute: Symptoms happen a few weeks up to 2 years after exposure to a large amount of silica.
- Permanent and Irreversible
- Can be either debilitating or deadly



Crystalline Silica Health Effects

Effects of silica on the lungs

- Microscopic lacerations of the alveoli
- Formation of scar tissue
  - Creation of fibroids
  - Non-detectable until ~1cm in size
  - Now observable on a radio graph (x-ray)
- Scar tissue & fibroids prevent the exchange of gasses in the lung tissue
  - Oxygen and Carbon dioxide
- The body will be starved for O2
- The condition is irreversible
  - Bronchio-dialators may provide temporary relief early on
- Medical oxygen may be necessary as the disease progresses
- Patients have cough, shortness of breath (SOB), weakness and tiredness
  - May lead to death
- Diagnosed by a work history and chest X-ray (CXR) +/- pulmonary function testing (PFTs)
  - Often misdiagnosed as TB

Normal CXR

Small parenchymal opacities

Large parenchymal opacities

Smoking & Silica

Cigarette smoking adds to the lung damage caused by silica, and contributes significantly to the development of lung disease.

Risk Assessment

How do you know which employees are being exposed?

Risk assessment includes:

- Hazard Assessment – identify anything that may cause harm
  - Perform Personnel Monitoring
  - Perform Area Monitoring
  - Review Objective Data
- Risk – determine the severity and likelihood that exposure to a hazard will cause injury or disease
  - Frequency of Exposure
  - Duration of Exposure
  - Concentration Present Compared to the OEL
- What actions can prevent/mitigate exposures to the hazard
  - Develop a Program
  - Utilize the Hierarchy of Controls
  - Continuous Improvement

Various Respirable Crystalline Silica Rules

Several International Standards and Rules:

- UK HSE has a permissible exposure limit of 0.1 mg/m3.
- United States has a permissible exposure limit of 0.05 mg/m3, and an action limit of 0.025 mg/m3.
- Canada has a permissible exposure limit of 0.025 mg/m3 for respirable silica.
- Colombia, Costa Rica and Mexico follow ACGIH, so TLV-TWA for Silica α-quartz and cristobalite is 0.025 mg/m3.
- Brazil calculates Silica % first, but also uses the value is 0.025 mg/m3 for a standard.
- Argentina has separate standards for Silica Quartz at 0.025 mg/m3, and Cristobalite at 0.05 mg/m3.
- Perú has a limit 0.05 mg/m3 by regulation D.S. 015-2005-SA
- South Africa has a limit 0.05 – 0.10 mg/m3

QQ from HSE

Need to comply: COSHH 2002,

for RCS, control measures must be effective in keeping exposure below the Workplace Exposure Limit (WEL) (0.1 mg/m3 respirable dust, averaged over 8 hours);

monitor to ensure that controls are effective and that the WEL for RCS is not exceeded, (this may include measurement of the dust levels in your work are

Do not: dry sweep – use a vacuum of dust class M or H, or wet cleaning; use compressed air for removing dust from clothing.

Dust extraction equipment should have an airflow indicator to show that it is working properly.

UNQQ

US OSHA Respirable Crystalline Silica Rule

Shares Similar Requirements to Canada, Central and South America Standards

Alternative Exposure Control Methods – Permissible Exposure Limit (PEL)

- OSHA PEL = 50 µg/m3 as an 8-hour TWA
- OSHA Action Level = 25 µg/m3 as an 8-hour TWA
- ACGIH TLV = 25 µg/m3 as an 8-hour TWA * (Most Central and South American OELs Based on ACGIH TLV)

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

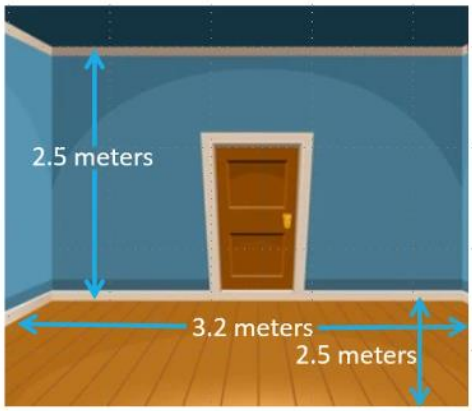
- Includes air monitoring data from industry-wide surveys or calculations based on the composition of a substance
- Demonstrates employee exposure associated with a particular product or material or a specific process, task, or activity
- Must reflect workplace conditions closely resembling or with a higher exposure potential than the processes, types of material, control methods, work practices, and environmental conditions in the employer's current operations

Silica PEL Perspective

1,000 µg in the air of this room = 50 µg/m^3

500 µg in the air of this room = 25 µg/m3

500 µg of silica in each small pile adjacent U.S. Dime.



20 cubic meters of air

Action Level (AL)

OSHA Action Level – Medical Exams

Beginning on June 23, 2020, U.S. employees must offer their employees a medical exam if their employees will be exposed to silica at or above the action level of 25 µg/m^3, averaged over an 8-hour work day, for 30 or more days in a year.

Written Exposure Control Plan

The written plan must describe:

- Person responsible for implementing the plan
- All task that may involve exposure to silica
- For each task the specific methods used to limit silica exposure
- General housekeeping measures used to limit exposure to silica

Regulated Areas

The employer shall post signs at all entrances to regulated areas that bear the following legend:

"DANGER RESPIRABLE CRYSTALLINE SILICA

MAY CAUSE CANCER

CAUSES DAMAGE TO LUNGS

WEAR RESPIRATORY PROTECTION IN THIS AREA

AUTHORIZED PERSONNEL ONLY"

Medical Surveillance

Medical Surveillance must be offered:

- Within 30 days of assignment
- Every 3 years

Medical Exams for Silica must include:

- Medical and work history
- Physical exam
- X-rays
- Tuberculosis (TB test) – A TB test is done only for the initial exam, which is the first exam that you receive under the silica standard
- Lung function test – This involves using an instrument called a spirometer to measure how much air you can blow out and how fast you can blow it out after taking a deep breath

QQ HSE

Your employer may also need to arrange for you to be placed under health surveillance. This may include: □ health and working history questionnaires; □ lung function tests; □ chest X-rays.

Decisions on the appropriate form of health surveillance may require the advice of an occupational health professional. The precise form of health surveillance will depend on the particular circumstances of exposure (level, frequency and duration) identified by the risk assessment.

UNQQ

Other Required Training

Employers must have other H &S programs and training to support:

- Hazard Communication Program
  - Review of materials being used and associated hazards (i.e. SDS)
- Respiratory Protection Program

Copy Of The Standard

Employers must make a copy of the regulatory standards available to employees upon request

- Country
- State
- Region
- Local

Recordkeeping

Employers must:

- Keep medical and exposure records
  - Duration based on regulatory requirements
- Make them available upon request

Alternate Exposure Control Methods – Exposure Assessments

Regulators require that employers do the following:

- Identify potential exposures
- Perform representative air sampling
- Let representatives observe
- Give employees results
- Create Exposure Control Plans

Written Exposure Control Plan - UK

When health surveillance is required

■ Health surveillance for silicosis must be considered for workers who are involved in high-risk occupations, including construction, foundry work, brick and tile work, ceramics, slate, manufacturing, quarries and stonework.

■ Where workers are regularly exposed to RCS dust and there is a reasonable likelihood that silicosis may develop, health surveillance must be provided.

■ Further examples of where health surveillance for silicosis may be appropriate include:

– where there have been previous cases of work-related ill-health in the workplace;

– where there is a reliance on Respiratory Protective Equipment (RPE) as an exposure control measure for RCS; or

– where there is evidence of work-related ill-health in the industry.

Measuring Exposure To Silica

Why Measure The Concentration Of Silica?

- To prevent disease and protect people from silica by identifying where the exposure is highest
- To determine how much silica is actually present and ensure a safe and healthy workplace
- To evaluate the controls by demonstrating which ones work best
- To improve the health and productivity of the workforce

Measuring Exposure To Silica

Collection of Samples

- Dust particles from the air are pulled into a sampling device using a pump and collected onto a filter
- The smaller sized respirable particles must be separated from the larger particles when measuring exposures using a size-selective device
- Various Cyclones or personal impactors may be utilized
- Need to take multiple samples due to variability

Measuring Exposure To Silica

Proper Sampling For Silica

- The sampling pump should be worn for the entire duration of the work shift for TWA personal monitoring
  - Results can be compared to occupational exposure limits
  - OELs are often the basis for assessing risk, making recommendations, and instituting controls
- Short Term or task sampling may be helpful in some cases
  - Ensure that the minimum volume is collected
  - Higher flow rates may be required
  - Used to validate controls
- Area sampling may be helpful in some cases
  - Real-time monitoring for particulates
  - Fixed systems can perform continuous monitoring

Measuring Exposure To Silica

Air Sampling For Silica

- The flow rate of the sampling pump must be carefully calibrated to
  - Ensure pump is collecting for the correct size particle diameter (Respirable < 4um)
  - Calculate the total volume of air sampled
- The filters will be sent to a laboratory and analyzed for crystalline content using two methods
  - X-ray diffraction
  - Infrared analysis
- The filter is also weighed before and after sampling to determine the total weight of respirable dust

Sampling Strategies – Personnel Monitoring

Air Sampling According to the New OSHA Standard

- Six existing sampling methods are identified in the 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 min. x 8 hours = 816 L = 0.816 CM. This may not be enough volume to 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 possible 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. This may be achieved 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.

Aaron Apostolico is sharing

Sampling Strategies – Personnel Monitoring

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 appropriate size selection curve (i.e. 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.

Sampling Strategies – Personnel Monitoring

Choosing the Right Cyclone

- Cyclones with various flow rates and media sizes are available for numerous applications
  - Consider how visibly dusty is the process or environment
  - How long do you need to sample (i.e. task less than 1 hr)
  - Consider the diameter and pore size of the filter
  - Know the back pressure capability of the pump
  - Is your media pre-weighed
  - Is your filter media pre-loaded into cassettes
  - Know the manufacturer's flow rate specification for the device selected
    - Some cyclones can independently measure thoracic and respirable fraction, and have a unique flow rate for each

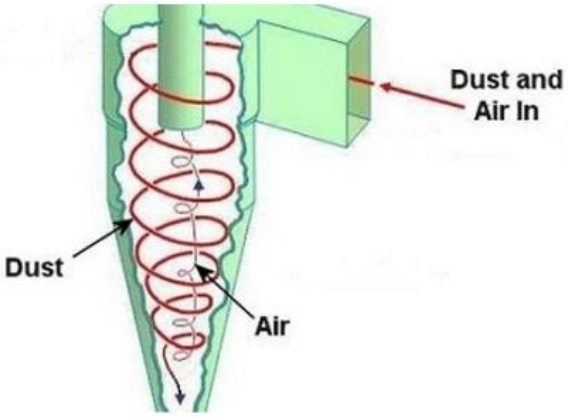
Pre-weigh filter.

Task Time & Aprox. Volume of the boiler.

Sampling Strategies – Personnel Monitoring

Cyclones

- Centrifugal force spins dust particles to inverted cone base
- Heavy particles drop out into a grit pot
- Lighter (respirable) particles are pulled up on to the filter medium



Sampling Strategies – Direct Read Equipment

What is a Dust Meter/Nephelometer?

- A Dust Meter/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.
- Instruments incorporate a Laser light source.
- Some have interchangeable Inlet Heads for various fractional sizes
- Can be an extremely useful tool for screening and validating controls, is lightweight, reliable and quite sensitive.

NOTE – Dust Meters and Nephelometer do NOT distinguish Silica from Other Particulates

Common Issues Customers Experience

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.

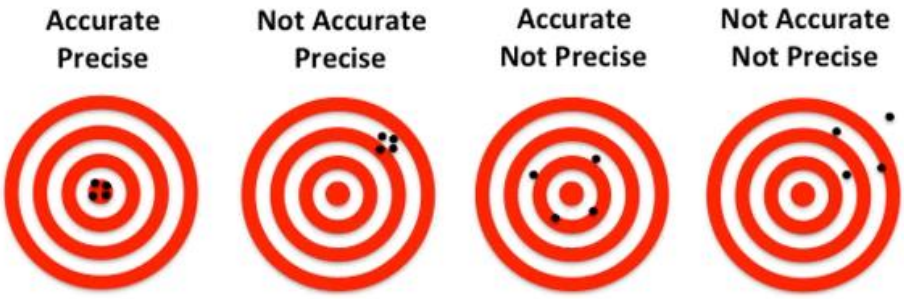
Objective Data

- 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

Calibration Reliability – Accuracy and Precision

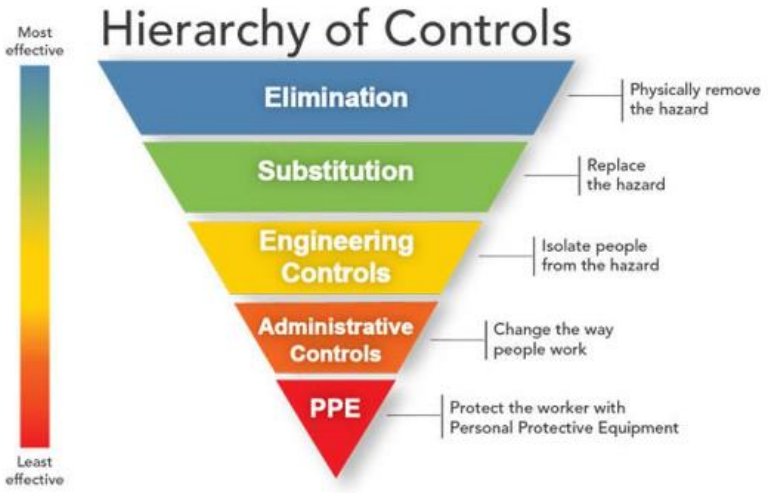
- Accuracy and precision are two ways of measuring targeting. Although accuracy is intuitively understood and desirable, precision is often confused with accuracy, where the measurements are not representing the true value.
- If successive results agree, a false sense of confidence may be formed that is not merited. When a group of results are precise, they have minimal deviation. When they are accurate, they are close to the desired target.



Hierarchy of Controls

Hierarchy of Controls:

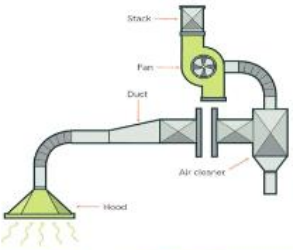
- Elimination
- Substitution
- Engineering controls
  - Wet methods
  - Isolate the process
  - Isolate the worker
- Administrative Controls
- Personal protective equipment



Engineering Controls

Change the process to reduce exposure:

- Retrofitting or purchasing equipment capable of wet or dry methods for cutting, sawing, etc.
- Enclosing the process to remove the worker from the hazard
  - Glove box for sandblasting
  - Covers on conveyor belts
  - Ventilation
  - Cabs for construction/mining equipment
- Visual dust emissions indicate that a control is needed
- Engineering controls (primarily wet methods) found to be the most cost-effective silica control strategy in developing and developed countries



Ventilation = Engineer Control.

Visual Dust = control needed.

Engineering Controls: Wet Methods

Wet methods can significantly reduce exposures, but require pre-planning:

- Cutting with saws equipped with water basin
- Drilling with water pump through the drill stem
- Grinding and hammering on pre-wetted surfaces
- Fogging or steaming to suppress dust in areas where dust is generated
  - Wet spray misting is important to reduce exposure to smaller particles

Dry sawing concrete

Wet sawing concrete
Water is added at saw blade

Notice puddle at feet of wet saw operator. It contains the same amount of dust as seen in picture of dry saw operator. What happens to the dust when puddle dries?

Could we pre- wet/ Fogging/Steaming surface?

Need HEPA vac to take up residues.

Engineering Controls: Dry Methods

The most common dry collection method is vacuum dust collection:

- May be more expensive and require electricity.
- Cutting with a vacuum system affixed to the saw blade
- Drilling with an enclose around where the drill enters the surface
- Grinding with a shroud that surrounds the grinding wheel

Administrative Controls

Recommend policies and procedures to:

- Perform routine housekeeping to reduce dust sources in the cab
- Prohibit dry sweeping and implement wet sweeping methods
- If services are available, institute a medical monitoring program
- Consider keeping doors and windows closed for worksite machinery
- Educate and train employees on the hazards of working with RCS

Prohibit dry sweeping.

Administrative Controls

Example of Work Practice Controls:

- Use of HEPA Vacuum or Wet Sweep versus Dry Sweeping

or

vs

TOOLBOX TALK: Silica Dust To: Managers

Education & Training

It is important for employees to:

- Be informed of the hazards of working with silica
- Be able to recognize when the hazard is present
- Know how to prevent themselves from being exposed
- Know how to operate engineering controls
- Be familiar with required PPE and how to wear it

Personal Protective Equipment (PPE)

Respirators may be of immediate assistance

- Half-face
- Full-face
- Filtering face piece

Respirators are a good method to prevent exposure if engineering controls aren't in place, but they have limitations, including:

- Highly dependent on seal
  - Employees should be instructed on seal checks
- Require regular change-out
- Must be medically fit

Know the correct PPE to use and filters to be changed regularly.

What can employers do?

Employers can:

- Keep dust levels down
  - There are a several different ways of keeping dust levels down on your 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
  - As every region has 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.

Ensure workers follow and exposure monitoring & testing needs to be done.

What can employees do?

Employees can:

- Use all available engineering controls such as blasting cabinets and local exhaust ventilation.
- Avoid using compressed air for cleaning surfaces.
- Use water sprays, wet methods (e.g. wet spray misting) for cutting, chipping, drilling, sawing, grinding, etc.
- Substitute non-crystalline silica blasting material.
- Use respirators approved for protection against silica; if sandblasting, use abrasive blasting respirators.
- Do not eat, drink or smoke near crystalline silica dust.
- Wash hands and face before eating, drinking or smoking away from exposure area.
- Quit smoking