Introduction

• Silica Exposures in Construction
• Welcome! Over the next hour, this session will provide basic information on controlling silica exposures in construction.
  – Crystalline silica hazard
  – Jobs tasks that put you at risk
  – Various engineering controls
  – Proper work practices
Introduction

• Agenda
• This session will cover potential silica exposures in:
  – Use of specific equipment
  – Performance of various operations
  – General housekeeping
• This module is based primarily on the OSHA guidance document “Controlling Silica Exposures in Construction” publication number 3362_04.
Introduction

• References
• Occupational Safety and Health Administration
  – 29 CFR 1926.55(a)
  – 29 CFR 1926.404(b)(1)
  – 29 CFR 1926.103
• National Institute for Occupational Safety and Health
• American Conference of Governmental Industrial Hygienists

Tip: The Occupational Safety and Health Act of 1970 (OSH Act) encourages states to develop and operate their own job safety and health plans. OSHA approves and monitors these plans. Twenty-four states, Puerto Rico, and the Virgin Islands currently operate approved state plans. States and territories with their own OSHA-approved occupational safety and health plans must adopt standards identical to, or at least as effective as, the Federal OSHA standards.
Crystalline Silica

• What Is Silica?
• Dusts containing crystalline silica are produced by cutting, grinding, crushing, or drilling materials.
  – Small particles suspended in air
  – When inhaled, penetrate deep into lungs
  – Known to cause silicosis, a serious lung disease
  – Increases risk for lung cancer, other diseases

Safety Tip: The term “silica” used in this course refers to respirable crystalline silica.
Crystalline Silica

• What Is Silica? (cont.)
• Quartz is the most common form of crystalline silica.
  – Brick and mortar, concrete
  – Slate, tile
  – Dimensional stone, stone aggregate
  – Sand used for blasting
• Asphalt filler, roofing granules, plastic composites, soils, joint compounds, paint, plaster, caulking, putty
• Cristobalite:
  – A less common form of crystalline silica.
  – Formed at high temperatures (>1,470°C)
  – The ceramic and brick lining of boilers and vessels, some ceramic tiles, and volcanic ash contain cristobalite.

Safety Tip: Quartz is the second most common surface material—accounting for almost 12% by volume of the earth’s crust.
Crystalline Silica

- Visible and Respirable Dust
- Dust-generating activities produce a mixture of visible and respirable particles.
  - Respirable dust poses the greatest hazard.
    - Tiny particles
    - Not visible
    - Able to get deep into lungs

Safety Tip: Never rely on visible dust alone to determine the extent of the silica hazard.
Crystalline Silica

- Permissible Exposure Limit
- PEL for crystalline silica is expressed differently.
  - Construction (particle count method): millions of particles per cubic foot, or mppcf (Now obsolete)
    - Current method: respirable mass or gravimetric sampling, expressed in milligrams per cubic meter (mg/m³).
  - General industry (gravimetric sampling): milligrams per cubic meter, or mg/m³
- OSHA benchmark: 8-hour time-weighted average exposure of 0.1 mg/m³ of respirable silica dust

Safety Tip: Measures that control tool-generated dust at the source usually reduce all types of particle emissions, including respirable particles.
Crystalline Silica

• Permissible Exposure Limit (cont.)

• Other organizations have recommended lower PELs.
  – NIOSH: 0.05 mg/m³ as a time-weighted average for up to 10 hours
  – ACGIH: 0.025 as an 8-hour time-weighted average

Safety Tip: OSHA is continually reviewing the construction and general industry PELs for silica in its ongoing silica rulemaking.
Silica Dust Control Measures

• General Methods of Control
• Depending on your task, dust exposures may be reduced in multiple ways.
  – Dust suppression (wet methods, surfactants, etc.)
  – Vacuum dust collection (VDC)
  – Respiratory protection
  – Ventilated booths
  – Operator isolation
  – Fans (supplement only)
Silica Dust Control Measures

- Wet Dust Suppression

- Wet dust suppression techniques use water sprays to wet material so that it generates less dust.
  - Often easiest and most effective dust control
  - Harder for wet dust to become airborne
  - Water applied in different ways to suit situation
  - Construction employees can use a variety of equipment (portable garden sprayer, fire hose)
Silica Dust Control Measures

• Wet Methods: Freezing Temperatures
• Freezing temperatures complicate the use of water.
  – Consider heating the local work area.
  – Drain systems that are not in use.
  – Chip away ice and sand to control slipping.
Silica Dust Control Measures

- Wet Methods: Electrical Safety
- Electrical safety is very important in wet areas.
  - Ground-fault circuit interrupters (GFCIs)
  - Watertight, sealable electrical connectors
  - Assured equipment grounding conductor program
Silica Dust Control Measures

• Dust Collection Systems

• A vacuum dust collection system (VDC):
  – Pulls dust away from source
  – Dust collector, vacuum, vacuum hose, filter(s)
  – Ensure system is clean and free of leaks or cracks

Safety Tip: It’s a good idea to choose a vacuum equipped with a back-pulse filter cleaning cycle. Such auto-cleaning mechanisms will reduce the time required for vacuum maintenance and improve overall efficiency. If the vacuum does not have an auto-cleaning mechanism, the employee can periodically turn the vacuum cleaner on and off, which allows the bag to collapse and causes the prefilter cake to dislodge from the filter.
Silica Dust Control Measures

- VDC System Selection
- Dust collector: use appropriate size, follow manufacturer’s instructions
- Vacuum: appropriate power capacity for the job
- Vacuum hose: airflow resistance increases as diameter shrinks and length increases
- Filter(s): double filtration is crucial; use a high-efficiency particulate air (HEPA) filter

Safety Tip: Review manufacturers’ operating specifications and recommendations for your equipment.
Silica Dust Control Measures

- Respiratory Protection
- Factors affecting respiratory protection systems:
  - Enclosed versus open spaces, # of operations generating silica dust, wind direction and speed, the percentage of silica found in materials
- Respirators are required if dust control measures are otherwise insufficient.
  - Written respiratory protection program
    - Selection and use of respirators
    - Medical evaluations and fit testing
    - Maintenance and cleaning
    - Required training

Safety Tip: Employees working near operations where silica dust is generated may need respiratory protection even if they themselves are not performing a task that exposes them to crystalline silica.
Silica Dust Control Measures

- Levels of Respiratory Protection
- Respiratory protection depends on level of exposure.
  - Open versus closed work environment
  - Number of operations generating dust
  - Wind direction
  - Percentage of silica in material
- Must have N-, R-, or P-95 filter
- Half-facepiece or disposable: up to 1.0 mg/m³
- Full-facepiece: up to 5.0 mg/m³

Safety Tip: Caution, levels of respiratory protection may change, stay informed of changes.
Silica Dust Control Measures

• Fans

• Do not use fans as your sole method of dust control.

• Fans may supplement other control methods.
  – Useful in enclosed spaces
  – The bigger the better
  – Best with two open windows or doors

Safety Tip: The use of compressed air to clean surfaces or clothing is strongly discouraged. Using compressed air to clean work surfaces or clothing can significantly increase employee exposure, especially in enclosed and semi-enclosed spaces. Cleaning should be performed with a HEPA-filtered vacuum or by wet methods.
Silica Dust Control Measures

• Hazardous Equipment and Operations
• Equipment and operations that may expose workers:
  – Stationary and handheld masonry saws
  – Hand-operated grinders
  – Tuckpointing/mortar removal
  – Jackhammers, rotary hammers and similar tools
  – Vehicle-mounted rock drilling rigs
  – Drywall finishing
  – General housekeeping operations

Safety Tip: If you choose to modify equipment, it is important to follow equipment manufacturers’ recommendations in order to ensure that modifications do not adversely affect equipment performance and that no additional hazards are created.
Stationary Masonry Saws

• Hazard

• Using stationary masonry saws can result in hazardous levels of airborne silica.
  – Cutting bricks, concrete blocks, similar materials
  – Exposures 20 times OSHA PEL
  – Always use dust control measures
Stationary Masonry Saws

- Hazard Control
- Two primary methods:
  - Wet cutting (does not typically require respirator)
  - VDC (requires respirator)
- Third method: ventilated booths

Safety Tip: Data indicate that vacuum dust collection alone can only reduce exposures to 0.4 mg/m³. Therefore, to supplement this control option, employees may need to wear respiratory protection.
Stationary Masonry Saws

• Wet Cutting
• Wet cutting is the most effective method for controlling silica dust generated during sawing.
  – Controls exposure at its source
  – Exposures below 0.05 mg/m³ as an 8-hour TWA
  – Most stationary saws equipped with a water basin
    • Typically holds several gallons of water
    • Pump for recycling water for wet cutting

Safety Tip: Results obtained by OSHA and NIOSH at five construction sites indicate that wet masonry saw operators’ exposures were routinely below 0.1 mg/m³, and usually below 0.05 mg/m³, not only when averaged over an 8-hour shift, but also during just the period evaluated. In comparison, OSHA reported a significantly higher exposure at another site on a day when wet methods were not used due to cold weather.
Stationary Masonry Saws

• Vacuum Dust Collection
• VDC systems offer an alternative to wet methods.
  – Commercially available
  – Able to capture a substantial amount of dust
• Vacuum pulls dust from cutting point through:
  – Fittings connected to the saw (fixed-blade)
  – Exterior hood connected to the back (plunge-cut)

Safety Tip: Erect baffles on either side of the saw to improve dust capture by rear-mounted dust collection devices (exterior hoods).
• Vacuum Dust Collection (cont.)

• To prevent clogging:
  – Maintain sufficient airflow
  – 25 cubic feet per minute per inch blade diameter (ACGIH recommendation)
Stationary Masonry Saws

- Ventilation Booths
- A booth erected around a saw can help reduce dust.
  - Minimize the size of the operator opening.
  - Do not let the saw blade protrude.
  - Build a trapdoor into the lower back for cleaning.
  - Ensure fan does not blow dusty air onto others.

Safety Tip: Use a fan large enough to provide an average of 250 feet per minute air velocity across the face of the operator opening.
Handheld Masonry Saws

• Hazard

• Operating gas-, air-, electric- and hydraulic-powered handheld masonry saws can cause silica exposures.
  – Operating outdoors without dust controls: as high as 14 times OSHA benchmark of 0.1 mg/m³ (8-hour TWA)
  – Operating indoors or short-term: up to 10 mg/m³
Handheld Masonry Saws

- Hazard Controls

- Wet cutting
  - Outdoor exposures usually ≤ 0.1 mg/m³
    - May not need respiratory protection
  - Indoor exposures usually ≤ 1 mg/m³
    - May need half-facepiece, disposable respirator

- VDC
  - Outdoor or indoor exposures may be > 0.1 mg/m³
    - May need full-facepiece respirator

Safety Tip: Employers should conduct exposure monitoring periodically while controls are being used to ensure that the controls are working properly and that the appropriate level of respiratory protection is in place.
Handheld Masonry Saws

• Wet Cutting
• Most handheld saws have water-fed equipment.
  – Use pressurized portable water supply, or constant water source (e.g., municipal supply)
  – For saws without water-fed feature - apply water directly to cutting point
  – Maintain rate of $\geq 0.13$ gallons per minute

Safety Tip: One study found that respirable dust levels were reduced by up to 94 percent for pressurized portable water supply systems and up to 96 percent for a constant supplying water source.
Handheld Masonry Saws

• Vacuum Dust Collection
• Handheld saws can be equipped with VDC systems.
• Study result:
  – A VDC system on the handheld saw reduced mean respirable concrete dust concentrations from 8 mg/m³ to 0.7 mg/m³ (88 percent reduction in respirable concrete dust).
  – However, this study used a dust collection device that may not be commercially available, and other studies have shown that handheld VDC-equipped saws do not offer a reliable reduction in exposure to dust.

Safety Tip: The American Conference of Governmental Industrial Hygienists (ACGIH) recommends airflow of 25 CFM per inch of blade diameter.
Hand-Operated Grinders

- Hazard
- Grinder operators’ silica exposures are among the highest in the construction industry.
  - Regularly above 0.2 mg/m3
  - During periods of intensive grinding:
    - Outdoors: ≥ 1.2 mg/m3
    - Indoors: ≥ 4.5 mg/m3
Hand-Operated Grinders

- Hazard Control
- Wet grinding: unlikely to need respiratory protection
- VDC: likely to need respiratory protection
- Adjustments in work methods and equipment

Safety Tip: The stone processing industry has shown that water-fed grinders function well to control dust even on uneven surfaces and near corners and edges, often problem areas for vacuum dust collection equipment.
Hand-Operated Grinders

• Wet Grinding
• Wet grinding is highly effective to reduce dust, consistently keeping silica exposures below PEL.
  – Water-fed equipment is commercially available.
  – Conventional equipment can be retrofitted.
  – A helper can apply water by hand (spray nozzle).

Safety Tip: Water-fed equipment is regularly used to control dust during granite and concrete grinding and polishing operations, as well as during concrete and masonry cutting with abrasive wheels.
Hand-Operated Grinders

• Wet Grinding Equipment and Training
• Tools for wet grinding include a nozzle or spout that provides a stream of water to the grinding wheel.
• Training is required for water-fed grinders.
  – Wet surface looks different from dry one
  – Obscured visibility (water spray, slurry)
  – Slurry removal requires extra cleaning

Safety Tip: Avoid splashing concrete slurry on vehicles or other objects with specialty finishes.
Hand-Operated Grinders

• VDC System
• Where wet methods are not appropriate or feasible, VDC systems can be an alternative control option.
  – Purchased or retrofitted
  – Shroud which surrounds the grinding wheel
  – Effectiveness depends on several factors.
    • User’s technique
    • Surfaces being finished
    • Efficiency of the dust collection system

Safety Tip: The addition of the shroud and vacuum hose may make it more difficult to work effectively while reaching overhead.
• Work Methods and Equipment
• Adjustments in methods and equipment can lower exposure levels.
  – Employee positioning: increase distance from grinding point (e.g., use a pole)
  – Type of wheel: smallest, least aggressive possible
Hand-Operated Grinders

• Work Methods and Equipment (cont.)
• Where possible, minimize pouring, casting, finishing, and installing concrete.
  – Minimize flaws and defects.
  – Ensure tight-fitting forms.
  – Finish grinding on pre-cast panels outdoors.
  – Use factory installed chase and grooves.
  – Grind while concrete is still “green.”
  – Remove some material as larger chips.
Tuckpointing/Mortar Removal

- Hazard
- Removing mortar from brick, stone, and concrete block units (tuckpointing) generates significant amounts of silica-containing dusts.
  - Among the highest amounts in construction
  - More than half of exposures exceed 1.0 mg/m³
  - Frequently reach 2.4 mg/m³ and higher

Safety Tip: Brick and building renovation masons have been diagnosed with silicosis.
Tuckpointing/Mortar Removal

- Hazard Control
- VDC (likely requires respiratory protection)
- Wet methods are not generally used.
  - Deposit a slurry of mortar dust and water
  - Water may penetrate building envelope.
Tuckpointing/Mortar Removal

- VDC System
- VDC systems are the most readily available means for controlling silica dust during tuckpointing.
  - Can lower silica exposures substantially
  - Require careful work practices
  - Generally will not reduce dust levels below PEL

Safety Tip: Purchasing a dust collection system equipped with a static pressure gauge allows the employee to monitor the system’s efficiency. Systems lacking a static pressure gauge can be monitored visually. If a dust plume increases and becomes more visible where the shroud meets the working surface, the system is not working efficiently.
Tuckpointing/Mortar Removal

- **Work Practice Controls**
- VDC may be improved by proper work practices.
  - Blade insertions: place left-hand side of the shroud against working surface
  - Blade depth: maintain full depth of cut
  - One-way movement: 2nd pass only if necessary
  - Grinding direction: counter to blade rotation
  - Blade removal: back off before removing
  - Force: normal (not excessive) force

Safety Tip: Leaving a large gap between the shroud and uncut mortar and not utilizing a high enough airflow exhaust rate will allow dust to escape and may expose employees to high levels of respirable silica. Reducing the size of the gap significantly and maintaining a high exhaust airflow rate ensures that most of the dust generated from tuckpointing is captured.
Jackhammers

• Hazard
• Employees produce dust containing silica when using jackhammers to chip and break rocks or concrete.
  – May exceed OSHA’s benchmark of 0.1 mg/m³ as an 8-hour time-weighted average
Jackhammers

- Hazard Control
- Wet methods: manual and semi-automatic water-feed devices
- Respiratory protection: disposable air purifying respirator or half- or full-facepieces may be required.

Safety Tip: Water flow onto the impact point is an important element in reducing silica exposure to the operator. However, the angle of water delivery is just as important.
Jackhammers

• Manual Spraying

• Manual spraying is the simplest method for suppressing dust while jackhammering.
  – One employee operates the jackhammer
  – Helper supplies a constant source of water
  – Spray must be directed at the point of impact
  – Spray application must be continuous

Safety Tip: An experienced helper will be able to adjust the water flow to achieve the maximum dust suppression using the minimum amount of water, thus reducing water run-off.
Jackhammers

- Water Spray System
- Water-fed jackhammers are not commercially available, but equipment may easily be retrofitted.
  - Water source, control valve
  - Hose to bring water from source to jackhammer
  - Flexible, durable tubing to supply water to nozzle
  - Sturdy water flow control valve on jackhammer
  - Spray nozzle that can provide a spray or stream
  - Fittings to connect valves, tubing, and nozzle

Safety Tip: Employees may wish to keep a damp cloth handy to wipe their protective faceshields or eyewear.
Jackhammers

• Using a Water-Fed Jackhammer

• Correct use of a water spray system requires:
  – Ensure spray covers tip of tool blade.
  – A flow rate of ~ 350 ml/min is usually optimal.
  – Coned-shape spray angle of 80° is recommended.
  – More water is usually not better.
  – Try to prevent visible dust release.

Safety Tip: Water flow onto the impact point is an important element in reducing silica exposure to the operator of a jackhammer. However, the angle of water delivery is just as important.
Jackhammers

• Using a Water-Fed Jackhammer (cont.)
• Enclosed Areas:
  – Wet methods work as well indoors as outdoors.
  – Decreased airflow can increase dust levels.
  – Provide good fresh air circulation.
  – Dust concentrations can increase quickly.
• Water runoff:
  – Comply with local requirements
  – May be necessary to channel
Jackhammers

- Water Spray System Maintenance
- Dust and debris can clog spray nozzles: change if dripping, spitting, squirting, spraying at an odd angle
- Check water spray angle frequently:
  - Focused on the breakpoint?
  - Wetting dust before it can disperse?
- Consistent flow: prevent interruptions from kinked hoses, vehicular traffic, and drops in water pressure
Jackhammers

- Respiratory Protection
- Respiratory protection is based on exposure.
  - Use of effective wet methods
  - Length of time jackhammers are in operation
  - Indoor versus outdoor operations
  - Number of jackhammers in operation
Jackhammers

• Respiratory Protection (cont.)
• Use a half-facepiece or disposable air purifying respirator where exposures > 0.1 but < 1.0 mg/m3.
  – Operating a jackhammer more than 4 hours
  – Multiple jackhammers in use within 15 feet
  – Operating a jackhammer in enclosed spaces
• Full-facepiece may be required:
  – Operating multiple jackhammers indoors
  – When wet methods aren’t feasible
Rotary Hammers and Similar Tools

- Hazard
- Using rotary hammers or similar tools, exposures can be as high as 0.78 mg/m³ during active drilling.
  - Concrete
  - Bricks
  - masonry blocks
  - Tiles
Rotary Hammers and Similar Tools

• Hazard Control

• Three primary methods exist to control silica dust while using rotary hammers.
  – VDC: small-diameter hole drilling operations
  – Dust barriers or enclosures: for occasional drilling
  – Wet methods: not appropriate with all tools

Safety Tip: Where employee exposure exceeds 0.1 mg/m³, it may be necessary to use a properly fitted, NIOSH-approved half-facepiece or disposable respirator equipped with an N-, R-, or P-95 filter to supplement use of VDC or wet methods.
Rotary Hammers and Similar Tools

- Dust Collections Systems
- VDC systems are commercially available for handheld drills, usually as add-ons.
  - Enclose the drill bit in a suction ring
- Some tools have built-in dust collection systems.
  - Integral impeller (rotor blade) that draws dust
  - May not provide as much protection as VCD

Safety Tip: Make sure that the vacuum bags and filters are changed regularly, as often as necessary to prevent a decrease in airflow. Dust escaping from the collection device can be a sign that airflow is inadequate.
Rotary Hammers and Similar Tools

- Dust Barriers
- Dust barriers can minimize exposure for those who drill only the occasional small hole.
  - Initially developed for asbestos abatement
  - Insert drill bit through a barrier
  - Press barrier against work surface while drilling
  - Dust exiting hole will collect against barrier

Safety Tip: If the barrier is damp, it forms a better seal against the working surface and also moistens the dust, thus capturing more dust and reducing the amount that can escape when the employee removes the barrier. For example, employees sometimes drill through shaving cream in an upside-down waxed paper cup or through a damp sponge to minimize exposure to asbestos.
Rotary Hammers and Similar Tools

- Dust Barriers (cont.)
- Insert the bit through the barrier until just visible.
- Prevent gaps between working surface and barrier.
- Withdraw the bit by pulling it through the barrier.
- Handle the barrier carefully to minimize dust release.
- Dispose of debris after completing each hole.
- Use a waxed paper cup rather than a Styrofoam cup.
- Do not allow the barrier to become overloaded.

Safety Tip: For deeper holes, periodically check under the barrier; it may be necessary to clean or empty it before the hole is complete.
Rotary Hammers and Similar Tools

- Wet Methods
- OSHA believes wet methods can help control silica dust generated by smaller drills.
  - Generally not used with electric rotary hammers
  - Tools must be designed for damp environments.
  - Pneumatic drills:
    - Can be used for wet drilling
    - May come equipped with water feed capability

Safety Tip: While designed primarily for use in explosive atmospheres, water-fed pneumatic drills can also be used to control silica exposures.
Vehicle-Mounted Rock Drilling Rigs

- Hazard
- Employees produce dusts containing silica when they use rock-drilling rigs mounted on trucks, crawlers, or other vehicles to drill into rock, concrete, or soil.
- Obtain a profile of the silica content of soil and rock.
  - Concentrations may vary widely.
    - Type of underlying rock formation
    - History of volcanic eruptions
Vehicle-Mounted Rock Drilling Rigs

• Hazard Control

• OSHA recommends that operators always use a combination of dust control techniques.
  – Dust collection systems
  – Wet methods
  – Operator isolation
Vehicle-Mounted Rock Drilling Rigs

- Dust Collection Systems
- Dust collection systems are commercially available and work well in all climates and with all drill types.
  - Movable suction duct, attached to shroud (flexible rubber skirt), encloses hole and captures cuttings
  - Dusty air pulled from shroud, passes through flexible duct to primary and secondary filters
  - Dust separator often includes self-cleaning “back-pulse” feature that discharges particles to ground
  - Exhaust air is discharged to the atmosphere

Safety Tip: Drilling equipment that does not include dust collection controls can be retrofitted by the manufacturer or a mechanical shop.
Vehicle-Mounted Rock Drilling Rigs

- Dust Collection Systems (cont.)
- Drill bit shroud: minimize flaps and gaps
  - Single-seam conical shroud over conventional
- Adequate airflow: draw more air than bailing air
  - Conventional shroud: ≥ 3 times bailing airflow rate
- Dust collector discharge shrouds: sleeve guides particles to the ground, reducing dust
  - Heavy tarps, coil-type flexible duct materials
- Exhaust air: direct discharge away from employees

Safety Tip: If a flexible duct is extended near ground level, avoid placing the opening where the exhausted air will blow on other employees. Instead, place the duct opening near the ground where exhausted dust might deposit. To minimize airflow resistance in the flexible duct, run extensions in a relatively straight line, use the same diameter as the discharge flexible duct, and keep added lengths to the minimum needed to move the discharged air away from employees.
Vehicle-Mounted Rock Drilling Rigs

- Dust Collection System Maintenance
- Check the following points on a regular basis.
  - Shroud: ensure bit is fully enclosed
  - Ducts: remove accumulated material
  - Filters: replace clogged or damaged filters
  - Fans: conduct regularly scheduled inspections

Safety Tip: experts recommend scheduled inspections to check the following points on the fan blower unit:
- Bearings and lubrication
- Belt tension, wear, slippage
- Excessive vibration
- Coupling and belt alignment
- Fan impeller alignment and rotation
- Excessive wear or caking on the impeller
- Mounting bolts, set screws and bushings
- Safety guards
Vehicle-Mounted Rock Drilling Rigs

- Wet Methods
- Water injection method:
  - Good for percussion, drag, and button bits
  - Special consideration required to protect bits with rollers (tri-cone bits) from excess water
- Too much water: mud slurry can entrap bit, coupling, and steel extensions
- Too little water: will not effectively control emissions

Safety Tip: The proper use of wet methods requires a skilled operator. Optimal water flow rate is best achieved by slowly increasing the water to the point where visible dust emissions are eliminated.
Vehicle-Mounted Rock Drilling Rigs

- Water Injection at the Bit
- In wet drilling systems that use forced air to flush cuttings from the hole:
  - Water is introduced into bailing air at drill head
  - Water gathers small particles into larger ones
  - Dust emissions are reduced
  - 29% more effective than dust collection system
- Wet drilling combined with a conventional dust collection system offers even better dust control.
Vehicle-Mounted Rock Drilling Rigs

- Water Injection at Dust Collector Exhaust
- Injecting small quantities of water into the exhaust air discharge duct can reduce silica dust emissions.
  - To avoid clogging, don’t use too much water.
  - Slowly increase the flow rate.
  - Visible dust should be significantly reduced.
  - Recommended valves: flow regulator, on/off
  - In-line water filter keeps debris needle valve clear.
  - Clear the flexible duct interior daily.

Safety Tip: Even at ideal water flow rates, it will be necessary to check the flexible duct interior daily and clear dust deposits that may form in it. A quick-release clamp on the flexible duct will make the process easier.
Vehicle-Mounted Rock Drilling Rigs

- Operator Isolation
- Drill operators using rigs with enclosed cabs can reduce silica exposure by staying inside the cab.
  - Cab must be tightly sealed and well ventilated.
  - Provide a slight positive pressure using filtered air.
  - Consider aftermarket air conditioning if necessary.
  - Clean cabs daily to remove any dust tracked in.

Safety Tip: Some equipment permits the operation of the drill from inside the cab. While the use of enclosed cabs substantially reduces silica exposures, operators might be unwilling to keep windows and doors closed if the cab is not air conditioned. Equipment might be upgraded by installing aftermarket ventilation and air conditioning systems.
Vehicle-Mounted Rock Drilling Rigs

- Combining Methods for Better Dust Control
- Best: wet drilling AND dust collection system AND operator’s cab
- 2nd: wet drilling AND dust collection system or operator’s cab
- 3rd: Wet drilling or dust collection system
- Worst: no control
Vehicle-Mounted Rock Drilling Rigs

- Work Practices
- Position workers upwind from drill’s dust emissions.
- Use regular maintenance schedule for equipment.
- Train employees to:
  - Watch for sources of dust.
  - Make necessary adjustments or repairs.
  - Reduce emissions and their own exposure.

Safety Tip: Operators of rock drilling rigs working in enclosed, well-ventilated, and sealed cabs should not experience silica exposures in excess of 0.1 mg/m³ as an 8-hour time-weighted average. However, those operators and helpers working outside of cabs, or those using cabs that are not enclosed, well-ventilated, and sealed, can experience elevated exposures and may require additional respiratory protection.
Drywall Finishing

• Hazard

• When sanding drywall joint compound, employees generate substantial airborne dust.
  – Particles may be deposited deep in the lungs
  – Harmful even when dust does not contain silica
  – Tissue injury in eyes, ears, respiratory passages
  – 3% silica joint compound could exceed benchmark

Safety Tip: The silica exposures of drywall finishing employees are typically well below allowable limits, primarily due to the low silica content of joint compounds. Nonetheless, drywall joint compounds may contain varying amounts of silica and drywall finishing employees can be overexposed in certain circumstances.
Drywall Finishing

• Hazard Control
• Implement effective dust control measures.
  – Vacuum dust collection equipment
  – Wet sanding methods
• Use only silica-free joint compounds.

Safety Tip: The use of silica-free joint compounds, wet methods, and/or effective vacuum dust collection methods are very effective in virtually eliminating or suppressing silica and respirable dust. With the use of such controls, it may be possible to eliminate the need for respiratory protection. However, if wet methods or vacuum dust collection methods are not feasible, employees may be required to wear appropriate respiratory protection.
Drywall Finishing

• Silica-Free Joint Compounds
• Many manufacturers offer joint compounds that contain little or no silica.
  – In 6 brands, no crystalline silica was found in 3.
  – Check label and MSDS (usually Section 3).
  – Avoid crystalline silica or quartz (another term).
  – Always use dust control methods, regardless.
Drywall Finishing

• VDC Systems

• VDC systems reduce dust exposure 80 to 97%.
  – Commercially available
  – Sanding screen and head
  – Hose port to connect portable wet or dry vacuum
  – Can be handheld or pole-mounted
  – Conduct exposure monitoring during use.

Safety Tip: Some dry sanding vacuum system manufacturers recommend using a shop vacuum, while others suggest using industrial vacuums (wet or wet/dry), especially for heavy-duty sanding projects.
Tips for Selecting a Drywall Finishing Tool with VDC

Employers can concentrate on features such as:

- Comfortable handle and lightweight hose
- Good connection between hose and tool
- Flexibility and stability in sanding head
- Allowance of comfortable posture
- Ease of cleaning and servicing
- For wet systems, ease of changing water

Safety Tip: Some contractors are concerned about the increased drying time associated with wet methods. All wet-sanded areas must dry thoroughly before applying additional coats of joint compound or decorating. Using heat guns or space heaters to shorten joint compound drying times allow painting to begin sooner, even after wet sanding. Further, the time spent drying the joint compound might be offset by the time it would otherwise take to remove dust particles from the walls before painting.
Drywall Finishing

- Wet Sponge Method
- Wet sanding for drywall finishing uses a sponge to wet joint compound and remove residues.
  - Saturate sponge with clean, lukewarm water.
  - Wring to prevent dripping.
  - Gently rub high spots (as few strokes as possible).
  - Clean sponge frequently.

Safety Tip: In addition to reducing employee exposures, wet finishing methods offer other advantages. For example, wet methods often require less cleanup, the wallboard face is not scuffed during finishing, and joints are easier to conceal with paint than joints that are dry sanded.
Drywall Finishing

- Tips for Using Drywall Sponges
- Minimize excess joint compound on the surface.
- Minimize sanding strokes to avoid grooving.
- Use drying aids to shorten drying time.
- Clean sponges and water buckets after each use.
- Consult manufacturers’ recommendations.

Safety Tip: Wet finishing can be more complicated on poorly finished joints because it may be difficult to remove large amounts of joint compound with this method. Therefore, employees should apply joint compound smoothly so that little finishing is required.
General Housekeeping

- Hazard
- Employees may be exposed to silica dust during general housekeeping activities.
  - Dry sweeping, operating and emptying vacuums
  - Using blowers or compressed air for cleaning
  - Dumping bags of raw material, wheelbarrow loads
  - Crushing and spreading materials
  - Dropping, tossing, or pouring dusty materials
  - Driving over piles of dust or debris

Safety Tip: NIOSH determined that a concrete finisher handling a vacuum bag containing concrete dust was exposed to approximately 0.79 mg/m³, more than five times the finisher’s average silica exposure for the day, which already exceeded the OSHA benchmark.
General Housekeeping

• Hazard Control
• Housekeeping activities require the same types of dust control as many other construction tasks.
  – Water and other dust suppressants
  – Vacuuming
  – Cabs and enclosures
  – Modification of work practices
General Housekeeping

• Dust Suppressants
• Types of dust suppressants include:
  – Water (mists, sprays, steam, fog)
  – Surfactants (including foams)
  – Other compounds
General Housekeeping

- Water
- Water is applied in different ways to collect dust.
  - Wet mopping or spraying
  - Wet vacuum or squeegee
  - Wet scrubbing or pressure washing
- Water is used in a variety of activities, including:
  - Heavy construction vehicles on unpaved surfaces
  - Blasting operations
  - Materials handling and transport operations

Safety Tip: For optimal results, use nozzles and flow regulators to control water volume. Clean up water and slurry as soon as it is practical. If allowed to dry, the dust contained in slurry may become a source of silica and other dust exposure. Rewet surfaces as often as necessary to maintain dust control.
General Housekeeping

• Fogging Methods
• Advantages of fog (fine water particles):
  – Larger contact area than water sprays
  – Dust and water particles stick (ideally same size)
  – Added weight prevents dust becoming airborne
• Limitations:
  – Fog dries quickly, no lasting benefit
  – In open areas droplets may blow away
  – May reduce visibility, condense on windows

Safety Tip: Water fog can be generated with a two-fluid system that uses water with compressed air to increase impact force on the nozzle impinging device or a single-fluid system where water is pumped at very high pressure and hydraulically forced through a very small nozzle opening.
General Housekeeping

- Electrostatic Charging
- Electrostatic water spray attracts oppositely-charged dust particles to charged water droplets.
  - Emitter: waterproof power supply, control panel, insulated charging coil, siphon-type nozzle
  - Sources of clean air and water
  - Relatively long time (seconds) to interact

Safety Tip: Steam is the gaseous state of water. Like fog, steam can reach a larger contact area than sprayed water. Also like fog, steam can visually restrict operations and condense on surfaces.
General Housekeeping

• Surfactants and Other Soil-Binding Materials

• Surfactants break the surface tension of water.
  – Highly concentrated soap or detergent
  – Allows water to penetrate deeper
  – Better saturates dust particles, slows evaporation
  – Can be applied in either a water or foam spray
  – Reduce fugitive dust amounts by up to 90 percent

Safety Tip: Surfactants formulated to enhance dust particle water absorption capabilities are not recommended for materials handling system applications because they will make dust particles stick to many other surfaces. Use surfactants formulated to alter the static surface charge of dust particles instead.
General Housekeeping

• Surfactants and Other Soil-Binding Materials (cont.)
• Other compounds used on soils for dust suppression:
  – Acrylic polymers
  – Solid asphalt
  – Liquid asphalt
  – Chloride compounds
  – Lignin compounds
  – Natural oil resins
  – Organic resin emulsions

Safety Tip: Petroleum-based oils and waste products should not be used as a dust suppressant. This is a violation of multiple EPA regulations.
Acrylic Polymers

Acrylic polymers are synthetic plastic adhesives that work as a ground surface dust suppressant.
- Chemically bind during curing (may take 24 hours)
- Create a surface crust
- Colder temperatures result in longer cure times
- Environmentally safe, non-corrosive, non-leaching
- Non-slippery when wet
- Flexible after curing

Safety Tip: Users have found various levels of success with acrylic polymers as a dust suppressant on unpaved roads.
General Housekeeping

- Asphalt
- Recycled asphalt may be used for dust suppression on unpaved roadways or when crushing rock.
  - Obtained as residue in distillation of petroleum
  - Can help reduce disposal or storage costs
  - May result in higher maintenance fees (ruts)
- Liquid asphalts:
  - Used in the past to treat gravel roads
  - Now banned in most locations
General Housekeeping

- Chloride Compounds
- Chloride compounds are popular in surface dust control and road stabilization.
  - Work by attracting moisture from the air
  - Created from naturally occurring brines
  - Used as water additives
  - Resist evaporation
  - Remain active after ground is tilled or rebladed
  - Lower freezing point of water (useful in cold)

Safety Tip: Chloride compounds exhibit high surface tension and low vapor pressure, which helps bind or aggregate smaller particles to larger and heavier particles which are less likely to become airborne.
General Housekeeping

- Chloride Compounds (cont.)
- Drawbacks of chloride compounds:
  - Perform poorly in low humidity
  - Corrosive without inhibitor additives
  - May be harmful to vegetation and groundwater
  - May leach away with precipitation
  - May be slippery when wet
General Housekeeping

• Lignin Compounds

• Lignin compounds are used to coat ground surfaces, forming a crust as they cure.
  – Work by reducing tension between clay and water
  – Made from byproducts of wood pulping process
  – Chemically bind soil particles together
  – Water soluble, most effective in dry climates.
  – Immediately active, remain active after reblading
  – Lower freezing point of water (useful in cold)
Lignin Compounds (cont.)

Drawbacks of lignin sulfates and sulfonates:
- Leach away with precipitation
- May be slippery when wet
- May become brittle when dry
- Can be harmful to ground water
- May have unpleasant odor when first applied
- May also be corrosive to aluminum

Safety Tip: Lignin compounds work best with a well-graded aggregate mix (a wide range in grain sizes).
General Housekeeping

- Natural Oil Resins
- Oil resins are added to water to make a suspension and applied to ground surfaces, such as roads.
  - Coating leaves residue, makes dust particles heavier, they become adhesive (agglomeration)
  - Can be sprayed (bituminous asphalt applicator)
  - Immediately active
  - Effective after reblading
  - Non-corrosive and environmentally safe

Safety Tip: Used vegetable oil has also been explored as a dust suppressant. Due to its relatively low cost, it may be an attractive option in some situations, although its performance duration may be limited. Vegetable oil has also been used as a dust suppressant in the agriculture industry, specifically to reduce dust in grain storage and processing areas. However, researchers disagree about its effectiveness.
General Housekeeping

• Natural Oil Resins (cont.)
• Drawbacks of natural oil products:
  – May be an offensive odor
  – May become brittle when dry
  – May leach away with precipitation
  – May also be slippery when wet

Safety Tip: Used motor oil is restricted or prohibited for use as a dust suppressant in most jurisdictions.
General Housekeeping

- Organic Resin Emulsions
- Organic resin emulsions bind and adhere to dust particles as they cure and create a surface crust.
    - Natural resins, emulsified in liquid (e.g., sap)
    - Environmentally safe, noncorrosive, non-leaching
    - Non-slippery when wet
    - Waterproof

Safety Tip: Drawbacks of natural resins include that they may become brittle when dry, they must be cleaned from equipment quickly, and they will take longer to cure in colder temperatures.
General Housekeeping

- Vacuum Methods
- Vacuum filter media must be chosen carefully.
- Rating systems indicate ability to capture dust.
  - Collection efficiency (percent of particles caught)
  - Smallest size of particles that will be captured
- More efficient filters typically:
  - Provide greater employee protection.
  - Require more “lift” (suction power).
  - Cost more
General Housekeeping

- Vacuum Methods (cont.)
  - Extend life of expensive filters by adding prefilters.
    - Offer protection by catching larger dust
    - Can be changed frequently at low cost
- Consider filter surface area.
  - Greater surface area holds more dust
  - Larger areas require less suction power.

Safety Tip: Prefilters are available in various grades. Select a relatively efficient prefilter that will capture most of the dust. An inefficient prefilter will allow more dust to pass, causing the high efficiency particle filter to become overloaded more quickly.
General Housekeeping

• Cabs and Enclosures
• Use material handling equipment for moving large amounts of silica-containing dusty material.
• Select equipment with enclosed cabs, positive pressure ventilation systems, and air conditioning.
General Housekeeping

• Work Practices
• Common sense work practices can help employees limit their exposure to silica.
  – Clean up spills and waste before dust can spread.
  – Wear a rubber apron to keep wet dust off.
  – Whenever possible, work upwind of dust sources.
  – Keep roadways damp if silica content is high.
  – Wet silica-containing debris prior to disturbance.

Safety Tip: Employees should be encouraged to watch for dust sources containing silica and make adjustments or use dust control methods to reduce their silica exposure.
General Housekeeping

• Dumping or Pouring Materials
• When dumping materials, minimize the drop.
  – The farther the fall, the more dust on impact
  – Release materials close to destination level.
  – Slowly add materials onto a pile.
  – Use wheelbarrow ramps of appropriate height.
  – Moisten dumpsters and their contents.
  – Spray the debris stream with water mist.
General Housekeeping

• Sweeping

• Take steps to limit the use of dry sweeping.
  – Limit quantity of debris, distance, frequency
  – Use a vacuum or wet mop or moisten materials.
  – Make smaller piles to avoid pushing.
  – Avoid sweeping compounds with quartz sand.
General Housekeeping

• Removing Debris from Slots or Uneven Surfaces
• Use a vacuum instead of a blower to remove debris.
• Flush cracks with water instead of compressed air.

Safety Tip: Avoid depositing or storing collected debris where it will be disturbed or run over and become a source of dust exposure for another employee.
Employer Responsibilities

- Provide a workplace free from serious recognized hazards and comply with standards, rules and regulations issued under the OSHA Act.
- Examine workplace conditions to make sure they conform to applicable OSHA standards.
- Limit employee exposure to silica and related air contaminants in accordance with the requirements of Federal or state OSHA air contaminant standards.
- Make sure employees have and use safe tools and equipment and properly maintain this equipment.
- Use color codes, posters, labels or signs to warn employees of potential hazards.
- Establish or update operating procedures and communicate them so that employees follow safety and health requirements.
- Provide medical examinations and training when required by OSHA standards.
- Keep records of work-related injuries and illnesses such as silicosis or silica related pneumoconiosis.

LINK: http://www.osha.gov/as/opa/worker/employer-responsibilities
Summary

This module covered basic information on the hazard of crystalline silica in the construction industry.

- What silica is, where it’s found, why it’s hazardous
- Equipment and operations that may subject you
- Various methods of protection
- Rules and regulations
Conclusion

• Resources

• Additional information about controlling silica exposures in construction is available at OSHA’s Web site at www.osha.gov.

• For more information on how to determine proper respiratory protection, visit the OSHA Web site or the NIOSH Web site at www.cdc.gov/niosh.