

Respirable Crystalline Silica: Occupational Exposures and Disease

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Education and Information Division**

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New Jersey Section of the
American Industrial Hygiene Association
Scotch Plains, New Jersey
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Topics

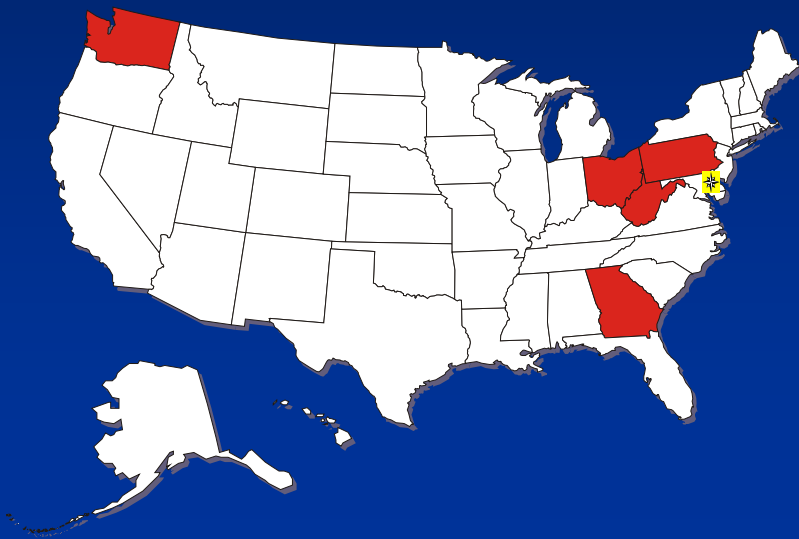
- NIOSH
- Respirable Crystalline Silica
- NIOSH Hazard Review Document
- New Information
- Information Sources

National Institute for Occupational Safety and Health (NIOSH)



Main NIOSH Locations

NIOSH Staff: ~1,400



Washington, DC
Atlanta, GA
Cincinnati, OH
Morgantown, WV
Pittsburgh, PA
Spokane, WA

NIOSH Mission

To provide leadership in research to prevent work-related illness, injury, disability, and death.

Occupational Safety and Health Act of 1970 created:

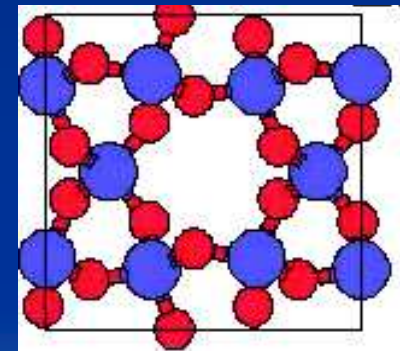
- DHHS/CDC/**NIOSH**
 - Research, information, education, training
- DOL/**OSHA**
 - Regulation and enforcement for workplace safety and health

Respirable Crystalline Silica

- What is it?
- Where is it?
- Why be concerned?

“Silica”

- Silicon Dioxide (SiO_2)
- **Crystalline** or amorphous structure
- Can be **respirable**



Source: NIOSH NMAM

Quartz

<http://www.cdc.gov/niosh/nmam/pdfs/chapter-r.pdf>

Crystalline Polymorphs

- Three polymorphs in occupational settings
 - 1) Quartz
 - Most common
 - In Earth's crust
 - Component of most mineral deposits
 - Most exposures are to “silica-containing” dust
 - 2) Cristobalite and 3) Tridymite
 - High temperature forms
 - e.g., Foundries, Ceramics, DE processing

α -quartz \rightarrow β -quartz \rightarrow β -tridymite \rightarrow β -cristobalite
~570 °C ~870 °C ~1470 °C

IARC [1997]

Occupational Activities with Potential Silica Exposure

- Agriculture
 - Plowing, harvesting, burning, processing agricultural products
- Mining
 - Most occupations, rock drilling, dredging
- Quarrying and related Milling Operations
- Furnace/kiln installation and repair
- Silicon carbide production

Occupational Activities with Potential Silica Exposure-II.

- Slate work (e.g., pencil manufacturing)
- DE calcination
- Abrasive blasting--structures, buildings
- Highway/tunnel construction
- Excavation, earth moving, digging
- Masonry, concrete work, brick work, demolition
- Dry sweeping and brushing
- Pressurized air blowing

Occupational Activities with Potential Silica Exposure-III.

- Removing rust or paint
- Sanding, scaling (e.g., boilers), hauling, pouring, mixing, grinding, or dumping silica-containing materials
- Raw material processing
- Jack hammering
- Laying railroad track
- Replacement of asphalt roofing

Occupational Activities with Potential Silica Exposure-IV.

- Glass mfg., etching, frosting
- Jewelry manufacturing
- Arts, crafts, sculpture, pottery
- Polishing dental material

Probable Use of Silica



If you can answer YES to any of these, then it is likely that Silica is used at your work and that it is airborne.

Industry

Do you work in any of these?

- Abrasive blasting
- Asphalt pavement manufacturing
- Blast furnaces
- Cement manufacturing
- Ceramics, clay, and pottery
- Concrete mixing
- Concrete tunneling
- Construction (mainly cement, concrete work)
- Demolition
- Electronics industry
- Foundry industry: grinding, molding, shakeout, core room (High Risk)
- Hand molding, casting, and forming
- Jack hammer operations
- Manufacturing abrasives, paints, soaps, and glass
- Mining
- Repair or replacement of linings of rotary kilns and cupola furnaces
- Rolling and finishing mills
- Sandblasting (High Risk)
- Setting, laying, and repairing railroad track
- Steelwork
- Stone, brick, and concrete block cutting, blasting, chipping, grinding, and sawing
- Tunneling operations

Occupations

Are you one of these?

- Brickmason/stonemason
- Construction laborer
- Crane and tower operator
- Crushing and grinding machine operator
- Furnace, kiln, non-food oven operator
- Grinding, abrading, buffing, and polishing machine operator
- Hand molder/shaper (not jeweler)
- Heavy-equipment mechanic
- Janitor or cleaner
- Machinist
- Metals/plastics machine operator
- Molding and casting machine operator
- Mining machine operator
- Miscellaneous material moving equipment operator
- Millwright
- Operating engineer
- Painter who sandblasts (High Risk)
- Production supervisor
- Rock driller (High Risk)
- Roof bolter (High Risk)
- Sandblaster (High Risk)
- Steelworker
- Welder/cutter

[See how the chance of death is increased according to occupation](#)

Materials

Are any of these involved?

- Abrasives
- Coal Dust
- Concrete
- Dirt
- Filter Aids
- Graphite, natural
- Mica
- Mineral Products
- Paints
- Pavement
- Perlite
- Plant Materials
- Plastic Fillers
- Polishing Compounds
- Portland Cement
- Sands
- Silicates
- Slag
- Soapstone
- Soil

Source:
OSHA Silica eTool
www.osha.gov

Some Silica-Containing Materials

- **Sand, mortar, joint compound, grout, abrasives**
- **Asphalt, asphalt roofing, roof tiles, slate, some siding**
- **Concrete, brick, block, ceramic tile**
- **Plaster, paint, shingles, soil, agricultural products**
- **Clays, glazes, gemstones, mineral products**

NIOSH REL

- 0.05 mg/m³ (TWA for up to 10-hour workday during 40-hr week)
- Established in 1974
- Quartz, cristobalite, and tridymite as respirable dust

REL (Recommended Exposure Limit)

Can exceed 8-hr limits in a few minutes of exposure



- Observed Concentration: **14 mg/m³** respirable quartz
- Time to exceed 0.05 mg/m³ 8-hr TWA: **1.7 min.**

Photo: Ken Linch, NIOSH Source: Linch KD [2002]. Appl Occup Environ Hyg



Silica Particle Toxicity

- Not an “inert dust”: Highly reactive surface related to biologic effects
- Cytotoxic--Silica particles damage cell membranes
- Highly reactive surface radicals, esp. with freshly ground or fractured silica
 - cleavage of Si-O bonds create sites for adsorption of biological materials
- In vitro studies

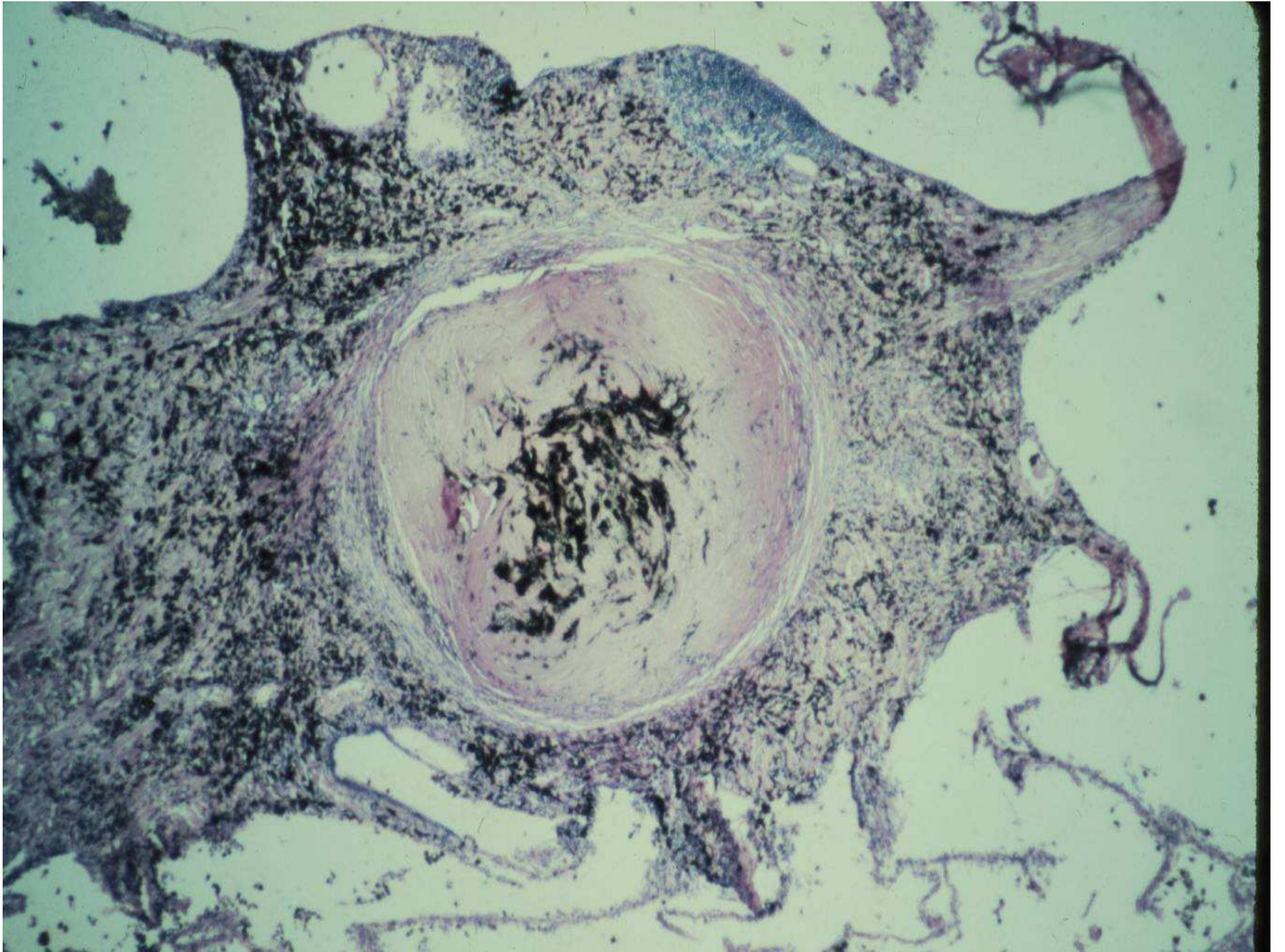
Silicosis

Occup Resp. Cryst. Silica → (causes) → Silicosis

A Preventable Disease

Silicosis

- Usually a nodular pulmonary fibrosis
 - **Disabling and progressive**
 - **May be no symptoms**





Concerns-cont'.

- ~200 reported U.S. silicosis deaths/year
 - includes deaths in workers <45 years old
- Number of current cases not known
- ~2 million U.S. workers potentially exposed
 - ~100,000 \geq two times the NIOSH REL (excl. mining, ag.)
- Overexposures in many industries, U.S. and worldwide

SICs with Silica Exposures $\geq 10x$ REL excluding Mining, Agriculture

- Masonry, plastering
- Heavy construction (not highway)
- Painting, paper hanging
- Iron and steel foundries
- Metal services

Source:

Linch et al. [1998]--OSHA inspection data 1993

More:

Work-Related Lung Disease Surveillance Report 2002 [2003]
NIOSH Pub. 2003-111

Worker Health Chartbook, 2004 NIOSH Pub. 2004-146

Concerns-cont'.

- Lung Cancer and other Silica-related Diseases
 - 1996 IARC classification of inhaled quartz or cristobalite from occupational sources as human carcinogen (Group 1)

Forms of Silicosis

- **Chronic:** after >10 years of exposure
- **Accelerated:** 5-10 years from 1st exposure
 - rapid progression
 - may not be on chest radiograph
- **Acute:** symptoms w/in weeks to 5 yrs.
 - high concentrations
 - fibrosis may not be present

U.S. Silicosis Cases and Deaths

New Jersey: 135 Silicosis Cases 1993-2002

- Main **industries**: Manufacturing (63%), Construction (17.8%), Mining (14.8%)
- Main **occupations**: Operators, fabricators, & laborers (63.7%); Precision production, craft, repair (29.6%)
- **Years employed** in potential silica job:
 - <10: 11.1%
 - 10-19: 23.7%
 - 20-29: 22.2%
 - 30-39: 19.3%
 - \geq 40: 11.9%
 - Unknown: 11.9%

New Jersey Silicosis Deaths*

- 1995-2004, age ≥ 15 years: **36 deaths**
 - Ranked 16th in number of silicosis deaths
 - Two to six deaths per year

*Sources: NIOSH e-WORLD

<http://www2a.cdc.gov/drds/WorldReportData/FigureTableDetails.asp?FigureTableID=538&GroupRefNumber=T03-04> & 2007T03-05

National Center for Health Statistics multiple cause-of-death data.
Population estimates from U.S. Bureau of the Census.

U.S. Silicosis Deaths:

Most frequently recorded industries on death certificate, U.S. residents age 15 and over, selected states and years, 1990-1999

Industry	No. of Deaths	Percent
Construction	118	13.4
Metal mining	86	9.8
Coal mining	69	7.8
Blast furnaces, steelworks, rolling and finishing mills	51	5.8
Iron and steel foundries	49	5.6
Nonmetallic mining and quarrying, except fuel	48	5.5
Miscellaneous nonmetallic mineral and stone products	44	5.0

Sources: National Center for Health Statistics multiple cause of death data. Complete table on NIOSH eWoRLD:

<http://www2a.cdc.gov/drds/WorldReportData/FigureTableDetails.asp?FigureTableID=540&GroupRefNumber=T03-06>

I. Recent information about U.S. silicosis

- *Silicosis Mortality, Prevention, and Control --- United States, 1968—2002*; CDC MMWR April 29, 2005
<http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5416a2.htm>
- Silicosis Mortality Decline in U.S. 1968–2002
 - Implementation of national standards in 1970s
 - Ancillary prevention (e.g., respiratory protection)
 - Declining employment in heavy industries (e.g., mining industry)
- However, U.S. “*silica overexposure remains widespread*”
 - **Surveillance and interventions needed.**

II. Recent information about U.S. silicosis

- *Silicosis-Related Years of Potential Life Lost Before Age 65 Years --- United States, 1968--2005* CDC MMWR July 18, 2008
<http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5728a3.htm>
-Overall decline, however, deaths in young adults still occur (aged 15-44 years).
- *National Trends in Silicosis Mortality in the United States, 1981-2004.*
Bang et al. [2008] American Journal of Industrial Medicine

What determines risk of silica-related disease?

Some Factors: Toxicity/Disease

- Intensity of Dust Exposure
 - concentration (includes cumulative dust “dose”)
 - respirable fraction
 - crystalline silica content of total dust
- Particle size

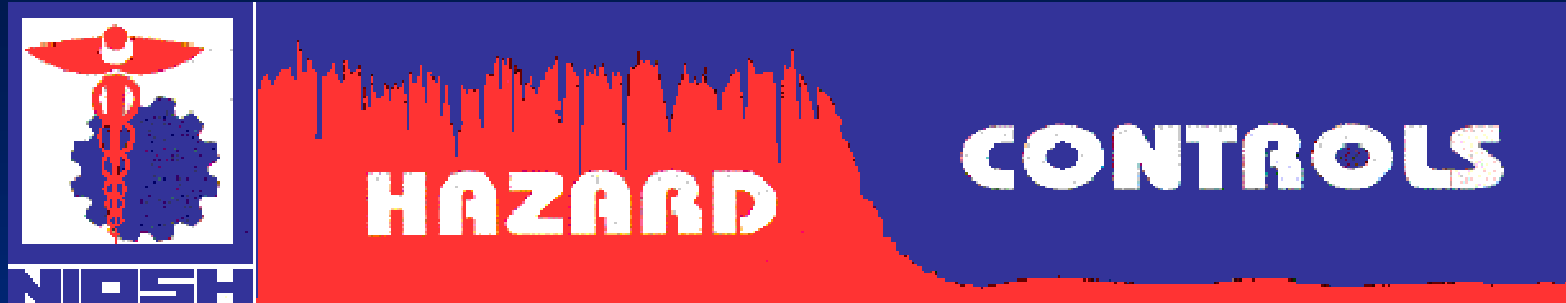
Factors-cont'.

- Surface properties of silica particles
 - e.g., freshly cut vs. old surface
- Contamination by other minerals
- Duration of Dust Exposure
- Time from first exposure to diagnosis (months to >30 years)
- Confounding exposures
 - other carcinogens

NIOSH DOCUMENTS

- Policy Documents
 - Criteria Docs., CIBs, **Hazard Reviews**, Alerts, NIOSH Policy Statements
- Technical Documents
 - Surveillance Reports, Control Technology Reports, Conference Proceedings
- Educational Documents
 - Hazard Controls, Posters, Bibliographies

Educational Documents:



**New Shroud Design Controls Silica Dust from
Surface Mine and Construction Blast Hole Drills**
[HC27]

**Controlling Silica Dust from Foundry Casting-
Cleaning Operations** *[HC23]*

Control of Drywall Sanding Dust Exposures
[HC30]

NIOSH

HAZARD ID

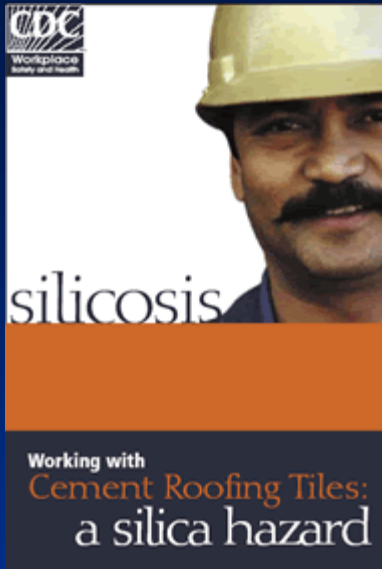
Respirable Crystalline Silica Exposures During Tuckpointing

Updated in:

NIOSH **Workplace Solutions** 2008-126

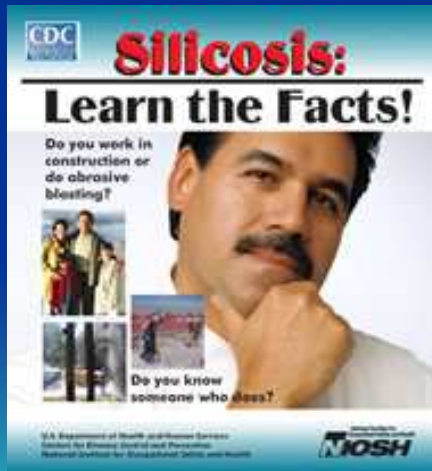


<http://www.cdc.gov/niosh/docs/wp-solutions/2008-126/>



Silicosis - Working with Cement Roofing Tiles: A Silica Hazard

<http://www.cdc.gov/niosh/docs/2006-110/>



Silicosis: Learn the facts! Do you work in construction or do abrasive blasting?

<http://www.cdc.gov/niosh/docs/2004-108/>

Educational Documents

The cover features the CDC Workplace Safety and Health logo in the top left. The title 'A Compendium of NIOSH Construction Research 2002' is centered in bold black text. Below the title are four black and white photographs: a tall construction crane, a welder in a protective suit, a worker kneeling on a construction site, and a worker in a hard hat and safety vest. At the bottom, the text reads: 'Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health' and the NIOSH logo.

CDC
Workplace
Safety and Health

**A Compendium of
NIOSH Construction
Research
2002**

Department of Health and Human Services
Centers for Disease Control and Prevention
National Institute for Occupational Safety and Health

NIOSH

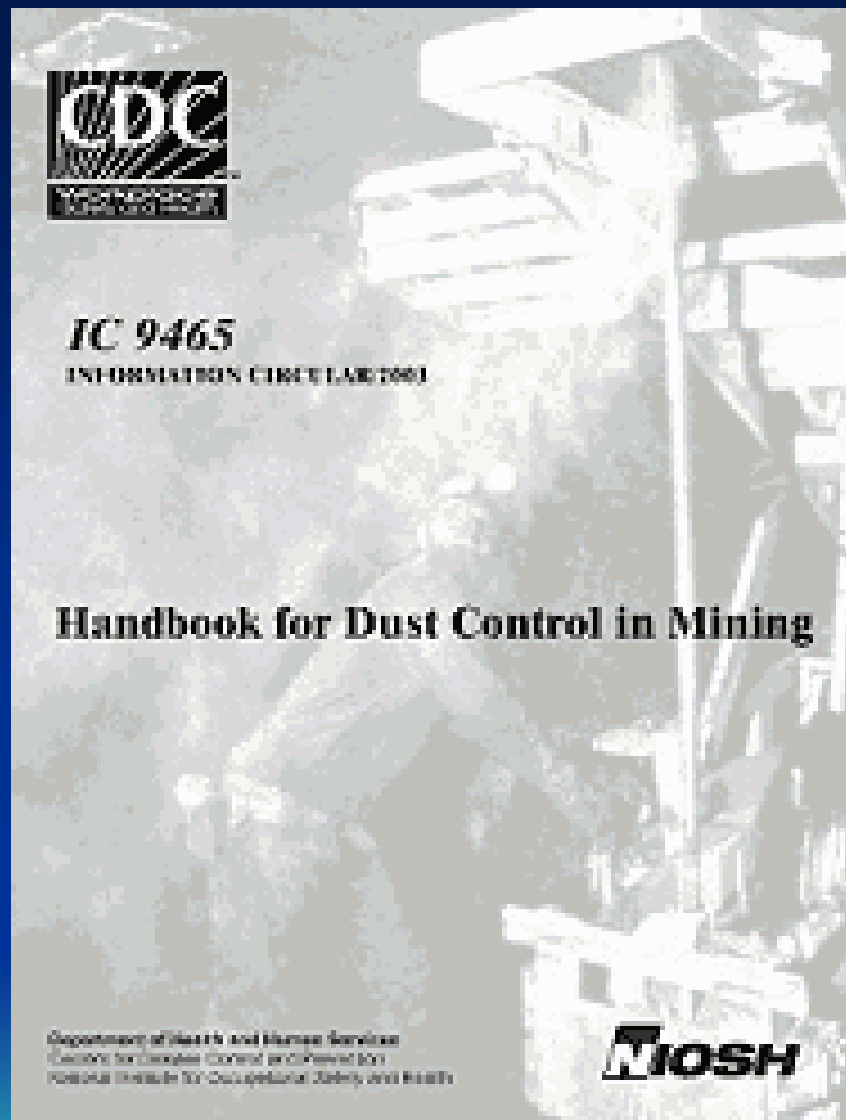
The cover features the NIOSH logo in the top left. The title 'A Compendium of NIOSH Mining Research 2000' is centered in bold blue text. Below the title are three black and white photographs: a worker in a hard hat operating machinery in a mine, a large dump truck in a mine, and two workers in a mine. At the bottom, the text reads: 'U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health' and the CDC logo.

NIOSH

**A Compendium
of NIOSH Mining Research
2000**

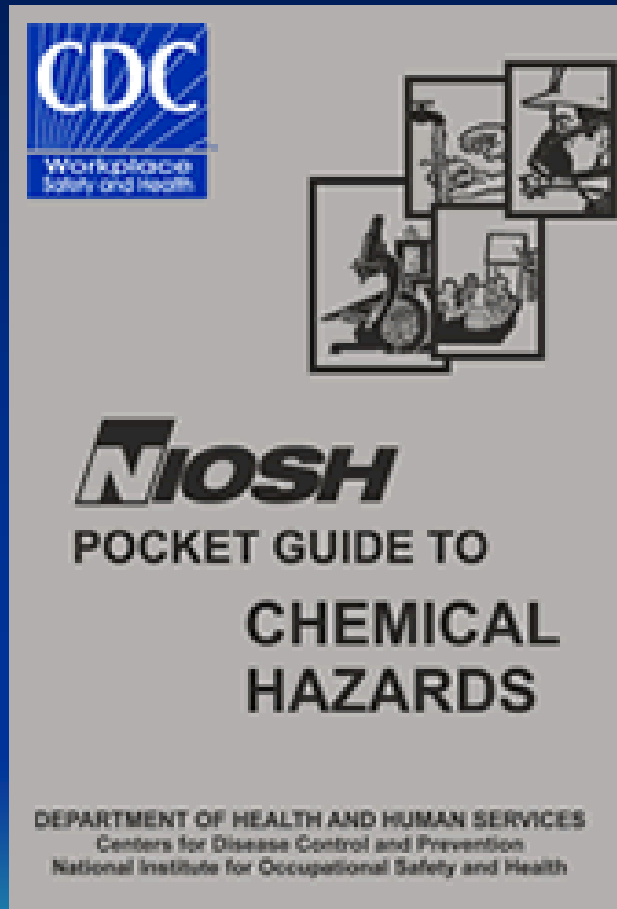
U.S. Department of Health and Human Services
Public Health Service
Centers for Disease Control and Prevention
National Institute for Occupational Safety and Health

CDC
CENTERS FOR DISEASE CONTROL
AND PREVENTION



NIOSH Publication No. 2003-147

Popular



<http://www.cdc.gov/niosh/npg/>



NIOSH Hazard Review

Health Effects of Occupational Exposure to Respirable Crystalline Silica

DEPARTMENT OF HEALTH AND HUMAN SERVICES
Centers for Disease Control and Prevention
National Institute for Occupational Safety and Health



DOCUMENT TITLE

NIOSH Hazard Review
Health Effects of
Occupational Exposure to
Respirable Crystalline Silica

Pub. 2002-129

<http://www.cdc.gov/niosh/02-129A.html>



WHY Crystalline Silica?

- *IARC 1987: Crystalline silica is carcinogenic in experimental animals.*
- *NIOSH 1988: Crystalline silica is a potential occupational carcinogen.*
 - ✓ *Do NIOSH document for support*

CHAPTERS

1. Introduction

- issues, history, scope

2. Properties, Production, & Potential for Exposure

- No. of workers potentially exposed

- Dust-generating activities

- 2.4 Sampling & Analytical Methods

 - NIOSH, OSHA, MSHA, HSE

 - feasibility of measuring at various concentrations

CHAPTERS-cont'.

3. Human Health Effects

- *Epidemiologic Studies*

- Silicosis

- Tuberculosis and other infections

- Lung Cancer (IARC 1997 and later)

- COPD, emphysema, bronchitis, PFT, NMRD mortality

- Autoimmune & chronic renal diseases

- Other

Chapters—cont'.

4. Experimental Studies

5. Conclusions

6. Research Needs

CONCLUSIONS: Health

- Significant estimated risk of chronic silicosis over a working lifetime at the current OSHA PEL, MSHA PEL, or NIOSH REL
- Occupational exposure to respirable crystalline silica is also associated with:
 - Lung cancer
 - Airways diseases (i.e., bronchitis, emphysema, COPD)
 - Mycobacterial and Fungal Infections (e.g., Pulmonary tuberculosis)

CONCLUSIONS: Health-cont'.

- Stat. sig. number of deaths or cases of autoimmune disease, renal disease, subclinical renal changes

CONCLUSIONS:

Exposure, Monitoring, & Engineering Controls

- Improved sampling and analytical methods needed to measure accurately below REL
- Many occupational exposures still exceed Federal standards
- Engineering controls may not be feasible; may need other worker protection measures (e.g., substitution, respirator use)

More Research Needed

- Health Effects
- Exposure Measurement
- Control of Exposure
 - Construction
 - Foundries
 - Abrasive Blasting
 - Surface & other mining
 - Paints, coatings, glass, cosmetics, plastics, and cleaning products

NIOSH Projects

- Dust Control Technology for Construction, Mining
- Analytical Methods
- Risk Assessment
- Surveillance
- Control Banding
- Global Assistance
- Assist OSHA

What's New?

I. Selected News

- Legal sandstorms (Silicosis)
 - Judge Jack's ruling
 - More information:
<http://www.aiha.org/aihce06/handouts/rt241warren.pdf>
- 2005: CalEPA OEHHA new ambient air toxic regulation for respirable crystalline silica
http://www.oehha.ca.gov/air/chronic_rels/silica_final.html
 - Set Chronic Reference Exposure Level
- 2006: ACGIH[®] TLV[®] lowered for quartz, cristobalite
 - 0.025 mg/m³, respirable particulate mass

“New reports of silicosis in industries and work settings not previously recognized to be at risk still occur”.

**American Thoracic Society, Official Statement
Adverse Effects of Crystalline Silica Exposure
June 1996**

Silicosis in....

U.S. Dental Technicians, Dental laboratory workers, dental supply factory workers

- Silicosis cases (MMWR 2004; de la Hoz 2004)
- Crystalline Silica as filler in dental materials
 - e.g., impression mixes, resins, abrasives, investment casting powders (high crystalline silica content (quartz, cristobalite))
- Sandblasting
- Grinding porcelain and castings
- Cleaning, maintenance

Can Silicosis Be Cured?

No. There is no known medical treatment to reverse silicosis or stop its progress. This disease can only be prevented by controlling exposure to silica dust. Workers who have been exposed to silica should stop smoking to reduce their risk of developing lung cancer.

Are There Other Potential Health Hazards Associated With Working in a Dental Lab?

Yes. They include the following:

☑ **Bloodborne pathogens** – Exposure to the agents that cause HIV, Hepatitis B, and C can occur when handling impressions and other items if contaminated with blood or saliva.

☑ **Methyl methacrylate** – Used in making dentures and plates, it can be absorbed into the body by inhalation, through the skin, and by ingestion. It is irritating to the eyes, skin, and respiratory tract. Repeated and prolonged exposure can cause skin sensitization and asthma, as well as adverse effects on the nervous system.

☑ **Electroplating chemicals** – The process of electroplating can release hazardous contaminants into the air that pose a variety of risks to the dental lab worker. The contaminants include various acid and alkaline mists that can cause respiratory and skin problems.

☑ **Metals** such as beryllium, chromium, cobalt, and nickel. These metals in alloys used for castings of bridge framework and other dental prosthesis components can cause a variety of lung problems.

☑ **Repetitive motion disorders** – A range of injuries to the muscles, tendons, nerves, ligaments and joints of arms, hands, wrists, shoulders, neck, and upper back. These injuries result from damage to the body over a period of time. If not treated they can result in chronic pain and permanent disability.

☑ **Noise** – grinding, sandblasting, and other dental lab machinery can make noise that may cause hearing loss.

☑ **Chemical sterilants** – These are used to sterilize impressions and prosthetic devices, received from dental offices, contaminated with blood and saliva. Sterilant chemicals include aldehydes, phenols, and quaternary ammonium compounds. These chemicals may cause lung problems and dermatitis.

Who Can I Contact for Additional Information?

If you have any questions about silicosis or need information about occupational health hazards in dental laboratories, please write, phone, e-mail, or fax your request as shown below:

NJ Department of Health & Senior Services
Occupational Health Surveillance Program
PO Box 360
Trenton, NJ 08625-0360

Phone: (609) 984-1863
e-mail: surveillance@doh.state.nj.us
Fax: (609) 292-5677

Visit our web site at
www.state.nj.us/health/eoh/survweb

James E. McGreevey
Governor

Clifton R. Lacy, M.D.
Commissioner

What Dental Technicians Need to Know About Silicosis



Division of Epidemiology, Environmental and Occupational Health

http://www.state.nj.us/health/eoh/survweb/dent_bro.pdf

Jeans Sandblasters

- in Turkey [Akgun et al. 2005, 2006, 2008; Sevinc et al. 2003; Sahbaz et al. 2007]
- “...uncontrolled and primitive conditions without protective measures”.
- Young males with silicosis
- ~3 years as sandblaster

Silicosis in Jewelry Workers

- “Chalk” molds in jewelry trade
 - “Lost-wax” casting technique
 - 70% quartz and cristobalite in imported “chalk” powder
 - 100 goldsmiths and silversmiths in Italy
 - CT scanning found 23 cases of “suspected” silicosis

Source: Murgia et al. Am J Ind Med [2007]

- Tatami mat manufacturing in China
 - [Xiao et al. in Occup Environ Med 2004]
- Dried mud
- Respirable dust
- ~26% silica
- 2.57% $\geq 1/0$ small opacities (661 X-rayed)

Disease Risk in....

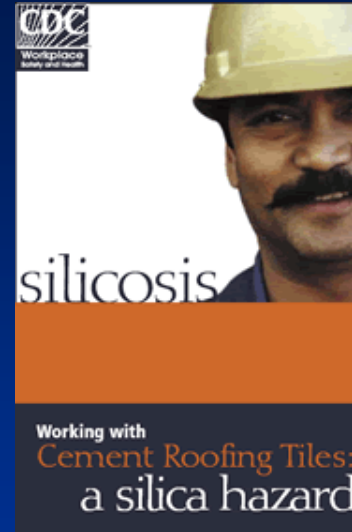
U.S. highway repair workers

- New Jersey Silica Partnership
 - 1999
 - Study NJ road & highway workers
- Air sampling
- Silicosis surveillance data
- Results: *“...a large population of highway workers is at risk of developing silicosis from exposure to crystalline silica.”* Valiante et al. [2004]



Exposures

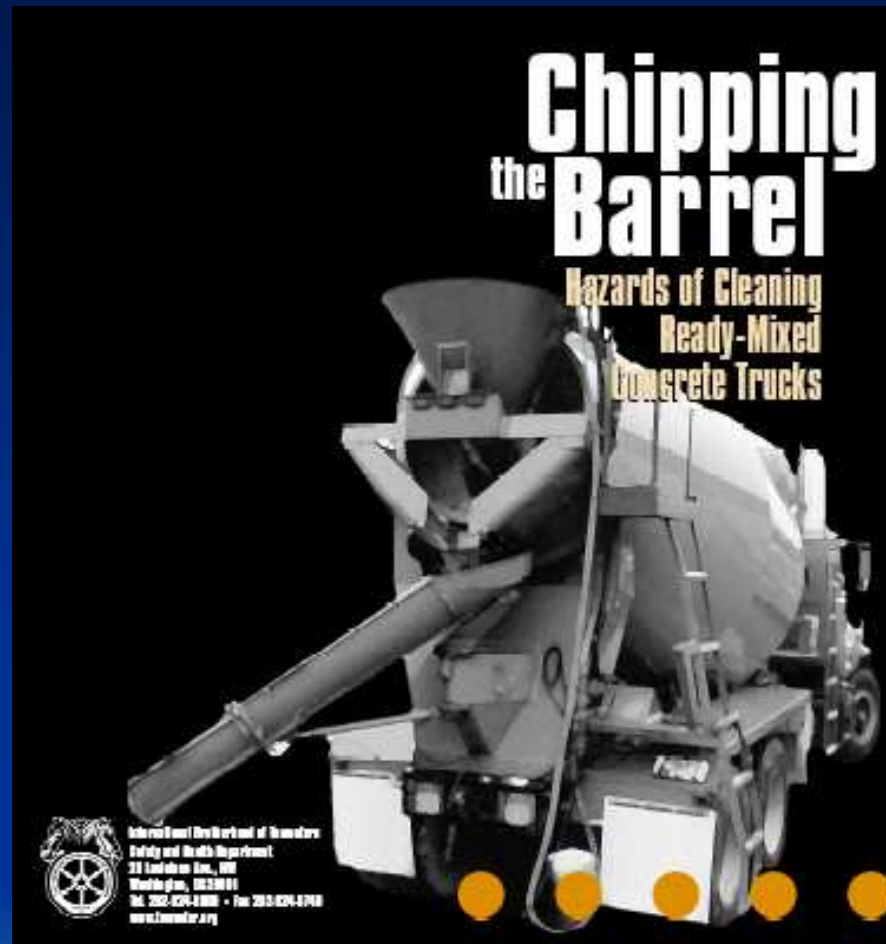
- Exposures >NIOSH REL in roofers cutting cement roofing tiles
<http://www.cdc.gov/niosh/docs/2006-110/>
- Granite countertop fabrication industry
 - 2004 CA Division of Occupational Safety and Health Hazard Alert
http://www.dir.ca.gov/dosh/dosh_publications/granitehazardalert.pdf



Exposures – cont'.

- Fibercement siding installation
 - Washington state study (Lofgren et al. 2004)
 - Hardiplank[®], WeatherBoards[™]
 - **35-55% crystalline silica per MSDS**
 - Seven worksites (contractors)
 - Overexposures to noise and silica
 - Cutting & sawing

Exposures – cont’.



Info:<http://www.cdc.gov/elcosh/docs/d0100/d000044/d000044.pdf>

<http://www.cdc.gov/niosh/topics/silica/pdfs/CT-247-19-readymix.pdf>

Other/Emerging Issues

1) OSHA Rulemaking (in Prerule stage)

- **2003**: Draft Standard posted; SBREFA done
<http://dockets.osha.gov/vg001/V037B/00/00/39.PDF>
- August **2008**: Complete peer review of health effects and risk assessment

2) January **2008**: OSHA National Emphasis Program for Crystalline Silica

http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=DIRECTIVES&p_id=3790

2) Nanoparticle Health Effects Research



**Draft NIOSH Document on
NIOSH Nanotechnology Topic Page**
<http://www.cdc.gov/niosh/topics/nanotech/>

NIOSH Silica/IH-related Publications [2008]

- **NIOSH Policy Statement: Respiratory Protection Recommendations for Airborne Exposures to Crystalline Silica**

<http://www.cdc.gov/niosh/docs/2008-140/pdfs/2008-140.pdf>

- **NIOSH Workplace Solutions—Silica series**
 - **Water Spray Control of Hazardous Dust When Breaking Concrete with a Jackhammer. No. 2008-127**
 - **Control of Hazardous Dust during Tuckpointing. No. 2008-126**

All NIOSH Workplace Solutions:

http://www.cdc.gov/niosh/pubs/workplace_date_desc_nopubnumbers.html



How to Contact NIOSH

Phone NIOSH

1-800-CDC-INFO (1-800-232-4636)
Outside the U.S. 513-533-8328
Email: cdcinfo@cdc.gov
Website: www.cdc.gov
1-888-232-6348 TTY

In English, en Espanol
24 Hours/Day, 7 Days/Week

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Inquire about the Health Hazard Evaluation program.

[Go to the Health Hazard Evaluation Page](#)

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Page last updated: March 3, 2008

Page last reviewed: January 10, 2008

Content Source: National Institute for Occupational Safety and Health (NIOSH)

Agency Silica-related Information

- NIOSH

- Silica Topic Page

- <http://www.cdc.gov/niosh/topics/silica/default.html>

- Control Banding Topic Page

- <http://www.cdc.gov/niosh/topics/ctrlbanding/>

- Construction Topic Page

- <http://www.cdc.gov/niosh/topics/construction/>

- Mining

- <http://www.cdc.gov/niosh/mining/>

- ORDS Topic Page

- <http://www.cdc.gov/niosh/topics/surveillance/ORDS/>

- Respirators Topic Page

- <http://www.cdc.gov/niosh/npptl/topics/respirators/>

Agencies-cont.'

- **OSHA** <http://www.osha.gov/SLTC/silicacrystalline/index.html>
 - <http://dockets.osha.gov> “H” for health
- **MSHA**
<http://www.msha.gov/S&HINFO/SILICO/SILICO.HTM>

\$New Jersey Department of Health and Senior Services, Occupational Health Surveillance Program
-*Dry Cutting and Grinding is Risky Business*

http://www.state.nj.us/health/eoh/survweb/documents/dry_cutting.pdf

Agencies-cont'.

- WHO

Occupational Health; Silicosis

http://www.who.int/occupational_health/en/

http://www.who.int/occupational_health/topics/silicosis/en/

Quartz CICAD*

<http://www.inchem.org/documents/cicads/cicads/cicad24.htm>

*Concise International Chemical Assessment Document
[2000]

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