

Q & A

NATIONAL INDUSTRIAL SAND ASSOCIATION

Q What is Crystalline Silica?

A Compounds of the elements silicon and oxygen make up most of the minerals and rocks found in the earth's crust. When the basic structure of the molecule is a pattern that is repeated and symmetrical, the silica compound is said to be "crystalline." Generally, the term silica is used to mean crystalline silica or quartz.

Q Where is Crystalline Silica Found?

A Silica minerals form most of the rocks found in the earth's crust. Over time, natural geologic processes have decomposed the rock crust to form gravels, sands, and soils. Thus, crystalline silica compounds are found virtually everywhere on the surface of the earth.

Q What Materials of Commercial Importance May Contain Silica?

A Many minerals or rocks of commercial value may contain varying amounts of crystalline silica. Silica can be a predominant constituent or only present as a minor accessory mineral with minerals of commercial value. Some rocks and minerals characterized as described above include:

Andalusite	Pyrophyllite
Barite	Talc
Beach Sand	Tripoli
Bentonite	Rutile
Calcite	Wollastonite
Clay	Zeolite
Diatomaceous Earth	Zirconium Sand
Feldspar	Vermiculite
Kaolin	Granite
Limestone	Sandstone
Mica	

Q What are the Common Uses of Sand Containing Crystalline Silica?

A Silica has been used for thousands of years.

Everyday Uses Include:

Agricultural Uses	Paint
Asphalt Paving	Glass Manufacturing
Brick and Tile	Soaps & Detergents
Concrete	Fiber Glass
Cleansers	Electronics
Foundry Casting	Plaster
Ceramics & Pottery	Sandblasting

Environmental Applications Include:

Monitoring Wells
Industrial Effluent Filtration
Drinking Water Filtration
Hazardous Waste Control

Because of the ubiquitous occurrence and many commercial uses of silica, potential exposure to silica dust is widespread.

Q How Are Workers Typically Exposed to Crystalline Silica?

A Because of the abundant occurrence and many uses of silica, potential exposures to silica dust are widespread. The National Institute for Occupational Safety and Health (NIOSH) has estimated that 3.2 million workers in 238,000 plants in the U.S. are potentially exposed to crystalline silica dust.

Occupational exposure to crystalline silica is primarily through the breathing of silica containing dusts. Workers may be exposed to dusts containing silica in many industries including those in mining and quarrying; steel, iron, and other metal foundries; abrasive blasting; construction; glass and ceramics; paint and pigments; and the granite and stone industries.

Q&A

Health Aspects of Crystalline Silica...

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What Are the Known and Suspected Health Risks From Working With Silica?

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The primary health risk is from inhaling silica dust particles smaller than 10 micrometers (about 1/2500th of an inch). Generally speaking, the smaller the silica particles are, the greater the potential injury to the lungs. Dust particles larger than these are not capable of penetrating the defense mechanisms of the lung to produce injury to the important lower regions of the lung where oxygen transfer takes place. Dust particles 10 micrometers and smaller are commonly referred to as "respirable" dusts.

Prolonged excessive exposure to respirable crystalline silica may cause a delayed chronic lung disease—silicosis. Chronic silicosis may take many years of exposure to develop. However, with heavy exposure, acute or rapidly developing silicosis may occur in a shorter period of time. Cases of acute silicosis have been reported in certain occupations, such as sandblasting and drilling through silica containing rock. Silicosis is a pulmonary fibrosis (development of scar tissue in the lungs) which can be progressive, disabling, and can lead to death. In the latter stages of silicosis, known as complicated or conglomerate silicosis, lung function may be reduced, resulting in symptoms of shortness of breath.

The International Agency for Research on Cancer (IARC) has determined from a review of human epidemiology studies that there is limited evidence for the carcinogenicity of crystalline silica. Additional information on this subject is presented on pages 3 & 4.

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What Regulations Are There for Permissible Levels of Exposure to Crystalline Silica in the U.S.?

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Occupational exposure to crystalline silica in general industry is regulated by the Occupational Safety and Health Administration (OSHA) and is under the laws of some states. Occupational exposure to crystalline silica in the mining industry is regulated by the Mine Safety and Health Administration (MSHA).

At present, the permissible exposure limit based on an 8-hour time-weighted average concentration of respirable silica is 0.1 milligrams of quartz per cubic meter of air (mg/m³) for OSHA, and the American Society for Testing and Materials (ASTM) Standard E 1132.

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What Kinds of Silica Health Research Have Been Conducted?

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Research regarding the health effects of silica in humans and animals has been conducted since the early part of this century while experiments involving animals have been performed since the early 1930s. Human epidemiology studies have included investigations of morbidity or causes of illness, as well as, mortality or causes of death among silica-exposed workers.

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What Have Animal Studies Revealed About Crystalline Silica?

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Various forms of crystalline silica have been studied by different routes of exposure in animals. While some experiments that involve inhalation of the silica particles, a normal route of entry, have been performed; others involve intratracheal installation or intrapleural injections, which bypass normal defense mechanisms.

Recently, several of these installation/injection studies, as well as some inhalation studies, have been positive for an increased development of benign and cancerous tumors.

The experimental animal evidence has been the subject of scientific criticism because:

- (1) the observations are limited to one species, the rat, and suggest that females are more susceptible than males (studies of mice and Syrian Golden Hamsters have been negative);
- (2) the increased tumorigenicity occurs only at high doses and properly designed cancer studies to demonstrate dose-response have not been performed;
- (3) the pathologic response demonstrated in these animal experiments, generally speaking, is not characteristic of human silicosis;
- (4) the pathology was not conducted in a rigorous scientific fashion that would support a carcinogenic finding;
- (5) the response observed occurs as a non-specific reaction in experiments using other dust.

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What Have Human Studies Revealed About Crystalline Silica and Cancer?

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A number of mortality studies have investigated the relationship of exposure to silica-containing dust and lung cancer among occupationally exposed workers. The results have been mixed and no consistent results of a positive relationship have been concluded.

The epidemiology studies showing a positive association for silica exposure and lung cancer generally did not assess confounding exposure to radon or other lung carcinogens, including tobacco products. On the other hand, workers exposed to crystalline silica without confounding exposures (such as Vermont granite workers, South Dakota gold miners, and taconite miners) show little or no increase in lung cancer, despite sufficient silica exposure among the granite workers and gold miners to produce increases in deaths due to non-malignant respiratory disease (silicosis and silico-tuberculosis).

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What is the International Agency for Research on Cancer (IARC)?

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In 1969 IARC was formed as a part of the World Health Organization. One of IARC's functions is to evaluate the carcinogenic risk of various substances to which humans are exposed. In a typical evaluation process, IARC gathers a working group of scientists to evaluate research studies on a selected substance. According to IARC guidelines, the group reviews the published scientific studies and classifies the evidence of carcinogenicity for the substance in humans and experimental animals. IARC classifies substances using the following categories:

Group 1—*Sufficient evidence of human carcinogenicity*

Group 2A—*Probably carcinogenic to humans*

Group 2B—*Possibly carcinogenic to humans*

Group 3—*Not classifiable as to human carcinogenicity*

Group 4—*Probably not carcinogenic to humans*

Crystalline silica was classified as Group 2A in "IARC Monographs on the Evaluation of Carcinogenic Risks to Humans," Supplement 7, (1987). For more information, see "IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Humans—Silica and Some Silicates," Volume 42; and IARC Scientific Publication entitled "Occupational Exposure to Silica and Cancer Risk," No. 97.

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Why Did the International Agency for Research on Cancer Evaluate the Scientific Literature on Crystalline Silica?

A

Since 1969, IARC has been evaluating the carcinogenic risks of various agents to which humans are exposed. The agents are selected for evaluation on the basis of two main criteria:

- (1) there is evidence of human exposure, and
- (2) there is some experimental evidence of carcinogenicity and/or there is some evidence or suspicion of a risk to humans.

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What Did the International Agency for Research on Cancer Conclude About Silica?

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Based on its review (and using its own definitions), IARC determined that there is sufficient evidence of carcinogenicity of crystalline silica to experimental animals and that there is limited evidence of the carcinogenicity of crystalline silica to humans.

Q

What Does "Sufficient Evidence" in Animals Mean?

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In evaluating evidence of carcinogenicity in experimental animals, IARC defines "sufficient evidence" as follows:

- "Sufficient evidence of carcinogenicity is provided when there is an increased incidence of malignant tumors:
- (1) in multiple species of strains; or
 - (2) in multiple experiments (preferably with different routes of administration or using different dose levels); or
 - (3) to an unusual degree with regard to incidence, site or type of tumor, or age at onset. Additional evidence may be provided by data on dose-response effects."

Q&A

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What Does "Limited Evidence" in Humans Mean?**A**
In evaluating evidence of carcinogenicity in humans, IARC defines "limited evidence" as follows:

"Limited evidence of carcinogenicity indicates that a casual interpretation is credible, but that alternative explanations, such as chance, bias or confounding, could not adequately be excluded."

Confounding means that consideration was not given to known cancer causes. In the research studies on which the IARC finding was based, exposure to silica in humans was often accompanied by exposure to other known carcinogens such as smoking, radon in underground mines, and arsenic or polynuclear aromatic compounds in foundries.

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What Does the Effect of this IARC Finding Require Regarding OSHA's Hazard Communication Standard?**A**
Under OSHA's Hazard Communication Standard and the laws of some states, IARC's finding must be reported on Material Safety Data Sheets and labels provided for substances where crystalline silica is present in amounts greater than 0.1 percent. The United States is one of the few countries to adopt regulations which automatically trigger this requirement based on an IARC finding without first requiring a more definitive evaluation in the form of complete hazard identification or risk assessment.**Q**
Can Crystalline Silica Be Used Safely?**A**
NISA believes silica can be used and handled with relative safety if appropriate work practices are followed to limit exposure to respirable silica dust. However, as previously noted, prolonged excessive exposure to respirable crystalline silica may cause the lung disease—silicosis.

Since such concentrations of dust may be invisible to the naked eye, employers using silica should monitor worker exposures using NIOSH-approved sampling and analytical methods conducted by a qualified industrial hygienist or trained personnel. For additional information on crystalline silica, refer to OSHA Regulations, ASTM Standard Practice E 1132-89, Material Safety Data Sheets, and applicable governmental regulations.

Q
What Are the Proper Work Practices for Handling Materials Which Contain Silica?**A**
Proper dust control measures such as adequate ventilation, engineering process controls, administrative control measures, employee training, exposure monitoring, and respiratory protection are some of the programs or practices which should be followed in handling materials which contain silica. For more information, employers should obtain a copy of ASTM E 1132, "Standard Practice for Health Requirements Relating to Occupational Exposure to Quartz Dust," along with appropriate OSHA guidelines and governmental regulations on controlling occupational exposure, and implement immediate control measures.

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