Using crystalline silica safely

SAFESILICA

Executive summary

Crystalline silica is a mineral, and a vital ingredient in many products we use every day. It is present in our computers and phones, cars and buses, roads and railways, glass and ceramics, and throughout our homes.

In everyday contexts, crystalline silica is safe. However, in industrial workplaces, where materials containing crystalline silica are crushed, ground, drilled, or used in similar processes, a very fine dust is produced. This is known as Respirable Crystalline Silica or RCS. When high levels of RCS dust are inhaled into the lungs on a regular basis over many years, it can cause lung irritation which can lead to a lung disease known as silicosis. Severe cases of silicosis can in turn lead to lung cancer as a secondary disease.

This poses a risk to workers operating in the direct vicinity of industrial processes, who are repeatedly exposed to high levels of RCS dust on a daily basis – typically those working regularly within 10 metres of such processes. This is a well-understood occupational hazard, and safe practices exist to manage the risk to workers who are operating in those areas. Industry, trade unions, national government policy makers, regulators, and the EU are all working together to protect workers' health through the NEPSI agreement. NEPSI's multi-stakeholder approach is regarded as a role-model for cooperation between industry, workers and regulators.

It is important to understand that RCS does not pose a risk to anyone else. RCS dissipates quickly in the open air, meaning that outside the direct vicinity of industrial processes levels of RCS are tiny, and well below safe levels. This has been confirmed by multiple health and safety regulators. For example, the UK Health and Safety Executive, has stated that "no cases of silicosis have been documented among members of the general public in Great Britain, indicating that environmental exposures to silica dust are not sufficiently high to cause this occupational disease." Likewise, the French government stated in May 2018 that "no consumer use [of products containing crystalline silica] leading to a significant exposure to crystalline silica by inhalation has been identified."

In short, RCS is a known occupational hazard which can pose a risk to workers in industrial workplaces - although safe measures exist to minimise this risk. It does not pose a danger to anyone else, including people working in other parts of industrial sites, or living nearby.

What is crystalline silica?

Silica is a mineral made up of silicon and oxygen, two of the most common elements on the planet. It comes in several forms, although by far the most common is crystalline silica. Crystalline silica is so abundant that it makes up over 12% of the earth's crust, making it the second-most common mineral on the planet.

Crystalline silica comes in the forms of quartz, cristobalite and tridymite. Quartz is the most common of these, which transforms into cristobalite when heated at high temperatures (over 1450 degrees centigrade).

Crystalline silica is an extremely useful mineral, and products containing it have been used for thousands of years to build and make things. Crystalline silica is present in thousands of different raw materials, including almost all types of material extracted from the earth's crust. It is present in almost all materials that are quarried, including sand, clays, gravel and metallic ores. It is hard, chemically inert, and has a high melting point, qualities which make it a valuable raw material for many industrial and manufacturing processes.

A key ingredient in products we use every day

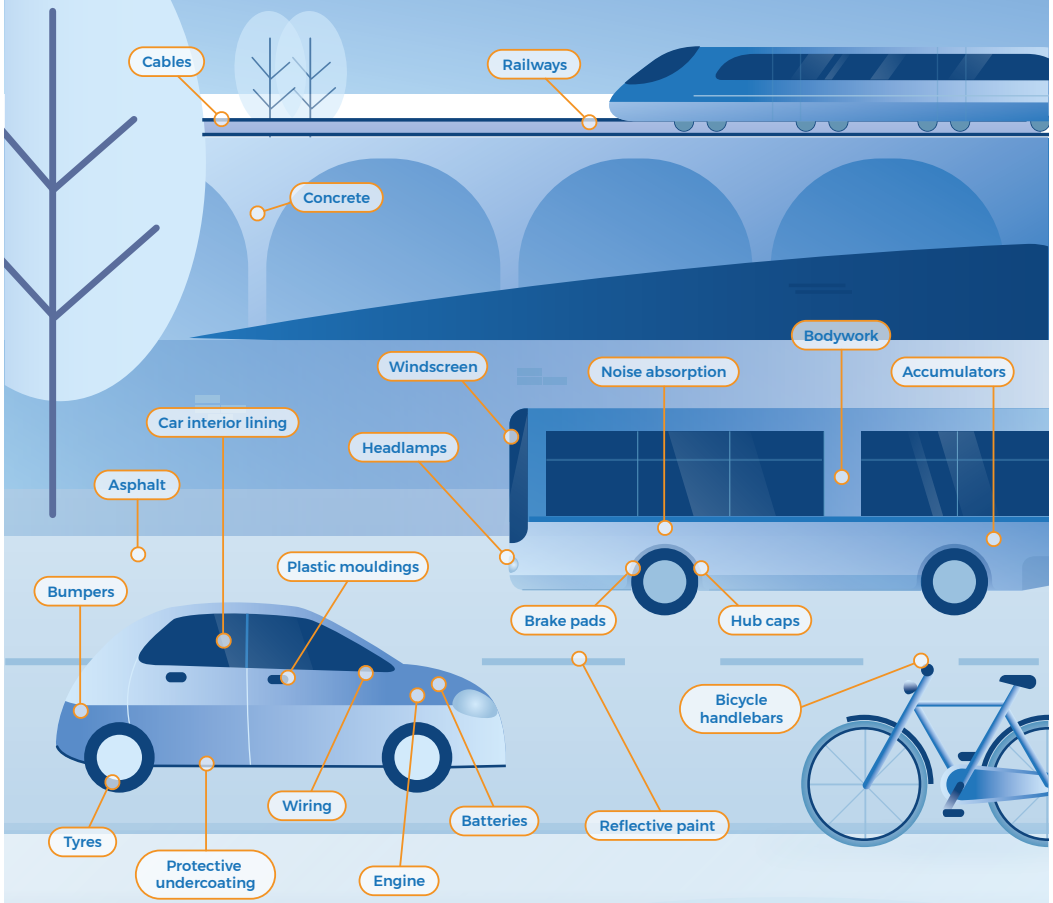
Crystalline silica is so common that products containing it are used in a vast array of industries, including glass, foundries, construction, mineral wool, ceramics, chemicals, horticulture, and even sports and leisure. It is used as a filler for paints, plastics, and rubber, whilst silica sand is used in water filtration and agriculture.

Crystalline silica is irreplaceable in a series of high-tech applications, for example precision casting, fibre-optic cables, and the raw materials for computer chips. It is also used in the metallurgical industry, oil and gas extraction, and recycling.

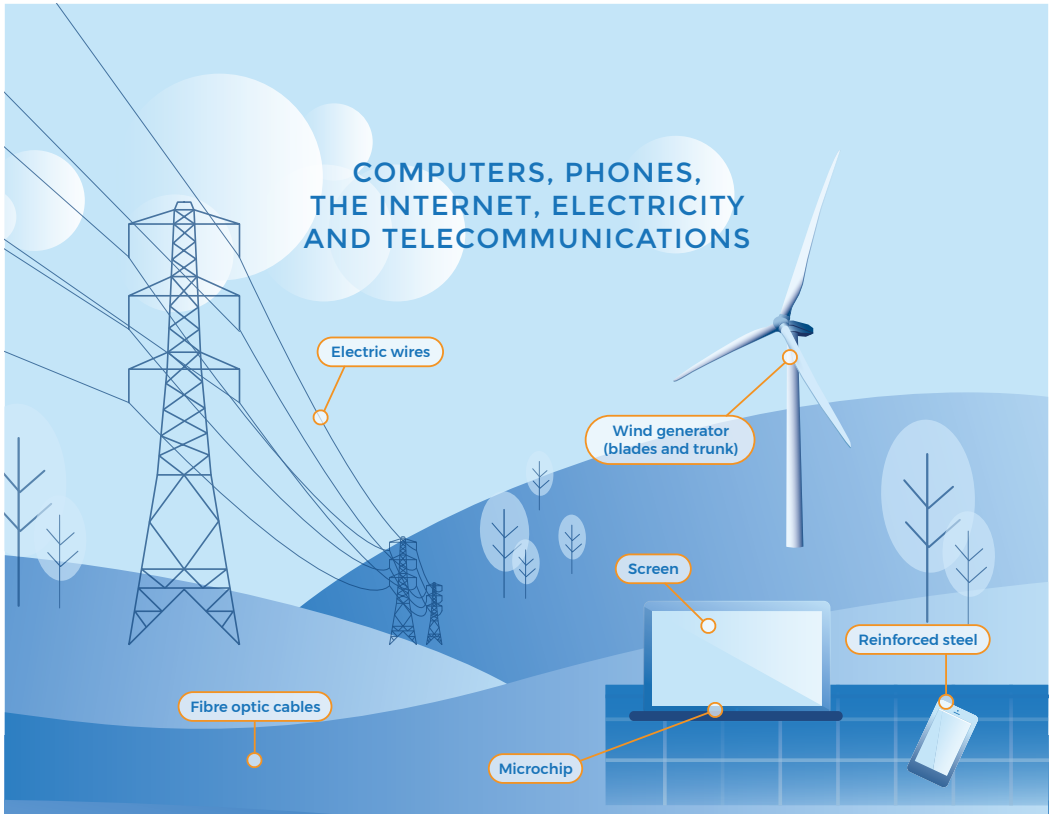
That means that crystalline silica is a key component in the manufacture of almost everything we use on a daily basis. It is present in our computers and phones, cars and buses, roads and railways, glass and ceramics, and throughout our homes. It is even key to the infrastructure of the internet, renewable energy and telecommunications. It can truly be described as one of the building blocks of modern life.

Crystalline silica is a mineral found in almost every type of material extracted from the earth's crust. It has many uses, and is a key ingredient in the manufacture of many products we use every day.

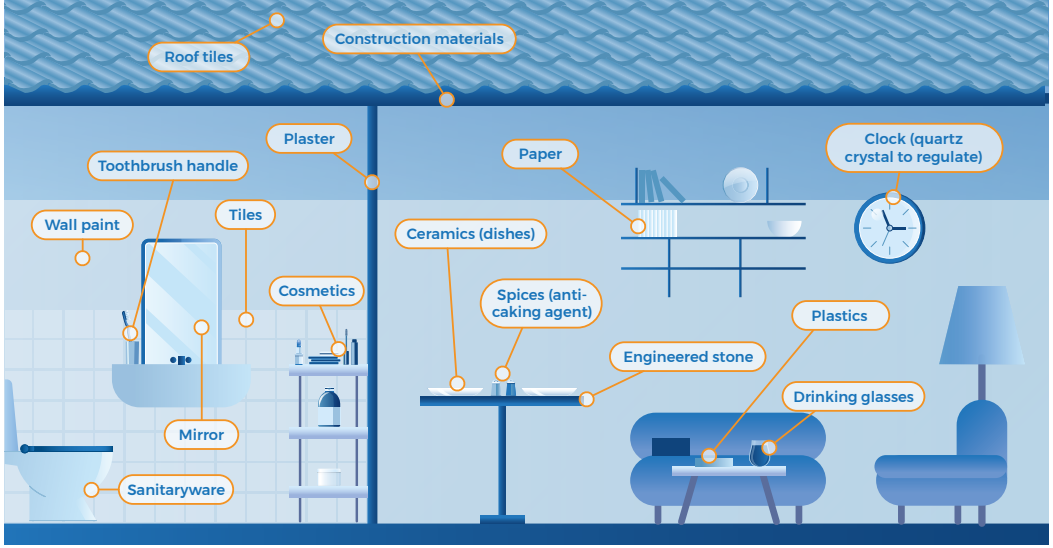
CARS, BUSES, BICYCLES, ROADS AND RAILWAYS



COMPUTERS, PHONES, THE INTERNET, ELECTRICITY AND TELECOMMUNICATIONS



YOUR HOME



Respirable crystalline silica (RCS)

An avoidable risk in industrial workplaces, and no risk to the general public

In everyday contexts, crystalline silica is safe. It is inert, meaning that it does not react with any chemicals, and it is not harmful to health.

However, when rocks and other materials containing crystalline silica are cut, crushed, ground, drilled or used in similar industrial processes, dust particles are produced. Some of these particles are very fine – known as Respirable Crystalline Silica or RCS. If high quantities of this very fine dust are inhaled on a regular basis over many years, there is a potential risk that the cumulative effects can cause a lung disease known as silicosis, followed in severe cases by lung cancer. That is why the EU has recently updated the *Directive on Carcinogens and Mutagens at Work* to implement a legal RCS occupational exposure limit of 0.1 mg/m^3 in industrial workplaces (more commonly written as 100 µg/m^3).

It is about very fine dust created in industrial workplaces – and there is no risk to neighbours, communities, or those working in other parts of an industrial facility

There is a natural, tiny level of RCS particles in all the air on the planet, known as the 'background level'. At this level, RCS poses no risk to humans or animals. However, in the immediate proximity of industrial processes involving materials containing crystalline silica, the levels of RCS can be hundreds of times higher than the background level, potentially posing a risk to people working in those environments for many years.

Outside this immediate radius – typically within 1-10 metres – RCS disperses very rapidly, reducing concentrations back to background or near-background levels. This has been shown in numerous scientific studies measuring RCS around industrial sites. For example, a recent study found that in the open air of quarries and construction sites, ambient concentrations of RCS are low, typically being less than one tenth of the EU workplace occupational exposure limit, even downwind of high energy industrial processes[2].

This means that people living or working near an industrial site will not be exposed to potentially harmful levels of RCS. It is only a risk to people working directly with the industrial process, and only when inhaled regularly over many years.

It's official – no public risk, confirmed by government regulators

The UK Health and Safety Executive, tasked with ensuring health in the workplace, has stated that "no cases of silicosis have been documented among members of the general public in Great Britain, indicating that environmental exposures to silica dust are not sufficiently high to cause this occupational disease."[3]

In May 2018, the French government stated that "no consumer use [of products containing crystalline silica] leading to a significant exposure to crystalline silica by inhalation has been identified."[4] This means that even if you occasionally engage in some processes which may generate RCS dust (eg. drilling into a concrete wall), you will not be exposed to high levels for long enough for the dust to have negative health effects.

Scientific evidence shows that RCS produced by industrial processes only poses a potential risk to those working within metres of the process – not to anyone working or living near a site.

[2] Stacey P, Thorpe A, Roberts P, Butler O (2018), Determination of respirable-sized crystalline silica in different ambient environments in the United Kingdom with a mobile high flow rate sampler utilising porous foams to achieve the required particle size selection, HSE Harpur Hill, Buxton, SK17 9JN, Atmospheric Environment 182 (2018) 51–57
[3] http://www.hse.gov.uk/quarries/silica.htm
[4] https://echa.europa.eu/registry-of-clh-intentions-until-outcome/-/dislist/details/0b0236e180b9b823

RCS exposure in the workplace

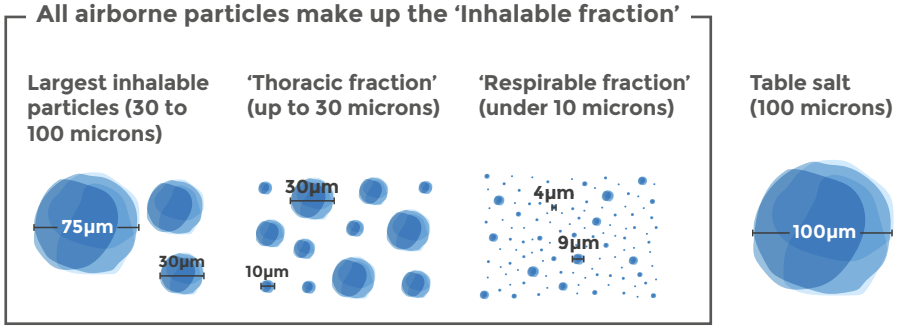
The science

Dust “fractions” – size matters!

To understand the potential risks to workers more clearly, it is necessary to explain what makes up the dust created by industrial processes.

Not all crystalline silica dust particles are the same size. Like chipping ice from a block, processes like drilling and crushing cause different sized pieces to be broken off. The smallest pieces become airborne, and form a cloud of dust. Within this cloud there are many different sizes of particle, measured by diameter in microns, symbolised by µm (millionths of meters, or thousandths of millimetres).

Different sized particles are grouped together into three ‘fractions’ - the ‘inhalable’, ‘thoracic’, and ‘respirable’. The ‘inhalable fraction’ includes all of the particles in the dust cloud, which range from 1 to 100µm in size. These are all small enough to be breathed into the nose or mouth. The ‘thoracic fraction’ includes particles ranging from 1-30µm, which are able to penetrate into the lungs. The ‘respirable fraction’ are particles from 1-10µm in size, which are able to penetrate into the gas exchange areas of the lungs, and cause irritation. RCS is exclusively made up of the ‘respirable fraction’.



[5] WHO: Hazard Prevention and Control in the Work Environment: Airborne Dust http://www.who.int/occupational_health/publications/en/oehairbornedust3.pdf, p 8

The largest inhalable particles (30 to 100 microns in diameter)

The majority of particles in a dust cloud are between 30 and 100 microns in diameter, comparatively large enough to be captured by cilia hairs in the nose and throat, and safely expelled through coughing, sneezing or blowing one’s nose. It is these 30 to 100 microns diameter particles which can most commonly be seen by the naked eye and are large enough to be picked up and carried by the wind over long distances - much in the same way that sand can be blown across a beach in windy weather.

Crystalline silica particles of this size do not stay in the body and pose no risk to health.

‘Thoracic fraction’ (up to 30 microns in diameter)

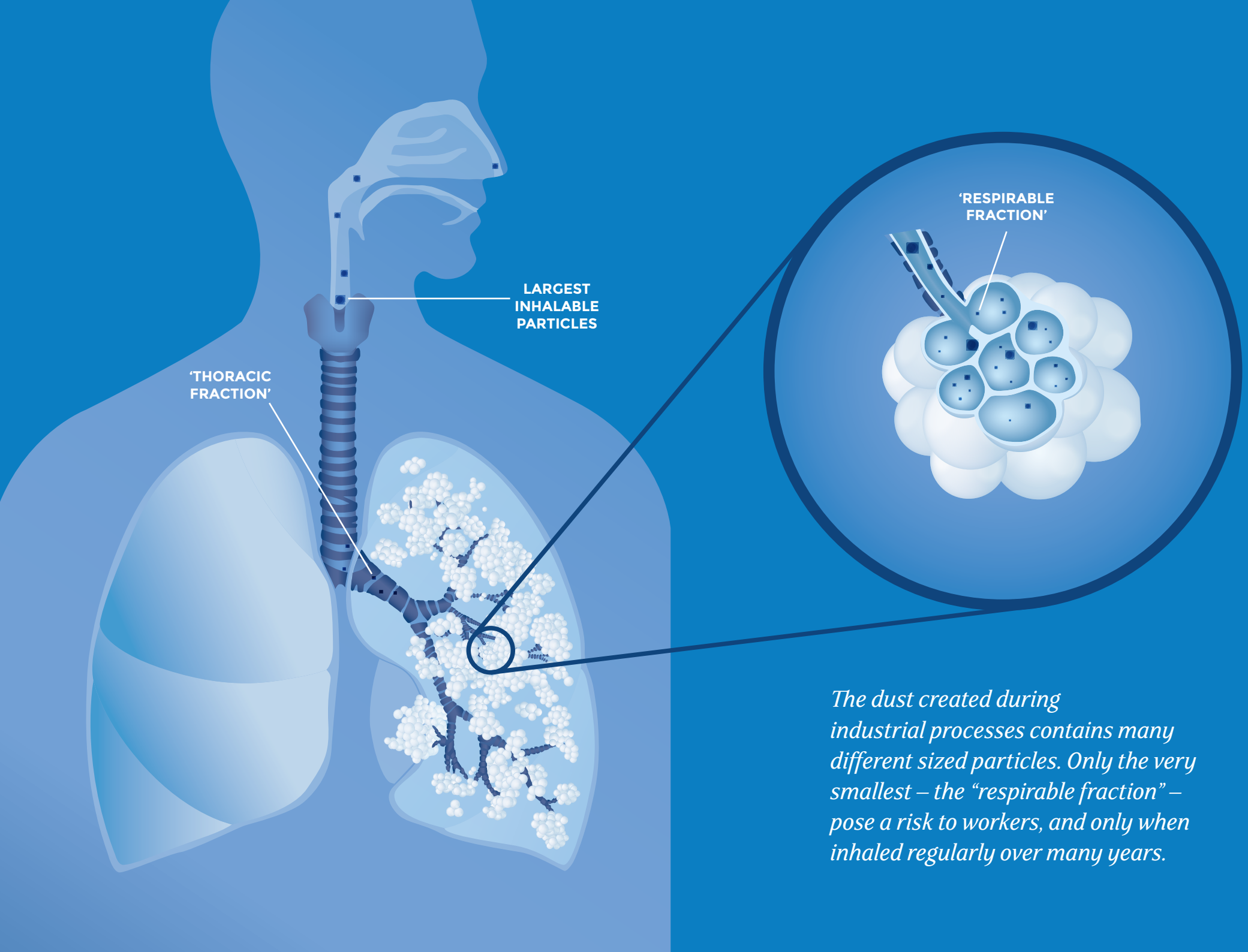
The thoracic fraction is made up of dust particles smaller than 30 microns in diameter. These particles are small enough to move past the cilia hairs in the nose and throat and may enter the sinuses and the airways of the lung. Once there, the particles sized between 10 and 30 microns are big enough to be trapped by the body’s natural defences and prevented from going further. They are then breathed out, coughed out or sneezed out.

Particles of this size do not pose a health risk, as they are dealt with by the body’s natural defences.

‘Respirable fraction’: RCS dust (under 10 microns in diameter)

The third and smallest fraction of crystalline silica particles is the respirable fraction or RCS. This fraction is small enough to penetrate the natural defences of the nose, throat and lungs, and enter the tiny vessels deep in the lungs where gas is exchanged in the breathing process.

It is in these gas exchange areas that RCS can cause irritation and inflammation. The cumulative effect of repeated high doses of RCS can silicosis, which in turn can increase the risk of lung cancer.



The dust created during industrial processes contains many different sized particles. Only the very smallest – the "respirable fraction" – pose a risk to workers, and only when inhaled regularly over many years.

Silicosis and lung cancer

The facts

For many years, it has been known that prolonged inhalation of respirable crystalline silica dust may cause a specific type of lung damage called silicosis. In fact, silicosis is often referred to as the world's oldest known occupational disease.

Although silicosis has been recognised for centuries, our understanding of how it works and its links to lung cancer have become better understood over the past two decades. A suspicion of lung cancer occurrence among workers exposed to RCS was first proposed in the 1960s. However, confirmation of a link between prolonged silica exposure and lung cancer was generally considered impossible until the 1980s.

In 1987, the International Agency for Research on Cancer (IARC) evaluated RCS as a probable human carcinogen for the first time, and in 1997 concluded on the basis of a literature review that inhaled RCS from occupational sources is carcinogenic to humans. In 2012, IARC confirmed its conclusions as: "Crystalline silica in the form of quartz or cristobalite dust is carcinogenic to humans".

It is now accepted in medical science that prolonged and intense RCS exposure can cause lung cancer – but only in patients who are already suffering from silicosis.

To understand more about the risks to those working in industrial environments, a hazard assessment of the health effects of RCS was commissioned in 2009, run by a team of scientific experts.[6] The assessment concluded that:

- **Silicosis is the primary health effect of direct, long-term RCS exposure**
- **Any potential cancer risk due to RCS exposure is limited to lung cancer**
- **Any lung cancer excess risk is demonstrated only under high occupational exposures to RCS**
- **Any cancer effect is indirect/secondary to lung inflammation**

This means that silicosis is the primary risk to those working in industrial environments and that cases of lung cancer caused by RCS exposure are caused first by lung inflammation. This means that minimising the risks of silicosis in those working in industrial environments will also minimise or even eradicate the risk of lung cancer from RCS exposure. This view was validated by the European Scientific Committee for Exposure Limit Values (SCOEL), who in a 2003 report concluded that:

Preventing the onset of silicosis will also reduce the cancer risk

This understanding has helped policy makers and regulators implement regulations to protect workers' health, and the industries concerned to adopt measures to protect workers from the risks of RCS.

[6] Review and Hazard Assessment of the Health Effects of Respirable Crystalline Silica (RCS) Exposure to inform Classification and Labelling under the Global Harmonised System: Overview Report (Borm P, Brown T, Donaldson K, Rushton L, 2009); and Review of the Literature of the Health Effects of Occupational Exposure to Crystalline Silica: Silicosis, Cancer and Autoimmune Diseases (Brown T, Rushton L, 2009)

Doing what is necessary to prevent silicosis and cancer in the workplace

Protecting workers' health, and preventing diseases such as silicosis and cancer, are of paramount importance. That is why governments, unions and industries in which RCS dust exposure poses a risk are working to implement measures to protect workers.

Thankfully, crystalline silica-related diseases can be prevented through the application of good practices in the workplace, ensuring, and going beyond, regulatory compliance. Effective control of those industrial processes also helps to ensure that any release of dust into the surrounding environment is kept to a minimum.

Industry and Unions

In 2005, a series of industries where RCS exposure may be present and trade unions representing workers joined together to develop good practices for protecting workers' health. Together, they set up an EU Social Dialogue Agreement – the first of its kind – with the mandate to share and provide guidance on these good practices and encourage the continual improvement of health and safety standards. Called the European Network for Silica (NEPSI), the organisation ensures that all parties have the tools needed to protect workers' health by doing the right things to minimise exposure to RCS.

NEPSI was funded by the European Commission, and its good practices and guidance on managing RCS exposure are freely available online. They provide companies clear and easy to implement recommendations to protect the health of their employees. This includes practical advice on reducing the amount of RCS dust produced and enhancing effective ventilation in industrial workplaces. NEPSI engagement also provides a strong incentive for continuous improvement across industries where RCS may pose a risk.

The NEPSI measures have already been implemented across sectors and are extremely effective, so much so, that a newly updated EU Directive 'on the protection of workers from the risks related to exposure to carcinogens or mutagens at work' (2017/2398/EC) names NEPSI good practices as a benchmark of "valuable and necessary instruments to complement regulatory measures and in particular to support the effective implementation of limit values…". The sectors involved are committed to ensuring that this remains the case.

"Guides and examples of good practices produced by the Commission, the Member States or the social partners, or other initiatives, such as the Social Dialogue 'Agreement on Workers' Health Protection Through the Good Handling and Use of Crystalline Silica and Products Containing it' (NEPSI) are valuable and necessary instruments to complement regulatory measures and in particular to support the effective implementation of limit values."

EU Directive 2017/2398/EC

"The NEPSI Agreement deserves praise for leading to lower levels of exposure through spreading good practices which employers have actively bought into. And it has helped to increase the knowledge of the health effects of RCS. Crucially, it has and still is complementing European legislation in the field of worker protection. Setting limit values through EU legislation is instrumental for protection of workers' health. But it is the quality of implementation and enforcement on the ground [...] that will determine whether lives are saved. That is where we see the true value of the bottom-up approach, which has driven the success of NEPSI."

EU Commissioner Marianne Thyssen
NEPSI 10 year anniversary

European legislation

In January 2018, the European Commission issued a revision of the Carcinogens and Mutagens at Work Directive.

The Directive implements a binding Limit Value of 0.1 mg/m³ on "works involving exposure to respirable crystalline silica dust generated by a work process". This legal limit will apply to all industrial workplaces, including those which have already been mentioned earlier in this paper, where silica-containing materials such as concrete, bricks, or rocks are mined, quarried, cut, crushed, manufactured or ground.

All EU Member States will now have to develop national legislation implementing this legal limit, at the latest by January 2020.

The NEPSI signatory industries and partners[7] welcome the revision of the Directive and the establishment of a binding legal limit value at EU level at 0.1 mg/m³. This EU-wide maximum exposure limit value is also expected to support the aims of NEPSI – in encouraging all industries to implement good practices where necessary, to limit worker exposure. This limit is already in place in many EU Member States, with some member states even implementing a lower limit.

The text of the EU Directive can be found in multiple languages on the European Union website.

[7] NEPSI involves 18 industries, plus trade unions representing workers

Examples of dust control measures in place across industry

There are several things companies can do to manage the amount of dust created, and minimise exposure to RCS amongst workers.

Enclosure
Conducting RCS producing processes in a sealed environment

Extraction / Ventilation
Ensuring that RCS is extracted and stored for secure removal

Water
Keeping processes wet to prevent dust becoming airborne

Protective equipment
(eg. face masks) preventing dust being breathed in

Good hygiene / housekeeping
Washing work clothes and vacuuming up dust produced by processes

The example below gives a visual representation of the improved conditions that effective ventilation and air filtering has on reducing dust in industrial workplaces – with the dust being captured by the ventilation system and stored for safe disposal:

Continually improving worker protection

Whilst great efforts are being made to protect workers from RCS exposure, there is still progress to be made.

This is partly about enhancing understanding of RCS, and how workers' health can best be protected through new techniques and technologies. NEPSI signatory industries contribute to this through biennial reporting against eight key performance indicators, all related to minimising risks to workers' health.

It is also about ensuring the widest possible implementation of existing measures to protect workers' health, beyond the sectors which are already NEPSI signatories. Any industry in which RCS poses a risk is welcome to use NEPSI good practices to minimise the risk to their workers.

To support these goals, NEPSI has developed a 5 year roadmap which will address the following objectives:

1. Develop a specific action/training programme and guidance for SMEs and the new generations of workers and develop up-to-date information /communication on RCS exposure control for different audiences.
2. Review the Good Practice Guide and Task Sheets and update when necessary.
3. Development of a detailed standardized RCS exposure measurement methodology.
4. Continue Key Performance Indicator (KPI) reporting, enhance the participation through continuous awareness, promote the Agreement in co-operation with Health and Safety specialists
5. Review the Agreement and the Good Practice Guide to check language coherence with the amended Carcinogens and Mutagens Directive (2017/2398/EC).

Where to find more information

- EU Directive
- NEPSI guidance for HSE managers and staff

This white paper was developed by:

IMA-Europe AISBL
Rue des Deux Eglises, 26
1000 Brussels, Belgium

IMA Europe

www.safesilica.eu