nepSiO2

Crystalline Silica / Silice cristalline

GOOD PRACTICE GUIDE

Good Practice Guide on Workers Health Protection through the Good Handling and Use of Crystalline Silica and Products containing it

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This document was issued by the signatories of the Social Dialogue Agreement on Workers' Health Protection through the Good Handling and Use of Crystalline Silica and Products Containing it, in the framework of art. 139 of the Treaty on European Union and with the support of the European Commission.

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PREAMBLE

WHY THIS GUIDE

This guide is the result of an assembly of existing knowledge and information within sectors, which produce and/or use products or raw materials containing crystalline silica about the management of respirable crystalline silica. The publication of this guide is a contribution of the industry (employers and employees) towards the protection of workers from possible exposure to respirable crystalline silica in the workplace.

OBJECTIVE OF THIS GOOD PRACTICE GUIDE

The objective of this guide is to give producers and users of products and raw materials that contain crystalline silica guidance on the practical application of a programme to manage respirable crystalline silica and guidance on the safe use of crystalline silica containing products in the workplace.

The silica producing and using industries stress that employees should be protected against potential health effects caused by occupational exposure to respirable crystalline silica in the workplace. Therefore, efforts should be focused on minimising potential personal exposure to respirable crystalline silica in the workplace.

This is a dynamic guide, which concentrates on the aspects that are considered the most significant. Although comprehensive, it has not been possible to cover in detail all areas of concern.

Users, customers, workers, and readers are advised to consult occupational health professionals and other experts concerning all matters regarding control of respirable crystalline silica in each specific workplace.

This Good Practice Guide is an Annex to the Agreement on Workers Health Protection Through the Good Handling and Use of Crystalline Silica and Products Containing it, based on certain principles: The Parties agree that crystalline silica and materials / products / raw materials containing crystalline silica are, as further described in Annex 5 hereto, basic, useful and often indispensable components / ingredients for a large number of industrial and other professional activities contributing to protecting jobs, and securing the economic future of the sectors and companies, and that their production and wide-range use should therefore continue.

PREAMBLE

COMPLEMENTARITY WITH THE EUROPEAN CARCINOGENS AND MUTAGENS DIRECTIVE (2017/2398 AMENDING DIRECTIVE 2004/37/EC)

In 2018, works involving exposure to respirable crystalline silica dust generated by a work process were included in the European Carcinogens and Mutagens at Work Directive (Directive 2017/2398). A European Binding Occupational Exposure Limit of 0.1 mg/m³ was set in Annex III for respirable crystalline silica dust.

The Directive recognises in its Recital 19 that NEPSI good practices are

"valuable and necessary instruments to complement regulatory measures and in particular to support the effective implementation of limit values. It is the quality of implementation of the good practices that determines whether lives are saved"

Commissioner Mrs Marianne Thyssen at the NEPSI 10th Anniversary Conference.

Moreover, a subsequent amendment of the Directive (2019/130/EC) encourages social partners to conclude social dialogue agreements like the NEPSI Agreement to complement regulatory measures, and requests that the list of such agreements should be published on the European Agency for Safety and Health at Work (EU-OSHA) website (new Article 13a).

NOTE TO USERS

This guide, updated in October 2020, represents a summary of information collected from a number of sources, including existing documents providing information on the respirable crystalline silica issue, legal documents and expertise of people working in the industry.

In this short document it is not possible to cover all of the topics mentioned comprehensively, nor is it possible to cover in detail all areas of concern regarding respirable crystalline silica in the workplace. Users, customers, workers, and readers are advised to consult occupational health professionals and other experts concerning all matters regarding control of respirable crystalline silica in each specific workplace.

PART 1: RESPIRABLE CRYSTALLINE SILICA ESSENTIALS

1. INTRODUCTION

Crystalline silica is an essential raw material of products which have an abundance of uses in industry and are a vital component in many things used in our everyday lives. It is impossible to imagine houses without bricks, mortar or windows, cars without engines or windscreens, or life without roads or other transport infrastructures, and everyday items made of glass or pottery.

For many years, it has been known that the inhalation of fine dust containing a proportion of crystalline silica can cause lung damage (silicosis). In fact, silicosis is the world's oldest known occupational disease. However, the health risks associated with exposure to crystalline silica dust can be controlled and, by using appropriate measures, reduced or eliminated completely. It is just a matter of assessing the risk and taking appropriate action.

The first part of this Good Practice Guide is aimed primarily at employers. It is designed to help them decide whether the health of their employees, or others present in the workplace, is at risk from exposure to respirable crystalline silica. This booklet will guide them through the process of risk assessment and provide them with some general guidance on methods for controlling exposure to respirable crystalline silica in the workplace. It also stresses the importance of continual improvement.

At the end of Part 1, there is a glossary, which defines some of the more technical terms that are used in the document.

The second part of this guide is aimed at both employers and those who actually work with materials containing crystalline silica. It provides detailed guidance on methods for safe production, handling and use of these materials.

PART 1: RESPIRABLE CRYSTALLINE SILICA ESSENTIALS

1. INTRODUCTION

1.1 WHAT IS SILICA?

Silica is the name given to a group of minerals composed of silicon and oxygen, the two most abundant elements in the earth's crust. In spite of its simple chemical formula, SiO_2, silica exists in many different forms. Silica is found commonly in the crystalline state but occurs also in an amorphous (non-crystalline) state. Crystalline silica is hard, chemically inert and has a high melting point. These are prized qualities in various industrial uses.

This Good Practice Guide only covers three of the different forms of crystalline silica, i.e. the mineral quartz, cristobalite and tridymite. It does not cover amorphous silica, fused silica or other silicate minerals. Quartz, cristobalite and tridymite are often referred to as types of "free" crystalline silica because the crystalline silica is not chemically combined.

Quartz is by far the most common form of crystalline silica. It is the second most common mineral on the earth's surface and it is found in almost every type of rock i.e. igneous, metamorphic and sedimentary. Since it is so abundant, quartz is present in nearly all mining operations. Irrespective of industrial activities, respirable crystalline silica is naturally present in the environment.

Cristobalite and tridymite are not abundant in nature. However, they are found in some igneous rocks. In industrial circumstances, cristobalite is also obtained when quartz is heated (to temperatures in excess of 1,400°C), for example during the production and use of refractory materials. Cristobalite is also formed when amorphous silica or vitreous silica is heated at high temperature.

1.2 RESPIRABLE CRYSTALLINE SILICA

Not all dust is the same! For any kind of dust, there are different particle sizes, often referred to as dust fractions. When dust is inhaled, its point of deposition within the human respiratory system is very much dependent upon the range of particle sizes present in the dust.

Three dust fractions are of main concern: the inhalable, thoracic and respirable dust fractions, which are defined in the European Standard EN 481. Information on this standard is given in section 3.1. In the case of crystalline silica, it is the respirable fraction of the dust that is of concern for its health effects.

Respirable dust can penetrate deep into the lungs. The body's natural defence mechanisms may eliminate much of the respirable dust inhaled. However, in case of prolonged exposure to excessive levels of this dust, it becomes difficult to clear the respirable dust from the lungs and an accumulation of dust can, in the long term, lead to irreversible health effects. Due to the fact that the health effects of crystalline silica are related to the respirable dust fraction, this Good Practice Guide will focus on the control of respirable crystalline silica.

1.3 OCCUPATIONAL EXPOSURE TO RESPIRABLE CRYSTALLINE SILICA

Occupational exposure to respirable crystalline silica can occur in any workplace situation where airborne dust, containing a proportion of respirable crystalline silica, is generated.

Respirable dust particles are so small that they cannot be seen with the naked eye. Once airborne, respirable dust takes a very long time to settle. A single release of dust into the workplace air can lead to significant occupational exposure. In fact, in situations where the air is constantly stirred-up and where no fresh air is being introduced, respirable dust may remain airborne in the workplace for days.

Occupational exposure to respirable crystalline silica occurs in many industries including quarrying, mining, mineral processing (e.g. drying, grinding, bagging and handling), slate working, stone crushing and dressing, foundry work, brick and tile making, some refractory processes, construction work, including work with stone, concrete, brick and some insulation boards, tunnelling, building restoration and in the pottery and ceramic industries.

2.1 WHERE SILICA OCCURS

Crystalline silica, in the form of the mineral quartz, is found in many different materials – with sandstone being almost pure quartz. Other forms of silica occur but are of little importance occupationally. The table below gives an indication of typical levels of "free" crystalline silica in certain mineral sources, but it must be noted that these figures do vary.

MINERAL SOURCES	PERCENTAGE OF CRYSTALLINE SILICA
Aggregates	0 to 100%
Ball clay	5 to 50%
Basalt	Up to 5%
Natural Diatomite	5 to 30%
Dolerite	Up to 15%
Flint	Greater than 90%
Granite	Up to 30%
Gritstone	Greater than 80%
Iron Ores	7 to 15%
Limestone	Usually less than 1%
Quartzite	Greater than 95%
Sand	Greater than 90%
Sandstone	Greater than 90%
Shale	40 to 60%
Slate	Up to 40%

Source: HSE brochure, Control of respirable crystalline silica in quarries.

2.2 ACTIVITIES INVOLVING USE OF CRYSTALLINE SILICA CONTAINING MATERIALS

AGGREGATES

Aggregates are a granular material used in building and infrastructure construction. Nearly 3 billion tonnes of aggregates are produced and used in Europe annually. However, a majority of operators in the sector are small and medium sized enterprises. A typical site provides direct employment for 7 to 8 persons. The aggregates industry operates in around 23,000 extraction sites with over 130,000 employees in the EU.

The most common natural aggregates are sand, gravel and crushed rock, from rocks of different geological origin, and with a wide range of free silica content (from 0% to 100%).

Subject to the individual risk assessments to be carried out under this Agreement, the sites with deposits with a high content of crystalline silica are more relevant. Nevertheless even in such cases, the risks of respirable crystalline silica exposure for workers are normally low, with low number of cases of silicosis reported.

The content of crystalline silica in recycled and manufactured aggregates varies depending on the composition of the material they are produced from.

CALCIUM SILICATE MASONRY UNITS

Calcium silicate masonry units are produced by mixing sand, lime and water. This mixture of natural ingredients is moulded into shape by mechanical or hydraulic presses. After moulding, the "green" material is hardened in an autoclave. In these autoclaves steam is introduced at pressures of 8 to 16 bars to raise the temperature up to approximately 200 °C. After some hours of autoclaving the units have developed their final properties, especially the strength, and are ready for packing and dispatch. Dust generation can mainly occur in raw material handling and shaping mechanical treatments.

120 plants in 7 European countries produce calcium silicate masonry units.

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CEMENT INDUSTRY

Cement is a powdered substance mainly used as the binding agent in the making of concrete. It is produced through several stages, basically made up of the two following essential phases:

- manufacture of a semi-finished product, so-called "clinker", obtained from the calcination in a high-temperature kiln (1,450°C) of a "raw mix" made up of a mixture of clay, limestone, and several other additives.
- manufacture of cement as a finished product, obtained by the homogeneous mixture of the ground clinker and calcium sulphate (gypsum).
- depending on the type of cement - one or more additional components: slag, fly ash, pozzolana, limestone, etc.

In 2017, the cement production of the current 28 Member States of the EU was 175 million tons, about 4% of the total world production (4.1 billion tons).

There are nearly 226 installations in the EU. The cement industry directly employs about 47,000 persons among CEMBUREAU's members.

CERAMICS INDUSTRY

The ceramics industry uses silica principally as a structural ingredient of clay bodies and as a major constituent of ceramic glazes. The principal ceramic products containing silica include tableware and ornamental ware, sanitary ware, wall and floor tiles, bricks and roof tiles, refractories etc.

Around 2,000 companies produce ceramics in the EU, of which 80% are small and medium size enterprises. The number of employees in the EU ceramics industry is estimated at around 200,000. The ceramic industry is present in virtually all EU Member States.

ENGINEERED STONES

According to the European Standard EN -14618, Engineered Stone is called Agglomerated Stone.

Agglomerate Stones are the evolution in the tradition of the old "Terrazzo Tiles".

Today, Agglomerate Stone is industrially manufactured by means of different moulding technologies, through vibration and simultaneous compression under vacuum; chemical additives functional to the process, pigments and a binder, generally polyester resin, added in the minimum quantity just to assure the complete bonding between filler and particles.

A subsequent hardening phase, conducted at room temperature or at medium temperature in suitable kilns, allows the mixture to reach the final stone consistency. The products are realised in forms of blocks or slabs, which are transformed into finished slabs for counter tops, tiles for floorings and wall coverings and other architectural elements.

Agglomerate Stone can technically be defined as a composite material, because it is made up of several different raw materials; the composition of this product, in a simplified way, can be divided into four distinct categories: raw materials constitute the structure; powders fill the interstices (fillers), binders bind the product and additives of varied nature (pigments, for example) give technical or aesthetic performances.

The original raw materials for Agglomerate Stone are marble, granite, feldspar, or quartz, which can be found in large dimensions in nature and which can be crushed or have already been crushed by natural events.

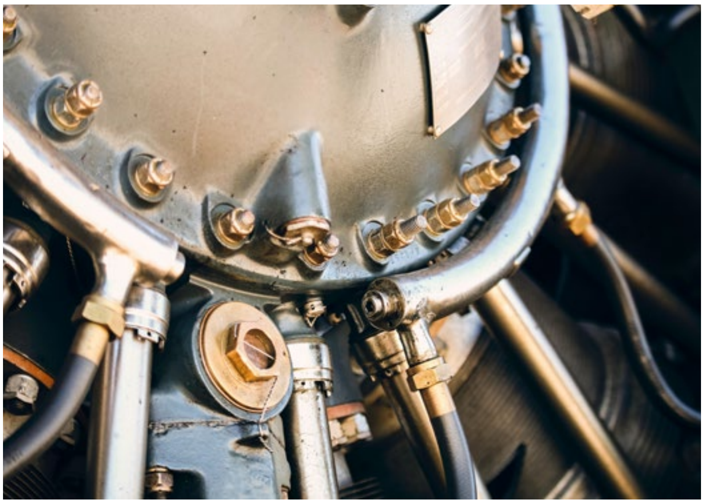
This industry can also make use of marble and granite excavation refuse, which is an interesting contribution to solving the problem of the environmental impact of the stone processing industry.

EXPANDED CLAY INDUSTRY

Expanded clay is a ceramic-based lightweight aggregate made by heating clay to approx. 1,200 °C in a rotary kiln. The yielding gases expand the clay during heating, producing a honeycomb structure. Expanded clay pebbles have a round or oval shape and are available in different sizes and densities.

The clay is extracted from clay pits normally located close to the plants. Once transported to the plant the clay is pre-treated and processed in rotary kilns. After passing through the kiln, the now expanded clay is cooled. As the hot clay cools, cold air is warmed and this heated air is used to dry, heat and expand the clay in the kiln. Expanded clay is used in a variety of application in the construction and green sector.

Some 13 companies manufacture expanded clay in 11 countries, operating 17 plants throughout Europe. Their annual production is approximately 4,500,000m^3 of expanded clay and they offer direct employment to around 2,000 people.



FOUNDRIES

The foundry industry's products are ferrous, steel or non-ferrous metal castings produced by pouring molten metal into moulds which are typically, in total or in parts, made of bonded silica sand. The foundry industry is an important supplier to the automotive industry, mechanical engineering and other industries. It is a branch of mostly small and medium sized companies: roughly 4,000 foundries with 300,000 employees are situated in the EU Member States.

GLASS INDUSTRY

Silicon dioxide is the principal glass forming oxide and thus silica sand is the major raw material used in most glass types. The main glass products include packaging glass (bottles, jars etc.), flat glass (for buildings, mirrors, cars, etc.), domestic glass (tableware: drinking glasses, bowls; decoration, etc.), reinforcement glass fibres, glass wool (for insulation) and special glass (for tv, laboratory, optics etc.).

Currently, the EU-28 glass industry employs about 190,000 people (incl. processors who are not melting glass and are therefore not exposed to respirable crystalline silica). The number of workers involved in glass melting activities is estimated to be around 100,000.

After melting the raw material, there is no crystalline silica anymore in glass which is an amorphous material.

2. SILICA AND THE SILICA INDUSTRY

INDUSTRIAL MINERALS

Industrial minerals are commercially valuable minerals and rocks, which are used in the industries based on their physical and/or chemical properties.

Around 138 million tons of industrial minerals – bentonite, borate, calcium carbonate, diatomite, feldspar, kaolin, lime, mica, plastic clays, sepiolite, silica, talc, vermiculite – are extracted every year in Europe. Each of these industrial minerals have specific properties, which make them special and essential for some industrial applications. They are used in various markets such as glass, ceramics, industrial fluids, agriculture, construction materials, metallurgy, coatings, pet litter, plastics, paper, paints, electronics, detergents and other. Although not all do, industrial minerals may contain variable amounts of crystalline silica.

Silica is found commonly in the crystalline state but occurs also in an amorphous (non-crystalline) state. Crystalline silica is hard, chemically inert and has a high melting point. These are prized qualities in various industrial uses, mainly in foundry, construction, ceramic and chemicals industries.

Those industrial minerals are produced by 300 companies or groups operating about 810 mines and quarries and 830 plants in 21 EU Member States, and in Switzerland, Norway and Turkey. The industrial minerals industry employs about 100,000 persons in the EU.

METAL ORES

A wide range of metal ores are extracted within the EU and for some, such as, antimony, bauxite, chromium, cobalt, copper, gold, iron, lead, manganese, nickel, silver, titanium, the EU is a relatively significant producer. In some cases, the European producers rank amongst the first ten producers in the world.

Metal ores are produced in 14 EU Member States as well as in Norway, Turkey, Kosovo and Serbia. In the EU, this section of the mining and minerals industry employs directly more than 20,000 people. There are about 90 metal mines operating in EU plus a number of exploration companies.

Although not all do, metal ores may contain variable amounts of crystalline silica.

MINERAL WOOL

Mineral wool has a unique range of properties, combining high thermal resistance with long-term stability. It is made from molten glass, stone or slag that is spun into a fibre-like structure which creates a combination of thermal, fire and acoustic properties, essential to the thermal and acoustic insulation as well as to the fire protection of domestic and commercial buildings or industrial facilities.

These properties derive from its structure, a mat of fibres which prevent the movement of air, and from its chemical composition.

Insulation manufacturers are developing to meet the growing environmental concerns of society, improving standards and regulations for the use of insulation materials.

Among mineral wools, only glass wool is of concern with regard to crystalline silica as glass wool is manufactured using sand, whilst stone wool is not. After melting the raw material for glass wool, there is no crystalline silica any more, as it becomes an amorphous material.

The mineral wool industry is present in all European countries and employs over 20,000 people across the EU.

NATURAL STONE INDUSTRY

Dimension stone exists in nature as an almost ready-made building material. Few realise, however, that it takes millions of years for this material to get to the point at which it can be easily produced and processed.

The industry consists only of small to medium-size enterprises of between 5 to 100 employees and is an essential supplier of the building industry. More than 40,000 companies exist in the EU, employing around 420,000 persons in the EU. Work with natural stones not only covers the production of stone in quarries, much more important is the processing of stones and the implementation of stones. Restoration and high-tech applications need qualified education and training which starts with stone workers up to high-tech stone engineers.

MORTAR INDUSTRY

Mortar is a generic term comprising masonry and repair mortars, plaster and renders, adhesives, screeds as well as mortars for special uses, such as anchoring mortars. Mortars consist of aggregates, one or more binders, possibly additives and/or admixtures as well as, depending on the type of binder, water. Mortar is distinguished from concrete based on the grain size of the aggregates. By definition, mortars include aggregates within general < 4mm grain size. However, in case of special decorative renders and in floor screeds grain sizes of up to 8mm are also common.

The factory-made mortar industry provides both dry-mixed products (predominantly based on inorganic binders) and ready to use mortar products (based on inorganic and/or organic binders). Besides factory-made mortars a large part of the sector also designs and provides thermal insulation composite systems (ETICS) for renovation and new buildings.

Based on an internal survey conducted 2019 among the members of the European Mortar Industry Organisation (EMO), there are approximately 280 mortar manufacturers (legal entities) within EU 28 with up to 840 production sites. According to this estimate and the NEPSI reported figures, the sector has more than 35,000 employees of which approximately 11,600 are exposed to respirable crystalline silica.

PRECAST CONCRETE INDUSTRY

Precast concrete is a factory-made building material widely used worldwide and available in all sizes and forms, from very small paving units to more than 50 metres long bridge elements.

Its production process consists in mixing cement, aggregates, water, additives and admixtures in different proportions, pouring them in moulds and letting them harden. The products are supplied to the market in a dust-free hardened state. Dust generation can mainly occur in raw material handling and post-manufacturing mechanical treatments. The industry is composed of small to medium-size enterprises, spread all over Europe. Estimated figures for the EU are: 10,000 production units, 250,000 workers and 300 to 400 million tons of products.

READY MIXED CONCRETE

Ready mixed concrete is a mixture of cement, water, aggregates (sand, gravel or crushed stone), chemical admixtures, eventually additions (fly ash, silica fume, ground granulated furnace slags and others) entrapped and entrained air.

Dust generation can mainly occur in the plant where the aggregates are stored before being mixed: ready mixed concrete is manufactured in batching plants and mixed with either stationary or truck mounted mixers. Aggregates containing limited amounts of fines or dirt/clay are washed out. Ready mixed concrete is transported in closed truck mixers whereas the concrete is kept under continuous agitation until it is discharged for use: in this state, concrete does not produce any dust, neither during transport nor during dischargement.

Due to the wide range of applications, its ease of use, high quality, convenience and economy, ready mixed concrete is extensively adopted today, from pavements to high rise buildings and bridges.

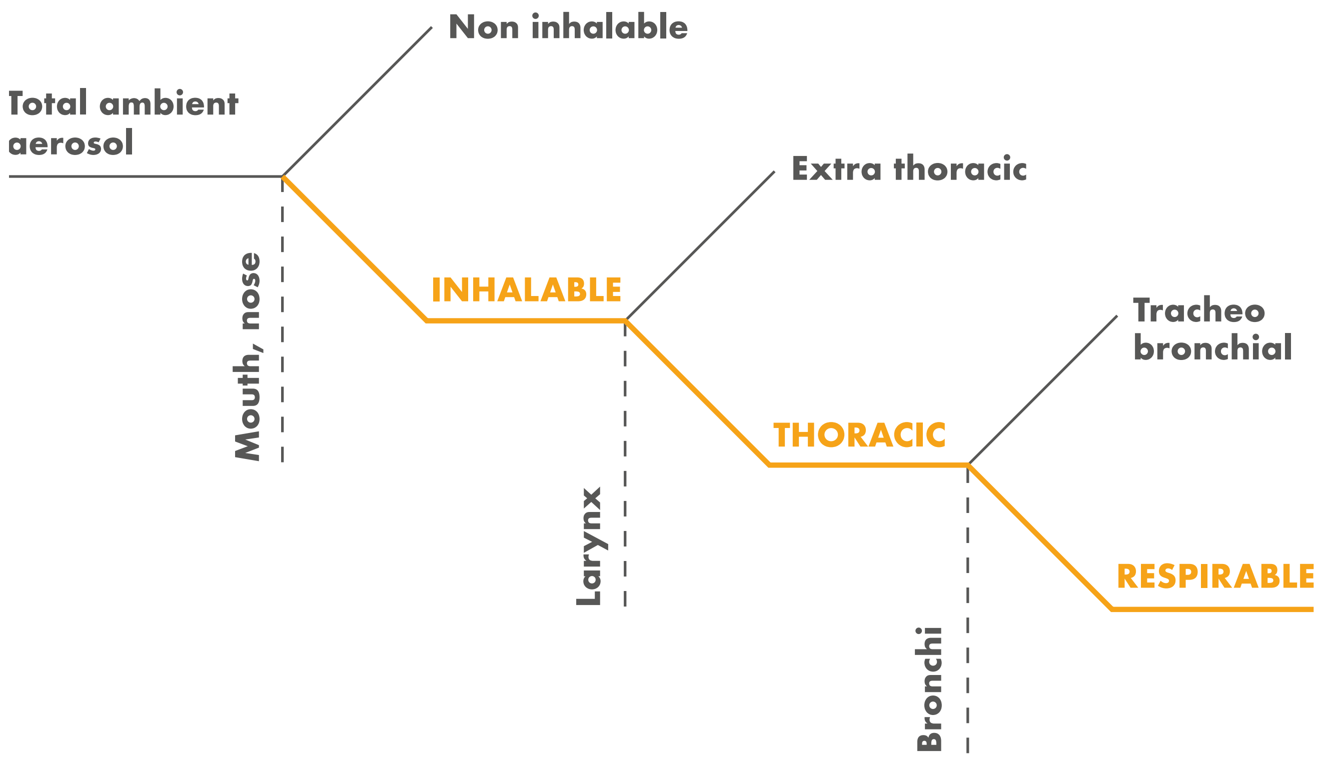
The European industry consists mainly of SMEs - small to medium-size enterprises. There are (2018) more than 12,000 plants in Europe, with a production of 250 million of m3 and more than 44,000 employees.

3.1 RESPIRABLE CRYSTALLINE SILICA

When considering dust, three dust fractions are of main concern: the inhalable, thoracic and respirable dust fractions. However, for crystalline silica, the respirable dust fraction is the most important due to its potential health effects in humans.

It is also important to note that national occupational exposure limit values for crystalline silica apply to the respirable dust fraction. This dust fraction corresponds to the proportion of an airborne contaminant, which penetrates to the pulmonary alveolar (gas exchange) region of the lungs. This fraction normally represents 10 to 20% of the inhalable dust fraction, but the proportion can vary considerably.

The following diagram explains the difference between the various dust fractions:



Source: Dichotomous model of aerosol fractionation according to Görner P. and Fabriès J.F.

3. RESPIRABLE CRYSTALLINE SILICA AND ITS HEALTH EFFECTS

This illustration identifies the different sections of the lung. The larynx (mentioned in the diagram above) lies between the pharynx (upper part of the airway) and the trachea (windpipe). The pulmonary alveolar region is made up of approximately 300 million alveoli, or air sacs.

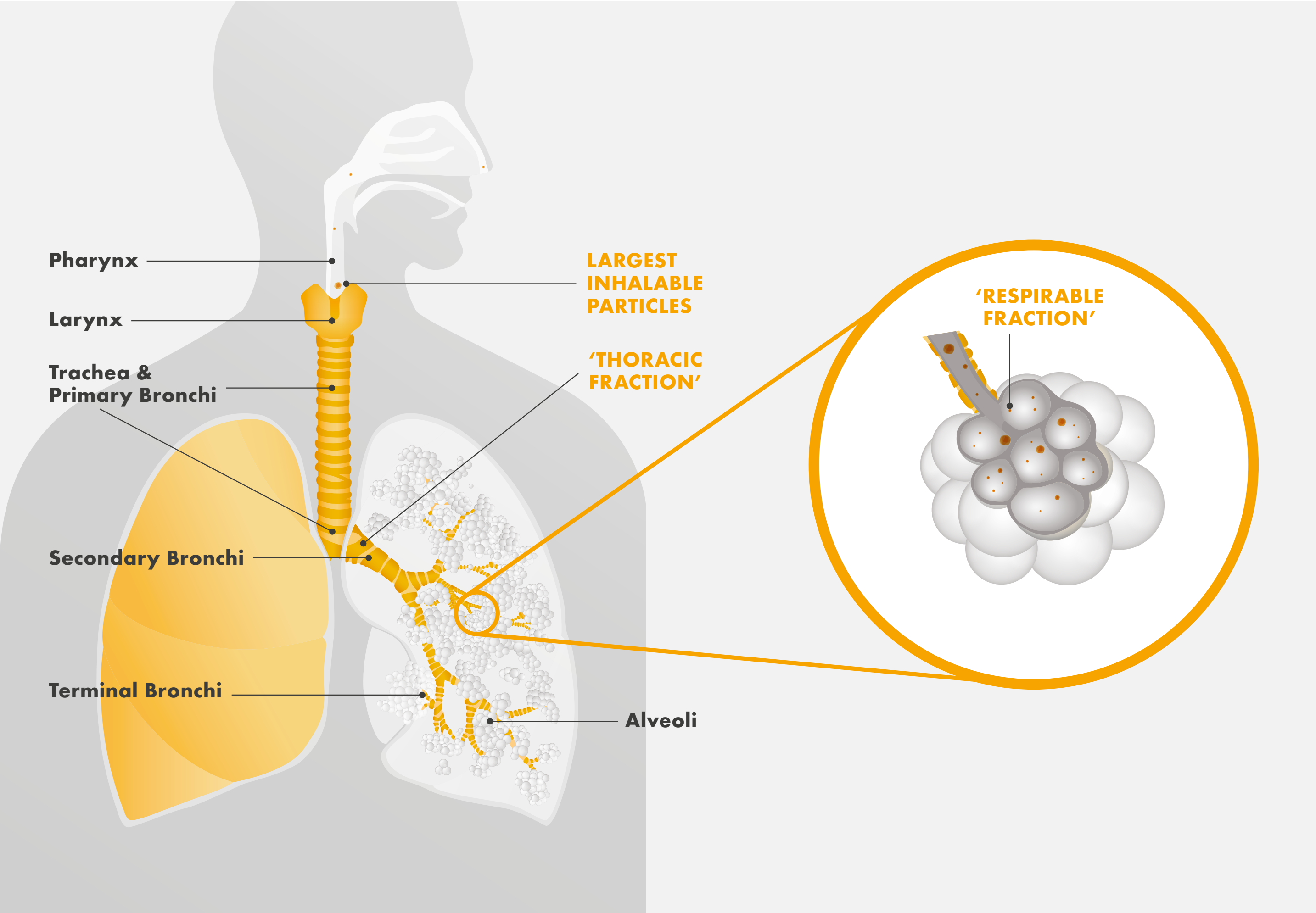


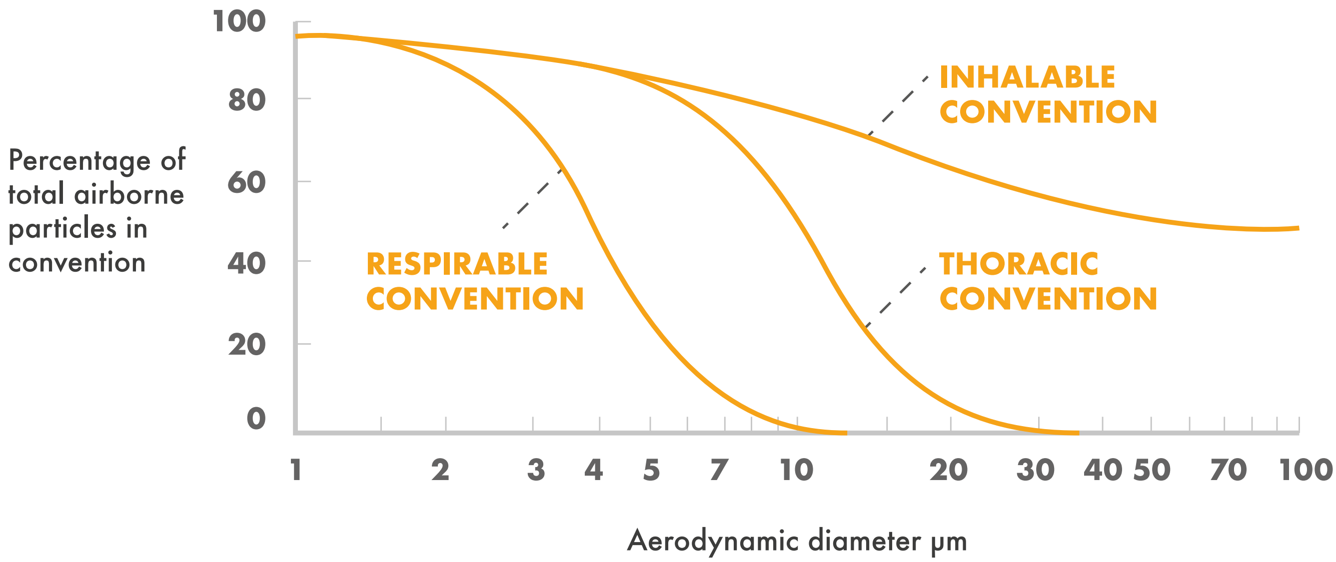
Diagram showing the different parts of the lung.

3. RESPIRABLE CRYSTALLINE SILICA AND ITS HEALTH EFFECTS

The European Standards Organisation (CEN) and the International Standards Organisation (ISO) have agreed standardised conventions for the health-related sampling of dusts or aerosols in workplaces (EN 481, ISO 7708).

These conventions represent target specifications for instruments used to assess the possible health effects due to inhalation of aerosols.

The following figure illustrates the sampling conventions:



The inhalable, thoracic and respirable conventions as percentages of total airborne particles, from EN 481.

The graph shows the probability that a particle of a specific aerodynamic diameter will penetrate the different parts of the human respiratory system.

For example, following the respirable convention, there is a 50% chance (or a probability of 0.5) that a particle of aerodynamic diameter 4 μm will penetrate the pulmonary alveolar region of the lung. Similarly, there is a 30% chance (probability of 0.3) that a particle of aerodynamic diameter 5 μm will penetrate this region of the lung.

The following table shows numerical values of the conventions in percentage terms.

AS PERCENTAGE OF TOTAL AIRBORNE PARTICLES			
AERODYNAMIC DIAMETER µm	INHALABLE CONVENTION %	THORACIC CONVENTION %	RESPIRABLE CONVENTION %
0	100	100	100
1	97.1	97.1	97.1
2	94.3	94.3	91.4
3	91.7	91.7	73.9
4	89.3	89.0	50.0
5	87.0	85.4	30.0
6	84.9	80.5	16.8
7	82.9	74.2	9.0
8	80.9	66.6	4.8
9	79.1	58.3	2.5
10	77.4	50.0	1.3
11	75.8	42.1	0.7
12	74.3	34.9	0.4
13	72.9	28.6	0.2
14	71.6	23.2	0.2
15	70.3	18.7	0.1
16	69.1	15.0	0
18	67.0	9.5	
20	65.1	5.9	
25	61.2	1.8	
30	58.3	0.6	
35	56.1	0.2	
40	54.5	0.1	
50	52.5	0	
60	51.4		
80	50.4		
100	50.1		

Source: EN 481. Numerical values of the conventions, as percentages of total airborne particles.

3.2 HEALTH EFFECTS OF RESPIRABLE CRYSTALLINE SILICA

People at work are rarely exposed to pure crystalline silica. The dust they breathe in at the workplace is usually composed of a mixture of crystalline silica and other materials.

The response of an individual is likely to depend on:

- the nature (e.g. particle size and surface chemistry) and crystalline silica content of the dust
- the dust fraction
- the extent and nature of personal exposure (duration, frequency and intensity, which may be influenced by the working methods)
- personal physiological characteristics
- smoking habits

SILICOSIS

Silicosis is a commonly known health hazard and one of the world's oldest known occupational diseases (e.g. NIOSH 2002, OSHA 2013, ANSES 2019). Silicosis is historically associated with the inhalation of crystalline silica-containing dust and the causal relationship between silicosis and crystalline silica exposure is well-established (Morfeld 2013). A threshold value for the respirable quartz dust concentration and silicosis incidence (1/1, ILO 1980/2000) is estimated through a statistical model in the German porcelain worker cohort (Morfeld 2013). Silicosis is one of the most common types of pneumoconiosis. It is a nodular progressive fibrosis caused by the deposition in the lungs of fine respirable particles of crystalline silica. The resulting scarring of the innermost parts of the lungs can lead to breathing difficulties and, in some cases, death. Larger (non-respirable) particles are more likely to settle in the main (upper) airways of the respiratory system and may be cleared by mucus and/or ciliary action.

Common silicosis is generally caused by prolonged chronic inhalation of respirable crystalline silica dust generated by a work process. Silicosis can vary greatly in its severity, from "simple silicosis" to "progressive massive fibrosis".

Generally, three types of silicosis are described in literature (EUR 14768; INRS 1997):

- Acute silicosis occurs as a result of extremely high exposure to respirable crystalline silica over a relatively short period of time (within 5 years). The condition causes rapidly progressive breathlessness and death, usually within months of onset
- Accelerated silicosis can develop within 5 to 10 years of exposure to high levels of respirable crystalline silica
- Chronic silicosis is often described as the result of exposure to lower levels of respirable crystalline silica, occurring over longer periods of time (exposure duration greater than 10 years).

Future cases of silicosis can be reduced by implementing appropriate measures to reduce exposure to silica-containing dusts. Such measures include improved work practices, engineering controls, respiratory protective equipment and training programmes.

3. RESPIRABLE CRYSTALLINE SILICA AND ITS HEALTH EFFECTS

SILICA AND CANCER RISK

According to a number of epidemiological studies among occupationally exposed populations, under some circumstances there is a relation between lung cancer and exposure to respirable crystalline silica dust.

In 1997, a working group of the International Agency for Research on Cancer (IARC) concluded on the basis of literature review that inhaled respirable crystalline silica from occupational sources is carcinogenic to humans (IARC, 1997).

In making this evaluation, the IARC working group noted also that carcinogenicity was not detected in all industrial circumstances studied and may be dependent on inherent characteristics of the crystalline silica or on external factors affecting its biological activity.

In 2011, IARC updated its Monographs and confirmed that crystalline silica dust, in the form of quartz or cristobalite, is carcinogenic for human (group 1) and that the variable hazard of different types of silica related to its surface properties (IARC, 2011).

According to the French Agency for Sanitary Safety, no other cancer than lung cancer association with exposure to respirable crystalline silica has been proven (ANSES 2019).

A recommendation (SUM DOC 94 final) from the EU Scientific Committee for Occupational Exposure Limits (SCOEL) was adopted in June 2003. The main conclusions were as follows:

The main effect in humans of the inhalation of respirable silica dust is silicosis. There is sufficient information to conclude that the relative lung cancer risk is increased in persons with silicosis (and, apparently, not in employees without silicosis exposed to silica dust in quarries and in the ceramic industry). Therefore preventing the onset of silicosis will also reduce the cancer risk. Since a clear threshold for silicosis development cannot be identified, any reduction of exposure will reduce the risk of silicosis.

The different modes of action of RCS-induced genotoxicity have been evaluated in a series of toxicological studies since 2011. According to an updated review of respirable crystalline silica genotoxicity, the role of inflammation driven by quartz surface after inhalation is confirmed and findings support a practical threshold (secondary effect) (Borm et al 2019).

The role of freshly fractured crystalline silica particles has been outlined in new studies and acknowledged in regulatory evaluations (Turci et al 2016; ANSES 2019). How the chemical features and configuration of the silica surface can trigger variable toxic responses remains to be explained. Promising interdisciplinary research is ongoing to elucidate the puzzling mechanisms of crystalline silica pathogenicity and possibly mitigate or reduce its surface reactivity (Pavan et al 2019).

OTHER HEALTH EFFECTS

In scientific literature, papers are published about the possible association between silica exposure and autoimmune disorders (e.g. scleroderma, lupus and rheumatoid arthritis). In its 2019 opinion, the ANSES confirms that while such an association may be observed in some studies for systemic scleroderma, systemic lupus and rheumatoid arthritis, one cannot establish a direct (causal) correlation or dose-response relation between exposure to crystalline silica and auto-immune disease occurrence.

As far as other pathologies are concerned, such as renal and cardio-vascular pathologies, one cannot conclude on a role for crystalline silica particles in the occurrence of these diseases (ANSES 2019).

4. RISK MANAGEMENT – WHAT DO I NEED TO DO?

Since 2018, works involving exposure to respirable crystalline silica dust generated by a work process are included in the European Carcinogens and Mutagens at Work Directive (Directive 2017/2398). A European Binding Occupational Exposure Limit Value of 0.1 mg/m³ is set in Annex III for respirable crystalline silica dust.

The Directive recognises in its Recital 19 that NEPSI good practices are "valuable and necessary instruments to complement regulatory measures and in particular to support the effective implementation of limit values".

This section integrates the obligations of the Carcinogens and Mutagens at Work Directive and provides recommendation to the reader on when and how to apply the advice given in this Good Practice Guide to their specific circumstances.

Using a simple question and answer format, it will introduce basic risk management techniques that should be applied to workplace situations where persons may be exposed to respirable crystalline silica.

PREAMBLE: OBLIGATIONS OF THE CARCINOGENS AND MUTAGENS DIRECTIVE

This Directive 2004/37/EC (and its amendments) aims at the protection of workers against risks to their health and safety arising or likely to arise from exposure to carcinogens or mutagens at work, see Articles 4 and 5.

Its obligations include:

- Reduction and replacement: the employer shall reduce the use of a carcinogen or mutagen at the place of work, in particular by replacing it, in so far as is technically possible, by a substance, preparation or process which is not dangerous or is less dangerous.
- Use of closed systems: where the replacement is not technically possible the employer shall ensure that the carcinogen or mutagen is, in so far as is technically possible, manufactured and used in a closed system.
- Where a closed system is not technically possible, the employer shall ensure that the level of exposure of workers is reduced to as low a level as is technically possible. Exposure shall not exceed the limit value of a carcinogen as set out in Annex III.
- The employer shall also apply the following measures:
  - Limitation of the RCS quantities at the place of work
  - Reducing the number of workers exposed or to be exposed to RCS
  - Design of work processes and engineering control measures in order to avoid or minimise the release of RCS
  - Evacuation of RCS at source, local extraction system or general ventilation
  - Use of existing appropriate procedures for the measurement of RCS
  - Application of suitable working procedures and methods
  - Collective protection measures and/or individual protection measures
  - Hygiene measures, in particular regular cleaning of floors, walls and other surfaces
  - Information for workers
  - Demarcation of risk areas and use of adequate warning and safety signs (e.g. "no smoking")
  - Plans to deal with emergencies in case of high exposure
  - Means for safe storage, handling and transportation, in particular by using sealed and clearly and visibly labelled containers
  - Means for safe collection, storage and disposal of waste by workers, including the use of sealed and clearly and visibly labelled containers.

4. RISK MANAGEMENT – WHAT DO I NEED TO DO?

The specific advice given on the following pages will help the reader to decide to what extent this Good Practice Guide applies to their circumstances.

Guidance will be given on:

ASSESSMENT	How to assess whether there is a significant risk from exposure to respirable crystalline silica.
CONTROL	How to decide what type of control and prevention measures should be put in place to treat the risks that are identified – i.e. to eliminate them, or to reduce them to an acceptable level.
MONITORING	How to monitor the effectiveness of the control measures in place. How to monitor workers' health.
EDUCATION	What information, instruction and training should be provided to the workforce in order to educate them about the risks to which they may be exposed.

The risk management processes of **Assessment, Control, Monitoring and Education** make up the foundation of all European health and safety legislation, including the European Carcinogens and Mutagens at Work Directive.

QUESTION 1:
How do I determine whether people are exposed to respirable crystalline silica in my workplace?

ANSWER

Respirable crystalline silica enters the body when dust containing a proportion of crystalline silica is inhaled. When the particle size range of the dust is sufficiently small (such that the particles fall within the respirable fraction), the dust will travel deep into the lungs. It is at this point that respirable crystalline silica can cause health effects. Occupational exposure to respirable crystalline silica can occur in any workplace situation where airborne dust is generated, which contains a proportion of respirable crystalline silica. Occupational exposure to respirable crystalline silica occurs in many industries.

Use the simple flow chart below to carry out an initial assessment to determine whether there is any significant risk of exposure to respirable crystalline silica. The possible presence of fine particles of crystalline silica means that there may be a risk. If there is no foreseeable risk, then you don't need to take any specific measures. However, you should always obey the general principles of prevention.

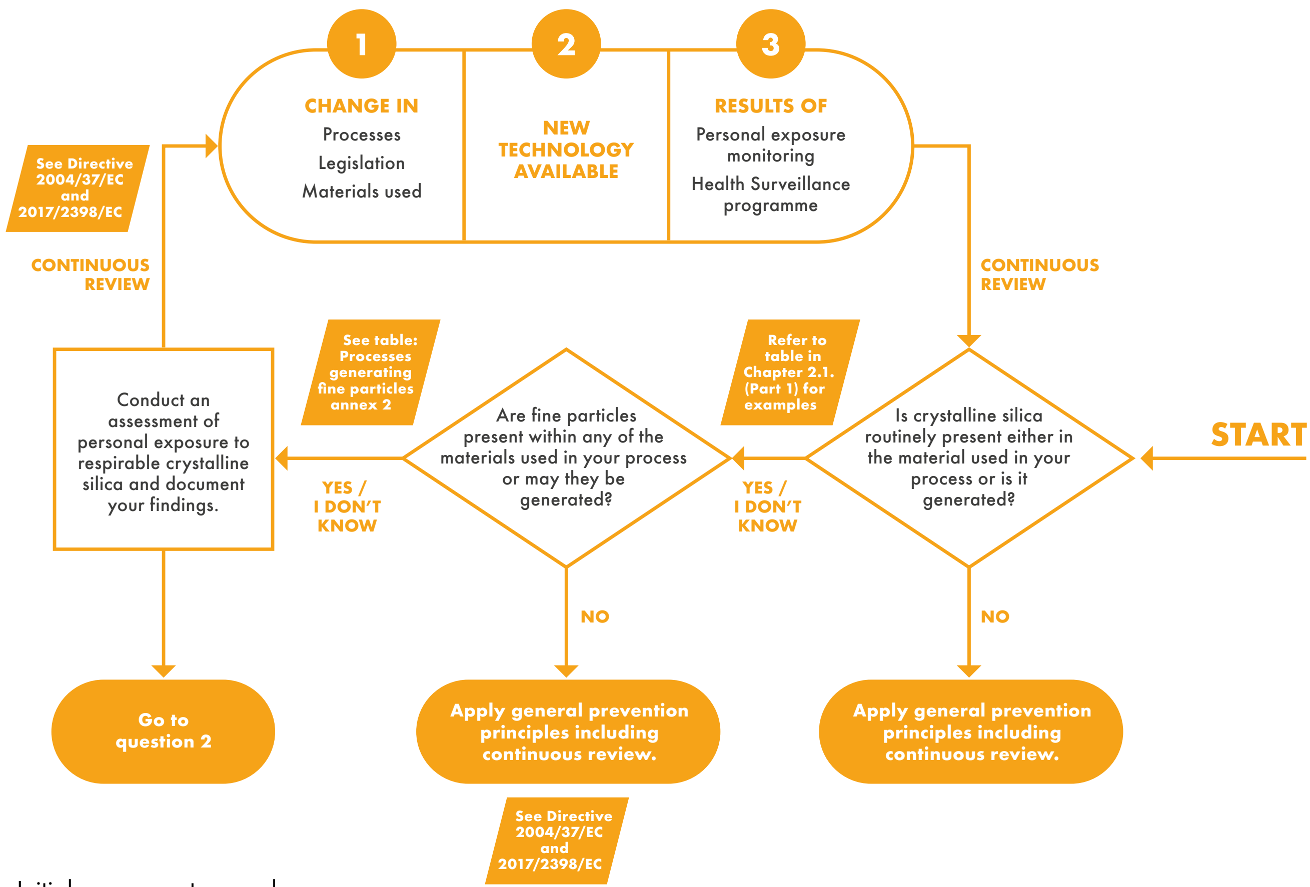


Figure: Initial assessment procedure.

QUESTION 2:
How do I conduct an assessment of personal exposure to respirable crystalline silica?

ANSWER

Use this simple flow chart to help you to carry out your assessment of personal exposure levels. It's a good idea at this stage to make detailed notes of the dust control measures that are already in place in your workplace. You will need this information later, in order to assess whether you are complying with the general principles of prevention.

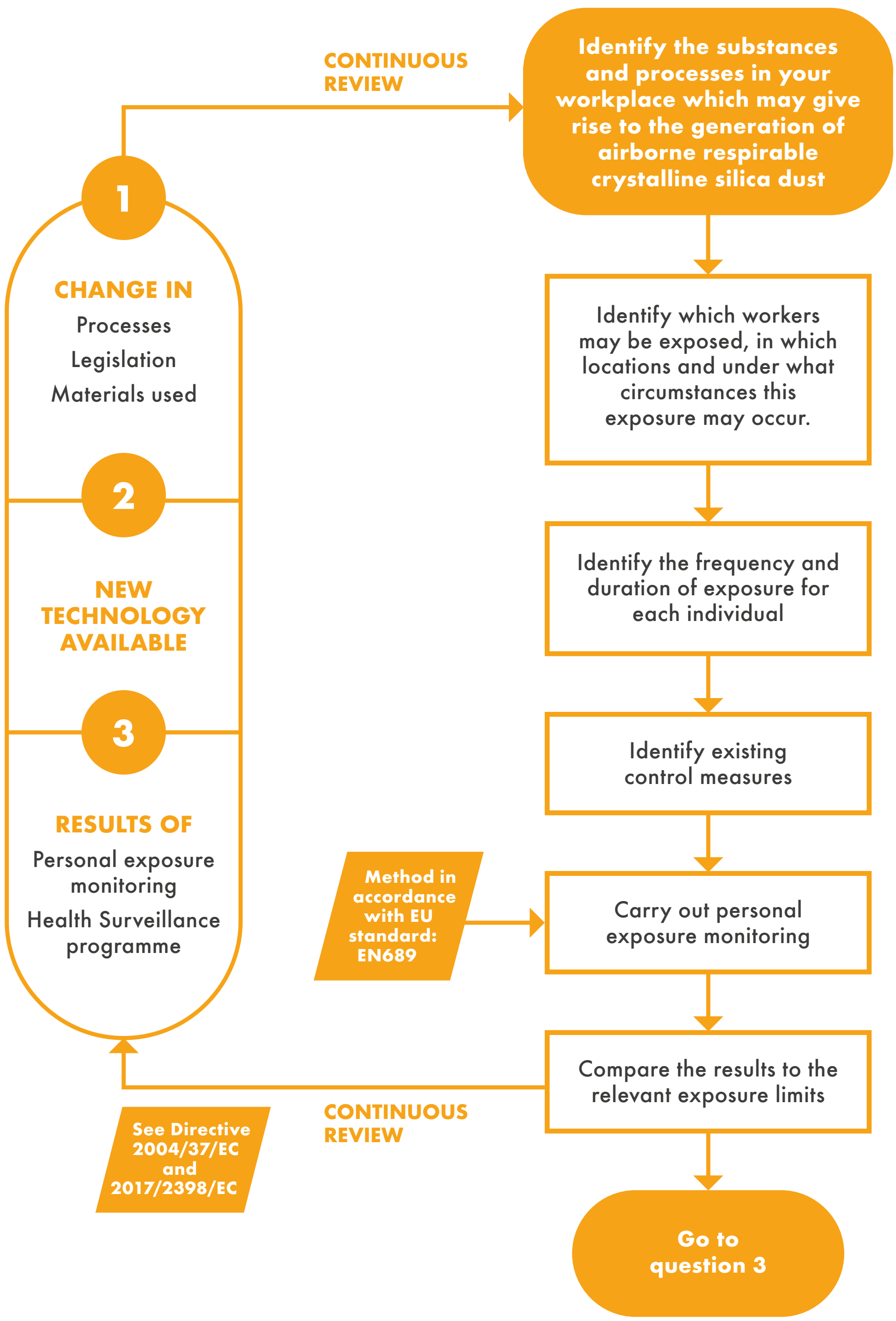


Figure: Assessment of personal exposure levels to respirable crystalline silica.

4. RISK MANAGEMENT – WHAT DO I NEED TO DO?

PERSONAL EXPOSURE MONITORING

The only way to quantify the amount of respirable crystalline silica present in the workplace atmosphere is to perform sampling of the air and analysis of the dust collected. Occupational exposure assessment is the process of measuring or estimating the intensity, frequency and duration of human contact with such contaminants.

There are two types of measurements commonly used:

- Personal;
- Static

Both types of measurement can be used jointly as they are complementary. It is up to the experts designated by the employers and the employees' representatives to opt for the most adequate solutions, while respecting the national and European provisions.

General requirements for dust monitoring (taken from the European Standards EN 689 and EN 1232) are provided in the "Dust Monitoring Protocol", **Annex 2** of the *Agreement on Workers Health Protection through the Good Handling and Use of Crystalline Silica and Products Containing it.* Producers and end users of products and raw materials containing crystalline silica are encouraged to adopt this protocol. Advice on organising a dust-monitoring programme can be sought from a competent occupational hygienist.

OCCUPATIONAL EXPOSURE LIMITS

An occupational exposure limit value represents the maximum time-weighted average concentration of an airborne contaminant to which a worker can be exposed, measured in relation to a specified reference period, normally eight hours.

Currently there are many different types of occupational exposure limit value, defined by individual Member States of the European Union. These limits are all different and, in addition, cannot be compared directly.

In 2018, works involving exposure to respirable crystalline silica dust generated by a work process were included in Annex I of the European Carcinogens and Mutagens at Work Directive (Directive 2017/2398). A European Binding Occupational Exposure Limit Value of **0.1 mg/m³** is set in Annex III for respirable crystalline silica dust.

QUESTION 3:
I have done my exposure assessment, but I'm not sure how to interpret the results. What do I need to do now?

ANSWER

You need to compare the results of your assessment against the occupational exposure limit for respirable crystalline silica that applies in your country and you need to check that you are complying with the general principles of prevention.

It may be necessary for you to implement additional control measures (following the general principles of prevention), and in the case carcinogenic processes are identified following the CMD obligations, to eliminate, or reduce, exposure to respirable crystalline silica so that you meet the relevant occupational exposure limit.

In any case, you will need to provide training to your workforce on the risks to their health, which may arise from exposure to respirable crystalline silica and how to use the control measures provided.

The following flow chart will guide you through the process.

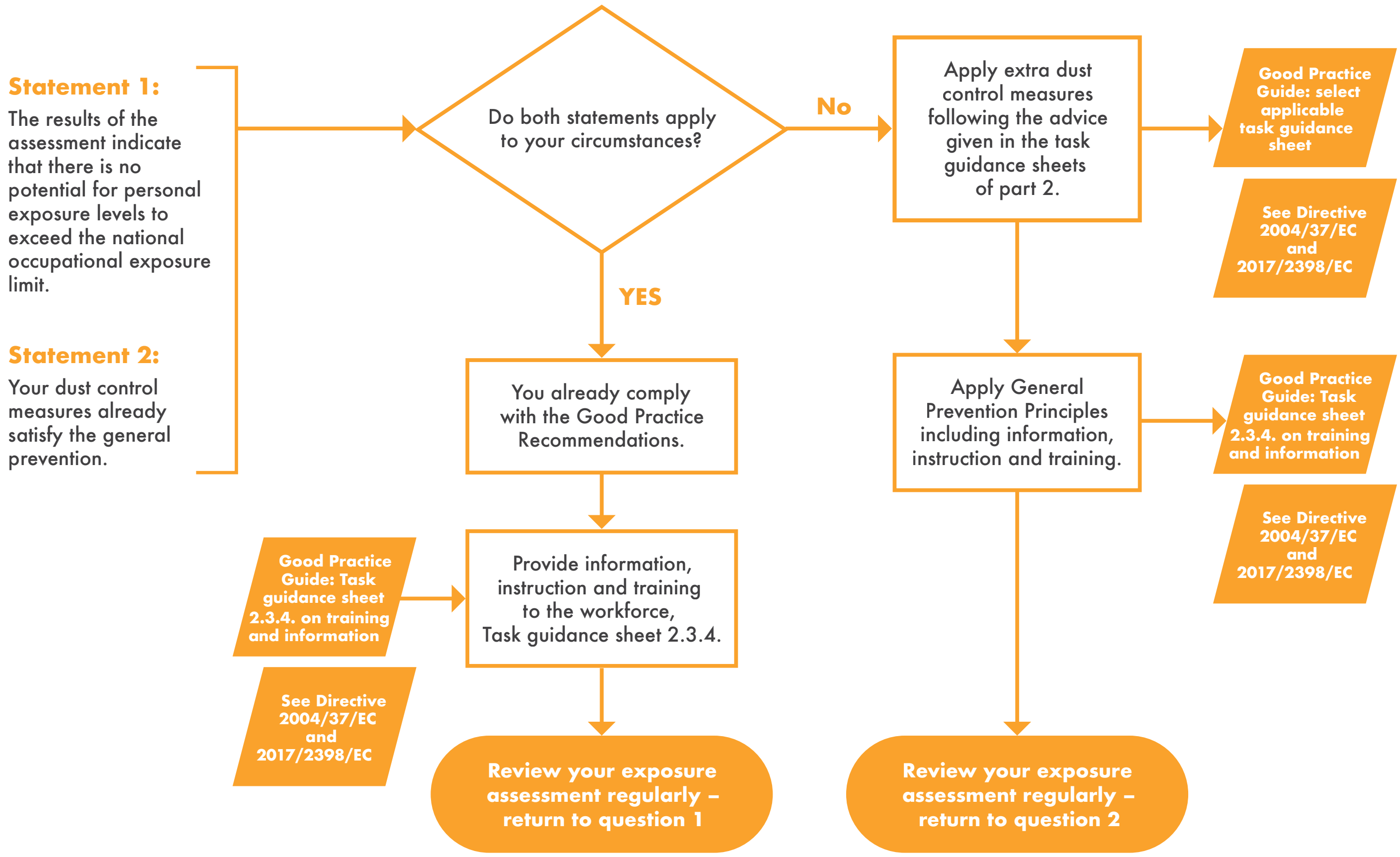


Figure: Simple decision flow chart for control of exposure to respirable crystalline silica.

4. RISK MANAGEMENT – WHAT DO I NEED TO DO?

GENERAL PREVENTION PRINCIPLES

In the development of this Good Practice guide, the authors respected the prevention strategy, which is described in Council Directive 89/391/EEC and in its transposition in the national laws, and the measures of the CMD 2017/2398 whenever carcinogenic processes are identified.

Nine prevention principles are described and one must consider the following hierarchy in the preventive measures to be taken:

- avoiding risks
- evaluating the risks which cannot be avoided
- combating the risks at source
- adapting the work to the individual
- adapting to technical progress
- replacing the dangerous by the non dangerous or the less dangerous
- developing a coherent overall prevention policy (including the provision of health surveillance of workers)
- giving collective protective measures priority over individual protective measures
- giving appropriate information, instruction and training to the workers

In the context where crystalline silica is handled in the workplace, examples of practical applications of the principles opposite are:

- **Substitution:** taking into account economic, technical and scientific criteria, replace a dust-generating process with a process generating less dust (e.g. use of a wet process instead of a dry process, or an automated process instead of a manual process)
- **Provision of engineering controls:** de-dusting systems (dust suppression[1], collection[2] and containment[3]) and isolation techniques[4]
- **Good housekeeping practices**
- **Work pattern:** establish safe working procedures, job rotation
- **Personal protective equipment:** provide protective clothing and respiratory protective equipment
- **Education:** provide adequate health and safety training to the workers, information and instructions specific to their workstation or job

Compliance with Member State Occupational Exposure Limits is just one part of the Risk Management process. You should additionally always ensure that you comply with the General Principles of Prevention, as defined in Council Directive 89/391/EEC and the measures of the CMD 2017/2398 whenever release of carcinogens by a work process into the place of work is identified.

[1] e.g. water, steam, mist or fog sprays
[2] e.g. cyclones, scrubbers, bag filters, electrostatic precipitators and vacuum cleaners
[3] e.g. encapsulation
[4] e.g. control room with a clean air supply

4. RISK MANAGEMENT – WHAT DO I NEED TO DO?

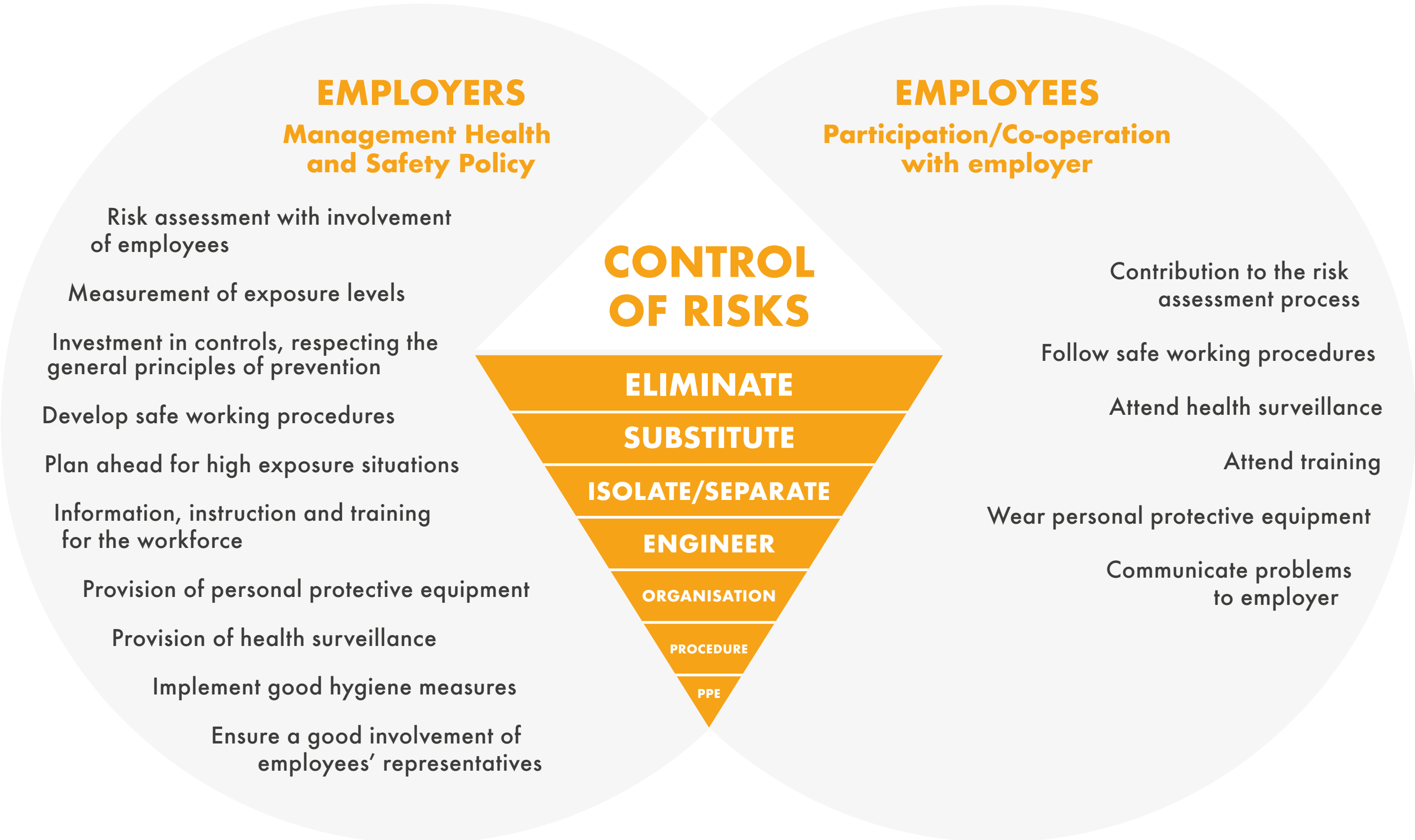
TRAINING FOR THE WORKERS

One of the task guidance sheets in Part 2 of this guide gives detailed guidance on the format and content of training, which should be provided to workers to inform them of the risks to their health that may arise from the handling and use of substances containing crystalline silica.

RISK MANAGEMENT - SUMMARY

The following diagram summarises the risk management process, from the perspective of both employer and employee, when applied to control of respirable crystalline silica.

The health and safety systems implemented in the companies must be respected by both employer and employee.



Take into account all types of employees, i.e. contractors, temporary, fixed term contract, agency, students on work experience, young people and new employees.

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GLOSSARY

Aerodynamic diameter: diameter of a sphere of density 1g.cm-3 with the same terminal falling velocity in the air, related to the particle in question, in the same conditions of temperature, pressure and relative humidity.

Bagging: a process during which products are put into bags (manually or automatically).

Control measures: measures carried out in order to reduce personal exposures of a workplace contaminant to an acceptable level.

Crushing: a process during which coarse material is broken down (crushed) into smaller fragments.

Dust: a dispersed distribution of solids in air, brought about by mechanical processes or stirred up.

Epidemiology: the study of the distribution and causes of health-related conditions and events in populations and the application of this study to control health problems.

Exposure: inhaled exposure results from the presence of an airborne contaminant in the air within the breathing zone of a worker. It is described in terms of the concentration of the contaminant, as derived from exposure measurements and referred to the same reference period as that used for the occupational exposure limit value.

Exposure assessment: the process of measuring or estimating the intensity, frequency and duration of human contact with airborne contaminants which may be present in the working environment.

Grinding: the minerals production process in which individual mineral grains are broken down to a required particle size, typically to a fine flour. The process is sometimes also referred to as "milling" since it is carried out inside a grinding mill.

Hazard: an intrinsic property of a substance with the potential to cause harm.

Health surveillance: the assessment of an individual worker to determine the state of health of that individual.

HSE: The United Kingdom Health and Safety Executive.

IARC: International Agency for Research on Cancer.

Inhalable dust (also referred to as total inhalable dust): the fraction of an airborne material which enters the nose and mouth during breathing and which is therefore available for deposition anywhere in the respiratory tract (MDHS 14/2). The standard EN 481 gives the percentage of the suspended total particulate that can be inhaled according to particle size.

INRS: Institut National de Recherche et de Sécurité.

ISO: International Standardisation Organisation.

Measurement: a process carried out in order to determine the airborne concentration of a substance in the workplace environment.

Measurement procedure: a procedure for sampling and analysing one or more contaminants in workplace air.

Milling: the minerals production process in which the lumps of mineral are broken down to individual grains. See also "grinding".

Occupational exposure limit value: the maximum admissible exposure of a worker to an airborne contaminant that is present in the air in the workplace. It represents the maximum time-weighted average concentration of an airborne contaminant to which a worker can be exposed, measured in relation to a specified reference period, normally eight hours.

GLOSSARY

Personal protective equipment: equipment designed to be worn or otherwise held by the worker to protect him against one or more hazards likely to endanger his safety and health at work, or any addition or accessory designed to meet this objective.

Personal sampler (or personal sampling device): a device worn by a person that samples the air in that person's breathing zone, in order to determine his personal exposure to airborne contaminants.

Pulmonary alveolar region: the gas exchange region of the lung, made up of approximately 300 million alveoli, or air sacs.

Prevention: the process of eliminating or reducing occupational health and safety risks.

Respirable dust fraction: fraction of an airborne material that penetrates to the gas exchange region of the lung.

Risk: likelihood that the potential for harm will be realised under the conditions of use and/or exposure.

Standard: Document elaborated by consensus and agreed by an approved organisation with standardisation activities. This document gives, for common and repeated practices, rules and guidelines on how an activity should be conducted.

Static sampler: sampling device positioned at a fixed point in the workplace for the duration of a measurement (as opposed to being worn by a person).

Thoracic dust fraction: fraction of an airborne material that penetrates beyond the larynx.

Workplace: the place intended to house workstations on the premises of the undertaking and/or establishment and any other place within the area of the undertaking and/or establishment to which the worker has access in the course of his employment (Directive 89/654/EEC).

ANNEX 1:

TABLE OF OCCUPATIONAL EXPOSURE LIMIT VALUES (IN MG/M³)

A European Binding Occupational Exposure Limit Value of 0.1 mg/m³ is set for respirable crystalline silica in Directive 2017/2398. Member States must establish a corresponding national binding OEL value which can be stricter but cannot exceed the Community limit value.

See **www.nepsi.eu/workplace-exposure-crystalline-silica**

ANNEX 2:

TABLES OF PROCESSES GENERATING FINE PARTICLES WHICH COULD RESULT IN RESPIRABLE CRYSTALLINE SILICA EXPOSURE

The following tables may be helpful when assessing whether the processes in your specific workplace may cause the generation of fine particles which, if airborne, could lead to personal exposure to respirable crystalline silica.

Processes generating fine particles which could result in respirable crystalline silica exposure in mines and quarries:

MINE/QUARRY PROCESS	WHERE MAY FINE PARTICLES BE GENERATED? (Non exhaustive list)
EXTRACTION (Mining and quarrying)	• Wind blown dust • Blasting • Ripping/bulldozing • Vehicle movements • Conveyor transport • Loading and unloading • Drilling
CRUSHING AND MILLING	• All dry processes • Low risk in wet milling process
WASHING/CHEMICAL TREATMENT/ SEPARATION	Low risk of airborne dust generation
DRYING AND CALCINING	All drying and calcining processes
DRY SCREENING **DRY GRINDING**	• All dry screening processes • All dry grinding processes
PACKAGING	• Bagging • Palletising • Vehicle Movements
STOCKPILING	• Wind blown dust from stockpiles • Vehicle Movements around stockpiles
LOADING AND TRANSPORT	• Vehicle loading (free-fall of materials) • Vehicle movement • Conveyor transport
MAINTENANCE	Activities requiring dismantling/opening/access to equipment, or entry into dusty process areas listed above.
CLEANING	Cleaning activities involving entry into dusty process areas listed above and/or done using a dry brush or compressed air.

Not every process step is necessary/applicable for every product/factory

PART 1: RESPIRABLE CRYSTALLINE SILICA ESSENTIALS
ANNEX 2

Processes generating fine particles which could result in respirable crystalline silica exposure in the aggregates production:

The most common natural aggregates are sand, gravel and crushed rock, from rocks of different geological origin, and then with a wide range of free silica content (from 0% to 100%). The content of crystalline silica in recycled and manufactured aggregates will vary depending on the composition of the wastes they are coming from. The level of RCS may depend on the type of materials processed and the intensity of physical processes for the reduction of size and sorting, etc.
If the production process is in wet conditions, dust generation is normally lower.

AGGREGATES PRODUCTION	WHERE MAY FINE PARTICLES BE GENERATED? (Non exhaustive list)
EXTRACTION/QUARRYING	• Site preparation (overburden removal) • Drilling and blasting • Ripping and bulldozing • Mechanical extraction • Rehabilitation/restoration
TRANSPORT OF RAW MATERIALS	• Vehicle movements • Conveyor transport (transfer points) • Loading and unloading
AGGREGATES PROCESSING	• Feeding • Crushing/grinding/milling • Screening • Drying • Mixing and blending • Handling of unsuitable material
RAW MATERIAL/AGGREGATES STORAGE	• Loading and unloading
PACKAGING	• Bagging • Palletising
TRANSPORT OF AGGREGATES	• Vehicle loading • Vehicle movement
MAINTENANCE	Activities requiring dismantling/opening/access to equipment, or entry into dusty process areas listed above, including filters Risk is strongly linked to the type of materials (i.e. step in production process)
CLEANING	Cleaning activities involving entry into dusty process areas listed above Higher risk of airborne dust generation: • Dry cleaning / sweeping Low risk of airborne dust generation: • Wet cleaning and vacuum cleaning

Not every process step is necessary/applicable for every product/factory

ANNEX 2

Processes generating fine particles which could result in respirable crystalline silica exposure in the calcium silicate masonry units production:

CALCIUM SILICATE MASONRY UNITS	WHERE MAY FINE PARTICLES BE GENERATED? (Non exhaustive list)
RAW MATERIALS (SUPPLY, UNLOADING, TRANSPORT, STORAGE)	• Vehicle unloading/Bulk unloading • Bulk road tanker unloading (blowing off) • Bag emptying
RAW MATERIALS (PREPARATION)	• Weighing out • Crushing of minerals • Drying minerals • Mixing of materials • Quarry mobile plant – excavation and haulage • Screening
SHAPING	• Moulding • Wet cutting • Surface treatment
CLEANING	• Cleaning of internal transport lorries

Not every process step is necessary/applicable for every product/factory

ANNEX 2

Processes generating fine particles which could result in respirable crystalline silica exposure in the cement production:

The level of RCS may depend on the type of materials used.
The risk of presence of respirable crystalline silica (RSC) is low and is limited to the first phases of the cement production process (extraction/quarrying; transport of raw materials, grinding/crushing, raw mill). In and after the kiln system, the risk is negligible.

CEMENT PRODUCTION	WHERE MAY FINE PARTICLES BE GENERATED? (Non exhaustive list)
EXTRACTION/QUARRYING	• Wind blown dust • Blasting • Ripping bulldozing
TRANSPORT OF RAW MATERIALS	• Vehicle movements (mostly closed systems) • Conveyor transport (mostly closed systems) • Loading and unloading (mostly closed systems)
GRINDING/CRUSHING	Raw material processing: clay, sand, limestone, diatomaceous earth
RAW MEAL	• Blown dust (mostly closed systems) • Maintenance (mostly closed systems)
BLENDING, STORAGE AND TRANSPORT RAW MEAL	-
KILN	-
TRANSPORT AND STORAGE	-
CEMENT MILL	-
PACKAGING	• Bagging • Palletising
TRANSPORT	• Vehicle loading • Vehicle movement
MAINTENANCE	Activities requiring dismantling/opening/access to equipment, or entry into dusty process areas listed above, including filters Risk is strongly linked to the type of materials (i.e. step in production process)
CLEANING	Cleaning activities involving entry into dusty process areas listed above

Not every process step is necessary/applicable for every product/factory

ANNEX 2

Processes generating fine particles which could result in respirable crystalline silica exposure in the glass and mineral wool industries:

GLASS MANUFACTURING	WHERE MAY FINE PARTICLES BE GENERATED? (Non exhaustive list)
RAW MATERIAL STORAGE	When no silo storage • Wind dispersion • Loading/unloading • Transporting (conveyor belt)
BATCH PREPARATION	• Mixing • Conveying • Cleaning
LOADING AND TRANSPORT	• Batch ingredients
BATCH CHARGE	• Manual charge of batch • Automated charge of batch
FILTER INSTALLATION	• Operating • Cleaning • Maintenance • Repair
CLEANING OPERATIONS	• Batch conveyor installation • Furnace parts
REPAIR AND DISMANTLING OPERATIONS	• Batch conveyor installation • Furnace parts

Not every process step is necessary/applicable for every product/factory

ANNEX 2

Processes generating fine particles which could result in respirable crystalline silica exposure in the ceramics industry:

CERAMICS PROCESS	WHERE MAY FINE PARTICLES BE GENERATED? (Non exhaustive list)
SUPPLY, UNLOADING, TRANSPORT, STORAGE	• Vehicle movement • Vehicle unloading/Bulk unloading • Bulk road tanker unloading (blowing off) • Bag emptying • Conveyor transport • Other transport systems
RAW MATERIAL'S PREPARATION FOR BODY AND GLAZE	• Proportioning • Mixing of materials • Grinding / Milling • Screening • Dewatering (Spray drying) Low risk in wet processes: • Wet milling • Plastification • Resolving
SHAPING	• Dry pressing • Isostatic pressing • Green extrusion • Green shaping by machining • Dressing of cast parts • Cutting and deburring of pressed parts • Garnishing Low risk in wet processes: • Mould making • Slip casting • Plastic shaping
DRYING	• Periodic and continuous drying
GLAZING	• Charging or unloading parts to/from kiln Low risk of airborne dust generation during firing (Biscuit-, final-, decoration-, ...)

Not every process step is necessary/applicable for every product/factory

ANNEX 2

CERAMICS PROCESS	WHERE MAY FINE PARTICLES BE GENERATED? (Non exhaustive list)
FIRING	• Charging or unloading parts to/from kiln Low risk of airborne dust generation during firing (Biscuit-, final-, decoration-, ...)
SUBSEQUENT TREATMENT	• Grinding (squaring, bevelling...) • Polishing • Lapping, sanding (dry and wet) • Rectifying • Cutting / sawing • Drilling Low risk of airborne dust generation: • Sorting • Packaging
MAINTENANCE	• Cutting Refractory Materials (for kilns) • Removing dust or sludge from an extraction unit
CLEANING	• Dry cleaning Low risk of airborne dust generation: • Wet cleaning

Not every process step is necessary/applicable for every product/factory

ANNEX 2

Processes generating fine particles which could result in respirable crystalline silica exposure in the expanded clay industry:

Storage and transport, preparation, mixing, shaping and forming, drying and firing can lead to dust emissions

EXPANDED CLAY PROCESS	WHERE MAY FINE PARTICLES BE GENERATED? (Non exhaustive list)
SUPPLY, UNLOADING, TRANSPORT, STORAGE	• Vehicle movement • Vehicle unloading/Bulk unloading • Bag filling and emptying • Truck transport • Other transport systems • Storage areas
RAW MATERIAL'S PREPARATION	• Mixing of materials • Grinding
SHAPING	-
FLUE DUST CLEANING	-
DRYING	• Periodic and continuous drying • Spray drying
FIRING	• Kiln firing processes
MAINTENANCE	-

Not every process step is necessary/applicable for every product/factory

ANNEX 2

Processes generating fine particles which could result in respirable crystalline silica exposure in the engineered stones industry:

AGGLOMERATED STONES PROCESS	WHERE MAY FINE PARTICLES BE GENERATED? (Non exhaustive list)
SUPPLY, UNLOADING, TRANSPORT, STORAGE	• Vehicle movement • Vehicle unloading/Bulk unloading • Bulk road tanker unloading (blowing off) • Bag emptying • Conveyor transport • Other transport systems
RAW MATERIAL'S PREPARATION	• Proportioning • Mixing of materials • Grinding / Milling • Screening
SLAB SHAPING	• Under vacuum pressing • Curing and/or hardening kiln • Wet pressing • Moulding
SUBSEQUENT TREATMENT	• Grinding / Calibration • Polishing • Cutting / sawing • Drilling Low risk of airborne dust generation: • Sorting • Packaging
MAINTENANCE	• Removing dust or sludge from an extraction unit
CLEANING	• Dry cleaning Low risk of airborne dust generation: • Wet cleaning

Not every process step is necessary/applicable for every product/factory

ANNEX 2

Processes generating fine particles which could result in respirable crystalline silica exposure in the foundry industry:

CASTING PRODUCTION	WHERE MAY FINE PARTICLES BE GENERATED? (Non exhaustive list)
SAND TRANSPORT AND STORAGE	• Pneumatic conveying
SAND PREPARATION	• Mixing • Transport
CORE MAKING AND MOULDING	• Mixing • Transport
MELTING SHOP	Lining and break-out of refractory material (ladles, furnaces)
KNOCKOUT	Separating castings from sand
FETTLING SHOP	• Shot-blasting • Grinding of castings

Processes generating fine particles which could result in respirable crystalline silica exposure in the mortar industry:

MORTAR PRODUCTION	WHERE MAY FINE PARTICLES BE GENERATED? (Non exhaustive list)
RAW MATERIAL PREPARATION	• Excavation of aggregates • Screening • Drying of aggregates
RAW MATERIAL STORAGE	• Wind dispersion (when stored in the open) • Unloading (trucks, bags)/Loading (silos) • Transporting (conveyor belt)
MIXING OF BATCHES	• Conveying • Charging (manual / automatic) • Mixing process
FILLING OF DRY-MIXED MORTARS	• Trucks • Mortar silos • Bags
CLEANING	• All installations
REPAIR AND MAINTENANCE	• All installations

Not every process step is necessary/applicable for every product/factory

ANNEX 2

Processes generating fine particles which could result in respirable crystalline silica exposure in the precast concrete industry:

PRECAST CONCRETE MANUFACTURING	WHERE MAY FINE PARTICLES BE GENERATED? (Non exhaustive list)
RAW MATERIALS (SUPPLY, UNLOADING, TRANSPORT AND STORAGE)	• General storage (indoor and outdoor) • Handling and transportation systems • Bag emptying • Bulk loading/unloading • Crushing/grinding of minerals
CONCRETE MANUFACTURE **GENERALLY WET PROCESS**	• Mixing of materials • Proportioning of bulk materials • Drying • Plastic shaping
POST-PRODUCTION	• Final treatment (dry) • General storage (indoor and outdoor) • Handling and transportation systems
CLEANING	• Mould cleaning • Handling and transportation systems

Processes in the ready mixed concrete industry generating fine particles which could result in respirable crystalline silica exposure:

READY MIXED CONCRETE PRODUCTION	WHERE MAY FINE PARTICLES BE GENERATED? (Non exhaustive list)
RAW MATERIALS HANDLING (CEMENTS, AGGREGATES, FLY ASHES, SILICA FUME)	• Unloading • Storing (indoor and outdoor) • Handling and transport • Bulk loading/unloading • Crushing of returned concrete
CONCRETE MANUFACTURING	• Mixing of materials • Proportioning of bulk materials

Not every process step is necessary/applicable for every product/factory

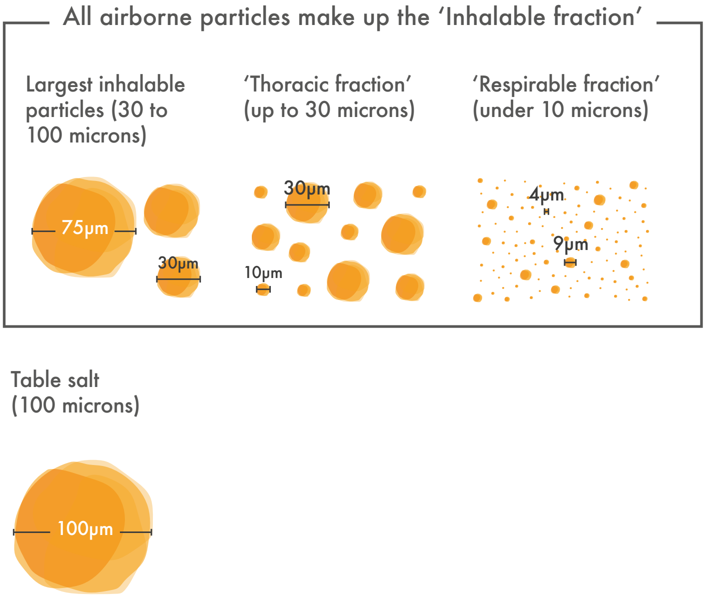
PART 2: TASK MANUAL

1. INTRODUCTION

The aim of this part of the Good Practice Guide on dust prevention is to reduce risks to which workers may be exposed from respirable crystalline silica.

The first section is an introduction on respirable crystalline silica.

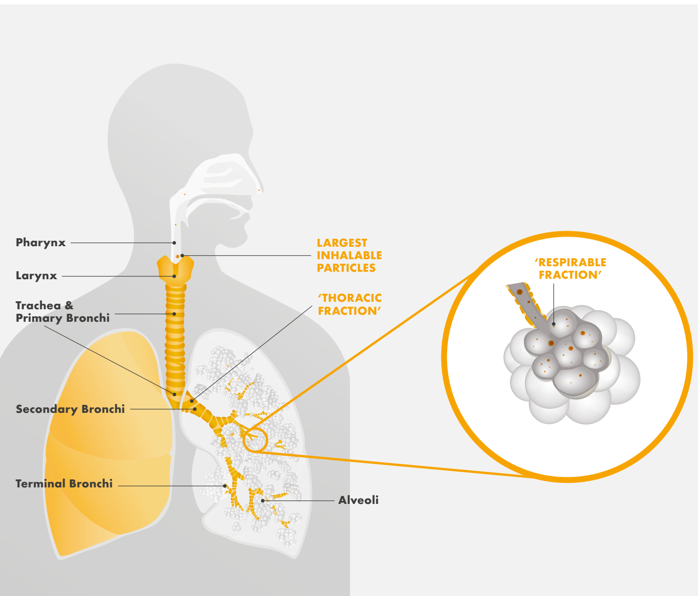
The second section contains a range of task guidance sheets which describe good practice techniques for various common and specific tasks. The general task guidance sheets (section 2.1.) apply to all of the industries which are signatories of the Agreement on Workers' Health Protection through the Good Handling and Use of Crystalline Silica and Products containing it. The specific task guidance sheets (section 2.2.) relate to tasks concerning only a limited number of industry sectors. The management task guidance sheets relate to general management tasks and apply to all industries.



1.1 WHAT IS RESPIRABLE CRYSTALLINE SILICA?

By definition, respirable crystalline silica is the fraction of airborne crystalline silica dust that can penetrate the alveoli (gas exchange region) of the lung.

In the case of crystalline silica dust, it is the respirable fraction of the dust that is of concern for its health effects. These particles are so small that they cannot be seen with the naked eye. Once airborne, respirable dust takes a very long time to settle. A single release of dust into the workplace air can lead to significant exposure. In fact, in situations where the air is constantly stirred up and where no fresh air is being introduced, respirable dust may remain airborne in the workplace for days.



1.2 HOW DOES RESPIRABLE CRYSTALLINE SILICA GET INTO THE BODY?

Respirable crystalline silica enters the body when dust containing a proportion of crystalline silica is inhaled. When the particle size range of the dust is sufficiently small (such that the particles fall within the respirable fraction), the dust will travel deep into the lungs. It is at this point that respirable crystalline silica can cause health effects.

1.3 WHAT ARE THE KNOWN HEALTH EFFECTS ASSOCIATED TO RESPIRABLE CRYSTALLINE SILICA EXPOSURE?

The principal health effect associated to the inhalation of respirable crystalline silica is silicosis.

Silicosis is one of the most common types of pneumoconiosis. Silicosis is a nodular progressive fibrosis caused by the deposition in the lungs of fine respirable particles of crystalline silica. When one experiences prolonged overexposure, the body's natural defence mechanisms may find it difficult to clear respirable crystalline silica from the lungs. An accumulation of dust can, in the long term, lead to irreversible health effects. These health effects involve scarring of the innermost parts of the lungs that can lead to breathing difficulties and, in some cases, death. Larger (non-respirable) particles are more likely to settle in the main airways of the respiratory system and may be cleared by mucus action.

Workers are rarely exposed to pure crystalline silica. The dust they breathe in the workplace is usually composed of a mixture of crystalline silica and other materials.

The response of an individual is likely to depend on:

- **the nature and silica content of the dust**
- **the dust fraction**
- **the extent and nature of personal exposure (duration, frequency and intensity, which may be influenced by the working methods)**
- **personal physiological characteristics**
- **smoking habits**

1.4 WHERE IS RESPIRABLE CRYSTALLINE SILICA FOUND?

Occupational exposure to respirable crystalline silica can occur in any workplace situation where airborne dust is generated, which contains a proportion of respirable crystalline silica.

Occupational exposure to respirable crystalline silica occurs in many industries including quarrying, mining, mineral processing (e.g. drying, grinding, bagging and handling); slate working; stone crushing and dressing; foundry work; brick and tile making; some refractory processes; construction work, including work with stone, concrete, brick and some insulation boards; tunnelling, building restoration (painting) and in the pottery and ceramic industries.

HOW TO USE THE TASK GUIDANCE SHEETS

At each site, before commencing any work activity that may result in occupational exposure to respirable crystalline silica, employers must carry out a risk assessment to identify the source, nature and extent of that exposure.

When the risk assessment identifies that workers may be exposed to respirable crystalline silica, then control measures should be put in place to control exposures, in accordance with appropriate legal obligations.

The following task guidance sheets identify appropriate control measures that will assist employers in reducing exposure levels for many common work activities. When deciding which sheet(s) to apply, priority should be given to the most significant sources of exposure to respirable crystalline silica in the workplace.

Depending on the specific circumstances of each case, it may not be necessary to apply all of the control measures identified in the task guidance sheets in order to minimise exposure to respirable crystalline silica i.e. to apply CMD obligations (Article 4).

FINDING YOUR WAY AROUND THE TASK GUIDANCE SHEETS

The task guidance sheets have been categorised for your convenience. Task guidance sheet types, sections and sectors that they are relevant to, have been given visual treatments to help you find what you are looking for.

THEME COLOURS

- **GENERAL** Task Guidance Sheets Part 2.1
- **SPECIFIC** Task Guidance Sheets Part 2.2
- **MANAGEMENT** Task Guidance Sheets Part 2.3

SECTION ICONS

- Access
- Design & equipment
- Maintenance
- Examination & testing
- Cleaning & housekeeping
- Training
- Supervision
- Personal protective equipment
- Undertaking the work
- General
- Health & safety
- Organisation
- Communication
- Written agreement
- CNC machines
- Half face respirator
- PAPR
- Manual tools
- Manual saws

SECTOR TABS

AGG	Aggregates
AST	Agglomerated Stones
CEM	Cement
CER	Ceramics
CSMU	Calcium Silicate Masonry Units
EXCA	Expanded Clay Aggregates
FND	Foundry
GLA	Glass
IMA	Industrial Minerals
INS	Mineral Wool
MIN	Mining
MOR	Factory-Made Mortars
NST	Natural Stones
PC	Precast Concrete
RMC	Ready Mixed Concrete

ALL

GENERAL TASK GUIDANCE SHEETS

2.1.	GENERAL GUIDANCE SHEETS	ALL SECTORS
2.1.1	Cleaning of surfaces and installations	X
2.1.2	Design of buildings	X
2.1.3	Design of control rooms	X
2.1.4	Design of ducting	X
2.1.5	Design of dust extraction units	X
2.1.6	Planning for unforeseeable high exposure situations	X
2.1.7	General indoor storage	X
2.1.8	General outdoor storage	X
2.1.9	General ventilation	X
2.1.10	Good hygiene	X
2.1.11	Handling and transport systems	X
2.1.12	Laboratory work	X
2.1.13	Local exhaust ventilation	X
2.1.14	Maintenance, service & repair activities	X
2.1.14a	Dry cutting and grinding applications using hand-held angle grinders/cutters or electric wall chasers	X
2.1.14b	Dry grinding of concrete and other materials using electric concrete surface grinders	X
2.1.14c	Dry sanding activities using hand-held electric power tools	X
2.1.14d	Wet processing of mineral workpieces containing crystalline silica using hand-held power tools	X
2.1.15	Personal protective equipment	X
2.1.16	Removing dust or sludge from an extraction unit	X
2.1.18	Systems of packaging	X

SPECIFIC TASK GUIDANCE SHEETS

2.2.	SPECIFIC GUIDANCE SHEETS	AGG	AST	CEM	CER	CSMU	EXCA	FND	GLA	IMA	INS	MIN	MOR	NST	PC	RMC
2.2.1a	Bag emptying – small bags	X	X	X	X	X		X		X	X	X	X		X	
2.2.1b	Bag emptying – bulk bags	X	X	X	X	X		X		X	X	X	X		X	X
2.2.2	Batch charging into the process – glass								X		X					
2.2.3a	Bulk road tanker loading	X	X	X			X	X		X		X	X		X	X
2.2.3b	Bulk loading	X		X		X	X	X		X		X	X		X	X
2.2.4a	Bulk road tanker unloading (blowing off)	X	X	X	X	X	X	X	X	X	X	X	X		X	X
2.2.4b	Bulk unloading	X	X	X	X	X	X	X	X	X	X	X	X		X	X
2.2.5	Core making and moulding in foundries							X								
2.2.6	Crushing of minerals/raw materials	X		X		X	X			X		X			X	
2.2.7	Cutting and polishing ceramic and stone materials		X		X			X						X		
2.2.8	Drying minerals/raw materials	X		X		X	X		X	X			X			X
2.2.9	Dry pressing in ceramics				X											
2.2.10	Fettling larger castings in foundries							X								
2.2.11	Fettling smaller castings in foundries							X								
2.2.12	Final treatment (dry or wet) in ceramics and concrete				X										X	
2.2.13	Firing (biscuit, glaze, final, decoration) in ceramics and stones		X		X									X		
2.2.14	Glass furnace batch charging – container glass								X		X					
2.2.15	Sandblasting in factories				X			X								
2.2.16	Grinding of minerals/raw materials	X		X					X	X					X	
2.2.17	Isostatic pressing (dry) in ceramics		X		X											
2.2.18	Jumbo bagging	X	X	X			X	X		X			X			
2.2.19	Knock-out and shake-out in foundries							X								
2.2.20	Lining and break-out in foundries							X								
2.2.21	Mixing of materials	X	X	X	X	X	X	X	X	X			X		X	X

2.2.	SPECIFIC GUIDANCE SHEETS	AGG	AST	CEM	CER	CSMU	EXCA	FND	GLA	IMA	INS	MIN	MOR	NST	PC	RMC
2.2.22	Periodic and continuous drying				X		X	X	X						X	
2.2.23	Plastic shaping in ceramics and concrete				X		X								X	
2.2.24	Preparation in ceramics		X		X		X									
2.2.25	Preparing sand in foundries							X								
2.2.26a	Weighing out small quantities				X	X										
2.2.26b	Weighing out of bulk materials				X	X	X						X		X	X
2.2.27	Using water/additives on the roads or open surfaces to reduce dust levels	X		X			X	X		X	X					X
2.2.28	Screening	X		X	X	X	X			X						
2.2.29	Shot-blasting in foundries							X								
2.2.30a	Small bag filling – coarse products	X	X				X			X			X			
2.2.30b	Small bag filling – flours/fines	X	X				X						X			
2.2.30c	Automated small bag filling	X	X	X						X			X			
2.2.31	Spray drying in ceramics and concrete				X										X	
2.2.32	Spray glazing in ceramics				X											
2.2.33	Transport systems for fine dry silica products	X	X	X	X				X	X	X					
2.2.34	Use of a drilling rig	X		X						X						
2.2.35	Water assisted dust suppression	X	X	X	X		X	X		X	X			X	X	X
2.2.36	Installation of countertops		X											X		
2.2.37	Respiratory protective equipment for the slab industry		X											X		
2.2.38	Manufacturing of stone by fabricators: water-integrated machinery tools at the fabrication plant		X											X		
2.2.39	Cleaning of hardening carriages of calcium silicate masonry units					X										
2.2.40	Moulding of calcium silicate masonry units before hardening					X										
2.2.41	Surface treatment of calcium silicate masonry units					X										
2.2.42	Wet cutting processes of masonry units stones materials		X			X								X		

2.2.	SPECIFIC GUIDANCE SHEETS	AGG	AST	CEM	CER	CSMU	EXCA	FND	GLA	IMA	INS	MIN	MOR	NST	PC	RMC
2.2.43	Quarry mobile equipment – excavation and haulage	X		X		X				X			X			
2.2.44	Quarry mobile processing plant	X		X						X						

MANAGEMENT TASK GUIDANCE SHEETS

2.3.	GENERAL GUIDANCE SHEETS	ALL SECTORS
2.3.1	Dust monitoring	X
2.3.2	Real time dust monitoring	X
2.3.3	Supervision	X
2.3.4	Training	X
2.3.5	Working with contractors	X

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TASK GUIDANCE SHEETS

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