Managing the health risks associated with exposure to respirable crystalline silica

In their document 'Health and safety at work – Summary statistics for Great Britain, 2021'* the UK's Health and Safety Executive (HSE) gives the following stark statistics:

> 13,000 deaths each year are estimated to be linked to past exposure at work, primarily to dust and chemicals.

> Occupational lung diseases account for 12,000 of these deaths.

> On average during the past three years, there have been an estimated 17,000 new cases of respiratory problems caused or made worse by work each year.

To put these figures into perspective, an average double decker bus holds approximately 100 passengers, and the average passenger plane that takes us on holiday holds around 400 passengers... Just imagine 120 busloads or 30 planeloads of passengers losing their lives every year, because of exposure to something which is often man-made and always preventable.

Silica is just one substance associated with lung diseases.

What is silica?

Silica is a naturally occurring substance found in stone, rocks, sand and clay.

It is a major component of many construction materials including bricks, tiles, concrete and some plastic composites.

Silica is found in two forms – a crystalline form which includes quartz and cristobalite and so-called 'amorphous' form which include diatomaceous earth and silica gel.

The amount of crystalline silica contained in materials varies greatly. Examples of approximate crystalline silica content of some materials commonly used in industry are given in the table below.

Material	Approximate crystalline silica content of different materials (% w/w)
Sandstone, gritstone, quartzite	Above 70%
Mortar, concrete	25 – 70%
Shale	40 – 60%
China stone	Up to 50%
Granite	20 – 45%
Slate	20 – 40%
Ironstone	Up to 15%
Basalt, dolerite	Up to 5%
Limestone, chalk	Up to 5%
Marble	Up to 5 % (Can contain veins of crystalline silica, so actual content may be much higher).

Why is exposure to RCS a problem?

Crystalline silica is at its most toxic when it is freshly fractured through processes such as cutting, drilling or polishing.

During these and other processes where, high energy is applied to the crystalline silica, a very fine dust is released which can be breathed in. This dust is known as Respirable Crystalline Silica (RCS), and it is so fine that once breathed in, it can reach the deep lung where it remains.

RCS particles are not visible to the naked eye in normal light, so high concentrations can be inhaled without a person being aware of it.

The respirable particles are typically less than around 5 micrometers in size. Compare this to the full stop at the end of this sentence, which is around 200–300 micrometers in diameter, and the finest sand on a beach, which is about 50–70 micrometers.

Exposure to RCS over an extended period can cause serious, irreversible long term health effects, beginning with fibrosis (hardening or scarring) of the lung tissue with a consequent loss of lung function.

Sufferers are likely to have severe shortness of breath and may find it difficult or impossible to walk even short distances or upstairs. The effect continues to develop after exposure has stopped and is irreversible. Sufferers usually become house- or bed-bound and often die prematurely due to heart failure.

Acute silicosis is a rare complication of short-term exposure to very large amounts of RCS. This condition is life-threatening and associated with very significant clinical consequences.

Silica may also be linked to lung cancer. Precautions taken to control the risk of fibrosis will also control the risk of lung cancer. Workers with silicosis are at an increased risk of tuberculosis, kidney disease and arthritis. Exposure to RCS may also cause chronic obstructive pulmonary diseases (COPD) such as emphysema.

RCS dust is also abrasive and drying when in contact with the skin and can give rise to contact dermatitis.

Lung disease case study: **https://www.hse.gov.uk/lung-disease/case-study-stoneworker-terry.htm**

Who is at risk of exposure to RCS?

Common workplace activities where people may be exposed to RCS include:

> Breaking, crushing, grinding or milling silica-containing material such as concrete, aggregate or mortar.
> Drilling, cutting, chiselling or sanding silica-containing material.
> Working with cement.
> Moving earth, e.g., excavating, mining, quarrying or tunnelling.
> Abrasive blasting or sandblasting.
> Handling, mixing or shovelling dry materials that contain silica.
> Using silica, sand or silica-containing products in the manufacturing process of glass and other non-metallic mineral products.
> Using sand as a moulding medium in foundries.
> Using silica flour (a finely ground form of crystalline silica) for example as an abrasive additive to polishes and cleaning products.
> Working with natural and artificial/engineered stone e.g. Stonemasonry activities or kitchen worktop manufacture.
> Dry sweeping up after a task where silica dust has been created.
> Contamination of clothing with dust containing silica.
> People or vehicular movement causing accumulated dust to be raised from the ground.

What must I do to manage the health risks associated with exposure to RCS to ensure that my people and my business are protected?

RCS is process-generated i.e. It only occurs as a result of applying a high energy process (e.g. Cutting) to a crystalline silica-containing material. However, it is still classified as a carcinogen, and exposure to it should therefore be controlled in a manner similar to any other hazardous material with an associated serious ill health effect.

The Control of Substances Hazardous to Health (COSHH) Regulations, 2002 (as amended) and associated Approved Code of Practice, provide the legal framework for managing the health risks associated with work-related exposure to RCS. Copies are available to download here:

> **Control of substances hazardous to health: The Control of Substances Hazardous to Health Regulations 2002. Approved Code of Practice and guidance L5 (Sixth edition) HSE 2013 https://www.hse.gov.uk/pubns/books/l5.htm**

Prior to implementing these, however, the employer must consider whether they can avoid exposure and prevent the release of RCS in the first place.

Matters to consider include:

> The removal or substitution of materials containing silica from the work process – it may be possible to use a different material, for example substituting olivine or another safer material for silica sand in abrasive blasting.

> Taking account of RCS dust control at the design stage of a project e.g. by planning in recesses for services such as water, gas and electrics so there is no requirement to cut or drill masonry later in the project.

> If it is not possible to protect operatives from exposure to RCS silica at the design stage of a project or by changing processes or materials, then employers must assess and control the exposure risks.

Risk assessment

Regulation 6 of the COSHH Regulations and the associated Approved Code of Practice and Guidance details what should be included in a suitable and sufficient assessment and who should undertake it.

Generally, more dust will be released during tasks which involve the use of power tools, are carried out on dry rather than wet material, and undertaken for a longer duration and/or at a greater frequency.

Remember that if tasks are undertaken indoors in poorly ventilated areas, the build up of RCS is likely to be greater.

Once the risks have been identified, the employer must identify effective measures to be implemented to control exposure to RCS.

It is important to involve employees in the risk assessment so that they have a better understanding of it and why any control measures may be needed.

It is also important that the risk assessment is documented clearly, so that the employer is able to demonstrate that the risks of each task have been assessed, as well as the thought process which informed the selection of control measures.

If a risk assessment is revised, for example in the event of a process change, it is good practice to keep a record of any historic risk assessments in order to demonstrate compliance with legislative requirements of the time. This should be an integral part of an employer's claims resilience plan.

Recording risk assessments is a legal requirement only where five or more people are employed, however, doing so is a good way of demonstrating that the risks of each task have been assessed in a suitable and sufficient way.

Control measures

The control measures should follow the 'Hierarchy of Control', concentrating on engineering and administrative controls. Sole use of Personal Protective Equipment (PPE) as a control measure is not appropriate, but its use may be considered as part of a range of control measures.

Hierarchy of Controls

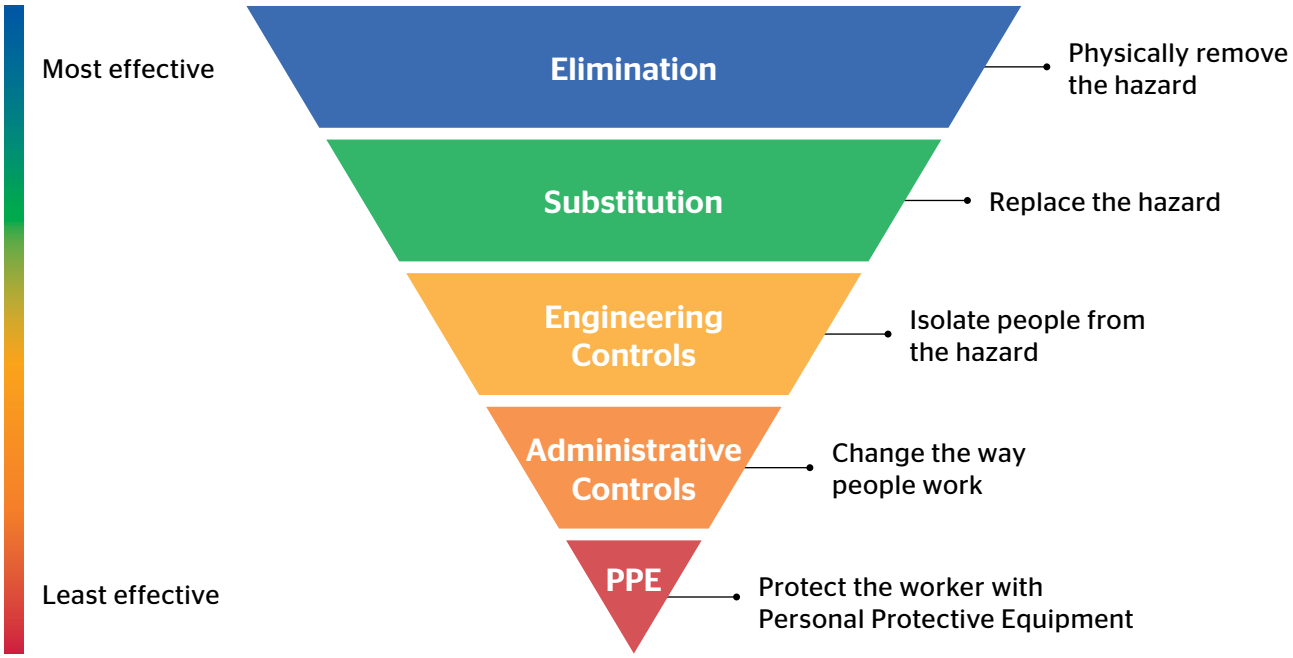

Image by NIOSH

In a factory or workshop environment, the best strategy is to use engineering controls like enclosures or hoods and local exhaust ventilation to extract the contaminated air at the point it is produced, or to use water suppression on fixed machinery.

Where work with hand-held power tools generates dust, for example on construction sites, the best strategies are to use localised ventilation on the tool or suppress the dust using water spray systems.

When buying or renting new equipment, make sure the controls are appropriate. High-value plant and equipment, for example the rock-drilling machines used in tunnelling or the crushing equipment operating at recycling plants, are now likely to have dust suppression integrated into the design.

Standards of housekeeping should be high. Regular cleaning should be implemented using methods such as vacuuming (with a vacuum of dust class M or H) and wet cleaning. Dry brushing must be avoided.

Other measures to consider include:

> The use of materials with a lower crystalline silica content – remember, if you are using a material with 70% silica content, then the RCS generated from cutting this will also be 70% RCS.

> Enclosing the task where possible and applying Local Exhaust Ventilation (LEV).

> Controlling dust emission at source by use of water suppression, LEV or both.

If this control measure is selected, it is important to ensure that pre-use checks of tools include checking that the water attachment inlet is functioning effectively and has not become blocked by any process debris.

If water suppression is by means of recirculated water, a programme of regular checks and maintenance should be implemented to ensure that conditions control the growth of bacteria including Legionella. Risk factors include the temperature of the water (20-45 degrees C.,) the dirtiness of the water and the extent of agitation. Methods to control the risk factors include regular changing of the water, cleaning the reservoir and the proper use of biocides.

> The use of low energy tools for cutting e.g. a guillotine rather than a cut-off saw.

> Cutting silica containing materials off site where it may be easier to implement effective engineering control measures.

> Segregation of high-risk processes such as pneumatic chiselling, cutting, and polishing from the general work area. Examples of means of achieving this include restricting access to authorised personnel only, the use of fixed screens where power tools are being used, sequencing of work to minimise the number of other workers on site when RCS-generating processes are occurring.

If it is necessary to use vehicles such as earth movers and tractors etc. during activities involving RCS, the following measures should be considered:

> Use water (e.g. from a bowser) to dampen down road surfaces to minimise dust generation.

> Select a vehicle that has an appropriate enclosed ventilated cab fitted with suitable filtered air intakes.

> Ensure a comfortable working environment for the operator. Where appropriate, provide air conditioning to reduce the likelihood of the windows being opened.

> Use high-efficiency particulate filters and pre-filters on the air intakes to stop dust getting into the cab.

> Ensure the cab door and windows are always closed except during entry and exit.

> Use radios, closed-circuit television (CCTV), public announcement (PA) or suitable communication system to prevent the need for the driver to open the cab door/ window to communicate with colleagues.

> Provide facilities for the worker to minimise the transfer of contamination into the cab from personal protective equipment and workwear.

In practice, it is likely that a combination of some of the control measures described above will be needed to ensure adequate control of exposure.

What is adequate control and what about exposure limits?

To be considered 'adequate', the measures implemented should be in accordance with Schedule 2A of the COSHH Regulations the 'Principles of Good Practice for the Control of Exposure to Substances Hazardous to Health.' The principles are as follows:

> Design and operate processes and activities to minimise emission, release and spread of substances hazardous to health.

> Take into account all relevant routes of exposure – inhalation, skin and ingestion – when developing control measures.

- Control exposure by measures that are proportionate to the health risk.
- Choose the most effective and reliable control options that minimise the escape and spread of substances hazardous to health.
- Where adequate control of exposure cannot be achieved by other means, provide, in combination with other control measures, suitable personal protective equipment.
- Check and review regularly all elements of control measures for their continuing effectiveness.
- Inform and train all employees on the hazards and risks from substances with which they work, and the use of control measures developed to minimise the risks.
- Ensure that the introduction of measures to control exposure does not increase the overall risk to health and safety.

Again, involve employees in the determining control measures – and document why particular methods of control have been selected.

The UK Workplace Exposure Limit for RCS is listed in this HSE publication:

- EH40/2005 Workplace exposure limits HSE 2020 https://www.hse.gov.uk/pubns/books/eh40.htm

The current WEL for RCS is 0.1 mg/m^3, however this should not be classed as a 'safe' level of exposure which means that adequate control is being achieved.

For exposure to be considered adequate by the HSE, the employer must be able to show that they have implemented control measures in accordance with the 8 principles described above.

Use and maintenance of controls

Once suitable controls have been identified, the employer must ensure that they are used properly.

This is usually best achieved by means of training the operators on the proper use of control measures and effective supervision of their implementation. There should also be an effective means of reporting any defects in control measures such that remedial action is prompt. This is particularly important if wear and tear on the LEV system, caused for example by abrasive materials such as RCS, is liable to mean that the system's effectiveness will degrade between routine testing. Use indicators such as pressure gauges to identify quickly and easily if controls are not working correctly.

Employees also have a duty under the COSHH Regulations to make full and proper use of control measures.

In the case of engineering controls such as LEV systems, the employer must ensure that they undergo Thorough Examination and Testing (TExT) at least every 14 months (or other stipulated frequency) by a competent person.

A suitable record of each TExT must be made by the tester and maintained at site.

Personal protective equipment (PPE)

Whilst not deemed an adequate control measure in its own right, PPE may often be used as part of a suite of control measures.

RCS dust is abrasive and hazardous and its spread should be minimised (e.g.. Preventing the transfer between work and home on workers' clothing) If coveralls are provided to effect this, they should be made of suitable synthetic materials rather than cotton which retains the dust.

Coveralls should be laundered at a contract laundry facility – the employee should not take their PPE home to wash. The contract laundry must be informed that the dust on the coveralls contains RCS so they can protect their employees.

Other protective equipment such as gloves, safety eyewear and hearing protection may be required.

Respiratory protective equipment (RPE)

RPE only protects the worker wearing it, and its effectiveness depends on the correct selection, use and maintenance.

However, for many activities, despite the use of engineering controls, and particularly where hand held power tools are used or materials contain a crystalline silica content of 5% or more, a residual risk of RCS exposure may remain, and it may be necessary to provide RPE.

RPE should be selected to be both adequate for the hazard and suitable for the wearer, task and environment such that the wearer can work freely and further risks are not introduced as a result of wearing the RPE.

Select suitable and adequate RPE for the task in consultation with the workforce e.g. RPE with an Assigned Protection Factor (APF) of at least 20, and possibly higher depending on the risk.

Ensure reusable PPE, including RPE, is appropriately cleaned, stored and kept in working order.

Provide powered respirators or breathing apparatus if the RPE needs to be worn continuously for more than one hour.

Air supplied to breathing apparatus should meet minimum quality requirements, in line with the latest British standard.

When tight-fitting RPE is selected, there is a need to ensure that the seal to the face is complete as it is this that provides the protection to the wearer. The presence of facial hair, and or interference from spectacle arms around the face seal will prevent a tight-fitting respirator being suitable.

Workers should be face fit tested for any tight-fitting respirator. They should also be trained on the correct use and maintenance of the respirator. Records of the face fit testing and the training should be maintained by the employer.

As part of an effective RPE management programme, it is good practice to have a system in place to review when a repeat fit test may be required.

A fit test should be repeated whenever there is a change to the RPE type, size, model or material or whenever there is a change to the circumstances of the wearer that could alter the fit of the RPE; for example:

> Weight loss or gain;

> Substantial dental work;

> Any facial changes (scars, moles, effects of ageing etc.) around the face seal area;

> Facial piercings;

> Introduction or change in other head-worn personal protective equipment (PPE).

For reusable RPE change the filters on respirators in accordance with manufacturer's recommendations and if; – the shelf-life expiry date has passed; – they are damaged or visibly contaminated; – they become harder to breathe through.

For reusable RPE, a thorough maintenance, examination and test should be carried out at least once a month. However, if the RPE is used only occasionally, an examination and test should be carried out before use and, in any event, the interval should not exceed three months.

Guidance on RPE is available in:

> HSG53 Respiratory protective Equipment at work. A practical guide. www.hse.gov.uk/pubns/books/hsg53.htm

Guidance on APFs and breathing apparatus is available in:

> R3 - UK Assigned Standard Protection Factor 20 (APF20) https://www.hse.gov.uk/pubns/guidance/rpe3.pdf

> R4 - UK Assigned Standard Protection Factor 40 (APF40) https://www.hse.gov.uk/pubns/guidance/rpe4.pdf

> R5 – Breathing Apparatus with UK Assigned Standard Protection Factor 40 (APF40) https://www.hse.gov.uk/pubns/guidance/rpe5.pdf

Further information of face fit testing is available on the HSE website:

> www.hse.gov.uk/pubns/indg479.pdf and guidance on fit testers can be found at https://fit2fit.org

Further guidance on COSHH and RCS can be found here:

> Silica - COSHH e-tool hse.gov.uk

Health surveillance

Early stage silicosis does not have any symptoms, and the individual will not know that they are developing a life-altering, and potentially life-limiting condition.

To detect early signs of COPD, silicosis and dermatitis, a health surveillance programme should be introduced.

Health surveillance is not a control measure, but it is a means of monitoring the workforce to make sure they are not developing silicosis.

An appropriate health surveillance programme can help to detect the early signs of lung disease, and the employer can then manage the affected individual to ensure that they are no longer exposed to RCS. However, as well as removing affected individuals from further exposure, the employer must also re-examine their work processes to identify where potential exposures to RCS are occurring and what additional controls must be implemented.

Advice from a competent occupational health professional (doctor or occupational health advisor) should be sought when setting up a health surveillance programme.

Further guidance on health surveillance is available here:

> G403 – Health surveillance for occupational contact dermatitis (OCD). https://www.hse.gov.uk/pubns/guidance/g403.pdf

> G404 – Health surveillance for silicosis. https://www.hse.gov.uk/pubns/guidance/g404.pdf

Exposure monitoring for RCS

Once control measures have been implemented, air monitoring may be needed to show that adequate control of exposure to RCS is being achieved by the systems in place. This should be undertaken by a competent person such as a suitably qualified occupational hygienist.

Further guidance on exposure monitoring is available here:

> Exposure measurement: Air sampling. https://www.hse.gov.uk/pubns/guidance/g409.pdf

Information, instruction and training

Employees should be trained on the health hazards associated with exposure to RCS and how they can be exposed to it during the course of their work.

They should also be trained on the control measures being used at the workplace, how to use them safely, how to check and maintain them, and how to recognize and report any faults with them.

Employers should make sure their employees maintain good skin hygiene and provide facilities such as access to hot water and where appropriate, skin conditioners and barrier creams to ensure that the risk of dermatitis is controlled.

It is important to make sure that any training given to employees concerning the hazards, risks and control measures associated with RCS includes a means of knowledge checking. This and the training attendance records should be maintained to demonstrate that the information has been shared in an appropriate manner.

Sustained health, compliance and claims risk resilience

By implementing the measures described in this document, the risk of exposure to RCS will either be avoided or suitably controlled, and workers' long-term health will be protected. Current UK legal requirements concerning RCS will also be complied with.

However, a documented review programme should be introduced to ensure that risk assessments, control measures and associated training are reviewed on a regular basis, or where the process and/or people change.

If you are in any doubt about what measures may be necessary or how to implement them in order to achieve adequate control of exposure to RCS, you should seek competent advice e.g. from a suitably qualified occupational hygienist.

This will ensure that risk elimination and control activities remain sustainable, systematic and targeted to protect worker health in the long term.

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