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Controlling exposure to stone dust

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INTRODUCTION

1 Workers who process stone can develop occupational lung diseases caused by breathing in stone dust, especially if it contains respirable crystalline silica (RCS). These diseases include silicosis, lung cancer and chronic obstructive pulmonary disease (COPD). Silicosis can continue to get worse even after exposure has stopped. Severe shortness of breath may eventually develop, making it difficult to walk even short distances. Silicosis is a serious and irreversible lung disease that can cause permanent disability and early death. There is an increased risk of lung cancer in workers who have silicosis.

2 In addition to the health effects arising from the inhalation of stone dust, there are also other health effects associated with stone working. These include:

- dermatitis, as dust can be abrasive and drying when in contact with skin;
- hearing damage, due to the high levels of noise from power tools;
- hand–arm vibration syndrome when working with power hand tools, especially stone chisels/ hammers;
- musculoskeletal disorders, from the manual handling of stone.

This guidance focuses on the health risks associated with the inhalation of stone dust and how to control these risks. Guidance on controlling the other health risks is available (see Appendix A).

3 This guidance is relevant to those who work with stone (eg traditional masons, memorial/gravestone masons and worktop fabricators), at dimension stone quarries, on construction sites or elsewhere. It may also be helpful for others associated with the stone working industry (eg employees, safety representatives, machinery suppliers and health and safety consultants).

4 The aim of this guidance is to help both employers and employees understand:

- the health risks associated with exposure to stone dust;
- the health and safety law applicable when working with stone;
- the factors they need to consider within their workplace;
- the control measures required.

1 RISKS FROM EXPOSURE TO STONE DUST

1.1 Health effects

5 Stone dust consists of a mixture of dust particles of different sizes. Those which can be breathed in through the nose and mouth are referred to as 'inhalable dust' (typically less than 100 µm (microns) in diameter), while those which are small enough to penetrate deep into the lungs are called 'respirable dust' (typically less than 10 µm in diameter) (see Figure 1).

6 Although inhalable dust can cause irritation of the eyes, nose and throat, it is the fine respirable dust that is the main cause of serious long-term health problems. Unlike inhalable dust, the fine respirable dust cannot normally be seen with the naked eye when airborne, but it can be made visible by using a dust lamp (effectively a very bright torch with sufficient illumination).[1]

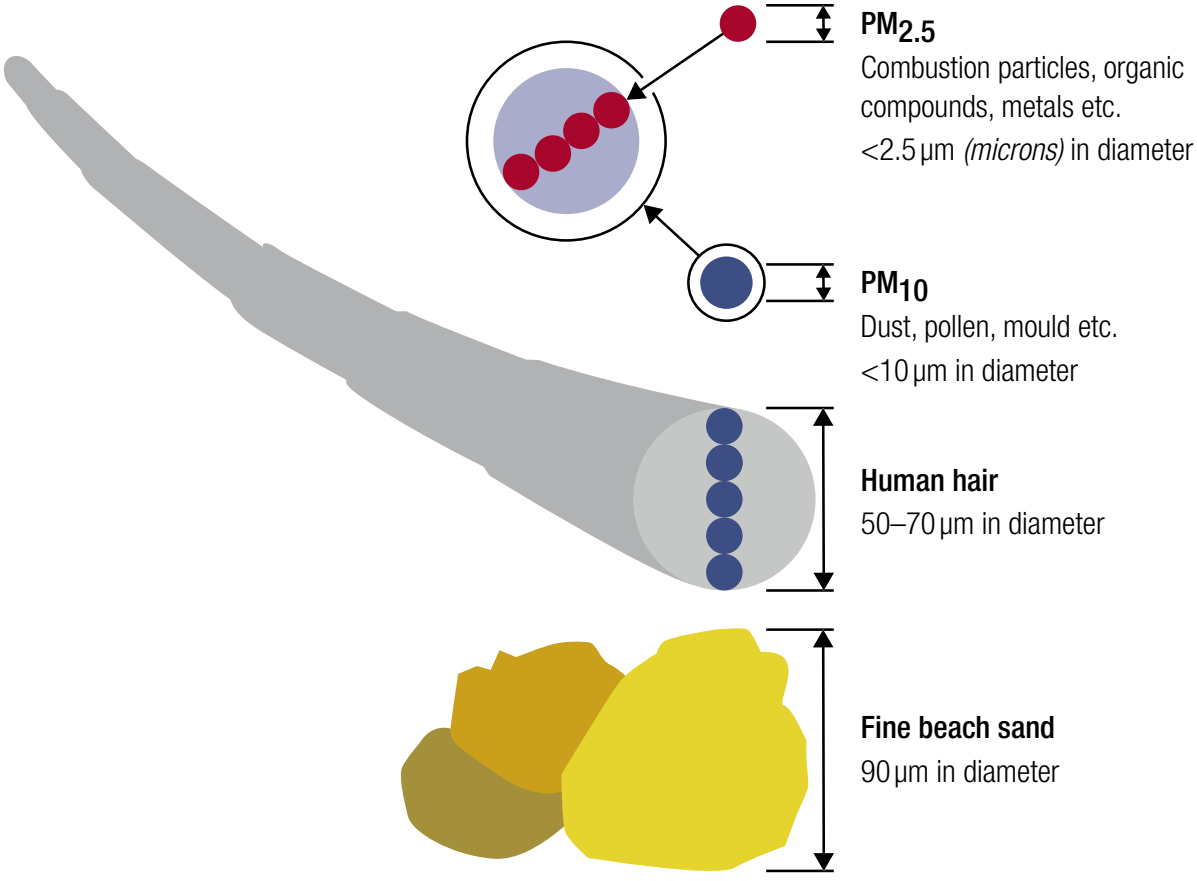


Figure 1 Relative sizes of small particles

RCS particles are less than 10 µm in diameter and so are part of the particulate matter (PM_{10}) fraction (dust, pollen, mould etc)

7 When the stone being processed contains crystalline silica (the most common form being quartz), the airborne stone dust that is breathed in will contain RCS. RCS has the potential to cause serious lung conditions like silicosis, lung cancer and COPD. There is a wide range of stone types that contain various levels of crystalline silica (see section 2).

Silicosis

8 This is a fibrotic disease of the lungs produced by the inhalation and build-up of RCS dust in the lungs (see Figure 2). There are different forms of silicosis depending on the level and duration of exposure (see Appendix B). Silicosis results in a hardening or scarring of the lung tissue with consequential loss of lung function. Silicosis can continue to get worse even after exposure has stopped. Severe shortness of breath may eventually develop, making it difficult to walk even short distances. Silicosis is a serious and irreversible lung disease that can cause permanent disability and early death. There is an increased risk of lung cancer in workers who have silicosis.

Lung cancer

9 RCS exposure is associated with the development of lung cancer. Lung cancer is a serious disease and symptoms include a persistent cough, coughing up blood and persistent breathlessness.[2] It can significantly shorten life expectancy.

Chronic obstructive pulmonary disease

10 Chronic obstructive pulmonary disease (COPD) is a progressive and potentially serious breathing problem. It is mainly caused by smoking but is also linked to exposure to RCS. In its more advanced stages, COPD can cause severe breathlessness, cough and frequent chest infections.

Prolonged exposure and other risks

11 While the greatest risk to health comes from the inhalation of stone dust containing RCS, other minerals present in the stone dust can also cause damage to the lungs and affect breathing.

Undamaged lungs
Image courtesy of Getty Images

Lungs with silicosis
Image courtesy of Nicol *et al.* 2015[3]

Figure 2 Comparison of chest X-rays showing undamaged lungs and those affected by silicosis

12 It is important to note that exposure to 0.05 mg/m³ of RCS over a working lifetime of 45 years still presents a 5 in 100 risk of developing silicosis.[4] It is important that adequate control measures are selected, checked and maintained by competent persons (for more information, see section 4). Regular exposure to even very small amounts of RCS can put workers at risk of developing lung disease (see Figure 3).

Figure 3 Comparison of an accumulation of RCS dust with a penny

1.2 Health and safety law

13 Employers have a legal duty to put in place suitable arrangements to manage for health and safety. Under the Control of Substances Hazardous to Health Regulations 2002 (as amended) (COSHH),[5] any dust generated when processing stone can be hazardous to health even if it does not contain RCS.

14 Stone dust exposure must be adequately controlled; dust of any kind can become a substance hazardous to health under COSHH when:

'present at a concentration in air equal to or greater than 10 mg/m³, as a time-weighted average over an 8-hour period of inhalable dust; or 4 mg/m³, as a time-weighted average over an 8-hour period, of respirable dust'.

15 Under COSHH Regulation 7(7), control is defined as adequate only if the principles of good practice (Schedule 2A) are applied, exposure is below the WEL, and if the control measures are proportionate to the health risk.

16 Individual substances, including RCS, have their own set WELs. These limits are listed in the publication EH40/2005[6] and must not be exceeded. If a substance is not stated in EH40/2005, this does not necessarily mean that the substance is safe.

17 Although RCS is process-generated it is classified as carcinogenic, meaning 'it is capable of causing cancer and/or heritable genetic damage'.[7] Therefore control measures should be in line with those required for any hazardous substance with an associated serious health risk. Selecting effective controls (see section 5) and applying the principles of good practice in COSHH Schedule 2A should result in employers doing enough to comply with the law and achieve exposure levels below the WEL.

18 Employers are required to assess and control the risks as follows:

- Undertake a risk assessment to assess exposure, then identify the controls required. The risk assessment should be recorded where the company has five or more employees (Regulation 6). See section 3.
- For potentially serious health effects, such as those caused by exposure to RCS, the risk assessment will need to be more comprehensive and the control measures more stringent to reduce exposure. Very toxic substances such as carcinogens require a more comprehensive assessment and a higher standard of control.
- Implement the controls required to prevent or adequately control exposure (Regulation 7). See sections 4–6.
- Use, maintain and test the controls required to ensure they are effective (Regulations 8 and 9). See sections 4–6.
- Monitor work exposures where required (Regulation 10). See section 7.
- Use health surveillance where appropriate (Regulation 11). See section 8.
- Provide employees with suitable and sufficient information, instruction and training (Regulation 12). See section 9.

2 CRYSTALLINE SILICA CONTENT OF NATURAL AND ARTIFICIAL STONE

2.1 Natural stone

19 The crystalline silica content of natural stone, and other mineral-based materials, can vary widely (see Table 1). Figure 4 shows examples of different types of natural stone and mineral-based materials.

20 When stone containing crystalline silica is cut, ground or polished, the dust produced is likely to contain RCS. The proportion of RCS in stone dust generated by these activities has been found to be similar to, or less than, the proportion of crystalline silica in the corresponding bulk stone.

21 Substitution of stone containing higher levels of crystalline silica with one containing lower levels should be considered to reduce potential exposure to RCS dust. The opportunity to substitute the stone is likely to be very limited as:

- some sites, such as quarries, process only one type of stone;
- the choice of stone used by fabricators is usually dependent on customers' requirements.

Table 1: Crystalline silica content in different types of natural stone and mineral-based materials

Types of natural stone or other mineral-based materials	Crystalline silica content (%w/w)
Sandstone, gritstone, quartzite	Above 70%
Mortar, concrete	25–70%
Shale	40–60%
China stone	Up to 50%
Granite	20–45% (typically 30%)
Slate	20–40%
Ironstone	Up to 15%
Basalt, dolerite	Up to 5%
Limestone, chalk	Up to 5% (typically less than 2%)
Marble	Up to 5% (but can contain veins of crystalline silica so the overall content may be a lot higher)

Figure 4 Examples of different types of natural stone and mineral-based materials

Asbestiform minerals

22 Asbestiform minerals have been identified in some faintly veined white marble and some serpentinite (also known as soapstone). If there is evidence to suggest that asbestiform minerals may be present in marble or other stone, laboratory testing may be necessary to confirm whether the fibres are asbestos and to establish the amount.

23 Where the amount of asbestos is below trace levels (defined as 'one or two fibres' during the analysis of bulk materials for asbestos), the risk from asbestos in these situations will be negligible and any residual risk will be adequately managed by control measures provided for RCS. If the amount of asbestos is above trace levels, the stone would be classified as an asbestos-containing material under the Control of Asbestos Regulations 2012, and these Regulations must be complied with. Further guidance is available in AM1: *Asbestos in some types of marble and other stone: assessing the risk.*[8]

2.2 Artificial stone

24 Artificial stone is a synthetic product made from various materials, including cement, sand, natural aggregates (eg stone pieces), bound together using either physical means (eg heat and pressure) or chemical means (eg resins). It resembles natural stone but may have different properties (eg lightweight, coloured, homogenous, stain resistant) that make it useful for internal surfaces such as worktops and floors.

25 There are several types of artificial stone (also called agglomerated stone) and they can contain varying levels of crystalline silica depending upon the type of natural stone pieces/minerals from which they were produced.

26 **Engineered stone** typically comprises around 95% crushed stone pieces (usually marble or quartz), 5% resin (usually polyester) and low levels of additives and colourants. Quartz-based stone is used for kitchen and bathroom work surfaces, while marble-based stone is used for indoor floors and walls. Other engineered stone may contain no silica (eg if based on aluminium trihydrate and resin). To prevent heat generation causing the formation of resin fume and surface charring, engineered stone may be cut at a slower speed than natural stone, and polished using water suppression.

27 **Cast and sintered stone** is made by applying pressure and temperature to crushed stone or mineral mixtures (including aluminosilicates, clay, sand, feldspar, granite minerals and porcelain) but no resin binder is used. Sintered stone includes ceramic and porcelain, and usually contains around 5–25% crystalline silica.

28 **Terrazzo** is produced by pouring concrete and then embedding crushed stone in the upper layer. Terrazzo tiles can be made in factories, but if terrazzo floors are made in situ (eg hotel floors), the addition of the crushed stone and subsequent polishing of the floor can generate significant dust.

29 It is important that employers considering manufacturing and processing artificial stone determine the level of crystalline silica present (eg by asking their manufacturer/supplier, having the material analysed, or making a worst-case assumption that it contains a high level of crystalline silica). Employers should use alternative stone with a lower crystalline silica content to eliminate or reduce the risk to workers' health. Where this is not reasonably practicable, employers should ensure that they implement adequate controls to protect their workers from exposure to the stone dust and RCS.

3 RISK ASSESSMENT

30 A COSHH risk assessment is required to determine the health risk to workers from exposure to stone dust during work activity.[9] This needs to consider the types of stone, including their crystalline silica content (see section 2), and all tasks that could generate dust, including maintenance and cleaning of equipment and premises. It is important to remember risk assessments are not limited to substances labelled as 'hazardous'.

31 An assessment of the level of dust, and RCS within it, released by the work activity may be:

- qualitative, when observation reveals that a task produces a high level of dust;
- quantitative, if you have exposure monitoring data for your site.

32 When you have no specific data, it may be possible to find some from published sources for similar workplaces or tasks (eg Silica Baseline Survey).[10] If estimates or judgements of exposure are used, it is important to be precautionary in their application.

33 The dust will contain more RCS for stone containing higher percentage levels of crystalline silica. If the tasks are carried out indoors, with limited ventilation, the build-up of dust in the air will be greater.

34 Generally, more dust will be released for tasks:

- involving the use of power tools rather than manual tools;
- without effective engineering controls (eg extraction or water suppression) in place;
- carried out on dry rather than wetted stone;
- of longer duration and/or greater frequency.

4 CONTROLLING STONE DUST

4.1 Control measures

35 The legal requirement for an employer, under COSHH Regulation 7(1), is to ensure that 'the exposure of his employees to substances hazardous to health is either prevented or, where this is not reasonably practicable, adequately controlled'.

36 The principles of good control practice must be followed as set out in COSHH Schedule 2A. When considering the suitability of different control options, the hierarchy of control, given in the COSHH Approved Code of Practice, should be applied (see section 4.2).

37 The types of control measures that can be used will depend upon:

- the process and tooling: as artificial stone can be manufactured to specific thicknesses (often thinner than natural stone blocks), different tooling may be required to process it;
- the type of emission (eg stone dust and/or mist from water suppression);
- the location of the stone working (eg on fixed factory premises or temporary construction and heritage sites).

38 Achieving adequate control is likely to require a combination of controls, especially when greater levels of RCS dust are released (eg for stone containing higher crystalline silica content; see section 4.3).

39 For some typical stone processing tasks, the following HSE COSHH Essentials Guidance Sheets are available that identify suitable combinations of controls to achieve good control practice:

- ST0: Advice for managers;[11]
- ST1: Primary and secondary sawing;[12]
- ST2: Automated boring and polishing using rotary tools;[13]
- ST3: Cutting and polishing using hand-held rotary tools;[14]
- ST4: Hand and pneumatic chiselling;[15]
- ST5: Sawing slate;[16]
- ST6: Manual slate splitting;[17]
- ST7: Dressing slate (edge bevelling).[18]

Some other potentially high-risk stone processing tasks that are not covered by these sheets (eg surface finishing/blasting) are considered in section 5.

40 If the recommended controls are all applied, used and maintained effectively, they should adequately control the risk of exposure to stone dust containing high levels of RCS for the specific task. If the stone contains a low level of crystalline silica and the control measures in place are proportionate to the risk from the dust generated, it may not be necessary to implement the full set of controls.

41 Further HSE guidance is available on control measures for construction site tasks which generate dust that may contain RCS. This includes Construction Information Sheets (CIS) and COSHH Essentials Guidance Sheets:

- CIS36: Construction dust;[19]
- CIS54: Dust control on cut-off saws used for stone or concrete cutting;[20]
- CN3: Drilling with hand-held rotary power tools;[21]
- CN7: Abrasive blasting.[22]

QY 0–8, a series of COSHH Essentials Guidance Sheets (QY series) on control measures for tasks undertaken in the quarry industry which generate stone dust that may contain crystalline silica (Quarries silica[23]), may also be helpful.

42 There is other relevant guidance available on controlling exposure to stone dust, including that containing RCS; for example:

- The EU Senior Labour Inspectorate Committee (SLIC) has guidance on dust controls including for a bench-top masonry saw and abrasive pressure blasting;[24]
- The European Network on Silica (NEPSI) has good practice guidance including task guidance sheets for working with natural stone;[25]
- The British Occupational Hygiene Society (BOHS) has construction trade fact sheets including one for stonemasons;[26]
- Safe Work Australia have produced a Code of Practice for managing the risks of respirable crystalline silica from engineered stone in the workplace;[27]
- The Institute of Occupational Safety and Health (IOSH) provides information to assist with toolbox talks (eg factsheets and pocket cards).[28]

4.2 Hierarchy of control

43 If it is not possible to prevent exposure to hazardous substances (eg by substituting the stone or eliminating the process), control measures appropriate to the task should be applied. The control measures should be effective for the material and process undertaken (for further information see COSHH Approved Code of Practice L5).

Elimination (substitution and/or change of process)

44 It may be possible to change the process to remove or reduce worker exposure to RCS by, for example:

- choosing a different material rather than stone, or a stone with lower crystalline silica content, if the exact material required is not specified by the customer;
- getting stone pre-cut to size before delivery by the supplier, who should have adequate control in place.

Engineering controls

45 Engineering controls include one or both of the following:

- Automating to reduce manual working, and/or enclosing the task using extraction. This will prevent, or minimise, dust being released. These controls will reduce the risk to the operator, the risk of secondary worker exposure, and how often the work task area will need to be cleaned.
- Controlling the dust at source by use of water suppression (see Appendix C), local exhaust ventilation[29] (LEV; see Appendix D) or both (eg water suppression on power tools being used in an extracted booth). Most stone processing tasks will require the use of at least one of these.

Segregation

46 High-risk processes (eg primary sawing, cutting and polishing using rotary tools and pneumatic chiselling) should be segregated when possible. Access should be restricted to authorised persons only, wearing suitable and adequate personal protective equipment (PPE).

47 Segregation could be achieved by:

- time, ie stay outside the work area until any airborne dust has settled;
- distance, where the risk has already been significantly reduced, ie by short-duration work, manual tasks or when stone with a lower crystalline silica content is used.

Segregation may be unnecessary in certain circumstances (eg when tasks are very short and generate only a little dust containing a low level of RCS).

48 Segregation may need to be more extensive (eg use of fixed screens where power tools are used) for longer-duration tasks and for stone that contains higher levels of crystalline silica. Fully screening/enclosing the task can reduce the spread of RCS dust but should not increase the exposure risk to the worker.

49 Construction sites should ensure necessary segregation. Principal contractors may need to sequence work to minimise the number of other workers on site when stone cutting tasks are taking place.

Organisational controls

50 Employers should ensure that they have established suitable work methods and operating procedures that the workers understand and follow. These should include:

- minimising the number of workers exposed;
- ensuring employees have received sufficient information, instruction and training on the hazards and risks arising from exposure to the substance, and know how to use and maintain any required control measures effectively;
- suitable, frequent and proactive cleaning and housekeeping practices, to prevent the build-up of dust on floors, walls and other surfaces. This should include the allocation of appropriate roles and responsibilities for the cleaning tasks;
- providing adequate washing facilities;
- prohibiting eating, drinking and smoking in contaminated areas.

Personal protective equipment

51 Personal protective equipment (PPE) is likely to be required (eg synthetic coveralls to reduce dust accumulation and the risk of secondary exposure; water-resistant coveralls if workers are exposed to water suppression mist; eye protection to protect eyes from dust and particles; and hearing protection, especially for hand-held power tools).

52 Respiratory protective equipment (RPE)[30] will be needed to protect workers from any residual risk (see Appendix E). It is likely to be required (in addition to control at source) for most stone processing tasks, as well as cleaning and maintenance tasks when dry dust is present. The RPE provided must be:

- adequate (ie right for the hazard and reduces exposure to the level required to protect the wearer's health);
- suitable for the wearer, task and environment, such that the wearer can work freely and without additional risks due to the RPE.

53 Employers should make sure the selected RPE is of the right size and can correctly fit the wearer. For tight-fitting facepieces, the initial selection should include a face-fit test by a competent person. Tight-fitting RPE will only provide effective protection if the wearer is clean-shaven, so they should also be clean-shaven when fit tested. If workers have beards, or are unable to be clean-shaven, a tight-fitting device will not be suitable, so an appropriate loose-fitting device should be chosen.

54 Further information on the type of RPE to be used is provided in Appendix E.

55 If RPE is required to protect workers who work near a process where exposure to mist can occur, advice on appropriate RPE should be sought from the RPE manufacturer because mist could cause caking on the filter, increase breathing resistance, and increase face seal leakage.

4.3 Combinations of controls

56 A combination of controls is likely to include most of the following:

- water suppression that is appropriate for the task;
- extraction that is well-designed and effective in capturing dust and/or mist;
- segregation of activities that generate dust and/or mist containing RCS;

- workplace organisation, including suitable, frequent and proactive cleaning and housekeeping arrangements;
- the use of PPE, especially RPE, which must be adequate and suitable, worn correctly, and adequately checked and maintained. Coveralls should be synthetic, not cotton, to reduce dust accumulation on the surface;
- the provision of information, instruction, and training to employees on the risks and control measures required.

57 Employees who are not working with stone may still be exposed to stone dust from the activities of others working nearby, and from residual background levels. In some stone working sheds, for example, the background levels of RCS can exceed the WEL. Suitable control measures for workers could include:

- leaving the stone working area when they are not processing stone;
- segregation (by barriers or distance) from others who are working with stone;
- performing regular workplace cleaning using suitable 'dust-free' methods; eg wet cleaning or vacuuming (with vacuum of dust class M or H);
- improving the general ventilation to reduce airborne dust levels;
- wearing adequate and suitable RPE whenever they are in the stone working area.

4.4 Maintaining controls

58 To sustain adequate control of dust exposure, any control measures introduced should be checked and maintained to ensure that they continue to be effective:

- LEV systems,[31] including on-tool extraction systems, should undergo a thorough examination and test (TExT) at least every 14 months by a competent person (unless otherwise stipulated);
- All engineering control measures need to be regularly checked and maintained, and records kept. If wear and tear on the LEV system is liable to mean that the system's effectiveness will degrade between tests, maintenance should be more frequent.
- Anyone undertaking the maintenance of control measures should have adequate knowledge, training and expertise in examination methods and techniques.
- Reusable RPE should be maintained in accordance with manufacturers' instructions for use. It should be subjected to regular maintenance carried out by properly trained personnel. Thorough maintenance, examination and tests should be carried out at least once a month if the RPE is used regularly. If the RPE is only used occasionally, then the examination and test should be done before the next use, and in any event the interval should not exceed three months.
- There should be procedures in place, eg supervision, to ensure that workers are using the control measures correctly.
- Airborne exposure monitoring should be carried out as required to show that the effectiveness of controls is maintained.

5 CONTROLS FOR SPECIFIC TASKS

59 The control measures set out for the following tasks are based on the processing of stone with high crystalline silica content. Processing stone with low crystalline silica content may not require the full range of control measures. This should be justified in the task-specific risk assessment.

60 For some tasks the COSHH Essentials Guidance Sheets provide further information on good control practices (compared to that summarised below), and these sheets are referenced in the relevant sections.

5.1 Primary and secondary sawing

Description	Primary saws (eg single and multiple circular bridge saws, wire saws and frame/gang saws), along with secondary circular saws, are used to cut stone into manageable-sized pieces. Primary saws are used to cut quarried stone into smaller pieces, which are then further cut by secondary saws.
Picture	 *Bridge saw*  *Wire saw*  *Frame saw* **Figure 5** Primary and secondary saws *(The photographs are for illustrative purposes only – these machines require suitable guarding)*

Key controls	Provide water suppression with adequate water flow to the tool. Segregate the process and limit access to authorised persons only. Place the control panel away from the process. Control the spread of mist generated (eg by positioning baffles used on the guard and an absorbent coating such as artificial grass of appropriately sized baffles and absorbent wall coverings on the wall of the segregated area). Segregate the process and limit access to authorised persons only. Place the control panel away from the process. Provide ventilation to a good standard, helping to prevent the build-up of mist. Use RPE with an assigned protection factor (APF) of at least 20 when workers have to work near the process where exposure to the mist can occur (ST1: *Primary and secondary sawing*). Consider whether RPE is required for others in the work room who may be exposed to the mist.
Comments	Water flow is usually specified and designed according to manufacturers' instructions to cool and protect the blade. It needs to be checked at regular intervals. Recirculated water needs a programme of regular checks and maintenance to ensure conditions control the growth of bacteria, including *Legionella*, so that worker exposure is kept low. The frequency of the checks and maintenance should be determined by risk assessment. Risk factors include the temperature of the water (20–45°C), the dirtiness of the water and extent of agitation, while methods of control include changing the water, cleaning the tank or using biocides.[32] It may be possible to fully enclose and automate smaller saws. Work locations close to moving and rotating machinery or where parts may be ejected are inherently unsafe. There is a foreseeable risk of being crushed, cut, entangled or struck unless adequate controls are in place (eg enclosure of automated machines, suitable guarding or restricted access). Information on bridge saw guarding is available.
References	Appendix C Appendix E COSHH Essentials Guidance Sheet ST1: *Primary and secondary sawing* *Safer by design: Bridge saw guarding*[33]

5.2 Cutting and polishing using hand-held power rotary tools

Description	Hand-held power rotary tools include circular saws, grinders and polishers, and these generate high levels of dust. Grinders remove unwanted burrs from rough stone surfaces by abrasion but leave fine grinding lines on the surface that need removing by polishing.
Picture	  *With water suppression* *With LEV extraction and RPE* **Figure 6** Cutting using hand-held power rotary tools
Key controls	Provide water suppression with adequate water flow to the tool. If water suppression is not reasonably practicable, use suitable LEV (eg an extracted booth). If working within an extracted booth to control the stone dust, place the work on an open-frame rotating banker and position the worker so as not to obstruct the airflow. Always aim the ejected dust towards the extractor / water wall. Segregate the process and limit access to authorised persons only. Use RPE (APF of at least 20) if using water suppression. Use RPE (APF of at least 40) if using LEV unless the risk assessment or monitoring data justifies that a lower level of protection is adequate (ST3: *Cutting and polishing using hand-held rotary tools*).
Comments	Water suppression and on-tool extraction may both be needed (where compatible) when the task and/or location indicate that fixed systems are not appropriate (eg on construction sites). Water suppression systems used on construction sites will need to ensure adequate supply and flow of water to optimise dust suppression. Recirculated water needs a programme of regular checks and maintenance to ensure conditions control the growth of bacteria, including *Legionella*, so that worker exposure is kept low. The frequency of the checks and maintenance should be determined by risk assessment. Risk factors include the temperature of the water (20–45°C), the dirtiness of the water and extent of agitation. Methods of control include changing the water, cleaning the tank or using biocides. The use of hand-held power rotary tools can also create a high potential for hand–arm vibration syndrome (HAVS).

References	Appendix C Appendix D Appendix E COSHH Essentials Guidance Sheet ST3: *Cutting and polishing using hand-held rotary tools* CIS54: *Dust control on cut-off saws used for stone or concrete cutting* COSHH Essentials Guidance Sheet CN3: *Drilling with hand-held rotary power tools* Section 2.11 on bench-top masonry saws in *Guidance for National Labour Inspectors on addressing risks from worker exposure to respirable crystalline silica on construction sites.*

5.3 Pneumatic chiselling

Description	Pneumatic chiselling is used to shape stone. The worker is often very close to the workpiece, in order to work on the fine detail, so has the potential to be exposed to the high levels of dust generated.
Picture	 **Figure 7** Pneumatic chiselling
Key controls	Remove the bulk excess of stone to reduce the amount of chiselling required. Use suitable LEV (eg an extracted booth or appropriately located receiving hood). If the worker is working within an extracted booth, place the work on an open-frame rotating banker and position the worker so as not to obstruct the airflow. Always aim the ejected dust towards the extractor / water wall. Segregate the process and limit access to authorised persons only. Use RPE (APF of at least 40) if using LEV, unless the risk assessment or monitoring data justifies that a lower level of protection is adequate (ST4: *Hand and pneumatic chiselling*).
Comments	Water suppression is unlikely to be used as the slurry can be drawn back towards the tool, making the method impractical. In addition, water suppression can prevent clear vision of the details being created. The use of hand-held pneumatic chiselling can create a high potential for hand–arm vibration syndrome (HAVS).
References	Appendix D Appendix E COSHH Essentials Guidance Sheet ST4: *Hand and pneumatic chiselling*

5.4 Chiselling using hand-held non-power tools

Description	Although non-power tools (eg saw and chisel) typically generate less dust than equivalent power versions, controls are still required.
Picture	 **Figure 8** Hand-held non-power chiselling
Key controls	Use suitable LEV (eg an extracted booth or capturing hood). If the worker is working within an extracted booth, place the work on an open-frame rotating banker and position the worker so as not to obstruct the airflow. If using a capturing hood, ensure it is correctly positioned to effectively capture the dust. Wet the stone and keep it damp during processing, where reasonably practicable. Segregate the process and limit access to authorised persons only. Use RPE.
Comments	If fine-detailed work is being carried out, the mason may need close observation of the work and this may impact on the potential effectiveness of controls. This situation should be addressed in the task risk assessment.
References	Appendix D Appendix E COSHH Essentials Guidance Sheet ST4: *Hand and pneumatic chiselling*

5.5 CNC machining

Description	Computer numerical control (CNC) is the automated control of machining tool centres. These can carry out functions including cutting, grinding and routing. Modern machines are often fully enclosed with the control panel located remotely from the process, both of which help reduce worker exposure. Significant energetic mist can be generated by CNC machines and should be controlled.
Picture	 **Figure 9** CNC machining
Key controls	Automate and enclose the process where reasonably practicable. Provide water suppression with adequate water flow to the tool. Control any mist generated (eg by use of brushes/curtains around the rotary tool). Segregate the process and limit access to authorised persons only. Locate the control panel away from the process. Use RPE (APF of at least 20) when workers have to work near the process where exposure to the mist can occur (for more information see Appendix E).
Comments	Water suppression is usually used. LEV may also be necessary to remove resultant mist. Ensure the doors on any enclosure remain interlocked until the mist has cleared. Recirculated water needs a programme of regular checks and maintenance to ensure conditions control the growth of bacteria, including *Legionella*, so that worker exposure is kept low. The frequency of the checks and maintenance should be determined by risk assessment. Risk factors include the temperature of the water (20–45°C), the dirtiness of the water and extent of agitation, while methods of control include changing the water, cleaning the tank or using biocides.
References	Appendix C Appendix E ST2: *Automated boring and polishing using rotary tools*

5.6 Automated edge polishing

Description	Polishing is an abrasive process used to remove grinding lines and produce smooth stone surfaces.
Picture	  *Feeding stone into the machine* *Water jets for dust suppression* **Figure 10** Automated edge polishing machine
Key controls	Automate and enclose the process where reasonably practicable. Provide water suppression with adequate water flow to the tool. Control any mist generated. Segregate the process and limit access to authorised persons only. Use RPE (APF of at least 20) when workers have to work near the machine where exposure to the mist can occur.
Comments	Recirculated water needs a programme of regular checks and maintenance to ensure conditions control the growth of bacteria, including *Legionella*, so that worker exposure is kept low. The frequency of the checks and maintenance should be determined by risk assessment. Risk factors include the temperature of the water (20–45°C), the dirtiness of the water and extent of agitation, while methods of control include changing the water, cleaning the tank or using biocides.
References	Appendix C Appendix E

5.7 Surface finishing / blasting

Description	Stone surface finishing can be done by abrasive blasting. This technique may be used to remove surface finishes, roughen surfaces to give a weathered look or engrave inscriptions using stencils. It can generate large amounts of dust which will be a mixture of that from the blasting material and the stone surface being removed.
Picture	 *Automated blasting cabinet*   *Blasting cabinet for small-scale manual tasks* **Figure 11** Abrasive blasting cabinets
Key controls	Do not use blasting material that contains crystalline silica. Automate and enclose the process where reasonably practicable. If blasting structures on temporary sites (eg construction-related work), enclosures may be required. Use suitable LEV to control the dust. Segregate the process and limit access to authorised persons only. Use RPE (APF of at least 40) if manually blasting stone or entering an area where blasting is in operation. Clean the system using wet methods or dust class M or H vacuums and suitable RPE (with APF of at least 20).

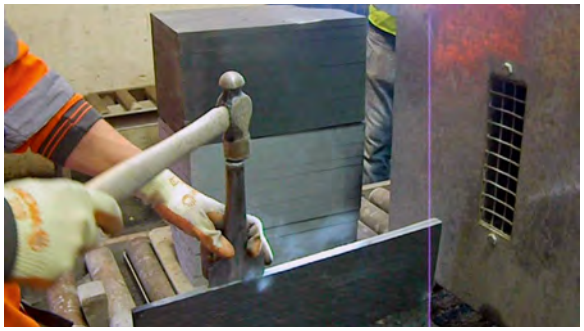
Comments	Sand containing free silica is prohibited for blasting articles. Alternative silica-free materials are widely available and should be used instead. There is no definition of 'silica-free' in COSHH, but a pragmatic limit was defined and if there is more than 1% free silica present the material is deemed to contain silica. Surface roughening can also be done by alternative techniques such as bush hammering, stone flaming and tumbling. The emissions should be controlled at source. Bush hammering involves the repeated impact of a grid of points onto a stone surface to create a pockmarked texture. In stone flaming a propane torch rapidly heats the stone surface causing it to expand and flake, exposing rough stone. Stone tumbling can remove smooth edges or polish rough stone. Where reasonably practicable, it should be enclosed to prevent the release of dust and reduce worker exposure to noise. LEV and/or water suppression can be used to help control the dust. For manual blasting activities, RPE with a constant flow airline breathing apparatus with hood/helmet should be used as it covers the wearer's head, neck and shoulder and provides protection from rebounding abrasive material.
References	Appendix D Appendix E CN7: Abrasive blasting WL18: Surface preparation: pressure blasting (small items)[34]* WL19: Surface preparation: pressure blasting (medium-sized items)[35]* WL20: Surface preparation: pressure blasting (large items)[36]* FD9: Shot-blasting castings.[37]

* COSHH Essentials Guidance Sheets WL18–20 were developed for blasting metals, but the control measures within them may be acceptable for stone blasting if allowance is made for the increased dust generated from stone, compared to metal blasting.

5.8 Water jet cutting

Description	Stone can be cut using a jet of water (sometimes containing an abrasive) at high pressure to achieve a narrow, precise and well-controlled cut. Mist is generated, which may contain RCS.
Picture	  **Figure 12** Water jet cutting
Key controls	Water is used as the primary cutting function and can help suppress dust generation. The water used for cutting needs to be clean so accumulations (eg of silica) do not block the tool Control the mist generated (eg appropriate LEV may be necessary to extract the mist). Segregate the process and limit access to authorised persons only. Place the control panel away from the process. Use RPE (APF of at least 20) when workers have to work near the process where exposure to the mist can occur.
Comments	If LEV is required to extract mist, the filtration system selected must be appropriate for wet contaminants. Recirculated water needs a programme of regular checks and maintenance to ensure conditions control the growth of bacteria, including *Legionella*, so that worker exposure is kept low. The frequency of the checks and maintenance should be determined by risk assessment. Risk factors include the temperature of the water (20–45°C), the dirtiness of the water and extent of agitation, while methods of control include changing the water, cleaning the tank or using biocides.
References	Appendix E

5.9 Slate processing

Description	Slate processing can vary from other stone processes as the layered structure of slate enables it to be sawed, split and dressed (edge bevelled) using different tooling and force. The amount of dust generated is likely to be higher for sawing and dressing operations than for manual splitting.
Picture	  **Figure 13** Manual slate splitting and dressing
Key controls	For sawing use an automated saw with enclosure and suitable LEV as far as reasonably practicable (ST5: *Sawing slate*). Automated sawing may also be carried out using bridge saws with water suppression (ST1: *Primary and secondary sawing*). For splitting use suitable LEV (eg a capturing hood correctly selected and positioned) as far as reasonably practicable. For dressing use an automated system with suitable LEV as far as reasonably practicable. Wet the slates and keep them damp during processing. Segregate the process and limit access to authorised persons only. Use RPE (APF of at least 20) for slate splitting and dressing (ST7: *Dressing slate (edge bevelling)*).
Comments	If using LEV and local air displacement, ensure that the airflow from the latter does not adversely affect the effectiveness of the former. The stacking of slates can also create fine dust that should be controlled.
References	Appendix D Appendix E COSHH Essentials Guidance Sheet ST1: *Primary and secondary sawing.* COSHH Essentials Guidance Sheet ST5: *Sawing slate* COSHH Essentials Guidance Sheet ST6: *Manual slate splitting* COSHH Essentials Guidance Sheet ST7: *Dressing slate (edge bevelling).*

6 CLEANING AND HOUSEKEEPING

6.1 Personal decontamination

61 Stone dust should be adequately controlled at source so that work clothing does not become heavily contaminated. Heavily contaminated work clothing should be cleaned before removal to minimise dust resuspension during removal. The cleaning should be done by dustless methods including the use of a dust class M or H vacuum or wiping down with a moist cloth.

62 Work clothing should be gently removed, and further cleaned as necessary (eg by wiping down or placing it in a receptacle for sending to the contract laundry) or disposed of safely. It should not be taken home for laundering as it is likely to be contaminated with dust containing RCS.

63 Hands should be washed before eating, drinking, smoking, and after work to prevent transfer of dust. They should be washed using warm water, mild cleansers (avoid abrasive cleaners) and dried on soft paper or fabric towels. The use of pre-work skin creams helps make it easier to wash dirt off the skin, while after-work creams help replenish skin oils.

6.2 Site cleaning

64 It is important to keep the site clean as stone dust on surfaces can be disturbed and become airborne again, leading to increased inhalation exposure.

65 A schedule for cleaning down equipment and surfaces around the site, with allocated responsibilities, is necessary to ensure regular cleaning occurs. The frequency of cleaning will depend on the level of dust from the process, but typical regimes are daily for work equipment and the work area, and at least weekly for the remaining equipment and areas. The employer needs to ensure the cleaning process is monitored to check that it is carried out effectively.

66 Hard surfaces should be cleaned using wet methods or vacuuming for dry dust. Dry brushing and compressed airlines (even at low pressure) should be avoided as they resuspend dust from surfaces. If compressed air is the only option for cleaning inside machinery, then any airborne dust generated from its use must be adequately controlled.

67 Water hoses and wet sweeping are more practical in areas where water suppression is used, rather than vacuums which tend to block with slurry. Care should be taken whenever wet cleaning is being carried out near electrical equipment.

68 Vacuum systems used to clean up dust should be of dust class M or H. Figure 14 shows labels for dust class M and H. These vacuum systems are designed to give a high filtration efficiency and meet a specific operational standard (ie BS EN 60335-2-69[38]). They should be regularly checked and properly maintained.

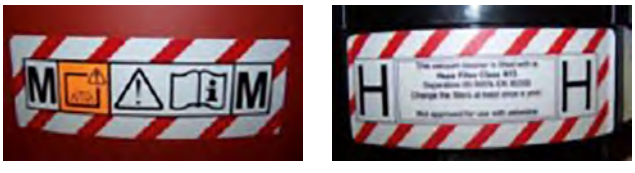


Figure 14 Labelling on dust class M and H vacuum systems

69 Suction hoses may be added to central (often multi-branched) extraction systems and used to remove dust, provided the extraction system has sufficient capacity and pressure to remain effective.

7 WORKPLACE EXPOSURE MONITORING

70 Exposure monitoring means using suitable techniques to assess the extent of employees' exposure to substances hazardous to health, via all routes (inhalation, ingestion and/or skin). Information gathered from exposure monitoring can help an employer to assess whether control is effective, but should not be used as an alternative to controlling exposure.

71 The COSHH Approved Code of Practice (Control of Substances Hazardous to Health Regulations 2002 as amended) says that exposure monitoring is necessary if:

- the risk assessment shows that an initial exploratory monitoring exercise is necessary to reach an informed and valid judgement about the risks;
- failure or deterioration of the control measures (eg a lack of containment, or LEV not performing as intended) could result in a serious health effect;
- measurement is required to be sure that a WEL or any self-imposed (in-house) exposure standard is not exceeded;
- any change in the conditions affecting employees' exposure means that adequate control of exposure is no longer being maintained;
- it is needed as an additional check on the effectiveness of any control measure provided.

72 Where the employer can demonstrate worker exposure has been prevented, or adequately controlled (COSHH Regulation 7) by another method of evaluation, exposure monitoring will not be necessary.

73 Exposure monitoring for airborne RCS is usually based on personal air sampling to collect respirable dust. The sampler is normally positioned on the worker's lapel, so it is within their breathing zone. Laboratory analysis is used to determine the crystalline silica content in the dust collected. Personal exposure data, expressed as an 8-hour time-weighted average, can be compared to the WEL.

74 Details for the sampling and analysis of RCS are available in *Crystalline silica in respirable airborne dust*[39] and *Workplace air – Guidance for the measurement of respirable crystalline silica.*[40]

75 Static (or area) monitoring, using the same sampling and analytical methods, can also be useful. They can help identify the main sources of dust emission and can be used to monitor trends in airborne RCS levels in the workplace. They should not be compared to the WEL.

76 Real-time devices are also available and can be used to get 'instantaneous' measurements of dust in the air. They do not detect RCS specifically and need to be calibrated if quantitation of dust is required. However, they may provide useful information; for example, identifying sources of high dust exposure, aiding the implementation of effective engineering controls to minimise dust exposure, and forming part of active control systems that are triggered if dust levels rise above pre-determined limits. The indicative nature of these devices means that they are not suitable for determining whether personal exposures are below the WEL.

77 When exposure monitoring is carried out, the results, and any recommendations made by those conducting the monitoring, should be acted upon. If monitoring data illustrates inadequate control, then improvements in control measures must be implemented to ensure that any risk is adequately controlled.

78 In summary, exposure monitoring can provide:

- an informed and valid judgement of the risk;
- confirmation that worker exposures do not exceed the WEL;
- demonstration of the effectiveness of the critical control measures.

8 HEALTH SURVEILLANCE

79 Health surveillance is required under COSHH Regulation 11 where there is a risk of workers developing ill health from exposure to stone dust.

80 Health surveillance is used to identify cases of silicosis and COPD in workers exposed to RCS, and to enable early detection of breathing problems or lung damage. Detecting breathing problems or lung damage early could indicate that improved protection is necessary to prevent or reduce a worker's exposure to stone dust.

81 Health surveillance involves periodic and suitable health checks, performed and interpreted by a competent person. It is important in monitoring the effectiveness of your controls and deciding whether the risk assessment should be reviewed; however, it is not a substitute for controlling risk at source.

82 Where workers are exposed to silica dust or undertake wet work, health surveillance should also include regular reviews of the skin.

83 Health surveillance should be undertaken and interpreted by a suitably qualified occupational health professional. Employers should follow their advice regarding the health surveillance that may be required.

84 Before starting a programme of health surveillance, workers should be informed why it is being performed, what it consists of, what results will be shared with the employer and what will happen if any abnormalities are identified. Its introduction should also be discussed with safety or union representatives.

85 The results of health surveillance and any implications should be explained to the individual employee by a suitably qualified occupational health professional. The outcome in terms of fitness for work will be given to the employer and will require them to take any appropriate action. There should be clear procedures in place for the management of any affected workers.

86 Where health surveillance shows that an employee's health is being adversely affected (either a new case or worsening of an existing condition) the employer should:

- review the risk assessment and, if necessary, modify control measures;
- check the health of employees doing similar work;
- prevent further exposure to RCS (eg through alternative duties with no or reduced risk of exposure), taking into account advice received from an occupational health professional;
- perform further health surveillance of the worker as advised by the occupational health professional.

87 Further guidance is available in COSHH Essentials Guidance Sheet G404: *Health surveillance for those exposed to respirable crystalline silica (RCS).*[41]

9 INFORMATION, INSTRUCTION AND TRAINING

88 Employers have a duty under COSHH Regulation 12 to provide suitable and sufficient information, instruction and training to employees working with hazardous substances. For those in stone working, this should include:

- details of any substances hazardous to health, including process-generated RCS, to which they are liable to be exposed, and the risks that these substances may present to their health. This should include the relevant WEL or similar occupational exposure limit;
- any relevant information on the composition of the stone, including the crystalline silica content, from your supplier;
- the significant findings of the risk assessment;
- the appropriate control measures to be taken by the employee in order to safeguard themselves and other employees at the workplace, including water suppression, LEV, other engineering controls, work procedures, and use of RPE and PPE. This should include how to use and maintain any controls correctly, as well as how to identify and report any problems with them;
- the results of any exposure monitoring, and if the WEL has been exceeded, the relevant employee should be informed;
- understanding the health risks of working with RCS, how symptoms might present and what to do if this happens;
- the collective results of health surveillance such that no individual can be identified.

89 Information to help with toolbox talks is available from many sources including HSE (eg leaflet INDG463: *Control of exposure to silica dust. A guide for employees*[42]), the IOSH website (eg factsheet, pocket card and poster) and Construction Dust Partnership resources.[43]

APPENDIX A: OTHER HEALTH RISKS FROM STONE WORKING

Excluding the risks to health arising from the inhalation of stone dust, which is covered in this guidance, there are other risks to health associated with stone working as outlined below.

Dermatitis

Stone dust containing silica is abrasive and drying, and can cause damage to skin including the area around your eyes. When in contact with skin it can cause irritant contact dermatitis. Information on dermatitis is available at https://www.hse.gov.uk/skin/employ/dermatitis.htm

Noise

Work with machinery and power hand tools can expose workers to a high level of noise, resulting in the possibility of hearing damage. Information on the noise risk is available in the stoneworkers' health and safety topics: vibration and noise, at https://www.hse.gov.uk/stonemasonry/vibration-noise.htm.

Vibration

Work with power hand tools can expose workers to a high level of hand–arm vibration. Vibration from stone chisels/hammers is also of concern, resulting in conditions such as hand–arm vibration syndrome (HAVS). Information on the vibration risk is available at https://www.hse.gov.uk/stonemasonry/vibration-noise.htm

Manual handling

The manual handling and storage of large stone slabs can create a high risk of musculoskeletal disorders unless carried out appropriately. Information about handling, and more specific information on identifying high-risk manual handling activities and on using lifting equipment, are available at https://www.hse.gov.uk/stonemasonry/handling-storage-slabs.htm.

APPENDIX B: TYPES OF SILICOSIS

Silicosis is a lung disease caused by inhaling RCS. It results in a hardening or scarring (fibrosis) of the lung tissue with loss of lung function. It usually develops after at least 10 years of exposure to the RCS, with there being no symptoms initially and the changes in the lungs only being found on X-ray. The disease can continue to get worse even after exposure has stopped. Severe shortness of breath may eventually develop, making it difficult to walk even short distances.

Higher levels of RCS exposure, typically associated with poor controls, can result in a more rapid onset of silicosis. The acute form of silicosis can occur within a few weeks or months of heavy RCS exposure and is life-threatening.

APPENDIX C: USE OF WATER SUPPRESSION

General aspects

RCS exposure can be controlled by the use of water suppression, where compatible with the stone working process. Consideration must be given to the safety aspects if any electrical equipment is to be used, and how the water/slurry is managed.

Water suppression will generate small water droplets / mist that may contain RCS particles. These droplets may be inhaled, and if they are small enough, they could transfer RCS deep into the lungs. If they are larger, they would have a greater tendency to be deposited on surfaces where they may dry out, creating dust that could become resuspended into the air. Even with the use of water suppression or extraction, suitable RPE with an assigned protection factor (APF) of at least 20 will be needed.

Using a suitable water suppression system, applied at the point of dust generation, can reduce worker exposure by around 70–95%. This reduction is similar to that for LEV, but water suppression is less dependent on individual work practices, and copes better with large-scale processes and/or ones that generate a lot of energetic dust.

During sawing, water is usually supplied to the blades to aid cutting and to help protect the blade by keeping it cool. The manufacturers specify the pressure and flow for the blade and task, and the water supplied will normally be adequate to suppress the dust generated. LEV systems may be unnecessary, and could become blocked quickly in the presence of water. RPE is likely to be needed when workers have to work near the process where exposure to mist can occur. As mist could cause caking on the filter, increase breathing resistance and increase face seal leakage, advice on appropriate RPE should be sought from the RPE manufacturer.

The reliability of the water supply, and the direction and flow rate of the water onto the stone being processed, will affect the efficiency of dust suppression. If the residual dust exposure is still high (due to high dust generation and/or low efficiency of the water suppression) then additional controls may also be required; for example, LEV and RPE.

Water used for dust suppression is often recirculated. It will become contaminated with the stone dust and may need to be filtered before reuse. Figure 15 shows a waste water system. Silica particles / grit in recirculated water could damage the blade in bridge saws, but may assist in the polishing of stone.

Figure 15 Waste water/slurry management system

An appropriate procedure to manage the quality of the water is required to:

- ensure that risk of microbial growth, including *Legionella* (https://www.hse.gov.uk/legionnaires/other-risk-systems.htm), is adequately controlled. The risk from *Legionella* is likely to be low for mains water that does not become stagnant, remains below 20°C, and does not contain organic nutrients;
- include the cleaning of filters, and removal of sediment from gullies and sedimentation tanks. If the tanks are in a confined space, then compliance with the Confined Spaces Regulations (https://www.hse.gov.uk/pUbns/priced/l101.pdf) will be required. Dust contamination on PPE used by workers entering the tanks is likely to be high, and as it dries, may become a major source of exposure.

Types of water suppression systems

Pre-soaking stone in water fully wets the surface and helps reduce RCS levels as the surface of the stone is worked, but becomes ineffective once processing reaches the dry material inside the stone. Pre-soaking is not as effective as water suppression where there is a continuous flow of water over the stone. Workers may need to be provided with suitable PPE for a wet working environment.

Water jetting / deluging is used to control dust in large-scale and/or automated stone processing activities. A high volume of water is delivered via a nozzle that should be directed at the source of dust generation. Any electrical controls must be located outside the wet area. Usually a mist is produced that should be controlled. It is recommended that where water impacts on surfaces, these are coated/lined to reduce the generation of mists; for example, with artificial grass or similar. A large amount of waste water (slurry) is produced. Water jetting is typically used for:

- primary and secondary sawing (bridge saws) as the main control, but this should be supplemented with segregation. RPE should be used if the worker is inside the wet area during sawing. The mist can be controlled by using a combination of screens, baffles and wall coatings;
- CNC-controlled boring and polishing of stone. The mist can be controlled by enclosing the process and/or placing brushes/curtains around the rotary tool.

On-tool water suppression is typically used on portable tools (eg on construction sites) and requires a water supply of adequate volume and flow rate to be linked into the tool operation. This is potentially a good solution for tools when fixed systems for extraction or water deluging are inappropriate, and large-scale water management is not a problem. It is usually compatible with petrol-driven or pneumatic tools, but not electric tools unless they have been designed to be compatible with water. It may be unsuitable if the tool is percussive (eg pneumatic chiselling) as slurry could be drawn into the tool. Segregation of the task may be necessary to limit the spread of mist by wind or draughts and to contain the slurry. It is typically used for:

- portable tools on construction sites;
- cut-off saws when used for stone or concrete cutting.

Manual water suppression may be viable if a water supply cannot be linked into the tool operation. Water could be pumped from a stand-alone tank onto the work piece or discharged from a bowser onto dusty floors during cleaning. The water supply must be adequate for the duration of the processing task – just damping stone at the start is not adequate to suppress the dust.

Misting is the dispersion of a fine spray of water, usually from misters, intended to knock down dust particles in the air and reduce the background level of dust. However, it is unlikely to provide adequate control of the larger amounts of dust present at the point of generation during stone processing. The mist generated from water suppression of stone dust can contain RCS and may be inhaled in a similar manner to free, dry dust particles.

APPENDIX D: USE OF AN EXTRACTION (LEV) SYSTEM

General aspects

Dust generated during stone working activities can be extracted at the point of generation by using LEV. Where the work involves the use of power tools, some dust is likely to escape into the general work area unless the processes are enclosed. General information on LEV is available on the HSE website (https://www.hse.gov.uk/lev/) and in HSE guidance on controlling airborne contaminants at work (https://www.hse.gov.uk/pubns/priced/hsg258.pdf).

The effectiveness of any LEV system will depend upon the task, tool type and size of work piece, as well as the appropriateness of the design of the system (particularly the choice, size and position of the hood and the vacuum extraction source flow rate and pressure). A standard capturing hood may not be effective for large amounts of high-energy dust.

Discharge extracted air to a safe place outside the building away from doors, windows and air vents. Do not use a recirculating LEV system unless the air is thoroughly cleaned before its return to the workplace.

For all types of extraction, routine daily/weekly checks should be in place. This is in addition to a planned maintenance regime and statutory thorough examination and test (TExT) (https://www.hse.gov.uk/pubns/indg408.pdf).

A suitable LEV system, correctly used and adequately maintained and tested, can reduce stone dust exposures by around 70–95%. Many systems have been poorly designed so much lower efficiencies are common. If the residual dust exposure is still high, due to high dust generation (especially by power tools), and/or a low extraction efficiency, then additional controls may also be required; for example, enclosure, water suppression and RPE.

General ventilation can provide clean air into the work area and may be an effective way to help reduce the general build-up of dust over the working day, providing any airflow does not adversely affect the effectiveness of the extraction systems in place.

Types of extraction system

Full or partial booths can be used when stone working with power rotary hand tools:

- the energetic dusty air should be directed towards, and extracted by, the booth, which should be fitted with suitable filtration media;
- working practices are important – stone pieces should be on rotating bankers and workers should be trained to work in the correct position so as not to hinder the airflow into the extraction system;
- temporary booths should be considered for construction or heritage sites where a fixed booth is not feasible.

Down-draught bench/table can be used for stone working with manual tools:

- the energy of the dust must not be so great that it travels off the table before it is extracted downwards, so this type of extraction is not suitable if power tools are used;
- the surface of the table should be kept clear of tools, rags etc which will impair the efficiency of the extraction;
- the efficiency of down-draught benches can be improved if side panels are used, and these can be very effective if the benches are positioned within an extracted enclosure;
- consider segregating down-draught benches from other workstations to reduce the spread of dust.

On-tool extraction is a system in which the capturing hood is integrated into, or attached to, the tool:

- It is used when fixed systems for extraction are unsuitable (eg a stone piece is too large and you need to move around it, or on a temporary construction site) and water suppression is inappropriate (eg a slurry stain on the surface of sandstone).
- It is more effective than capturing hoods where straight lines or flat surfaces are being worked.
- All parts of the system must be compatible to ensure adequate control; see CIS69: *Controlling construction dust with on-tool extraction* (https://www.hse.gov.uk/pubns/cis69.pdf).
- On some tooling the guard may act as the dust-collecting hood. The guard must be designed so that the on-tool extraction can work effectively.
- If a portable extraction unit is used it must be an industrial vacuum of dust class M or higher.
- It may obscure direct sight of the cut so sometimes working methods will need to be adapted.
- Effectiveness may be reduced where there are curves, bends or uneven surfaces being worked or where work is at the edge of the stone.
- Although on-tool extraction can reduce RCS exposure by over 90% (https://www.hse.gov.uk/research/rrpdf/rr926.pdf), there is still a need for a high standard of RPE to be used in conjunction with it.

A capturing hood is suitable for use with manual hand tools, but not usually power tools:

- It is impractical for large workpieces, including worktops where the stone is worked across its full size.
- As power tools produce higher-energy dust releases, they can often overcome a capturing hood.
- The worker needs to be able to easily adjust the position of the hood so it is always close to the point of dust generation.
- The worker should be aware of the effective capture distance of the hood.
- A rotating banker should be used.
- Where capturing hoods are used, dampening the work piece is recommended.

A water-backed booth is a system in which a water wall is used to remove larger particles, and then a water spray system and multi-surface pathway are used to remove the finer particles from contaminated air:

- The addition of side walls and a roof to the water wall will create a partial booth (the water-backed booth) and improve capture of the dust.
- Dust should be directed towards the water wall from within the booth (eg from cutting stone). The larger particles hitting the moving water will be removed and carried down into a trough, creating a slurry.
- The water flow down the wall should be continual to effectively capture the dust.

- A procedure will be required to manage the removal of the slurry and maintain the quality of the water (see Appendix B), especially if it is being recirculated.
- The smaller particles in the contaminated air are drawn under the wall and subjected to a mixture of water sprays used to knock them down and multi-surfaces (baffles/honeycomb) to remove them by impaction (also known as a convoluted pathway).
- Research has suggested that the removal efficiency for small, respirable particles may be low, although manufacturers' data indicate high removal efficiencies, and it is based on the mass removed rather than the number of particles removed. Exhaust air should be discharged externally. Where this is not reasonably practicable, the air that is to be recirculated must be thoroughly cleaned.

APPENDIX E: USE OF PERSONAL PROTECTIVE EQUIPMENT – ESPECIALLY RESPIRATORY PROTECTIVE EQUIPMENT

Dust generated during stone working activities should be controlled according to the hierarchy of control given in the COSHH Approved Code of Practice (https://www.hse.gov.uk/pubns/books/l5.htm). The use of personal protective equipment (PPE), including respiratory protective equipment (RPE), is considered to be a last resort as its effectiveness is dependent on the correct selection, use and maintenance, and only protects the worker wearing it. General information on RPE is available on the HSE website (https://www.hse.gov.uk/respiratory-protective-equipment/index.htm) and in HSG53 *Respiratory protective equipment at work. A practical guide* (https://www.hse.gov.uk/pubns/books/hsg53.htm).

For many activities, especially those involving hand-held power tools and/or stone containing higher levels of crystalline silica (typically 30% or above), a residual risk from RCS exposure may remain despite the use of engineering controls. In these situations, in addition to engineering controls such as water suppression or LEV and organisational controls (work procedures), RPE and PPE are likely to be required.

RPE should be selected to be both of the following:

- **adequate** for the hazard and reduces exposure to airborne stone dust, RCS and any other hazards present to the level required to protect the wearer's health;
- **suitable** for the wearer, task and environment, such that the wearer can work freely and without additional risks due to the RPE.

Assigned protection factor

For stone-working activities **using water suppression** an APF of 20 is normally adequate (eg a FFP3 disposable respirator). Figure 16 shows some examples of RPE with an APF of 20 or more.

For operators **using power hand tools** with extraction an APF of at least 40 is recommended unless the task is short and exposure data shows that a lower level of protection is adequate. Powered masks and hoods or constant flow airline breathing apparatus may be suitable.

For **abrasive blasting** that is not fully enclosed, constant flow airline breathing apparatus is likely to be needed.

For **maintenance and cleaning** (by dust-free methods such as wet cleaning and vacuum cleaning; dry sweeping should be avoided) RPE with an APF of 20 should be worn.

Tight-fitting RPE

When a tight-fitting respirator is selected, there is a need to ensure that the seal to the face is complete. The presence of facial hair and/or interference by other PPE (eg spectacle arms) in the area of the face seal will prevent a tight-fitting respirator being suitable.

Workers should be face-fit tested for any tight-fitting respirator. Further information is

Disposable face filtering piece (FFP3) APF of 20

Reusable half-mask respirator with P3 filters (APF of 20)

Powered full face mask respirator with P3 filter (APF of 40)

Constant flow airline with hood (APF of 40)

Figure 16 Examples of RPE for use during stone processing operations

available on fit testing for RPE facepieces/masks (https://www.hse.gov.uk/pubns/indg479.pdf) and fit testers can be found via the Fit2Fit website (https://fit2fit.org).

The continuous wear time for tight-fitting (unpowered) RPE is recommended to be no longer than one hour, after which the wearer should take a break. Otherwise, the RPE can become uncomfortable to wear, and may lead to the loosening or removal of the mask in the work area.

Where RPE is required to be worn continuously for long periods, the use of a powered mask (respirator), hood or helmet, or breathing apparatus may be considered.

Use and maintenance

Workers should be trained in how to perform pre-use checks, put on the respirator correctly, conduct a fit check and identify when filters (if appropriate) should be changed, or when the respirator needs to be replaced.

Maintenance should be carried out by a properly trained and competent person. It is required for all except disposable RPE.

For RPE used regularly, thorough maintenance, examination and tests should be carried out at least monthly, in accordance with manufacturers' instructions. Records must be kept of testing undertaken and any repairs made.

As stone dust containing RCS dust is abrasive, maintenance may need to be carried out more frequently than once a month.

If RPE is only used occasionally, an examination and test should be carried out before use, and in any case the interval should not exceed three months.

Disposable RPE should be replaced regularly, either at the end of a shift for single-use RPE, when it becomes harder to breathe through, or when the RPE shows signs of damage.

Filters have only a limited capacity or can become clogged, making breathing difficult. Replaceable filters should be changed when necessary to make sure the RPE device can remain effective.

To prevent contamination, damage and deterioration, RPE should be stored in accordance with the manufacturer's instructions. The storage provided should be easily accessible so that RPE can be safely stored during breaks; RPE must not be left on benches.

RPE should be maintained properly and cleaned before being stored to prevent the storage area becoming contaminated.

Further information can be found in HSG53 *Respiratory protective equipment at work.*

A practical guide
(https://www.hse.gov.uk/pubns/priced/hsg53.pdf).

Coveralls may be required depending upon the outcome of the risk assessment for the task to be undertaken:

- As RCS dust is abrasive and hazardous, its spread should be minimised (ie transfer between work and home on workers' own clothing should be prevented).
- Coveralls provided should be made of suitable synthetic materials (rather than cotton) so they do not retain RCS dust.
- If exposure to water or mist occurs, coveralls should also provide water protection.
- Coveralls should be washed at a contract laundry, or equivalent, and the laundry should be informed that the dust contains crystalline silica.

Other PPE may also be required:

- Gloves suitable for the task (eg for wet working and contact with abrasive crystalline silica). Reputable glove manufacturers/suppliers should be able to recommend suitable gloves based on your specific requirements. There is a template to help in HSG 262 *Managing risks from skin exposure at work* (www.hse.gov.uk/pubns/books/hsg262.htm).
- Safety eyewear to prevent airborne dust getting into a worker's eyes. This must be compatible with any tight-fitting RPE that needs to be worn, and should be worn during the fit test.
- Safety footwear suitable for the working area, considering that the floor may become wet from water suppression or wet cleaning.
- Hearing protection (eg muffs or plugs) may be required in certain situations (eg when using hand-held power tools). It must provide adequate hearing protection and be compatible with any other PPE such as tight-fitting RPE.

APPENDIX F: GLOSSARY OF TERMS

Term/abbreviation	Description/definition
accumulation	The acquisition or gradual gathering of something.
AIOH	Australian Institute of Occupational Hygiene.
APF	An assigned protection factor (APF) is used to categorise the type and class of RPE. The APF is a number rating that indicates how much protection that RPE is capable of providing if it is correctly selected, used and maintained.
Asbestiform	A mineral that grows in a fibrous aggregate of thin crystals. The fibres are flexible, long and of high tensile strength, and have the appearance of asbestos.
BOHS	British Occupational Hygiene Society.
CIS	Construction Information Sheet produced by HSE.
CNC	Computer numerical control (CNC) is a method for automating control of machine tools through the use of software embedded in a microcomputer attached to the tool.
COPD	Chronic obstructive pulmonary disease (COPD) is the name for a group of lung conditions that cause breathing difficulties, including emphysema (damage to the air sacs in the lungs) and chronic bronchitis (long-term inflammation of the airways).
COSHH	Control of Substances Hazardous to Health (COSHH) is UK legislation on assessing, controlling and monitoring worker exposure to hazardous substances.
COSHH Essentials	COSHH Essentials are a series of guidance sheets for specific hazardous tasks that outline the key control measures necessary to achieve good control practice. They include the ST series for some hazardous stone working tasks.
Dust class	A British standard defines the dust classes for industrial vacuum cleaners as L (low), M (medium) and H (high). The higher dust class vacuums have additional features that make them suitable for more toxic substances.
IOSH	Institute of Occupational Safety and Health.
Legionella	*Legionella* is a type of bacteria that occurs naturally at low levels in water. If water is stored and/or recirculated, it may reach a temperature between 20–45°C and contain deposits which can support bacteria growth. Exposure to mist containing high levels of *Legionella* can lead to Legionnaires' disease.

LEV	Local exhaust ventilation (LEV); also called extraction. These systems consist of a hood (to capture dust/fume/mist), ducting, an air cleaner (to filter out the contaminant) and a fan (to pull air through the system). See HSG258 for more detailed information.
NEPSI	The European Network on Silica (NEPSI) has produced good-practice guidance sheets for a number of tasks involving the processing of natural stone.
PPE	Personal protective equipment (PPE) is equipment that will protect the user against health and/or safety risks at work. It can include items such as safety helmets, gloves, eye protection, high-visibility clothing, safety footwear and safety harnesses. It also includes respiratory protective equipment (RPE).
RCS	Respirable crystalline silica (RCS) is the fraction of crystalline silica particles that are less than 10 µm in diameter (with a mass median diameter of 4 µm) that can get deep in the alveoli of the lung and cause silicosis and other lung diseases.
RPE	Respiratory protective equipment (RPE) is a particular type of PPE designed to protect the wearer from breathing in harmful substances. RPE includes tight-fitting facepieces, often referred to as respirators or masks, and loose-fitting facepieces (ie hoods, helmets, visors, blouses and suits), as well as powered and/or constant flow airline breathing apparatus.
Silicosis	Silicosis is a type of fibrosis (ie scarring of the lungs). It is caused by the inhalation of RCS which affects the lungs by damaging the lining of the lung air sacs and leads to scarring.
SLIC	The European Senior Labour Inspectorate Committee (SLIC) includes representatives from regulating bodies in different member states.
TExT	A thorough examination and test is a detailed and systematic examination sufficient to make sure that the LEV can continue to perform as intended by design and will contribute to the adequate control of exposure. The thorough examination would normally include functional testing to provide sufficient evidence to indicate adequate control is being achieved.
TWA	Time-weighted average (TWA) is a way of averaging exposure data over a period of time to get an average value.
Water suppression	Use of a deluge of water at the point of dust generation to wet the dust and prevent it from becoming airborne. A mist is usually created, but this appears to be less hazardous than the dust.
WEL	Workplace exposure limit (WEL) is the airborne concentration of a hazardous substance, expressed as an 8-hour TWA. Worker exposure should not exceed this.

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- Quarry Partnership team https://www.safequarry.com/Qpt.aspx
- Worktop Fabricators Federation (WFF) https://www.worktopfabricators.org/

Controlling exposure to stone dust

The aim of this guidance is to help both employers and employees understand the health risks associated with exposure to stone dust, especially dust containing respirable crystalline silica (RCS). This guidance will help to identify the processes and control measures to adopt within the workplace to ensure adequate control of stone dust, protection of workers' health, and compliance with the Control of Substances Hazardous to Health Regulations 2002 (as amended) (COSHH).

This guidance may also be helpful for others associated with the stone working industry (eg other employees, safety representatives, machinery suppliers, and health and safety consultants).

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