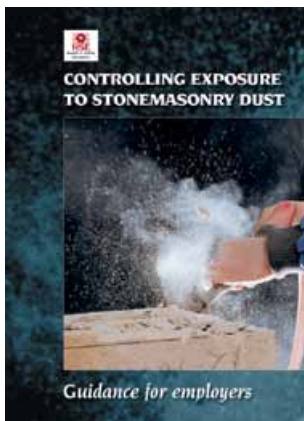


Controlling exposure to stonemasonry dust

Guidance for employers



This is a free-to-download, web-friendly version of HSG201 (First edition, published 2001). This version has been adapted for online use from HSE's current printed version.

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ISBN 978 0 7176 1760 9

Price £10.95

This guidance book is aimed at employers of stonemasons, managers in stoneworking businesses, suppliers of stone, stone dust control equipment manufacturers and stone tool manufacturers and suppliers. The guidance describes the risks stonemasons face from stone dust, how to assess and control exposure and how to maintain these controls.

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First published 2001

ISBN 978 0 7176 1760 9

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Introduction

1 Stonemasons can suffer ill health and disease caused by the stone dust that they breathe in. This book describes these health risks and how dust exposure occurs. It also gives guidance on how it can be assessed and how stone dust exposure can be controlled. If the approaches described in this book are followed the stone dust exposure of stonemasons will be reduced and many should live healthier and longer lives.

2 The guidance in this book is relevant to various groups exposed to stone dust including stone workers, monumental masons, building restoration masons and sculptors. Other publications are available for construction and quarry workers.^{1,2} See the box on the right for information about self-employed workers.

3 The book is aimed at employers of stonemasons, managers in stoneworking businesses, suppliers of stone, stone tool manufacturers and suppliers, and stone dust control equipment manufacturers. All have responsibilities in the control of stone dust exposure. If you are a self-employed person the information will also be of use.

If people working under the control and direction of others are treated as self-employed for tax and national insurance purposes, they may never-the-less be treated as their employees for health and safety purposes. It may therefore be necessary to take appropriate action to protect them.

If such workers are employed on the basis that they are responsible for their own health and safety, legal advice should be sought before doing so.

Aim of this book

4 If stonemasons get lung diseases and damage from inhaling too much stone dust, and they do, then the solution is to reduce the amount of dust they inhale. But this simple common sense statement begs a number of questions:

- Is the type of dust important?
- How much dust is too much dust?
- What controls will reduce the stonemason's exposure enough?
- How do I know whether the controls are working?
- How do I keep the controls working?

The overall aim of this book is to answer these questions in as logical, practical and clear a way as possible.

Structure of this book and how to use it

5 This book describes the risks stonemasons face from airborne stone dust, how exposure can be assessed and controlled, and how these controls can be maintained. Worked examples are included. The book is divided into six chapters:

- 1 Stonemasons – stone dust and health;
- 2 Stone dust – the law, exposure limits and the four steps to successful dust control;
- 3 How to assess stone dust exposure;
- 4 How to control stone dust exposure;
- 5 How to keep control of stone dust exposure;
- 6 Occupational health surveillance.

6 At the end of each chapter there are simple checklists which you can use to test your understanding of the key points. It will take time to read this book, and absorb and apply the approaches suggested, but it will be time well spent. There is no way of getting around the need to properly assess exposure and the controls required to minimise it.

7 The book is as self-contained as possible but other publications are listed which do supply more detailed information on some topics. The guidance can be used to assess the risk from new stonework or to review your current arrangements for exposure control. It may well be possible to do the assessments in-house but there will be occasions when expert advice and assistance is needed, for instance, in air sampling or the design of stone dust control systems. The people who do this work should be competent and experienced and guidance is available on how to select consultants, if they are needed.³

8 The evidence on the health risks from stone dust reviewed in the next chapter indicates that many employers of stonemasons will find that they need to improve stone dust control. If you are not an employer of stonemasons but supply stone, stoneworking tools or dust control equipment this guidance can be used to assess whether the information being supplied with your equipment or product is accurate and helps employers control the risk.

1 Stonemasons – stone dust and health

9 Some of the evidence for the effects of stone dust on the health of stonemasons is outlined here. But first we start with some important concepts and definitions.

Concepts and definitions

10 *Stone dust* Airborne 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'. Particles which are small enough to penetrate deep into the lungs are called 'respirable' dust.⁴ The fine respirable dust cannot be seen with the naked eye, but it can be made visible by using a 'dust-lamp'.⁵ The cover photograph was taken using such a lamp, as were most of the photographs in this book.

11 Inhalable dust can cause irritation of the eyes, nose and throat, but it is the fine respirable dust which is of prime concern for serious long-term health problems. Excessive inhalation of **any** type of fine respirable dust can damage the lungs and impair health, but some forms of dust are more harmful than others.

12 *Pneumoconiosis* The potential health effects that fine airborne stone dust particles have on the lung tissue will depend on their composition which in turn will depend on the type of stone being worked. If the stone contains crystalline silica, the most common form of which is quartz, then so will the airborne stone dust particles which are breathed in. While the greatest risk to health comes from crystalline silica dusts, other mineral dusts can cause scarring of the lungs or 'pneumoconiosis'. The death rate from pneumoconiosis in stonemasons who have worked stone without a high crystalline silica content, but which may contain some, is approximately 13-times higher than the average for the total national working population.⁶

13 *Silicosis* This is a type of pneumoconiosis caused by breathing in fine stone dust containing crystalline silica. Stonemasons, as a group, run a high risk of contracting silicosis. This is a debilitating scarring or fibrotic lung disease which continues to develop after exposure has stopped and is irreversible. Victims suffer severe shortness of breath and will find it difficult to walk even short distances. Sufferers usually become house or bed-bound and often die prematurely from heart failure. The greater the concentration of silica dust and the more prolonged the stonemason's exposure, the greater the risk.

14 The silicosis death rate for stonemasons is 43-times greater than the national average for the total UK working population and for stonemasons the risk is not a thing of the past. An HSE-financed health surveillance scheme suggests that the current relative risk of being diagnosed with silicosis, for stonemasons, is about 63-times the average for the total UK working population.⁶

15 Classic silicosis develops slowly, disabling the victim over years. Cases diagnosed now will have been caused by exposures accumulated over 10, 20 or even 30 years. However, there is an acute form of silicosis which can occur where silica dust exposures are high (daily averages around 1–5 mg/m³ respirable crystalline silica dust), and sustained for a relatively short time, perhaps one or two years. This accelerated form of silicosis can kill within a few years of first exposure. Two stonemasons in Scotland are known to have died in this way in the late 1980s.⁷

16 *Lung cancer* Silica dust may be linked, in certain circumstances, to lung cancer. People who get silicosis have a greater risk of contracting lung cancer. Silica dust exposure by itself does not appear to cause lung cancer and the complete picture is not clear.⁸ However, the possibility is yet another reason for prudent control of dust exposure.

17 *The 'good old days'?* Most of the health effects listed here are due to regular and prolonged exposure over past decades. It is often assumed that modern working conditions are better but for stonemasons this may not be so. It is possible that dust exposures have gone up in the last couple of decades with the introduction of electrically powered disc cutters and polishers. It may be that silicosis and other adverse health effects amongst stonemasons will also rise.

Dust is dangerous

18 In the past certain diseases were seen as inevitable, they went with the job. Boilermakers went deaf, foundry fettlers got vibration white finger and stonemasons got lung diseases (and vibration white finger). There is nothing inevitable about this risk. The number of cases of dust-related disease reviewed indicate that stonemasons have been exposed to too much dust. The solution is to control the dust. The message from the disease figures is that stone dust control has got to improve and dust exposures have got to fall. This is perfectly possible as this book will show.

Summary checklist: Stonemasons – dust and health	Yes	No
Do you know what the health risks from stone dust are?		
Can you list them?		
What causes the risks?		



Photograph 1 Stonemasons see the large stone chips but not the fine dust (also see figure 8 on page 25)

2 Stone dust – the law, exposure limits and the four steps to successful dust control

Airborne stone dust

19 Anyone assessing and planning to control stone dust exposure must understand some fundamental properties of airborne stone dust, apart from the fact that fine, respirable dust is virtually invisible in normal lighting. Working on stone creates and releases into the air dust particles with a wide range of sizes. The large particles fall out of the air quickly and cannot be inhaled but the smaller, including respirable dust particles, will float, suspended in the air, for many minutes or longer, depending upon their size. The key point to understand is that fine stone dust particles do not move in the air by themselves. They move with the air in which they are suspended. To assess exposure you must understand how people are exposed to dust-laden air. And it follows that controlling exposure to airborne stone dust is all about containing, drawing away and diluting dust-laden air. The various definitions which cover different size ranges of dust particles are discussed in paragraph 10.

What does the law say?

20 This book will not describe the relevant law in detail. There is a clear requirement under the Control of Substances Hazardous to Health Regulations 1999 (COSHH)⁹ for employers and the self-employed to assess and control the risks from stone dust exposure. The Regulations set out the steps, in a logical order, that employers and self-employed people need to take (see COSHH: *A brief guide to the Regulations*¹⁰).

21 Apart from the employer of stonemasons, suppliers of stoneworking equipment, particularly devices which emit large amounts of dust, may have legal responsibilities under the Supply of Machinery Regulations 1992.

Exposure limits: descriptions and definitions

22 Under the COSHH Regulations various standards for airborne dust are implemented. They are listed in terms of milligrams of dust per cubic metre of air (mg/m³). The system of occupational exposure limits in the UK, including definitions, is described in Appendix 1.¹¹ The important points that you need to know to use this book are as follows:

- *Silica maximum exposure limit (MEL)* Respirable crystalline silica dust has been assigned a maximum exposure limit (MEL). Exposure should never normally exceed the MEL of 0.3 mg/m³, when measured or estimated for any 8-hour period, called a time-weighted average or TWA (see Appendix 1). This is not a safe limit and there may be residual silicosis risk at exposures below the MEL.¹² To comply fully with COSHH, employers must reduce exposure to respirable crystalline silica dust as far as is reasonably practicable below the MEL.
- *Silica medical surveillance threshold (MST)* Health surveillance is recommended for people who are regularly exposed to respirable silica dust levels greater than 0.075 mg/m³ (one quarter of the MEL), because of the residual risk at exposures below the MEL. In this book this value is referred to as the medical surveillance threshold or MST. If at all possible respirable silica

dust exposure should be reduced to 0.075 mg/m³ and below to minimise the potential risk of silicosis. In other publications (for example, *Respirable crystalline silica*¹²) the number 0.075 is rounded up to 0.1 for convenience but this could confuse and this book sticks to 0.075 mg/m³ as the MST.

- **Respirable dust standard** ‘Respirable’ dust has a technical definition and is the fine dust which can be inhaled deep into the lungs.⁴ When exposures to respirable dust of any kind, including stone dust, exceed 4 mg/m³ (when measured or estimated for any 8-hour period) the COSHH Regulations apply. The 4 mg/m³ value is in effect a respirable dust standard. A similar logic applies to inhalable dust.
- **Inhalable dust standard** ‘Inhalable’ dust, like ‘respirable’ dust has a technical definition⁴ and consists of all sizes of particles which can be inhaled. By definition, inhalable dust includes all respirable dust particles. When exposures to inhalable dust of any kind, including stone dust, exceed 10 mg/m³ (when measured or estimated for any 8-hour period) the COSHH Regulations apply.
- **Recent scientific evidence** Recent evidence suggests that the higher the exposure to respirable crystalline silica dust the greater the risk of silicosis and that the risk rises faster the higher the exposure – it is multiplicative. That is, the risk of silicosis at, say, sustained exposures at 4 mg/m³ is not simply twice that from exposures at 2 mg/m³, it is four times riskier. This new information reinforces the need for very effective controls where exposures to respirable crystalline silica dust are high.

23 Adherence to the general respirable and inhalable dust standards is required under COSHH. However, it would be prudent to reduce stone dust exposures below the standards where possible.

Defining ‘overexposure’

24 In this book overexposure will be taken to be any exposure to respirable crystalline silica dust greater than the MST, 0.075 mg/m³ (when measured or estimated for any 8-hour period). Or, exposures above the respirable or inhalable dust standards of 4 mg/m³ and 10 mg/m³ respectively (when measured or estimated for any 8-hour period). In practice the main problems for stonemasons will be overexposure to respirable crystalline silica dust (where stone contains significant crystalline silica) and to respirable dust.

25 By a combination of control options it is possible to keep the exposure of stonemasons below the MST, 0.075 mg/m³ (when measured or estimated for any 8-hour period) and the same applies to the respirable dust standard.

How to achieve successful stone dust control

26 There are four steps to successful dust control and they are best put in the form of questions. Keep asking yourself the questions until you have developed practical and effective answers. The first step will be dealt with in the next chapter, steps two and three in chapter four and the final step in chapter five.

The four steps to successful dust control

STEP 1: Is overexposure likely? If so, by how much and what’s causing it?

STEP 2: What are the control options available and how effective are they?

STEP 3: What blend of control options will be adequate and sustainable?

STEP 4: What monitoring, checking and maintenance are needed to make sure that the control measures continue to work?

Cautionary note on numbers

27 Stone dust controls need to cope with and minimise dust exposures whatever their level. The details of how this should be done are dealt with in the next two chapters. It is important to be clear about the uncertainties in this process. You will be making assumptions about how exposed to dust stonemasons are and these estimates will be uncertain. Even if you arrange for exposure to be measured the results will be a snapshot in time and cannot cover the day-to-day variation in stone dust exposure. The effectiveness of stone dust controls are also uncertain and variable.

28 In the next two chapters you are asked to estimate the stonemasons' exposure and to work out how effective dust controls are likely to be. Be aware that in practice neither gauging exposure or control effectiveness are exact sciences. The numbers in this book are there to guide you in your assessments. They are useful tools to help you make judgements. But be wary of reading too much into the numbers and err on the cautious side in any judgement you make.

Summary checklist: Stone dust – the law, exposure limits and control	Yes	No
Can you describe the fundamental properties of fine stone dust?		
Do you know which laws cover the control of stonemasonry dust?		
Do you know what the exposure limits relevant to stone dust exposure are?		
Do you know how to define 'overexposure' to stone dust?		
Can you list the four steps to successful stone dust control?		

3 How to assess stone dust exposure

Assessing and understanding stone dust exposure

29 There is a simple and useful way of thinking about stone dust exposure and it is illustrated in Figure 1.

30 As stonemasons work more with processes which tend to create stone dust their exposure rises (left to right in Figure 1). At the top of the illustration some of the factors which tend to lower or raise exposure are listed. In addition, Figure 1 shows the effect of increasing the percentage of crystalline silica in the stone worked (bottom to top of the figure). The greater the percentage of crystalline silica in the stone the greater the chances of overexposure.

31 The lowest, least significant stone dust exposures occur with intermittent hand working on stone containing no crystalline silica. The highest exposures will occur where stonemasons work with powered tools for prolonged periods on stone containing a high percentage of crystalline silica. As potential overexposure to stone dust increases so must the effectiveness of controls applied as shown in Figure 1. The biggest challenge to dust controls is represented by the top right hand corner of Figure 1. To adequately control exposures in this region will almost certainly require a combination of a number of control options.

32 The overall aim of this chapter is to help you identify in which dust exposure region of Figure 1 the stonemasons that you employ are likely to be working. This aim is achieved by considering Step 1 of the four steps to successful stone dust control.

STEP 1: Is overexposure likely? If so, by how much and what's causing it?

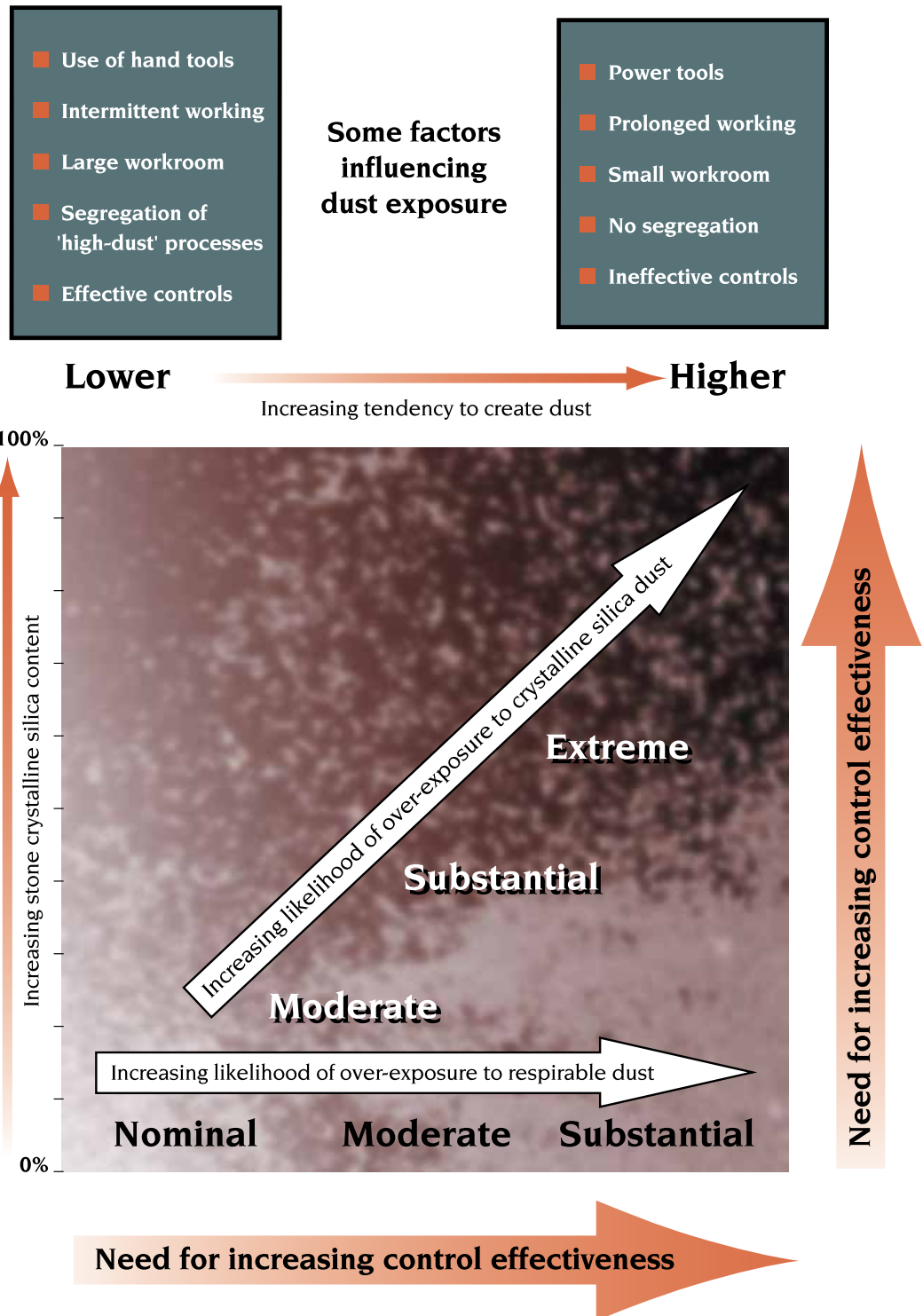
33 Answering the questions in Step 1 must be done in a logical order which is shown as a flowchart in Figure 2.

34 You are aiming to work out three things:

- 1 The stonemason's daily average stone dust exposure.
- 2 The most significant sources of stone dust exposure.
- 3 The way the significant sources emit stone dust and cause exposure.

And you start, as shown in Figure 2, with stone working processes. To assess exposure for each process you need to know two things:

- 1 What stone dust exposure does the process cause?
- 2 How long is the stonemason exposed to dust from this process each day?



Percentage crystalline silica in some stone types

Quartzite (90~100%), Sandstone (50~100%), Siltstone (50~100%)
 Gritstone (60~90%), Granite (15~45%), Slate (20~40%), Diorite (0~15%),
 Serpentinite (0~15%), Limestone (0~10%), Marble (0~5%), Basalt (0%),
 Gabbro (0%), Dolerite (0%)

Figure 1 Assessing the likelihood of significant stone dust exposure

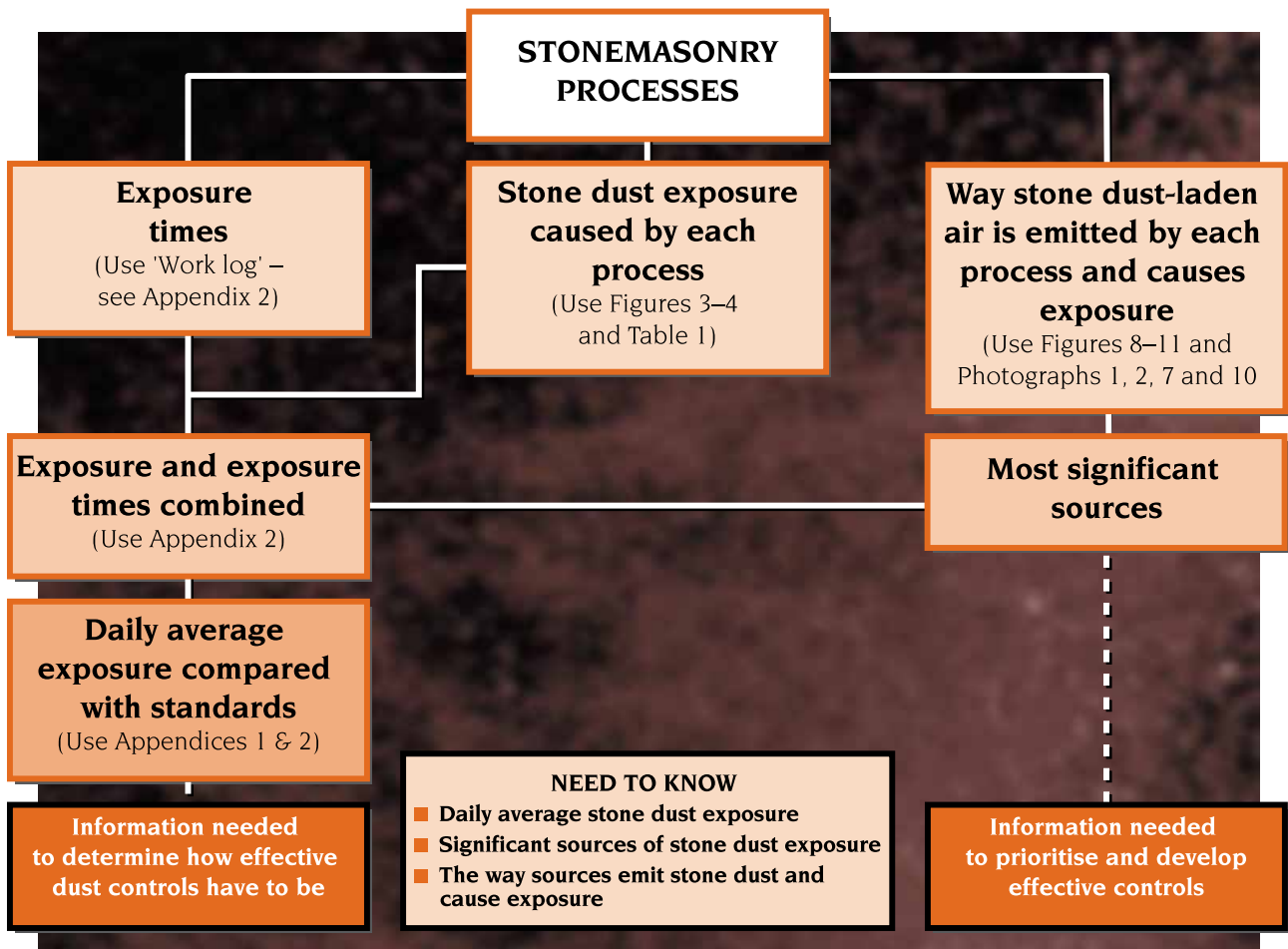


Figure 2 Assessing and understanding exposure

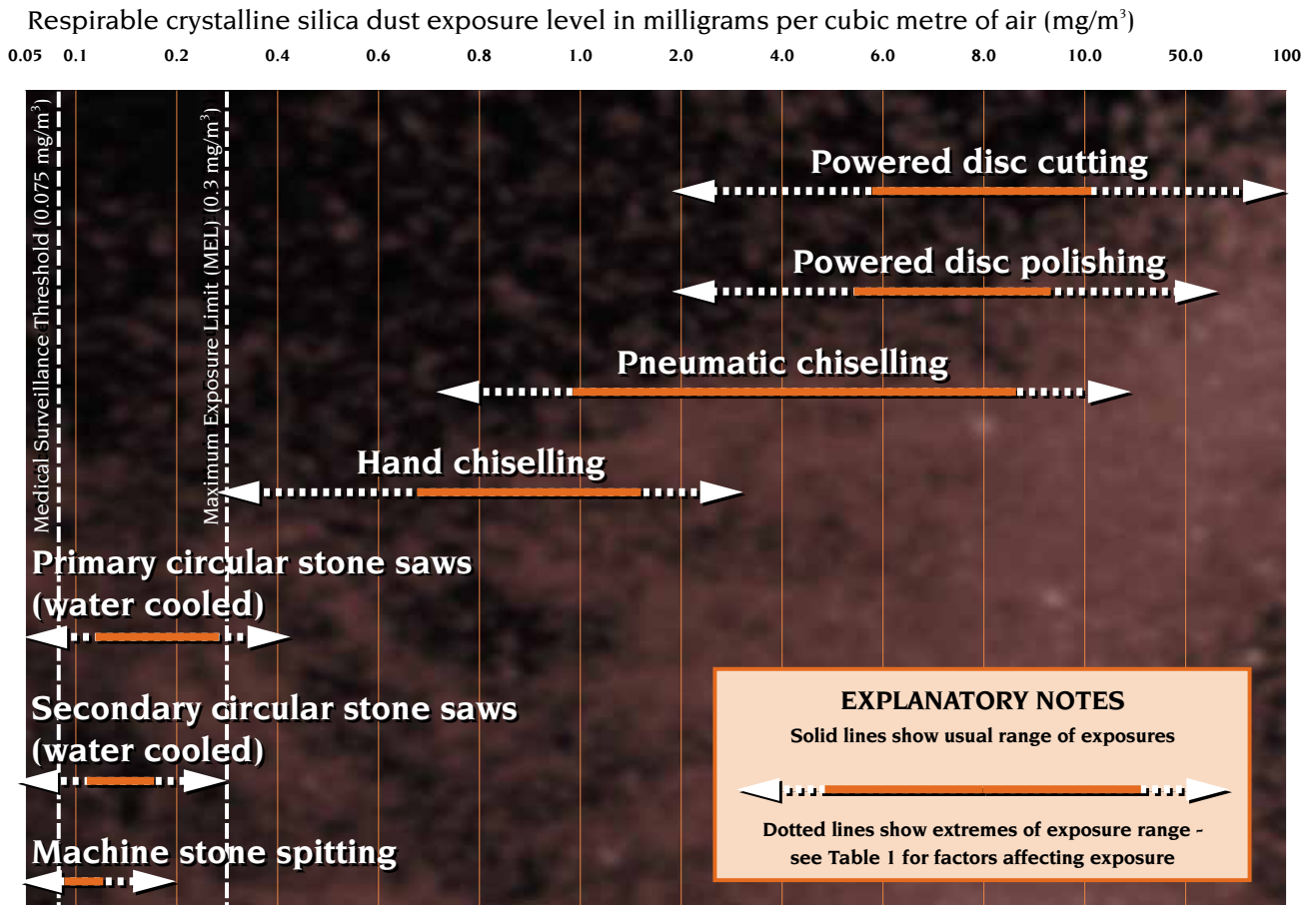


Figure 3 Approximate dust exposure ranges when working on stone with a high crystalline silica content

Estimating exposure from different stonemasonry processes

35 Different stonemasonry processes produce different amounts of stone dust. Figure 3 shows the range of respirable crystalline silica dust levels which can be created by various processes when working on stone with a high crystalline silica content. It is based on past HSE measurements of stonemasons' respirable crystalline silica dust exposure.

36 The ranges are very wide and which position in the spectrum applies to your specific processes will depend on a number of factors, many of which are listed in Table 1.

Table 1 Factors affecting stone dust exposure (see Figures 3 and 4)

<i>Factor tending to push exposure towards the lower end of the range</i>	<i>Factor tending to push exposure towards the higher end of the range</i>	Comments
Hand tool working	Powered tool working	See Figures 2 and 3
Stone type (see Comments)	Stone type (see Comments)	Working on 'hard' stone may release more fine dust when doing hand chiselling work than 'soft' stone. But 'soft' stone may release more fine respirable dust when cut with a power tool. Which effect applies will take careful judgement. It is a question of knowing your stone.
Low crystalline silica content stone	High crystalline silica content stone	See Figures 1, 5 and 6 and note that quartz content does not have to be that high to lead to high silica dust exposures.
Wet working	Dry working	Pre-soaking stone will reduce emission of dust and should be standard practice. Active wetting, with running water, of cutting/polishing operations is particularly effective. More potential for its use.
Small amount of stone removed	Large amount of stone removed	The amount of stone removed will be an important factor affecting exposure.
Short term, infrequent, short duration stone working	Long term, frequent and prolonged stone working	Length of work time has a direct effect on exposure.

Table 1 *Cont*

<i>Factor tending to push exposure towards the lower end of the range</i>	<i>Factor tending to push exposure towards the higher end of the range</i>	<i>Comments</i>
--	---	------------------------

Environmental factors

Large workroom (relative to the number of masons)	Small workroom (relative to the number of masons)	Larger, taller rooms tend to have better natural general ventilation.
Segregation of fundamentally dusty processes from less dusty processes	No segregation of fundamentally dusty processes from less dusty processes	Too many stonemasonry workshops conduct all stonemasonry processes in the same workroom whether they are dusty or not

Control factors

Planned, effective exhaust ventilation	Unplanned, ineffective exhaust ventilation	Exhaust ventilation is often far less effective than believed. See Chapter 4 <i>How to control stone and dust exposure</i> .
Vacuuming-off debris from stone being worked	Blowing-off debris from stone being worked (with pneumatic exhaust)	Brushing is better than blowing but vacuuming is best. Not a common control practice–yet.
Cleaning workroom by vacuum or wet removal	Cleaning workroom by dry brushing	May not be a big source of exposure but it could be significant and it is unnecessary.
Work overalls made from low dust retention/release cotton fabric	Work overalls made from high dust retention/release cotton fabric	Dust on clothing maybe quite a significant source.

*Note – some factors are more important than others

37 Figure 4 gives a very approximate range of exposures for respirable stone dust. It is based on less information than Figure 3 and is less accurate and should be used carefully.

38 Combining the factors in Table 1 will help you judge where a stonemason's exposure, from a particular process, is likely to be in the ranges shown in Figures 3 and 4. For instance, if you've ticked off most of the factors in column two then exposure will be towards the higher end of the range.

39 Currently the information is not available to produce an equivalent figure covering inhalable stone dust exposures and in any event it is the respirable stone and crystalline silica dust exposures which are of most concern.

40 Some general observations on the potential respirable stone and crystalline silica dust exposures can be drawn from Figures 3 and 4.

- 1** All hand working processes on stone with a high crystalline silica content can cause significant exposure.
- 2** Powered tools can cause very high dust exposures.
- 3** Hand chiselling of stone with a high crystalline silica content can cause high exposures. At the top end of the range they overlap the exposures caused by pneumatic chiselling.
- 4** Water-cooled primary and secondary circular saws working on stone with a high crystalline silica content can cause, perhaps surprisingly, significant exposure. The cooling water reduces dust release but it doesn't eliminate it.

Dust exposure from stone containing crystalline silica

Time to reach MEL/MST

41 The relationship between respirable silica dust exposure and the time to reach the maximum exposure limit (MEL) or medical surveillance threshold (MST) limits is made clearer by examining Table 2 and the associated Figure 5.

Respirable dust exposure level in milligrams per cubic metre of air (mg/m³)

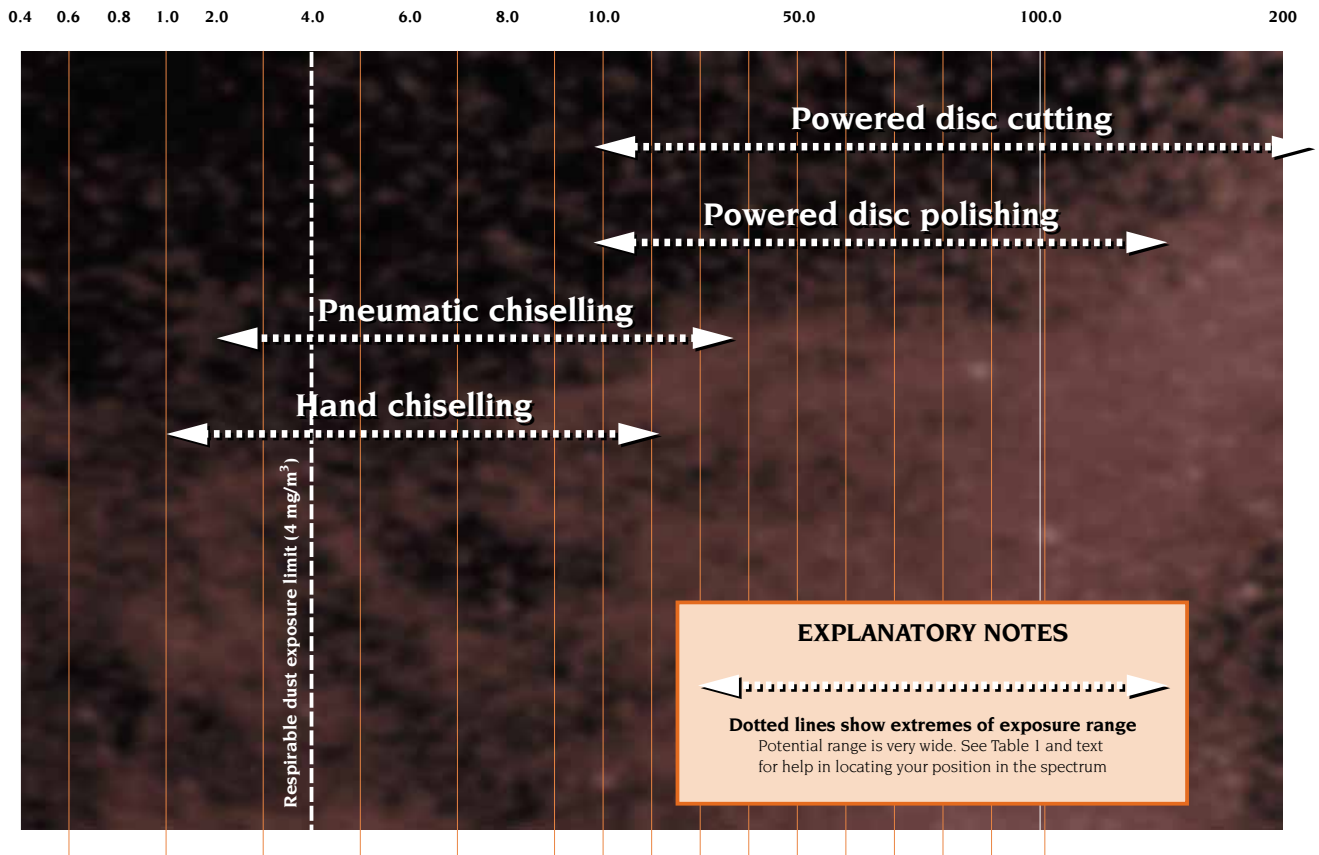


Figure 4 Very approximate respirable stone dust exposure ranges for some stone masonry processes

Table 2

Times to reach maximum exposure limit (MEL) and medical surveillance threshold (MST***) at different levels of respirable crystalline silica dust exposure**

	Respirable crystalline silica dust exposure levels (mg/m ³)									
	100	50	20	10	5	2	1	0.07	0.3	0.075
<i>Time to reach MEL</i>	1 m 26 s	3 m	7 m 12 s	14 m 24 s	28 m 48 s	1 h 12 m	2 h 24 m	4 h	8 h	–
<i>Time to reach MST</i>	22 s	44 s	1 m 48 s	3 m 36 s	7 m 12 s	17 m 59 s	35 m 58 s	48 m	2 h 8 m	8 h

** MEL = 0.3 mg/m³ (8 hour TWA)

*** MST = 0.075 mg/m³ (8 hour TWA)

h = hours, m = minutes, s = seconds

42 At the respirable crystalline silica dust exposures which common stonemasonry processes cause (see Figures 3 and 4), the MEL and MST levels can be reached in a surprisingly short time. At 2 mg/m³ the MST is reached in less than 18 minutes and the MEL in under 75 minutes. At 3 mg/m³ the times are less than 13 minutes and 48 minutes respectively. Hand chiselling of stone with a high crystalline silica content can, if the factors are right (see Table 1) push exposure into the 2–3 mg/m³ respirable crystalline silica region. The message from Figures 3 and 5 is that, if the conditions are right, stone-masons who are hand chiselling stone with a significant crystalline silica content can be significantly overexposed to respirable crystalline silica dust.

43 As for pneumatic chiselling, disc cutting and polishing, the position is even more serious. At 5 mg/m³, well within the usual range of exposures which pneumatic chiselling can cause, the MST is reached in well under 8 minutes and the MEL in under 30 minutes. At 50 mg/m³, which disc cutting, especially the larger 7 inch (0.18 metre) and 9 inch (0.23 metre) discs and polishing, can cause, the MST is reached in hardly any time –44 seconds and the MEL in under 3 minutes.

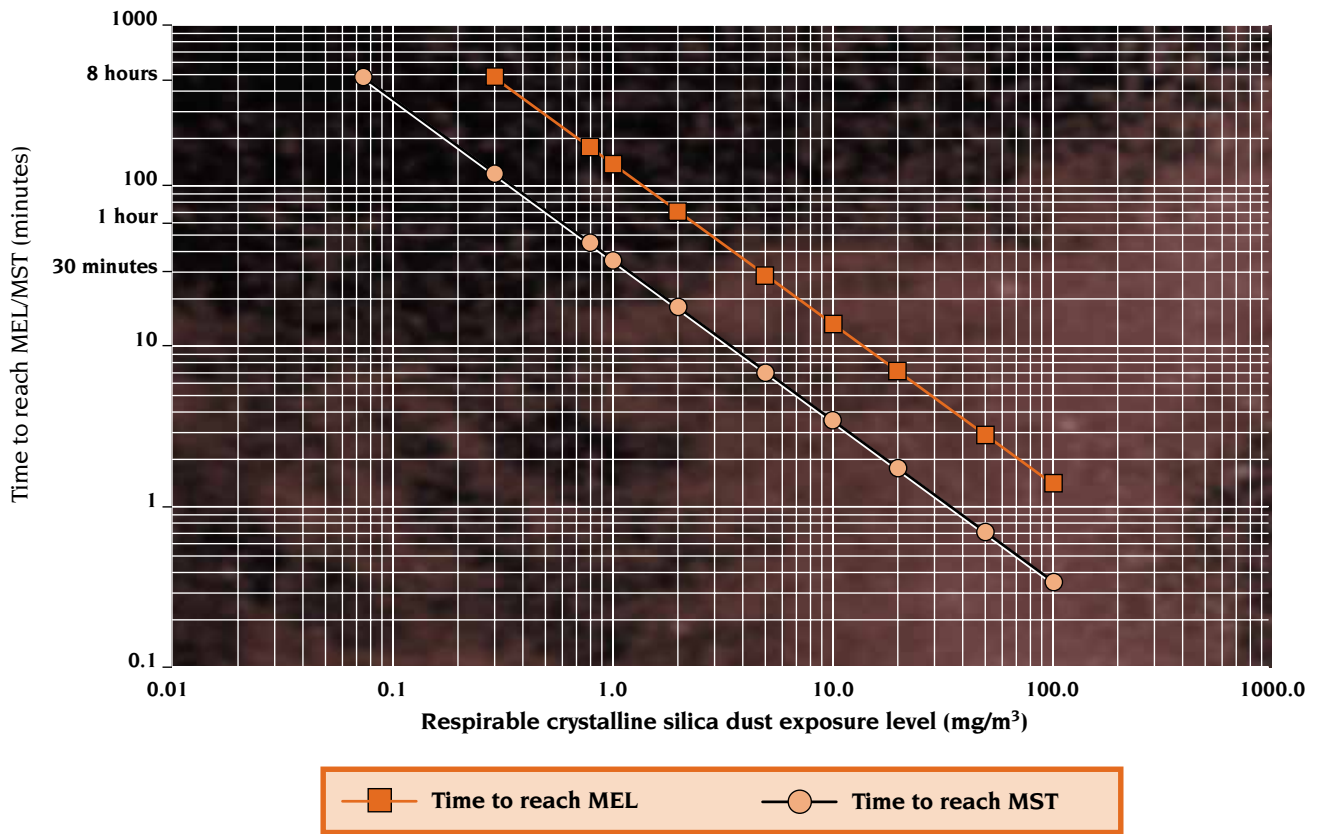


Figure 5 Times to reach maximum exposure limit and medical surveillance threshold at increasing levels of respirable crystalline silica dust exposure

It is quite clear that powered tools have the potential to cause massive overexposure to respirable crystalline silica dust.

Working on stone with a significant crystalline silica content

44 Figure 1 shows the qualitative relationship between respirable stone dust exposure and the percentage of crystalline silica in the stone. The higher the crystalline silica content the more likely overexposure will move into the 'substantial' or even 'extreme' regions. Figure 6 shows quantitatively the relationship between respirable stone dust exposure and the crystalline silica content of stone.

45 If you have worked out a stonemason's daily average respirable stone dust exposure, and know how much crystalline silica the stone contains, Figure 6 can be used to read off the respirable crystalline silica dust exposure. For instance, if a stonemason is exposed at the respirable dust standard of 4 mg/m³ (8-hour TWA) the crystalline silica content of the stone being worked need only be approx 2% for the MST to be reached and approximately 8% to reach the MEL standard. You can easily do this calculation using the automated table on HSE's website (www.hse.gov.uk/fod/metalmin.htm)

46 There are two key messages worth taking from Figure 6:

- 1 Even a relatively small proportion of crystalline silica in the stone being worked will push exposures above the MST or MEL levels and it is therefore essential to know the crystalline silica content of the stone being worked.
- 2 Working with high crystalline silica stone, coupled with high respirable dust exposures, can lead to **very** high overexposures, many, many times the MST and MEL levels.

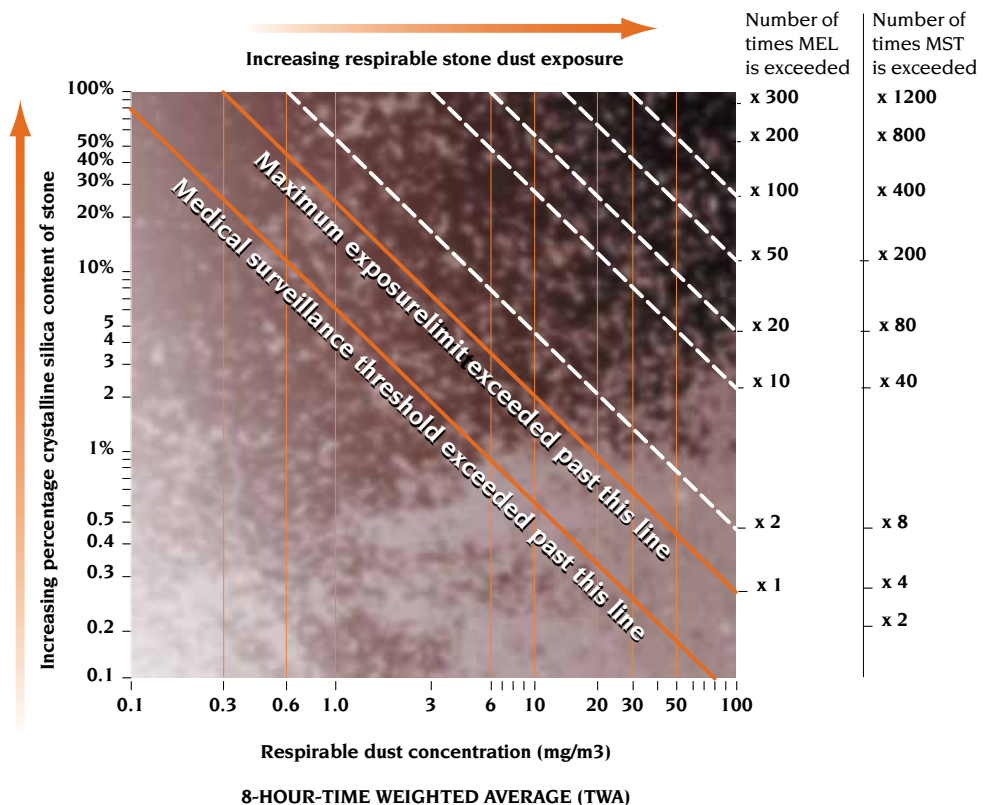


Figure 6 Aid to assessing likely overexposure to respirable crystalline silica dust

Measuring exposure

47 Where it is difficult to make a realistic estimate of stone dust exposure, personal air sampling may be necessary. This should be done by a competent, qualified person trained in occupational hygiene measurement and assessment techniques (see section on Airborne dust monitoring, paragraphs 106 and 107 and *Further information*).

Exposure time: A day in the dusty life of a stonemason

48 Figure 7 shows the pattern of stone dust exposure over one work day. It illustrates the exposure analysed in Worked example 1 (see Appendix 2).

49 Exposure is highly variable and depends, to a large extent, upon what tools the stonemason uses and for how long. From a control point of view you want to know which stonemasonry processes are causing the most exposure. From an exposure point of view you want to know what exposure each process causes and for how long. It is this information you need to work out the total exposure over the work day. Figure 7 illustrates how the total durations spent on each individual process can be combined (also see Worked example 1 in Appendix 2).

50 To work out the daily average exposure you need to know how long someone uses a disc cutter, pneumatic chisel, etc. A simple and effective way of doing this is to ask the stonemasons to fill in work logs over a full working day. An example of such a log is shown in Appendix 2. Or, you could observe people's patterns of work and estimate times spent on each process.

Calculating daily average exposure

51 Unless stonemasons are working in production-type environments, which are rare, their exposure will vary a lot from day-to-day. 'Typical' exposures may be difficult to estimate or measure. One useful way around this problem is to estimate or measure 'worst case' exposure. To do this:

- select the highest likely exposure generated by each of the stonemasonry processes (using Figures 3 and 4 and Table 1);
- select the longest durations from the ranges in the stonemason's work logs;
- calculate the highest daily exposures (see Appendix 2).

52 To help you with calculating daily average respirable stone and crystalline silica dust exposures three worked examples are given in Appendix 2. These examples will be used later in the next chapter when it comes to deciding what dust controls are needed. The tables in Appendix 2 provide further help in doing the necessary calculations. They are also available in downloadable form on HSE's website (www.hse.gov.uk/fod/metalmin.htm). The automated table enables you to quickly see what happens to a stonemason's exposure as changes are made to how long they work with a particular tool, or when working on stone containing different amounts of crystalline silica. You can quickly ask yourself and answer 'What if' questions using the table. Questions like 'What if the limestone we are working on contains 1% or 2% or 3% crystalline silica?'

How stonemasonry processes cause exposure

53 Different stonemasonry processes release and disperse dust-laden air in different ways. Figures 8 to 11 show the mechanisms for the more common stonemasonry processes. See also Photographs 1, 2 and 12 (pages 6, 27 and 62).

54 You need to understand how dust-laden air flows away from each stonemasonry process and causes exposure in order to effectively control it. Particularly difficult to control are processes such as polishing or disc cutting where fast moving dust-laden air jets are created. Some control options can control them but others cannot.

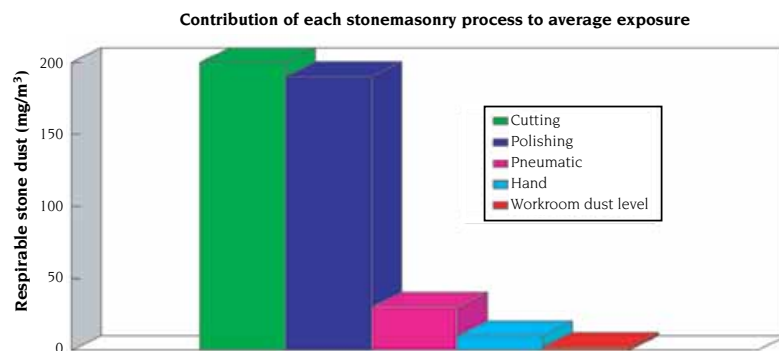
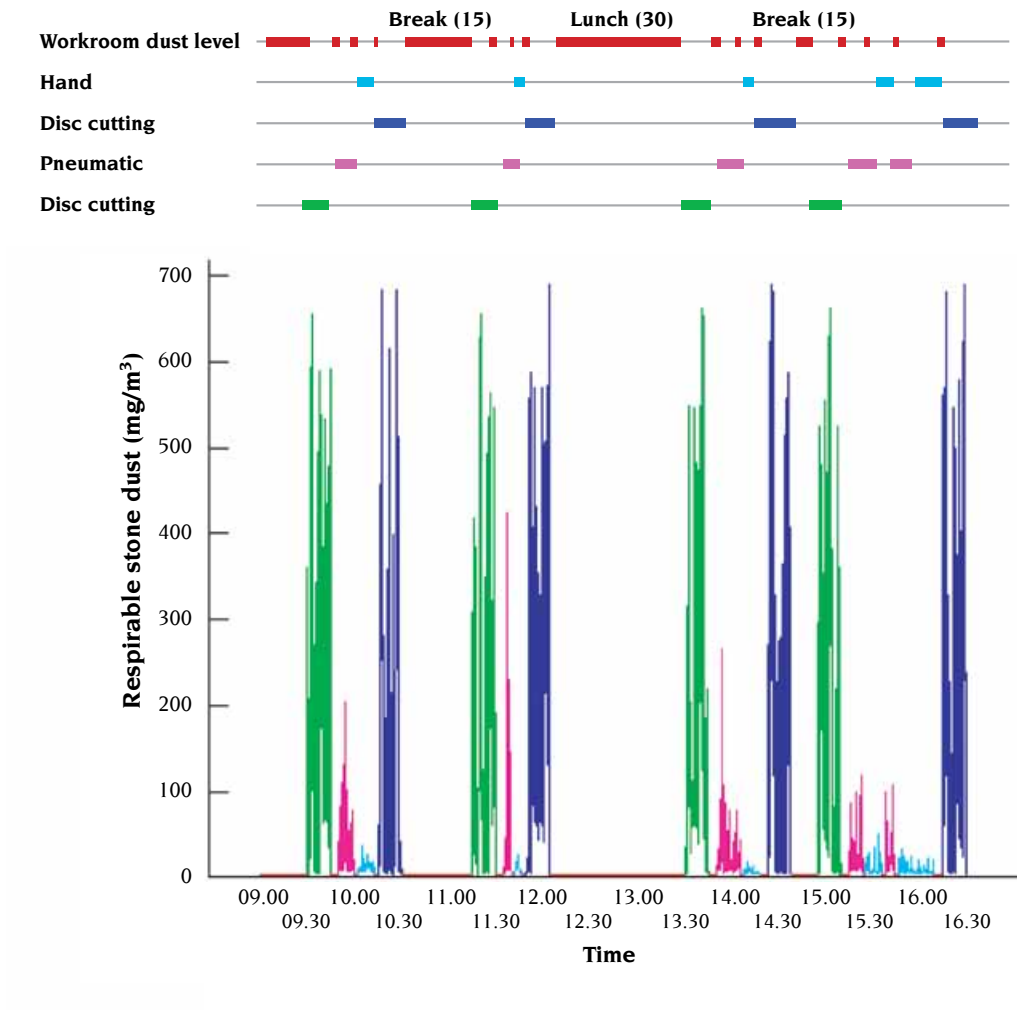


Figure 7 A day in the dusty life of a stonemason

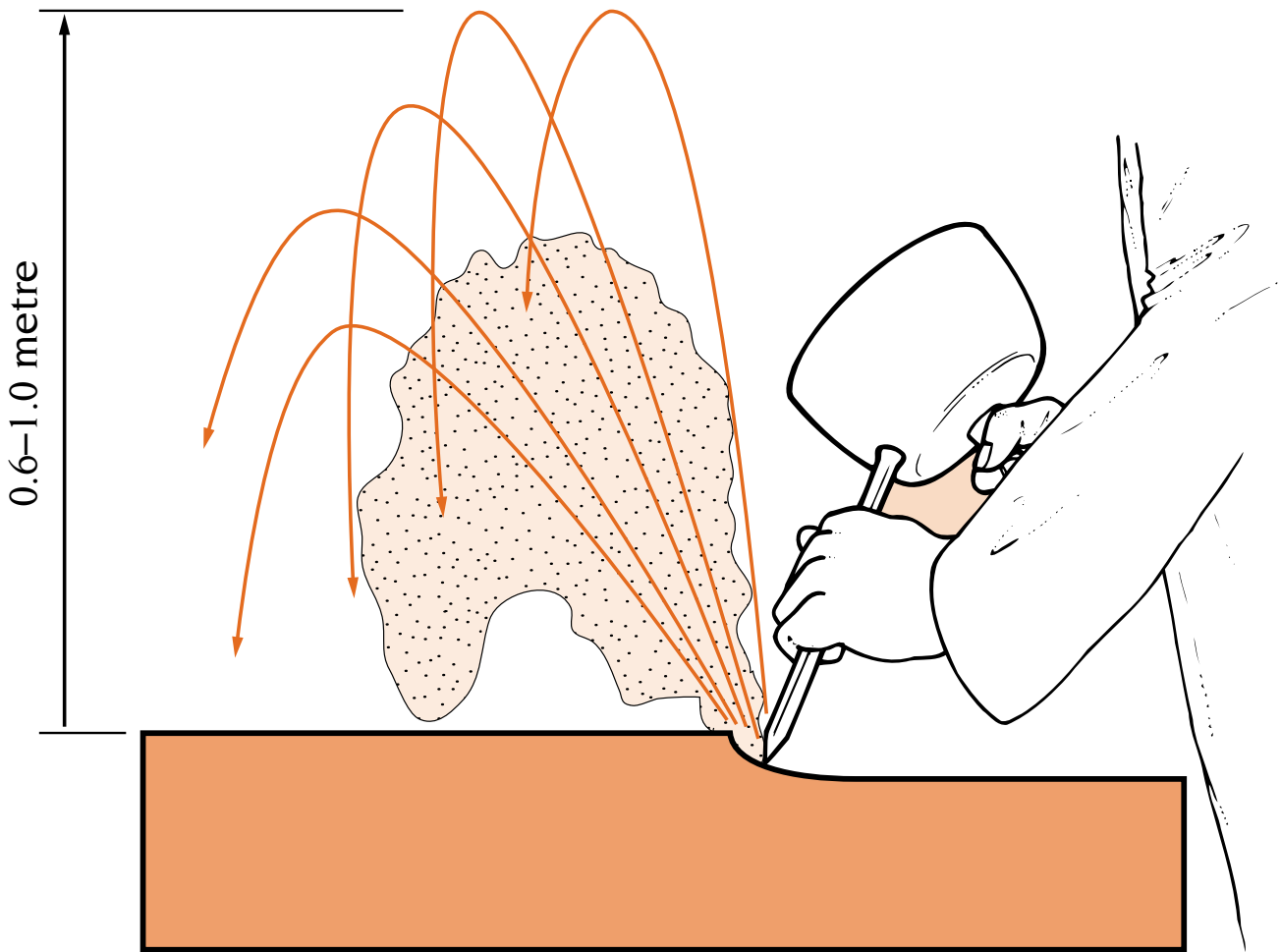


Figure 8 Hand chiselling With hard stone hand chiselling can create an almost explosive release of stone chips dragging in their wake a cloud of fine dust. Stone chips fly up and forward away from the impact site reaching as high as 1 metre. Chips fall in arcs landing close to and around the stone. fine dust almost appears to ‘explode’ outwards away from the impact site but not as far as the stone chips (perhaps 0.25–0.5 metres).

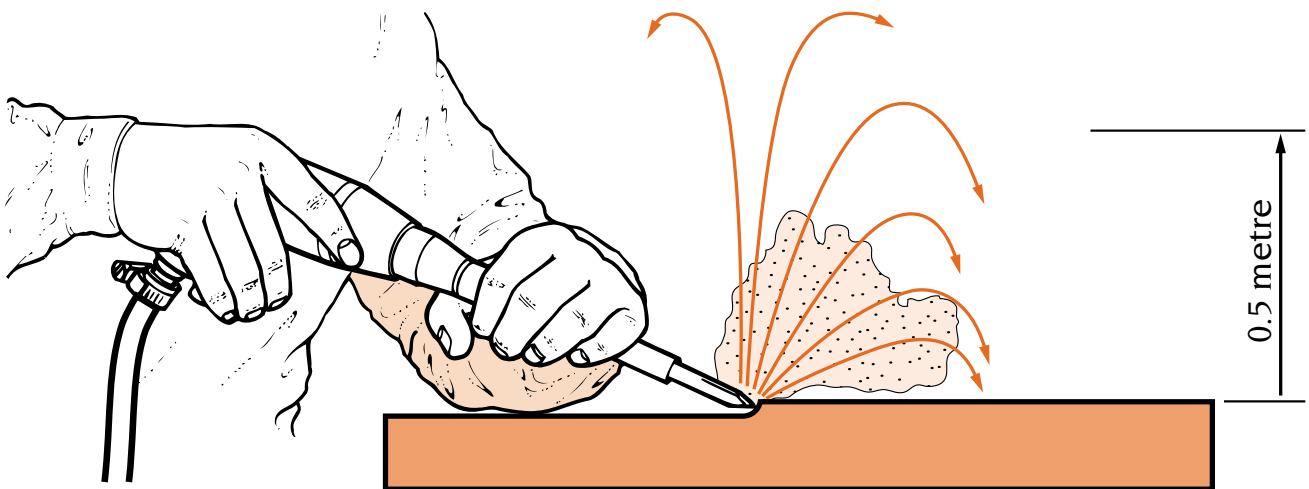


Figure 9 Pneumatic chiselling Pneumatic chisel tends to nibble the stone and dust tends to ‘boil’ away from the impact site. A less violent form of dust creation than hand chiselling.

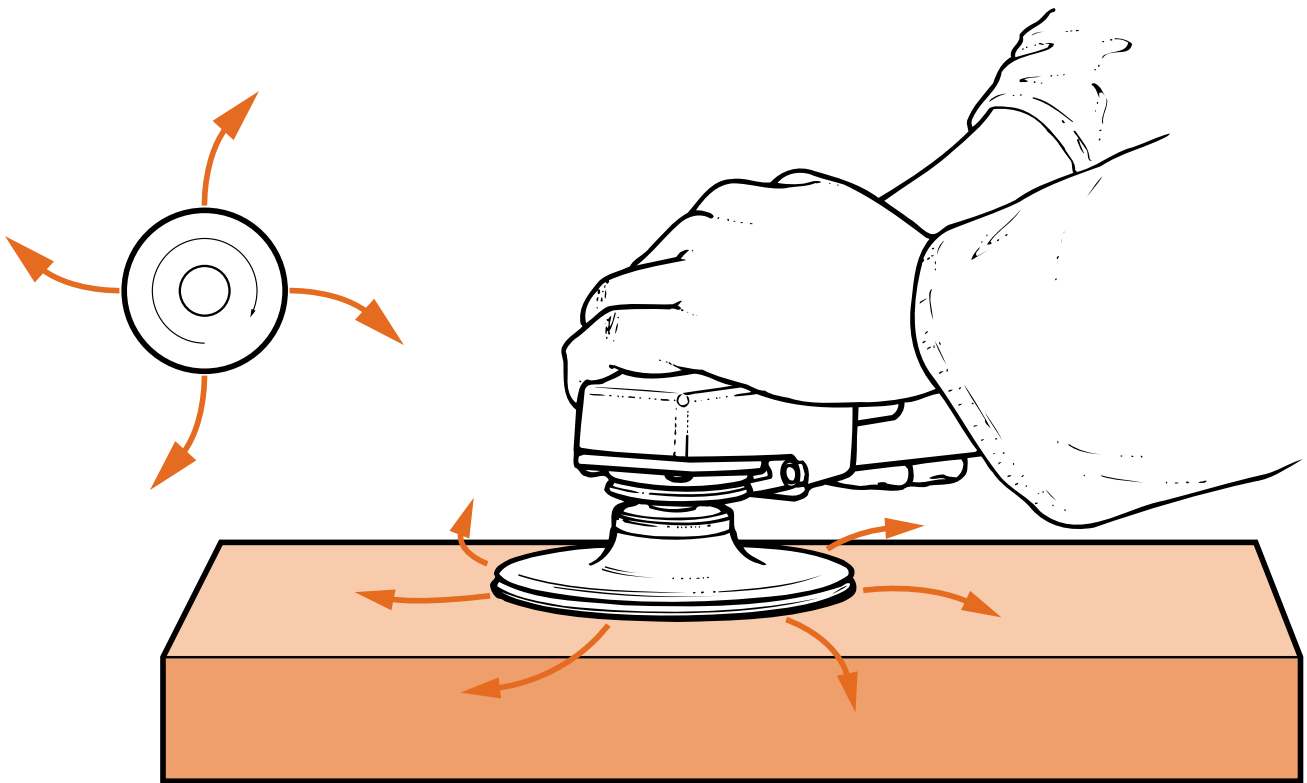


Figure 10 Polishing Disc rotation creates radial jets of dust laden air which flow outwards from any point on the disc periphery. If they flow towards the stonemason they rise straight up into the breathing zone. 'Spinners' which contain segmented abrasive surfaces turn more slowly and the jets of dust-laden air do not travel as far as with disc polishers.

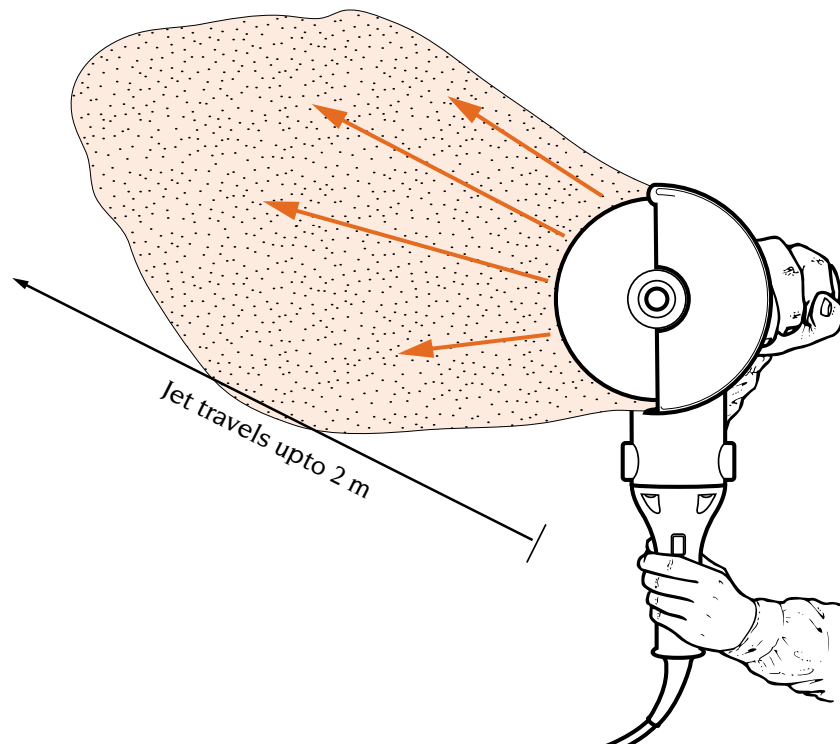


Figure 11a Disc cutting Broad dust-laden air jet created by the fan action of the rotating disc. Some dust flows away from disc cutting point in the broad air jet created by the rotating disc.

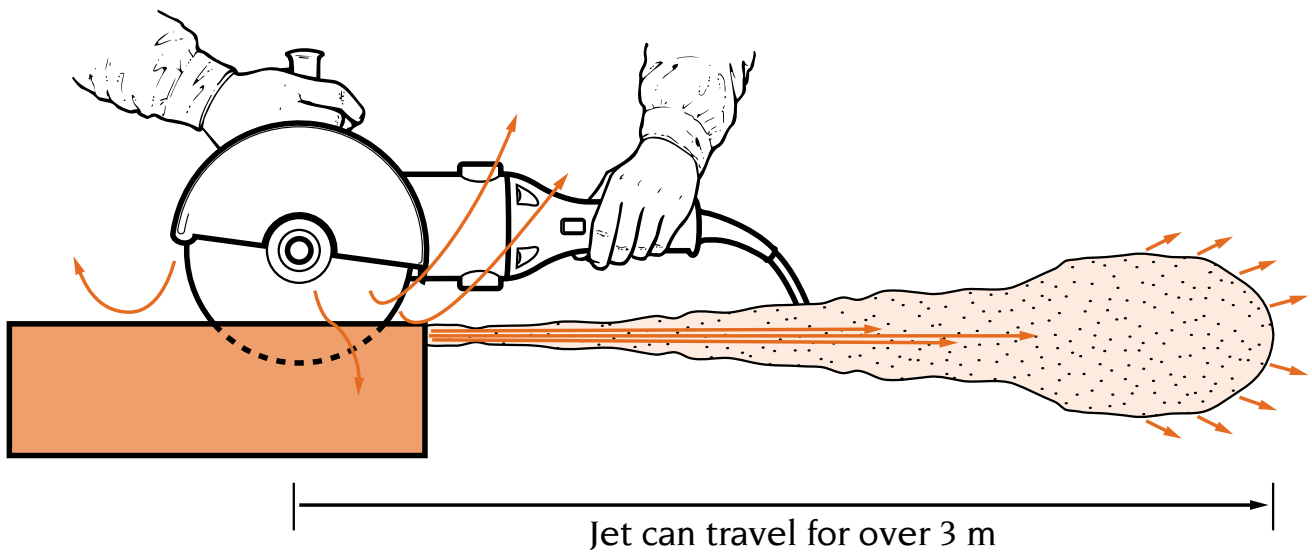


Figure 11b Start of disc cut Narrow jet of large and fine stone particles moving initially at the peripheral speed of the disc blade. This is roughly 70 metres per second (m/s) for a 9 inch blade turning at 6000 revolutions per minute (rpm) and 65 m/s for a 5 inch diameter blade at 10 000 rpm.

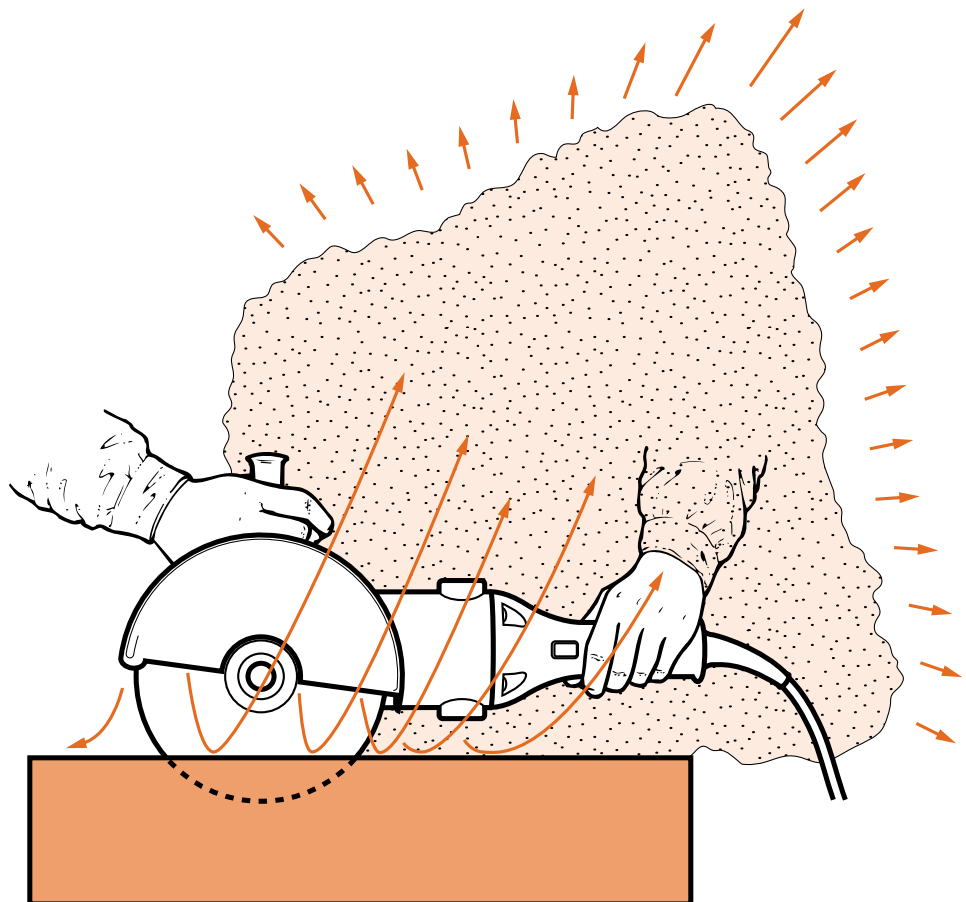


Figure 11c Middle and end of disc cut Thin, high speed jet of stone dust and entrained air disappears. It is replaced by a broader, slower moving jet of dust-laden air created by a combination of airflow from the rotating disc and the stone dust jet. Broad, dust-laden, air jet now flows horizontally and vertically probably due to interaction of the air jet and the stone surface. Significant part of the dust-laden air jet now flows directly up through the stonemason's breathing zone.



Photograph 2 Disc cutting. End of disc cutting through a stone block. Jets of dust-laden air are very fast moving and difficult to control (see also Figure 11)

55 At the end of the assessment you should be able to identify three things:

- 1 whether overexposure to airborne stone dust is occurring;
- 2 how overexposed to stone dust people are likely to be; and
- 3 how this overexposure is occurring, ie what are the most significant sources and how they are causing exposure.

Why bother assessing exposure?

56 But why is exposure assessment important, why just not apply some 'controls'? And the answer to this common sense and, perhaps, obvious question is that the controls applied have to be matched to the degree of overexposure. If stonemasons are potentially exposed to respirable stone dust levels 50-times the limits they will require a blend of controls which will cope with this big challenge. These controls will be different from those applied to control an overexposure of, say, twice the limit. And different controls are more or less effective at reducing dust exposure. We have now reached Step 2 in our quest for successful dust control.

<i>Summary checklist: Dust exposure from stonemasonry processes</i>	Yes	No
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Do you know how to use Figures 3 and 4 to estimate the dust exposure from the different stonemasonry processes?		
Do you know which stonemasonry processes generate the highest dust exposures?		
Do you know what effect the crystalline silica content of stone has on stone dust overexposure?		
Do you know the crystalline silica content of the stone you or your stonemasons work with?		
Do you know how to calculate daily stone dust exposure?		
Do you know how each stonemasonry process causes exposure?		



Photograph 3 Disc cutting control. Disc cutting in an exhaust ventilation booth – good dust control but poor working position. It would be better to have 'banker' on RHS and work side-on to the booth airflow



Photograph 4 Polishing. Polishing creates fast moving radial jets of dust-laden air which are difficult to control (also see Figure 10)

4 How to control stone dust exposure

The golden rule

57 If there is one golden rule of control it is that control measures must be matched to the stonemasonry processes causing exposure. There are a range of control options available and each varies as to when it can be applied and how much it can reduce exposure. Where rotary tools, which produce dust-laden jets of air, are used only certain controls will work. Effective, reliable control is always a question of selecting and integrating the right blend of control options and matching them to the control challenge – the degree of stone dust exposure. Having completed Step 1 on the path to successful stone dust control you know how overexposed people are, what the main sources of exposure are and how they cause exposure. Now you need to consider the control options available.

STEP 2: What control options are available and how effective are they?

Control hierarchy

58 There is a broad hierarchy of control options, referred to in the COSHH Regulations, starting with elimination of the hazardous substance and running through modification of the process and then on to application of controls to the process, such as exhaust ventilation. The 'hierarchy' can sometimes be too constricting and used by rote too rigidly. The key message is that there is a rough hierarchy of **reliability** of control.

59 Changing the process fundamentally so that it releases less dust is a very reliable form of control and it will reduce the direct exposure of the stonemason and those working nearby. The effectiveness of a small movable exhaust ventilation hood, used to suck away the dust-laden air, may be as good as changing the process. However, it will not be as **reliable** because, to be effective, the hood has to be regularly repositioned near the source of the stone dust. Achieving a reliable, defined reduction in exposure using respirators can be even more difficult and offers no protection to others working nearby.

Selecting an effective blend of controls

60 In practice, the way to achieve effective control is not to become obsessed with one type of control at the expense of others but to select a **blend** of control options which, when integrated, reliably reduce stone dust exposure. Controls must be matched to the challenge, not just how high the dust exposure is but the way in which the different processes cause exposure. Hence the emphasis in the last chapter on how different processes released dust-laden air. To select the right mix you need to understand what the broad control options are and how much each option can reduce exposure.

Classes of control option

61 Control options can be divided into four classes, five if you count the need to integrate them into an effective set of 'control measures'. The control options are:

- 1 workplace and process changes;
- 2 ventilation;

- 3 personal protective equipment;
- 4 work methods.

The important features of each will be described including some comments on how effective each method can be.

Workplace and process changes

62 If well applied, this class of control can fundamentally reduce stone dust exposure. For instance, the stonemasonry operations can be divided up and separated so that people not directly involved in the most dusty processes are not exposed to them. Efforts can then be focused on problem processes and those stonemasons directly exposed to too much stone dust. It may be possible to redesign a process so that it creates less stone dust.

Workplace changes

63 Stonemasonry work can trace its existence back thousands of years into prehistory. It is probably the oldest human craft skill and it is steeped in tradition. The traditional method of working has been for stonemasons to work on stone placed on 'bankers' positioned close together in one workroom and to work on the stone by moving round the 'banker'. The problem with this arrangement is that highly dusty processes not only cause high exposure to the stonemason doing the work but also potentially cause high exposure to everyone in the workroom.

64 If the stonemasonry your employees carry out involves significant numbers of highly dusty processes you should consider segregation. Indeed, it may not be possible to adequately control stone dust exposure without some degree of segregation. This will mean reorganisation and possibly expansion of the workshop. Indeed, expansion of the workshop may also be necessary to allow the effective application of controls to dusty processes. An advantage of such reorganisation is that production can be streamlined and made more efficient, although this may require stonemasons to work in different ways from those that they are traditionally used to. Figure 12 outlines a general segregation arrangement which separates dusty from less dusty processes. Stonemasons will need to be able to move the stone easily from area to area. See also Photograph 5 on page 31.

Process changes

Reduced power tool usage

65 There are at least two ways of doing this:

- 1 Shape and cut stone earlier in the production process using water cooled saws or other fixed stone shaping or cutting machinery rather than hand-held powered tools.
- 2 Do more hand chiselling and less hand-held powered tool work.



Figure 12 Segregation of dust-creating stonemasonry processes



Photograph 5 Segregation of dusty processes. Figure 12 shows segregation in diagrammatic form and these two photographs show practical ways of segregating power tool work from less dusty stonemasonry processes.

66 The first method requires some investment and a change in the order of stone working/production. The second option requires stonemasons to work differently. Older stonemasons may prefer hand working and be just as productive as their younger colleagues who may need some retraining in traditional masonry work methods. Whether this is a viable control option will depend on the amount and type of stone working done. It may be an option for those stonemasons who have simply got into the habit of using powered tools.

Using water to suppress stone dust

67 A lot of stonemasonry work is done on dry stone. Simply keeping stone wet will reduce dust emissions particularly from hand and pneumatic chiselling and, to a lesser degree, from polishing and disc cutting (see Photograph 9 on page 45). Stone will be wet after primary and secondary sawing and keeping the stone damp afterwards should not be too much of a problem. It is a practical process change which should be applied in many stonemasonry workshops.

68 It also may be possible to apply running water to operations such as polishing and disc cutting. This will require careful design so that stone slurry can be washed away. Disc cutters will almost certainly need to be pneumatically powered and stonemasons will need aprons and other personal protective equipment. Also, additional heating will be needed especially in winter. Potentially this is a very effective method of stone dust control where a lot of hand-held powered disc cutting or polishing is done.

69 Whether or not any of the options described are viable will depend on the specifics of the stone being worked and the stone products being made. Other examples of process change which reduce stone dust exposure will no doubt exist. They are likely to be successfully introduced if they have productive advantages. If

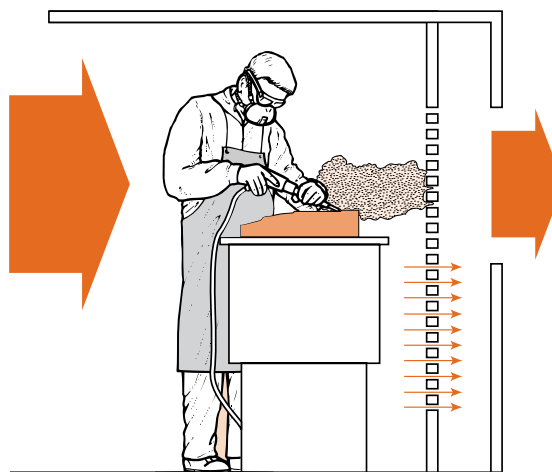
they are viable they will reduce dust exposure fundamentally and minimise the size of the task facing any other controls applied to reduce stone dust exposure, such as exhaust ventilation.

Ventilation

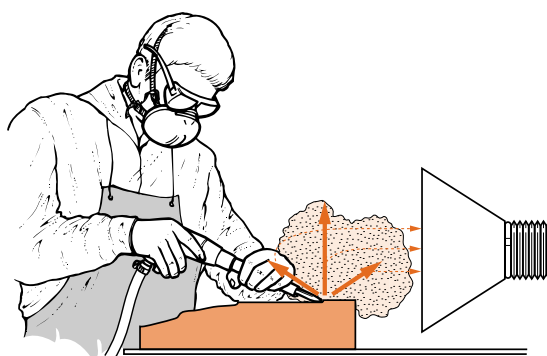
70 There are two main types of ventilation to be considered.^{13,14} The first, **exhaust ventilation**, is applied to the stone dust generating processes. The second, **general ventilation**, is organised to dilute stone dust in the workroom air which escapes the control of the exhaust ventilation.

Exhaust ventilation

71 There are three key points to understand when applying any type of exhaust ventilation to a dusty process.



1 Enclosure or receiving hood Airflow, which should be even through the 'face' of the booth, contains the dust-laden air and sweeps it away from the stonemason's breathing zone.



2 Captor or external hood Principle of operation - air sucked into the hood must generate sufficient air movement at this point to reverse the movement of the dust-laden air and draw it into the hood.

Figure 13 The two main types of exhaust ventilation hood

- 1** You must understand how the process to be controlled creates dust and how the dust-laden air flows away from the process.
- 2** You must understand how the two main types of exhaust ventilation hood work, their capabilities and limitations.
- 3** You must take account of how stonemasons work and allow for this when applying exhaust ventilation and/or changing their work methods.

72 There are two main types of exhaust ventilation, receiving systems and captor systems, the basics of which are illustrated in Figure 13 (see also Photographs 3, 6, 7 and 10).

73 The most well-known form of receiving system is the ventilation booth. If it can be said that there is one basic rule when applying exhaust ventilation it is that receiving hoods, which surround the dust-emitting process, are more effective than captor hoods which stand outside the process. Generally the more the process is enclosed the greater the potential reduction in exposure.

Enclosures

74 The big advantage of the ventilation booth over captor systems is that, within the booth, airflow is relatively even and constant and will tend to sweep away any dust-laden air wherever the stonemason is working on the stone. Well-designed booths can significantly reduce dust exposure from all stonemasonry operations involving manual and powered tools.

Exhaust ventilation booth design

75 There are some simple good design guidelines which can be applied to any exhaust ventilation booth. Booths need to:

- be big enough for foreseeable operations;
- enclose the process as much as possible;
- be well lit; and
- have an even face velocity and a minimum velocity within the booth of at least 1 m/s (approximately 200 feet per minute (fpm)).

In addition:

- air turbulence within the booth needs to be minimised by good design and restricting clutter; and
- work should be arranged so that stonemasons are not forced to place themselves between the source of stone dust and the back of the booth, ie where the dust-laden air will be drawn through their breathing zones.

Note: Even with well-designed booths, if powered tool working is intense, respirators may still be needed (see paragraph 92 on selecting combinations of control options).

Disc cutting and polishing and exhaust ventilation booths

76 Some essential design features of an exhaust ventilation booth for stonemasonry work are summarised in Figure 14.

77 Booths can cope with the large volumes of dusty air created by disc cutting as long as the dust jet is directed into the back of the booth although, when long deep cuts are made, the booth volume can still be filled with dusty air. The booth airflow should be sufficient to cope with this filling effect.

78 To ensure that stonemasons direct the jet into the back of the booth they must not work round the stone as often happens. They must be able to work on any part of the stone and yet still direct the jet into the booth. To be able to do this either the 'banker' needs to be on lockable wheels or it needs to incorporate a lockable turntable.

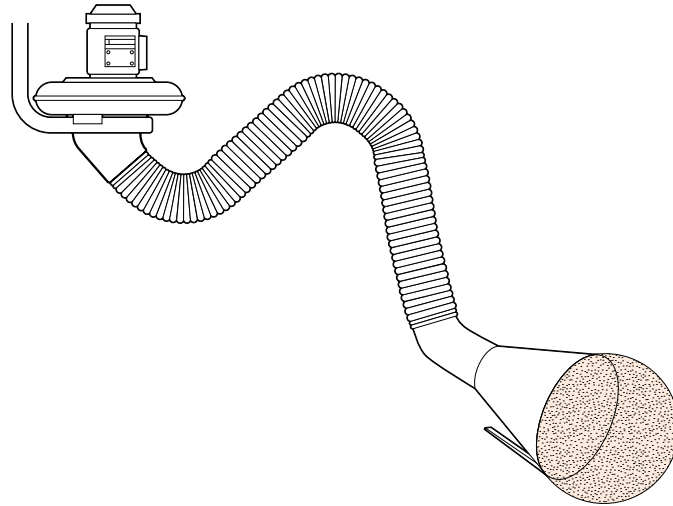


Figure 14 Some features of exhaust ventilation captor hood systems

Note: Captor hoods tend not to cope well with energetic processes such as disc polishing or cutting. Even with hand and pneumatic chiselling the hood will have to be positioned close to the work area and re-positioned regularly.



Photograph 6 Hand chiselling and captor hood exhaust ventilation. Sequence of three photographs shows stonemason working within the hood capture zone, partially within it and well outside it. Dust control is only effective when work takes place within capture zone (see Figure 14).

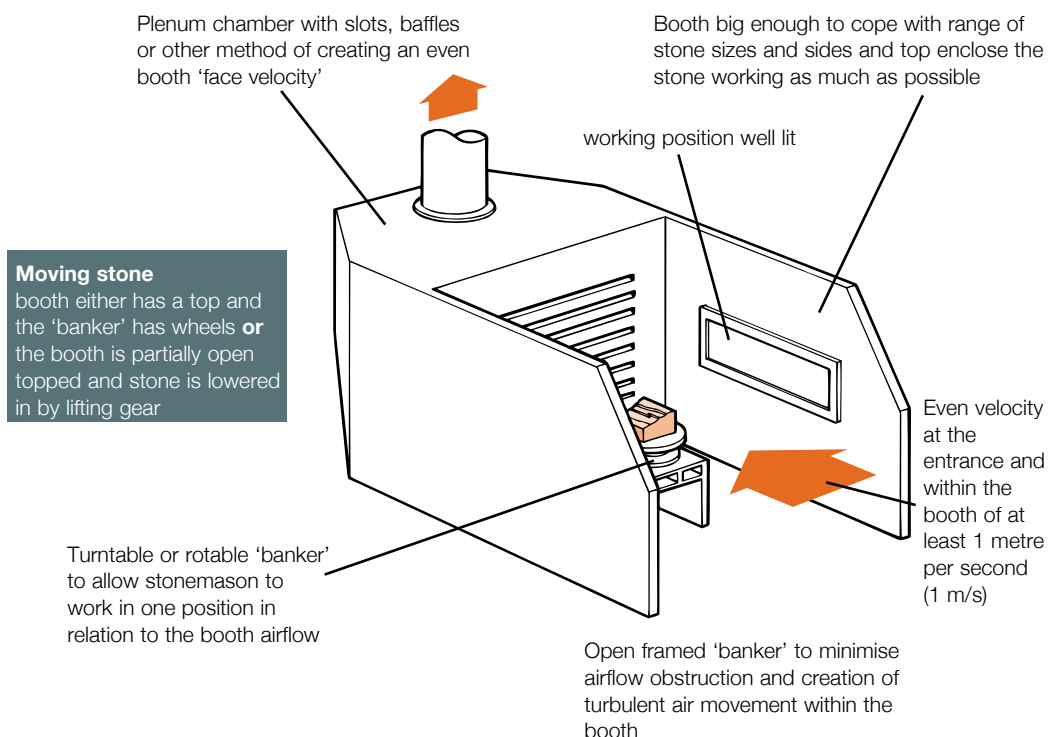


Figure 15 Some essential design features of an exhaust ventilation booth for stonemasonry work

79 There is also the second jet effect at the middle/end of the cut (see Figure 11) to be dealt with and this is more difficult. Working side-on to the booth airflow would probably be best but even then the air jet generated by the disc may overwhelm the booth airflow. Even an air velocity of 1m/s through a booth will not completely control stone dust exposure from disc cutting and polishing.

Exhaust ventilation 'captor' hoods—strength and limitations

80 Captor hoods have to generate sufficient air velocity at the stone dust source, overcome any air movement generated by the process, and draw in the dust-laden air – they 'capture' dusty air. In practice, the zone of control or 'capture distance' of a captor hood is limited. It will have hardly any effect well within two diameters of the hood and usually much less than this distance. Thus, for a 0.3 m (1 foot) diameter captor hood, the maximum 'capture distance' will be considerably less than 0.6 m (2 feet). Figure 14 summarises some essential features of captor systems. See also Photographs 6, 7 and 10 on pages 34, 36 and 48.

81 A captor hood can be quite effective, when applied to stonemasonry operations which take place on relatively small areas of stone, such as hand and pneumatic chiselling, as long as it is big enough and it is positioned close to the dust generation site. Stonemasons will need to get used to regularly repositioning the hood if they are working across or around a piece of stone. The captor hood ductwork will need to be sufficiently long and with enough reach and manoeuvrability so that the hood can be positioned correctly wherever the stonemason is working. If there is one thing that can be said about captor hoods it is that people are always over-optimistic about their effective range. Be realistic about exhaust ventilation captor hood 'capture distances': they will almost certainly be smaller than you realise and plan for.



Photograph 7 Polishing dust control. Dust-laden radial air jets (top and see Figure 10) are too big and fast moving to be captured. Almost no control of stone dust by captor hood (top and see Figure 14) although quite effectively swept away within an exhaust ventilation booth (bottom and see Figure 15)

On-tool captor hoods

82 Small captor exhaust ventilation hoods which can be fixed to hand-held powered tools are available. The more effective hoods are usually the ones built into the tool as part of its design. For disc cutting in straight lines on flat stone surfaces some designs, which enclose the blade completely, can be quite effective. Usually, the hood/guard does not enclose the blade and/or the amount of air extracted is not sufficient and only limited stone dust control is achieved. Equipment can be made cumbersome and such systems can be easily damaged. Select on-tool exhaust ventilation carefully and critically.

General workroom ventilation

83 Even with the best controls some stone dust will be released into the workroom atmosphere, unless all stone working is done wet or with good segregation of the dustiest processes. Adequate, planned general ventilation will be needed to dilute this dust. Otherwise, on cold days when the doors and windows are closed, airborne stone dust levels will build up throughout the workshop, increasing everyone's exposure whether or not the work they do is dusty. Clean air input creating local displacement ventilation where people work is most effective.

Personal protective equipment

Respirators

84 Respirators only provide protection for the wearer. They are towards the bottom of the control hierarchy and selection of control options should not start with respirators. Having said this, no local exhaust ventilation is anywhere near 100% effective and if stonemasonry work involves regular and intensive use of powered tools, especially disc cutters/polishers, it is quite possible that exposure will not be adequately controlled simply by exhaust ventilation. With site refurbishment work it may not be practical to apply exhaust ventilation although on-tool exhaust ventilation may be feasible. In these cases stonemasons will have to wear respirators.

85 A respirator should be technically capable of providing the degree of protection required, ie it should have the right 'protection factor' or PF. These are described in detail in *The selection, use and maintenance of respiratory protective equipment. A practical guide*¹⁵ but put simply the PF is the number of times a respirator can be expected to reduce a wearer's exposure to airborne stone dust (see Photograph

11 on page 50). A device with a 'PF' of 10 should reduce the wearer's stone dust exposure by 10 times. Apart from the PF a respirator should be comfortable, especially if a stonemason needs to wear it for prolonged periods.

86 Some key points to be aware of:

- Different respirator types provide different 'protection factors' – the type chosen should be related to, and capable of dealing with, the airborne stone dust levels the stonemason is exposed to.
- Devices which sit on the face (negative pressure respiratory protective equipment (RPE)) must be well sealed at all points. As with clothing and shoes, **one size of respirator does not fit all** and stonemasons should be offered a choice from a range of types/manufacturers if they are to be able to select a respirator that fits. If the stonemason has a beard no negative pressure device will work and if he is not clean shaven it will not work well.
- Where high 'protection factors' are needed for relatively long times, only powered or air-fed positive pressure devices will be adequate and suitable.
- The filter material in **disposable respirators** contains many millions of electrostatically-charged sites which attract stone dust particles. When most of these sites are used up the filter material will no longer work well. Other types of filter, mostly used in renewable cartridges, physically strain the air of stone dust particles and will eventually become clogged. Whichever type is used, whether disposable respirators or devices with renewable filters, the devices or filters should be renewed well before their performance is likely to deteriorate.
- All respirators, apart from disposable one-use devices, need maintenance.
- All respirators, including disposables, should be stored in suitable and clean containers. If respirators do not come in protective containers these should be supplied separately.
- People need to be trained to fit respirators properly and maintain their RPE.

Work clothing

87 Work clothing becomes contaminated with stone dust and can release a cloud of particles which rise, in the warm layer of air near a person's body, into their breathing zone. People literally walk around in their own personal stone dust clouds (see Photograph 12 on page 51). This effect was noted on pottery workers' clothing in the 1950s and a lower dust retention/release fabric 'ceramic terylene' was developed. Modern fabrics are more comfortable and hard wearing and have dust retention/release characteristics at least 20-times better than cotton. Where stonemasons' clothing tends to get highly contaminated, the use of such modern fabrics could significantly reduce indirect exposure and the clothing is likely to last longer than cotton. Protective clothing in potteries¹⁶ identifies HSE's report on the recent research and the four modern fabrics which performed best. Approach your supplier of work clothing for assistance.



Photograph 8 Blowing off stone debris. Using the pneumatic exhaust to blow off stone debris creates a large fine stone dust cloud. This is reduced by soaking stone and keeping it damp but better still would be to vacuum or carefully brush off debris

Work methods

Stone debris

88 Blowing off stone debris with the pneumatic tool exhaust when working on a high silica content stone can increase exposure by 70-80% over and above the exposure caused by chiselling itself. If exhaust ventilation is applied it will reduce the stone dust exposure caused by the pneumatic exhaust, but compressed air travels at high velocity and is difficult to control. A less dusty alternative way of removing stone debris such as vacuuming or gentle brushing, with exhaust ventilation control, should be used.

Using controls

89 Stonemasons need to understand how the controls they are provided with work and how to get the best control of dust exposure using such controls. They need to be trained and best practice needs to be described and, where possible, written down. Several examples of where clear instructions are needed have already been touched on and they include:

- If captor hoods are being used to control dust from hand and pneumatic chiselling the stonemasons will need to keep repositioning their hoods. They will also need to understand the concept of 'capture distance' and what the 'distance' is in practice for their hood.
- If disc cutting is being done in an exhaust ventilation booth the stonemason will need to direct the dusty jet into the booth and work in a position so that the air jet created by the spinning disc is most effectively drawn away from the breathing zone by the booth airflow (see Photograph 3 on page 28).
- Respirators, if used, will need to be maintained and filters changed.
- Work clothing will need to be changed when it gets too contaminated.

90 The right work methods are integral to the control options described and stonemasons have an important part to play in minimising their own stone dust exposure.

How effective are the potential control options?

91 Having worked out, or measured, exposure you now have to select the right mix of controls to deal with the degree of overexposure. The first thing you need to know is by how much a particular control option can reduce exposure (see Photographs 3, 5, 7 and 9 on pages 28, 34, 41 and 54). No control works perfectly and an indication

of how effective the various control options can be is given in Table 3. The amounts by which each type of control can reduce exposure, given in the table, are approximate but they are not unreasonable. Most of the estimates are given as ranges. The notes in the 'Comments' column of the table should enable you to identify which end of the range your controls are likely to be working.

Table 3 Estimated exposure reduction potential of some control options

Note: Estimates of control effectiveness are approximate but not unreasonable. Discuss likely reduction with designer or supplier.

Control option	Amount control option can reduce exposure from a particular process compared to the control not being applied †	Comments
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Workplace and process changes

Segregation	>20	Potentially a very effective method of reducing the exposure of those not directly involved in dusty processes. Workplace size and design will also affect dust levels in the workroom (see Figure 12 on page 33 and Photograph 5 on page 34).
Substitution	Variable (see comments)	Using a different type of stone containing less crystalline silica may sometimes be an option and can dramatically reduce potential overexposure. No specific factor is listed but a rough estimate could be made using Figure 6 on page 22.
Dry stone to wet stone	2–3	Keeping stone wet is probably most effective when applied to chiselling and polishing, less so when applied to disc cutting (see Photograph 9 on page 54). Effectiveness will vary with stone type.
Dry working to actively wet working	>20	Well-applied wet working can reduce dust emissions very effectively. The critical factors appear to be the amount of water used and how it is applied to the stone cutting/working zone.

†Example – A stonemason is exposed to 10 mg/m³ stone dust (8 hour daily average) and the control option reduces exposure by a factor of 2. The stonemason's exposure is therefore 10/2= 5 mg/m³. If the control reduction factor was 1.5 the stonemason's exposure would have been 10/1.5=6.7 mg/m³.

Table 3 cont

Control option	Amount control option can reduce exposure from a particular process compared to the control not being applied †	Comments
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Ventilation

Exhaust ventilation booth	Comment: Which end of the exposure reduction spectrum a particular booth sits will depend on how well it, the 'banker' and the work methods have been designed.	
Disc cutting	2–10	Dust 'jet' should be aimed into back of booth (see Photograph 3 on page 28). If booth size and airflow rate are inadequate discing will 'fill' the booth with dust-laden air and envelop the stonemason and it will spill out into the workroom.
Disc polishing	3–10	Stonemasons should position themselves so that the airflow has maximum effect. As with disc cutting, booth size and airflow rate will have a big effect on dust exposure reduction.
Pneumatic chiselling	4–15	As for disc polishing
Hand chiselling	4–20	As for disc polishing
Exhaust ventilation captor hood	Comments: As with booths, how effective a mobile captor hood is will depend on how well the hood matches the process. and, eben more than with a booth, how the stonemason uses, positions and re-positions the hood. Note: An exposure reduction of '1' means that the captor hood has no effect which, for some processes is, unfortunately the case.	
Disc cutting	1–3	For large discs, captor hoods will have little or no effect. They will be completely overwhelmed by the disc induced air-jet (see Figure 11 on page 26 and Photograph 10 on page 48). For smaller discs with a relatively large captor hood positioned to receive the dust 'jet', some dust exposure control will occur. How much will very much depend upon the stonemason's work method and the demands of the job.
Disc polishing	1–2	Captor hoods have limited 'reach' and because polishing can emit jets of dust-laden air from any point at the edge of the disc, dust control effectiveness will also be limited (see Figure 10 on page 25 and Photograph 6 on page 34).

Table 3 *cont*

Control option	Amount control option can reduce exposure from a particular process compared to the control not being applied †	Comments
Pneumatic chiselling	1–5	For all but work on small stones the captor hood will need to be regularly re-positioned to keep the chiselling point within the hood's 'capture zone' (see Photograph 6 on page 34). This may or may not be practicable depending upon the work being done
Hand chiselling	1–10	Similar to pneumatic chiselling except that when working on hard stone with large chisels, fine dust is created explosively in a bigger volume of air (see Figure 8 on page 24) which tends to be out of the reach or 'capture distance' of the hood. Can be effective on small-scale engraving type work.
Exhaust ventilation- on- tool captor system	1–5	A well-designed system which surrounds the disc blade and draws enough air can be quite effective but may not be applicable to many types of stonemasonry work. It may have a place in restoration and architectural work.
General ventilation	1.2–1.5	Unless it is well planned, general ventilation will only reduce the personal exposure of the stonemasons directly involved in stone working by a small amount. It will help to reduce the exposure of those indirectly exposed.
Work clothing		
Work clothing	1.2–1.5	By how much the use of modern fabrics can reduce exposure is difficult to say. If the stone work tends to cause heavy clothing-contamination, significant and worthwhile reductions are potentially possible (see Photograph 12 on page 51).
Work methods		
Removal of stone debris by vacuum	3–5	Blowing debris can be a big debris by vacuum contributor to exposure. Very significant reductions in exposure could be obtained by changing from the common practice of blowing off stone debris with the pneumatic exhaust to vacuuming it off.

Table 3 *cont*

Control option	Amount control option can reduce exposure from a particular process compared to the control not being applied †	Comments
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Respirators

Note: Respirators only provide protection for the wearer and are towards the bottom of the control hierarchy. **When selecting the appropriate blend of control options do not start with respirators.**

FFP 1 (Filtering facepiece to P1 filtration standard)	4	Well selected, fitted and maintained, these devices are likely to provide greater protection than the 'Assigned Protection Factor' listed (See Ref 15).
FFP 2 (Filtering facepiece to P2 filtration standard)	10	Well selected, fitted and maintained, these devices are likely to provide greater protection than the 'Assigned Protection Factor' listed (See Ref 15).
FFP 3 (Filtering facepiece to P3 filtration standard)	20	Well selected, fitted and maintained, these devices are likely to provide greater protection than the 'Assigned Protection Factor' listed (See Ref 15 and Photograph 11 on page 60).
Fullface mask – negative pressure	40	Well selected, fitted and maintained, these devices are likely to provide greater protection than the 'Assigned Protection Factor' listed (See Ref 15).
Fullface mask – powered device	40	Well selected, fitted and maintained, these devices are likely to provide greater protection than the 'Assigned Protection Factor' listed (See Ref 15).
Air-fed visor	100	Well selected, fitted and maintained, these devices are likely to provide greater protection than the 'Assigned Protection Factor' listed (See Ref 15).

STEP 3: What blend of control options will be adequate and sustainable?

92 Which mix of control options you choose will depend on the type of work done and the extent of stone dust overexposure. In the worked examples in Appendix 2 stonemasons are overexposed by between 3 and 208 times the relevant standard. What combination of control options will cope with this range of overexposures? The answer to these questions lies in understanding how effective the various control options can be and which will work effectively with what processes.

93 Selection starts with the most reliable control options which also reduce emission of stone dust into the workroom, ie you start at the top of the control option hierarchy and work down. How to combine control options is probably best illustrated by referring to the worked examples.

Worked example 1:

'Soft' stone containing no crystalline silica (Overexposure estimated to be about 14-times the respirable dust limit)

94 On the face of it, looking at the potential reductions listed in Table 3 uncritically, a combination of captor hood plus a respirator (to P1 filtration standard) could be enough ($4 \times 4 = 16$ fold reduction). But this is not correct because captor hoods, for the reasons already given, have limited 'reach' and a limited ability to cope with processes which energetically emit dust-laden air (see Figure 14 on page 38, and Photographs 6, 7 and 10 on pages 39, 41 and 58). The captor hood is unlikely to have much effect on the stone dust emitted from disc polishing and cutting. Where significant disc polishing and particularly cutting are done the only exhaust system which can control the dust-laden air is a well-designed booth. Or, if it can be made to work, water suppression of stone dust.

95 Let's assume that a booth is chosen, it's well designed and used and returns an exposure reduction of eight. In this case, if the stonemason wore a well selected and fitted respirator (to filtering facepiece – FFP1 standard) the potential total protection supplied would be $8 \times 4 = 32$, more than enough to reduce the overexposure. Whether disposable FFP devices are 'suitable' will depend upon how long the stonemasons have to wear them. In this case it is at least two hours (disc polishing and cutting times). Is it feasible for stonemasons to wear such a device, intermittently for a total of two hours over the work day? A difficult but essential question to answer.

Worked example 2:

'Soft' stone containing 5% crystalline silica (Overexposure estimated to be 35-times the respirable crystalline dust medical surveillance threshold (MST))

96 As a precautionary measure, because it minimises exposure and it probably makes economic sense stonemasons should wear overalls made from low dust retention/release fabrics.¹⁶

97 As with Worked example 1, because an important source of exposure is the disc polishing and cutting, a movable captor hood is not an option. This leaves a choice of booth, on-tool exhaust extraction system and respirators or water suppression. Also, as with example 1, if we assume the booth could reduce exposure by eight times then the other controls will have to reduce exposure a further six times. This degree of reduction could be obtained from on-tool exhaust ventilation working at the top of its capabilities or from respirators (to

FFP2 standard) (booth = x 8 and FFP2 = x 10, giving $8 \times 10 = 80$ fold reduction). Whether on-tool control is an option will depend on the stone work undertaken.

98 As with Worked example 1, whether disposable FFP-type respirators are a realistic option will depend on how long the stonemasons have to wear the devices. To get the Assigned Protection Factors listed in Table 3 people must wear the devices all the time they are exposed. If respirators are uncomfortable, people tend to ease the device off their face or slip them off to get some relief. These actions dramatically reduce the effectiveness of respirators. In terms of comfort, powered or air-fed respirators, which do not rely on a close fit to the face, might be a more reliable control option. Although, simply on the basis of exposure reduction, in this case, they are not needed. At Step 3 we are looking for reliable and sustainable control. You must ask yourself searching questions when selecting each control option whether the options you have selected are reliable and sustainable. This particularly applies to respirator selection.

Worked example 3:

'Hard' sandstone containing 90% crystalline silica (Overexposure estimated to be approximately 208 times the respirable crystalline dust medical surveillance threshold (MST))

99 With this degree of overexposure you must be thinking in terms of segregating the dustiest processes from other less dusty work and exploring process change options. If this cannot be done then the only combination of control options which will protect the stonemasons directly exposed is a well-designed booth, careful working by the stonemason and the use of air-fed respirators. This combination according to Table 3 would, in theory, produce an exposure reduction of $10 \times 100 = 1000$ although the reduction in practice will probably much less.

100 In this example it is particularly important to consider bystander exposure because, even if the booth reduced stone dust emission by ten times, this could still put dust levels in the vicinity of the stone working operation at over ten times the MST, hence the emphasis on segregation. If this cannot be done then others working in the stonemasons' workshop will have to wear respirators and it will be important to install planned and effective general ventilation.

Final control comment

101 Step 3 in controlling dust exposure is about selecting the right blend of control options that together add up to adequate and sustainable control measures. The options may be chosen from the classes of control listed earlier and will include working procedures that stonemasons need to adopt to get the best out of the controls. Control measures must be seen and managed as an integrated whole. This thought brings us to the final step in the quest for successful stone dust control.

<i>Summary checklist: Stone dust control</i>	Yes	No
Do you know what the 'golden rule' of control is?		
Do you know what the 'control hierarchy' is and means?		
Do you know what the four classes of control option are?		
Can you describe the essential features of a well-designed exhaust ventilation booth?		
Can you describe the strengths and limitations of exhaust ventilation 'captor' hoods?		
Do you know how to select and fit respirators?		
Do you know how to select the appropriate blend of dust controls?		
Do you know how stonemasons should best use the dust controls?		
Have you written down a description of the most effective dust control work methods?		



Photograph 9 Keeping stone well soaked and damp reduces release of fine stone dust particles especially for hand and pneumatic chiselling work

5 How to keep control of stone dust exposure

STEP 4: What monitoring, checking and maintenance are needed to make sure that the control measures continue to work?

Checking and maintaining control measures

102 If successful control of stone dust exposure is all about integrated control measures, including work methods, then ensuring that control is maintained is about monitoring, checking and maintaining these control measures—all of them. While it is convenient to divide control measures into ‘hardware’, such as exhaust ventilation or respirators, and ‘software’ such as instructions to stonemasons, it is important not to lose sight of the concept of control measures as an integrated whole.

‘Hardware’

103 Local exhaust ventilation performance will fall off with time, often imperceptibly, and will need regular examination and monitoring. This could include static pressure checks in the ducts to the hood or regular measurement of face velocity. Guidance is given in *Maintenance, examination and testing of local exhaust ventilation*.¹⁷ The frequency of checks should be related to the rate at which the exhaust ventilation system performance is likely to fall off. Regulation 9 of COSHH requires a 14 monthly ‘thorough examination and test’ by a competent person but regular and effective checks will be needed far more frequently than this. Given that it will be the stonemasons who use the equipment day to day it would make sense that they did regular and simple checks. One method is to link a (static) pressure gauge to the booth/hood ductwork with a simple green (for ‘go’) and red (for ‘stop’) scale.

104 If respirators are part of the control measures they will need regular maintenance including replacement of filters, etc. If respirators with replaceable filters are used the body of the respirator itself will need replacing: they don’t last forever. Also, if respirators are battery-powered the batteries will also need replacing after a time.¹⁵ And it is not just a question of listing what maintenance needs to be done but of deciding who is going to do it, how often, and who is going to supervise maintenance.

‘Software’

105 Apart from checks on the hardware of control, the way people are working and using the controls needs to be monitored. So that supervisors and the stonemasons themselves are able to do this effectively and fairly, the appropriate work methods need to be described and written down, as a benchmark for all concerned.

Airborne dust monitoring – what’s it for and is it needed?

106 So far the checks mentioned have been on the control measures and this is certainly far easier, cheaper and more direct than measuring exposure. But the acid test of any set of control measures is how much the exposure of the stonemasons has been reduced. Measurement should be done under ‘worst case’ conditions as these are the most severe test of the control measures. If they reduce exposure sufficiently under ‘worst case’ conditions then exposure under less severe dust

challenges will definitely be controlled. However, measurement may not be necessary if you have already made conservative estimates of likely dust exposures and selected control options to deal with these potential exposures.

107 Dust measurements are not an end in themselves, they are a means to an end – good stone dust control. If this can be attained without dust measurements then so be it. Whether this is the case will take informed, competent judgement. If in doubt–take advice. Where dust sampling is needed it should be done carefully and competently by an experienced and qualified person (see *Further information*).

Getting control and keeping control

108 The four steps needed to successfully control the stone dust exposure of stonemasons have been outlined. Please keep asking yourself the questions posed at each step until you have developed robust, convincing answers. If necessary take advice.

109 If your stonemasonry work involves low intensity, intermittent, hand working on stone which contains no crystalline silica then it's possible no dust overexposure is occurring and you stop at Step 1. Conversely, if your business involves a lot of stone working with hand-held power tools, particularly if it is on stone with a high crystalline silica content, then overexposure is highly likely and selection of the right mix of control options is going to be critical and important. And you will need to integrate your selection too. It can be done.

110 If the steps outlined in this guidance are followed the diseases suffered by generations of stonemasons will truly be a thing of the past and we will, finally, have put the 'good/bad old days' behind us.

111 For further information on stone dust control please consult the *References and Further information* sections in this guidance and/or HSE's Metals and Minerals Sector (HSE Cardiff Office).

Summary checklist: Maintenance of dust controls	Yes	No
Do you know what monitoring and checking of control 'hardware' is needed to maintain the effectiveness of dust control measures?		
Do you know what monitoring and checking of control 'software' is needed to maintain the effectiveness of dust control measures?		
Do you know what airborne dust monitoring can be used for and when it is needed?		



Photograph 10 Disc cutting using a captor hood. Stonemason attempting to direct dust jet into a captor hood with limited success at the start of the cut and almost no effective control at the end of the cut. Captor hoods cannot cope with large, fast moving dust-laden air jets.

6 Occupational health surveillance

112 This topic is dealt with in more detail in *Respirable crystalline silica* and only a basic outline is given in this guidance.¹²

113 Regulation 11 of COSHH requires employers to introduce health surveillance where it is appropriate. At regular exposures above the MST of 0.075 mg/m³ (when measured or estimated for any 8-hour period) there may be an increased risk of silicosis developing. (Note: 0.075 mg/m³ is often rounded up to 0.1 mg/m³.) If exposure can be kept well below the MST, health surveillance may not be needed.

114 As far as health surveillance is concerned, the major problem is not when it should be done, but what should be done. In the early stages, all forms of silicosis are silent, and affected individuals do not have any symptoms. The only way to detect the disease is by chest X-ray. A reasonable frequency of chest X-rays for workers with exposures above 0.075 mg/m would be every five years during the first 20 years' exposure and thereafter at more frequent intervals (at least every 3 years) at the discretion of the medical adviser and dependent on the level of exposure. Many experts also recommend periodic chest examination and lung function tests, but it is difficult to see what value these add to chest radiography. See *Respirable crystalline silica* for additional details.¹²

115 Acute silicosis does not present the same radiological picture as either accelerated silicosis or classical silicosis, so doctors who are reading chest X-rays should be aware of these differences. All positive cases should be referred to a chest specialist for consultation and, if necessary, diagnostic lung biopsy.

116 Over-emphasis should not be placed on medical surveillance: at the end of the day it is a process that detects disease rather than preventing it. It is important that surveillance is targeted at those who are truly at risk and that resources are directed towards control of exposure to silica dust.

Summary checklist: Occupational health surveillance	Yes	No
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Do you know when medical surveillance is needed?		
Do you know what medical surveillance is needed and how often?		



Photograph 11 Pneumatic chiselling on grit stone (see Figure 1 for likely crystalline silica content) can cause exposures up to 10 mg/m³ respirable silica dust (see Figure 3). The respirator being worn would not protect the stonemason from this level of exposure.

Appendix 1: Occupational exposure limits in the UK

1 Under the Control of Substances Hazardous to Health Regulations 1999 (COSHH), an occupational exposure limit (OEL) is a legal standard which refers to the concentration or amount of a substance in air which can be breathed in over a stated period of time, referred to as a time-weighted average (TWA). There are two types of OEL within COSHH, a maximum exposure limit (MEL), and an occupational exposure standard (OES).

2 MELs are set for substances with serious health effects and these exposure limits should not be exceeded. There may be some residual risk at or below the MEL which is why there is a legal obligation to control exposure to as far below the MEL as reasonably practicable.

3 There is a MEL for respirable crystalline silica of 0.3 mg/m^3 averaged over an 8-hour TWA. It is known that there may be some residual risk of silicosis at prolonged exposures at 0.3 mg/m^3 and every effort should be made to reduce exposures below the MEL. It is a limit to work down from and not up to. Because of the residual risk below 0.3 mg/m^3 , HSE recommends that all people regularly exposed to respirable crystalline silica dust levels greater than 0.075 mg/m^3 averaged over an 8-hour TWA should be under medical surveillance.

4 A number of mineral dusts produced by stoneworking have OESs which are listed in the HSE publication *Occupational exposure limits* (EH40),¹¹ for example, limestone, marble and gypsum. The values of these OESs are 4 mg/m^3 for the respirable dust, and 10 mg/m^3 for the total inhalable dust, both as 8-hour TWAs.

5 For dusts which do not have a specified OEL listed in *Occupational exposure limits* (EH40), COSHH states that a risk assessment must be carried out when 'substantial dust concentrations occur' which are defined as 4 mg/m^3 for respirable dust, and 10 mg/m^3 for total inhalable dust (8-hour TWA).

6 Adherence to these limits is required under COSHH.¹⁰ However, it would be prudent to reduce dust exposures below the limits where possible.



Photograph 12 Work clothing and personal dust clouds. Stone dust released from badly contaminated work clothing (see text and Table 3)

Appendix 2 Calculating daily exposure and comparing it with exposure limits

Steps in calculating exposure

1 There are three steps to calculating exposure and comparing it with the relevant exposure limits, four if the stone being worked contains crystalline silica. The steps are:

STEP 1: Exposure by process – how much and how long?

STEP 2: What is the daily average exposure? Use automated table from HSE website (see Worked example 1)

STEP 3: How does the daily average exposure compare with the relevant exposure limit?

STEP 4: How does respirable crystalline silica dust exposure compare with the MEL and MST (if the stone contains crystalline silica)?

Warning – spurious precision alert!

2 Calculations produce numbers. When these are used, without an understanding of all the assumptions and uncertainties in the assessment process, it is tempting to imagine that the stonemason really is exposed to 16.987 mg/m³ of stone dust! The calculations help define the size of the problem but the estimates behind the calculations are imprecise and 16.987 should be rounded up and taken to be, say, between 15 and 20 mg/m³. Round up and be aware of the imprecision of the assessment method you are using.

Exposure time

3 Chapter 3 covered how you estimate the exposure of a stonemason for each stonemasonry process used. To calculate exposure over the work day you also need to know how long a stonemason is exposed to each process. A simple way of doing this is to ask the stonemason to keep a work log such as the following:

Stonemason's work log

Stoneworking process	Start time	Stop time	Duration	Cummulative sum of durations for each process	Comments
Hand chiselling					
Pneumatic chiselling					
Disc cutting					
Polishing					
Other operation					
Other time in the workshop					

4 The steps in calculating stone dust exposure are illustrated in three worked examples.

Worked example 1: 'Soft' stone containing no crystalline silica.

STEP 1: Exposure by process – how much and how long?

5 Prepare a table listing all the processes which are causing stone dust exposure and how long the stonemason is exposed to each source. An example is given in the following table. A general automated version of this table is available, to use or to download, on the Metals and Minerals section of the HSE website (www.hse.gov.uk/fod/metalmin.htm). The stonemason does a variety of work over the day. The assessor has noted the cumulative time for each type of work and using Figures 3, 4 and 6 together with the factors in Table 1 from Chapter 3, has gauged the likely exposure from each process.

Worked example 1: Calculating or estimating average daily stone dust exposure

<i>Process or operation</i>	<i>Estimated or measured exposure to respirable stone dust in mg/m³</i>	<i>Exposure time (minutes)</i>	<i>Notes</i>
Disc cutting	200	60	All work done on 'soft' stone containing no crystalline silica
Disc polishing	200	60	As above
Pneumatic chiselling	30	45	As above
Hand chiselling	10	60	As above
Workroom exposure	2.5	225	Background exposure can be significant in mason's workshops

STEP 2: What is the daily average exposure?

6 The general formula for calculating the daily time weighted average (TWA) exposure is:

$$\frac{C_1 \times T_1 + C_2 \times T_2 + \dots + C_n \times T_n}{480}$$

Where C = concentration of respirable stone dust in mg/m³ and T is the time in minutes (8 hours being 480 minutes). Using the numbers in the Worked example should make the calculation clearer.

$$\frac{200 \times 60 + 200 \times 60 + 30 \times 45 + 10 \times 60 + 2.5 \times 225}{480} = \text{Approximately } 52 \text{ mg/m}^3 \text{ (8-hour TWA)}$$

STEP 3: How does exposure compare with the relevant exposure limit?

7 The standard to apply is 4 mg/m³ (8-hour TWA) (see Chapter 2). An exposure of 52 mg/m³ is approximately:

$$\frac{52}{4} = \text{Approximately 13-times the standard}$$

8 The calculations for the other two worked examples are shown below. In both these cases the stone contained crystalline silica and this adds an additional step to the calculations.

Worked example 2: 'Soft' stone containing 5% crystalline silica.

9 Steps 1 to 3 are described above and are not listed separately. Dust exposures and times are as for Worked example 1 but 5% of the stone dust is crystalline silica. Respirable dust exposure is:

$$\frac{200 \times 60 + 200 \times 60 + 30 \times 45 + 10 \times 60 + 2.5 \times 225}{480} = \text{Approximately } 52 \text{ mg/m}^3 \text{ (8-hour TWA)}$$

10 The comparison with the respirable dust standard is the same as in Worked example 1 and the stonemason's 8-hour TWA exposure is approximately 13 times the standard. But, because the stone being worked contained 5% crystalline silica, there is a Step 4 in the process.

STEP 4: How does respirable crystalline silica dust exposure compare with the MEL and MST?

11 The 52 mg/m³ respirable dust contains 5% crystalline silica, thus the respirable crystalline silica dust exposure is:

$$\frac{52 \times 5}{100} = 2.6 \text{ mg/m}^3$$

12 And 2.6 mg/m³ respirable crystalline silica dust is then compared with the MEL and MST (0.3 mg/m³ and 0.075 mg/m³ (8-hour TWAs)) respectively:

$$\frac{2.6}{0.3} = 9\text{-times the MEL} \quad \frac{2.6}{0.075} = \text{Approximately 35-times the MST}$$

Worked example 3: 'Hard' stone containing 90% crystalline silica.

STEP 1: Exposure by process – how much and how long?

Worked example 3: Calculating or estimating average daily stone dust exposure

Process or operation	Estimated or measured exposure to respirable stone dust in mg/m ³	Exposure time in minutes	Notes
Disc cutting	75	60	All work done on sandstone containing 90% crystalline silica. Respirable dust assumed to be 90% crystalline silica
Pneumatic chiselling	30	60	As above
Hand chiselling	20	90	As above
Workroom exposure	0.7	270	Background exposure can be significant in mason's workshops

STEP 2: What is the daily average exposure?

The daily time weighted average (TWA) exposure is:

$$\frac{75 \times 60 + 30 \times 60 + 20 \times 90 + 0.7 \times 270}{480} = 17.3 \text{ mg/m}^3 \text{ (8-hour TWA)}$$

STEP 3: How does exposure compare with the relevant exposure limit?

14 The standard to apply is 4 mg/m³ (8-hour TWA) (see Chapter 2).

$$\frac{17.3}{4} = \text{Approximately 4-times the respirable dust standard}$$

STEP 4: How does respirable crystalline silica dust exposure compare with the MEL and MST?

15 Comparison with the MEL and MST:

Respirable dust exposure – 17.3 mg/m³ of which 90% is crystalline silica therefore respirable crystalline silica exposure is:

$$\frac{17.3 \times 90}{100} = 15.5 \text{ mg/m}^3$$

$$\frac{15.2}{0.3} = \text{Approximately 52-}$$

times the MEL

$$\frac{15.5}{0.075} = \text{Approximately 208-}$$

times the MST

References

- 1 *Silica* HSE Information Sheet Construction Sheet No 36 Second Edition HSE Books 1999; *Dust control in concrete cutting saws used in the construction industry* HSE Construction Sheet No 54 **HSE Books 2000**
- 2 *Control of respirable crystalline silica in quarries* HSG73 **HMSO 1992 ISBN 0 11 885680 4**
- 3 *Need help on health and safety? Guidance for employers on when and how to get advice on health and safety* INDG322 **HSE Books 2000 ISBN 0 7176 1790 4**
- 4 *General methods for sampling and gravimetric analysis of respirable and total inhalable dust* MDHS 14/3 **HSE Books 2000 ISBN 0 7176 1749 1**
- 5 *The dust lamp – A simple tool for observing the presence of airborne particles* MDHS 82 **HSE Books 1997 ISBN 0 7176 1362 3**
- 6 Figures based on an analysis of government statistics produced by Suzi Curtis (HSE Health Division, Epidemiological and Medical Statistics Unit (EMSU), Room 246, Magdalen House, Bootle, Merseyside.
- 7 Seaton A, Legge JS, Henderson J et al 'Accelerated silicosis in Scottish stonemasons' *Lancet* 1991 **337** (9 February) 341-344 ISSN 0140 6736
- 8 Department of Social Security *Lung cancer in relation to occupational exposure to silica: Report by the Industrial Injuries Advisory Council in accordance with section 171 of the Social Security Administration Act 1992 on the question whether lung cancer in relation to occupational exposure to silica should be prescribed* **HMSO 1992 ISBN 0 1012 0432 9**
- 9 *General COSHH ACOP (Control of substances hazardous to health) and Carcinogens ACOP (Control of carcinogenic substances) and Biological agents ACOP (Control of biological agents). Control of Substances Hazardous to Health Regulations 1999. Approved Codes of Practice L5* **HSE Books 1999 ISBN 0 7176 1670 3**
- 10 *COSHH: A brief guide to the Regulations* INDG136 (rev1) **HSE Books 2000 (available in priced packs, ISBN 0 7176 2444 7)**
- 11 *Occupational exposure limits* 2001 EH40/2001 (revised annually) **HSE Books 2001 ISBN 0 7176 1977 X**
- 12 *Respirable crystalline silica* (second edition) EH59 **HSE Books 1997 ISBN 0 7176 1432 8**
- 13 *An introduction to local exhaust ventilation* HSG37 **HMSO 1993 ISBN 0 11 8821342**
- 14 *Industrial ventilation – a manual of recommended practice* American Conference of Governmental Hygienists (ACGIH) 23rd edition **1998 ISBN 188 241 7224**
- 15 *The selection, use and maintenance of respiratory protective equipment: A practical guide* Second edition HSG53 **HSE Books 1998 ISBN 0 7176 1537 5**

- 16 Dyson H M and Johnson DJ/Leeds University *Protective clothing in potteries*
HSE contract research report no 208/1999 **HSE Books 1999**
ISBN 0 7176 1694 0

Note report recommended four types of fabric:

- Tightly woven fabric; plain weave, polyamide, optimum filament size 15 µm, lightly calendered.
 - Microporous coated fabric; plain weave, polyamide base fabric, tightly woven, optimum filament size 10–12 µm.
 - Hydrophylic polyurethane coated fabric; plain weave, polyamide base fabric, tightly woven, average filament diameter size 20 µm.
 - Disposable non-woven; suit with high moisture vapour transmission for one-off use, and a non-hairy variety, type 5 particle transmission.
- 17 *Maintenance examination and testing of local exhaust ventilation* HSG54
HSE Books 1998 ISBN 0 7176 1485 9

While every effort has been made to ensure accuracy of the references listed in this publication, their future availability cannot be guaranteed.

Further information

British Institute of Occupational Hygienists (BIOH)
Suite 2, Georgian House
Great North Road
DERBY DE1 1LT
Tel: 01332 298 087; Fax: 01332 298 099; e-mail: bioh@compuserve.com
website: www.bioh.org

Stone Federation of Great Britain
18 Mansfield Street
LONDON W1M 9FG
Tel: 020 7580 5404; Fax 020 7636 5984

National Association of Memorial Masons
27a Albert Street
Rugby
Warwickshire CV21 2SG
Tel: 01788 542264; Fax: 01788 542276

Heating and Ventilating Contractor's Association (HVCA)
Esca House
34 Palace Court
LONDON W2 4JG
Tel: 020 7229 2488; Fax: 020 7727 9268; website: www.hvca.org.uk
Members of HVCA are classified by the 'specialist services' they offer including 'local exhaust ventilation systems (COSHH)'.

This book is accompanied by a free leaflet for stonemasons: *Stonemasonry dust and you: Guidance for stonemasons* INDG315 HSE Books 2001, due for publication autumn 2001.

For information about health and safety ring HSE's Infoline Tel: 0845 345 0055
Fax: 0845 408 9566 Textphone: 0845 408 9577 e-mail: hse.infoline@natbrit.com or
write to HSE Information Services, Caerphilly Business Park, Caerphilly CF83 3GG.

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at www.opsi.gov.uk.