Assessment of exposure to respirable crystalline silica (RCS) and benchmarking of exposure controls during manual splitting and dressing of slate

Prepared by the Health and Safety Executive
Respirable crystalline silica (RCS) is a substantial contributor to the burden of occupational lung disease. Exposure can cause silicosis, lung cancer and chronic obstructive pulmonary disease (COPD). Quarry workers carrying out manual slate splitting and dressing are potentially exposed and the health risks can be significant if effective exposure control measures are not in place. At present, four GB companies employ workers to do these tasks.

This report describes research to assess levels of exposure to RCS in manual slate splitting and dressing and the effectiveness of current exposure control measures. The aim was to identify benchmarks for good control practice, and to provide evidence to inform the planned update of HSE guidance for industry. The researchers measured exposure and assessed exposure control at two quarries. They found that some ancillary tasks to the slate splitting process were sources of exposure to RCS for which no controls were applied and that HSE’s guidance could be improved by including these tasks and providing clearer illustrations of recommended controls. The researchers also reviewed the scientific literature. They identified studies conducted in Wales and in Norway which highlight potential worker respiratory health issues.

HSE’s updated guidance, informed by the findings of this research, was published in October 2019. This guidance is COSHH essentials for stone workers: Silica ‘ST6: Slate Splitting Manual’ and ‘ST7 Dressing slate (edge bevelling)’.

This report and the work it describes were funded by the Health and Safety Executive (HSE). Its contents, including any opinions and/or conclusions expressed, are those of the authors alone and do not necessarily reflect HSE policy.
Assessment of exposure to respirable crystalline silica (RCS) and benchmarking of exposure controls during manual splitting and dressing of slate

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KEY MESSAGES

Respirable crystalline silica (RCS) is a substantial contributor to the burden of lung disease and can cause silicosis, lung cancer and chronic obstructive pulmonary disease (COPD). Quarry workers are potentially exposed to RCS in their work carrying out manual slate splitting and dressing.

Control of Substances Hazardous to Health (COSHH) essentials direct advice sheets, which provide guidance on controlling exposures to hazardous substances in different industries, are available on the HSE website. They include sheets relevant to the slate industry, on the control of respirable crystalline silica (RCS) splitting and dressing slate. This research, which involved an occupational hygiene assessment at two slate splitting companies, aimed to establish whether the control measures recommended on these sheets are still current, practical and effective in adequately controlling RCS dust generated during the processing of slate.

This research has shown the following.

- The measured 8-hour time-weighted average (8-hr TWA) exposures to RCS ranged from <0.012 to 0.09 mg/m$^3$ for slate splitting, and 0.01 to 0.12 mg/m$^3$ for dressing.

- A comparison of these exposure data, with those measured previously at the companies visited for the same tasks, showed that the addition of engineering controls such as local exhaust ventilation (LEV) over the years has reduced exposures to RCS.

- However, there are ancillary tasks to the slate splitting and dressing processes that are also sources of exposure to RCS and are not currently controlled at the sites visited. One example is the packing and stacking of slates after they have been split / dressed, where no exposure control measures were applied.
EXECUTIVE SUMMARY

Introduction

One of the main occupational health concerns for workers in the quarrying sector is respiratory disease, caused by exposure to respirable crystalline silica (RCS). Exposure to RCS can cause silicosis, lung cancer and chronic obstructive pulmonary disease (COPD)\(^1\).

HSE is aware that:

- there may be a significant variation in engineering control measures, and the level of control used to reduce employee exposure to RCS; and
- quarries visited may not operate systems that are in accordance with the COSHH Essentials direct advice sheets for slate works.

At the start of the project there were specific sheets for slate working that included slate splitting (SL4) and slate dressing (SL5). It was not clear if the control information provided in these sheets was current, practical and effective in adequately controlling the RCS dust generated.

HSE, therefore, needed information on the crystalline silica content of slates being quarried, and on typical exposure levels of RCS following application of the control measures recommended in the slate sheets. This information would help to establish future benchmarks for the control of RCS that could be used within the slate industry.

There are reportedly three main locations in Great Britain (GB) where slate is quarried, and in those areas there are a total of four companies that carry out manual slate splitting and dressing. These four companies were invited to volunteer to participate in this research work.

Findings

A literature search on slate and RCS found two relevant research papers. One was from a survey of the exposure to RCS of slate workers in Norway\(^2\) and the other was on the effect of mining on lung function and risk of COPD in a cohort of Welsh slate miners\(^3\). The conclusions were that, ‘there is reason to fear that silicosis will be an increasing problem among quarry workers if efforts to reduce quartz exposure are not put into effect’ and ‘Slate mining may reduce lung function and increase the incidence of COPD independently of smoking and pneumoconiosis’ respectively.

Of the four companies within GB that reportedly carry out manual slate splitting and dressing, two companies were visited and the other two declined to volunteer. This represents 50% of the industry.

Findings from the site visits were:

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\(^1\) [http://www.hse.gov.uk/aboutus/occupational-disease/cancer/silica.htm](http://www.hse.gov.uk/aboutus/occupational-disease/cancer/silica.htm)


Local exhaust ventilation (LEV) for manual slate splitting was as illustrated in the SL4 sheet. At one of the companies this extraction was accompanied by local air displacement (LAD), as mentioned in SL4.

At one company the LEV systems for splitting released the extracted (and cleaned) air back into the workplace. The LAD systems drew in air from the workplace and filtered it. If the filters for these systems were to fail there would be significant exposure to the worker. This highlights the need for alarms and pressure gauges.

Some slate dressing was in accordance with the details provided in the SL5 sheet, but most of that observed was more enclosed, with the worker remote from the cutting / bevelling process.

It was noted, at one of the companies, that stacking slates after they had been split / dressed created airborne dust which was a likely source of exposure to RCS. This task was not carried out under the influence of extraction and was not covered in the slate sheets. Hence the slate sheets do not fully cover the ancillary tasks associated with slate splitting and dressing.

Measured 8-hour time-weighted average (8-hr TWA) exposures to RCS ranged from <0.012 to 0.09 mg/m³ for slate splitting and 0.01 to 0.12 mg/m³ for slate dressing. Further breakdown of the results into manual and automated splitting, shows ranges of <0.012 to 0.07 mg/m³ and 0.08 to 0.09 mg/m³ respectively. Further breakdown of the dressing results into rotary and ‘automated and enclosed’ shows exposures of 0.02 mg/m³ and 0.01 to 0.12 mg/m³ respectively. It is known that long-term exposure to RCS at levels below the WEL still represent a risk to health⁴.

Respiratory protective equipment (RPE) was worn at both companies, but deficiencies in the RPE regimes were noted at both companies.

By comparison with the historic data obtained from HSE’s National Exposure Database (NEDB) it appears that since 1994, both splitting and dressing have evolved from having no engineering controls, through to being able to be fully enclosed and extracted with minimal worker contact (observed for splitting at one company, and for dressing at both companies). This has had a positive effect on reducing worker exposure to RCS. However, there are other sources of exposure that need to be adequately controlled.

In conclusion, based on this research and assuming the two companies visited are typical of the industry then:

- Sheet SL5 on slate dressing could be improved to include the use of fully enclosed and extracted slate dressing systems, in addition to the use of rotary dressers currently mentioned.
- Ancillary aspects of the processes of slate splitting and dressing, in particular, packing and stacking slates, could be mentioned on both sheets to make slate workers aware that these processes also need to be adequately controlled.

⁴ Respirable crystalline silica - Phase 1 Variability in fibrogenic potency and exposure-response relationships for silicosis, HSE 2002 www.hse.gov.uk/pubns/books/eh75-4.htm
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1 INTRODUCTION

1.1 BACKGROUND
One of the main occupational health concerns for workers in the quarrying sector is respiratory disease, caused by exposure to respirable crystalline silica (RCS). Exposure to RCS can cause silicosis, lung cancer and chronic obstructive pulmonary disease (COPD)\(^1\).

Visits, by HSE, to a number of slate quarries in Great Britain (GB) have revealed a significant variation in the types of engineering control measures used to reduce employee exposure to RCS. A significant variation in the level of control was also observed. Most of the quarries visited did not operate control systems in accordance with the COSHH Essentials direct advice sheets for slate works.

At the start of the project there were specific COSHH Essentials sheets covering slate splitting and dressing (called SL4 and SL5 respectively), and it was not clear if the control information provided in these sheets was current, practical and effective in adequately controlling RCS. These sheets can be seen in Appendices 1 and 2.

Information was therefore required on the silica content of slates being quarried, and on typical exposure levels of silica following application of the control measures recommended in the advice sheets and those being used within the industry.

This research aimed to quantify RCS exposures associated with various controls in use at a range cross-section of sites. The information obtained would help in establishing benchmarks for the control of RCS that could to be used within the slate industry to reduce RCS exposure during slate splitting and dressing operations.

Internal HSE knowledge advised that there are four companies within three main GB locations that carry out manual slate splitting and dressing. The intention was that these four companies would be invited to volunteer to participate in this research work.

1.2 AIM AND OBJECTIVES
The aim of the research was to establish if the control measures provided in COSHH Essentials direct advice sheets for slate working remained current, practical, and effective by obtaining RCS exposure measurements during manual slate splitting and dressing.

In order to fulfil this aim, the stated objectives were:

- Obtain ethical approval for the work;
- Carry out a literature review to determine the extent of current knowledge regarding RCS exposure controls for manual slate splitting and dressing;
- Obtain bulk samples of slate from quarries in each of three geographical locations to determine silica content of the raw material in order to understand geographical variations;
- Undertake visits to up to four slate quarries where manual splitting and dressing take place to identify current exposure scenarios\(^5\);

\(^5\) Note - All visits were carried out in accordance with HSE's research protocol [www.hse.gov.uk/fee-for-intervention/assets/docs/protocol-hsi-visits.pdf](http://www.hse.gov.uk/fee-for-intervention/assets/docs/protocol-hsi-visits.pdf)
• Identify current control practices and good control practice techniques for each scenario;
• Undertake monitoring of RCS exposure for each scenario (and determine if industry data are available, to enable exposure trends to be identified); and
• Obtain sufficient information for HSE to develop a matrix of RCS exposure that can be used to benchmark effective control.

1.3 HEALTH EFFECTS OF RCS
In GB the control of occupational exposure to hazardous substances must comply with the Control of Substances Hazard to Health Regulations (COSHH) 2002 (as amended). COSHH Regulation 7(1) states “Every employer shall ensure that the exposure of his employees to substances hazardous to health is either prevented or, where this is not reasonable practicable, adequately controlled”. Regulation 7(7) states that “without prejudice to the generality of paragraph (1) (i.e. regulation 7 (1)) where there is exposure to a substance hazardous to health, control of that exposure shall only be treated as being adequate if -

a) The principles of good practice for the control of exposure to substances hazardous to health set out in schedule 2A are applied;

b) Any workplace exposure limit approved for the substance is not exceeded; and

c) For carcinogens, asthmagens and those substances capable of causing heritable genetic damage, exposure is reduced to as low a level as reasonably practicable.”

RCS has a workplace exposure limit (WEL) of 0.1 mg/m³, as an 8 hour time weighted average (TWA). There is no short-term (15-minute) limit and in these cases a figure of three times the 8-hour TWA limit is recommended as a guide. Uncontrolled long-term exposure to RCS can cause silicosis (a chronic irreversible lung disease) and lung cancer. The principles of good practice in Schedule 2A of the COSHH Regulations require measures to be applied proportionate to the health risk, therefore employers should reduce exposure significantly below the WEL because of the serious risk to health posed by RCS.

The COSHH approved code of practice (ACoP) and guidance (L5) states that “Dust of any kind can also become a substance hazardous to health under COSHH when it is present at concentrations in the air equal to or greater than 10 mg/m³ (as a time-weighted average over an 8-hour period) of inhalable dust or 4 mg/m³ (as a time-weighted average over an 8-hour period) of respirable dust”.
2 METHODS

2.1 LITERATURE SEARCH
A literature search was requested which covered the following search words:

- Slate splitting + manual + RCS;
- Slate dressing + manual + RCS;
- Slate working + manual + RCS;
- UK slate types and regions;
- Silica in UK slate; and
- RCS or silicosis

These words were entered into:

Endnote, Proquest, Web of Science and HSE’s e-Library.

A search was also carried out through the Mint UK database (a database of company information), for companies in the UK with a SIC code 0811 (quarrying of ornamental & building stone, limestone, gypsum and slate).

A search of HSE’s National Exposure Database (NEDB) using ‘slate’ as the industry term was carried out to determine if any exposure monitoring for respirable dust and RCS had been carried out before.

2.2 ETHICAL APPROVAL
In accordance with internal procedures this project required ethical approval from an in-house research ethics panel. As part of this process, project specific information sheets and consent forms were developed and approval granted.

2.3 SITE RECRUITMENT
The companies were initially recruited by the HSE sector contact. Following on from this, telephone contact was made with each company, and the project information sheets forwarded on to the company by the project technical lead.

2.4 SITE VISITS
At both sites, exposure monitoring for respirable dust and RCS was carried out on the workers who spent their shifts splitting and dressing slate. Sampling periods were representative of the whole shift. Bulk samples of slate were also collected and analysed for quartz (RCS) content.

Exposure monitoring samples were collected in accordance with HSE’s Methods for the Determination of Hazardous Substances (MDHS) 14/4 ‘General methods for sampling and gravimetric analysis of respirable, thoracic and inhalable aerosols’4. Respirable dust concentrations were determined gravimetrically with RCS concentrations determined using X-ray diffraction (XRD) in accordance with an in-house method based on MDHS 101/2 ‘Crystalline silica in respirable airborne dust’5.

The bulk slate samples were analysed using XRD.
Engineering controls including LEV systems within the work areas were assessed using a combination of dust lamp, smoke tubes and anemometer.

Findings from the site visits were fed back to the volunteer companies via a site visit report.
3 FINDINGS

3.1 LITERATURE SEARCH

The literature search results included two research papers and links to the previously mentioned COSHH Essentials direct advice sheets SL4 and SL5.

An in-house search of NEDB came up with historical records from three different companies, two of which were the two companies that participated in this work. These records are discussed in Section 3.3.

One of the research papers was entitled ‘Quartz Exposure in the Slate Industry in Northern Norway’, written by B E Bang and H Suhr and printed in Annals of Occupational Hygiene Vol 42 No 8 pp 557-563, 1998. Published by Elsevier Science Ltd.6

Conclusions from the paper included:

- The slate factory had lower quartz levels (RCS exposures) than the quarry;
- Assessment of historical exposure showed that 32 of 45 quarry workers with available exposure history had a lifetime inhaled quartz dose of more than 10 g; and
- There is reason to fear that silicosis will be an increasing problem among quarry workers if efforts to reduce quartz exposure are not put into effect.

The summary of this study is in Appendix 3.


This study looked at the cumulative effect of mining on lung function and risk of COPD in a cohort of Welsh slate miners based on a secondary analysis of Medical Research Council (MRC) survey data. The conclusion was that:

‘Slate mining may reduce lung function and increase the incidence of COPD independently of smoking and pneumoconiosis.’

The summary of this study is in Appendix 4.

3.2 SITE VISITS

Of the four companies invited to take part in this project, two declined. The two companies visited (50 % of the industry) are referred to in this report as company 1 and company 2.

3.2.1 Exposure controls

Company 1

Company 1 had extraction in the form of fixed captor hoods for slate splitting. These hoods were at the work station facing the worker and offered good capture of the dust at the work position. There was no LAD as recommended in SL4, or any other means of forced mechanical ventilation, although
open doors were present providing air dilution. Some dressers were rotary and in accordance with those recommended in SL5. Other dressers were present which were fully enclosed.

At Company 1 RPE with an assigned protection factor (APF)\(^6\) of 20\(^8\) was worn. RPE was said to be face fit tested and the workers trained in its use; however, it was noted that some workers had stubble which would affect the fit of the RPE type used. The company stated that they were taking further advice on their RPE.

**Company 2**

Company 2 had exposure controls for splitting in accordance with those in SL4 (extraction in the form of fixed captor hood and LAD). Fixed captor hoods were facing the worker for some splitters and side on the worker for some splitters. LAD systems were above the workers head when they were in the work position. Dressers were fully enclosed; however, in both processes there were tasks that were outside of the influence of extraction (i.e. packing and stacking slates). In addition, not all splitting was carried out within the capture zone of the hood.

The ‘cleaned air’ from the LEV system at Company 2 was released back into the work area. Any failures of the filters / air cleaners would lead to additional exposures for anyone in the vicinity. In addition, the LAD systems drew air in from inside the building through filters and down over the workers breathing zone. This air would be contaminated, and therefore it is imperative that the system has no leaks and the filters are intact.

At Company 2, RPE with APFs of 20 and 10 were worn. Whilst workers were face fit tested, a significant portion wore their masks incorrectly. Some also had stubble. Both incorrect use and stubble would adversely affect the protection offered.

Airflow indicators / pressure gauges to check the air flows into the LEV hoods / from the LAD were not present at either company. This meant that the user of the systems did not know if they were working correctly.

### 3.2.2 Exposures

A summary of the 8-hr TWA exposures to respirable dust and RCS can be seen in Table 1. Tasks have been split up to allow direct comparisons between information obtained at each company.

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\(^6\) *The APF is a number rating that indicates how much protection that RPE is capable of providing. For example, RPE with an APF of 10 will reduce the wearer’s exposure by at least a factor of 10 if used properly, or, to put it another way, the wearer will only breathe in one-tenth or less of the amount of substance present in the air.*

\(^8\)
### Table 1 Summary of the exposures (in mg/m$^3$) obtained at Companies 1 and 2

<table>
<thead>
<tr>
<th>Task</th>
<th>Company</th>
<th>No. of samples</th>
<th>8-hr TWA</th>
<th>RCS median</th>
<th>RCS number ≥WEL</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slate splitting (manual)</td>
<td>1</td>
<td>9</td>
<td>0.18 – 0.40</td>
<td>0.03 – 0.07</td>
<td>0.05</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>5</td>
<td>0.05 – 0.35</td>
<td>&lt;0.01 – 0.06</td>
<td>0.05</td>
<td>0</td>
</tr>
<tr>
<td>Slate splitting (automated and enclosed)</td>
<td>2</td>
<td>2</td>
<td>0.36 – 0.40</td>
<td>0.08 – 0.09</td>
<td>0.09</td>
<td>0</td>
</tr>
<tr>
<td>Slate dressing (rotary)</td>
<td>1</td>
<td>2</td>
<td>0.15 – 0.18</td>
<td>0.02</td>
<td>0.02</td>
<td>0</td>
</tr>
<tr>
<td>Slate dressing (automated and enclosed)</td>
<td>2</td>
<td>6</td>
<td>0.12 – 0.49</td>
<td>0.02 – 0.12</td>
<td>0.05</td>
<td>2</td>
</tr>
<tr>
<td>Cleaning *</td>
<td>2</td>
<td>2</td>
<td>N/A</td>
<td>0.28† – 0.55‡</td>
<td>-</td>
<td>N/A</td>
</tr>
</tbody>
</table>

* Task based samples not 8-hr TWA
† Wet cleaning
‡ Ride on sweeper

The crystalline content of the bulk slate samples was 23 and 33 % at Company 1 (two bulk samples were taken) and 32 % at Company 2.
### 3.2.3 Comparisons with SL4 and SL5

Tables 2 and 3 show the comparisons of the controls found at both companies with SL4 slate splitting and SL5 slate dressing respectively.

#### Table 2 Comparisons with SL4 Slate splitting

<table>
<thead>
<tr>
<th>Controls (SL4 Manual slate splitting)</th>
<th>Site comment</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Equipment</strong></td>
<td></td>
</tr>
<tr>
<td>Keep slates damp during handling and packing</td>
<td>Slate blocks were not dampened specifically for splitting as such. Company 1 dampened the surface on which the slates were placed, and at Company 2 slate blocks had previously been wet cut and some may still have been damp.</td>
</tr>
<tr>
<td>Use local air displacement (air inlets)</td>
<td>Used at Company 2 but not Company 1. The air was drawn in from within the building, filtered, then directed down through the workers breathing zone.</td>
</tr>
<tr>
<td>Arrange the work station layout so that dust is directed towards the capture hood</td>
<td>This was the case at Company 1. At Company 2, the work station was set out so that the dust would be directed towards the hood, but at some work stations the slate was lower than the capture zone. In addition, stacking slates was outside of the LEV influence.</td>
</tr>
<tr>
<td>Make sure that draughts do not interfere with the air flow</td>
<td>There was some interference at Company 1 but not at Company 2.</td>
</tr>
<tr>
<td>An air speed of between 5 and 10 m/s into the capture hood</td>
<td>At both companies the air speeds were either within this range or higher.</td>
</tr>
<tr>
<td>Fit manometers or pressure gauges to the hood with marked acceptable reading ranges</td>
<td>Neither company had these; Company 1 had noted this and was going to investigate. At Company 2, the extracted air was filtered and released back into the workplace. Manometers / pressure gauges would alert the user to any filter problems which could result in significant additional exposure.</td>
</tr>
<tr>
<td><strong>PPE</strong></td>
<td></td>
</tr>
<tr>
<td>RPE with an APF of 40 if slates are dry and air inlets are not used</td>
<td>At Company 1 the RPE APF was 20. At Company 2 sit-down splitters wore APF 20; stand-up splitters did not wear RPE. Where used RPE was face fit tested.</td>
</tr>
<tr>
<td>Protective goggles</td>
<td>Safety glasses were worn at both companies.</td>
</tr>
<tr>
<td>Dust resistant coveralls</td>
<td>Not worn at either company, though Company 1 were looking into purchasing some.</td>
</tr>
<tr>
<td>Use a contract laundry or suitable equivalent to wash work clothing</td>
<td>At Company 1, overalls were laundered at home at the time of the visit. During the writing of the site visit report on-site laundry facilities were provided. At Company 2, overalls were laundered by a contract laundry.</td>
</tr>
<tr>
<td><strong>Cleaning and housekeeping</strong></td>
<td></td>
</tr>
<tr>
<td>Wash down the work room at the end of each work day</td>
<td>Yes for Company 1 and no for Company 2.</td>
</tr>
<tr>
<td>Use a type H vacuum cleaner fitted with a HEPA filter to clear up dust</td>
<td>Neither company used a H-type vacuum.</td>
</tr>
</tbody>
</table>
### Table 3 Comparisons with SL5 Slate dressing

<table>
<thead>
<tr>
<th>Controls (SL5 Dressing slate (edge bevelling))</th>
<th>Site comment</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Equipment</strong></td>
<td></td>
</tr>
<tr>
<td>Use the body of the dressing machine as an extracted enclosure. Locate the equipment in an extracted booth</td>
<td>This was the case at both companies.</td>
</tr>
<tr>
<td>An inward air speed of between 1 and 2.5 m/s into the enclosure openings</td>
<td>At Company 1, one rotary dresser was within range and the other was lower, the company stated that they would investigate this. At Company 2 (all dressers were enclosed and extracted) airflow could not be measured due to access restrictions.</td>
</tr>
<tr>
<td>Fit manometers or pressure gauges to the hood with marked acceptable reading ranges</td>
<td>Neither company had these.</td>
</tr>
<tr>
<td>Have a supply of clean air coming into the room to replace extracted air</td>
<td>Company 2 had planned, forced mechanical ventilation. Open doors and windows provided air dilution at Company 1 who were taking advice on this.</td>
</tr>
<tr>
<td>Indicator or alarm on LEV to show if filters are blocked or have failed</td>
<td>Neither company had these.</td>
</tr>
<tr>
<td><strong>PPE</strong></td>
<td></td>
</tr>
<tr>
<td>Decide the level of protection of RPE from air sampling data. Otherwise use RPE with an APF of at least 40</td>
<td>At Company 1 the RPE APF was 20. At Company 2 the APF was 10.</td>
</tr>
<tr>
<td>Face fit tested RPE</td>
<td>Yes for both companies.</td>
</tr>
<tr>
<td>Dust resistant coveralls</td>
<td>Not worn at either company, though Company 1 were looking into purchasing some.</td>
</tr>
<tr>
<td>Use a contract laundry or suitable equivalent to wash work clothing</td>
<td>At Company 1, overalls were laundered at home at the time of the visit. During the writing of the site visit report on-site laundry facilities were provided. At Company 2, overalls were laundered by a contract laundry.</td>
</tr>
<tr>
<td><strong>Cleaning and housekeeping</strong></td>
<td></td>
</tr>
<tr>
<td>Wash down the work room at the end of each work day</td>
<td>Yes for Company 1 and no for Company 2.</td>
</tr>
<tr>
<td>Use a type H vacuum cleaner fitted with a HEPA filter to clear up dust</td>
<td>Neither company used a H-type vacuum.</td>
</tr>
</tbody>
</table>

### 3.3 NEDB SEARCH RESULTS

NEDB records were found for companies 1 and 2 that participated in this work (two and three records respectively). Summaries of exposures (and exposure controls where data were available) are in Table 4. Records were also found for a third company (Company 3), the summaries of which can also be found in Table 4.
Table 4 Summaries of historical records from NEDB

<table>
<thead>
<tr>
<th>Company (year)</th>
<th>8hr TWA RCS (mg/m³)</th>
<th>Exposure controls</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 (1994)</td>
<td>Splitting &lt;0.02 – 0.09 Dressing &lt;0.02 – 0.05</td>
<td>Fixed captor hood LEV for splitting, no RPE LEV for dressing, no RPE</td>
</tr>
<tr>
<td>1 (2004)</td>
<td>Splitting 0.07 – 0.17 Dressing 0.08 – 0.26</td>
<td>Fixed captor hood LEV for splitting, no RPE LEV for dressing, no RPE</td>
</tr>
<tr>
<td>2 (1994)</td>
<td>Splitting 0.07 – 0.28 Dressing 0.11 – 0.19</td>
<td>Some splitting stations had LEV in the form of flexible captor hoods; some stations did not have LEV Some dressing was carried out under LEV some was not No details on any RPE provided</td>
</tr>
<tr>
<td>2 (2002)</td>
<td>Splitting 0.05 – 0.15 Dressing 0.09 – 0.51</td>
<td>All splitting stations had LEV; all but one also had LAD Dressers were enclosed and extracted Some workers wore RPE some did not</td>
</tr>
<tr>
<td>3 (1990)</td>
<td>Splitting 0.19 – 0.42 Dressing 0.19 – 0.23</td>
<td>No LEV or RPE for either process</td>
</tr>
</tbody>
</table>

The above results for companies 1 and 2 are further split between process and exposure controls in Tables 5 and 6 within Appendix 5 of this report. Line graphs have been produced from the median of each dataset from those tables to show RCS exposures has over the years (see Figures 1 and 2).

Figure 1 Graph to show how exposures to RCS have varied over time at company 1

The company 1 graphs show that there has been little difference in exposures in 1994 and 2017 for rotary dressing and splitting. Exposures were higher in 2004, however with so few samples collected (n = 4 for splitting and n = 3 for dressing), no statistical conclusions can be drawn. In 2017 the
exposure controls for these two tasks at this company were the same as those first observed in 1994/2004.

Figure 2 Graph to show how exposures to RCS have varied over time at company 2

Figure notes:
- LAD had been installed at splitting stations when sampling was carried out in 2002.
- LEV? – Report does not say if LEV was present or not.

The company 2 graph indicates that RCS exposures have decreased as exposure controls such as LEV have been added. The graph also shows that RCS exposures when splitting with LEV and auto dressing have decreased since 1994. LAD was introduced to the splitting task in 2002 and a decrease in RCS exposures can be seen. The exposures for 2017 show little statistical difference between auto splitting and splitting with LEV and LAD. Automated dressing exposures have decreased since 1994.
4 DISCUSSION

4.1 SLATE SPLITTING

SL4 (slate splitting) showed an illustration of a typical work station layout, see Figure 3. The quoted recommendation was ‘use local air displacement — see illustration’. However, the configuration in the illustration differed from that for a LAD given in HSE Guidance Publication HSG 258 ‘Controlling airborne contaminants at work: A guide to local exhaust ventilation (LEV)’, where the plenum (air outlet) for LAD is located close to the workers head as in Figure 4. The arrangement in SL4 more closely resembled a push-pull LEV system than LAD.

![Figure 3 The slate splitting workstation layout from SL4](image1)

![Figure 4 A LAD system in HSG 258](image2)

The LEV used for manual slate splitting at both companies was in accordance with the illustration in SL4 in that it was a fixed captor hood located at the work position. Company 1 did not have a LAD, whilst that at Company 2 was similar to the one in Figure 4. Neither the LEV configuration, nor the LAD observed, would offer control of the dust generated during slate stacking, which was observed at company 2 but not company 1.

At company 2 automated and enclosed splitting was also carried out. The worker only had contact with the slates when feeding them into the machine and then stacking them afterwards. This latter task is the most probable source of their exposure to RCS which approached the WEL. As can be
seen in Table 1, automated splitting gave the highest 8-hr TWA exposures to RCS for this task on this site.

4.2 SLATE DRESSING

SL5 (Slate dressing) had an illustration of a rotary dresser (see Figure 5) and the recommendation to:

‘Use the body of the dressing machine as an extracted enclosure. Locate the equipment in an extracted booth’.

![Figure 5 Rotary dresser set-up from SL5](image)

Although each company had rotary dressers, the majority of the dressing was seen to be carried out in enclosed and extracted systems. These were small units (not much bigger than the slate tiles), fitted to a conveyor at company 1. Larger systems (approximately 1.5 m high, separated from the worker by plastic / mesh barriers) were seen at company 2. In theory, both these systems should offer better control than the rotary dresser as worker contact was limited to stacking the slates afterwards. However, the task of stacking slates may be contributing to the dresser exposures at company 2. RCS exposures for automated and enclosed dressing were less than half the WEL at company 1, but at company 2 one was at the WEL and one exceeded it.

4.3 CLEANING

At company 2, cleaning was carried out at the end of the shift. Two personal task specific exposures to RCS were measured and these were 0.28 and 0.55 mg/m$^3$. The former was during a wet cleaning task that took approximately five minutes. The latter was when using a ride on sweeper that disturbed a significant amount of settled dust making it airborne. The sampling time was 17 minutes which meant that the notional 15-minute short-term exposure limit of 0.3 mg/m$^3$ would have been exceeded indicating inadequate control.

Company 1 also cleaned towards the end of the shift. This was done by hosing down work areas with water and damp sweeping. Vacuum cleaners were also reportedly used. Some occasional dry sweeping was carried out and this was for slate fragments too large to vacuum and too close to equipment that must not get wet.
4.4 OTHER COMMENTS
It was noted that none of the LEV / LAD systems at either company had airflow indicators / pressure gauges present. This meant that the user of the systems did not know if the systems were working as they should. These indicators / gauges would be extremely beneficial at company 2 as, due to the recirculation of extracted air back into the workplace from the LEV, and the drawing of workplace air into the LAD system, there is the potential for significant additional exposure if filters fail.

The APF of the RPE worn at both companies was not of the level recommended for dry slate processing. Deficiencies in the use of RPE were also common at both companies.

4.5 EXPOSURE TRENDS
Data in the NEDB enabled graphs to be plotted (Figures 1 and 2) that show median exposures over time (from 1994 – 2017) obtained from research visits covering slate splitting and dressing. Over the years, both splitting and dressing have evolved from having no engineering controls, through to fully enclosed and extracted processes with minimal worker contact (apart from some splitting at company 2, and dressing at both companies). At company 1, there appears to be little difference in exposures over the years for manual splitting and rotary dressing. This is of little surprise as the exposure controls were the same. At company 2 the addition of exposure controls have had a positive effect on reducing worker exposure to RCS. However, as mentioned in this report, there are other sources of exposure, namely stacking and packing, that could be better controlled in order to better protect worker health in this industry sector.
5 CONCLUSIONS

The aim of the research was to establish if the control measures provided in COSHH essentials direct advice sheets SL4 and SL5 remained current, practical and effective in adequately controlling exposure to RCS, by obtaining RCS exposure measurements during manual slate splitting and dressing.

RCS exposures for the operators of automated splitters and dressers approached the WEL (for splitting) and were at, and exceeded, the WEL (for dressing). The only worker contact with the slate was during packing and stacking of slates, and this was a source of exposure (only observed at company 2) that was not covered by the LEV systems present. It is known that long-term exposure to RCS at levels below the WEL represent a risk to health and as such there is a need to further improve exposure controls in this sector.

At company 2 the LEV systems for splitting released the extracted (and cleaned) air back into the workplace. The LAD systems drew in air from the workplace and filtered it. If the filters for these systems were to fail there would be significant exposure to the worker. This highlights the need for monitoring systems e.g. alarms and pressure gauges.

Cleaning at company 2 was a source of exposure to RCS (no monitoring of cleaning was done at company 1). In particular the use of a ride on sweeper which re-suspended settled dust back into the air gave a significant task specific RCS exposure.

Conclusions made about SL4 and SL5 in relation to the findings of this study (assuming the two companies visited are typical of the industry) are:

- Sheet SL5 on slate dressing could be improved to include the use of fully enclosed and extracted slate dressing systems, in addition to the use of rotary dressers currently mentioned.
- Ancillary aspects of the processes of slate splitting and dressing, in particular, packing and stacking slates, could be mentioned on both sheets to make slate workers aware that these processes also need to be adequately controlled.

The introduction of engineering controls since the 1990’s has had a positive effect on reducing worker exposure to RCS at one of the companies visited. However, as mentioned in this report, there are other sources of exposure, namely the stacking and packing of slates that could be better controlled in order to better protect worker health in this industry sector.
6 REFERENCES


7 APPENDIX

7.1 APPENDIX 1 SL4 MANUAL SLATE SPLITTING

SL4

Manual slate splitting

COSHh essentials for slate works: Silica

Control approach 2 Engineering control

Hazard
- Cutting, splitting or dressing slate can produce airborne respirable crystalline silica (RCS).
- RCS is hazardous, causing silicosis. This is a serious lung disease causing permanent disability and early death.
- Silicosis is made worse by smoking.
- ‘Respirable’ means that the dust can get to the deepest parts of the lung. Such fine dust is invisible under normal lighting.
- Keep inhalation of RCS as low as possible.
- When all controls are applied properly, less than 0.1 mg/m³ RCS is usually achievable (based on an 8-hour time-weighted average).

Crystalline silica concentrations in common materials
- Slate contains up to 40% crystalline silica.

Access and premises
- Only allow access to authorised staff.
- Floors should slope gently towards gutters, to help dust removal by wet washing.

Equipment
- Splitting, separation, closing and stacking slates create local jets of fine dust.
- Reduce dust by keeping slates damp during handling and packing.
- Use local air displacement – see illustration. The inlet air must be clean.
- Arrange the workstation layout so that dust is directed towards the capture hood.
- You need an air speed at 1 metre per second from the air inlet, and between 5 and 10 metres per second into the capture hood.
- Make sure that draughts do not interfere with the air flow.
- Fit manometers or pressure gauges near the air supply and extraction points, to show that the system is working properly.
- Mark the acceptable range of readings.
✓ Discharge cleaned, extracted air to a safe place outside, away from doors, windows and air inlets.
✓ Fit an indicator or alarm to show if filters have blocked or failed.
✓ Consult HSI on new system designs. See ‘Useful links’

Procedures
✓ Always confirm that the extraction system is turned on and working before starting work.
✓ Shake down air filters regularly (e.g. every hour), or use automated reverse-jet cleaning.
✓ Make sure you can get spares easily.

Maintenance, examination and testing
✓ Minerals and silica-containing dusts are very abrasive. Plan regular maintenance.
✓ Follow the instructions in the manual - keep equipment in effective and efficient working order.
✓ Check that filter settings are in good condition.
✓ If the dust extraction or filtration plant is faulty, stop work until it is repaired.
✓ Daily, look for signs of damage. Noisy or vibrating fans can indicate a problem.
✓ At least once a week, check that the dust extraction system and gauges work properly.
✓ You need to keep all controls in good working order. See sheet C406 for advice on engineering controls.
✓ You need to know the manufacturer’s specifications to check the extraction’s performance.
✓ If this information isn’t available, hire a competent ventilation engineer to determine the performance needed for effective control.
✓ The engineer’s report must show the target extraction rates.
✓ Keep this information in your testing log-book.
✓ Get a competent ventilation engineer to examine the extraction thoroughly and test its performance at least once every 12 months. See the HSE publication HS304 - see ‘Further information’.
✓ Keep records of all examinations and tests for at least five years.
✓ Review records - failure patterns show where preventive maintenance is needed.
✓ Carry out air sampling to check that the controls are working well. See sheet C403.

Personal protective equipment (PPE)
✓ Ask your safety equipment supplier to help you get the right PPE.
✓ Provide storage for clean and contaminated PPE.
Respiratory protective equipment (RPE)

- RPE should not be needed if the controls work properly.
- RPE is often needed for maintenance and some cleaning jobs.
- Powered or air-fed RPE is more comfortable to wear.
- If slates are dry and local air displacement is not used, select RPE with an APF of at least 40. See sheets R4 and R5.

Other protective equipment

- Provide protective goggles. A visor may not stop flying debris.
- Provide clean, dust-resistant coveralls.
- Use a contract laundry or a suitable equivalent to wash work clothing. Warn them that the dust contains silica.
- Skin creams help in washing contamination from the skin. After-work creams help to replace skin oils.
  Caution: Never allow use of compressed air for removing dust from clothing.

Health surveillance

- You need health surveillance unless exposure to RCS is well below the limit. See sheet G1/01.
- Consult an occupational health professional - see ‘Useful links’.

Cleaning and housekeeping

- Wash down the workroom at the end of each day’s work.
- Use a Type H vacuum cleaner fitted with a HEPA filter to clear up dust eg. on overhead fittings.
  Caution: Don’t clean up with a brush or compressed air.

Training and supervision

- Tell workers that silica dust can cause serious lung diseases.
- Working in the right way and using the controls correctly is important for exposure control. Train and supervise workers. See sheet S1/00.

Further information

- Maintenance, examination and testing of local exhaust ventilation
- Control of respirable crystalline silica in quarries HSG73 HSE Books
  1992 ISBN 0 11 885680 4
- For environmental guidelines see sheet SL0
Useful links

- The Stone Federation may advise on health and safety consultants and training providers. Website: www.stone-federationgb.org.uk.
- For information about health and safety, or to report inconsistencies or inaccuracies in this guidance, visit www.hse.gov.uk. You can view HSE guidance online and order priced publications from the website. HSE priced publications are also available from bookshops.
- For details of local air displacement controls contact the Health and Safety Laboratory (HSL) Tel: 0129 821 8000 e-mail hslinfo@hsl.gov.uk.
- Contact the British Occupational Hygiene Society (BOHS) on 01332 298101 or at www.bohs.org for lists of qualified hygienists who can help you.
- Look in the Yellow Pages under ‘Health and safety consultants’ and ‘Health authorities and services’ for ‘occupational health’.
- Also see www.nhspius.nhs.uk.

Employee checklist

☐ Are you sure how to use all dust controls?
☐ Is the air supply and extraction working and in the correct position?
☐ Look for signs of leaks, wear and damage every day.
☐ If you find any problems, tell your supervisor. Don’t just carry on working.
☐ Make suggestions to improve the effectiveness of dust control.
☐ Co-operate with health surveillance.
☐ Use, maintain and store your protective equipment in accordance with instructions.
☐ Use skin creams provided as instructed.

This document is available at: www.hse.gov.uk/pubns/guidance/ and www.hse.gov.uk/coshh/essentials/

This document contains notes on good practice which are not compulsory but which you may find helpful in considering what you need to do.
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SL5

Dressing slate (edge bevelling)

Control approach R
Respiratory protective equipment (RPE)

Hazard
- Cutting, splitting or dressing slate can produce airborne respirable crystalline silica (RCS).
- RCS is hazardous, causing silicosis. This is a serious lung disease causing permanent disability and early death.
- Silicosis is made worse by smoking.
- “Respirable” means that the dust can get to the deepest parts of the lung. Such fine dust is invisible under normal lighting.
- Keep inhalation of RCS as low as possible.
- When all controls are applied properly, less than 0.1 mg/m³ RCS is usually achievable (based on an 8-hour time-weighted average).

Crystalline silica concentrations in common materials
- Slate contains up to 40% crystalline silica.

Access and premises
- Only allow access to authorised staff.
- Floors should slope gently towards gullies, to help dust removal by wet washing.

Equipment
- PPE is normally needed to reduce exposures to an acceptable level.
- Dressing creates fine and coarse dust that tends to blow into the workroom.
- Use the body of the dressing machine as an extracted enclosure.
- Locate the equipment in an extracted booth.
- Can you also use water suppression?
- You need an air speed between 1 and 2.5 metres per second into the enclosure openings.
- You need an inward air speed between 1 and 1.5 metres per second at the face of a cross-draught booth.
- Fit a manometer or pressure gauge near the extraction point, to show that the system is working properly.
- Mark the acceptable range of readings.
With multiple extraction points, a simplified pressure check method may suffice.
Discharge cleaned, extracted air to a safe place outside, away from doors, windows and air inlets.
Have a supply of clean air coming into the workroom to replace extracted air.
Fit an indicator or alarm to show if filters have blocked or failed.
Consult a qualified ventilation engineer to design new control systems or to update current controls. See sheet Q406.

Procedures
Always confirm that the dust extraction is turned on and working before starting work.
Make sure that workers check that their RPE works properly every time they put it on.
Shake down air filters regularly (eg every hour), or use automated reverse-air cleaning.
Make sure you can get spares easily.

Maintenance, examination and testing
Minerals and silica-containing dusts are very abrasive. Plan regular maintenance.
Follow the instructions in the manual - keep equipment in effective and efficient working order.
Check that filter sealings are in good condition.
If the dust extraction or filtration plant is faulty, stop work until it is repaired.
Maintain all RPE in effective and efficient working order.
Keep airline oil and water traps empty, and filters clean.
Daily, look for signs of damage. Make repairs.
At least once a week, check that the dust extraction system and gauges work properly.
You need to keep all controls in good working order. See sheet Q406 for advice on engineering controls.
You need to know the manufacturer’s specifications to check the extraction’s performance.
If this information isn’t available, hire a competent ventilation engineer to determine the performance needed for effective control.
The engineer’s report must show the target extraction rates.
Keep this information in your testing log-book.
Get a competent ventilation engineer to examine the extraction thoroughly and test its performance at least once every 14 months. See the HSE publication HSG54 - see ‘Further information’.
Keep records of all examinations and tests for at least five years.
Review records - failure patterns show where preventive maintenance is needed.
Check the air flow and air quality to air-fed RPE at least once every three months or before use. Ensure that compressors (including mobile compressors) take in only clean air.
Make sure that users examine their RPE and test it works properly every time they use it.
Keep records of these tests.
Carry out air sampling to check that the controls are working well. See sheet G404.

**Personal protective equipment (PPE)**
- Ask your safety equipment supplier to help you get the right PPE.
- Provide storage for clean and contaminated PPE.

**Respiratory protective equipment (RPE)**
- RPE is needed and must be compatible with hearing protection.
- RPE is often needed for maintenance and some cleaning jobs.
- Select RPE that suits the wearer, the job and the work environment.
- Powered or air-fed RPE is more comfortable to wear.
- Decide the level of protection from air sampling data. Otherwise, use RPE with a UK standard assigned protection factor (APF) of at least 40. See sheets F14 and F15.
- Make sure all RPE is properly fit-tested - get advice from your supplier.
- Train workers to check their RPE works properly before use.
- Examine and test RPE thoroughly at least once every three months.
- Replace RPE filters as recommended by your supplier.
- Keep RPE clean and store it away from dust.

**Other protective equipment**
- Provide clean, dust-resistant coveralls.
- Use a contract laundry or a suitable equivalent to wash work clothing.
- Wash them that the dust contains silica.
- Skin creams help in washing contamination from the skin. After-work creams help to replace skin oils.
- **Caution:** Never allow use of compressed air for removing dust from clothing.

**Health surveillance**
- You need health surveillance unless exposure to RCS is well below the limit. See sheet G404.
- Consult an occupational health professional - see ‘Useul links’.
- Wet work can lead to dermatitis. Check regularly for skin dryness or soreness.

**Cleaning and housekeeping**
- Wash down the workroom at the end of each day’s work.
- Use a Type H vacuum cleaner fitted with a HEPA filter to clear up dust eg on overhead fittings.
- **Caution:** Don’t clean up with a brush or compressed air.

**Training and supervision**
- Tell workers that silica dust can cause serious lung diseases.
- Working in the right way and using the controls correctly is important for exposure control. Train and supervise workers. See sheet SL5.
Further information
- Controlling exposure to stonemasonry dust: Guidance for employers HSG201 HSE Books 2001 ISBN 0 7176 1760 2
- Control of respirable crystalline silica in quarries HSG73 HSE Books 1992 ISBN 0 11 885680 4
- For environmental guidelines see sheet SLO

Useful Links
- The Stone Federation may advise on health and safety consultants and training providers. Website: www.stone-federation.org.uk
- For information about health and safety or to report inconsistencies or inaccuracies in this guidance, visit www.hse.gov.uk/. You can view HSE guidance online and order priced publications from the website. HSE priced publications are also available from bookshops.
- Contact the British Occupational Hygiene Society (BOHS) on 01332 298101 or at www.bohs.org for lists of qualified hygienists who can help you.
- Look in the Yellow Pages under ‘Health and safety consultants’ and ‘Health authorities and services’ for ‘occupational health’.
- Also see www.nhsplus.nhs.uk.

Employee checklist
- Are you sure how to use all dust controls?
- Is the equipment switched off and locked off for maintenance and cleaning?
- Check your RPE works properly every time you use it.
- Is the dust extraction working? Check the gauge.
- Look for signs of leaks, wear and damage every day.
- If you find any problems, tell your supervisor. Don’t just carry on working.
- Make suggestions to improve the effectiveness of dust control.
- Cooperate with health surveillance.
- Use, maintain and store your protective equipment in accordance with instructions.
- Use skin creams provided as instructed.

This document is available at: www.hse.gov.uk/pubs/guidance/ and www.hse.gov.uk/coshh/essentials.

This document contains notes on good practice which are not compulsory but which you may find helpful in considering what you need to do.
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7.3 APPENDIX 3 QUARTZ EXPOSURE IN THE SLATE INDUSTRY IN NORTHERN NORWAY


‘In this study we have measured exposure levels to quartz in different parts of the slate industry in Alta, Northern Norway. Full shift personal samples were collected from the breathing zones of outdoor and indoor workers in the slate quarries and a slate factory. The quartz content of respirable dust was between 7 and 41 %. The slate factory had the lower quartz levels although 41 % of total and 73 % of respirable samples were above the Norwegian TLV for quartz. The average concentration of total quartz in the slate factory was 0.27 mg/m$^3$ and the average concentration of centration of respirable quartz was 0.12 mg/m$^3$. Outdoor in the quarries the average levels of quartz were 0.58 and 0.13 mg/m$^3$ for total and respirable quartz, respectively. From the beginning of the last decade most of the quarry-workers have built quarry halls to protect themselves against a cold winter climate. Inside in these quarry halls the average levels were 1.74 mg/m$^3$ total quartz and 0.46 mg/m$^3$ respirable quartz. Assessment of historical exposure showed that 32 of totally 45 quarry workers with available exposure history had a lifetime inhaled quartz dose of more than 10 g. There is reason to fear that silicosis will be an increasing problem among quarry workers if efforts to reduce quartz exposure are not put into effect.’
7.4 APPENDIX 4 CHRONIC OBSTRUCTIVE PULMONARY DISEASE IN WELSH SLATE MINERS


‘Exposure to respirable crystalline silica (RCS) causes emphysema, airflow limitation and chronic obstructive pulmonary disease (COPD). Slate miners are exposed to slate dust containing RCS but their COPD risk has not previously been studied.

The aim of this work was to study the cumulative effect of mining on lung function and risk of COPD in a cohort of Welsh slate miners and whether these were independent of smoking and pneumoconiosis.

The study was based on a secondary analysis of Medical Research Council (MRC) survey data. COPD was defined as forced expiratory volume in 1 s/forced vital capacity (FEV₁/FVC) ratio <0.7. We created multivariable models to assess the association between mining and lung function after adjusting for age and smoking status. We used linear regression models for FEV₁ and FVC and logistic regression for COPD.

In the original MRC study, 1255 men participated (726 slate miners, 529 unexposed non-miners). COPD was significantly more common in miners (n = 213, 33%) than non-miners (n = 120, 26%), P < 0.05. There was no statistically significant difference in risk of COPD between miners and non-miners when analysis was limited to non-smokers or those without radiographic evidence of pneumoconiosis. After adjustment for smoking, slate mining was associated with a reduction in %predicted FEV₁ (β coefficient = -3.97, 95% confidence interval (CI) -6.65, -1.29) and FVC (β coefficient = -2.32, 95% CI -4.31, -0.33) and increased risk of COPD (odds ratio: 1.38, 95% CI 1.06, 1.81).

Slate mining may reduce lung function and increase the incidence of COPD independently of smoking and pneumoconiosis.’
### 7.5 APPENDIX 5 HISTORICAL EXPOSURES AT COMPANIES 1, 2 AND 3

#### Table 5 Company 1 (8-hr TWA exposures)

<table>
<thead>
<tr>
<th>Task / process</th>
<th>1994*</th>
<th>2004</th>
<th>2017</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No. samples</td>
<td>Range (mg/m³)</td>
<td>Median (mg/m³)</td>
</tr>
<tr>
<td>Splitting green shed</td>
<td>3</td>
<td>0.02 – 0.08</td>
<td>0.05</td>
</tr>
<tr>
<td>Splitting blue shed</td>
<td>2</td>
<td>&lt;0.02† – 0.09</td>
<td>N/A</td>
</tr>
<tr>
<td>Dressing green shed</td>
<td>2</td>
<td>&lt;0.02† – 0.05</td>
<td>0.03</td>
</tr>
<tr>
<td>Dressing blue shed</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

* = LEV had just been installed  
# = Only the rotary dresser used as this is a direct comparison  
† = For the less than limit of detection values above, a value of half quoted value has been used for the median calculation that has been used in the preparation of figures 1 and 2

#### Table 6 Company 2 (8-hr TWA exposures)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No. samples</td>
<td>Range (mg/m³)</td>
<td>Median (mg/m³)</td>
<td>No. samples</td>
</tr>
<tr>
<td>Splitting (no LEV)</td>
<td>2</td>
<td>0.07 – 0.13</td>
<td>0.1</td>
<td>N/A</td>
</tr>
<tr>
<td>Splitting (with LEV)</td>
<td>2</td>
<td>0.18 – 0.28</td>
<td>0.23</td>
<td>N/A</td>
</tr>
<tr>
<td>Splitting (LEV?)</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>NK</td>
</tr>
<tr>
<td>Auto splitting</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Dressing (with LEV)</td>
<td>2</td>
<td>0.12 – 0.15</td>
<td>0.14</td>
<td>N/A</td>
</tr>
<tr>
<td>Dressing (no LEV)</td>
<td>2</td>
<td>0.11 – 0.14</td>
<td>0.13</td>
<td>N/A</td>
</tr>
<tr>
<td>Auto-dressing</td>
<td>2</td>
<td>0.18 – 0.19</td>
<td>0.19</td>
<td>N/A</td>
</tr>
<tr>
<td>Dressing YT LEV ?</td>
<td>4</td>
<td>0.13 – 0.48</td>
<td>0.29</td>
<td>N/A</td>
</tr>
</tbody>
</table>

† = For the less than limit of detection values above, a value of half quoted value has been used for the median calculation that has been used in the preparation of figures 1 and 2  
‡ = The median has been calculated using the min and max values  
LEV? = Records were not clear as to whether or not LEV was present  
YT LEV? = Youth training scheme workers and no details as to whether or not LEV was present
Table 7 Company 3 (8-hr TWA exposures)

<table>
<thead>
<tr>
<th>Task / process</th>
<th>No. samples</th>
<th>Range (mg/m(^3))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Splitting</td>
<td>3</td>
<td>0.19 – 0.42</td>
</tr>
<tr>
<td>Dressing</td>
<td>2</td>
<td>0.19 – 0.23</td>
</tr>
<tr>
<td>Splitting and dressing</td>
<td>1</td>
<td>0.73</td>
</tr>
</tbody>
</table>

No LEV or RPE
Assessment of exposure to respirable crystalline silica (RCS) and benchmarking of exposure controls during manual splitting and dressing of slate

Respirable crystalline silica (RCS) is a substantial contributor to the burden of occupational lung disease. Exposure can cause silicosis, lung cancer and chronic obstructive pulmonary disease (COPD). Quarry workers carrying out manual slate splitting and dressing are potentially exposed and the health risks can be significant if effective exposure control measures are not in place. At present, four GB companies employ workers to do these tasks.

This report describes research to assess levels of exposure to RCS in manual slate splitting and dressing and the effectiveness of current exposure control measures. The aim was to identify benchmarks for good control practice, and to provide evidence to inform the planned update of HSE guidance for industry. The researchers measured exposure and assessed exposure control at two quarries. They found that some ancillary tasks to the slate splitting process were sources of exposure to RCS for which no controls were applied and that HSE's guidance could be improved by including these tasks and providing clearer illustrations of recommended controls. The researchers also reviewed the scientific literature. They identified studies conducted in Wales and in Norway which highlight potential worker respiratory health issues.

HSE's updated guidance, informed by the findings of this research, was published in October 2019. This guidance is COSHH essentials for stone workers: Silica ‘ST6: Slate Splitting Manual’ and ‘ST7 Dressing slate (edge bevelling)’.

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