Management of Silica Dust.

Kevin Hedges
Department of Mines and Energy
Safety and Health
Senior Principal Occupational Hygienist (Northern Region)
kevin.hedges@dme.qld.gov.au

Fritz Djukic
Department of Mines and Energy
Safety and Health
Senior Principal Occupational Hygienist (Southern Region)
fritz.djukic@dme.qld.gov.au
What is respirable crystalline silica?

Crystalline silica is a common mineral (SiO$_2$) found in most types of rock/stone, sands, shale, clays and gravel. It mainly occurs in the form of quartz.

- Sandstone – > 70% quartz.
- Granite - up to 30% quartz.
- Clays - 6-30% quartz.

“Respirable”: airborne particles small enough to reach the deep lung (less than 10 microns diameter).
Crystalline silica

- Why a priority
- The risk
- How well is the risk being managed
- The way forward
Occupational Exposure to Respirable Crystalline Silica

Approximately 33,000 employees in Queensland Mining

- Mines
- Quarries
- Granite
- Flint
- Slate
- Sand
- Clays
- Gravel
- Sandstone
- Shale
- Steel/Iron foundries
- Bricks
- Tiles
- Glass making
- Ceramics
- Potteries
- Construction-stone/concrete/plaster
- Silica flour; paints, filtration, specialist products

Queensland the Smart State

Queensland Government
Department of Mines and Energy
Health effects

Silicosis

Lung cancer

Chronic obstructive pulmonary disease (COPD)
Silicosis

- **High exposures** over just **a few months** can result in "**acute silicosis**" – often a fatal condition.

- Chronic silicosis is a slow progressive, **irreversible disease** that usually takes many years to develop.

- *Silicosis may **further develop** even when exposure to silica has ceased.*
What are the symptoms of silicosis?

**Early stages**
Without medical exam may go unnoticed

**Continued exposure**
Shortness of breath upon exercising
Possible fever
Bluish skin at ear lobes or lips
Susceptibility to infectious lung diseases such as tuberculosis.

**Progression of the disease**
Fatigue
Extreme shortness of breath
Loss of appetite
Pain in the chest
Respiratory failure

Suffering prior to death may occur for many years.
The Hazard

• Significant risk from dust containing silica, in:
  – Rock
  – Sands
  – Clays
  – Shale
  – Gravel
Intensity of exposure.

Freshly cut crystalline silica has a higher degree of potency to crystalline silica that has aged. This may mean that if you breath in a relatively high concentration for a short duration of time, this may be more hazardous than breathing in a lower concentration over a longer period of time. Even though the average exposure over a day is the same.
## Potency matrix

<table>
<thead>
<tr>
<th>Factors</th>
<th>Comment</th>
<th>Situations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Particle size</td>
<td>Enhances potency</td>
<td>Grinding and abrasive process.</td>
</tr>
<tr>
<td>Dry and freshly cut</td>
<td>Reference point to compare potency</td>
<td>Drilling, crushing.</td>
</tr>
<tr>
<td>Wetting</td>
<td>From dust suppression</td>
<td>Wet extraction processes</td>
</tr>
<tr>
<td>Aged</td>
<td>Reduces potency</td>
<td>No abrasion, grinding.</td>
</tr>
<tr>
<td>Presence of clay</td>
<td>Aluminium reduces potency</td>
<td>Mines extracting low rank coal</td>
</tr>
</tbody>
</table>

Adapted from HSE EH 75/4 page 7
Chronic obstructive pulmonary disease (COPD)

COPD encompasses chronic bronchitis and emphysema.

- Excess mucus
- Alveoli
- Bronchial tube
- Emphysema
- Collapsed bronchiole
- Enlarged alveoli
What is the risk?
# What is the risk?

**Study in Scottish coal miners.**

<table>
<thead>
<tr>
<th>15 years exposure to RCS in mg/m³</th>
<th>Predicted risks of developing silicosis within 15 years following exposure</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.02</td>
<td>0.25%</td>
</tr>
<tr>
<td>0.04</td>
<td>0.5%</td>
</tr>
<tr>
<td>0.1</td>
<td>2.5%</td>
</tr>
<tr>
<td>0.3</td>
<td>20%</td>
</tr>
</tbody>
</table>

Study in Scottish Coal Miners Source: HSE EH75/4 2002 p. 73.
“The quality of the exposure data for this study is more detailed and better documented compared to other studies”

HSE 2002 EH75/4 p.67
According to this study:
15 years exposure at 0.1mg/m³ followed by 15 years of non exposure,
equals:
1 in 40 chance of being diagnosed with silicosis
(ILO Category 2/1)
There is an additional risk!

What about long periods of low exposure with short periods of high exposure.
Table 4.5 Predictions of risk (%) of silicotic signs of profusion 2/1+ (with standard error in italics), 15 years after exposure ends, as a function of years spent in low (0.1 mg m^-3) quartz concentration and months spent in high (2 mg m^-3) quartz concentration. From Table 4.3, population aged 50-74, equation based on ISP 3-7. After reclassification of two suspect cases.

| Years in     | 0    | 2    | 4    | 6    | 8    | 10   | 12   |
|low quartz   |      |      |      |      |      |      |      |
| conc.       |      |      |      |      |      |      |      |
| 15          | 2.49 | 0.89 | 3.21 | 1.70 | 10.58| 3.72 | 20.32| 7.97 | 35.46| 14.18| 54.21| 18.86| 71.84| 18.37|
| 14          | 2.31 | 0.36 | 4.84 | 1.64 | 9.88 | 3.58 | 19.10| 7.73 | 33.72| 13.97| 52.29| 19.08| 70.25| 19.05|
| 10          | 1.70 | 0.71 | 3.60 | 1.40 | 7.45 | 3.07 | 14.78| 6.72 | 27.20| 12.90| 44.60| 19.41| 63.43| 21.55|
| 9           | 1.58 | 0.68 | 3.34 | 1.33 | 6.93 | 2.94 | 13.83| 6.47 | 25.70| 12.58| 42.70| 19.37| 61.62| 22.08|
| 5           | 1.17 | 0.56 | 2.48 | 1.13 | 5.19 | 2.47 | 10.55| 5.49 | 20.26| 11.15| 35.37| 18.69| 54.11| 23.72|
| 4           | 1.08 | 0.54 | 2.30 | 1.08 | 4.82 | 2.36 | 9.84 | 5.25 | 19.04| 10.77| 33.63| 18.40| 52.19| 23.98|
| 0           | 0.80 | 0.44 | 1.70 | 0.89 | 3.59 | 1.95 | 7.42 | 4.36 | 14.73| 9.23 | 27.12| 16.89| 44.50| 24.37|

0.1 mg m^-3 Low + high

IOM Research Report TM/01/03 February 2001
TABLES

Table 3.1 Distributions of age and smoking status at follow up survey by profusion category

<table>
<thead>
<tr>
<th>Age at survey:</th>
<th>Profusion category</th>
<th>All</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>&lt;40</td>
<td>57</td>
<td>2</td>
</tr>
<tr>
<td>40-49</td>
<td>48</td>
<td>7</td>
</tr>
<tr>
<td>50-59</td>
<td>86</td>
<td>24</td>
</tr>
<tr>
<td>60-69</td>
<td>123</td>
<td>42</td>
</tr>
<tr>
<td>70+</td>
<td>75</td>
<td>36</td>
</tr>
</tbody>
</table>

Smoking status:

<table>
<thead>
<tr>
<th>smoking status</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>All</th>
</tr>
</thead>
<tbody>
<tr>
<td>smoker</td>
<td>167</td>
<td>61</td>
<td>53</td>
<td>249</td>
</tr>
<tr>
<td>ex-smoker</td>
<td>152</td>
<td>40</td>
<td>36</td>
<td>210</td>
</tr>
<tr>
<td>never smoked</td>
<td>70</td>
<td>18</td>
<td>9</td>
<td>88</td>
</tr>
</tbody>
</table>

Total          | 389| 111| 100| 547 |
<table>
<thead>
<tr>
<th>Country</th>
<th>Occupational Exposure Limit for Alpha Quartz (mg/m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>UK</td>
<td>0.1</td>
</tr>
<tr>
<td>Austria</td>
<td>0.15</td>
</tr>
<tr>
<td>Netherlands</td>
<td>0.075</td>
</tr>
<tr>
<td>France</td>
<td>0.1</td>
</tr>
<tr>
<td>Belgium</td>
<td>0.1</td>
</tr>
<tr>
<td>Ireland</td>
<td>0.05</td>
</tr>
<tr>
<td>Italy</td>
<td>0.05</td>
</tr>
<tr>
<td>Australia</td>
<td>0.10</td>
</tr>
<tr>
<td>ACGIH</td>
<td>0.025</td>
</tr>
</tbody>
</table>
Occupational Exposure Limits – are not fine dividing lines!

**Case in point** respirable crystalline silica!
Australian Institute of Occupational Hygienists (AIOH)

“Where there is a likelihood of 50% of the exposure standard being exceeded, control strategies and health surveillance should apply”.

AIOH draft position paper for respirable crystalline silica. Rio Tinto also requires health surveillance at 50% of the exposure standard.
Current situation

“Snapshot of mining”
Queensland the Smart State

Sandstone Quarry

<table>
<thead>
<tr>
<th>mg m⁻³</th>
<th>Loader Operator - Sandstone Quarry</th>
<th>Excavator Operator - Sandstone Quarry</th>
<th>Excavator Saw Operator - Sandstone Quarry</th>
<th>Saw Operator - Sandstone Quarry</th>
<th>Stonemason - Sandstone Quarry</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.1</td>
<td>[Loader Operator]</td>
<td>[Excavator Operator]</td>
<td>[Excavator Saw]</td>
<td>[Saw Operator]</td>
<td>[Stonemason]</td>
</tr>
<tr>
<td>0.2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.35</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Respirable quartz

Queensland Government
Department of Mines and Energy
3 of the 23 workers exceeded 0.1mg m$^{-3}$

These employees were not wearing respiratory protective equipment (dust masks).

Equates to 13% at risk.

Crude estimate – a lot more data is needed.
Questionnaire Feedback
About 113 completed questionnaires have been assessed

Operations responded

<table>
<thead>
<tr>
<th>% reply</th>
<th>Exploration</th>
<th>Mine</th>
<th>Quarry</th>
</tr>
</thead>
<tbody>
<tr>
<td>100%</td>
<td>22</td>
<td>14</td>
<td>17</td>
</tr>
<tr>
<td>90%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>80%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>70%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>60%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>50%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>40%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>30%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0%</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Silica flour 100%
Sandstone, quartzite 100%
Sand / gravel / flint > 70%
Calcined diatomite 25 – 65%
Shale 40 – 60%
Marl up to 60%
Slate up to 40%
Granite up to 30%
Talc up to 30%
Ball clay 15 to 30%
Pumice up to 25%
Ironstone up to 15%
Basalt, dolerite up to 5%
Kaolinite < 5%
Limestone, chalk, marble < 2%
Queensland the Smart State

Controls

- Screen deck covers
- Stockpile sprinklers
- Muck pile watering
- Remote monitoring of crusher
- Air-con vehicle cabins
- Air-con control rooms
- RPE
- Conveyor covers
- Curtains
- Stockpile discharge socks
- Wetting agent
- Enclosure
- Rotation
- Wind barriers
- Road watering
- Dust extraction
- Fogging sprays
- Water sprays
Controls

Do the controls work?

Have you checked their effectiveness?
Control rooms

Are the control rooms under positive pressure?
Do the filters remove very fine particles?
Vehicle cabins

Are the cabins under positive pressure?
Do the filters remove very fine particles?
**Dust masks**

- **Does your site have a clean shaven policy?**

- **Is fit testing carried out?**

---

**What type of respiratory protective equipment is worn?**

- Dust masks (disposable)
- Cartridge
- PAPR
- Don’t wear

**Is fit testing carried out?**

- Fit testing (yes)
- Fit testing (no)
- Fit testing (don’t know)
Respirable dust is invisible!

How often are dust masks worn?

- RPE (always worn)
- RPE (when dusty)
- RPE (never wear)
Monitoring should be carried out to evaluate the effectiveness of controls!

Queensland the Smart State

Queensland Government
Department of Mines and Energy
Do you use an appropriate doctor?
The way forward!

Review and **improve controls** and then monitoring.

What gets measured gets noticed, what gets noticed gets action!
Respirable dust and respirable crystalline in WA Mining

**CONTAM EXPOSURE TREND REPORT**
for Contaminant: Respirable and Silica Dust

**Respirable Dust TWA-OES <2005** 5.0 mg/m³
**Respirable Dust TWA-OES >2005** 3.0 mg/m³

Source Lindy Nield DOCEP

Queensland Government Department of Mines and Energy
Queensland Mining Health Improvement and Awareness Committee

Committee Structure

- CFMEU
- AWU
- Metal
- Coal
- Quarries
- QRC
- Mines Inspectorate
- Simtars
2nd Meeting hosted by Xstrata

Topics:

1. Pneumoconiosis in USA
2. Health surveillance
3. Dust control in coal mines
4. Dust control in quarries
5. Dust control in metal mines
6. Exposure assessment
7. Dust plan including research and auditing