***HSE Series of publications on Silica***

Following the introduction of the workplace exposure limits (WEL) scheme and corresponding reliance on good practice, HSE have produced this extensive, detailed guidance on hazard control and health surveillance measures for work with respirable crystalline silica. Although very detailed, there remains uncertainty over the value of compliance when defending a civil or H&S enforcement action. Good practice, as defined in this guidance, includes compliance with permitted exposure levels; suggesting that exposure levels are the ultimate test of compliance, a situation which HSE have been trying to steer away from.

HSE have produced a very extensive series of publications on the control and management of silica. Described as 'COSHH essentials', they focus on the principle industrial exposures to respirable crystalline silica: brick and tile making, construction, manufacturing, foundries, ceramics making, quarrying and slate working. Each area is divided into guidance for managers and specific risk and control guidance for specific tasks within the production process.

The series attempts to define good practice. They do not comprise an Approved Code of Practice but the guidance states that compliance would normally be sufficient to comply with the law. Health and Safety Inspectors are not constrained by the guidance but may use it to check their judgement.

There are over 60 publications in the series which also make reference to Approved Codes of Practice and specific guidance on air supply to control cabs, health surveillance, air sampling and selection and fitting of respiratory protection. Each guide attempts to be self contained but in such a large work it is no surprise that there are inconsistencies and occasional lapses where there is assumed knowledge. As a package the series is informative.

It is not possible to summarise the series efficiently and comprehensibly. Instead key points from each industry are identified where they are specific to that industry. The more detailed presentation of 'brick and tile-making' conveys much of the information which is repeated (frequently) in the remainder of the series.

<u>Brick and Tile making</u>
Publications:

- BK0 Advice for managers
- BK1 Clay milling (pug-mill)
- BK2 Sand handling and screening
- BK3 Facing green bricks with sand
- BK4 Moving green and fired bricks
- BK5 Manual dehacking and batching
- BK6 Tile pressing
- BK7 Ventilated vehicle cabs

The key points are collated below.

Typical silica composition of raw materials:
Raw materials used in brick and tile making may contain a high proportion of crystalline silica. Most of this will be in non-inhalable form but can become respirable during processing e.g. crushing, sawing drilling etc. The proportion of crystalline silica in each material does not convey complete risk information but serves to remind the reader that silica is a common and significant constituent of raw materials:

| | |
|---|---|
| sand, gravel, flint | more than 70% |
| marl | up to 60% |
| slip, glazes, colours | 10% to 60% dry composition |
| tile | 30% to 45% |
| ball clay | 15% to 30% |
| brick | up to 30% |

Outcomes:
Silicosis causes permanent disablement and early death and is made worse by smoking.

Control:

If degree of exposure is uncertain then it should be measured in accord with good hygiene standards. Cost effective controls should be tailored to the specific situation. If current controls are maintained and in alignment with those recommend then exposures should usually be below the workplace exposure limit 0.1 mg/$m^3$.

Records of control measures and their maintenance should be taken.

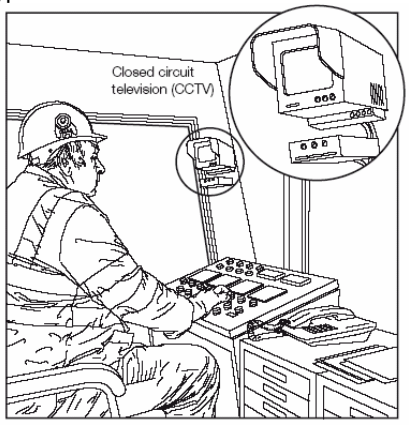
Training:
Tell workers:

- that dust from clay, sand, bricks and ash can cause silicosis, which leads to disablement and early death;
- to avoid breathing in dust;
- to do the job in the correct way and minimise dust clouds;
- to always use the dust suppression and extraction equipment properly;
- to keep this equipment clean and working properly;
- if equipment is not working - report it;
- to keep their protective equipment clean, and wear it properly;
- to keep surfaces clean as this helps to prevent dust being made airborne again;
- to wash dust off skin
- to avoid cotton or knitted clothing; and
- to vacuum clean, not sweep.

And ensure that monitoring/supervision ensures that work is done accordingly.

Provisions:

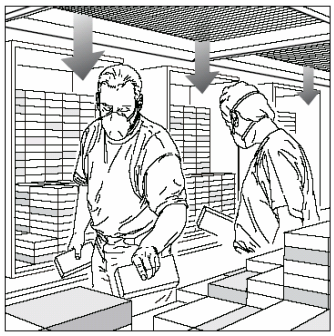
- Use materials with a lower silica content if possible.
- Reduce vehicle movements involving exposed dry materials e.g. keep roadways wet.
- Vehicle cabs should be provided with a clean air supply with an overpressure of 10 Pascals
    - pre-filters, to protect the main filter if coarse silica dusts are present;
    - HEPA filters (BSEN 1822):
        - type H11 for external RCS concentrations below 1 mg/m3;
        - type H12 or H13 for external RCS concentrations above 1 mg/m3;



*Control cabin*

- Keep fluidised materials wet.
- Use CCTV monitoring of operations in dusty areas.
- Use automated enclosed materials-handling where possible. Extraction rates should ensure air speeds between 1 and 2.5 $ms^{-1}$into enclosure openings. Extraction should be checked before work commences.
- For sand facing work, extraction should be at 10 to 20 $ms^{-1}$.
- Provide indicators to demonstrate that air speeds and differential pressures are maintained during operations.
- **Use air sampling to check that ventilation controls provide sufficient protection.**
- Replace extracted air with clean, filtered air.
- Isolate dirty work clothes from clean areas
- Ensure personal protective equipment (PPE) is appropriate (overalls should be of synthetic fibre, face masks should provide a protection factors of at least 20 for brick facing and 10 for brick handling) well maintained properly fitted and clean.
- Restrict access to dusty areas.
- Provide health surveillance where controls could be insufficient.
- Provide washing facilities.
- Provide a clean refreshment area.

- You need a downward (clean) air speed between 1 and 1.5 $ms^{-1}$ around workers' breathing zones. See figure.



- Washing of overalls should take account of the likely silica contamination.
- **Never allow use of compressed air for removing dust from clothing.**

Comment

For the most part the guidance is self consistent. At several points it describes the appropriate air speeds and pressure differences required to prevent significant exposure. These guidelines would be described as 'good practice'. However, for each the advice is to then use air sampling to check that controls are 'working well'. This probably means that the WEL of 0.1 $mgm^{-3}$ should not be exceeded (8 hour average) and seems to imply that the WEL takes precedence over good practice. To some extent this contradicts earlier messages provided by HSC.

Construction

Those guidelines which are specific to construction are collated. Otherwise the guidance is very similar to that for brick making.

Publications

- CN0 Advice for managers
- CN1 Concrete scabbling
- CN2 Chasing with hand-held power tools
- CN3 Drilling and coring with hand-held rotary power tools
- CN4 Crushing and screening demolition material
- CN5 Clearing and removing rubble
- CN6 Cutting paving and kerbstones with rotary cutters
- CN7 Abrasive blasting
- CN8 Tunnelling and shaft sinking
- CN9 Pneumatic breaker in poor ventilation (eg indoors)
- CN10 Cutting silica-filled composites
- CN11 Control cabins and vehicle cabs

Typical silica composition of raw materials

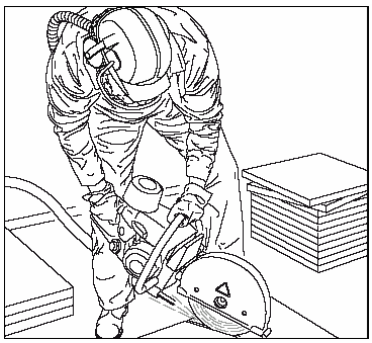
| | |
|---|---|
| plastic composites | up to 90% |
| sandstone, gritstone, quartzite, flint | more than 70% |
| concrete, mortar | 25% to 70% |
| shale | 40% to 60% |
| china stone | up to 50% |
| tile | 30 to 45% |
| slate | up to 40% |
| granite | up to 30% |
| brick | up to 30% |
| ironstone | up to 15% |
| basalt, dolerite | up to 5% |

Outcomes:
As before.

Control:
Emphasis on health surveillance may be unfamiliar to many in construction.

Provisions:

- Emphasis on design such that dressing of materials on site is less common.
- For scabbling work drilling, coring and chasing with hand held power tools the extraction air speed should be between 10 and 20 $ms^{-1}$.
- For scabbling work drilling, coring, cutting paving and kerb stones and silica-filled composites with rotary cutters, tunnelling, pneumatic breaking and chasing with hand held power tools the respiratory protection equipment should ensure a protection factor (PF) of at least 40 unless air sampling data suggests a different standard.



- For crushing and screening demolition material use PF ≥ 20.
- For hand shovelling rubble use PF ≥ 10.
- Workers need coveralls, eye and face protection, hearing protection, a hard hat (worn correctly) and protective gloves and footwear.
- Use an air blower to get fresh air into restricted working places.
- Use tools fitted with water suppression and dust extraction where practicable.
- For abrasive blasting:
    - Use a permit-to-work for access.
    - Designate an exclusion zone. Fence it off and post warning signs.
    - Ensure that workers wear RPE and blasting suits.
    - Air for RPE must be clean. Supply air for breathing from upwind of air contaminants and blasting operations. PF ≥ 40.
    - Use alumina or other non-sand abrasives.

- For tunnelling work;
    - You need an air speed above 0.5 metres per second to clear dusty air.
    - Daily, look for signs of damage and stagnant air.
    - Machine operators should be protected by cabs
    - **If methane is present you must control explosion risks in the ventilation system.**

<u>Ceramics</u>
Those guidelines which are specific to ceramics are collated. Otherwise the guidance is very similar to that for brick making.

There is an Approved Code of Practice for Pottery Production:
Control of substances hazardous to health in the production of pottery. The Control of Substances Hazardous to Health Regulations 1994. The Control of Lead at Work Regulations 1998. The Workplace (Health, Safety and Welfare) Regulations 1992. Approved Code of Practice L60 HSE Books 1995 ISBN 0 7176 0849 2

Publications in this series:

- CR0 Advice for managers
- CR1 Glaze and colour preparation
- CR2 Casting
- CR3 Fettling
- CR4 Kiln loading (placing) and unloading
- CR5 Spraying glazes and colours

Typical silica composition of raw materials:

| | |
|---|---|
| silica flour, cristobalite flour | 100% |
| sand, gravel, flint | more than 70% |
| calcined diatomite | 25% to 65% |
| slip, glazes, colours | 10% to 60% dry composition |
| tile | 30 to 45% |
| industrial grade talc | up to 30% (some are silica-free) |
| ball clay | 15% to 30% |
| kaolinite | less than 5% |

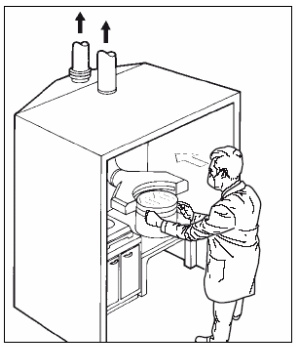
Outcomes:
As before. This time, the guidance states in addition: 'Wet work may lead to dermatitis'.

Control:
Emphasis on clean-up using wet methods. Never let slip clay or glaze spills dry out. **Dry sweeping is prohibited.** Never use compressed air to move dust. Use a Type H vacuum cleaner fitted with a HEPA filter to clear up dust e.g. on overhead fittings.

Dermatitis risk can be reduced using pre-work creams and after-work moisturiser (after washing).

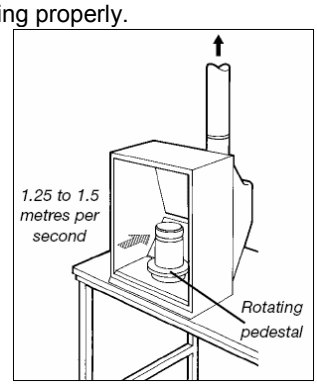
Provisions:

- Glaze and colour preparation: respiratory protective equipment (RPE) is normally needed (PF ≥ 20) though operation should be as enclosed as possible with an inward airspeed of 1.5 $ms^{-1}$. There may also be a need to asses lead exposure and include lead related diseases in the health surveillance specification.



*Store and prepare colours and glazes in a booth with an inward air speed of 1 to 1.5 metres per second*

- Casting: RPE not normally needed.
- Fettling: use fettling booths as described in the Approved Code of Practice L60 HSE Books 1995 ISBN 0 7176 0849 2. RPE should not be needed if the extraction is working properly.
- Kiln loading and unloading: RPE may be needed; use air sampling to find out. RPE is often needed for maintenance work.
- Spraying glazes and colours: use extracted enclosures wired-in to lighting; RPE should not be needed if extraction is working properly.



Foundries

Publications in this series:

- FD0 Advice for managers

**Advice sheets concerning silica:**

- FD4 Sand plant
- FD5 Coremaking and shell moulding (small scale)
- FD6 Knock-out, shakeout, etc
- FD7 Fettling small castings
- FD8 Fettling large castings
- FD9 Abrasive blasting small castings in a cabinet
- FD10 Gouging
- FD14 Furnace relining

**Other advice sheets:**

- FD1 Fume: General ventilation
- FD2 Molten metal fume: Melting
- FD3 Molten metal fume: Pouring and casting
- FD11 Pattern assembly (investment casting)
- FD12 Spray coating a large casting (open workshop)
- FD13 Cleaning dust collectors



Typical silica composition of raw materials:

| | |
|---|---|
| sand | up to 100% crystalline silica |
| Investment casting slip | may contain silica flour. |
| Investment casting wax | may contain modified colophony (rosin) |
| spray coatings | may contain chromates, epoxy compounds, isocyanates, or other hazardous substances - see the safety data sheet. |

Outcomes:
As before, but in addition: Ferrous foundry fume can cause cancer. Fume from pattern assembly can cause asthma, and spray mists can cause lung diseases including asthma.

Manufacturing using silica flour

Publications in this series:

- MN0 Advice for managers
- MN1 Making products that include silica flour
- MN2 Making products that include mineral powder
- MN3 Dry-mixing powders containing silica
- MN4 Small packing operations: Dry products containing silica

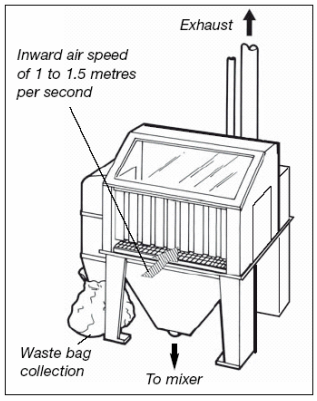
Composition of raw materials:
Silica flour is 100% crystalline silica. It is a common ingredient in products such as surface coatings, abrasives, plastics, grouts, mastics, ceramic glazes and investment casting media. This may not be widely known.

Control:
Composition of all raw materials should be known and checked for silica. Use wet methods where possible otherwise clean up dust with HEPA Type H vacuum cleaner.

Outcomes:
As before.

Provisions:

- RPE (PF ≥ 20) is normally needed when handling raw materials. Use air extraction booths as with glaze and colour preparation in section on ceramics. Roll up empty bags with the open end close to an extraction point.
- Dry mixing: Health surveillance is usually needed. Only allow authorised access, enclose operations as much as possible, RPE (PF ≥ 10) is usually needed.




- Small packing operations: RPE (PF ≥ 10) is usually needed, use extracted enclosures where possible.

Work in Quarries

Publications in this series:
- QY0 Advice for managers
- QY1 Rock drilling
- QY2 Excavating and haulage
- QY3 Crushing
- QY4 Drying and cooling
- QY5 Dry screening
- QY6 Dry grinding
- QY7 Jumbo bag filling: 500-1500 kg
- QY8 Silica flour: Small bag (15-50 kg) filling and transfer
- QY9 Mineral powders: Small bag (15-50 kg) filling and transfer
- QY10 Cleaning up silica dusts
- QY11 Control cabins and vehicle cabs

Typical silica composition of raw materials:

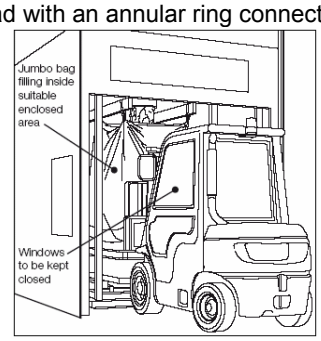
| | |
|---|---|
| silica flour, cristobalite flour | 100% |
| sandstone, gritstone, quartzite | more than 70% |
| sand, gravel, flint | more than 70% |
| calcined diatomite | 25% to 65% |
| shale | 40% to 60% |
| marl | up to 60% |
| china stone | up to 50% |
| slate | up to 40% |
| granite | up to 30% |
| industrial grade talc | up to 30% (some are silica-free) |
| ball clay | 15% to 30% |
| pumice | up to 25% |
| ironstone | up to 15% |
| basalt, dolerite | up to 5% |
| kaolinite | less than 5% |
| limestone, chalk, marble | up to 2%<br>(but these can contain silica layers) |

Outcomes:
As before.

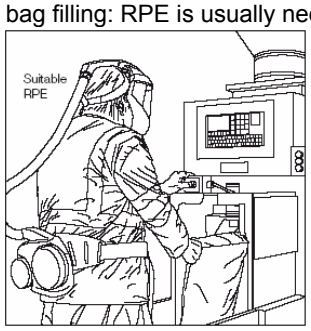
Control:
Emphasis on automation, enclosure, air extraction RPE and timing dustier work to coincide with rainy weather.

Provisions:

- Rock drilling: The guidance anticipates that this will be controlled from a cabin. Use water suppression and make sure this is not frozen in cold weather. RPE should not be needed if the cabin air is properly controlled. Work that is proximal to drilling work should be protected with RPE PF ≥ 40.
- Excavating and haulage: dampen roadways, use water mist suppression, use air controlled cabs. If exposed use RPE PF ≥ 40.
- Crushing: situate outdoors away from occupied buildings, use water suppression, operate from a control cabin, RPE should not be needed for work in control cabin, otherwise PF ≥ 40.
- Drying and cooling: always minimise the drop distance, control cabins otherwise RPE PF ≥ 40.
- Jumbo bag filling: RPE is normally needed. Use air monitoring to determine the required protection, otherwise PF ≥ 40. Install a vibrator in the bagging head and a vibrating table below the bag. Use a bagging head with an annular ring connected to a dust extraction system.




- Silica flour, mineral powders bag filling: RPE is usually needed. Localised extraction 1 $ms^{-1}$.




Clean-up of silica dusts: RPE is usually required PF ≥ 40. Fit an integrated vacuum cleaning system with multiple connections to a central dust collector.


Slate works

Publications in this series:
- SL0 Advice for managers
- SL1 Primary sawing
- SL2 Automated slate sawing
- SL3 Sawing slate into special sizes and shapes
- SL4 Manual slate splitting
- SL5 Dressing slate (edge bevelling)

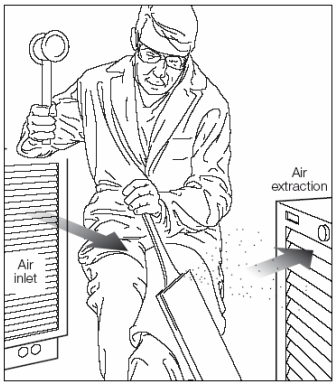
Composition of raw materials:
Slate contains up to 40% crystalline silica.

Outcomes:
As before: silicosis and dermatitis.

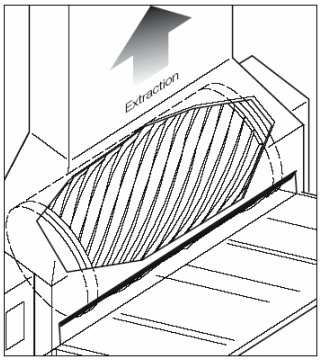
Control:
Splitting, separation, closing and stacking slates create local jets of fine dust. Dressing and sawing creates fine and coarse dust that tends to blow into the workroom. Water suppression helps to suppress dust. Reduce dust by keeping slates damp during handling and packing.

Provisions:

- Sawing: use air extraction (10 to 20 $ms^{-1}$), water suppression and spray containment. RPE PF ≥ 20 depending on degree of containment; fully contained system should not require RPE for operators. For manual non standard machine sawing PF ≥ 40.
- Slate splitting: use local air displacement air speed at 1 $ms^{-1}$ from the air inlet, and between 5 and 10 $ms^{-1}$ into the capture hood. If slates are dry and local air displacement is not used, select RPE with an APF of at least 40.




- Edge dressing: RPE is normally needed even though air extraction (1 to 2.5 $ms^{-1}$) is the norm.




Comment
This extensive series of good practice guides is clear and well informed. A full understanding of the issues can be provided by reading the whole series [individual guides may not be sufficient]. Guidance of this quality and demonstrable relevance would also be very valuable for understanding the duty of care relating to other kinds of exposure and in other industries.

Specific guidance is provided on: the appropriate respiratory protective equipment (RPE) for each identified task [depending on whether or not the system of work complies with other guidance on air extraction speeds]; exhaust management; damping down; isolation; substitution and containment. This information should reduce the uncertainty in designing safe systems of work.

There are some inconsistencies of information provision; essentially identical tasks are provided with different information, and, some information is only available by reading recommended references. Diagrams provide valuable clarity but are often also not consistent with the written advice e.g. use of RPE or protective clothing.

A consistent theme throughout is the validation, by means of air sampling at the breathing zone, of the adequacy of air extraction and containment. The exposure standard is < 0.1 $mg/m^3$ respirable crystalline silica for an 8 hour time-weighted average. Records should show that properly operating systems achieve this when a system of work is commissioned and maintenance records will be needed to show that in all probability the standard is consistently maintained.

Earlier statements made by the HSC indicated that good practice would take precedence over measured performance when deciding on enforcement action. Their view is that good practice is a more sustainable and representative measure of proper control; air sampling can be quite inconsistent. We would tend to agree. By defining good practice in some detail, HSE has relieved the need for extensive repetitive air sampling and has increased certainty that the chosen control methods will be adequate. Both these developments should encourage compliance. However, by referring to air sampling as the ultimate proof of a system of work, the uncertainty is reintroduced to some extent and, in our view, the perceived risk that systems will be over designed increases the probability of non compliance.

The residual risk of silicosis at a working lifetime's exposure at 0.1 $mg/m^3$ is around 10%. There are almost certain to be compensation claims even at this level of allowed dust exposure. The guidance does not provide certainty that fully documented control measures would be regarded as adequate in either civil or criminal courts. Silicosis often takes decades to manifest; the likelihood of fully informative records being maintained for this period is, in our view, not high.

The guidance is solely concerned with silicosis and dermatitis. There is no mention of lung cancer or kidney disease outcomes. Other evidence suggests that prevention of silicosis should be sufficient protection against lung cancer even if the causal mechanism is not directly related to silica exposure.

The standard of care defined in this set of guidance is not sufficient to guarantee protection against silicosis and related compensation claims. Estimates of residual liability exposure can be made; based on epidemiological work and actual exposure to hazard.