Occupational dust and silica conditions in some Queensland construction and related industries

A report supporting the Work-related disease strategy 2012-2022
Introduction
In 2002, on the back of national concern over the increasing monetary and social costs of occupational disease to the Australian community, the federal government released its *National Occupational Health and Safety Strategy 2002–2012* (the Strategy). The Strategy’s principal priorities included reduction in both the high incidence and severity of work-related disease, and to develop the capacity of workplaces to manage occupational health and safety (OHS) more effectively. These priorities, which include targeting work-related respiratory disease, have been continued in Safe Work Australia’s *Occupational Health and Safety Strategy 2012–2022*.

The priorities of the strategy have been adopted by Workplace Health and Safety Queensland (WHSQ) in the *Work-related disease strategy 2012–2022*.

WHSQ recognises there is a wide range of work-related respiratory diseases across many different industries in Queensland. Therefore it is necessary to consider respiratory disease (and its causative agents) a high priority and respond with programs specifically targeting disease by addressing its causative agents. This report presents findings on the causative agents of respirable dust and free silica experienced by workers found in some typical Queensland construction industry workplaces.

Background
Silica exposure occurs in construction related industries such as quarrying, tunnelling, civil construction, stonemasonry, cement manufacturing, concrete product fabrication, building demolition, high rise concrete construction, brick and tile manufacturing, concrete recycling, bench top manufacture and paving.

Respirable crystalline silica (RCS) remains an important risk factor for respiratory disease amongst construction workers. Construction constitutes the one of the largest groups of silica exposed workers in the community. While silicosis is an historically important disease in many areas of construction, RCS is now known to cause chronic obstructive lung disease including chronic bronchitis and emphysema. Chronic exposure to elevated levels of RCS is found to cause cumulative loss of respiratory volume, and still poses a risk of silicosis. Levels which are a concern for silicosis are also now a concern for lung cancer. Disease prevention relies entirely on control of dust and RCS exposure.

The effects of silica exposures on respiratory health will normally not be observed until after two or so decades of cumulative exposure (long latency). Outcomes cannot be exactly predicted from conditions measured during this survey, as risk is dependent on cumulative RCS exposure. Elevated exposures indicate greater risk. However, the constant efforts to minimise exposures, by dust control and through use of personal protective equipment, will certainly be accompanied by a decreasing risk for all diseases. However, the nature of construction work and patterns of exposure are not always conducive to regular use of respiratory protection in all necessary situations.

In 2004, the National Occupational Health and Safety Commission (NOHSC) reduced the workplace exposure standard (WES) for RCS from 0.2 mg/m$^3$ as measured by the British Medical Research Council (BMRC) penetration curve down to 0.1 mg/m$^3$ measured by the penetration curve defined by the International Organisation for Standardisation (ISO). This corresponded to a real reduction in the WES of around 30 per cent. This standard has been adopted into the Work Health and Safety Regulation 2011 (WHS Regulation).

The purpose of this intervention
This specific intervention report is the third on sectors involving silica exposure. The intervention targets respirable dust and RCS and their control in the construction and related industries. The number of trades and different industries related to construction that can expose workers to respirable silica is both multifaceted and vast. It is not possible to undertake a survey or audit which
is able to characterise all the dust and silica exposures for all possible work tasks in all construction related industries. However, all work tasks involving dust and silica exposures in Queensland are now regulated by WHS Regulation or legislation administered by the Department of Natural Resources and Mines.

The purpose of this intervention has been to:

- determine the respirable dust and RCS concentration ranges associated with a limited number of different but regularly occurring construction related operations
- evaluate the dust controls being used and determine the extent of compliance
- provide timely feedback and enhance the operator’s capacity to control this risk.

Information available from this intervention program is also available to inform national needs on any future development of the RCS exposure standard. To accompany the program a WHSQ website page on silica has been organised and documents developed to assist health and safety personnel in silica affected businesses.

**Note:** Australia’s RCS WES of 0.1 mg/m³ is in line with that of the United Kingdom and the current European Occupational Exposure Limit (EU-OEL) but significantly less stringent than the current recommendation of 0.025 mg/m³ from the American Conference of Governmental Industrial Hygienists.

**The intervention**

The program of intervention involved regular visits to different sites to conduct occupational hygiene monitoring for respirable dust and RCS conditions. Observations were made on dust control measures which included use of any exhaust extraction systems, dust suppression usually by use of water and use of respiratory protective equipment.

Respirable dust was sampled in accordance with *Australian Standard 2985:2004 Workplace Atmospheres – Method of sampling and gravimetric determination of respirable dust*. Dust was sampled in the breathing zones of target operators using a vertical cyclone elutriator connected to the lapel of the worker. Dust laden air was drawn through the elutriator using a small portable battery powered pump located on the belt of the worker. Some in-cabin samples were obtained where ergonomics prevented personal sampling. The elutriator/pump combination was calibrated to an air flow of 2.2 L/min to meet the International Organisation for Standardisation (ISO) sampling efficiency curve for respirability and the pumps were operated for periods from six to eight hours.

Some peak measurements of dust were made using a DustTrak™ direct reading dust monitor fitted with a vertical cyclone elutriator operating according to the ISO sampling efficiency curve. This proved useful for identifying some phases of an operation with the greatest potential for generation of dust, and some likely peak dust excursions. Lighting conditions in workplaces of many of the related production facilities (e.g. clay products, brick making, stone masonry) are not immediately conducive to recognising the presence of respirable dust, and the DustTrak™ can provide this information in real time.

Results of 20 monitoring interventions in construction related workplaces and 19 tunnelling monitoring events, together with recommendations to improve dust control were provided to the business operators. Dust sampling was conducted during day production shifts. Ventilation rates, where appropriate, were measured in some of the operations. Natural ventilation was relied upon in most circumstances. The most common form of dust control, where it was used, was respiratory protection.

**The targets of the intervention**

This intervention commenced in 2009 and was completed in 2012. It targeted fourteen common construction related settings and for completeness, includes a reference to tunnelling road-header...
operations previously reported by WHSQ, since tunnelling is classed as construction by WHSQ. Data from like industrial or construction sites has been combined. The monitoring programs included 20 workplaces which were traditionally considered to be construction or construction related industries based on sand or products with high silica contents, and 19 tunnel sites.

Details on the different kinds of construction workplaces are shown in Figures 1 to 4. Because of the large range of different industries, the vast range of different operations and different materials being encountered, it has not been possible to take sufficient samples to establish similarly exposed groups (SEGs) to determine typical or average exposures.

Instead, the program set out to identify the typical range of exposures to respirable dust and RCS which were found in each typical sector or kind of operation.

**Respirable dust conditions**

The following analysis is based on \( n = 92 \) paired measurements of respirable dust and RCS collected by WHSQ in regular construction or construction related workplaces and 43 paired measurements taken on road headers in tunnelling environments. Because the range of tunnelling dust concentrations is significantly greater than found in other workplaces in this survey, separate presentations are first provided without tunnelling to prevent compression of the concentration axis.

The reported measurements are the measured dust concentrations. Actual exposures may be lower where respiratory protection was consistently used. However, only nine workers of 92 non-tunnelling workers monitored used respiratory protective equipment (RPE) for either part or all of their work, so the measured dust concentrations were the personal exposures for most workers. All the tunnel workers were supplied with RPE for all their work.

![Range of respirable dust concentrations for some common tasks in construction and related industries, excluding tunnelling](image)

Figure 1: Respirable dust concentrations measured on workers in different construction and related industry tasks
Although both the spread of construction processes and the number of workplaces visited were limited, it is clear that workplaces which were located either indoors or with restricted capacity for dispersal (ventilation) or suppression of dust were amongst those presenting with the highest potential for respirable dust exposures. This included underground tunnelling, manual demolition indoors, concrete block production and block laying indoors, bench top production and stone masonry. Outdoor work, or using machinery for civil construction and demolition with associated suppression procedures resulted in lower overall dust conditions.

One task which repeatedly resulted in higher levels of dust exposure was related to the use of forklift vehicles. This was observed in different kinds of plant including brick, paving and block works, and concrete products construction. While efforts were often made to control plant dust exposures, roadways traversed in transferring raw and finished materials were often unsealed, were contaminated with the silica or clay raw material or (broken) finished product, and were constantly undergoing comminution by vehicle tyres with production of significant amounts of dust, including RCS.
Respirable silica concentrations

Figure 3: Range of RCS concentrations by operation, excluding tunnelling

Although the amount of dust produced will depend on the material inputs, the process and success in suppression, the concentration of respirable silica in a dust cloud will also depend on the free silica content of the parent material from which the dust is generated. In this regard, manual building demolition of brickwork produced high levels of dust and with high RCS content. Kitchen bench top production and stone masonry both commonly work with granite and sandstone, or reconstituted stone, all of which can contain high free silica contents.

Several of the Figure 3 work groups tested had workers with RCS exposures ranging well above the nominal eight-hour TWA RCS exposure standard (0.1 mg/m³). The overall percentage of non-compliant dust conditions for RCS based on a standard working day of 8 hours was 14 per cent. All (100 per cent) of these were found in within the six dustiest (non-tunnelling) industries tested; manual demolition, bench top production, stone masonry, in or below ground construction, concrete block production. Concrete block laying, though one of the dustier operations, was generally compliant due to exposure to dusts low in free silica, probably from cement dust. Based on an average nine hour working day, the non-compliance rises to 22 per cent or around one in five workers.

For comparison purposes, Figure 4 shows the same data as Figure 3 but includes road header tunnelling.
Shift lengths varied according to individual workplaces and different industries. Eight hour shifts were the norm, but tunnelling construction typically worked longer shifts (10 hours or more) with rotating shifts.

**Discussion (i.e. trends in dust concentrations, compliance and controls)**

**Respirable dust and RCS concentrations**

The fifteen different kinds of workplaces monitored are reasonably representative of the major groups associated with contemporary Queensland construction and construction related workplaces where respirable dust containing RCS occurs. Indoors work in those workplaces where natural ventilation is constrained or where dust extraction systems are not completely adequate can result in some excessive exposures. Use of mobile equipment in road building, civil construction and demolition has not been identified as creating significant risk to the operators from respirable dust or from RCS. Tunnelling road header operations are known to be associated with creation of significant risk.

Manual tasks in labouring were identified as creating significant risk, partly because of the close proximity of the worker to the source of dust generation, and partly because the arduous nature of work was a disincentive to be additionally encumbered by using respiratory protection. In some tested workplaces (manual indoor demolition and use of a jackhammer, bench top manufacture) there was a very high level of non-compliance on RCS exposures, with only one worker using RPE. Using power saws for cutting cement fibre board also has the potential for some excessive RCS exposures, as does concrete grinding.

RCS exposures of operators in large mobile machinery ranged from 0.01 to 0.09 mg/m³, but with the majority being <0.5 WES for RCS.

Within the non-tunnelling workplaces, 14 per cent of workers were exposed to excessive levels of RCS with some unprotected exposures three to five times the regulatory limit.

This program did not examine any of the those individual work practices such scabbling, concrete chasing or abrasive blasting which are also well known to be associated with potential for excessive exposures to RCS.
DustTrak™ measurements of peak respirable dust concentration were made in selected workplaces to assist in indentifying any particular procedures which might contribute to dust generation. Peak measurements were generally less than five times the average respirable dust exposures which is within the range expected for these types of operations. One exception was a concrete batching plant which created very high cement dust concentrations at the commencement of each batch processed.

**Controls**

One of the problems in dealing with the inhalation hazard which arises from dusts containing respirable silica is the persistent lack of perception about the risk since there are often no real visual clues about the existence of the hazard. The same problem has been identified in foundries. Respirable dust is essentially invisible under normal lighting conditions and the rapid settling of larger dusts belies the continued presence of respirable dusts. Further, the workplace exposure standard for RCS is exceptionally small.

In all the non-tunnelling construction and related workplaces, dust controls were mainly use of water suppression or occasional use of RPE. Because of the constant nature of change, the construction industry itself is not suited to use of high level controls involving exhaust ventilation. Forced dilution ventilation using floor mounted fans was used to assist in some dusty block cutting and laying operations.

Use of closed cab mobile machinery assisted in minimising some of these exposures, although this was not always completely effective since the regular cabin filtering units are not designed to address respirable sized dusts, and door seals are often inadequate. No fork lifts were fitted with closed cabs.

Water suppression was usefully applied in many of the outdoor operations in conjunction with excavating and earth moving machinery, and in use of wet saws in stone masonry and cutting of blocks used for paving. However, dust suppression with wet saws was found never to be complete.

Overall use of respiratory protection was low. Of the non-tunnelling workplaces, only eight (9 per cent of the total) of workers used a respirator (P1 or P2 disposable) either full time or for part of their work. Of all the workers working in excessive dust concentrations (≥ WES for RCS), only one used appropriate RPE; facial hair was not uncommon. Only at one workplace (sawing fibre cement boards) were all the workers wearing RPE for all their work tasks. Of the workers with precautionary use of RPE, none was working in non-compliant dust conditions although four (60 per cent of RPE wearers) had exposures ≥ 0.5 but < WES for RCS.

**Conclusion and recommendations**

This brief audit of respirable dust and RCS conditions across a broad spectrum of construction and construction related industries has identified that some workers are still being exposed to significant amounts of crystalline silica.

This survey indicated that many of the excessive exposure conditions were restricted to some relatively small sectors (bench top manufacture, manual demolition, stone masonry) or to indoor or restricted space operations which included some tunnelling. Within the top 6 dustiest non-tunnelling work tasks surveyed, 28 per cent of those workers were exposed at greater than and up to five times the nominal eight-hour WES-TWA for RCS, and with one exception, without adequate protection. Most workers on civil construction earthwork projects outdoors experienced low RCS exposures.

Apart from use of water sprays for suppression, where protection against dust exposure is required, it has to be provided by RPE. However, as many construction and related workplaces rarely undertake any independent dust monitoring, the risk assessment process which would have informed on the need to implement more rigorous controls has been largely absent. Section 50 of the WHS Regulation requires a person in control of a business or undertaking to conduct air
monitoring if there is any uncertainty about whether exposures exceed the relevant WES, and to control it when it occurs. The results of this survey indicate that some sectors need far more deliberate application of controls to achieve compliance, and probably closer regulatory attention.

Any workplace sector where there are observed high levels of exposure (significant risk) to a Schedule 14 (WHS Regulation) hazardous chemical, the workers who make this kind of work a long-term occupation should be considered as candidates for health monitoring for RCS. Health monitoring is required under the WHS Regulation wherever a significant risk occurs, irrespective of the source of the RCS.

Further information
Further information is available from www.worksafe.qld.gov.au or by calling the WHS Infoline on 1300 369 915.

The following publications are available on the website:

- *Silica and the lung* – fact sheet
- *Silica – identifying and managing crystalline silica dust exposure* - Information guide
- *Silica – Technical guide to managing exposure in the workplace: Work-related disease strategy 2012–2022*
- *Work Health and Safety Act 2011*
- *Work Health and Safety Regulation 2011*
- *Hazardous Chemicals Code of Practice 2003*
- *Tunnelling Code of Practice 2007*
- *Tunnelling road header operations: dust conditions and their control*