Australian Government

National Occupational
Health and Safety Commission

REGULATION IMPACT STATEMENT

on the Proposed Amendments to the

NATIONAL EXPOSURE STANDARDS

for

CRYSTALLINE SILICA

October 2004

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Executive summary

Crystalline silica (derived from sand) is present in building and construction materials such as cement, concrete, plaster, bricks and tiles. It is also present in the ground in quarries and mines. If the dust given off from working with these materials is fine enough to be breathed into the lungs it is termed “respirable”.

There is strong evidence that prolonged exposure to respirable crystalline silica (RCS) (through breathing in RCS) causes silicosis. On this basis, revised national exposure standards (NES) for crystalline silica of 0.1 mg/m^3 for quartz, 0.1 mg/m^3 for cristobalite and 0.1 mg/m^3 tridymite (from the current exposure standards of 0.2 mg/m^3 for quartz, 0.1 mg/m^3 for cristobalite and 0.1 mg/m^3 tridymite) have been recommended to reduce the incidence of silicosis. The balance of evidence also suggests there is a link between prolonged exposure to RCS and lung cancer and other diseases. Internationally, silica has been classified as a carcinogen (see Table 3). Research[1,] suggests that silicosis is likely to occur at exposures lower than those that may cause lung cancer. For this reason a lower exposure to RCS will also reduce the incidence of other important adverse health effects.

Over-exposure to RCS causes scar tissue to form in the lungs. In the majority of cases, diseases related to exposure to RCS have a long latency period (15-45 years). Most people who die from silica-related diseases do so in their 60s or 70s. Many experience breathing difficulties and chest pains for decades before becoming reliant on bronchodilators and oxygenators, and require palliative care due to severe incapacity.

Studies on silicosis mortality can be expected to underestimate the number of fatalities attributable to RCS as the symptoms of silicosis appear long after contact with silica dust has ceased. Victims may not link symptoms of silicosis with their exposure. It is therefore inappropriate to rely on such studies for the purpose of setting NES for RCS[2].

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1 ‘t Mannetje, A., et. al.(2002), “Exposure-response analysis and risk assessment for silica and silicosis mortality in a pooled analysis of six cohorts”, *Journal of Occupational and Environmental Medicine*, 2002, **59**, pp.723-728

2 de Klerk, N; Ambrosini, G & Musk, A (December 2002), *A Review of the Australian Occupational Exposure Standard for Crystalline Silica (Peer Reviewed)*, University of Western Australia; accessed on 06/05/04 at http://www.nohsc.gov.au/OHSInformation/Databases/ExposureStandards/Crystalline-Silica/ReviewExpStdCrystallineSilica.pdf.

The National Occupational Health and Safety Commission (NOHSC) estimates, based on NSW and national data, that the total annual cost of disease related to past exposure to crystalline silica in Australia is in the order of:

$14,022,857 in compensation payments (including medical costs, an indicator of potential cost) per annum[3]

305 hospital days per annum[4]

60 lives per annum[5]

Each life lost to diseases related to exposure to crystalline silica also incurs decades of progressively worsening health, and quality of life, for sufferers and family members/carers. Using *Value of Statistical Life* (VSL) methods, each year of healthy life can be valued at $AUD60,000, and each year of life gained through risk obviation can be valued at between $US75,000 and $US150,000. National or State figures for these measures have not been included in the VSL figures above, as VSL based calculations of benefits vary greatly according the individual circumstances of sufferers.[6]

It is estimated that at least 294,000 workers have the potential to be exposed to RCS. Working in any dusty environment where crystalline silica is present can potentially increase the risk of contracting silicosis. The incidence varies considerably by industry, with workers in the following industries being at considerable risk of exposure:

- mines and quarries
- iron and steel foundries
- construction
- ceramic (including pottery) and paint manufacture
- the heavy clay industry
- brick making, and stone-masonry

Research[7] shows that diseases caused by exposure to RCS at work can be prevented.

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3 This figure is an extrapolation based upon 2001-2002 respirable crystalline silica (RCS) disease compensated cost data provided by the NSW Dust Diseases Board (see table 5), NSW's thirty five percent share of total workers at risk (see table 4), and an estimated thirty eight percent reduction in incidences of RCS diseases under the new exposure standard (see table 15).

4 Based upon national hospital visit/separation and patient/hospital day data provided by the Australian Institute of Health and Welfare (see table 5).

5 This figure is an extrapolation based upon NSW's thirty five percent share of total workers at risk of developing RCS diseases (see table 4) and a comparison between the NSW Dust Diseases Board's 2001 and 2002 data for 'Reported Deaths Dust Disease Cases' (see table 7). The comparison between the Dust Diseases Board's 2001 and 2002 data revealed that 21 individuals died from RCS diseases in NSW over that twelve month period.

6 National Occupational Health and Safety Commission (March 2004), Cost of workplace injury and illness to the Australian economy: Reviewing the estimation methodology and estimates of the level and distribution of costs, Canberra

7 't Mannetje, A., et. al.(2002),*op cit*

Steenland, K., *et. al.* (2001), "Pooled exposure-response analyses and risk assessment for lung cancer in 10 cohorts of silica-exposed workers : An International Agency for Research on Cancer (IARC) Multicentre Study", *Cancer Causes and Control*, 2001, **12;** pp.773-784.

British Health and Safety Executive (HSE), Chemical Hazard Alert Notice (CHAN) No. 35 – *Respirable Crystalline Silica* accessed on 06/05/04 at http://www.hse.gov.uk/pubns/chan35.htm

Workplace exposures to RCS can be potentially high. Processes such as the dry cutting of crystalline silica materials e.g., bricks, tiles and pavers in confined spaces and dry abrasive blasting cleaning are able to generate RCS exposures of hundreds of mg/m^3. Accurate information on occupational exposures to RCS (i.e., occupational exposure monitoring data) were not made available by industry to assess RCS exposure. Industry comment has suggested that there is general compliance with the current NES.

Current NES

Under the National Hazardous Substances Regulatory Package, declared by NOHSC in 1993, NES, codes of practice and guidance material have been developed to manage the risks associated with exposure to hazardous substances in the workplace. NES provide protection by seeking to neither impair the health of, nor cause undue discomfort to, nearly all workers who are exposed for eight hours per day, and five days per week, for their working life.

The current NES for crystalline silica of 0.2 mg/m^3 for quartz, 0.1 mg/m^3 for cristobalite and 0.1 mg/m^3 tridymite was declared in 1996 and is a continuation of a NES first established in 1983-84.

Health statistics

It is estimated that a reduction in the NES to the proposed level has the potential to reduce the national incidence of RCS-related adverse health effects by up to 38%. This may be an overestimate, as the current NES may reduce the number of new cases of RCS-related adverse health effects for some time into the future. The potential overestimation, however, may be countered by the under-reporting of RCS-related adverse health effects in health statistics. Consequently, the real incidence may be higher.

The health statistics used in this Regulation Impact Statement (RIS) provide information on the incidence of adverse health effects attributable to RCS exposure. In observed cases of adverse health effects it is commonly not possible to identify when the causative exposure to RCS occurred and at what level. This means that it is usually not possible to know if adverse health effects arose from exposure that occurred before or after implementation of the current exposure standard for quartz of 0.2 mg/m^3.

As diseases caused by exposure to RCS are of long latency, it may be several more years before the impact of the current exposure standard is known.

Recent research[8], however, has shown that the current Australian NES may not provide the best protection to workers and therefore may not achieve the vision of the National OHS Strategy of having “workplaces free from injury and disease”. The current NES is higher than most international exposure standards, including those set by Australia’s major chemical trading partners, such as the USA and Europe.

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8 National Institute for Occupational Safety and Health (NIOSH) (April 2002), *Health Effects of Occupational Exposure to Respirable Crystalline Silica*, Hazard Review.

‘t Mannetje, A., et. al.(2002) *op cit*.

Steenland, K., *et. al.* (2001) *op cit*.

British Health and Safety Executive (HSE), Chemical Hazard Alert Notice (CHAN) No. 35 *op cit*

National Institute for Occupational Safety and Health (NIOSH) (April 2002) *op cit*.

Options

The following range of options has been considered in the RIS:

Option One maintains the current NES and the existing regulatory requirements of the States and Territories, which are 0.2mg/m^3 of quartz, 0.1mg/m^3 of cristobalite and 0.1 mg/m^3 of tridymite;

Option Two increases education about the current NES i.e., providing government and industry information and education programmes on the dangers of exposure to RCS. This education is aimed at reinforcing employers' obligations to make their staff aware of the risks of RCS and their legal obligations with respect to RCS;

Option Three increases enforcement of the current NES;

Option Four adopts exposure standards recommended by the University of Western Australia (UWA) report [9]. This is no longer a viable option due to changes in measurement methods. The UWA recommended exposure standards have been adapted into Option Five using the new measurement technique;

Option Five adopts a revised uniform NES for quartz, cristobalite and tridymite of 0.1 mg/m^3, based on all important adverse health effects, and using the recently issued Australian Standard AS 2985-2004 "Workplace Atmospheres - Method for sampling and gravimetric determination of respirable dust"; and

Option Six prohibits the use of crystalline silica.

The Australian Government Office of Regulation Review (ORR) requires that options other than a change in regulation, i.e., a change in the NES are assessed, including an analysis of costs and benefits. ORR needs to be satisfied that the preferred option i.e., the change in regulation, addresses the desired outcomes, together with a consideration of costs and benefits, better than the remaining options. A summary of the impacts of each option is provided in Table 1 below.

All of the cost benefit analyses in this document are based on the assumption that all industry complies with the current NES. Where industry does not currently comply with the existing NES, any costs of compliance that might be incurred to meet the existing NES should not be associated with the options contained within this document. Those costs should not be counted twice in terms of their impact on industry.

A single comment from industry suggested there may be an issue with non-compliance. This suggestion was not supported by evidence in the submission and could not be verified from external sources. The issue of non-compliance was not raised by the government agencies responsible for enforcement of the current NES.

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[9] de Klerk, N; Ambrosini, G & Musk, A (December 2002) *op cit.*

Table 1: Summary of Impacts of Options Considered

Objective: To contribute to achieving the goal of Australian workplaces free from injury and disease, by reducing the incidence of adverse health effects due to exposure to Respirable Crystalline Silica				
Option Number	**Outline of Option**	**Impact on**		**Likely benefit/Comment**
		Industry	Government	
1	No change to current NES of 0.2mg/m^3 of quartz, 0.1mg/m^3 of cristobalite and 0.1 mg/m^3 of tridymite	Nil – due to compliance with current standard	Nil – due to compliance with current standard	Workers are currently being exposed to levels which may result in adverse health effects
2	Increase education	Minimum cost if education is provided by government, or industry suppliers and associations. May improve use of controls	Minimum cost if education is provided by industry suppliers and associations. May improve use of controls	Increased education may not affect behaviour and may not reduce adverse health effects.
3	Increase enforcement	Nil cost to Industry that currently complies with current standard	Cost to state OHS regulators in increased inspections	May ensure greater compliance but workers are still exposed to levels that may result in adverse health effects
4	Change NES to 0.13mg/m^3 of quartz, 0.13mg/m^3 of cristobalite and 0.1 mg/m^3 of tridymite	Potential greater costs in terms of monitoring. Potential minor costs for those processes/workplaces that generate exposures less than the current standard but greater than the proposed standard.	Administrative costs of declaring a revised NES	The proposed standard is not based on all adverse health effects and doesn't account for the change in AS 2985. From a practical measurement point of view 0.13mg/m^3 is inappropriately precise
5	Reduce NES to 0.1mg/m^3 of quartz, 0.1mg/m^3 of cristobalite and 0.1 mg/m^3 of tridymite	Potential greater costs in terms of monitoring and upgrading inefficient work processes and practices. Potential costs for those processes/workplaces that generate exposures less than the current standard but greater than the proposed standard.	Administrative costs of declaring a revised NES	The proposed standard will reduce worker exposure to RCS. Reduced exposure may reduce adverse health effects. Accounts for change in AS 2985. Is easy to measure. Multi national companies currently comply. Brings Australia into line with most International Exposure Standards
6	Prohibition on the use of crystalline silica	High economic costs of abandonment and substitution of crystalline silica	Administrative and enforcement costs of a prohibition	Reduction to zero of adverse health effects over the long term as there will be no future exposure to RCS.

The proposal to be put to the National Occupational Health and Safety Commission is Option Five, to adopt the proposed NES of 0.1 mg/m^3 for quartz, cristobalite and tridymite. This is based on reducing the incidents of silicosis and thereby reducing the incidents of other important adverse health effects, and uses the recently issued Australian Standard AS 2985-2004 "Workplace Atmospheres - Method for sampling and gravimetric determination of respirable dust".

The UWA report and peer reviews, together with reviews of more recent, comprehensive studies and WA experience, indicate there would be significant improvements in health effects at occupational NES of 0.1 mg/m^3 for all three forms of crystalline silica.

Consultation

Due to the number of serious and contentious issues associated with the NES and adverse health effects related to breathing in RCS, an extensive program of consultation was undertaken as part of the NES setting process.

Industry believes that the main affected parties will be those concerned with building, construction, mining, and manufacturing of ceramics.

A number of large multi-national companies advised that they currently work to international best practice and therefore currently comply with a standard of 0.1 mg/m^3 for RCS. Most major cement and concrete operators in Australia monitor exposure levels and some larger operators currently have action limits as low as 0.05 mg/m^3 (action limits are exposures at which action may be taken to remedy the exposure and are usually at around half the exposure standard)

Industry has commented that changing the NES may:

- increase costs for industry particularly for small business. A cost model received from the quarry industry, estimated a national cost of $266,600,000 during the first year and an ongoing cost of $69,440,000 per annum thereafter;

  Response:

  - *A combination of several of the control measures suggested in the submitted model could minimise crystalline silica dust exposure at a lower cost. The majority of controls used to comply with the current NES will also comply with the proposed NES.*
  - *The information provided suggests that the submission has costed control measures and developed a cost model to eliminate, as far as practicable, exposure to RCS, which is industry best practice. This approach, while commendable, could be an unnecessary financial impost on industry. The costs to comply with the proposed NES are likely to be less than those necessary to eliminate exposures to RCS.*

- increase costs for workplaces that have processes that generate RCS exposures in between the current quartz NES of 0.2 mg/m^3 and the proposed quartz NES of 0.1 mg/m^3 e.g., 0.15 mg/m^3. Such workplaces or processes may incur additional costs to meet the proposed quartz NES;

  Response:

- *Most exposure controls will protect against 0.2 mg/m^3 and 0.1 mg/m^3. Those that do not, are likely to have marginal controls in place. The costs incurred could range from engineering controls ($100000s) to the addition of personal protective equipment (disposable P2 mask $5).*

- highlight current areas of non compliance;

  Response:

  - *Information from the States and Territories suggests that affected industries are not targeted for inspection once an amended NES is declared.*

- affect the labelling of silica containing products (the need to label silica as a carcinogen may reduce demand for a product);

  Response:

  - *RCS is already considered to be a carcinogen by a number of reputable international bodies, the proposed NES will not affect this. Consequently, products that contain RCS, or that may generate RCS in use, should already be classified in accordance with the Approved Criteria for the Classification of Hazardous Substances (Approved Criteria) and labelled according to the appropriate Code of Practice.*

- affect the MSDS of products containing silica;

  Response:

  - *industry may choose to update MSDS with the amended NES, although this is not mandated in the National Code of Practice for the Preparation of Material Safety Data Sheets 2nd Edition [NOHSC:2011(2003)] (MSDS 2nd CoP). This could be done in conjunction with a review of MSDS, made necessary by the need to comply with the new MSDS 2nd CoP, to reduce costs (MSDS 2nd CoP was declared in April 2003 and comes into effect in state and territory OHS legislation in 2006).*

- lead to insurance rate rises and increased liability;

  Response:

  - *RCS is already considered a carcinogen, consequently a change in the NES to reduce exposure will assist employers in meeting their duty of care.*

- increase costs for health surveillance and monitoring, as some industries do not conduct appropriate health surveillance;

  Response:

  - *monitoring is likely to increase in the short term as a compliance check against the new NES. Additional monitoring of high risk workers, processes or procedures, i.e., with potential RCS exposures close to the NES, could vary in cost, from as little as $200, but more typically $4000 - $8000 per site.*

Recommendation

State and territory, union and industry representatives have agreed to recommend to NOHSC, NES of 0.1 mg/m^3 for quartz, cristobalite and tridymite, supported by the RIS, measured using AS 2985-2004, and adopting a carcinogen category for RCS consistent with the Approved Criteria. Union representatives have suggested additional conditions, as outlined below:

- specific guidance and education material on RCS for industries where RCS exposure occurs. This guidance to include formal exposure monitoring and an action level at half the NES;
- a compliance program to be developed following recent developments in the construction industry with the potential to increase RCS exposure; and
- RCS to become part of a continuous review process.

The approach is consistent with the agreed NOHSC objective to reduce adverse health outcomes associated with exposure to chemicals. Updating the NES to align with international best practice in terms of exposure control will have benefits to workers and the community. Government OHS objectives are supported by this action. As well as direct benefits, indirect benefits include establishment of standards against which future monitoring can take place.

It is anticipated that the proposed NES will be declared by NOHSC in October 2004.

Background

NES are referenced directly in Commonwealth, State and Territory hazardous substances legislation and are, in some jurisdictions, in force immediately on declaration by NOHSC.

NOHSC may seek to recommend a minimum transitional time to implement the amended NES to assist in a consistent adoption and application of the revised standards in Australian workplaces. This action may assist in managing any costs incurred in meeting new or lower NES. It may, however, equally delay any realisable benefits.

The NOHSC review process is based on consultation with the State and Territory jurisdictions and with the social partners (the trade union bodies and industry groups), through NOHSC committees, to review the effectiveness of a revision of the NES.

NOHSC and its committee and sub-committee structure – with all of the above groups represented – meet regularly throughout the year (generally 3 meetings annually). This ensures an iterative opportunity for feedback and review of the effectiveness and consequences, both positive and negative, of the action taken. Any of the social partners may initiate a further review of the standards, if unforeseen adverse consequences result from an action.

Foreword

NOHSC is a tripartite body established by the Australian Government to lead and coordinate national efforts to prevent or reduce the incidence and severity of occupational injury and disease by providing healthy and safe working environments.

NOHSC comprises representatives of the Commonwealth, State and Territory governments and peak employee and employer bodies, the:

- Australian Council of Trade Unions (ACTU); and
- Australian Chamber of Commerce and Industry (ACCI).

In seeking to improve Australia's occupational health and safety (OHS) performance, NOHSC works to:

- support and add value to efforts in the jurisdictions to tailor approaches to prevention improvement;
- facilitate, through strategic alliances, the development and implementation of better approaches to achieving improved prevention outcomes; and
- integrate the needs of small business into its work.

In May 2002, the Workplace Relations Ministers' Council (WRMC) endorsed NOHSC's National OHS Strategy 2002–2012. The Strategy signifies the commitment of all Australian governments, ACCI and the ACTU, to work cooperatively on national priorities for improving OHS and to achieve minimum national targets for reducing the incidence of workplace deaths and injuries.

The Strategy was developed by the members of NOHSC and reflects their agreement to share responsibility for continuously improving Australia's performance in work-related health and safety.

The national vision, and the ultimate goal of the National OHS Strategy is Australian workplaces free from death, injury and disease. In addressing occupational death and injury the National OHS Strategy has identified some initial national targets. These are:

- to sustain a significant, continual reduction in the incidence of work-related fatalities with a reduction of at least 20 percent by 30 June 2012 (with a reduction of 10 percent being achieved by 30 June 2007); and
- to reduce the incidence of workplace injury by at least 40 percent by 30 June 2012 (with a reduction of 20 percent being achieved by 30 June 2007).

The Council of Australian Governments (COAG) requires a RIS to be prepared when making a new, or amending an existing, standard or regulation. The ORR assists COAG in reviewing and advising on draft RIS prepared by national regulatory bodies such as NOHSC. A RIS is provided to the decision making body and made public at the time of the decision.

In mid 2003, NOHSC developed a Preliminary Regulation Impact Statement (PRIS) in consultation with ORR. The PRIS contains similar information to that in the RIS, except that as a preliminary consultation document, it is used to elicit additional cost/benefit information to inform the decision maker. The PRIS was discussed with a range of stakeholders including state and territory OHS authorities, industry and unions. The PRIS was disseminated for public comment in August 2003 for a period of 12 weeks.

Once the comment period had closed, all of the public comment was assessed by members of an expert review group, the Crystalline Silica Review Group (CSRG). The CSRG consisted of representatives from the NOHSC Office, states and territories, employers (ACCI) and employees (ACTU). Some of the public comment received queried the validity of the data contained in the PRIS.

The NOHSC Office engaged Allen Consulting to undertake additional economic analysis. In addition, the NOHSC Office, on behalf of the CSRG, conducted further work on the data, and for this reason the data in the RIS differs significantly from that used in the PRIS.

In this RIS:

- Part One sets out information on the nature and extent of the problem.
- Part Two sets out the objectives of reviewing NES
- Part Three sets out the options
- Part Four sets out the costs and benefits
- Part Five sets out the consultation and comment
- Part Six sets out the conclusion and recommended option
- Part Seven sets out implementation

The current and proposed NES for RCS are time weighted average values (TWA), i.e., the exposure standard values represent the average airborne concentration of RCS when calculated over a normal 8 hour working day for a 5 day working week.

Part one - the nature and extent of the problem

What is crystalline silica?

Crystalline silica — also known as silicon dioxide (SiO_2) — is the basic component of sand, quartz and granite rock. It accounts for 12 percent of the earth's crust by weight and is found just about everywhere in varying proportions, including in aggregates, sand, mortar, concrete and stone, and is also in the air and the soil.

Crystalline silica may be found in more than one form (polymorphism) with the different forms reflecting different molecular structures. The three most common forms of crystalline silica encountered in the workplace are quartz, tridymite, and cristobalite.

Quartz is the most common form and is so abundant that the general term crystalline silica and 'free silica' are often used interchangeably with quartz. Quartz is a common component of soil and rocks; consequently, workers are potentially exposed to quartz dust in many occupations and industries.[10]

Cristobalite and tridymite are also found in rocks and soil and are produced in some industrial operations when alpha quartz or amorphous silica is heated (such as foundry processes, calcining of diatomaceous earth, brick and ceramics manufacturing, and silicon carbide production). Burning of agricultural waste, or products such as rice hulls, may also cause amorphous silica to become cristobalite (a crystalline form).[11]

Table 2 provides an overview of the three main types of silica, briefly describing their composition, nature and uses for each.

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[10] National Institute for Occupational Safety and Health (NIOSH) (April 2002), *op cit*

[11] ibid.

TABLE 2:

COMPARISON BETWEEN DIFFERENT FORMS OF CRYSTALLINE SILICA: QUARTZ, CRISTOBALITE AND TRIDYMITE

	Silica, Quartz	Silica, Cristobalite	Silica, Tridymite
Appearance	Colourless white, black, purple or green, and odourless solids	Colourless, white or yellowish, and odourless solids	Colourless or white crystals
Molecular Weight	60.09	60.09	60.09
Crystalline Form	Hexagonal; also in anhedral massive form	Octahedral, rarely cubical, also in massive form	Tabular, pseudo-hexagonal, also in massive form
Density (water = 1)	2.65	2.33	2.2
Hardness (Mohs scale)[12]	7.0	6.5	7.0
Chemical Features	Chemically identical, may differ on basis of crystalline form	Chemically identical, may differ on basis of crystalline form	Chemically identical, may differ on basis of crystalline form
Solubility – Water	Practically insoluble, 6 – 11 ppm at 25°C	Practically insoluble	Practically insoluble
Solubility — Acids	Soluble in hydrofluoric acid, but insoluble in most other acids	Soluble in hydrofluoric acid, but insoluble in most other acids	Soluble in hydrofluoric acid, but insoluble in most other acids
Location	Widespread in: granite, pegmatite, sandstone, shales, quartzites, slates, sand, stream beds, beaches, gardens and desserts	• Temperatures greater than 1500°C may convert amporphous silica and quartz to cristobalite • Often associated with metamorphosis in volcanic areas	• Temperatures greater than 1500°C may convert amporphous silica and quartz to tridymite • Often associated with metamorphosis in volcanic areas
Relationship	Inter-related — may change form under different conditions of temperature and pressure	Inter-related — may change form under different conditions of temperature and pressure	Inter-related — may change form under different conditions of temperature and pressure
Uses	Overseas — used for making fibreglass, electrical insulation, chemical filtration, and as an abrasive Australia — most widespread, due to magnitude of mining and construction industries	Overseas — used in foundry moulds, iron and steel castings, and in making fibreglass and ceramics Australia — appears to be restricted to the ceramic, diatomaceous earth, and hot metal industries	Negligible use in Australia

Source: de Klerk, N; Ambrosini, G & Musk, A (February 2002), *A Review of the Australian Occupational Exposure Standard for Crystalline Silica (Draft for Peer Review)*, University of Western Australia; accessed on 06/05/04 at http://www.nohsc.gov.au/OHSInformation/Databases/ExposureStandards/Crystalline-Silica/ReviewExpStdCrystallineSilica.pdf; and
National Occupational Health and Safety Commission (NOHSC) (1996), *Draft Technical Report on Crystalline Silica*, AGPS, Canberra

[12] The Mohs scale of mineral hardness was devised by the German mineralogist Frederich Mohs (1773-1839) in 1812

Adverse health effects that may result from exposure to RCS

Diseases caused by inhalation of crystalline silica may include:[13]

- *chronic silicosis (including simple and complicated or conglomerate silicosis)* — this is the most common form of silicosis. Small, hard nodules of scar tissue (fibrotic changes) develop in the lungs following 10 to 30 years of breathing excessive levels of silica dust. With simple silicosis, the nodules of scar tissue can be seen on chest X-ray as multiple, small, rounded or regular opacities, predominantly in the upper lungs. Many diseases resemble simple silicosis including military tuberculosis, welder's siderosis, haemosiderosis, sarcoidosis and coal worker's pneumoconiosis. Simple silicosis can develop into complicated or conglomerate silicosis, also known as progressive massive fibrosis, when the lung opacities reach greater than 1 cm in diameter and can reach up to 10 cm in diameter. Even after exposure to RCS has ceased, accumulated dust in the lungs can cause the fibrotic changes to continue to develop. The main symptoms are difficulty in breathing and cough. Severe cases can lead to a shortening of life expectancy. No effective treatment is know other that lung transplantation;
- *accelerated silicosis* — this results from the inhalation of very high concentrations of silica dust over a relatively short period (five to ten years). Although it develops in a pattern similar to that of chronic silicosis, the time from initial exposure to the onset of disease is shorter and the progression to complicated silicosis is more rapid;
- *acute silicosis* — this develops from the inhalation of exceptionally high concentrations of crystalline silica over a short period (seven months to five years). Symptoms include cough, weight loss, and fatigue, which may progress rapidly to respiratory failure and death within several months;
- *pulmonary tuberculosis* — silica particles can destroy or alter the metabolism of the pulmonary macrophage, thereby reducing its capacity for anti-bacterial defense. The risk of developing pulmonary tuberculosis while exposed, and also after exposure ends, depends on the amount of cumulative silica dust exposure. The presence of silicosis in the lung also increases the risk of developing pulmonary tuberculosis. Pulmonary tuberculosis is a bacterial infection that can spread to other organs from the lungs. Symptoms range from minor cough and mild fever, to fatigue, weight loss, night sweats, and persistent cough (which may contain blood). Some individuals with this disease may show no symptoms. Permanent lung damage may result from fibrosis and calcification of the lung.
- *chronic obstructive lung disease* — destruction of the alveolar walls can lead to emphysema which is the main cause of chronic obstructive lung disease. Emphysema develops primarily in people who smoke, but may be present in non-smokers with an occupational exposure to quartz. Silica dust can worsen the damage done by smoking. Chronic obstructive lung disease is the fourth leading cause of death in the USA;
- *heart effects* — in severe cases, fibrosis in the lungs can lead to prolonged increases in the blood pressure in the arteries and veins of the lungs (pulmonary hypertension). Pulmonary hypertension is poorly tolerated by the right side of the heart, which pumps blood to the lungs. The results of pulmonary hypertension can be enlargement (hypertrophy) of the right ventricle to compensate for pumping blood under high pressure

[13] National Centre for Occupational Health (NCOH) / Surveillance of Work-Related and Occupational Respiratory Diseases in South Africa (SORDSA) (February 1999), *Crystalline Silica: Health Hazards and Precautions*, accessed on 06/05/04 at http://www.asosh.org/Programmes/SORDSA/Crystalline_silica.htm

and eventually right-sided heart failure (known as *cor pulmonale*). Symptoms can include fatigue, difficult or laboured breathing, intolerance of exercise, chest pains, and swelling of the feet and ankles. At its most severe, this can lead to death;

- *lung cancer* — the balance of evidence suggests that RCS exposure causes lung cancer. There is dispute as to whether RCS exposure causes lung cancer directly, or whether RCS exposure causes lung cancer indirectly, i.e., whether the development of silicosis increases the risk of developing lung cancer. There is evidence to suggest that persons exposed to occupational RCS are at a higher risk of developing lung cancer as a result of that exposure than persons not exposed to RCS. A number of international bodies classify silica as a carcinogen, as set out in Table 3;

  In late 1996 the International Agency for Research on Cancer (IARC) concluded that there was sufficient evidence to categorise certain kinds of silica as carcinogens. Subsequently, inhaled crystalline silica (in the form of quartz or cristobalite) from occupational sources is classified by the IARC as a Group 1 human lung carcinogen.[14] This was concluded, "on the basis of a relatively large number of epidemiological studies that together provided sufficient evidence in humans for the carcinogenicity of inhaled crystalline silica under the conditions specified." [15] The National Toxicology Program (NTP) is an interagency program under the auspicies of the U.S. Department of Health and Human Services. In their "Ninth Report on Carcinogens", the NTP changed their assessment of silica, crystalline (respirable size) from *"Reasonably Anticipated to be a Human Carcinogen"* to *"Known to be a Human Carcinogen"* [16];

- *other health effects* — crystalline silica has been linked with cases of autoimmune diseases such as scleroderma, systemic lupus erythematosus (lupus) and rheumatoid arthritis. Chronic renal disease, possibly due to immunological abnormalities, has also been linked with silica dust exposure[13].

TABLE 3:

INTERNATIONAL CARCINOGEN CLASSIFICATION OF CRYSTALLINE SILICA

International Body	Carcinogen Classification
International Agency for Research on Cancer (IARC)	Crystalline silica - human carcinogen
National Institute of Occupational Safety and Health (NIOSH, USA)	Crystalline silica – *potential* occupational carcinogen
National Toxicology Program (NTP, USA)	RCS – known to be a human carcinogen
British Health & Safety Executive	RCS – causes lung cancer, but is probably a *weak carcinogen*
American Conference of Governmental Industrial Hygienists (ACGIH, USA)	Crystalline silica – *suspected* human carcinogen

14 International Agency for Research on Cancer (IARC) (1997), "Silica, Some Silicates, Coal Dust and Para-Aramid Fibils", *IARC Monographs on the Evaluation of Carcinogenic Risks to Humans and their Supplements*, Vol 68, p.41 accessed on 06/05/04 at http://193.51.164.11/htdocs/monographs/vol68/silica.htm

15 Statement by the International Agency for Research on Cancer (IARC) as cited by International Health Consultants (IHC), *Silica (Crystalline Silica)*, accessed on 06/05/04 at http://users.bigpond.net.au/InHealth/Silica1.htm. .

16 U.S. Department of Health and Human Services, *10th Report on Carcinogens*, Public Health Service, National Toxicology Program, 2002 accessed on 06/05/04 at http://ehp.niehs.nih.gov/roc/toc10.html.

The form and severity in which silicosis manifests itself depends on a number of factors including:

- amount and kind of dust inhaled;
- percentage of free silica in the dust;
- the form of silica;
- the size of the silica particles;
- the duration of exposure;
- the individual's natural body resistance; and
- presence or absence of complicating factors (such as infection).

Silicosis has a number of characteristics that make it a particularly problematic disease:

- the effects of exposure are cumulative, irreversible, and very difficult to detect prior to the point of illness;
- extremely high exposures (e.g., exposures of 90 mg/m^3 over 8 hr day for six months) are associated with much shorter latency and more rapid disease progression; and
- there are usually long lead times between exposure and eventual complications — a relatively 'short' latency period may be five to ten years.

Silicosis may work in conjunction with other diseases, and it may be aggravated by other conditions. Emphysema and asbestosis can cause an added damage to the lungs when coupled with silicosis, as can cigarette smoking.

Scientific evidence

There is a considerable amount of scientific evidence to show that exposure to RCS should be kept as low as possible. Based on current scientific evidence, a national exposure standard for crystalline silica of 0.1 mg/m^3 of quartz, 0.1 mg/m^3 of cristobalite and 0.1 mg/m^3 of tridymite will reduce the incidence of all important adverse health effects from RCS exposure. This evidence includes epidemiological studies and the setting of international exposure standards for RCS. The scientific evidence is discussed in more detail in Part four, Option five.

It is important to note that silicosis is not a naturally occurring disease; its occurrence is directly associated with workplace exposure to silica dust. Its earlier names (ie, miners' asthma, grinders' consumption, miners' phthisis, potters' rot and stonemasons' disease) demonstrate its connection to various occupations.

Exposure to crystalline silica

Silica dust is released during operations in which rocks, sand, concrete and some ores are crushed or broken. Work in mines, quarries, foundries, and construction sites, in the manufacture of glass, ceramics, and abrasive powders, and in masonry workshops is particularly risky.

On the basis of workplace measurements and job analysis, the occupations considered to be most at risk of exposure to RCS are:

Wall and Floor Tilers and Stonemasons
Drillers
Mobile Construction Plant Operators
Other Intermediate Stationary Plant Operators
Glass Production Machine Operators
Clay, Stone and Concrete Processing Machine Operators
Miners
Blasting Workers
Structural Steel Construction Workers
Other Process Workers
Mining Support Workers and Driller's Assistants
Earthmoving Labourers
Paving and Surfacing Labourers
Railway Labourers
Construction and Plumber's Assistants
Concreters
Electricians
Other Mining, Construction and Related Labourers eg Mechanics, Fitters and Turners, Electricians, Plant Maintenance workers

Workers in the above occupations may come into contact with RCS through the following tasks:

- underground mining, tunnelling and excavation work — the potential exposure to crystalline silica in mining and tunneling will vary depending on the geological formations worked;[17]
- extraction and cutting of quartzite, gneiss, granite and slate;
- foundry work;
- glass manufacturing;
- brick–making;
- manufacture of pottery, porcelain, refractory materials and siliceous abrasives;
- road building;
- explosive blasting work;
- chipping, hammering, and drilling in rock or concrete or brick;
- crushing, loading, hauling, and dumping of rock and concrete;
- abrasive blasting using silica sand or from the materials being blasted (concrete);
- sawing, hammering, drilling, grinding, and/or chipping on masonry or concrete;

[17] Although silicosis differs from the pneumoconiosis afflicting coal miners, some coal dust, particularly from anthracite coal, can contain free silica and therefore cause silicosis.

- demolition of brick, concrete, or masonry;
- dry sweeping concrete, sand, or rock dust;
- trenching and excavation; and
- tile and grout work.

While worker exposure to RCS can potentially occur in a number of industries, a case study from the United States National Institute for Occupational Safety and Health (NIOSH) demonstrates the severity of the hazard. NIOSH has indicated that an estimated one million US workers are exposed to silica in the workplace and so are at risk of developing silicosis and that 100,000 of these workers are employed as sandblasters. The NIOSH Alert also reports that of these one million workers, approximately 59,000 can be expected to develop silicosis. Sand blasting generates fine airborne particles of silica that appear to produce a more severe lung reaction than those airborne silica particles not freshly fractured. Also, most abrasive blasters work without adequate respiratory protection and workers adjacent to blasting operations often wear no respiratory protection. For these reasons, NIOSH has recommended since 1974, that silica sand (or other substances containing more than one percent crystalline silica) be prohibited as abrasive blasting material [18].

In Australia, there are various prohibitions in State and Territory hazardous substances regulations involving silica.

Silica Use	State/Territory Prohibition
Free silica in abrasive blasting	NSW, WA, Tasmania
More than 5% free silica in abrasive blasting	SA, WA, Tasmania, NT
Free silica in casting moulds/cores	NSW, Tasmania
Free silica in parting face powders in foundry work	NSW, Tasmania
Free silica in steel moulding compositions	NSW
Free silica in paints in foundry work	NSW, Tasmania

For details on the prohibition of silica for abrasive blasting in Victoria and Western Australia see Box 1.

Some operations, like dry sweeping, the clearing of sand or concrete, or the cleaning of masonry with pressurised air can generate large dust clouds. Dry abrasive blasting cleaning is the dustiest of the methods used for surface preparation and therefore results in the highest levels of worker exposure to airborne concentrations of hazardous dust. Even in open air these activities can be hazardous.

[18] National Institute for Occupational Safety and Health (NIOSH) (August 1992), *NIOSH Alert: Preventing Silicosis and Deaths from Sandblasting*, DHHS (NIOSH) Publication No. 92-102, accessed on 06/05/04 at http://www.cdc.gov/niosh/92-102.html

BOX 1

VICTORIA AND WESTERN AUSTRALIA BAN ON SILICA FOR ABRASIVE BLASTING

Since 1 January 2002 the use of materials containing more than one percent crystalline silica for abrasive blasting has been prohibited in all Victorian workplaces. Western Australian prohibits the use of two percent crystalline silica in workplaces. This means materials such as silica, river sand, beach sand and other white sands should not be used for abrasive blasting.

Blasting media that could be substituted include:

- garnet;
- crushed glass (amorphous silica);
- metal shot;
- steel grit;
- aluminium oxide;
- granulated plastic; and
- some metal slags (metal slags may contain high levels of toxic metals such as lead and chromium which may cause other health and safety and environmental risks).

WorkSafe Victoria has been conducting inspections of workplaces performing abrasive blasting since 1 January 2002 to ensure compliance with the prohibition.

Any use of sand or other materials containing more than one percent crystalline silica after 1 January 2002 in Victoria results in the issuing of prohibition notices and may be referred for investigation and possible prosecution.

Source: WorkSafe Victoria, *Hazardous Substances: Ban on Silica for Abrasive Blasting*, accessed on 06/05/04 at http://www.workcover.vic.gov.au/vwa/home.nsf/pages/so_haz_subs_silica

WorkSafe Western Australia, *Code of Practice – Abrasive Blasting*, accessed on 06/05/04 at http://www.safetyline.wa.gov.au/PageBin/codewswa0162.htm

Table 4 shows the industries in which workers are potentially exposed to silica in the course of their work. This shows that exposure is a national issue. It should be kept in mind that workers in some of these industries have a different likelihood of exposure compared to those in others, that not all workers in the same industry will have the same likelihood of exposure, and the different exposed workers are likely to be exposed to different levels of silica.

TABLE 4:

NUMBER OF WORKERS BY STATE/TERRITORY AND INDUSTRY

	NSW	VIC	QLD	SA	WA	TAS	NT	ACT	Total
Building Construction	59548	41481	22790	6445	12867	1751	924	1446	**147252**
Cement, Lime, Plaster and Concrete Product Manufacturing	5207	2285	3549	1613	1936	309	266	*	**15165**
Ceramic Product Manufacturing	1238	2883	1243	*	1232	*	na	*	**6596**
Construction Material mining and Other Mining	2832	1366	1234	623	2531	*	na	*	**8586**
Glass and Glass Product Manufacturing	1862	3011	2290	951	383	*	*	na	**8497**
Non-Building Construction	14212	9727	13780	2693	6834	956	618	418	**49238**
Non-Metallic Mineral Product Manufacturing, nec.	1432	2092	2299	423	1070	*	na	*	**7316**
Other Construction Services	10133	7003	4175	2249	3591	396	283	324	**28154**
Other Mining Services	*	na	*	*	1369	*	50	na	**1419**
Site Preparation Services	7484	4031	4022	1585	4264	*	347	*	**21733**
Total	**103948**	**73879**	**55382**	**16582**	**36077**	**3412**	**2488**	**2188**	**293956**

Note: Classification of Industry is from Australian and New Zealand Standard Industrial Classification 1993.
Nec – means not elsewhere classified
Construction Material mining and Other Mining does not include oil, coal, gas or metal ore mining. It includes among others gravel, sand, and clay quarrying
* - relative standard error greater than 50% therefore data not reliable
na - no employees in this industry in this state/territory

Source: NOHSC Denominator Data 2002 based on data from ABS.

Public comment indicated that analysis which focuses solely on primary employees (employees who work first hand with RCS) may understate the extent of silicosis. RCS dust is so small and light that it can remain airborne for a long time. The dust is able to travel long distances by air and may affect populations not otherwise considered to be at risk. An example of this may be a mechanic who regularly maintains and repairs rock crushing machinery. Other examples include electricians, mechanics and other maintenance workers.

Due to a long lag time between exposure and symptoms, it is difficult to ascertain how many people develop silica-related conditions, and when the causative exposure to RCS occurred.

There is limited information on workplace exposures to crystalline silica. Workplace exposures to RCS can be potentially high, with processes such as the dry cutting of crystalline silica materials in confined spaces and dry abrasive blasting cleaning generating RCS exposures of hundreds of mg/m^3. Conversely, the mining industry and some of the large and multi-national companies have in place appropriate work processes, practices and equipment to control RCS exposures to the current NES and below.

Workplace atmosphere monitoring data, conducted by industry to monitor compliance with the current NES, would constitute the most accurate information on occupational exposure levels. To give an indication of possible workplace exposures, the monitoring data would include a wide range of workplace scenarios, utilising different work processes, work practices and equipment across the industry sectors e.g., mining, building and construction. No monitoring data were provided by industry or regulators to inform the RIS during the public comment phase or as a result of the industry workshops. Comments made by industry during public comment phase and during the industry workshops suggested there is general compliance with the current NES.

There are significant problems with health statistics about the potential incidence of adverse health effects from RCS exposure. Adverse health effects arising from RCS exposure are not obvious until the manifestation of illness. Once illness is manifest, it is commonly not possible to identify when the RCS exposure occurred and at what level. Problems with attributing adverse health effects to exposure include;

- the familiarity of RCS exposure. This means that people who have been working in dusty environments may not appreciate the risk of exposure to RSC as the adverse health effects are not immediate;
- as with asbestos and mesothelioma, irreversible and cumulative lung damage caused by RCS is hidden, until it manifests as illness; and
- damage to the lungs can worsen after exposure ceases.

Information from the NSW Dust Diseases Board is based on silicosis cases for which compensation has been paid. Consequently, these figures do not account for other lung diseases or other diseases caused by RCS, or unsuccessful cases for compensation.

As diseases caused by exposure to RCS are of long latency, current cases of adverse health effects could reflect the effect of past exposures, when exposures were potentially greater than they are now under the current standard. Therefore current cases may be an over-estimate of the effect of the current NES.

Conversely, the current NES of 0.2 mg/m^3 of quartz, 0.1 mg/m^3 of cristobalite and 0.1 mg/m^3 of tridymite may be achieving their objectives, which is why there are few incidents of adverse health effects recorded in statistics. In addition, this could be a reflection of the under-reporting of adverse health effects resulting from RCS exposure in official health statistics. However, international research[19] shows that there may still be a risk of disease at this exposure level, with cases of silicosis and lung cancer predicted at exposures above 0.2 mg/m^3 of quartz, 0.1 mg/m^3 of cristobalite and 0.1 mg/m^3 of tridymite.

The costs associated with adverse health effects as a result of exposure to RCS

The calculable costs associated with diseases that result from exposure to RCS fall into the following categories:

- Hospitalisation (see Table 5);
- Workers' compensation including medical expenses;
- Deaths.

The health statistics used in this Regulation Impact Statement (RIS) provide information on the incidence of adverse health effects attributable to RCS exposure. This does not include non-fatal conditions, such as disease or a restriction of function that does not result in hospitalisation as these data are not available. In observed cases of adverse health effects it is not possible to identify when exposure to RCS occurred and at what level. This means that it is not possible to know if adverse health effects were due to exposure before or after implementation of the current NES. Adverse health effects attributable to RCS exposure are recorded in current health statistics and are likely to continue to be seen into the future.

In NSW, for 2001-2002, the reported costs associated with silica-related diseases are estimated to have been at least:

- $4,908,000 for workers' compensation, including compensated medical expenses; and
- 21 Deaths.

19 'the Mannetje, A., et. al.(2002), *op cit*
Steenland, K., *et. al.* (2001), *op cit*
UK HSE Chemical Hazard Alert Notice (CHAN) No. 35 *op cit*
National Institute for Occupational Safety and Health (NIOSH) (April 2002), *op cit*

TABLE 5:

SILICA RELATED HEALTH STATISTICS FOR HOSPITAL TREATMENTS IN AUSTRALIA (2000-01)

Principal Diagnosis	Separations*	Same day separations	Separations per 10,000 population	Patient days	Patient days per 10,000 population	ALOS (days)	ALOS (days) excluding same day
Pneumoconiosis due to dust containing silica							
Public Hospitals	32	6	<0.1	214	0.1	6.7	8.0
Private Hospitals	13	4	<0.1	91	<0.1	7.0	9.7

* Separations are defined as a discharge and closing of patient file
ALOS is average length of stay.

Source: Australian Institute of Health and Welfare, *Australian Hospital Statistics 2000-01*, Table S8.1 and S8.2, accessed on 06/05/04 at http://www.aihw.gov.au/publications/hse/ahs00-01/.

Table 6 shows data from the NSW Dust Diseases Board on dust-related deaths from 1968 to 2002. Of 1,369 deaths, 409 were due to dusts containing RCS and the average age of death was 63 to 73 years.

TABLE 6:

NSW SILICA DUST-RELATED DEATHS BY CAUSATION SINCE FEBRUARY 1968 - 2002

Disease	Death Due to Dust	Death Not Due to Dust	Total	Average Age of Death Due to Dust
Silicosis	**380**	944	**1,324**	70.10
Silico-Tuberculosis	**8**	12	**20**	62.80
Silico-asbestosis	**8**	4	**12**	64.22
Silica Induced Carcinoma	**12**	0	**12**	73.10
Silicosis and Silica Assoc Lung Cancer	**1**	0	**1**	64.56
TOTAL	**409**	**960**	**1,369**	

* including Asbestos & Hexavalent salt induced.

Source: Dust Diseases Board (DDB) of NSW, *2002 Statistics: Appendix 9*, accessed on 06/05/04 at http://www.ddb.nsw.gov.au/parent.asp?disp=st

The cost of payments of compensation to workers and their dependants according to type of dust disease in NSW for the period 2001-02 is set out in Table 7

TABLE 7:

COMPENSATED PAYMENTS MADE TO WORKERS AND BENEFICIARIES OF WORKERS IN NSW DURING THE FINANCIAL YEAR 2001 – 2002

		Silicosis	Silico-tuberculosis	Silico-asbestosis	Silica Induced Carcinoma	Total
Workers	Number of Workers	197	1	5	5	**208**
	Weekly* Comp ($,000)	1,656	6	33	92	**1,787**
	Hospital & Medical ($,000)	275	0	0	18	**293**
	Funeral ($,000)	29	0	0	0	**29**
	Total ($,000)	1,960	6	33	110	**2,109**
Dependants	Number of Dependants	304	14	2	10	**330**
	Weekly* Comp. ($,000)	1,483	55	12	83	**1,633**
	Lump Sum Payments ($,000)	988	0	0	178	**1,166**
	Total ($,000)	2,471	55	12	261	**2,799**
Total	Number of Beneficiaries	501	15	7	15	**538**
	Payments ($,000)	4,431	61	45	371	**4,908**

* This is the total per annum. On average each worker received $10,139 for the year, or $194 per week.

208 workers received compensation payments for silicosis or silica related asbestosis, tuberculosis and cancer.

$2,109,000 in compensation was paid to affected workers during the financial year 2001 – 2002.

The number of reported deaths due to dust diseases in NSW from February 1968 to 2002 is set out in Table 8**.**

TABLE 8

NUMBER OF REPORTED DEATHS DUST DISEASE CASES IN NSW — FEBRUARY 1968 – 2001 AND FEBRUARY 1968 - 2002

Disease	**Number of Deaths 1968 -2001**		**Number of Deaths 1968 -2002**		**Number of Deaths 2002-2001**
	Average Age (yrs)	Due to dust (no.)	Average Age (yrs)	Due to dust (no.)	
Silicosis	70	360	70	380	20
Silico-tuberculosis	63	8	63	8	0
Silico-asbestosis	64	8	64	8	0
Silica induced carcinoma	67	11	73	12	1
Total		**387**		**408**	**21**

Source: Dust Disease Board (DDB) of New South Wales, *Statistics 2002*, Appendix 5 accessed on 06/05/04 at www.ddb.nsw.gov.au/content/statistics/appendix/appendix5.htm

Is there a 'market failure'?

In economics, a market failure is a case in which a market fails to efficiently provide or allocate goods and services. Market failure refers to situations where market forces do not serve the perceived 'public interest'. One of the main reasons that markets fail is because of the inability to internalise costs or benefits into prices and the flow on effects on decision-making in markets. Ideally all goods should reflect their true value (opportunity and production costs).

In relation to RCS, potential market failures include:

- imbalance of access to information between employers and employees, where employers are more likely to have more information about the risks to health and safety in the workplace than employees; and
- 'externalities' that arise from the impact on third parties.

In this case, imbalance of information means that employers are likely to have more information than employees about the potential risks associated with RCS. This may lead to situations where employees don't fully understand the longer term implications and costs of working with RCS. Where employees do fully understand the risks, there may be demand for increased pay and changes in working conditions.

The externalities arising from the impact on third parties may include all the costs associated with the adverse health effects from exposure to RCS. This would mean that the true price should reflect the costs to the employee, their family and the community. If this were to occur, it may be that silica-containing products that release RCS when in use, may price themselves out of the market.

To some degree, employers engaged in the industries where there is exposure to RCS already have liability placed upon them in terms of workers' compensation insurance premiums and payouts. However, the difficulty in diagnosing diseases related to RCS exposure and their long latency means that employers often do not face the full financial costs of workplace exposure.

Two studies, one undertaken by the Industry Commission (IC) in 1995 and the other undertaken for NOSHC in 2004, have found that with regard to all OHS, employers have incurred much less than the total cost associated with occupational injury and disease. According to the IC report only 51 percent of costs were paid by the employer, with the rest of the costs being met by employees, their families and the community at large. The NOHSC study also revealed discrepancies between the costs covered by industry and those transferred to employees, their families and the community. In contrast with the findings of the IC study, the NOHSC study indicated that the costs carried by the community (35%) , and employees (41%) in 2003 were higher than in 1995, with employers in 2003 paying only 24% of costs. [20].

The IC report observed that 'the financial incentives on the employer to reduce the cost of injury and disease are weak' in view of the large proportion of the costs borne by the worker and the broader community.

The non-measurable costs faced by victims of work injuries and disease should be added to the measurable financial costs. The difficulties involved in quantifying these costs do not

[20] Ibid, p95.

make them any less important. In fact these costs reflect much of the real impact of failure to implement OHS measures.

In such circumstances, insurance and compensation costs alone cannot provide an adequate safety incentive.

Historical development of the crystalline silica exposure standards

Occupational exposure standards are established to provide protection, by neither impairing the health of, nor causing undue discomfort, to nearly all workers who are exposed for eight hours per day and five days per week for their working life. In 1983-84 the National Health and Medical Research Council (NHMRC) recommended exposure standards specifically for quartz (0.2 mg/m^3), cristobalite (0.1 mg/m^3) and tridymite (0.1 mg/m^3).

In 1988, the Exposure Standards Expert Working Group (ESEWG), working under the Standards Development Standing Committee (SDSC) of Worksafe Australia reconsidered the exposure standards for silica in the occupational environment. Following the recommendations of the American Conference of Governmental Industrial Hygienists (ACGIH),[21] the ESEWG recommended a reduction of the exposure standards to 0.1 mg/m^3 respirable fraction for quartz, silica (fused), and tripoli (as quartz). For cristobalite and tridymite, the proposed NES were set at half of these values, at 0.05 mg/m^3. This standard was released for a public comment period in late 1988.

Following public comment, the ESEWG believed a more thorough examination of the issue was warranted. The SDSC then established an Expert Working Group on Crystalline Silica (EWGCS) and a Reference Group to look at the NES for crystalline silica. A draft technical report on crystalline silica was prepared by the EWGCS in consultation with the reference group and other NOHSC staff. The draft technical report examined toxicity, health impacts in exposed populations, exposure data, exposure estimates and measurement, and it put forward a risk assessment model to predict the incidence of silicosis and cancer from different exposure levels. The draft report made recommendations to reduce the incidence of adverse health outcomes associated with silica exposure.

Between 1988 and 1996, no formal NES for crystalline silica existed in Australia, although some mining and OHS authorities issued their own standards.

After the draft technical report of 1996,[22] NOHSC reinstated the original 1983-84 NHMRC exposure standards (NHMRC no longer sets occupational exposure standards).

Current RCS exposure standards

In 1993, NOHSC declared a package of regulations, standards and codes of practice known as the National Hazardous Substances Regulatory Package. As part of this, NOHSC developed NES to be adopted and implemented on a nationally consistent basis. The NES

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[21] American Conference of Government Industrial Hygienists ACGIH) (1985), *Documentation for Threshold Limit Values and Biological Indices* (5th edition), Cincinnati.

[22] National Occupational Health and Safety Commission (NOHSC) (1996), *Draft Technical Report on Crystalline Silica*, AGPS, Canberra.

are developed and reviewed according to scientific knowledge and other sources such as overseas regulatory standards, where relevant. The existing standards are set out in Table 9.

While NOHSC has the power to establish national standards and codes of practice, they only form part of the statute law when adopted by state and territory jurisdictions. State and territory jurisdictions also undertake ultimate implementation and enforcement.

A review of the reinstated NES for crystalline silica was referred to the Hazardous Substances Sub Committee (HSSC) by NOHSC. In April 1998, the HSSC agreed to recommend an independent review of the crystalline silica NES. As part of this process, in 2002 the University of Western Australia (UWA) published an independent review of crystalline silica NES and recommended changes to existing standards[23].

TABLE 9:

EXISTING CRYSTALLINE SILICA EXPOSURE STANDARDS

Form of Crystalline Silica	Quartz	Cristobalite	Tridymite
Current NES	0.2 mg/m^3	0.1 mg/m^3	0.1 mg/m^3

International developments

Australia's current NES are higher than most international standards. In particular, the exposure limit for respirable quartz is higher than in most other countries. Respirable quartz is the most common form of crystalline silica and therefore the form that poses the greatest risk to the majority of the workforce.

Crystalline silica is a worldwide problem, but international comparisons are difficult because the collection and analytical methods used by the various national standard-setting bodies have resulted in differences in measured exposures and exposure standards.

These differences have an impact on the results of comparisons made between exposure standards. Table 10 (below) provides an overview of comparisons for international occupational exposure limits for crystalline silica. Consideration of overseas exposure standards in Table 10 should account for the different collection and analytical methods.

[23] de Klerk, N; Ambrosini, G & Musk, A (December 2002), *op cit*

TABLE 10:

INTERNATIONAL OCCUPATIONAL EXPOSURE LIMITS FOR CRYSTALLINE SILICA

Country	Quartz mg/m^3	Cristobalite mg/m^3	Tridymite mg/m^3	Date of Publication or Implementation
UK **(see box 3, pg 44)**	0.3	0.3	0.3	1999
Australia	0.2	0.1	0.1	1983
Finland	0.2	0.1	0.1	1993
Austria	0.15	0.15	0.15	1992
Germany	0.15	0.15	0.15	1996
Switzerland	0.15	0.15	0.15	—
Belgium	0.1	0.05	0.05	1995
Canada (Quebec)	0.1	0.05	0.05	1996
Denmark	0.1	0.05	0.05	1988
France	0.1	0.05	0.05	1996
Argentina	0.1	0.05	0.05	1991
Italy	0.1	0.05	0.05	1991
Norway	0.1	0.05	0.05	1994
Portugal	0.1	0.05	0.05	1988
Sweden	0.1	0.05	0.05	1993
South Africa	0.1	—	—	1996
Netherlands	0.075	0.075	0.075	1996
USA (NIOSH)	0.05	0.05	0.05	1974

Source: reported in de Klerk, N; Ambrosini, G & Musk, A (December 2002), *A Review of the Australian Occupational Exposure Standard for Crystalline Silica (Peer Reviewed)*, University of Western Australia; accessed on 06/05/04 at http://www.nohsc.gov.au/OHSInformation/Databases/ExposureStandards/Crystalline-Silica/ReviewExpStdCrystallineSilica.pdf.

One example of the differences in collection and analytical methods used is the US underground mines sampling of 'portal to portal' (mine entrance to mine exit) whereas most Australian measurements are 'crib room to crib room' (time near to the mine's work-face). 'Crib room to crib room' measurements are generally 30-40% higher than 'portal to portal'. There is also variation in the conventions for the definitions and cut-off values for a respirable dust. To convert the old ACGIH convention to the new CEN-ISO-ACGIH convention = x 1.3, and to convert the BMRC convention to the new CEN-ISO-ACGIH convention = ÷ 1.4. For a more comprehensive discussion of international exposure standards, see Part 3, Option Five of the RIS.

The ILO/WHO international programme [24]

In April 1995, the Joint ILO/WHO Committee on Occupational Health proposed a joint ILO/WHO Programme on Global Elimination of Silicosis in order to promote wide international cooperation in preventing silicosis. The programme aims to offer countries a

[24] International Labour Organisation (ILO) (September 1997), "Global Elimination of Silicosis: The ILO/WHO international Programme", *Mineral Dusts and Prevention of Silicosis*, Vol 4, No 2, September 1997 accessed on 06/05/04 at http://www.ilo.org/public/english/region/asro/bangkok/asiaosh/newsletr/silicosi/asialtr.htm,

framework for a broad international collaboration, and to contribute to the elimination of silicosis as an occupational health problem worldwide.

The immediate objective of the ILO/WHO programme is to promote the development of national programmes to eliminate silicosis, to reduce significantly the incidence rate of silicosis by the year 2010.

The development objective of the ILO/WHO programme is to establish wide international cooperation on global elimination of silicosis to eliminate it as an occupational health problem by the year 2030.

The principal means of action of the programme are:

- to catalyse long-term efficient cooperation between industrialised countries, developing countries and international organisations;
- to promote the establishment by countries of national programmes on elimination of silicosis accompanied by national action plans; and
- to provide technical assistance to countries in developing models (blue prints) of national programmes and national action plans on elimination of silicosis and support their implementation.

Part two - objectives of reviewing NES

The objective of the National Occupational Health and Safety Strategy (National Strategy) is to have workplaces free from injury and disease. The National Strategy was signed by Workplace Relations Ministers Council in 2002.

The *Guidance Note of the Interpretation of Exposure Standards for Atmospheric Contaminants in the Occupational Environment*[25] states that air inhaled at work should not contain chemical agents that produce adverse effects on health, safety or well-being.

NOHSC produces NES to assist occupational health and safety practitioners, regulatory agencies, employers and employees or their representatives to secure workplace atmospheres that are as free as practicable from hazardous contaminants. NES for individual chemicals substances, according to current knowledge, provide protection by seeking to neither impair the health of, nor cause undue discomfort to, nearly all workers who are exposed for eight hours per day and five days per week for their working life. In addition, NES may guard against narcosis or irritation that could precipitate industrial accidents. The NES serve as guides only, and have no legal status unless they are specifically incorporated into legislation by the Australian Government, states and territories.

The current Australian NES for crystalline silica were declared in 1996 and are a continuation of NES first established in 1983-84. NOHSC's objectives in reviewing the current NES are to:

- provide a safe working environment that reflects the current level of knowledge and international developments about the problem of exposure to RCS;
- reduce the incidence of death and illness arising from exposure to RCS in the workplace; and
- undertake this reduction in a cost effective manner for all parties involved.

25 National Occupational Health and Safety Commission (NOHSC) (1995), *Guidance Note on the Interpretation of Exposure Standards for Atmospheric Contaminants in the Occupational Environment* [NOHSC:3008(1995)], 3rd Edition, AGPS, Canberra, Australia.

Part three - options

This part sets out a range of options to achieve the National OHS Strategy goal of workplaces free from injury and disease. The costs and benefits of each option are outlined in Part Four.

Option one — the Status Quo

This option maintains the current NES and the existing regulatory requirements of the states and territories and current NES.

The current NES for the three main forms of crystalline silica are:

Form of Crystalline Silica	Quartz	Cristobalite	Tridymite
Current NES	0.2 mg/m^3	0.1 mg/m^3	0.1 mg/m^3

Option two — increased education

This option involves implementing a combination of;

- government and industry information and education programs on the dangers of exposure to RCS; and
- reinforcing employers' obligations to make their staff aware of the risks of RCS and their legal obligations with respect to RCS.

This option, which is based on the current NES, involves a more structured and far–reaching program of education than the current approach. The focus would be on ensuring that the employer provides adequate information and training to workers in order to influence employee behaviour.

The NHMRC and the Australian Government Department of Health and Ageing published the extensive *Approved Occupational Health Guide SILICA (Silicosis)* in 1978. Section 18 of the guide stated that all employees working with materials containing free silica should receive education on the hazards and possible precautionary measures.[26] Occupational health and safety legislation, including specific regulation of hazardous substances in each state and territory jurisdiction, reflects this. Every employer using silica-containing materials or potentially exposing employees to RCS has a duty under state and territory regulations to educate their employees about the dangers of working with crystalline silica.

The only effective protection against silicosis is to avoid the inhalation of silica dust in the air. Employers and persons in control of a workplace have the responsibility to take precautionary measures and ensure that workers receive adequate education and training on the dangers of silica dust and any preventative measure they can use to protect themselves.[27]

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26 National Health and Research Council, Commonwealth Department of Health, (1978), Approved Occupational Health Guide: Silica (Silicosis) AGPS

27 National Centre for Occupational Health (NCOH) / Surveillance of Work-Related and Occupational Respiratory Diseases in South Africa (SORDSA) (February 1999), *op cit*

Option three — increased enforcement

This option assumes that current standards are not being met by all of industry and that more rigorous enforcement of the existing standard by state and territory governments will result in industry adopting measures to reduce worker exposure. NOHSC does not have the mandate to increase enforcement in the states and territories.

This approach may be seen as a response to perceived limitations (from a crystalline silica perspective) in enforcement arrangements; namely;

- most inspections currently undertaken cover a broad range of issues from noise hazards to manual handling, as well as hazardous substances, and act only on reported cases, complaints received and companies with previous offences; and
- with the move towards performance-based rather than prescriptive legislative requirements[28] there has been an ongoing shift in the responsibilities and expectations of OHS inspectors.

Option four — adopting exposure standards recommended by the University of Western Australia report

In the Preliminary Regulation Impact Statement that formed part of the documentation to elicit public comment, option four involved the exposure standards recommended in an independent study prepared for NOHSC by the University of Western Australia (UWA).[29] The standards proposed by UWA are set out in Table 11.

TABLE 11:

EXISTING AND PROPOSED CRYSTALLINE SILICA EXPOSURE STANDARDS

Form of Crystalline Silica	Current NES	Proposed Exposure Standards in the UWA report
Quartz	0.2 mg/m^3	0.13 mg/m^3
Cristobalite	0.1 mg/m^3	0.13 mg/m^3
Tridymite	0.1 mg/m^3	0.1 mg/m^3

As the UWA report was issued in December 2002, the occupational exposures would have been measured using the Australian Standard “Workplace Atmospheres - Method for sampling and gravimetric determination of respirable dust” (AS 2985-1987).

From February 2004, AS 2985-1987 was replaced by AS 2985-2004. AS 2985-2004 uses different conventions for the definition and cut-offs for respirable dusts, giving different exposure values. Consequently, this option is no longer viable and exposure standard recommendations have been modified to form Option Five. Discussion of the UWA recommendations has been integrated into Option Five.

[28] The focus has been largely directed towards employers taking responsibility for the duty of care to provide a safe and healthy workplace, a philosophy consistent with the performance-based style of modern OHS legislation.

[29] de Klerk, N; Ambrosini, G & Musk, A (February 2002), *op cit*

Option five — adopting NES of 0.1mg/m^3 for quartz, cristobalite and tridymite

The proposed NES are a uniform standard for quartz, cristobalite and tridymite of 0.1 mg/m^3, based on all important adverse health effects and using the recently issued Australian Standard AS 2985-2004 "Workplace Atmospheres - Method for sampling and gravimetric determination of respirable dust".

This option takes into account recent developments in sampling and determination methodology and is based on the exposures recommended in the UWA report, with additional input from:

- public comment on the PRIS and public comment documentation (including the UWA report);
- industry workshops, held in February 2004 in Melbourne and Sydney and organised by the NOHSC Office in conjunction with the ACCI. The workshops had representation from mining, construction and manufacturing; and
- input from the CSRG which reviewed both the public comment, and more recent, relevant scientific literature published since the UWA report was finalised.

As a means of directly addressing the basis for determining a reasonable exposure standard based on observed effect levels, the emphasis of the UWA review was to examine the dose-response relationships for each of the silica-related diseases separately.

Therefore, the UWA based their recommended NES for crystalline silica on the relationships between exposure to crystalline silica and lung cancer, because:

- crystalline silica was classified a human carcinogen by the IARC in 1997, and given an A2 'suspected human carcinogen' rating by the ACGIH in 1998;[30]
- lung cancer is the least acceptable adverse health effect that may arise after exposure to crystalline silica, as it is very likely to be fatal; and
- the dose-response relationships between crystalline silica and lung cancer, while varied, represent the most consistent relationship in the available epidemiological data.

As there is no consensus on an acceptable level of risk of mortality from lung cancer, the UWA report followed the risk assessment guidelines set out by the Royal Society,[31] and concluded that; risks higher than one death per 10,000 person-years are unacceptable, while risks lower than one per 100,000 person-years are acceptable. Consequently, they proposed an exposure standard for silica that would limit the population average excess risk of lung cancer to between one and five per 100,000 person-years, and the peak excess risk to less than ten per 100,000 person-years (i.e., one per 10,000 person-years).

The UWA calculated the risks of lung cancer that would result from adherence to exposure standards between 0.05 and 0.2 mg/m^3. (These risks are confined to lung cancer deaths and do not take the other silica related diseases into consideration).

The UWA report proposed exposure standards of 0.13 mg/m^3 for quartz, 0.13 mg/m^3 for cristobalite and 0.1 mg/m^3 for tridymite.

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30 de Klerk, N; Ambrosini, G & Musk, A (February 2002), *op cit*.

31 Warner, F (1983), *Risk Assessment: Group Report of the Royal Society,* Royal Society, London.

The CSRG consisted of a NOHSC Office member, a state/territory representative, and employer (ACCI) and employee (ACTU) representatives. The CSRG had access to advice from an occupational health physician and an occupational hygienist.

The CSRG considered that the UWA proposal of 0.13 mg/m^3 for quartz was inappropriately precise and impractical (using AS 2985-2004, it is not possible to measure an atmosphere of crystalline silica accurately to the nearest 0.1 mg/m^3 as a single sample, therefore 0.13 mg/m^3 would require multiple samples to measure accurately). Rounding of 0.13 mg/m^3 gave a value of 0.1 mg/m^3. Some public comment supported this option and suggested 0.1 mg/m^3 as the NES for all three forms of crystalline silica. The review group by a majority agreed to recommend NES of 0.1 mg/m^3.

Expert peer-reviewers of the UWA report suggested that the NES be based on silicosis, as this is likely to occur at exposures lower than those that may cause lung cancer and the NES should be established at an appropriate level to protect against all important adverse health effects. The CSRG agreed that silicosis should be the basis for the NES and that it should reduce the incidence of all important adverse health effects.

Therefore the NOHSC proposes the NES for crystalline silica as set out in Table 12.

TABLE 12:

EXISTING AND PROPOSED CRYSTALLINE SILICA NES

Form of Crystalline Silica	Quartz	Cristobalite	Tridymite
Current Exposure Standards	0.2 mg/m^3	0.1 mg/m^3	0.1 mg/m^3
UWA Recommended Exposure Standards	0.13 mg/m^3	0.13 mg/m^3	0.1 mg/m^3
NOHSC Proposed Exposure Standards	0.1 mg/m^3	0.1 mg/m^3	0.1 mg/m^3

The UWA report was made available for public comment in December 2002. The exposure standards recommended in the UWA report would have been measured according to the Australian Standard “Workplace Atmospheres - Method for sampling and gravimetric determination of respirable dust” current at that time (AS 2985-1987). AS 2985-1987 and AS 2985-2004 use different conventions for the definition and cut-offs for respirable dusts (see Table 13)

TABLE 13:

AUSTRALIAN STANDARD “WORKPLACE ATMOSPHERES - METHOD FOR SAMPLING AND GRAVIMETRIC DETERMINATION OF RESPIRABLE DUST”

	Convention for “respirable dust”
AS 2985-1987	British Medical Research Council (BMRC) convention 50% cut-off diameter = 5 μm
AS 2985-2004	CEN-ISO-ACGIH convention 50% cut-off diameter = 4 μm

CEN-ISO-ACGIH Previously known as the Soderholm convention, this was adopted by the Comité Européen de Normalisation (CEN 1993), International Standards Organization (ISO 1995) and the American Conference of Governmental Industrial Hygienists (ACGIH 1994-5)

The different respirable dust conventions have different standard curves and cut-off diameters for respirable particles. Consequently to convert exposures measured using AS 2985-1987 to AS 2985-2004 requires division by 1.4. Therefore, the exposure standards recommended in the UWA report and measured using AS 2985-1987, roughly equate to, when rounded, the uniform NES of 0.1 mg/m^3 for all three forms of crystalline silica, proposed by NOHSC, using AS 2985-2004 (see Table 14).

TABLE 14:

PROPOSED CRYSTALLINE SILICA EXPOSURE STANDARDS AND AS 2985

Form of Crystalline Silica	Quartz	Cristobalite	Tridymite
UWA Recommended Exposure Standards using AS 2985-1987	0.13 mg/m^3	0.13 mg/m^3	0.1 mg/m^3
UWA Recommended Exposure Standards using AS 2985-2004	0.09 mg/m^3	0.09 mg/m^3	0.07 mg/m^3
Proposed Exposure Standards using AS 2985-2004	0.1 mg/m^3	0.1 mg/m^3	0.1 mg/m^3

Option six— legislative prohibition on the use of crystalline silica

This option would prohibit any activities or the use of any products resulting in the creation of RCS.

Compliance with a prohibition or regulatory ban is more straightforward to enforce than compliance with any NES.

Part four - costs and benefits

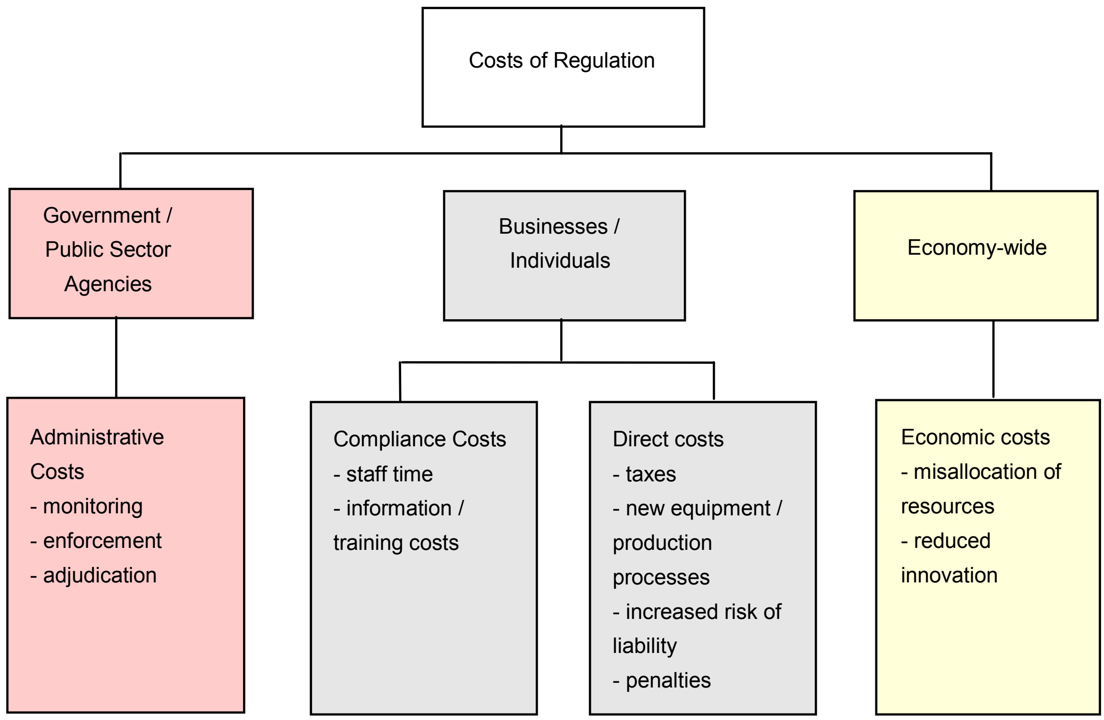
This part considers the actual or potential costs and benefits associated with the options in Part Three. To some degree, the nature (but not necessarily the quantum) of the benefits are relatively easy to understand - improved health outcomes. Specific dimensions of the benefits include:

- greater individual well being because of reduced illness;
- improved productivity in the economy; and
- reduced health care expenses (doctor visits, hospital stays, medication, etc) because of reduced illness.

In contrast, the costs of the options are more diverse and multi-faceted and are described in general terms in Figure 1. The framework below guides the analysis of each of the options.

FIGURE 1:

FORMS OF COSTS



Source: Adapted from the Ministry of Economic Development (2001), *Business Compliance Cost Statements: Guidelines for Departments*, Wellington, New Zealand, p.7.

When adequate data is not available, the usual approach is to use qualitative methods to describe these effects. Due to the difficulty involved with obtaining quantitative data, many of the costs and benefits in this analysis are captured in this manner.

It should be noted that all of the cost benefit analyses in this document are based on the assumption that all industry complies with the current NES. Where industry does not currently comply with the existing NES, any costs of compliance that might be incurred to meet the existing NES are not addressed in this document.

Option one — the Status Quo

Benefits

The expected benefits of the current NES are a reduction over time in the level of RCS-related diseases (including fatalities), compared with no NES, and their associated costs to the community. As with many of the options considered in the report, precise quantification is not possible. Some insight, however, can be gained by examination of data from New South Wales who have addressed OHS issues associated with airborne dust (including RCS).

The NSW Dust Diseases Board provides screening services to all persons whose employment as workers (excluding work in coal mines) exposes them to the inhalation of dust, which may cause a dust disease, with certain defined exceptions.[32] Table 14 shows the total number of identified dust-related deaths in NSW recorded from February 1968 to 2001.

The health statistics used in this Regulation Impact Statement (RIS) provide information on the incidence of adverse health effects attributable to RCS exposure. In observed cases of adverse health effects it is usually not possible to identify when the causative exposure to RCS occurred and at what level. This means that it is usually not possible to know if adverse health effects occurred as a result of exposure before or after implementation of the current NES of 0.2 mg/m^3 for quartz, 0.1 mg/m^3 for cristobalite and 0.1 mg/m^3 tridymite.

[32] These include: workers in or about a mine to which the *Coal Mines Regulation Act 1912* applies; employees of the Australian Government; persons whose exposure to the inhalation of dust occurred in the course of their employment outside NSW; and persons whose exposure to the inhalation of dust occurred whilst self-employed

TABLE 15:

NSW DUST-RELATED DEATHS BY CAUSATION SINCE FEBRUARY 1968 - 2002

Disease	Death Due to Dust	Death Not Due to Dust	Total	Average Age of Death Due to Dust
Asbestosis	249	240	489	70.25
Silicosis	**380**	944	**1,324**	70.10
Byssinosis	8	19	27	68.47
Hard Metal Pneumoconiosis	2	3	5	63.43
Farmer's Lung	1	2	3	61.17
Aluminosis	0	1	1	NA
Bagassosis	0	1	1	NA
ARPD	37	86	123	73.94
Silico-Tuberculosis	**8**	12	**20**	62.80
Asbestosis/ARPD	13	23	36	74.51
Emery Pneumoconiosis	0	1	1	NA
Talcosis	1	2	3	65.74
Silico-asbestosis	**8**	4	**12**	64.22
Mesothelioma	1,505	8	1,513	67.03
Carcinoma of the Lung*	245	6	251	67.29
Silica Induced Carcinoma	**12**	0	**12**	73.10
Asbestosis & Assoc Lung Cancer	4	0	4	73.82
ARPD/Lung Cancer	4	0	4	74.85
Lung Cancer in Assoc with Asbestosis	2	0	2	76.92
Silicosis and Silica Assoc Lung Cancer	**1**	0	**1**	64.56
TOTAL	**2,480**	**1,352**	**3,832**	**68.03**

* including Asbestos & Hexavalent salt induced.

Source: Dust Diseases Board (DDB) of NSW, *2002 Statistics: Appendix 9*, accessed on 06/05/04 at http://www.ddb.nsw.gov.au/parent.asp?disp=st

A summary of Table 15 shows that:

- of all diseases associated with exposure to crystalline silica (i.e. silicosis, silico tuberculosis, silico asbestosis, silica induced carcinoma and silicosis and silica associated lung cancer), approximately 30% of deaths were due to dust exposure; and
- where silicosis had caused death, the average age at death of the person (63 to 73 years) was less than the average for the population[33].

[33] See Australian Government Actuary (1999) and World Health Organization (2002) as cited by Australian Institute of Health and Welfare, *Mortality: Life Expectancy* accessed on 06/05/04 at http://www.aihw.gov.au/mortality/data/life_expectancy.html,

Costs

Compliance costs

The compliance costs for this option are focused on incremental costs. That is those costs additional to existing RCS exposure mitigation costs.

The current NES of 0.2 mg/m^3 of quartz, 0.1 mg/m^3 of cristobalite and 0.1 mg/m^3 of tridymite have been in force in all States and Territories since 1996. It is not expected that there will be additional costs, as government and industry have already established regimes and methods for the control of exposure to RCS, at or below the current NES.

The cost of complying with the current NES is not expected to increase at a rate above normal inflationary costs under this option.

Other costs

The social costs associated with this option would be at least:

- $14,022,857 in compensation payments (including medical costs) per annum[34];
- 305 hospital days per annum[35]; and
- 60 lives per annum[36].

International research also shows that the expected incidence of death and other health effects is at a level considered unacceptable.

Summary

Under Option One, the expected incidence of death and other adverse health effects resulting from exposure to RCS is unacceptable.

Although the current NES, compared with no NES, is likely to have some health benefits which are not reflected in current health statistics, they are unlikely to be sufficient to meet NOHSC's objectives. International research indicates that reducing exposure levels to as low as reasonably practicable can reduce the incidence of death and illness. Maintaining the status quo would contravene government OH&S objectives.

34 This figure is an extrapolation based upon 2001-2002 RCS disease compensated cost data provided by the NSW Dust Diseases Board (see table 5), NSW's thirty five percent share of total workers at risk (see table 4), and an estimated thirty eight percent reduction in incidences of RCS diseases under the new exposure standard (see table 15).

35 Based upon national hospital visit/separation and patient/hospital day data provided by the Australian Institute of Health and Welfare (see table 5).

36 This figure is an extrapolation based upon NSW's thirty five percent share of total workers at risk of developing RCS diseases (see table 4) and a comparison between the NSW Dust Diseases Board's 2001 and 2002 data for 'Reported Deaths Dust Disease Cases' (see table 7). The comparison between the Dust Diseases Board's 2001 and 2002 data revealed that 21 individuals had died from RCS diseases in NSW over that twelve month period.

Option two — increased education

Benefits

Education is aimed at changing behaviours. In order for RCS control measures to be effective employers and employees require training or experience. Education can address this issue and therefore reduce the risk of exposure[37].

It is difficult to quantify the reduction of adverse health effects that would be achieved through more formalised and enforced education and training programmes given the number of variables that can impact upon the quality and outcomes of education and training programmes. Research by NIOSH in the United States shows that while there have been instances where education has been observed to account for a 25% reduction in injury rates, the variables affecting the success of education and training as an OHS strategy are too numerous to ensure such high outcomes in every instance.

The education and training variables identified by NIOSH include[38]:

- the size of the training group;
- length and/or frequency of training;
- manner of instruction;
- trainer credentials; and
- training/transfer conditions.

Costs

The costs borne by governments and industry will depend on the precise nature of their involvement.

Government

It is likely that the costs incurred by government will relate to;

- the production and dissemination of education and training materials; and
- the enforcement costs associated with ensuring that industry meets its training and education requirements.

Where increased education is incorporated into existing inspection processes, the costs will not be significant. Costs may be reduced where there is leverage from other campaigns run by government.

Industry

Compliance costs borne by the private sector will also depend on the precise nature of the obligations. Employees may receive additional education and training on how to prevent exposure to RCS and this may be an additional cost to existing training programmes.

Currently construction industry employees are required to undertake OH&S induction programmes before they can work on site. There is no standard syllabus for these

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[37] Cohen, A. & Colligan, M.J., Assessing Occupational Safety and Health Training: A Literature review, National Institute for Occupational Safety and Health, USA, June 1998, www.cdc.gov/niosh/98-145-b.html.

[38] Ibid, p.3-4.

programmes but they generally contain some silica exposure training. Additional material may attract additional costs.

The costs of construction industry induction courses have been estimated at an average of $19/hr per employee and employee wages are $19.95/hr[39] (based on a 40 hour working week). For a business employing 100 people on site, an additional hour of RCS exposure training would cost $3895 or $38.95 per employee.

Labour on-costs, such as leave, superannuation, and payroll tax, have not been included in the calculations as they constitute common or fixed costs which would have been incurred regardless of the additional hour of training undertaken by staff. This is because annual leave, sick leave, and long service leave are calculated in terms of years, months, weeks, or days of service rather then hours worked. No additional cost would be incurred per employee.

Similarly costs associated with the hiring and termination of personnel should not be associated with the additional training, as they would have been incurred regardless of this activity.

In the case of the superannuation surcharge and payroll tax, the superannuation surcharge is levied as a percentage of individual employee's total annual wage/salary and payroll tax is levied as a percentage of an enterprise's annual wage bill. As training generally occurs during working hours and employees are paid their normal wage or salary rate for training, no additional wages or salary, and therefore no additional superannuation surcharge and payroll tax, is paid as an outcome of an additional hour of training. This means that the amount of superannuation surcharge and payroll tax paid will be the same regardless of the additional hour of training.

Summary

Behavioural changes combined with practised control measures may result in decreased costs in term of illness and compensation, but behavioural change is hard to monitor and difficult to enforce.

To ensure any permanent health benefits from the education program, the employer is responsible for facilitating permanent changes in employee behavior where there is a risk of exposure to RCS (or other hazardous substances). This means the employee must be aware of and respond to the information, understand its meaning and personal relevance, remember and implement it when needed, and act in accordance with the recommendation. If any one of these steps is not successfully completed, the information provided may not sufficiently change employee behaviour, and will not ensure any health benefits.

While necessary and useful, improved education and training may not necessarily limit workplace exposure to RCS and therefore are not considered an acceptable substitute for exposure standards in the workplace. The use of information and training is a primary

39 Australian Bureau of Statistics (ABS) (2003), *Construction: Average weekly earnings in the construction industry*, Year Book Australia, accessed on 06/05/04 at http://www.abs.gov.au/Ausstats/abs%40.nsf/94713ad445ff1425ca25682000192af2/b42c69f4a2d6a145ca256b360003228b!OpenDocument

requirement of OHS legislation, but it is employed in the context of a complete risk management program[40].

As discussed above, the costs associated with this option are limited to wage and training costs, with all labour on-costs excluded. These latter costs are common or fixed costs, that is, they would have been incurred regardless of the additional hour of training undertaken by staff.

Option three — increased enforcement

Benefits

This RIS assumes compliance with the current NES, so there is no perceived benefit from increased enforcement. A single comment from industry suggested there may be an issue with non-compliance. This suggestion was not supported by evidence in the submission and could not be verified from external sources. The issue of non-compliance was not raised by the government agencies responsible for enforcement of the current NES.

Costs

Government costs

State and Territory authorities responsible for enforcing the current crystalline silica NES would incur additional enforcement costs.

Industry costs

As the current NES of 0.2 mg/m^3 of quartz, 0.1 mg/m^3 of cristobalite and 0.1 mg/m^3 of tridymite has been in force in all states and territories since 1996, no additional costs are anticipated, and without any information to the contrary, it is assumed that industry has already established regimes and control methods that meet the current NES. In consultation, some sectors have suggested that they already comply with the proposed NES and record levels of exposure much lower than even the proposed NES. These comments came mainly from multinational companies who choose to comply with international exposure standards and industry best practice. This is voluntary, and accordingly, the costs of such compliance among these industries is not covered in the RIS.

The cost of these regimes and control methods are not expected to increase at a rate above normal inflationary cost increases under this method.

Summary

While governments may choose to direct more resources to enforcement in order to achieve a workplace free from injury and disease, a barrier to increased enforcement would be the limitation on government resources. Limited government resources would make it difficult to

[40] National Occupational Health and Safety Commission (NOHSC) (November 2001), *Proposed Amendments to the NOHSC Adopted Exposure Standards for Atmospheric Contaminants in the Occupational Environment*: *op cit*.

identify and inspect all premises where silica is present on a regular basis to ensure continued compliance[41].

Option four — adopting exposure standards recommended by the University of Western Australia report

As noted in **Part three – options**, the exposure standards proposed under Option four were based on the measurement method AS 2985-1987. As of February 2004, AS 2985-1987 was replaced by AS 2985-2004. This change in measurement gives different exposure values. Consequently Option four is no longer viable and its exposure standards and the impacts of this option, where relevant, have been adapted to become Option five.

Option five — adopting uniform NES of 0.1mg/m^3 for quartz, cristobalite and tridymite

Option five is based on exposure standards proposed in the UWA report (Option Four) which have been modified to account for: AS 2985-2004, all adverse health effects, public comment received, and input from CSRG.

Benefits

Scientific evidence

There is a considerable amount of scientific evidence to show that exposure to RCS should be kept as low as possible. Based on current scientific evidence, NES of 0.1 mg/m^3 of quartz, 0.1 mg/m^3 of cristobalite and 0.1 mg/m^3 of tridymite will reduce the incidence of all important adverse health effects from RCS exposure. This evidence includes epidemiological studies and the setting of international exposure standards for RCS.

Nurminen et al., predicted the occurrence of silicosis and cancer in the Australian labour force, based on the current exposure standard for RCS. Based on their methodology, reducing the NES to 0.1 mg/m^3 (using the measurement method AS 2985-1987), would reduce the risk of silicosis cases by 52% and the excess risk (risk above background rate) of lung cancer by 36% [42].

In a pooled exposure response analysis of 6 cohorts of exposed workers (totalling 18,364), the average length of exposure of the 170 deceased was 28 years with a mean exposure of 0.26 mg/m^3. As this was a cohort study, involving six studies from the USA, Australia and Finland, the variety of measurement and collection methods used means that 0.26 mg/m^3 could translate to a value between 0.11 mg/m^3 (portal to portal collection and BMRC dust convention) and 0.47 mg/m^3 (crib room top crib room collection, old ACGIH dust convention). A pooled analysis was conducted on the information from the 6 cohort studies to produce risk estimates of death from silicosis. The cumulative risk of death from silicosis, in persons exposed from the age of 20 to 65, was estimated to be 13 for every 1000 people exposed at

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41 ibid

42 Nurminen, M., et. al. (1992), "Prediction of silicosis and lung cancer in the Australian labor force exposed to silica". *Scandinavian Journal of Work, Environment and Health*, 1992 Dec;**18(6)**, pp.393-399.

0.1 mg/m^3, and at 0.05 mg/m^3, 6 per 1000 people exposed[43] (no information on the measurement method was included for the risk estimates).

A study of 65,890 workers and 1,072 lung cancer deaths (633 miners, 409 non-miners) estimated that the lifetime risk for a worker exposed from age 20 to 65 at 0.1 mg/m^3 RCS was 1.1-1.7% above a background rate of 3-6% i.e., the lifetime risk of dying of lung cancer by the age of 75 in the USA, China and Finland was increased by 1.1-1.7%. As with the above cohort study, the variety of measurement and collection methods used means that 0.1 mg/m^3 could translate to a value between 0.04 mg/m^3 (portal to portal collection and BMRC dust convention) and 0.18 mg/m^3 (crib room top crib room collection, old ACGIH dust convention). The median average exposure was 0.19 mg/m^3 (potentially 0.08 to 0.35 mg/m^3 due to variations in collection and measurement methods). The study showed the relative risk of lung cancer is reduced at very high exposures, i.e., that the risk of lung cancer plateaus at very high exposures. This plateau effect at very high exposures may be due to saturation of a biological system, poor estimation of very high exposures, the healthy worker survivor effect and limits to the size of relative risk at high exposures when the background rate of disease is high (depletion of susceptibles). This is similar to other occupational carcinogens including cadmium, radon, arsenic and dioxin [44].

International exposure standards

Crystalline silica is a worldwide problem, but international comparisons are made difficult because the collection and analytical methods used by the various national standard-setting bodies have resulted in differences in measured exposures, which will in turn have a bearing on the results of comparisons made between exposure standards. Any consideration of overseas exposure standards should account for the collection and analytical methods. Table 10 provides an overview of comparisons for international occupational exposure limits for crystalline silica. Examples of the differences in dust measurements and conventions are outlined in Box 2 and an explanation of the exposure standards in Britain for RCS is outlined in Box 3.

43 ‘t Mannetje, A., et. al. (2002), *op cit*

44 Steenland, K., et. al. (2001), *op cit*

BOX 2:

ALTERNATIVE DUST MEASURES AND CONVENTIONS

There are important differences between sampling practices and the interpretation of airborne dust measurements. In underground mines in the US, for example, full-shift personal samples are taken from 'portal to portal' (that is, from time at the entrance of the mine, usually some distance from the work-face, during work time and then after exit from the mine).

The majority of Australian mine sampling is, however, based on full-shift personal samples taken from 'crib room to crib room' (that is, time near to the work-face during work time, then removed before exit from the mine).

Travel distances underground may reach up to one and half hours in a full shift. Tomb *et al* determined that 2 mg/m^3 'portal to portal' may be equivalent to approximately 2.7 mg/m^3 'crib room to crib room'.[45]

In other words, 'crib room to crib room' results are higher than 'portal to portal' results by around 30 to 40 percent. Therefore, different sampling strategies do not give numerically comparable average values.

There are also differences in respirable dust conventions (see Part Three, Option Five). The most commonly used conventions are; the 'old' ACGIH convention, the BMRC convention and the new CEN-ISO-ACGIH convention.

To convert 'old' ACGIH values to CEN-ISO-ACGIH ⇒ 'old' ACGIH value x 1.3 = CEN-ISO-ACGIH value.

To convert BMRC values to CEN-ISO-ACGIH ⇒ BMRC value ÷ 1.4 = CEN-ISO-ACGIH value.

BOX 3

The current overseas occupational exposure limits (OELs) for quartz, cristobalite and tridymite forms of crystalline silica are listed in Table 9. Of the countries listed, the UK has the highest OEL for quartz, cristobalite and tridymite of 0.3 mg/m^3. This value is maximum exposure limit or MEL, expressed as a time weighted average exposure over a working day (TWA 8 hour). MELs constitute the upper limit of exposure for hazardous substances for which there is no safe level of exposure. The original MEL was 0.4 mg/m^3, but the British Health and Safety Executive altered the MEL to 0.3 mg/m^3 to accommodate a change from the BMRC to the CEN-ISO-ACGIH convention for respirable dust. The British HSE is currently reviewing RCS and its current information indicates that exposure at the current MEL value of 0.3 mg/m^3 (TWA 8 hour) there is a 20% risk of contracting silicosis. The British HSE has issued a Chemical Hazard Alert Notice (35 on respirable crystalline silica), suggesting that employers should aim to control exposures to 0.1 mg/m^3 (TWA 8 hour) or below, while a more stringent occupational exposure limit is developed.

Cost benefit analysis

The benefits associated with the proposed standard are significant in term of reductions in levels of deaths, suffering, medical costs, and compensation payments.

Results from a number of UWA studies have shown significant benefits can be obtained by reducing RCS exposures[46].

[45] Tomb, TF, Mundell, RL, and Jankowski, R. (1978), *Comparison of respirable dust concentrations measured with personal; gravimetric sampling instruments operated on-section and portal-to-portal*, United States Department of the Interior.

[46] In one study based on the WA data, a 40 year working life from the age of 20 years with a reduction of the exposure level to 0.13 mg/m^3 of quartz, 0.13 mg/m^3 of cristobalite and 0.1 mg/m^3 of tridymite (measured using AS 2985-1987) would:

In another study undertaken in September 1993[47], the impacts of exposure standards for quartz of 0.2 mg/m^3 and 0.1 mg/m^3 (measured using AS 2985-1987) were assessed. The findings of this study are set out in Table 16 and are based on a calculation of 'excess' cases over a forty-year exposure period with a stationary population.

TABLE 16:

IMPACT OF ALTERNATIVE SILICA EXPOSURE STANDARDS FOR QUARTZ (AVERAGE CASES/YEAR)

	0.2 mg/m^3	**0.1 mg/m^3**	**0.13 mg/m^3 (extrapolated)**
Silicosis	20	11	14
Lung cancer	14	10	11

Source: Source: Derived from Worksafe Australia (September 1993) Draft Technical Report on Crystalline Silica Completed in July 1992 Australian Government Publishing Service, Canberra, pp.96–98.

Table 16 (above) shows that a reduction in the quartz exposure standard from 0.2 mg/m^3 to 0.1 mg/m^3 equates to a drop of 45% in the annual incidence rate of silicosis and a 29% drop in the rate of lung cancer associated with respirable crystalline silica. On average the reduction in the quartz exposure standard from 0.2 mg/m^3 to 0.1 mg/m^3 will yield a 38% decrease in quartz related diseases. These decreases are similar to those reported by Nurminen[41], with differences in the calculations used.

It is estimated that a reduction in NES has the potential to reduce the national incidence of RCS-related adverse health effects by up to 38%. This may be an overestimate, as the current exposure standard may reduce the number of new cases of RCS-related adverse health effects for some time into the future. However this potential overestimation may be offset by the under-reporting of RCS-related adverse health effects in health statistics. Consequently, the real incidence may be higher.

- ensure that the excess risk of lung cancer is kept below one per 10,000 person-years, and should be considerably less than this;
- ensure that the cumulative risk of silicosis after a 40-year working lifetime be less than one percent; and
- ensure that the total excess decrement in lung function should be less than 200 mL

It should be noted that the presented risk estimates for lung cancer will be lower for non-smokers.

de Klerk, N; Ambrosini, G & Musk, A (December 2002), *op cit*

47 Worksafe Australia (September 1993), Draft Technical Report on Crystalline Silica, AGPS, Canberra.

NSW benefits

In terms of NSW's 2000-2001 compensated disease and deaths cost data, an average drop of 38% in the annual incidence rate of RCS related diseases would result in a annual savings or benefit to NSW as shown in Table 17.

TABLE 17:

INDICATORS OF POTENTIAL ANNUAL BENEFITS TO NSW OF A REDUCTION IN THE EXPOSURE STANDARD FROM 0.2 mg/m^3 TO 0.1 mg/m^3) – NEW SOUTH WALES

NSW DATA					
Incident Reduction	**Direct Compensation (including compensated Medical Expenses)**	**Compensation for Dependants**	**Hospital Visits**	**Hospital Days**	**Compensated Deaths**
38%[48]	$801,420[49]	$1,063,620[48]	6[50]	41[49]	8[51]

National benefits

When Table 17 is extrapolated to the national level, using the calculated benefits based on NSW's 2000-2001 compensated disease and deaths cost data, and NSW's percentage share of the national total of employees at risk, the national annual savings or benefits is shown in Table 18, below.

41 Nurminen, M., et. al. (1992), op cit

48 This figure is based on data from Table 15, showing a 38% reduction in the incidence of RCS disease following a reduction in the exposure standard from 0.2 mg/m^3 to 0.1 mg/m^3.

49 These figures are derived from the 38% reduction in the incidence of RCS disease (Table 15) and the NSW Dust Diseases Board compensated payments data (Table 7)

50 These figures are extrapolations from the silica-related health statistics (Australian Institute of Health & Welfare Table 5), the 38% reduction in the incidence of RCS disease (Table 15) and NSW 35% share of total workers at risk (Table 4).

51 This figure is based on the 38% reduction in the incidence of RCS disease (Table 15), NSW 35% share of total workers at risk (Table 4) and NSW Dust Diseases Board number of reported deaths (Table 7).

TABLE 18:

INDICATORS OF POTENTIAL NATIONAL ANNUAL BENEFITS OF A REDUCTION IN THE EXPOSURE STANDARD FROM 0.2 mg/m^3 TO 0.1 mg/m^3) - AUSTRALIA

NATIONAL DATA					
Incident Reduction	**Direct Compensation (including compensated Medical Expenses)**	**Compensation for Dependants**	**Hospital Visits**	**Hospital Days**	**Compensated Deaths**
38%[47]	$2,289,771[49]	$3,038,914[49]	17[52]	116[51]	23[53]

Due to a lack of national data the figures included in Table 17 are based upon an assumed nationally consistent rate of incidence for compensated RCS diseases and an assumed proportionate relationship between the incidence of disease and the number of workers at risk of exposure in each state and territory. As such these figures are only indicative.

It is acknowledged that there may be variations in health care costs dependant on the adverse health effect suffered e.g., the number of hospital days and hospital visits may be different for a lung cancer patient versus a silicosis patient. The values in the tables represent totals for adverse health effects related to RCS exposure.

The value of lives saved

Given that compensation payments tend to underestimate the economic costs of occupational injury, disease, and death, economists have developed a method known as Value of Statistical Life (VSL), to estimate a dollar value for lives lost or impaired due to industrial disease or accident[54].

The VSL method is based upon the assumption that individuals value their lives and are willing to pay to reduce risks to it. Through VSL meta-analyses, this 'Willingness To Pay' (WTP) is coupled with a range of other variables such as age, income and occupational risk to arrive at a dollar value for both injury and death.

Table 17 shows that if the establishment of the new NES results in a 38% drop in the annual incidence rate of RCS related diseases, an estimated 23 deaths would be avoided per year.

Depending on the VSL measure used, these 23 deaths avoided can be valued at between $US 75,000 to $US 150,000[55] for every year of life gained or $AUD 60,000 for every healthy year[56].

In terms of years of life gained, the benefit of the 23 premature deaths avoided can be significant, as the age of death for suffers of silico-tuberculosis or silico-asbestosis is 63 and 64 years of age, respectively, while the average life expectancy of an Australian is 75.9 years for males and 81.5 years for females. For example, a male who might have suffered silico-

[52] These figures are extrapolations from the national silica-related health statistics (Australian Institute of Health & Welfare Table 5) and the 38% reduction in the incidence of RCS disease (Table 15)

[53] This figure is extrapolated from NSW 21 RCS related deaths for 2001 to 2002 (Table 7) extrapolated to give a national figure and the 38% reduction in the incidence of RCS disease (Table 15)

[54] National Occupational Health and Safety Commission (March 2004), Cost of workplace injury and illness to the Australian economy: Reviewing the estimation methodology and estimates of the level and distribution of costs, Canberra, pg.23.

[55] ibid, pg 21.

[56] ibid, pg 22.

tuberculosis under the existing NES but avoided the disease under the new NES could on average live an additional 12.9 years. At $US75,000 for every year of life gained, this equates to a $US967,000 benefit.

Given the long-term impact of RCS diseases, with symptoms in some cases progressively worsening over periods of a decade or more, the compound value of healthy years gained would also be substantial. A decade of healthy years would be worth $AU600,000.

Costs

Compliance costs

The costs for this option only focus on incremental costs. Incremental costs are additional to existing silica exposure mitigation costs, as industry currently complies with the existing NES.

The assumption that industry currently complies with the existing NES was based upon the following factors:

- the existing standard has been in place since 1996; and
- while a comment from industry was received suggesting there may be an issue with non-compliance, this suggestion was not supported by any evidence that could be verified from external sources. The issue of non-compliance was not raised by any of the government agencies responsible for enforcement of the current NES.

Where industry does not currently comply with the existing NES, any costs of compliance that might be incurred to meet the existing NES should not be associated with the options contained within this document. In line with cost/benefit analysis principles, these costs cannot be counted twice in terms of their impact on industry.

Industry costs

Currently, Australian industry is required to operate at or below the current NES of 0.2 mg/m^3 of quartz, 0.1 mg/m^3 of cristobalite and 0.1 mg/m^3 of tridymite. The current NES has been adopted by all states and territories. In order to comply with the current NES, all employers that expose their employees and other individuals to levels of RCS above the current NES are obliged to reduce exposure levels to the existing standard. In doing this, employers incur a range of costs. General descriptions of the engineering and personal protective equipment measures currently used to mitigate exposure to RCS to the existing NES in the mining, quarrying, and construction industries are outlined below. State or territory OHS authorities provide advice to industry on the preferred method in each jurisdiction.

Costs currently incurred in mitigating exposure to crystalline silica include:

- administrative costs;
- engineering costs;
- equipment costs; and
- labour costs.

Following an initial introductory period during which an increase in the frequency of testing for airborne RCS can be foreseen, costs to industry under this option are not expected to increase at a rate above normal inflationary cost increases over the long term. This is because existing control measures, monitoring devices and personal protective equipment capable of controlling, monitoring, and preventing the inhalation of RCS at the current NES are capable of doing so at 0.1 mg/m^3 of quartz, 0.1 mg/m^3 of cristobalite and 0.1 mg/m^3 of tridymite (measured using AS2985-2004).

Introductory period costs: six to twelve months

Administrative costs	Engineering costs	Equipment costs	Labour costs
Increase	**Nil Increase**	**Nil Increase**	**Increase**
Increased reporting and recording costs due to increased monitoring during the introductory period	Existing engineering controls capable of controlling 0.2 mg/m^3 of RCS are capable of controlling 0.1 mg/m^3 of RCS.	Existing monitoring and personal protective equipment that can measure and obviate the inhalation of RCS at 0.2 mg/m^3 can do so for 0.1 mg/m^3	Increased monitoring and reporting labour costs due to increased monitoring during the introductory period

Long term : beyond six to twelve months

Administrative costs	Engineering costs	Equipment costs	Labour costs
Nil Increase	**Nil Increase**	**Nil Increase**	**Nil Increase**
Reporting and recording costs return to pre-introductory levels.	Existing engineering controls capable of controlling 0.2 mg/m^3 of RCS are capable of controlling 0.1 mg/m^3 of RCS	Existing monitoring and personal protective equipment is capable of measuring and obviating the inhalation of RCS at 0.1 mg/m^3.	Reporting and recording costs return to pre-introductory levels.

Examples of control measures, monitoring devices and personal protective equipment that can control, monitor, and prevent the inhalation of RCS at 0.1 mg/m^3 as well as 0.2 mg/m^3 can be found in both the mining and construction industries.

Mining Industry

Existing measures for the control of dust including crystalline silica in the mining industry include[57]:

1. **Monitoring regimes using:**

   a. BCIRCA, Higgins and Dewell, SIMPEDS or Aluminium Cyclones (as per AS 2985); and

   b. infrared and X-ray lab analysis.

2. **Engineering control systems using:**

   a. ventilation methods for machinery enclosures, galleries, shafts, and sealed cabs;

   b. screening methods for conveyor belts, hopper, crushers etc;

57 Mining and Quarrying Occupational Health and Safety Committee (February 1998), *QuarrySAfe Hazardous Substances in Quarries*, Adelaide. Accessed on 06/05/04 at http://www.maqohsc.sa.gov.au/ftp/MQ_HazSub.pdf

c. dust collection methods with collectors on equipment and for areas; and

d. Water/chemical suppression methods for drilling, mine walls, conveyer belts, crushers and heaps etc.

3. Personal protective equipment (PPE)

a. particulate dust masks (as per AS 1715); and

b. filtered self rescue respirators (as per AS 1715).

The effectiveness of these measures in reducing an individual's exposure to crystalline silica to 0.1 mg/m^3 have been verified by:

- the Northern Territory Government's February 2002 Advisory Note on 'Guidelines for the minimisation of dust emissions and engineered dust controls on mines', which identifies a comprehensive list of control methods that must meet exposures of 0.2 mg/m^3 and 0.1 mg/m^3 [58];
- their inclusion in the United States based National Institute for Occupational Safety and Health's (NIOSH) 'Handbook for Dust Control in Mining'; and
- the technical specification for materials and equipment commonly used in sealed cabs, PPE and monitoring dust levels.

The engineering control systems referred to above have been included and rated in NIOSH's *Handbook for Dust Control in Mining*. Only the control systems that meet NIOSH's standard of 0.05 mg/m^3 have been included in the handbook.

In terms of materials and equipment commonly used in sealed cabs, PPE and monitoring dust levels:

a. the Donaldson air filters used in the sealed cabs of Caterpillar Elphinstone's underground mining vehicles prevent RCS exposure to levels below 0.1 mg/m^3. Caterpillar Elphinstone's underground mining vehicles have approximately a 60% share in Australia's underground mining vehicle market;

b. in accordance with AS/NZ 1716 all Class P1, P2 and P3 respirators are suitable for use against silica with Class P3 allowing only 0.001 mg/m^3 of dust to pass through to the lung when the dust concentration is 10 mg/m^3 outside; and

c. the BCIRCA, Higgins and Dewell, SIMPEDS and Aluminium Cyclones all meet the Australian Standard for sampling respirable dust (AS 2985).

Given that the equipment mentioned above can control RCS exposures to 0.1 mg/m^3 or below, and that industry generally complies with the quartz exposure standard of 0.2 mg/m^3 (according to comment received), this would suggest that such equipment is not used to its full capacity. This may be because industry may employ work practices and work procedures that comply with the current NES but will not control exposures to the proposed NES.

The reworking of such work practices and work procedures to comply with the reduced exposure standard are a cost of the proposed exposure standard. However, except for those identified above, these costs cannot be qualified or quantified. Industry workshops were

[58] Department of Business, Industry and Resource Development (February 2002), *Guidelines for the minimisation of dust emissions and engineered dust controls on mines*, Northern Territory Government, Darwin.

conducted to obtain such information, but no information on the types of work processes and practices requiring upgrade, or information on the costs to upgrade, to comply with the reduced NES were provided.

Quarry Industry

Existing measures for the control of dust including crystalline silica in the quarrying industry include:

1. Monitoring regimes using:

   a. BCIRCA, Higgins and Dewell, SIMPEDS or Aluminium Cyclones (as per AS 2985); and

   b. infrared and X-ray lab analysis.

2. Engineering control systems using:

   a. ventilation methods for machinery enclosures, galleries, shafts, and sealed cabs;

   b. screening methods for conveyor belts, hopper, crushers etc;

   c. dust collection methods with collectors on equipment and for areas; and

   d. water/chemical suppression methods for drilling, mine walls, conveyer belts, crushers and heaps etc.

3. Personal protective equipment (PPE)

   a. particulate dust masks (as per AS 1715); and

   b. filtered self rescue respirators (as per AS 1715).

The NOHSC office has received a costings estimate[59], based on costs per tonne of quarrying product, to comply with three hypothetical crystalline silica exposure standard scenarios, less than 0.1 mg/m^3 (level 1), 0.1 – 0.2 mg/m^3 (level 2) and greater than 0.2 mg/m^3 (level 3). A medium-sized quarry was selected as a model, as outlined in Box 4.

[59] Additional information provided to the National Occupational Health & Safety Commission regarding the Proposed Amendments to the National Exposure Standard for Crystalline Silica by the Construction Material Processors Association (CMPA), Victoria. 24 May 2004.

BOX 4:

MEDIUM SIZED QUARRY MODEL

- Site crushes 200,000 – 250,000 tonnes per annum.
- Value of fixed plant = $4,900,000
- Total hours of employees and contractors = 6 people full-time = 15,000 hours
- Source material is hornsfels.
- Excludes transports leaving the site.
- Management consists of one quarry manager and one trainee manager.
- Mobile plant includes: 1 sales loader 8.5m bucket; 1 dump truck (face) 40 tonne size; 1 excavator 40 tonne size; Hire 1 water tank 3600 gallon capacity; Hire 1 drill rig
- Fixed plant includes 4 screens, 4 crushers and 22 conveyors.
- The plant is less than 10 years old.
- Crushing plant is not in buildings.
- 70% of water is available on-site costing $100/ML. Off-site water purchased at $155 per 3600 gallons.
- The site works to the work plan and complies with regulators requirements.
- The site has an access road of 1 km.

To achieve level 1 compliance:

- The site's plant dust collection is a 5 bag house system.
- A belt filter for removing water is installed.
- Dust suppression includes: sealed roads to the weighbridge, wash down of tracks, product restricted road systems, ongoing rehabilitation, minimal stockpiling capacity, increased plant size to pick up demand for sales, full plant hard stand, and wash down of all discharge points (full wash down or water mixed).
- Total value of fixed plant = $5,700,000.

Table 19 contains the costs per tonne of the initial capital upgrade required and the ongoing costs for maintenance.

TABLE 19:

COSTS PER TONNE OF PRODUCT FOR COMPLIANCE WITH LEVEL 1, 2 AND 3.

		Level 1 <0.1 mg/m^3	**Level 2 0.1 – 0.2 mg/m^3**	**Level 3 >0.2 mg/m^3**
1st year	Initial capital upgrade	$8.43	$5.25	$2.77
	1st year maintenance	$3.13	$2.01	$1.11
	Total	$11.56	$7.26	$3.88
2nd – nth year	Ongoing	$3.13	$2.01	$1.11

Source: CMPA submission to the NOHSC Office. May 2004.

From this model, the costs are extrapolated to those for quarries in Victoria. It is estimated that 36% of Victoria's production would have an issue with crystalline silica (55% of material produced contains 20% or more of crystalline silica, 19% of material produced is sand which does not liberate respirable crystalline silica as it is not crushed). The total tonnage for Victoria in 2002-2003 was approximately 37,521,000, consequently given the same level of production, the Victorian tonnage affected by the change in the exposure standard would be 13,507,560 tonnes[60] and the costs associated with the change are shown in Table 20 below:

TABLE 20:

COSTS OF THE PROPOSED EXPOSURE STANDARD FOR VICTORIAN QUARRIES.

	Level 1 <0.1 mg/m^3	**Level 2 0.1 – 0.2 mg/m^3**	**Level 3 >0.2 mg/m^3**
1st year	$156,147,394 [$147,906,680]	$98,064,886 [$92,889,492]	$52,409,333 [$49,643,420]
2nd – nth year	$42,278,663 [$40, 047,398]	$27,150,196 [$25,717,318]	$14,993,392 [$14,202,112]

Source: CMPA submission to the NOHSC Office. May 2004.

When extrapolating these costs to national figures, according to CMPA figures, national production is estimated to be 162,000,000 tonnes of which 62,000,000 tonnes would be affected by a change in the exposure standards (70% of national material produced contains 20% or more of crystalline silica, 20% of which is sand). The national costs associated with the change in exposure standards are shown in Table 21 below:

TABLE 21:

COSTS OF THE PROPOSED EXPOSURE STANDARD FOR AUSTRALIAN QUARRIES.

	Level 1 <0.1 mg/m^3	**Level 2 0.1 – 0.2 mg/m^3**	**Level 3 >0.2 mg/m^3**
1st year	$716,720,000	$450,120,000	$240,560,000
2nd – nth year	$194,060,000	$124,620,000	$68,820,000

Source: CMPA submission to the NOHSC Office. May 2004.

This RIS attempts to cost the change in regulation arising from the revision of the NES for crystalline silica. The revision is a change in the quartz exposure standard from 0.2 mg/m^3 to 0.1 mg/m^3. It is good occupational hygiene practice with exposure standards, that once an exposure of half the exposure standard is reached, this triggers an assessment of the exposure and any control processes. Consequently, the scenario that most closely fits to the current exposure standard is level 2 and that fitting the proposed exposure standard is level 1. The closest fit to the cost of regulation in this example, is the difference in the costs of levels 1 and 2, i.e., level 1 costs – level 2 costs = the costs of the proposed NES. Therefore, the costs of the change in regulation to the quarry industry based on the CMPA model are shown in Table 22 below:

[60] 36% of 37,521,000 = 13,507,560 tonnes. The CMPA submission calculates this value to be 14,220,000 tonnes, consequently the costings included in brackets are taken directly from the CMPA submission

TABLE 22:

COSTS OF THE PROPOSED EXPOSURE STANDARD FOR AUSTRALIAN QUARRIES.

		Level 1 – Level 2	Total
Costs per tonne	1st year Ongoing	$11.56 - $7.26 $3.13 - $2.01	= $4.30 = $1.12
Costs for Victorian quarries	1st year Ongoing	$147,906,680 - $92,889,492 $40, 047,398 - $25,717,318	= $55,017,188 = $14,330,080
National Costs for Quarries	1st year Ongoing	$716,720,000 - $450,120,000 $194,060,000 - $124,620,000	= $266,600,000 = $69,440,000

The information in the CMPA submission on Victorian and national quarrying is verifiable. However, there are a number of issues and caveats with the CMPA model and the extrapolated costings. These are:

- The controls to achieve Level 1 compliance in the CMPA model; and
- The adequacy or effectiveness of the Level 1 compliance controls.

Detailed capital costed control measures are included in the quarry model and are used as part of the estimation of the total costs of compliance for the quarry industry. These control measures are outlined in Box 5:

BOX 5:

CAPITAL COSTED CONTROL MEASURES

Control measure	Cost increase
On going development- Reduction of stockpile areas / Replanting - Containment of exposed working areas.	$10,000
Restriction of vehicle movements (and containment) - Site entry and sealed roads concrete, wash systems, assume 1Km, water, suppression.	$130,000
Administration complex / Workshops / Operator control room (moving away from transport systems of areas of risk to air filtration) air locks, air pressurisation, sealing buildings, sprinklers.	$110,000
Pre-wash down of areas where work is to be carried out - Water delivery systems; concrete hard stands; water collection, settling; and sumps, water settlement, dams and tanks.	$30,000
Wet screening (at the back end of the production system) factoring in the shorter life spans - hard stands, collection, settling, fines management; belt filter / cyclones.	$160,000
Dust collection (at all crushing and screening points) - Enclosure to ensure effective collection, number of bag houses.	$80,000
Full containment of transfer points, screens & crushing chambers, steel work.	$70,000
Removing operator from some work areas - Auto grease plant, video surveillance, access upgrades, and venting of confined spaces.	$80,000
Dust suppression at tip and transfer points - For example water, curtains, air collection, suppressants.	$25,000
Addition of water to scalps, crushed rocks and dusts at the point of plant discharge – Water delivery systems (hoses, pumps etc), dams, tanks; up to 10ML.	$0.00
Operator control cabins - Fitting of external storage compartments for clothing and tools, full sealing of doors and vents, and full air filtration system.	$20,000

This list of control measures falls into three main types; dust suppression, dust containment and dust removal. Each of these working optimally could minimise the generation of RCS dust. Therefore, from this list of control measures, it is likely that only a certain number of control measures in combination would be necessary to minimise dust exposure (see examples below):

- Dust collection (at all crushing and screening points); enclosure to ensure effective collection, number of bag houses;
- Full containment of transfer points, screens & crushing chambers, steel work; and
- Addition of water to scalps, crushed rocks and dusts at the point of plant discharge. Water delivery systems (hoses, pumps etc), dams, tanks; up to 10ML.

This approach would also protect against over-capitalisation at any one site. Using the quarry model information and the costing information supplied, these combined control measures would cost in the region of:

- $440,000 for a new quarry; or
- $150,000 to upgrade an existing quarry of the type similar to the submitted model.

Information in the RIS shows that controls i.e., equipment, processes and procedures that are adequate to meet the current NES would generally meet the proposed NES. Monitoring data from 2 quarry sites showed that where exposures did not exceed the current exposure standard of 0.2 mg/m^3 (for quartz), most of these exposures did not exceed 0.1 mg/m^3. This suggests that those quarries complying with the current NES would comply, or be close to compliance, with the proposed NES. Therefore, the costs of moving to the proposed NES would minimal or nil.

The information provided suggests that CMPA have costed control measures and developed a cost model to eliminate, as far as practicable, exposure to respirable crystalline silica i.e., industry best practice. This approach, while commendable, could be an unnecessary financial impost on industry. The costs to comply with the proposed NES are likely to be less than those necessary to eliminate respirable crystalline silica exposure.

Construction Industry

Industry operating in the construction sector is obliged to meet the current NES of 0.2 mg/m^3 quartz, 0.1 mg/m^3 of cristobalite and 0.1 mg/m^3 of tridymite. In order to comply, all industry whose operations expose their employees and other individuals to levels of RCS at or above 0.2 mg/m^3 are obliged to mitigate that exposure using effective measures. Again like the mining sector, the existing control measures, monitoring devices and personal protective equipment used to control, monitor, and prevent the inhalation of RCS at 0.2 mg/m^3 can do so at 0.1 mg/m^3.

Existing measures for the control of dust including RCS in the construction industry include[61]:

1. **Monitoring regimes using:**
   a. BCIRCA, Higgins and Dewell, SIMPEDS or Aluminium Cyclones (as per AS 2985).
2. **Water suppression methods for:**
   a. Drilling;
   b. Sawing;
   c. Jack hammering;
   d. Grinding; and
   e. Rubble removal.
3. **Dust collection methods using dust collectors attached to:**
   a. Masonry Drills;
   b. Masonry saws; and
   c. Grinders.
4. **Mechanical ventilation methods, including exhaust systems, for**
   a. Designated work areas; and
   b. Enclosed areas.
5. **Personal protective equipment (PPE)**
   a. Particulate dust masks (as per AS 1715); and
   b. Filtered self-rescue respirators (as per AS 1715).

The effectiveness of these construction industry measures in reducing exposures of RCS to 0.1 mg/m^3 has been verified by their appearance in a 1996 NIOSH publication entitled ' Preventing Silicosis and Deaths in the Construction industry' [62]. NIOSH has set its exposure limit at 0.05 mg/m^3.

Just as with the mining industry, construction generally complies with the quartz exposure standard of 0.2 mg/m^3 (according to comment received,) but equipment used can control RCS exposures to 0.1 mg/m^3 or below, suggesting that equipment is not used to full capacity. It is suggested that construction may employ work practices and work procedures that comply with the current NES but will not control exposures to the reduced NES. The reworking of such work practices and work procedures are a cost of the proposed NES, but these cannot be qualified or quantified due to a lack of information provided at industry workshops.

Issues determining costs

Costs are based on the assumption that industry meets current requirements. Information regarding the status of industry compliance was requested and has not been provided.

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[61] Queensland Workplace Health and Safety (January 2001), *Silica Dust in Building and Construction,* Queensland Government, accessed on 06/05/04 at http://www.whs.qld.gov.au/brochures/bro011v1.pdf.

[62] National Institute for Occupational Safety and Health (NIOSH) (1996), *NIOSH Alert: Preventing Silicosis and Deaths in Construction Workers*, DHHS (NIOSH) Publication No. 96-112. Accessed on 06/05/04 at http://www.cdc.gov/niosh/consilic.html

Industry Monitoring Costs

Industry will experience higher costs than government. During the introductory period for the new exposure standards, it is assumed that additional monitoring and reporting will be undertaken by industry.

Examples of monitoring costs are included in Table 23 below:

TABLE 23:

MONITORING COSTS TO INDUSTRY

Item	Cost
3 quartz and 3 respirable dust samples per site	$1650 – 2475
4 quartz and 4 respirable dust samples per site	$3080
5 quartz and 5 respirable dust samples per site	$1375 - 1430
Infrared quartz analysis	$55 per sample
X-ray diffraction quartz analysis	$132 per sample
Respirable filter dust gravimetric analysis	$66 per sample

Source: Personal communication . June 2004.

Gravimetric analysis of respirable dust is generally conducted in conjunction with infrared or X-ray diffraction quartz analysis.

Based on information provided by the NSW Department of Mineral Resources, an additional two tests would be required within the usual annual regime of six. Costs can vary from those companies with in-house equipment and expertise with easy access to facilities within a metropolitan area, for whom the costs would be relatively small, to those who would contract out for such services and require a complete initial audit for RCS exposure following the introduction of the proposed NES. A typical testing regime at a site would include the sampling of those workers, processes or procedures with the potential for significant RCS exposures.

Table 24, below, provides examples of total additional monitoring costs per site:

TABLE 24:

ADDITIONAL MONTORING AND REPORTING COSTS TO INDUSTRY

Items	Cost/Quantity	Cost for two tests
3 quartz and 3 respirable dust samples per site per test 4 quartz and 4 respirable dust samples per site per test 5 quartz and 5 respirable dust samples per site per test	$1980 – 3036 $3564 – 3872 $1980 - 2420	$3960 – 6072 $7128 – 7744 $3960 - 4840
Contracted initial audit for exposure, including labour, fares, accommodation, and report for a small site	$900/day for labour	$4000
In-house facilities and expertise within a metropolitan area	$100	$200

Sources: Various personal communications, including the NSW Department of Mineral Resources, Technical Section, January 2004.

Government costs

Capital and operational costs incurred by state and territory authorities responsible for the enforcement of crystalline silica NES, include administrative and equipment costs.

All costs to government, with the exception of administrative costs, under this option are not expected to increase at a rate above normal inflationary cost increases. The introduction of new exposure standards in the past, such as the 2003 ban on asbestos, have not led to increases in monitoring or reporting on the part of state and territory agencies.

In terms of increases in administrative costs additional costs that may be incurred include:

- the reprinting of existing printed material and/or the alteration of existing electronic documentation to replace the existing exposure standards with the revised exposure standards;
- informing government staff of the change and its consequences;
- informing the public by placing information in newsletters and on web sites; and
- informing industry (including unions and peak industry bodies) of the change and its consequences.

As the majority of government agencies now use electronic document production and delivery systems, the costs outlined above will be minimal and can be covered by existing communications budgets.

Summary

Reducing the current NES as proposed will reduce the incidence of workplace RCS-related disease by an average of at least 38%. This reduction is equivalent to an annual reduction of $5,328,685 in compensation payments (it should be noted that compensation is used as an indicator of potential costs), 116 fewer hospital days, 23 fewer lives lost to RCS-related disease, and will also prevent years of reduced quality of life for sufferers, their families and carers. This 38% reduction may be an overestimate, due to the current exposure standard reducing the numbers of new cases of RCS-related adverse health effects for some time to come. However, the under-reporting of RCS-related adverse health effects in health statistics, suggests that the 38% reduction could be an underestimate.

Each life lost or impaired can also be costed using Value of a Statistical Life (VSL) methods. Benefits based on VSL calculations vary greatly according individuals' circumstances, and therefore have only been discussed in general terms.

The cost of reducing the current NES will include administrative costs, and labour costs associated with the communication, enforcement, and compliance to the revised standards. Additional monitoring of high risk workers, processes or procedures, i.e., with potential respirable crystalline silica exposures close to the NES, could vary in cost, from as little as $200, but more typically $4000 - $8000.

It is assumed that industry is compliant with the existing NES as no evidence to the contrary has been received.

At least one multi-national company and one sector of the mining industry already complies with the proposed NES. Consequently, in respect of organisations in these circumstances, the benefits to workers and employer costs associated with the proposed NES are nil.

It is assumed that there may be additional costs to upgrade work practices and work processes to enable the equipment identified previously to operate to full capacity i.e., to control exposures to 0.1 mg/m^3 or below. Information on work practices and work processes and the costs to upgrade them was sought from industry.

A single example cost model was received from the quarry industry. This estimated an additional cost of $4.30 per tonne of quarried product giving a national cost of $266,600,000 during the first year and ongoing costs of $1.12 per tonne of quarried product and a national cost of $69,440,000 per annum thereafter. However, a combination of several of the control measures suggested in the submitted model could minimise crystalline silica dust exposure at a lower cost. Also, monitoring data from existing quarry sites meeting the current NES showed compliance, or close to compliance, with the proposed NES.

The information provided suggests that CMPA, which provided the cost estimate, have costed control measures and developed a cost model to eliminate, as far as practicable, exposure to respirable crystalline silica which is industry best practice. This approach, while commendable, could be an unnecessary financial impost on industry. The costs to comply with the proposed exposure standard are likely to be less than those necessary eliminate respirable crystalline silica exposure.

The additional costs to government in terms of communicating and enforcing the new NES should be minimal, with costs covered by existing budgets.

Option six— prohibition on the use of crystalline silica

Benefits

The major benefit of this option will be a reduction, over time, to almost zero in the number of cases of silicosis, lung cancer and other adverse health outcomes. There is also the option to prohibit the use of crystalline silica in any abrasive blasting or other processes which could give rise to silica dust.

Table 25 shows the number of deaths according to type of dust disease in NSW for the period 2000-01. As the number of deaths has been recorded since 29 February 1968, it represents a cumulative total rather than the annual impact.

TABLE 25:

NUMBER OF REPORTED DEATHS DUST DISEASE CASES IN NSW — FEBRUARY 1968 – 2001 AND FEBRUARY 1968 - 2002

Disease	Number of Deaths 1968 -2001		Number of Deaths 1968 -2002		Number of Deaths 2002-2001
	Average Age (yrs)	Due to dust (no.)	Average Age (yrs)	Due to dust (no.)	
Silicosis	70	360	70	380	20
Silico-tuberculosis	63	8	63	8	0
Silico-asbestosis	64	8	64	8	0
Silica induced carcinoma	67	11	73	12	1

Source: Dust Disease Board (DDB) of New South Wales, *2002 Statistics: Appendix 5*, accessed on 06/05/04 at www.ddb.nsw.gov.au/content/statistics/appendix/appendix5.htm, OHS inspectorate costs specifically devoted to monitoring exposure to crystalline silica are not currently known. It is assumed that existing resources devoted to inspecting workplaces will be dedicated to addressing other hazards.

Costs

Compliance costs

The costs associated with Option six relate to:

- abandonment — some industry may decide to cease supplying goods or services that previously involved the use or creation of RCS. For example, in industries such as mining and construction, few alternatives to crystalline silica are likely to be possible, and the widespread natural occurrence of crystalline silica means that an absolute ban would lead to substantial ceasing of activity. Given the significant contribution of these sectors to the economy, this would most probably be a large economic cost. For example, the mining sector contributes around 4.7 per cent of Australian GDP, with construction contributing 6.1 per cent, and the utilities sector (electricity, gas and water) contributing 2.2 per cent[63]. In absolute dollar terms, this corresponds to a total (across these three sectors) of $91 billion per annum; and
- substitution — in some cases, where feasible, less toxic substances may be substituted for silica sand.

The first of these costs (abandonment) is likely to be an overestimate as the capital investments e.g., the workers, equipment and machinery and worksites, are likely to be diverted into other activities i.e., largely recycled back into industry. However, the loss of production will still account for a significant proportion of the costs.

It is the second of these costs (substitution) that is the more complex.

A wide range of materials can be used as substitutes for hazardous silica sand. Examples include glass beads, steel grit, steel or iron shot, plastic blast materials, aluminium oxide and zirconium oxide. While these materials are more expensive than quartz sand, they are recyclable and they may have other benefits (e.g., in improved quality of the finished product).

The ferrous abrasives that are available include steel grit, and steel or iron shot having spherical particles. Steel and iron abrasives are not inherently hazardous. Aluminium oxide is a hard, sharp-edged, and effective cutting and cleaning material.

Few substitution possibilities are available for silica sand used in foundries, with olivine sand as perhaps the only economical alternative. Zircon or chromite sands are expensive and are useful in special cases.

When industry substitutes other substances for crystalline silica, they will incur a range of additional costs such including:

- capital costs associated with new equipment and technology, and the associated training and education;

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63 Australian Bureau of Statistics (ABS) (September 2002b), *National Income, Expenditure and Product,* Catalogue 5206.0, Canberra

- ongoing costs associated with the operation of new equipment and processes — however, in many cases these costs could be zero as new equipment may actually result in reduced ongoing costs; and
- cost increases for raw material substitutes — however, it is envisaged that the current differential in costs between silica and non-silica products will diminish over time. Thus after a government-mandated phase out, technological development of non-silica products would be accelerated and any market price differential that exists now between silica–containing products and non-silica products would eventually disappear. The reason why it is assumed that these cost reductions would occur in a linear fashion over the phase-out period is because:
  - industry would need to manage stocks over the phase-out period to ensure it is are not left with large quantities of banned products; and
  - commercial imperatives would lead industry to refrain from incurring the total cost of the phase-out period, up front.

Administration costs

There will be initial one-off costs incurred by those government authorities responsible for the incorporation of the ban into their legislative frameworks and ongoing costs for those government authorities responsible for enforcing compliance.

These cost will include costs associated with repealing existing legislation where required and introducing the legislative ban, such as instructions for Parliamentary Counsel, preparation of legislation by Parliamentary Counsel and printing. However, these costs which typically come out of jurisdictions' existing budgets and may be off-set by, or less than, the costs of enforcing crystalline silica NES. The costs to Government are, therefore, assumed to be reduced compared to the *status quo*.

Summary

Prohibiting all uses of crystalline silica, or those processes which could give rise to silica dust, would eliminate workplace exposure to respirable crystalline silica. This might result in less illness and death, and thus might translate over time into lower workers compensation insurance premiums. However, in practice, it has been the view of employers consulted that such costs will not reduce to any significant degree, because of exposure to other hazardous substances and dangerous goods and other workplace hazards. Similarly, it is envisaged that costs of worker protection (eg, goggles, overalls, etc) will not reduce to any significant degree due to the presence of other workplace hazards.

Balanced against these benefits is the potentially massive disruption to sectors that contribute substantially to the Australian economy. In some workplaces, operations could continue by using more expensive substitutes, but in a number of mining and construction settings, the nature of the operations and the natural occurrence of silica means that production would need to cease if a ban were enforced.

Part five – consultation undertaken

This part provides information on the consultation that was undertaken by the NOHSC Office in regard to amending the NES for RCS, and outlines the consultation arrangements that are continuing.

Due to the number of serious and contentious issues associated with the NES and adverse health effects related to breathing of RCS, an extensive program of consultation was undertaken as part of the NES setting process and to inform the RIS. This included:

- advertisements in national newspapers and on the NOHSC Internet site seeking public comment on the PRIS and public comment documentation (including the UWA report);
- industry workshops, organised by the NOHSC Office in conjunction with ACCI, and held in February 2004, in Sydney and Melbourne. There were representatives from the major industry sectors involved with crystalline silica i.e., mining, building and construction and manufacturing;
- formation of a Crystalline Silica Review Group (CSRG). The CSRG consisted of a NOHSC Office member, a state/territory representative, and employer (Australian Chamber of Commerce and Industry) and employee (Australian Council of Trades Unions) representatives. The CSRG reviewed the public comment and more recent, relevant scientific literature published since the UWA report was finalised; and
- ongoing discussions with industry, jurisdictions and the social partners.

A period for public comment on the PRIS and public comment documentation from August 2003 to November 2003, produced a total of 17 submissions. Analysis of the key public comments, and comments received from industry workshops, have been summarised and addressed below.

Industry believes that the main affected parties will be those concerned with building, construction, mining, and manufacturing of ceramics.

Industry has suggested that there may be some workplaces or processes that generate RCS exposures in between the current quartz exposure standard of 0.2 mg/m^3 and the proposed quartz exposure standard of 0.1 mg/m^3 e.g., 0.15 mg/m^3. Such workplaces or processes may incur additional costs to meet the proposed quartz exposure standard. However, most exposure controls will protect against 0.2 mg/m^3 and 0.1 mg/m^3. Those that do not are likely to be have marginal controls in place. The costs incurred could range from engineering controls ($100000s) to the addition of personal protective equipment (disposable P2 mask $5).

Some of the larger companies have a corporate memory with the impact of asbestos-related disease and this has assisted them to appropriately manage the risks associated with RCS.

A number of large multi-national companies advised that they currently work to international best practice and therefore currently comply with the proposed NES of 0.1 mg/m^3. One such company employs around 9,900 employees and 5,000 contractors in WA, NSW and Queensland. Of these employees, up to 1% (around 150) are potentially exposed to RCS at levels greater than 0.2 mg/m^3 and most are likely to be miners and crushers. The company works in conjunction with equipment suppliers, such as respirator suppliers, to run education and instruction programmes. It monitors and samples of each affected site for 4 weeks per year. The company aims to further reduce its own exposure limits to 0.05 mg/m^3.

Advice was provided which stated that coal mines have extensive education and training programmes. Underground coal mines in NSW comply with an exposure standard of 0.15 mg/m^3.

Most major cement and concrete operators in Australia monitor exposure levels and some larger operators currently have action limits as low as 0.05 mg/m^3. Action levels of 50% of the proposed NES demonstrates that it is possible to monitor and control exposure.

Industry believes that changing the exposure standard may:

- increase costs for industry, particularly for small business;
- highlight current areas of non compliance;
- affect the labelling and MSDS of silica containing products (the need to label silica as a carcinogen may reduce demand for a product);
- lead to insurance rate rises, and increased liability; and
- increase costs for health surveillance and monitoring.

The building industry expressed concerns about the compliance costs of a revised NES for small operators. There were concerns that the declaration of a revised NES may attract the attention of OHS regulators, increasing industry inspections and the potential need to implement appropriate controls on RCS exposure. Addressing the amended standard may lead to increased costs in relation to monitoring, education and training, reformulation and product stewardship, legal and insurance issues and supervision and management. The industry representative expressed a preference for prescriptive regulation of monitoring and measurement, as they believed that there was little or no inspection currently undertaken by regulators. The representative thought that the costs of complying with the current or revised NES may lead to increased costs being passed onto consumers with the cost of building houses likely to increase.

Comment was received about the lack of cost effective or suitable alternatives for most building products. There were also concerns that reformulation of products would have a cost impact and this would be a risk to industry, with small businesses potentially competing with imports.

Response: *In the hierarchy of controls elimination of silica is ideal, however, it is important to note that amending an exposure standard will not require alternative products to be used, or reformulation to take place, rather it will require more effective controls to be put in place. Where silica is removed from products there may in fact be a commercial advantage as there may be a requirement to label a crystalline silica product as a "carcinogen".*

Industry was concerned that engineering controls may be necessary and expensive.

Response: *It is important to note that in most cases, these controls should already be in place to comply with current standard.*

Industry was concerned that amending an exposure standard was not flexible enough for employers, and to take into account the introduction of significant engineering controls (such as the purchase of plant), a staged implementation approach should be scoped.

Response: *Advice from state and territory regulators indicates that there would be a reasonable time frame between declaration of new NES by NOHSC and adoption of the NES by the states and territories.*

There was also industry concern that there was no incentive to implement enhanced controls. One industry body suggested exploring tax incentives to encourage compliance.

Response: *It is important to note that companies which comply with the current NES will already have the controls in place to be able to comply with an amended NES. The additional benefits of a workplace free from injury and disease are not calculable, but would include a healthier and more productive workforce, with a flow on reducing in workers compensation claims.*

Industry was concerned that amendment to the exposure standard would highlight RCS as a carcinogen and this may lead to insurance rate rises and increased liability.

Response: *RSC is already considered a carcinogen and therefore a liability. Amendment to the exposure standard to reduce the level of exposure to RCS in the workplace will assist employers in meeting their duty of care.*

Industry was concerned that an amendment to the exposure standard would impact on the current labelling and MSDS provision for crystalline silica.

Response: *Although not mandated in the National Code of Practice for the Preparation of Material Safety Data Sheets 2nd Edition [NOHSC:2011(2003)] (MSDS 2nd CoP), industry may choose to update MSDS with the amended exposure standard. This could be done in conjunction with a review of MSDS, made necessary by the need to comply with the new MSDS 2nd CoP, to reduce costs (MSDS 2nd CoP was declared in April 2003 and comes into effect in state and territory OHS legislation in 2006). Any amendment to the exposure standard will not impact on labelling. This is because RCS is currently regarded as a human carcinogen, or a suspected human carcinogen, by a number of overseas authorities (including British HSE, NIOSH, IARC). When preparing MSDS and labels, industry is currently required to take into account the overseas classification data when applying the Approved Criteria for Classifying Hazardous Substances [NOHSC:1008(1999)]. An amended exposure standard would not impact on a hazard classification in accordance with the Approved Criteria.*

Industry was concerned about the increase in monitoring and health surveillance that would result with a change in the NES. Some industries currently carry out health surveillance but this may not assess the appropriate health effects e.g., no spirometry and chest x-rays.

Industry anticipated increased monitoring costs due to the increased frequency of testing and greater sampling, which would be required to be confident that samples were representative and meaningful. Comment received from the foundry industry outlined that although general limit of detection for RCS is around 0.04 there is a 20-30% error range in a single sample, and in order to overcome this multiple samples must be taken, and this adds to the expense incurred.

Industry commented that unions wanted better engineering controls rather than PPE. To meet the exposure standard the controls must be well maintained and industry believed this would cost money. In the foundry industry it was thought that significant engineering changes may mean closing the plant, and therefore loss of production would be a cost issue.

Comment from the quarry industry believed that the numbers of potentially exposed workers was underestimated in the PRIS as the figures didn't include maintenance personnel or contractors (eg maintenance electricians or mechanics).

Union representatives have provided comment that as there is no safe level of exposure to carcinogens, occupational and public exposure must be reduced as far as is possible. Therefore, it was recommended that:

- the use of crystalline silica in any abrasive or other processes which could give rise to silica dust be prohibited, and
- a single exposure standard of 0.05 mg/m^3 for all forms of crystalline silica be adopted, with an action level of half of that value be implemented in state and territory legislation/regulations.

Regarding prohibition, some workplace operations such as abrasive blasting could use less hazardous substitutes, and other workplace operations could continue by using more expensive substitutes. In a number of mining and construction settings, however, the nature of the operations and the natural occurrence of silica means that production would cease if processes giving rise to RCS dust were prohibited. Sectors that contribute substantially to the Australian economy may potentially be massively disrupted, with potential severe effects on employees.

Union representatives also proposed a uniform standard of 0.05 mg/m^3 for RCS, based on scientific evidence and the international exposure standard from NIOSH. Other public comment did not support 0.05 mg/m^3 for RCS, due to the difficulties in accurately quantifying exposures at this level (AS 2985-2004 measures to the nearest 0.1 mg/m^3). NIOSH is a US-based research agency which focuses on OHS issues, but it is not responsible for the development and enforcement of OHS in the USA (for example the development of NES).

Support for a reduction in the current exposure standard was received from a practicing medical practitioner specialising in respiratory disease.

Part six - conclusion and recommended option

Objective: To contribute to achieving the goal of Australian workplaces free from injury and disease, by reducing the incidence of adverse health effects due to exposure to Respirable Crystalline Silica				
Option Number	**Outline of Option**	**Impact on**		**Likely benefit/Comment**
		Industry	Government	
1	No change to current exposure standard of 0.2mg/m^3 of quartz, 0.1mg/m^3 of cristobalite and 0.1 mg/m^3 of tridymite	Nil – due to compliance with current standard	Nil – due to compliance with current standard	Workers are currently being exposed to levels which may result in adverse health effects
2	Increase education	Minimum cost if education is provided by Government, or industry suppliers and associations. May improve use of controls	Minimum cost if education is provided by industry suppliers and associations. May improve use of controls	Increased education may not affect behaviour and may not reduce adverse health effects.
3	Increase enforcement	Nil cost to Industry that currently complies with current standard	Cost to state OHS Regulators in increased inspections	May ensure greater compliance but workers are still exposed to levels that may result in adverse health effects
4	Change exposure standard to 0.13mg/m^3 of quartz, 0.13mg/m^3 of cristobalite and 0.1 mg/m^3 of tridymite	Potential greater costs in terms of monitoring. Potential minor costs for those processes/workplaces that generate exposures less than the current standard but greater than the proposed standard.	Administrative costs of declaring a revised exposure standard	The proposed standard is not based on all adverse health effects and doesn't account for the change in AS 2985. From a practical measurement point of view 0.13mg/m^3 is inappropriately precise
5	Reduce exposure standard to 0.1mg/m^3 of quartz, 0.1mg/m^3 of cristobalite and 0.1 mg/m^3 of tridymite	Potential greater costs in terms of monitoring and upgrading inefficient work processes and practices. Potential costs for those processes and workplaces that generate exposures less than the current standard but greater than the proposed standard.	Administrative costs of declaring a revised exposure standard	Proposed standard will reduce worker exposure to levels that may still cause adverse health effects. Accounts for change in AS 2985. Is easy to measure. Multi national companies currently comply. Brings Australia into line with most International Exposure Standards
6	Prohibition on the use of crystalline silica	Massive economic costs of abandonment and substitution of crystalline silica	Administrative and enforcement costs of a prohibition	Reduction to zero of adverse health effects resulting from exposure to RCS

Part six - preferred option

Option five to adopt exposure standards of 0.1 mg/m^3 for quartz, cristobalite and tridymite, is recommended. The UWA report and peer reviews, reviews of more recent, comprehensive studies and WA experience indicate there would be significant improvements in health effects at occupational exposure standards of 0.1 mg/m^3 for all three forms of crystalline silica.

The CSRG considered that the basis for the NES should be silicosis and that it should confer protection against all important adverse health effects. The UWA proposal of 0.13 mg/m^3 for quartz was based on a measurement method (AS 2985-1987) that has recently been superseded (by AS 2985-2004). As the change in measurement gives different exposure values, the UWA proposal has been adapted to 0.1 mg/m^3.

This approach is consistent with the agreed NOHSC objective to reduce adverse health outcomes associated with exposure to chemicals. Updating the exposure standard will enable industry and workers to align with international practice in terms of exposure control, and the related flow of benefits to the worker and the community. Government OHS objectives are supported by this action. As well as direct benefits, indirect benefits include establishment of standards against which future monitoring can take place.

The amended NES will assist in bringing Australia into line with international exposure standards, including those set by Australia's major chemical trading partners, such as the USA and Europe.

Reasons why the other options are not preferred

Option one: although the current standards are likely to have some health benefits as compared with no exposure standard, they are unlikely to be sufficient to meet NOHSC's objectives. International research indicates that reducing exposure levels to as low as reasonably practicable can reduce the incidence of death and illness, and that exposure at 0.2 mg/m^3 is likely to result in an unacceptably high incidence of adverse health effects e.g., silicosis and lung cancer. Maintaining the status quo would contravene government OH&S objectives.

Option two: an increased education program would not necessarily result in any reduction in potential exposure.

Option three, a more rigorous enforcement of the existing standard might lead to improved health outcomes if the existing standard is not currently being met. It is unlikely that the magnitude of the net benefits for this option would be as great as that of Option Five.

Option four, AS 2985-1987 was replaced by AS 2985-2004 as of February 2004, and AS 2985-2004 uses different conventions for the definition and cut-offs for respirable dusts, giving different exposure values. Consequently, this option is no longer viable and exposure standard recommendations have been modified to form Option Five. Discussion of the UWA recommendations has been integrated into Option Five.

Option six, prohibition on the use of crystalline silica, might result in less illness and death, however there is potential for massive disruption to industry sectors such as mining and construction that contribute substantially to the Australian economy.

Part seven - implementation

Following the completion of the RIS, NOHSC will consider declaring the proposed NES. It is anticipated that the proposed NES will be declared by NOHSC in October 2004.

NES are referenced directly in Australian Government, state and territory hazardous substances legislation and are therefore adopted on declaration by NOHSC.

However, the uptake of the proposed NES may vary between jurisdictions. NOHSC may seek to recommend a minimum transitional time to implement the amended NES to assist a consistent adoption and application of the revised standards in the Australian workplace.

This action may assist in managing the costs incurred in meeting new or lower exposure standards. It may, however, equally delay any realisable benefits.

The NOHSC review process relies on feedback from the state and territory jurisdictions and the social partners –, the peak trade union bodies and industry groups – through NOHSC committees, to review the effectiveness of a revision of the exposure standards.

The jurisdictions are responsible for workplace monitoring and will be in a position to report on industry compliance with the new standard;

NOHSC and its committee and sub-committee structure – with all of the above groups represented – meet regularly throughout the year (a minimum of 3 meetings annually), ensuring an iterative opportunity for feedback and review of the effectiveness and consequences, both positive and negative, of the action taken. Any of the social partners may initiate a further review of the standards, if unforeseen adverse consequences result from an action.

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