



PRELIMINARY REGULATION IMPACT STATEMENT

on the Proposed Amendments to the

NATIONAL EXPOSURE STANDARD

for

CRYSTALLINE SILICA

July 2003

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Forward

The National Occupational Health and Safety Commission (NOHSC) is a tripartite body established by the Commonwealth 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.

The National Commission comprises representatives of the peak employee and employer bodies the:

- Australian Council of Trade Unions (ACTU);
- Australian Chamber of Commerce and Industry (ACCI); and
- Commonwealth, State and Territory governments.

In seeking to improve Australia's occupational health and safety (OH&S) performance, the National Commission 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.

Workplace Relations Ministers' Council (WRMC) on 24 May 2002 endorsed the release of NOHSC's National OHS Strategy 2002–2012. The Strategy is a landmark development signifying the commitment of all Australian governments, the Australian Chamber of Commerce and Industry and the Australian Council of Trade Unions, 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 NOHSC 2000 to 2003 Strategic Plan describes five key output areas that define and differentiate NOHSC's role¹ from that of the state and territory jurisdictions:

- improving national data systems and analysis;
- improving national access to occupational health and safety (OHS) information;
- improving national components of the OHS and related regulatory framework;
- facilitating and coordinating national research efforts; and
- monitoring progress against the National OHS Improvement Framework.

There are five initial national priority areas for action to achieve short-term and longer-term improvements. They recognise that cooperation among OHS stakeholders will lead to more efficient and effective prevention efforts. The priorities are:

- reduce high incidence/severity risks;
- improve the capacity of business operators and workers to manage OHS effectively;
- prevent occupational disease more effectively;
- eliminate hazards at the design stage; and
- strengthen the capacity of government to influence OHS outcomes.

¹ NOHSC, "The Role of NOHSC" available at <http://www.nohsc.gov.au/AboutNOHSC/RoleofNOHSC> accessed November 2002.

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Abbreviations

ACGIH	American Conference of Governmental Industrial Hygienists
ALARA	as low as reasonably achievable
ALOS	average length of stay
BMRC	British Medical Research Council
CoAG	Council of Australian Governments
ESEWG	Exposure Standards Expert Working Group
EWGCS	Expert Working Group on Crystalline Silica
FEV1	Forced Expiratory Volume in one second
HSSC	Hazardous Substances Sub Committee
IARC	International Agency for Research on Cancer
IDC	inter-departmental committee
ILO	International Labour Organisation
MEL	maximum exposure limit
MOHSAB	Mines Occupational Health and Safety Advisory Board
NA	not applicable
NCP	National Competition Policy
NES	National Exposure Standards
NHMRC	National Health and Medical Research Council
NIOSH	National Institute for Occupational Safety and Health
NOAEL	no observed adverse effect level
NOHSC	National Occupational Health and Safety Commission
NPAP	National Priority Action Plan
NSW	New South Wales
OHS	occupational health and safety
ORR	Office of Regulation Review
PACE	Prevention And Control Exchange Programme
PEL	permissible exposure level
PRIS	preliminary regulation impact statement
REL	Recommended Exposure Limit
RIS	regulation impact statement

SA	South Australia
SDSC	Standards Development Standing Committee
TLV	threshold limit value
US	United States
UWA	University of Western Australia
WA	Western Australia
WHO	World Health Organization

Chapter One

Introduction

This preliminary regulation impact statement has been prepared to facilitate informed public comment about the regulation of crystalline silica. This introductory chapter outlines the context within which the preliminary regulation impact statement was commissioned by the National Occupational Health and Safety Commission, and its purpose.

1.1 The Role of the NOHSC

The National Occupational Health and Safety Commission (NOHSC) has a mission to lead and coordinate national efforts to prevent workplace death, injury and disease in Australia. NOHSC's vision is for Australian workplaces to be free from injury and disease.

NOHSC has functions to develop policy frameworks that can be referenced by individual States and Territories and provide the basis for a nationally consistent approach to preventing workplace injury and disease.

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 is the accepted body to develop National Exposure Standards (NES) to be adopted and implemented on a nationally consistent basis. The NES are developed and reviewed according to scientific knowledge and other sources such as overseas regulatory standards where relevant.

While NOHSC has the power to establish national standards and codes of practice, they only form part of the common law when declared, while state and territory jurisdictions undertake ultimate implementation and enforcement.

NOHSC also has a broad brief in terms of general policy and research, as well as disseminating information and educating the general populace.

1.2 Concerns About Exposure to Crystalline Silica

Crystalline silica is the basic component of sand, quartz and granite rock.

Excess exposure to crystalline silica has historically been linked with a range of diseases such as silicosis, tuberculosis, and lung cancer. The effects range from mild through to severe incapacitation, and/or death. A fuller discussion of the problems associated with crystalline silica, including the nature of the health effects, is set out in Chapter Two.

A review of the interim exposure standard for crystalline silica was referred to the Hazardous Substances Sub Committee (HSSC) by NOHSC. In April 1998, the HSSC agreed to recommend the current independent review² of the crystalline silica exposure standard. As a result of this review NOHSC is in the

² The University of Western Australia (February 2002) *A Review of the Australian occupational Exposure Standard for Crystalline Silica*, February 2002; www.inchem.org/documents/icsc/icsc/eics0809.htm

process of considering the appropriate exposure standard. Further details about the historical development of the exposure standard is contained in Box 1.1.

The existing and proposed standards are set out in Table 1.1

Table 1.1

EXISTING AND PROPOSED CRYSTALLINE SILICA EXPOSURE STANDARDS

Form of Crystalline Silica	Current Exposure Standards	Proposed Exposure Standards
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

Box 1.1

HISTORICAL DEVELOPMENT OF THE CRYSTALLINE SILICA EXPOSURE STANDARD

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 twelve 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 ($0.2\text{mg}/\text{m}^3$), cristobalite ($0.1\text{mg}/\text{m}^3$) and tridymite ($0.1\text{mg}/\text{m}^3$).

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

The following reasons were cited:

- the NHMRC standard of $0.2\text{mg}/\text{m}^3$ respirable quartz had been in force in Australia for a decade. The incidence of silico-pneumoconiosis in most areas of Australia (WA, SA, NSW and Queensland) was very low and current incidence probably related to those ageing workers who had been exposed to significantly higher levels of respirable silica in the past;
- the proposed standard of $0.1\text{mg}/\text{m}^3$ for respirable quartz adopted from ACGIH was based on a conversion of mppcf to mg/m^3 which was believed to be inaccurate;
- the ACGIH's definition of respirable dust corresponded to a median aerodynamic diameter of 3.5 micrometers, which was different from the Johannesburg Curve adopted in the draft document;
- it was argued that the Australian sampling technique would give a higher dust reading than the ACGIH recommended method; and
- the proposed exposure standard for respirable quartz was not adequately justified.

In view of strong opposition to the proposed standard, in particular from the mining industry, the ESEWG believed a more thorough examination of the issue was warranted. The SDSC regarded the issue of an exposure standard for crystalline silica sufficiently important to establish an Expert Working Group on Crystalline Silica (EWGCS) and a Reference Group. 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, put forward a risk assessment model to predict the incidence of silicosis and cancer from different exposure levels, and made recommendations to reduce the incidence of adverse health outcomes associated with silica exposure.

Between 1988 and 1996 no formal national exposure standard for crystalline silica existed in Australia, although some mining and OHS authorities assumed their own standards.

After the *Draft Technical Report* of 1996,⁴ NOHSC reinstated the original 1983-84 NHMRC atmospheric exposure standard of $0.2\text{mg}/\text{m}^3$.

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

³ American Conference of Government Industrial Hygienists (1985) *Documentation for Threshold Limit Values and Biological Indices* (5th edition), Cincinnati.

⁴ National Occupational Health and Safety Commission (1996) *Draft Technical Report on Crystalline Silica*, AGPS, Canberra.

1.3 The Role of this Preliminary Regulation Impact Statement

Setting the appropriate crystalline silica exposure standard is difficult because:

- excessive exposure can adversely affect health. There is also a range of indirect costs associated with crystalline silica exposure. Limiting exposure can generate benefits through avoided health costs; but
- there are costs associated with any regulation, including potential compliance and administration costs for industry and government.

As might be expected given stakeholders' different frames of reference, there has been a divergence of views in the past about the best way to frame the NES for crystalline silica.

A regulation impact statement (RIS) is a way of formalising the inquiry into these tradeoffs.⁵ This preliminary RIS (PRIS) has been prepared to facilitate informed public comment and form the basis for a final RIS that will be used to guide consideration of the adequacy of the current exposure standards for crystalline silica and possible alternatives.

A RIS is a well-established procedure for assessing the impact on affected stakeholders, industries, the economy and the community of policy and regulatory proposals.

Indeed, the preparation of a RIS is a requirement when making a new standard. At their 7 November 1997 meeting, the Council of Australian Government (CoAG) endorsed the report, *Monitoring and Compliance with the COAG Principles and Guidelines for National Standard Setting*, which set out monitoring arrangements for compliance with the *Principles and Guidelines* and established a role for the Commonwealth Office of Regulation Review (ORR) in reviewing and advising on draft RISs prepared by national regulatory bodies such as NOHSC.

The *Principles and Guidelines* require that a RIS address the following matters:

- a statement of *the problem* the proposed regulatory action seeks to address;
- *the objective* in terms of outcomes and goals that the regulatory action seeks to achieve;
- a statement of *the proposed action* and its alternatives in sufficient detail to allow comparative assessment and evaluation by the RIS;
- an assessment of the *costs and benefits* of the proposed action, including direct and indirect economic and social costs and benefits;
- *an evaluation* of the proposed action and any alternatives to establish that the proposed action will achieve the proposed policy objectives at least cost to business and the community;
- the *review procedures* that will be established to ensure ongoing monitoring of the operation and appropriateness of the proposed regulatory action; and
- an outline of the *consultation* that has or will take place with those affected by the regulatory action.

The RIS should also assess the extent to which the proposed action meets the broad principles of good regulatory practise in that the regulatory regime is

⁵ Office of Regulation Review (December 1998) *A Guide to Regulation* (2nd edition), Canberra.

simple, equitable, efficient, avoids excess and/or unnecessary rigidity and will be periodically reviewed for relevance and performance.

It is these issues that this PRIS seeks to address, and where particular industry feedback or clarification is needed this is identified with a  so that the final RIS will provide a considered and representative view of the merits of regulatory change.

Chapter Two

What is Crystalline Silica?

This chapter provides a brief overview of crystalline silica.

Crystalline silica — also known as silicon dioxide (SiO₂) — 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 the 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 industry are quartz, tridymite, and cristobalite.

The quartz form is so abundant that the term quartz is often used in place of the general term crystalline silica. Quartz is a common component of soil and rocks; consequently, workers are potentially exposed to quartz dust in many occupations and industries.⁶

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 car-bide production). Burning of agricultural waste or products such as rice hulls may also cause amorphous silica to become cristobalite (a crystalline form).⁷

Table 2.1 provides an overview of the three main types of silica, briefly describing their composition, nature, health impacts and the exposure standards applicable for each.

⁶ NOISH Hazard Review (April 2002) *Health Effects of Occupational Exposure to Respirable Crystalline Silica*.

⁷ *ibid.*

Table 2.1

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 (grams)	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) ⁸	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 amorphous silica and quartz to cristobalite • Often associated with metamorphism in volcanic areas	• Temperatures greater than 1500°C may convert amorphous silica and quartz to tridymite • Often associated with metamorphism 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: The University of Western Australia (February 2002) *A Review of the Australian occupational Exposure Standard for Crystalline Silica*, February 2002; www.inchem.org/documents/icsc/icsc/eics0809.htm, accessed 19/11/2002; and WorkSafe Australia (September 1993) *Draft Technical Report on Crystalline Silica*.

8

In 1812 the Mohs scale of mineral hardness was devised by the German mineralogist Frederick Mohs (1773-1839), who selected the ten minerals because they were common or readily available. The scale is not a linear scale, but somewhat arbitrary. See http://www.amfed.org/t_mohs.htm for more detail.

Chapter Three

The Problem

Specifying the problem is the crucial first step in taking appropriate action and forming public policy decisions.

While many stakeholders see exposure to crystalline silica as a problem, a threshold question is whether the problem is sufficient to justify government action. This is a separate question to what form any such government action could or should take (this subsequent question is addressed in Chapter Four that outlines the available Options).

Agreeing on the nature of the problem is a crucial first step in guiding appropriate future action. The ‘problem’ with crystalline silica relates to the potential adverse health impacts from exposure — ranging from mild irritation through to death. Two main tests can be considered in determining the seriousness and precise nature of the problem:

- mandatory regulation threshold criteria; and
- market failure test.

These tests are considered in turn below.

3.1 The ‘Mandatory Regulation’ Threshold Criteria

A useful framework for assessing the degree of a potential problem is to apply the Commonwealth’s quasi-regulation inter-departmental committee’s (IDC’s) finding that, as a general principle, governments should restrict the use of mandatory regulation in product and service markets to the protection of health, safety, the environment, consumers and/or competition.⁹

The IDC recommended that explicit government regulation should only be considered where:

- the problem is high risk or of high impact/significance, for example, major public health and safety issues;
- the government requires the certainty provided by legal sanctions;
- universal application is required;
- there is a systematic compliance problem with a history of intractable disputes and repeated or flagrant breaches; and
- existing industry bodies lack adequate coverage of industry participants, are inadequately resourced or do not have a strong regulatory commitment.¹⁰

An initial assessment of the potential exposure to crystalline silica in the workplace against each of these aspects is set out in Table 3.1.

⁹ Commonwealth Interdepartmental Committee on Quasi-regulation (1997) *Grey-Letter Law*, Canberra, p.xxii.

¹⁰ *ibid.*

Table 3.1

THE NATURE OF THE CRYSTALLINE SILICA EXPOSURE PROBLEM

IDC Regulation Criteria	Assessment of Crystalline Silica
High risk or high impact / significance	Exposure to crystalline silica is potentially catastrophic (resulting in death), though likely over a minimum five year period of exposure and more likely over a life time of work (ie, not instantaneous). Historically, hundreds of deaths have been attributed to silica exposure.
Government requires certainty	Exposure and effects are difficult to detect without relatively sophisticated tests and monitoring over time. Certainty is therefore useful though there are issues in practice relating to resources available for enforcement.
Universal application is required	This is one of the principles underlying OHS law and policy.
Systematic compliance problem	This does not appear to have been an issue in recent years, but given the different characteristics of the various workplaces and industries, then a unifying standard may be useful in securing consistency of compliance.
Lack of effective industry self-regulation	Workplaces with potential crystalline silica exposure vary from extremely large to individual contractors. It would be difficult to harness existing industry body coverage to engage all participants.

Source: The Allen Consulting Group

The most significant and contentious of the criteria discussed in Table 3.1 relates to the actual incidence and severity of the health problems attributable to crystalline silica (ie, are the health consequences high risk or of high impact/significance?). The following sections consider the incidence and severity of negative health impacts as a result of exposure to crystalline silica.

3.1.1 The Severity of Negative Health Consequences as a Result of Exposure of Crystalline Silica

Diseases caused by inhalation of crystalline silica may include:¹¹

- chronic silicosis — this is the most common form of silicosis. Fibrotic changes in the lung occur after ten to thirty years of inhalation of excessive levels of silica dust. Accumulated dust in the lungs can cause the fibrotic changes to continue to develop even after dust exposure has ceased;
- 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 within several months. Death occurs after a few 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;

¹¹ NCOH/SORDSA, *Crystalline Silica: Health Hazards and Precautions*, February 1999, available at http://www.asosh.org/Programmes/SORDSA/Crystalline_silica.htm, accessed 1/11/2002.

- 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 silica dust exposure potentiates the damage done by smoking. Nonsmokers rarely develop emphysema due to the effect of silica dust only;
- tuberculosis — people with silicosis are known to be much more susceptible to tuberculosis. Though the incidence of this is decreasing, it is still the most common complication of silicosis;
- heart effects — in severe cases the fibrous tissue can so hinder the flow of blood in the vessels of the lungs that the heart expands; endeavouring to pump more blood. This is known as *cor pulmonale*. Death can result from these complications;
- cancer — see Box 3.1 for an overview of the debate regarding the link between crystalline silica and cancer; and
- 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.

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 are associated with much shorter latency and more rapid disease progression; and
- there are long lead times between exposure and eventual complications — a relatively ‘short’ gestation period may be five to ten years.

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).

Box 3.1

THE UNCERTAIN RELATIONSHIP BETWEEN CRYSTALLINE SILICA AND CANCER

A link between silicosis and cancer has been the subject of speculation for some time.

The possible risk of lung cancer from silica has been reported in several studies.¹² For example:

- in a large study, Cherry et al (1995) found a slight increase in lung cancer incidence in pottery workers when compared to local rates on 88 cases forming the 'control group'. However, the risk of lung cancer was not related to length of employment in the pottery industry;¹³ and
- Levin argues that, "It looks as if crystalline silicosis carries with it an increased risk of lung cancer. We are concerned [and] there is enough evidence now to suggest it. The best thing is to protect workers."¹⁴

Despite these pointers to a link between crystalline silica and cancer considerable doubt has been, and continues to be expressed. Indeed, other studies have not shown there to be a cancer risk and a recent review concluded that, "there is little to suggest that any excess of lung cancer would be detectable at exposure levels sufficient to control the occurrence of radiologically apparent silicosis".¹⁵ Furthermore, another study concluded that, "The relation between silica exposure and lung cancer has been addressed in numerous epidemiological studies especially during the past decade. Despite the considerable attention given to this topic, no scientific consensus has been reached regarding the potential carcinogenicity of silica in humans."¹⁶

While OHS authorities worldwide have accepted that chronic exposure to fine silica dust causes silicosis (thickening and stiffening of the lungs with consequent disabling ill-health), in late 1996 the International Agency for Research on Cancer (IARC), in a controversial decision, 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.¹⁷ 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."¹⁸

How much silicosis people develop depends on their genetic background and the degree of exposure to respirable quartz, although the relationship between genetics and exposure is not well understood:

¹² Forestiere et al (1986) "Silica and Lung Cancer among Ceramic Workers: A case-referent study", *American Journal of Industrial Medicine* 10:363–370. Thomas et al (1990) "Lung Cancer risk in Pottery Workers in the United States: Occupational Exposure to silica and cancer risk" *IARC Scientific Publications No 97*, pp75–81 IARC Lyon. McCaughlin J K et al (1992) "A nested case-control study of Lung Cancer among silica exposed workers in China" *British Journal of Industrial Medicine* 49:169–171.

¹³ Cherry N, Burgess G, McNamee R, Turner S, McDonald C (December 1995) "Initial findings from a cohort mortality study of British pottery workers" *Applied Occupational Environment Hygiene* 10(12): 1042–1045.

¹⁴ Electronic Library of Construction Occupational Safety and Health (November 2000) "The Scourge of Silicosis – Deadly Dust Can Leave You Gasping at the Consequences" *Engineering News Record*, November 2000 available at www.cdc.gov/niosh/elcosh/docs/d0200/d000291/d000291.html accessed 18 November 2002.

¹⁵ McDonald J C (December 1995) "Silica Silicosis and Lung Cancer: An epidemiological update" *Appl Occup Environ Hyg* 10(12) 1051–1058. See also: Meijers et al (1990) "Silica exposure and lung cancer in ceramic workers: a case-control study" *International Journal of Epidemiology* 19:19–25.

¹⁶ Checkoway H (December 1995) "Methodological Considerations Relevant to Epidemiology studies of Silica and Lung Cancer" *Applied Occupational Environment Hygiene* 10(12) pp1049–1055.

¹⁷ <http://www.who.int/inf-fs/en/fact238.html>, accessed 1/11/2002.

¹⁸ Statement by the International Agency for Research on Cancer (IARC) available at <http://users.bigpond.net.au/InHealth/Silica1.htm> accessed 14/11/02. The classification of silica as a carcinogen has a number of major ramifications. In particular, the classification of Silica as a carcinogen means that any 'use' of any product/material containing more than 0.1 percent of crystalline silica, is regarded as the 'use' of a carcinogen and could in future be made subject to Part II of the Hazardous Substances Regulations. The problem is that almost all coal, ore, or minerals mined in Australia contain more than 0.1 percent crystalline silica, and therefore coal and ores could be classified as carcinogens in their entirety. Part II of the Hazardous Substances Regulations impose quite extensive obligations on any employer 'using' a carcinogen — where 'using' includes mining and processing, as well as using products such as cement and concrete, grouts, sands and an almost endless list of other materials.

“Two people can work side by side [in silica conditions] and in one, there will be scarring, and in the other, the scarring will be nominal. But you can’t do genetic testing on people before you send them out [to a jobsite] and if there is enough dust, everybody gets some [scarring].”¹⁹

Furthermore, though silicosis is not known to cause any other diseases it may be aggravated by other conditions. Emphysema and asbestosis can cause an additive crippling effect on the lungs when coupled with silicosis, as can cigarette smoking.

3.1.2 The Incidence of Negative Health Consequences as a Result of 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.

Obviously, the workers at risk are the large variety of occupations in contact with silica dust. These include:

- underground mining, tunnelling and excavation work — the potential exposure to crystalline silica in mining and tunneling will vary depending on the geological formations worked;²⁰
- extraction and cutting of quartzite, gneiss, granite and slate;
- foundries;
- glass manufacturing plants;
- brick-making;
- manufacture of pottery, porcelain, refractory materials and siliceous abrasives;
- road building;
- demolition work where potential sites of silica exist eg. breaking up concrete; and
- explosive blasting work.

While worker exposure to crystalline silica can potentially occur in a number of industries (see below), the most common path of exposure may be workers who are exposed to silica during abrasive blast cleaning.²¹ Abrasive blast cleaning is a surface preparation method that propels an abrasive by air pressure, centrifugal force, or water pressure against the surface to be cleaned. 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

¹⁹ Electronic Library of Construction Occupational Safety and Health, *The Scourge of Silicosis – Deadly Dust Can Leave You Gasping at the Consequences*, Engineering News Record, November 2000, available at www.cdc.gov/niosh/elcosh/docs/d0200/d000291/d000291.html.

²⁰ Although silicosis differs from the pneumoconiosis afflicting coal miners, some coal dust, particularly from anthracite coal, can contain free silica and therefore cause silicosis.

²¹ Demonstrating the severity of the hazard, the National Institute for Occupational Safety and Health (NIOSH) has indicated that an estimated one million US workers are at risk of developing silicosis and that 100,000 of these workers are employed as sandblasters. The NIOSH alert further reports that of these one million workers, approximately 59,000 will develop silicosis. 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.

airborne concentrations of hazardous dust. Some operations, like dry sweeping, the clearing of sand or concrete, or the cleaning of masonry with pressurised air can generate large dust clouds. Thus, even in open air these activities can be hazardous.

It is important to note that silicosis is not a naturally occurring disease; it's occurrence is directly associated with work place 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.

Using the identified risk industries and occupations as a basis for identification, Table 3.2 shows the number of employees in Australia by industry and occupation who *may* experience exposure to crystalline silica. Clearly, not all industries and occupations face the same exposure risk factor and a significant percentage of these workers may never come in contact with any form of silica. Thus, the exposure numbers presented in Table 3.2 must be seen as an upper bound of potential exposure.

Table 3.2

NUMBER OF WORKERS BY OCCUPATION AND INDUSTRY OF EMPLOYMENT

	Construction Material Mining	Mining, nec	Other Mining Services	Glass and Glass Product Manufacturing	Ceramic Product Manufacturing	Cement, Lime, Plaster and Concrete Product Manufacturing	Non-Metallic Mineral Product Manufacturing, nec	Building Construction	Non-Building Construction	Other Construction Services	Site Preparation Services	Total
Wall and Floor Tilers and Stonemasons	51	0	3	0	176	72	1,320	1239	36	125	6	3,028
Drillers	94	59	363	0	0	10	5	25	132	798	69	1,555
Mobile Construction Plant Operators	557	84	113	7	83	177	27	687	6,471	361	12,295	20,862
Other Intermediate Stationary Plant Operators	59	6	6	3	25	562	33	106	170	9	28	1,007
Glass Production Machine Operators	0	0	0	924	0	3	9	9	0	0	0	945
Clay, Stone and Concrete Processing Machine Operators	66	0	0	0	740	393	153	57	22	6	6	1,443
Miners	212	656	491	6	9	35	26	21	58	11	191	1,716
Blasting Workers	27	3	36	0	0	4	0	0	10	26	31	137
Structural Steel Construction Workers	0	0	21	6	0	102	3	1,702	562	1,486	51	3,933
Other Process Workers	3	0	0	539	575	530	216	125	24	37	0	2,049
Mining Support Workers and Driller's Assistants	118	49	135	0	3	17	15	12	21	208	21	599
Earthmoving Labourers	6	0	6	0	0	12	0	216	227	100	557	1,124
Paving and Surfacing Labourers	3	0	0	0	27	12	9	79	2,728	165	31	3,054
Railway Labourers	0	0	0	0	0	13	3	6	922	6	3	953
Construction and Plumber's Assistants	8	0	7	13	59	139	42	9,936	1,858	860	1285	14,207
Concreters	9	0	3	0	22	1,512	24	2,438	729	334	102	5,173
Other Mining, Construction and Related Labourers	3	0	3	0	0	11	42	322	75	3,643	28	4,127
Total	1,216	857	1,187	1,498	1,719	3,604	1,927	16,980	14,045	8,175	14,704	65,912

Source: ABS 2001 Census of Population and Housing, custom data.

Table 3.3 shows the geographical spread of employees potentially exposed to silica and hence at risk of silicosis, demonstrating that (although Queensland is

disproportionately represented compared to the State population) the incidence is national.

Table 3.3

NUMBER OF WORKERS BY STATE/TERRITORY AND INDUSTRY

	NSW	VIC	QLD	SA	WA	TAS	NT	ACT	Other
Construction Material mining	329	205	319	101	204	26	24	8	0
Mining, nec.	157	18	148	142	349	8	15	0	20
Other Mining Services	122	32	196	25	737	23	52	0	0
Glass and Glass Product Manufacturing	462	536	249	161	80	6	0	4	0
Ceramic Product Manufacturing	540	466	391	80	221	15	3	3	0
Cement, Lime, Plaster and Concrete Product Manufacturing	1,011	807	761	321	530	97	50	27	0
Non-Metallic Mineral Product Manufacturing, nec.	640	514	314	136	252	51	8	12	0
Building Construction	6,487	4,239	3,097	1,117	1,549	177	116	195	3
Non-Building Construction	4,118	2,848	4,010	879	1,619	339	149	80	3
Other Construction Services	2,642	1,798	1,567	637	1,202	128	104	97	0
Site Preparation Services	4,610	2,981	3,611	1,070	1,868	270	166	125	3
Total	21,118	14,444	14,663	4,669	8,611	1,140	687	551	29

Note: 'Other' includes additional Territories of the Commonwealth.

Source: ABS; 2001 Census of Population and Housing, custom data.



Are workers in these occupations and industries the parties that are likely to be exposed to crystalline silica on an ongoing basis? Is the list accurate? What industries and/or occupations should be included or excluded?

The maximum number of employees potentially exposed to crystalline silica is around one percent of the total workforce.

However, just focusing on employees may understate the problem of silicosis. Respirable silica dust may be invisible to the naked eye and is so light that it can remain airborne for a long time. It can thus travel long distances in the air and so affect populations not otherwise considered to be at risk. There is no evidence as to how many people are thus exposed to crystalline silica.

Despite these exposure numbers, the revealed incidence of silicosis is low, suggesting that actual exposure is not widespread. For example, Table 3.4 shows hospital usage by people with silica-related pneumoconiosis and that total admissions are less than 0.1 per 10,000 people among the population as a whole.

Even if all the admissions arose from workers within industries identified in Table 3.3, this shows an incidence of less than 0.1 per cent of workers.

Table 3.4

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
<i>Pneumoconiosis due to dust containing silica</i>							
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
<i>Unspecified pneumoconiosis</i>							
Public Hospitals	4	0	<0.1	250	0.1	62.5	62.5

Note: Unspecified pneumoconiosis separations are not published for private hospitals. ALOS is average length of stay.

Source: Australian Institute of Health and Welfare, *Australian Hospital Statistics 2000-01*, Table S8.1 and S8.2, available from <http://www.aihw.gov.au/publications/hse/ahs00-01/> (accessed 24 November 2002).

3.1.3 Conclusion

The discussion presented in the previous two sections suggests that the effects of exposure to crystalline silica can be very harmful to one's health (in some cases resulting in death), but that the incidence of harm is confined to a number of particular industries and does not appear to affect a significant portion of the community. That is, while the severity of the problem is high the incidence is relatively low.

3.2 Is There a 'Market Failure'?

A second relevant test in defining the nature of the problem focuses on the concept of 'market failure'. The 'market failure' test is separate to the 'mandatory regulation' criteria outlined in Section 3.1 and highlights different dimensions to the problem that may benefit from government action.

CoAG has publicly stated that government interventions in markets should generally be restricted to situations of market failure and that each regulatory regime should target the relevant market failure or failures.²² Market failure is a term given to instances where freely operating markets (that is, those operating in the absence of government intervention) are not likely to achieve an efficient allocation of resources from the viewpoint of society. Market failures may arise under a number of conditions including:

- the presence of public goods — public goods will tend to be under-produced because they are non-excludable (ie, people who have purchased the good cannot stop others using it also) and non-rivalrous (ie, the good is not used up with use). Common examples include aspects of the natural environment that are not owned by any party. It is a market failure when such goods are degraded but the costs do not fall on the beneficiaries of the particular transaction;
- externalities — these are positive or negative impacts of market transactions which are not reflected in prices and which affect third parties, and so lead

²² Council of Australian Governments (1991) *Report of Task Force on Other Issues in the Reform of Government Trading Enterprises*, released as part of the first COAG communiqué, p.22.

to non-optimal levels of production and consumption. These are commonly called spillover effects;

- natural monopolies — these exist when the costs of establishment, resources or infrastructure mean that setting up competition is socially wasteful; and
- severe information asymmetries — where one party (for example employers) have information that other parties (for example workers) do not. However, it needs to be stressed that information asymmetries are not uncommon, it is rare that the information available to the both parties in a transaction is the same. Information asymmetries are of concern where they are large and where they are of a type that may lead to significant damage if they are not corrected.²³ That is, failure can be said only to exist when the information asymmetries become so severe as to distort actual market outcomes.

In relation to crystalline silica, potential market failures include:

- asymmetric information between employers and employees where employers are likely to have more information about the risks to health and safety in the workplace than employees. This is exacerbated by the:
 - difficulty in diagnosing diseases related to crystalline silica exposure because of the absence of early symptoms. Main methods of diagnosis include chest x-rays, examination of work history post event, and tests of lung function using a spirometer;
 - the irreversible and possibly ‘catastrophic’ nature of the health effects (ie, potentially involving death);
 - lack of scientific knowledge and awareness of crystalline silica among employers themselves; and
- ‘externalities’ that arise from the impact on parties other than those directly affected by the regulation. For example, taxpayers may be required to contribute to fund costs to the health system attributable to diseases related to exposure to crystalline silica.

3.3 Initial Indications and Subsequent Objectives

Based on the analysis set out above, the significant nature of information asymmetries and the potentially catastrophic nature of the health effects would seem to justify some form of (continued) government intervention in relation to exposure to crystalline silica. This is because the current health effects resulting arising from the use of crystalline silica can be considered a market failure and insufficient government intervention.

Preliminary Issue

Is the exposure to crystalline silica of sufficient magnitude to justify government intervention?



Does this section accurately capture the essence of the problem?

Are there other contextual factors that have been omitted and that materially impact on the description of the problem?

Do you support the government intervention?

²³ See Financial Systems Inquiry (1996) *Discussion Paper*, AGPS, Canberra, p.97.

Based on the preceding analysis of the problem the objectives to guide government intervention should be to:

- provide a safer working environment that reflects the current level of knowledge about the problem of crystalline silica exposure;
- reduce future death and illness from exposure to crystalline silica dust in the workplace and the community more generally; and
- undertake this reduction in a cost-effective manner for all parties involved.

These objectives are consistent with moves by a number of international bodies — see Box 3.2

Box 3.2

THE ILO/WHO INTERNATIONAL PROGRAMME

In order to promote a wide international cooperation in the prevention of silicosis in this field, a joint ILO/WHO *Programme on Global Elimination of Silicosis* was proposed by the Joint ILO/WHO Committee on Occupational Health in April 1995). The purpose of the *Programme* is to offer countries a 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 by countries of *National Programmes on Elimination of 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 organizations;
- 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.

Source:

<http://www.ilo.org/public/english/region/asro/bangkok/asiaosh/newsletr/silicosi/asialtr.htm>, accessed 20/11/2002.



Does this section accurately capture the objectives of government intervention, including the NOHSC NPAPs set out in Chapter 1?

The following chapter assesses the available options, and describes the impacts in terms of benefits and costs.

Chapter Four

Options

This chapter outlines a series of options to address effects of exposure to crystalline silica, identifies indicative benefits and costs associated with those options and challenges stakeholders to provide additional information which is vital for finalising the regulation impact statement. The range of uncertainty and lack of data on some of the benefits and costs make it difficult to reach final judgement on the best option; the potential confidence interval is too wide. Informed comment is a key input into breaking this impasse.

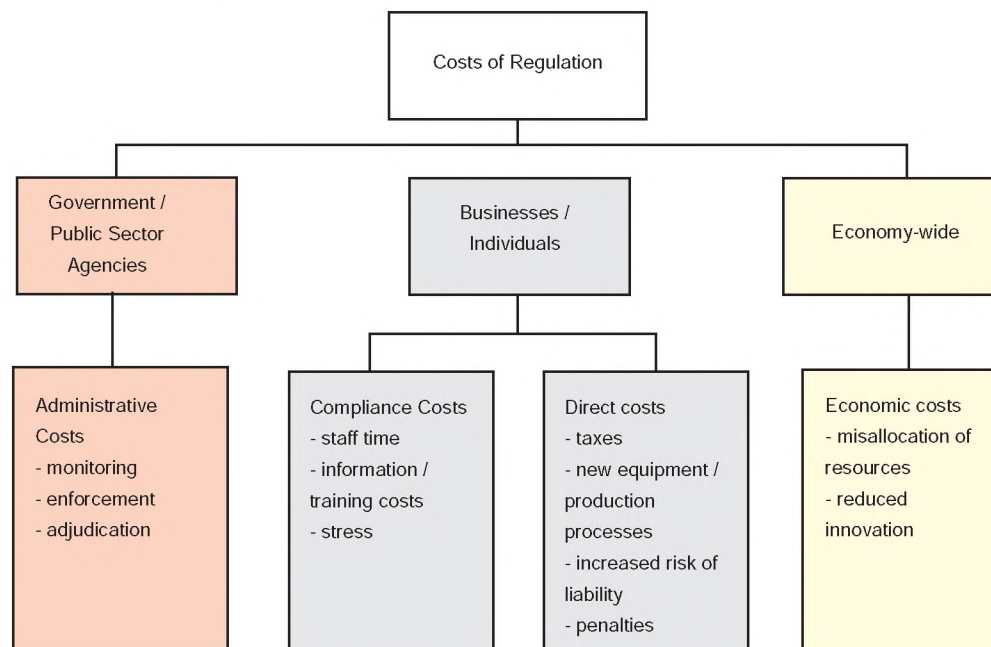
This chapter sets out a range of options and considers the actual or potential costs and benefits associated with these options. To some degree the nature (but not necessarily the quantum) of the benefits are relatively easy to understand; improved health outcomes. Specific dimensions of the benefits 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 multi-faceted and are described in general terms in Figure 4.1.

Figure 4.1

FORMS OF COSTS



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

4.1 Option One — The *Status Quo*

4.1.1 Description of Option

This option entails the maintenance of existing regulatory requirements in the States and Territories and current exposure standards.

In Australia, the States and Territories have responsibility for making laws about workplace health and safety and for enforcing those laws. Each state and territory has a principal OHS Act that sets out requirements for ensuring that workplaces are safe and healthy. These requirements spell out the duties of different groups of people who play a role in workplace health and safety (ie, the duty of care).

Some workplace hazards have the potential to cause so much injury or disease that specific regulations or codes of practice are warranted. These regulations and codes, adopted under States' and Territories' principal OHS Acts, spell out the duties of particular groups of people in controlling the risks associated with specific hazards. Regulations are legally enforceable. Codes of Practice provide advice on how to meet regulatory requirements. As such, codes are not legally enforceable, but they can be used in courts as evidence that legal requirements have or have not been met.

NOHSC provides a forum for the Commonwealth, state and territory governments, employer organisations and trade unions to develop national approaches to OHS matters. In the area of OHS legislation, NOHSC has the power to declare National OHS Standards and Codes of Practice. These are developed as the basis for nationally consistent OHS Regulations and Codes of Practice but they are not legally enforceable unless state and territory governments adopt them as regulations or codes of practice under their principal OHS Acts.

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

- 0.2 mg/m³ for quartz;
- 0.1 mg/m³ for cristobalite; and
- 0.1 mg/m³ for tridymite.

4.1.2 Benefits

The expected benefits of existing exposure standards are a reduction in the silica related disease (including fatalities) 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 the jurisdictions who have addressed OHS issues associated with airborne dust (such as crystalline silica) in most detail — Western Australia (WA) and New South Wales (NSW).

In WA the Department of Minerals and Energy Western Australia (DOMEWA) and mining companies have conducted long term air sampling, which has subsequently been used to estimate the levels of respirable silica in WA mines from the 1920s through to the 1990s (although with a number of significant breaks). The results are shown in Table 4.1.

Table 4.1

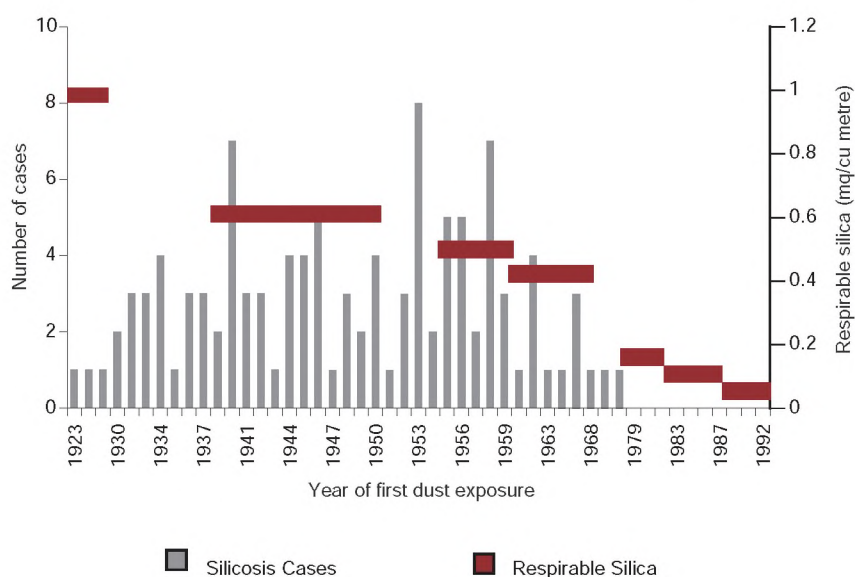
AVERAGE LEVELS OF RESPIRABLE SILICA IN WA MINES

Decade	Silica Level (mg/m ³)
1920s	1.0
1950s	0.5
1960s	0.4
1980s	0.2
1990s	0.1

Source: http://www.safetyline.wa.gov.au/institute/level2/course21/lecture67/l67_03.asp, accessed 1/11/2002.

As shown in Figure 4.2, since the 1950s there has been a distinct correlation between the degree of silica exposure and the falling onset of silicosis cases.

Figure 4.2

SILICOSIS CASES 1923–1994 BY YEAR OF FIRST EXPOSURE

Source: http://www.safetyline.wa.gov.au/institute/level2/course21/lecture67/l67_03.asp, accessed 1/11/2002.

While the benefit of reduced silicosis is that people's health is maintained, there is a consequent benefit for employers as the ability of employees to work is not impaired. This is an issue, because of the 110 cases of silicosis identified during the period 1923-1994, 38.2 percent were assessed to be unfit for work, 25.5 percent were fit for light work, 30 percent were fit for moderate work and 6.4 percent were fit for heavy work.²⁴ Limitations on the ability to work increases insurance premiums and costs associated with covering the employees absence or work limitations.

However, the results shown in Figure 4.2 suggest that the benefits associated with an exposure standard may be fully realised at the standard's current level. This is because, of the 110 cases only three cases commenced after 1968 and

²⁴ All cases exceeding 70 percent impairment were unfit for work.

none after 1974. The implication is that the problem of crystalline silicosis exposure has largely been addressed (and possibly even that industry practices are more stringent than the standard).



Are the positive health outcomes from the WA mining industry consistent across jurisdictions and industries?

Further insight can be gained from the NSW Dust Diseases Board. The Board provides screening services to all persons whose employment as workers exposes them to the inhalation of dust, which may cause a dust disease, with certain defined exceptions.²⁵ Table 4.2 shows the total number of identified dust-related deaths in NSW since February 1968.

Table 4.2

NSW DUST-RELATED DEATHS BY CAUSATION SINCE FEBRUARY 1968

Disease	Death Due to Dust	Death Not Due to Dust	Total	Average Age of Death Due to Dust
Asbestosis	212	234	446	69.44
Silicosis	360	937	1,297	69.74
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	16	78	94	75.84
Silico-Tuberculosis	8	12	20	62.80
Asbestosis/ARPD	10	20	30	73.82
Emery Pneumoconiosis	0	1	1	NA
Talcosis	1	2	3	65.74
Silico-asbestosis	8	4	12	64.22
Mesothelioma	1,363	8	1,371	66.78
Carcinoma of the Lung*	241	5	246	67.11
Silica Induced Carcinoma	11	0	11	67.11
TOTAL	2,241	1,327	3,568	67.65

Source: <http://www.ddb.nsw.gov.au/>, accessed 6/11/2002

* including Asbestos & Hexavalent salt induced.

The Table 4.2 summary shows that:

- around 28 per cent of diseases associated with exposure to crystalline silica caused death; and
- where silicosis had caused death the average age of the person was less than the average age of the population,²⁶ but not overly significantly. Indeed, comparisons with control employees from like sectors would probably suggest no difference in life expectancy.

²⁵ These include: workers in or about a mine to which the *Coal Mines Regulation Act 1912*; 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

²⁶ See Australian Government Actuary (1999) and World Health Organization (2002) as cited by Australian Institute of Health and Welfare at http://www.aihw.gov.au/mortality/data/life_expectancy.html.



Is there evidence about the benefits of current arrangements from other Australian jurisdictions? If yes, what?

Overall, there appears to be a correlation between introducing successively lower permissible exposure standards and the reduction in silicosis incidence, though this may also reflect changing levels of knowledge, availability of more capable engineering solutions, and changing attitudes toward worker OHS issues. The decline (to zero in the case of the WA mining industry) of new silicosis cases suggests that the current standard is achieving the objective of reduced new health costs.

4.1.3 Costs

In considering the costs of the *status quo* it is important to stress that we are interested in the *incremental* costs (ie, those costs additional to other OHS-related costs).

Enforcement Costs

Inspectors in each of the state and territory authorities have a range of duties covering the gamut of regulatory responsibilities, including policing of crystalline silica exposure standards. It is understood that decisions need to be made about the priority areas for enforcement, and that relatively little time is available to spend on crystalline silica issues specifically. Rather, the broad approach is to investigate after receiving complaints by individuals in the workplace. This suggests that silica specific enforcement costs are slight.



What government resources are spent on enforcing crystalline silica exposure standards? Are there significant variations between jurisdictions?

Compliance Costs

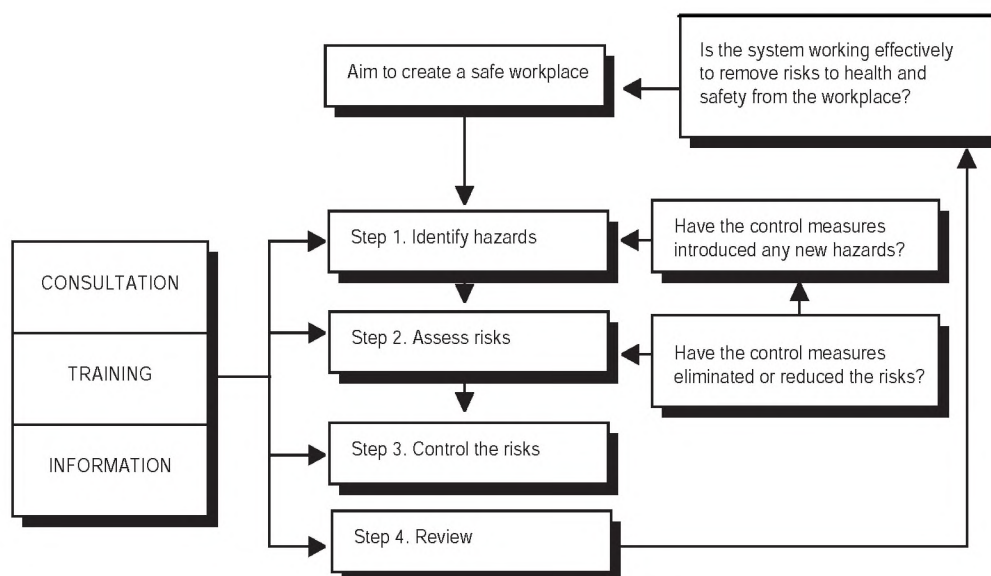
It is difficult to separate out the precise level of expenditure solely attributable to compliance with crystalline silica exposure standards.

This difficulty arises because there is a range of reasons why companies are likely to incur significant costs in the absence of specific crystalline exposure standards. These include:

- the need to facilitate efficient workplace surrounds;
- an interest in worker comfort, for both personal and worker efficiency reasons;
- general liability laws and a desire to avoid claims of negligence; and
- generic obligations in relation to OHS.

The process which underpins OHS management is shown in Figure 4.3.

Figure 4.3

A SYSTEMIC APPROACH TO OCCUPATIONAL HEALTH AND SAFETY

Source: <http://www.nohsc.gov.au/OHSInformation/NOHSCPpublications/fulltext/docs/h5/03297-03.htm>

Under all NOHSC standards and codes employers have a duty to:

- implement a systematic process of hazard identification, risk assessment, risk control and review in the workplace;
- make sure employees receive appropriate training, instruction and supervision, including induction and ongoing training;
- obtain and provide appropriate information;
- consult with employees likely to be exposed to risks, and with their health and safety representatives; and
- keep appropriate records.

Compliance costs associated with the specific exposure standard may include:

- abandonment — some firms may have made the decision to cease supplying goods or services that involved silica exposure levels above that allowed;
- substitution — in some cases, where feasible, less toxic substances may have been substituted for silica sand. For example, olivine and zircon sand could be used in moulds and cores in foundries. Metallic shot, slag products or grit could be used for abrasive blasting (in Victoria it is now illegal to use sand for abrasive blasting). Alumina could be substituted for flint in china placing in pottery;
- engineering controls — overexposure to silica dust can be the result of poorly designed and/or poorly maintained ventilation systems.²⁷ Engineering controls seek to address such concerns, and may take a number of forms:
 - tools causing dust (eg, grinders, saws, etc) may have been fitted with dust extraction devices;
 - dusty processes could have been fully enclosed and an exhaust hood attached;

²⁷ For example see the Workers Health Centre (Australia) 'Fact Sheet' available at <http://www.workershealth.com.au/facts060.html>

- a local ventilation system can be installed with hoses as close as possible to the head of cutting tools — using tools fitted with a water attachment to suppress dust (eg, on power saws, jackpicks, scabbling picks, etc). Spraying with water in processes such as grinding or drilling can reduce the amount of dust by as much as 75 percent;
- provision of personal hygiene facilities and practices, such as:
 - adequate handwash facilities;
 - lavatories maintained and provided with soap and towels;
 - showers;
 - clean change areas with provisions for storing clean clothing;
 - separate eating/lunch facilities away from areas of exposure;
 - food, drinks, tobacco products, and unapplied cosmetics are prohibited in work areas; and
 - work cloths are not to be cleaned by blowing or shaking, but should be vacuumed before removal with a High Efficiency Particulate Air filtered vacuum;
- good housekeeping standards — regular vacuuming and wet sweeping of floors, machinery and so on may remove settled dust and is particularly important to stop dust being kicked back into the air;
- air monitoring — employers are responsible for determining if employees are exposed to silica at or above the permissible exposure limits. Personal air monitoring consists of sampling personal respirable dust samples from a worker's breathing zone;
- job rotation — this results in a reduction in the total number of hours of exposure a worker faces during a full eight-hour work-day. There is a cost associated with job rotation as it may reduce the ability for specialisation and means that more training is required given the need to have a more multi-skilled workforce;
- medical surveillance — medical examinations (a complete medical and occupational history; annual chest x-ray; pulmonary function tests; and an annual evaluation for tuberculosis) are recommended to be made available to employees who may be exposed to crystalline silica before job placement and at least every five years. The examination is usually performed under the supervision of a licensed physician during normal working hours at no cost to employees;
- provision of personal protective equipment — protective clothing should be provided by the employer. Dust masks are unsuitable for use with a beard, and in these cases, an air supplied respirator with a hood or a helmet and visor should be used; and
- employee training — this may include:
 - instruction of each employee in the recognition and avoidance of unsafe conditions concerning crystalline silica;
 - information concerning the potential physical and health hazards, and adverse health effects, of crystalline silica;
 - information on personal hygiene and personal protective measures or equipment required;

- details of the employer’s hazard communication and crystalline silica programs including information on labelling, and material safety data sheets; and
- instruction on the employer’s personal protective equipment and respiratory protection programs including selection, inspection, use and maintenance of respirators.

This is a large list of actual and compliance approaches with a range of associated costs.

Firms would have chosen the least cost method of compliance. What is not clear is the degree to which such costs are purely attributable to the current exposure standard, and/or which are attributable to more general obligations under OHS Acts and/or common law.



What specific costs have been borne by industry in complying with the current exposure standard for crystalline silica? How significant are these costs?

Under all NOHSC standards and codes, employees have a duty to:

- comply, as far as they can, with all activities carried out in accordance with the standard; and
- report to their employer anything that might affect the employer’s compliance with the standard.

It is unclear to what extent, if any, individuals have felt that the existing exposure standard has increased costs for individuals.



What specific costs, if any, have been borne by individuals in complying with the current exposure standard for crystalline silica? How significant are these costs?

4.1.4 Summary

While it is difficult to determine whether silicosis has declined because of the exposure standard or because of other factors (eg, changes in technology and OHS procedures), the incremental compliance costs appear slight given the range of more general regulatory imposts on firms. Thus, it appears likely that the current exposure standard involves higher benefits than costs.

4.2 Option Two — Legislative Ban on the Use of Crystalline Silica

4.2.1 Description of Option

This option could, for instance, prohibit any activities resulting in the creation of silica dust, possibly above a threshold value of $x \text{ mg/m}^3$ and the use of any product containing crystalline silica possibly above a threshold value of $y \text{ mg/m}^3$.

Compliance with a prohibition or regulatory ban is more straightforward to enforce than compliance with any exposure standards. In practice, the ban would probably be phased in over an extended period of time to allow transitional adjustment strategies.

Conceptually, this proposal extends developments in Victoria where WorkSafe Victoria placed a ban on the use of silica for abrasive blasting — see Box 4.1.

Box 4.1

WORKSAFE VICTORIA 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. This means materials such as silica, river sand, beach sand and other white sands should not have been used for abrasive blasting from 1 January 2002.

Blasting media that could be substituted include:

- garnet;
- crushed glass;
- 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 results in the issuing of prohibition notices and may be referred for investigation and possible prosecution.

Source: http://www.workcover.vic.gov.au/vwa/home.nsf/pages/so_haz_subs_silica, accessed 20/11/2002

4.2.2 Benefits

The major benefit of this option will be, at least in theory, a reduction to zero in the number of cases of silicosis, lung cancer and other adverse health outcomes. The number of deaths and cost of compensation to workers and their dependants according to type of dust disease in NSW for the period 2000-01, are set out in Table 4.3. The number of deaths has been recorded since 29 February 1968, so it represents a cumulative total rather than the annual impact.

Table 4.3

NUMBER OF REPORTED DUST DISEASE CASES IN NSW — 2000-01 (\$'000)

Disease	Number of Deaths		Workers Compensation			Dependant Compensation		Total (\$'000)
	Average Age (yrs)	Due to dust (no.)	Weekly (\$'000)	Hospital & Medical (\$'000)	Funeral (\$'000)	Weekly (\$'000)	Lump sum (\$'000)	
Silicosis	70	360	1.780	263	17	1.460	665	4.185
Silico-Tuberculosis	63	8	5	0	0	54	0	59
Silico-asbestosis	64	8	32	0	0	11	0	43
Silica Induced Carcinoma	67	11	123	29	0	81	46	279

Source: Dust Disease Board of New South Wales, www.ddb.nsw.gov.au/content/statistics/appendix/appendix5.htm, accessed 11/11/2002.

These savings assume that it is indeed possible to reduce exposure of crystalline silica to zero.

Another saving would be avoided hospital and medical costs. Indicative 'average' hospital costs per separation are given in a report by the Commonwealth Department of Health and Ageing. This report²⁸ shows that the average cost per separation in the public sector is \$2,638.



Is it considered feasible to reduce to zero the health costs associated with processes that produce crystalline silica or use crystalline silica?

4.2.3 Costs

Compliance Costs

The costs associated with option two relate to:

- abandonment — some firms may make the decision to cease supplying goods or services that previously involved the use or creation of silica. For example, in industries such as mining and construction no alternatives to 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 cent²⁹. 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 have been substituted for silica sand.

It is the second of these options 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 (eg 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 the silica sand used in foundries; olivine sand is perhaps the only economical alternative. Zircon or chromite sands are expensive; they are useful in special cases.

Even when firms can substitute for crystalline silica they may incur a range of additional costs such as:

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

²⁸ Commonwealth Department of Health and Ageing (August 2002) *National Hospital Cost Data Collection. Cost Report Round 5, 2000–2001*, Canberra, Table 1, p10.

²⁹ Australian Bureau of Statistics (September 2002) *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 will be zero as new equipment may actually result in reduced ongoing costs; and
- cost increase 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 will eventually disappear. The reason why it is assumed that these cost reductions will occur in a linear fashion over the phase-out period is because:
 - businesses would need to manage stocks over the phase-out period to ensure they are not left with large quantities of banned products; and
 - commercial imperatives would lead businesses to refrain from incurring the total cost of the phase-out period, up front.

While such changes may be easier to make for larger firms (ie, because of better access to capital, more diversified business arrangements, etc), firms with employees potentially exposed to crystalline silica tend to be small. As shown in Table 4.4, fewer than ten percent of all affected businesses generate a turnover of more than one million dollars per year, and companies with a turnover of less than \$100,000 per year, account for more than 60 percent of the total number of businesses in industries who may face possible exposure to silica dust.

Table 4.4

NUMBER OF BUSINESSES PER STATE/TERRITORY BY TURNOVER SIZE

State & Territory	\$0 – \$49,999	\$50,000 – \$99,999	\$100,000 – \$1,000,000	\$1,000,001 – \$19,999,999	\$20 Million and over	Unknown	Total
NSW	12,591	15,223	15,463	2,085	79	8	46,303
VIC	8,548	9,744	10,993	1,534	44	7	31,396
QLD	8,183	8,458	9,269	1,551	41	4	27,855
SA	2,538	2,253	2,123	347	14	2	7,499
WA	4,592	4,908	4,286	705	46	10	14,814
TAS	763	691	732	20	0	0	2,407
NT	468	464	397	46	0	0	1,497
ACT	560	583	568	34	0	0	1,885
Total	38,365	42,466	44,028	8,338	274	31	133,879

Source: ABS; 2001 Census of Population and Housing, custom data.

Notes: Data of Companies not available for separate publication are included in the totals where applicable. The Population for this data set is all single state ABNs, which are registered and active for GST on the ABR as at June 2001, including all single and multi location entities that only operate in the one state or territory. Multi location entities with locations in more than one state or territory are excluded from this data.



What technologies rely on silica and for which is there no silica substitute?

Given a legislative ban on crystalline silica, what proportion of companies would cease operating or would cease activities that currently rely on silica as an input or by-product? What would be the value of such activities?

Administration Costs

OHS inspectorate costs specifically devoted to monitoring exposure to crystalline silica are not currently known, but it is assumed that there will be no change to existing resources devoted to inspecting workplaces as a result of the implementation of a legislative ban on silica.

There will be initial one-off costs for relevant state and territory government authorities associated with the adoption of the national requirements into their legislative frameworks. The costs 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. These costs, which will typically come out of jurisdictions' existing budgets, will be off-set by a reduction in the costs of the administration and enforcement of adherence to the crystalline silica exposure standard. The costs to Government are, therefore, assumed to be zero compared to the *status quo*.



Is it reasonable to assume that administrative costs are likely to remain largely unchanged with a ban on crystalline silica?

In addition, there may be lesser knowledge of the health risks of crystalline silica substitutes, and thus an uncertain ability to manage that risk, based on experience built up over many years in substitute handling.

4.2.4 Summary

Elimination of workplace exposure to crystalline silica may result in less illness and death, and thus may 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 due to exposure to other hazardous 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 exposure to hazardous and dangerous goods and 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.



Is this assumption reasonable?

4.3 Option Three — Increased Education

4.3.1 Description of Option

This option involves implementing a combination of:

- government information and education programmes on the dangers of exposure to silica dust; and
- increased obligations on employers to make their staff aware of the risks of crystalline silica and their legal obligations with respect to crystalline silica.

This option involves a more structured and far-reaching program of education than the current approach. The option would still require the ultimate presence of an exposure standard, but the means of achieving the target would be a particular emphasis. That is, the focus would be on ensuring that the employer provides adequate information and training to workers to ensure they are capable of taking appropriate action in areas that are difficult to monitor to take account of the risks that they face.

The NHMRC and the Commonwealth Department of Health 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.³⁰ The Hazardous Substances Regulations in each jurisdiction (promulgated in various States and Territories between the mid-1990s and 2000) support this statement. State and territory regulations should be carefully read and understood by every employer using silica-containing materials or if there is any potential that exposure to dust could arise in their operations.



What type of training, if any, would employers need to provide instruction on the safe use of crystalline silica in the workplace to employees? If required what would it cost?

The only effective protection against silicosis is to avoid the inhalation of silica dust in the air. Employers 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, to that end the employer must ensure::

- workers are educated on the main control solutions for crystalline silica. These control measures include:
 - use of a silica substitute;
 - use of appropriate engineering controls;
 - improvement of work practices; and
 - use of appropriate personal protective equipment;³¹
- workers need to receive education and training in preventative steps and measures to protect themselves from exposure to crystalline silica. These measures would require the employer to ensure workers:³²
 - are aware of the health effects of respirable crystalline silica;
 - participate in any medical examinations, air monitoring or training programs offered by his/her employer;
 - substitute less hazardous abrasive-blasting materials (e.g. steel grit or shot, aluminum oxide, etc) for those containing crystalline silica;
 - use engineering controls such as blast-cleaning machines, cabinets, dust collectors, wet methods and local exhaust ventilation to minimize exposure to silica dust;
 - always use the dust control systems and keep them well maintained;

³⁰ International Health Consultants, <http://users.bigpond.net.au/InHealth/Silica1.htm>, accessed 14/11/2002.

³¹ http://www.asosh.org/Programmes/SORDSA/Crystalline_silica.htm, accessed 18/11/2002.

- tell his/her employer when the control measures are not working properly;
- are aware that the highest silica dust concentrations may occur inside enclosed spaces during, for example, in concrete sawing, masonry sawing or abrasive blasting;
- use a supplied-air helmet/hood respirator operated in continuous flow mode when doing any abrasive blasting. Full face airline supplied respirators should be operated in pressure-demand or positive pressure mode, and use breathing quality air supply.
- change into disposable or washable work clothes at the worksite or workplace, and shower and change into clean clothes before leaving the worksite or workplace;
- not eat, drink or use tobacco products in dusty areas, and wash hands and face before eating, drinking or smoking outside dusty areas;
- call for an inspector if he/she suspects that dust levels are too high or that silica dust is involved, and ask for the results of any airborne dust monitoring conducted in his/her workplace; and
- talk to his/her employer, health and safety representative, employee representative or union if there is any concern about the dust in the workplace.

While these expectations currently exist, it is difficult to assess whether training is adequate, and hence there is a potential need for option three.



What initial and ongoing information and training is provided to employees who may be exposed to silica? Is this adequate?

4.3.2 Benefits

Education is aimed at changing attitudes. It provides a way of targeting those at particular risk (eg, smokers). Ideally, training provides a means for workers to recognise and avoid instances of particularly high exposure, and take a proactive approach rather than a rote-learned list. Part of this is to avoid instances that are not picked up by monitoring regimes.

Any controls involve discretion around the way that they are implemented. Education addresses this to change discretionary behaviour in a way that should reduce total exposure no matter what the specific standard.

It is difficult to predict what the precise impact of a more formalised and enforced education and training program would be in terms of reducing health impacts.



What mix of public and mandated private education and training would provide the maximum health outcomes?

What should be the nature of the health and education provided?

What health benefits could be obtained from a more vigorous training and education programme?

4.3.3 Costs

Administration

Administration costs borne by governments will depend on the precise nature of government involvement. However, it is likely that the costs will relate to:

- the production and dissemination of education and training materials; and
- the enforcement costs associated with ensuring that firms are meeting their training and education requirements. If incorporated into existing inspection processes it is felt that these costs are not likely to be significant.

Such costs may be reduced if it is possible to effectively leverage off other campaigns run by government departments.

Compliance

Compliance costs borne by the private sector will also depend on the precise nature of the obligations.

A variety of education and training programs are available in software packages and on the Internet. These programs can provide all necessary safety aspects of induction training. The training is done by the trainee without time or intervention of other staff members, and no computer skills are needed. The use of adequate education and training programs provide workers with the knowledge that is essential to working safely and productively.

The estimated time required for an induction-training program by a new employee is about 20 minutes. Programs available on the Internet are usually free and costs for software packages can be as low as \$10 per employee.³³

The US OSHA also provides on-line training on silica and the prevention of silicosis.

Employees can thus be educated and trained on how to protect themselves from the dangers of silica dust without any significant capital lay-out by employers and to no individual cost by employees. Increased protection and practised safety measures will ensure improved health of employees. This will result in a decrease in the cost of 'sick days' and compensation paid to employees who contracted illnesses due to the exposure to a hazardous substance.

Costs incurred by the employer for improved education and training will include:

- the 'cost of time' spent on training — which can be as little as 20 minutes per employee;
- cost of training material — with 'economies of scale' this will result in marginally low costs; and/or
- the cost of Internet usage — if training is done online.

As a rough guide, initial one-off total costs are likely to be in the order of \$370,000 of worker time (70,000 workers x 0.33 hours x \$16 per hour). With other materials etc, the total cost might be in the order of \$500,000. On an ongoing basis, there would need to be refresher courses as well as training for those that are new to the industry as part of ongoing staff turnover. These

³³ International Health Consultants, <http://users.bigpond.net.au/InHealth/Silica1.htm>, accessed 14/11/2002.

ongoing costs are likely to be significantly less than the upfront costs, perhaps \$100,000 to \$200,000 per annum.

These rough cost estimates are considered conservative as they relate to a 'lumpy' conception of education and training and do not include the costs associated with less formal ongoing training and education elements.



What would be the magnitude and nature associated with a more rigorous mandatory education and training programme?

What are the likely impacts on attitudes and workplace health and safety of such a programme? Are there other relevant programmes that deliver insight into potential impacts?

4.3.4 Summary

We are unaware of information that reliably suggests the likely outcome and effectiveness associated with any additional or improved education and training regarding crystalline silica in the workplace.

To ensure any permanent health benefits from the education program, the employer is responsible for facilitating permanent changes in the behavior of employees in any situation where he/she might be exposed to silica dust (or any other hazardous substances). This means the worker 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 behavior and will not ensure any health benefits.

As a result, and although necessary and useful, improved education and training will not necessarily ensure limited exposure to crystalline silica and be an acceptable substitute for exposure standards in the workplace. The use of information and training is a primary requirement of OHS legislation, but is employed in the context of a complete risk management program.³⁴

4.4 Option Four — Increased Enforcement

4.4.1 Description of Option

This option assume that current standards are not being met by industry and that more rigorous enforcement of the existing standard by governments will result in industry adopting measures to reduce worker exposure.

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

- 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

³⁴ NOHSC, *Proposed Amendments to the NOHSC Adopted Exposure Standards for Atmospheric Contaminants in the Occupational Environment: 1003, 1995, Regulatory Impact Statement*. November 2001.

- there has been an ongoing shift in the responsibilities and expectations of OHS inspectors. The numbers of inspectors has been declining as there has been a move towards performance based rather than prescriptive legislative requirements.³⁵

An important component of control strategies involves the technical monitoring of respirable dust exposure.³⁶ This option involves a greater commitment to onsite monitoring to place pressure on employers to ensure that the working environment meets the existing exposure limits.

Airborne concentrations of contaminants in most occupational settings vary markedly with respect to time and space. Air currents within the area, individual work practices, and variation in the emission rate of the contaminant are some of the factors contributing to this variation. In the measurement of personal exposures to crystalline silica for particular jobs or tasks, several considerations are important:

- which employees' personal exposures to sample;
- where sampling devices should be located;
- the number of samples needed to define a representative sample for a worker or job category;
- the sampling interval;
- whether any current control measures are functioning properly;
- the number of workdays during a year to be sampled; and
- the level of mobility associated with each job.

These considerations provide the foundation for decisions on the type of instrumentation to be used and the method of application.

While some Australian OHS legislation specifies sampling and analytical procedures for various mining situations, this is not generally true for all industries. In such instances an Australian Standard establishes the required method for the collection and gravimetric determination of respirable dust in Australia.³⁷ This standard calls upon a sampling device conforming to the British Medical Research Council (BMRC) deposition curve (and taken over a period not less than four hours) must be used to assess the personal exposure of a worker to 'respirable' dust containing crystalline silica.³⁸ This approach is different to that employed in the US — see Box 4.2.

³⁵ The responsibility 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.

³⁶ The current Australian collection method is based on the BMRC method which differs slightly in size selection, and hence the measurement of mass concentration, from the ACGIH criteria used in the US.

³⁷ Australian Standard AS 2985-1987 *Workplace Atmospheres — Method for Sampling and Gravimetric Determination of Respirable Dust*.

³⁸ It is the intention of Standards Australia to rewrite AS 2985 when the International Standards Organisation and the ACGIH reach agreement on the definition of fraction sizes. As in the past, it is then expected that individual Australian States and Territories will adopt the revised Standard for regulatory purposes.

Box 4.2

ALTERNATIVE MEASURES OF AIRBORNE SILICA CONCENTRATION

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 $2\text{mg}/\text{m}^3$ 'portal to portal' may be equivalent to approximately $2.7\text{mg}/\text{m}^3$ 'crib room to crib room'.³⁹

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.

4.4.2 Benefits

The benefit of higher enforcement is likely to be increased compliance. Of course, this will not provide benefits for people working on sites that currently comply with existing exposure standards, but may accrue to workers at sites where exposure levels are above current permissible levels.



Are there certain industries/occupations which are more likely to not comply with existing exposure levels? If yes, which industries/occupations?

The WA experience with crystalline silica (ie, a progressively declining trend, with virtual eradication) suggests that high compliance is a key to achieving increased health outcomes: "The WA experience is that high compliance of 90 percent or more with the current $0.2\text{mg}/\text{m}^3$ respirable crystalline silica standard, rather than lowering the Exposure Standard, will prevent silicosis."⁴⁰

To fully understand the potential health benefits associated with higher compliance (through stronger enforcement) it is necessary to get a stronger grasp of those industry sectors with sub-optimal compliance.



What level of compliance currently exists?

Are there certain industries/occupations that have relatively lower compliance rates?

4.4.3 Costs*Administration Costs*

It is assumed that this option would be managed by a reprioritisation of existing government resources. While this reduces the costs to government it would likely be at the cost of some other OHS issue.

³⁹ 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.

⁴⁰ Wan, K & Lee, E "Silicosis in Western Australia from 1984 to 1993" available at <http://pearsonandpearson-law.com/silicos/silwan2.html> accessed 21 November 2002

Compliance Costs

To the degree that additional actual or threatened enforcement increases compliance businesses may incur additional costs in engineering controls. Particularly small businesses may need some extensive capital lay-out to obtain and implement the necessary equipment, technology and facilities (as discussed in section 4.1.3).

The lack of available data makes it impossible to quantify either the impact of any additional compliance costs incurred or the degree to which businesses already comply with the existing exposure standards.



Would additional actual or threatened enforcement provoke industry to commit additional resources to meeting the exposure standard? If yes, what would be the magnitude of such a commitment?

4.4.4 Summary

While governments may choose to direct more resources to the inspection role in an effort to ensure a safe and healthy workplace, there would be significant barriers to overcome, particularly:

- removing the responsibility from businesses to innovate, plan and develop risk mitigation strategies suitable to their own workplaces;
- the inability to measure the effectiveness of increased enforcement as there is an indirect link to increased health and well-being; and
- the limitation on government resources, and hence the difficulty to identify and inspect all premises where silica is present on a regular basis to ensure continued compliance.⁴¹

4.5 Option Five — Adopting Exposure Standards Recommended by the University of Western Australia Report

4.5.1 Description of Option

This option involves the exposure standards recommended in the independent study prepared for NOHSC by the University of Western Australia (UWA).⁴² The proposed standard is set out in Table 4.5. The key proposed change relates to quartz, as this is the major form of crystalline silica in Australia.

Table 4.5

EXISTING AND PROPOSED CRYSTALLINE SILICA EXPOSURE STANDARDS

Form of Crystalline Silica	Current Exposure Standards	Proposed Exposure Standards
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

⁴¹ NOHSC (November 2001) *Proposed Amendments to the NOHSC Adopted Exposure Standards for Atmospheric Contaminants in the Occupational Environment: 1003, 1995, Regulation Impact Statement.*

⁴² 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

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. Diseases caused by or associated with inhalation of free crystalline silica include silicosis, pulmonary tuberculosis, bronchogenic carcinoma, industrial bronchitis with airflow limitation, and auto-immune diseases, including end-stage renal disease.

The study identified significant dose-response relationships between crystalline silica exposure, silicosis and a deficit in lung functions. Based on available evidence, it is also likely that the risk of auto-immune disease and tuberculosis is increased in workers who develop silicosis. However, it was not possible to determine if silicosis is a necessary precursor for these diseases.

Therefore, the UWA based their recommended exposure standard 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;⁴³
- 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,⁴⁴ where it is stated that an annual excess risk of death of:

- one per one million person-years is considered negligible, with any form of control unjustified;
- one per 100,000 person-years is considered low, such that ‘very few would consider action necessary’;
- one per 10,000 person-years is considered moderate, such that ‘few would commit their own resources to reduce risk’;
- one per 1,000 person-years is considered high; and
- one per 100 person-years is considered unacceptable.

Between the extremes of one in 100 and one in one million deaths per annum lies a tolerable region which may vary with different activities or exposures, depending on societal values and the ease or cost of achieving further risk reduction.

The UWA concluded that risks higher than one 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

⁴³ *ibid.*

⁴⁴ Warner, F (1983) *Risk Assessment: Group Report of the Royal Society* London: Royal Society.

and five per 100,000 person-years, and the peak excess risk to less than ten per 100,000 person-years (ie, 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 0.2mg/m³. (These risks are confined to lung cancer deaths and do not take the other silica related diseases into consideration.) The following assumptions were used for calculating these risks and are based on a 40 year working-life from age 20:

- the 1994 Australian mortality rate of lung cancer for 65 year old males were adjusted to the level anticipated in 2035. Lung cancer mortality has declined steadily since the 1980s and it was assumed that the same proportional rate of decline will continue in the future, giving a value of 80 per 100,000 person-years. While the vastly different rates for smokers and non-smokers could be incorporated into the standard, the Advisory Committee made it clear that such a dual standard would be unworkable;
- although various combinations of published studies were used to determine the dose-response function,⁴⁵ the pooled IARC study was considered to be the most reliable;
- only results from the fixed effects models were used (to enable comparison with single study results);
- adherence to the standard (ie, the proportion exceeding the standard) in WA varied between 30 percent in 1979–80 and three percent in 1991–93; and
- a log-normal distribution of measurements was made to assess exposure levels, with a standard deviation of either 0.75 or 0.85.

4.5.2 Benefits

The benefits associated with the proposed standard are shrouded in scientific debate. This can be seen by looking at three different studies of the issue.

The first study is the UWA report. It is motivated by an overriding desire to reduce risks of adverse health impacts, and does not explicitly consider compliance or other costs of the standard. The proposed standard can therefore be thought of as a risk-averse strategy to protect the health of workers in the event that there are no or little costs associated with the stricter standard.

The UWA results showed that the choice of an acceptable exposure standard varies greatly, depending on the different assumptions. Based on the pooled IARC study and current Australian measurement methods, the UWA considers an exposure standard of approximately 0.13mg/m³ of respirable silica as acceptable. At the level of 0.13 mg/m³ of respirable silica, based on the WA data and a 40 year working life from the age of 20 years, this standard will:

- 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 200mL.

⁴⁵ 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.

It should, however, be noted that the presented risk estimates for lung cancer will be appreciably lower for non-smokers. It should also be noted that the UWA study also strongly recommend that a separate standard for coal dust containing quartz be derived.

The second relevant study relates to compensated goldminers in WA.⁴⁶ Given the current exposure standard operating in the mining industry in WA, the study indicated that:

- the actual incidence of silicosis for levels of exposure under the current standard and exposure conditions is almost certainly less than 4.8 cases per 100,000 person-years (ie, between ‘very few would consider action necessary’ and ‘few would commit their own resources to reduce risk’);
- the observed number of cases of silicosis arising in men exposed only after the current standard was introduced is significantly less than the number expected from the same model used to estimate the above incidence of silicosis. That is, significantly fewer cases of silicosis (ie, none) have occurred at current levels of operation within the mining industry today, than would have been expected based on risk models fitted to the earlier cohort of goldminers. Exposure-response relationships from other studies would have predicted even more cases and appear to be even less appropriate for the current situation; and
- combining results from both studies, the cohort study of gold-miners indicated that the risk of lung cancer after a diagnosis of silicosis was 1.6 and that the relative risk for lung cancer after this adjustment was 1.0. The observed risk of silicosis in the study of silicosis compensation was zero with an upper 95 percent confidence limit of 4.8 per 100,000 person-years, so that an upper 95 percent confidence limit for lung cancer could be set at: $4.8 \times (1.6-1)/1.6 = 1.8$ per 100,000 person-years. That is, current standards should ensure a maximum excess risk of lung cancer well within the ‘acceptable’ range.

The third relevant study was undertaken under the auspices of NOHSC in September 1993.⁴⁷ It analysed, without providing a recommendation, the impacts of standards for 0.2 mg/m³ and 0.1 mg/m³. These are set out in Table 4.6 and are based on a calculation of ‘excess’ cases over a forty year exposure period with a stationary population.

Table 4.6

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

⁴⁶ Wan, K & Lee, E “Silicosis in Western Australia from 1984 to 1993” Paper presented at the Australian national Scientific Forum on Crystalline Silica, 9 November 1993 in Sydney and the 14th Asian Conference on Occupational Health, 16 October 1994 in Beijing, China. Available from www.osha-slc.gov/SLTC/silica/crystalline/kewan/silwan2.html accessed 21 November 2002.

⁴⁷ Worksafe Australia (September 1993) Draft Technical Report on Crystalline Silica Completed in July 1992 Australian Government Publishing Service, Canberra.

According to this analysis, the benefits of moving to the proposed UWA standard is six fewer cases of silicosis per annum, and three fewer cases of lung cancer per annum. A lower bound for the benefit calculation would be if these additional cases had only minor symptoms, and an upper bound would be if all additional cases resulted in death.

However, others have questioned such conclusions and suggest that there are negligible health benefits associated with tightening silica exposure standards. Indeed, one review of the appropriateness of a stricter exposure standard in the WA mining industry argued that stricter standards would have a negative health impact once compliance incentives were considered:

“the stricter standard may have a detrimental effect. At the present standard (0.2mg/m³), it is possible to direct surveillance at a small group of companies that have difficulty in meeting that standard. With the proposed standard (0.1mg/m³), direct surveillance will have to be spread over a wider spectrum since more companies will then not comply. This, in effect, means that, for the same resources, one is getting a shallower degree of surveillance which inevitably will lead to lowered compliance.”⁴⁸

Appendix One shows a number of exposure standards from around the world. With the exception of the UK, most of the standards are in the order of 0.1mg/m³ with the US at 0.05 mg/m³. This in itself does not justify lower standards, but gives some reinforcement that countries have judged the risks sufficient to impose such lower standards. Some care is required in interpreting international exposure standards, as they do not always translate directly to a comparison with Australian Standards because of differences in: measurement techniques including different definitions of particles; enforcement effort and approaches; and different sampling approaches.



What benefits, if any, would be generated by tightening silica exposure standards?

Does the proposed standard maximise health benefits?

4.5.3 Costs

Compliance Costs

Firms that are currently operating in above the proposed exposure standard will be forced to:

- abandon their silica-related operations;
- substitute other materials for silica;
- adopt new technical or process measures (eg, new machinery, different processes, etc) to suppress airborne crystalline silica; or
- provide protection for workers.

As discussed with respect to other options, there is significant uncertainty as to the number of firms potentially affected by the proposed standard and the likely magnitude of costs.

⁴⁸ K C Wan & E Lee, “Silicosis in Western Australia from 1984 to 1993” available at <http://pearsonandpearson-law.com/silicos/silwan2.html>.



How many firms will be required to modify their operations as a result of the proposed exposure standard? What costs would be associated with such changes?

Administration Costs

There will be initial one-off costs for relevant state and territory government authorities associated with the adoption of the new requirements into their legislative frameworks. Costs will be incurred in connection with:

- the mechanics of creating the new standard;
- informing government staff of the change and its consequences; and
- informing industry (including unions and peak industry bodies) of the change and its consequences.

It is assumed that ongoing enforcement will typically come out of jurisdictions' existing budgets and is unlikely to change from the *status quo*.

4.5.4 Summary

There is strong evidence that there have been benefits in terms of reduced health impact of the historical lowering of exposure standards. There is less certainty and agreement around the additional impact of further reducing the exposure standard.

Based on a number of technical analyses, reducing the exposure standard could generate health benefits. For the lower standard to have an impact, the following conditions are required:

- that companies not meeting the standards change their behaviour;
- proposed exposure standards are adequately enforced; and
- technical analysis and theoretical dose–response relationships hold in practice.



Is the standard proposed by the University of Western Australia the best alternative standard to that currently in place? If not, at what level should exposure levels be set at and why?

4.6 Evaluation of Options

Traditional cost-benefit analysis (which underpins the RIS process) evaluates the merits of public action by translating positive and negative effects to a common measure, normally dollars. However, a difficulty with an analysis such as this is that it is necessary to consider a wide range of costs and benefits, the majority of which are difficult to quantify. The potential for this to be a concern was highlighted in the Senate Select Committee report on the socio-economic consequences of National Competition Policy (NCP):

“The Committee continues to be concerned about the application of ‘public interest’ given the confusion that exists over what the term means or allows under NCP. The confusion, when combined with the administrative ease of simply seeking to measure outcomes in terms of price changes, encourages the application of a narrow, restrictive, definition. *The Committee considers that it is important to devise a method of assessment of the policy which attributes a numerical weighting to environmental and social factors to avoid the over-emphasis on dollars merely because they are easy to measure.*”

Senate Select Committee of the 39th Parliament of Australia on the Socio-Economic Consequences of the National Competition Policy (2000) *Riding the Waves of Change*, Canberra, p.35. Emphasis added.

As a way of comparing the relative impact of various options a ‘balanced scorecard’ approach has been adopted. The Department of Finance and Administration’s description of the ‘balanced scorecard’ demonstrates the scorecard’s applicability (although in terms of an organisational review) to a review that incorporates significant non-quantitative elements:

“The balanced scorecard is an approach to performance management that translates an organisation’s strategic objectives into a useful set of performance measurements. In addition to traditional financial indicators, it incorporates elements of organisational or non-financial performance such as customer satisfaction, internal business processes, and innovation and learning. This is particularly useful in a public sector environment where ‘bottom line’ drivers are not pre-eminent measures of success.”

Department of Finance and Administration, *Specifying Outcomes and Outputs*, Appendix E: Key Strategic Planning Methodologies, available at www.dofa.gov.au.

In order to make an aggregate assessment of the wider public costs and benefits, which includes economic, social and environmental costs and benefits, it is useful to adopt a methodology that uses a common scale of measurement.

Under this ‘balanced scorecard’ approach:

- consistent criteria are identified — the costs are described in a manner consistent with that set out in Figure 4.1;
- each criteria is given a score from +5 to –5 depending on whether the likely effect is considered ‘good’ or ‘bad’ and the likely nature of the impacts. For example, a score of +5 would be associated with a significant benefit, +3 with a moderate benefit and +1 with a marginal benefit. Negative scores indicate the presence of costs. This immediately raises the issue of what is meant by a ‘good’ or ‘bad’ effect. There is really no way of objectively answering this question — it would vary from criteria to criteria, and inevitably is a matter of judgment. However, the advantage of this approach is that such judgments are transparent; and
- the criteria are scored to reflect their relative importance. In this case a significant emphasis is given to the costs in gaining agreement and achieving implementation of the alternative approaches. This reflects the view that feasibility is a threshold issue.

Applying this framework, Table 4.7 sets out the unweighted balanced scorecard for the options under consideration, with the *status quo* not included as it is given a score of zero against each criterion.

Table 4.7

PRELIMINARY UNWEIGHTED BALANCED SCORECARD

	Option Two Ban Silica	Option Three Further Education	Option Four Enforcement	Option Five UWA Recommendations
Costs				
Administrative	0	-1	0	0
Compliance	-3	-2	-1	-1
Direct	-3	0	-1	-1
Economic	-4	0	0	0
Benefits				
Health	+3	+1	+1	+2
TOTAL	-7	-2	-1	0
RANK	4 th	3 rd	2 nd	1 st

A problem with Table 4.7 is that costs are given disproportionate consideration (ie, four cost categories compared to one benefit category). To remedy this, the results in Table 4.7 are weighted in the following way:

- benefits are given a 50 percent weighting; and
- each cost is given a weighting of 12.5 percent.

The approach adopted assumes that the benefits and costs are measured in equivalent units — ideally this would be dollars if sufficient data were available. Relative differences between the different cost categories are reflected in the scores given to each category, which are shown in Table 4.7. The weighted results are shown in Table 4.8.

Table 4.8

PRELIMINARY WEIGHTED BALANCED SCORECARD

	Option Two Ban Silica	Option Three Further Education	Option Four Enforcement	Option Five UWA Recommendations
Costs				
Administrative	0	-0.125	0	0
Compliance	-0.375	-0.25	-0.125	-0.125
Direct	-0.375	0	-0.125	-0.125
Economic	-0.5	0	0	0
Benefits				
Health	+1.5	+0.125	+0.125	+0.25
TOTAL	0.25	-0.25	-0.125	0
RANK	4 th	3 rd	2 nd	1 st

The weightings applied to the results from Table 4.7 did not alter the relative ranking of the options, suggesting that the results are relatively robust.

Preliminary Assessment of the Impact of Proposed Amendments

The University of Western Australia report indicated that there was a ‘net health’ benefit arising from the proposed exposure standards (Option 5). Using a weighted ‘balanced scorecard approach’ in the PRIS, there does not currently appear to be a clear ‘net benefit’ in moving from the current exposure standards for crystalline silica to the standards proposed by the University of Western Australia, taking into consideration factors other than health. It is expected that the ‘net benefit’ of this Option will be clarified when the public comment is reviewed. The assessment of ‘net benefit’ will be re-evaluated in the RIS, based on public comment.

The preliminary conclusion arising from the results shown in Table 4.8 are based upon initial analysis and will benefit significantly from stakeholder input. As a result, the scores in Table 4.7, and hence the results in Table 4.8, will be revised for the final RIS.



Does the preliminary balanced scorecard capture all the relevant costs and benefits?

Are the scores assigned to the criteria in the balanced scorecard appropriate? What scores are considered appropriate?

Are the weightings assigned to the criteria in the balanced scorecard appropriate? What weightings are considered appropriate?

Is the preliminary conclusion justifiable on the evidence available? Do you support it?

Chapter Five

Consultation and Implementation

The preliminary conclusions set out in this Preliminary Regulation Impact Statement will be significantly improved through broad public consultation.

The preparation of this PRIS has been based upon desk research and some initial discussions with a limited range of stakeholders (eg, employer, state OHS authorities, NOHSC officials and unions). The public comment period will be used to extend this consultation to reach a larger sample of stakeholder participants.

Following the completion of the public comment period, a final RIS will be developed, in consultation with the ORR, to incorporate as much additional qualitative and quantitative data on the costs and benefits of the proposed actions.

Appendix A

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Appendix B

Overseas Crystalline Silica 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 have in turn, influenced the results of comparisons made between exposure standards. Any consideration of overseas exposure standards should therefore also include an account of the collection and analytical methods prescribed. The current overseas occupational standards for crystalline silica quartz are listed in Table B.1.

Table B.1

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
Argentina	0.1	0.05	0.05	1991
Australia	0.2	0.1	0.1	1983
Austria	0.15	0.15	0.15	1992
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
Finland	0.2	0.1	0.1	1993
France	0.1	0.05	0.05	1996
Germany	0.15	0.15	0.15	1996
Italy	0.1	0.05	0.05	1991
Netherlands	0.075	0.075	0.075	1996
Norway	0.1	0.05	0.05	1994
Portugal	0.1	0.05	0.05	1988
South Africa	0.1	—	—	1996
Sweden	0.1	0.05	0.05	1993
Switzerland	0.15	0.15	0.15	—
UK	0.3	0.3	0.3	1999
USA (NIOSH)	0.05	0.05	0.05	1974

Source: reported in 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.

The defined respirable fraction of collected dust used in the majority of jurisdictions including Australia is detailed in the *First International Conference on Pneumoconiosis* (Johannesburg, 1958). A different definition has been used, and continues to be used, in the US. There are much overdue moves at an international level to standardise the dust collection fractions and adopt universal definitions for the inhalable and respirable fractions of airborne dust. Definitions endorsed by the International Standards Organisation are to be adopted by the ACGIH in 2001, and Australia is expected to follow.

