

Decision Regulation Impact Statement

Managing risks associated with lead in the workplace: blood lead removal levels and workplace exposure standard

30 August 2016

Safe Work Australia is an Australian Government statutory agency established in 2009. Safe Work Australia consists of representatives of the Commonwealth, state and territory governments, the Australian Council of Trade Unions, the Australian Chamber of Commerce and Industry and the Australian Industry Group.

Safe Work Australia works with the Commonwealth, state and territory governments to improve work health and safety and workers' compensation arrangements. Safe Work Australia is a national policy body, not a regulator of work health and safety. The Commonwealth, states and territories have responsibility for regulating and enforcing work health and safety laws in their jurisdiction.



Creative Commons

ISBN 978-1-76051-001-5 (PDF)
978-1-76051-002-2 (DOCX)

Except for the logo of Safe Work Australia, this copyright work is licensed under a Creative Commons Attribution-Noncommercial 3.0 Australia licence. To view a copy of this licence, visit <http://creativecommons.org/licenses/by-nc/3.0/au/>.

In essence, you are free to copy, communicate and adapt the work for non-commercial purposes, as long as you attribute the work to Safe Work Australia and abide by the other licence terms.

Contact information

Safe Work Australia

Email: info@swa.gov.au

Website: www.swa.gov.au

Contents

Executive Summary	5
1. Introduction	7
1.1. About Safe Work Australia	7
1.2. Background	7
1.3. Purpose of this document	8
1.4. Overview of the document	8
2. Background	10
2.1. What is lead and how is it used?.....	10
2.2. The adverse health effects of lead	10
2.3. Lead exposure in the workplace	10
2.4. How is workplace lead exposure measured?	11
2.5. Work Health and Safety legislative requirements	11
2.6. Biological monitoring of blood lead levels	12
2.7. Air monitoring in the workplace: workplace exposure standard for dusts and fumes of inorganic lead	13
2.8. Mandatory notifications	13
2.9. Jurisdictional differences.....	13
2.10. International standards	13
3. Statement of the problem	16
3.1. Toxicological and epidemiological evidence.....	16
3.2. Evidence of adverse health effects from exposure to lead at the workplace	18
4. Objectives of government action	20
5. Consultation	21
5.1. Objective of Consultation	21
5.2. Consultation methods	21
5.3. Submissions and targeted consultation.....	21
6. Options and analysis	23
6.1. Options considered.....	23
6.2. Analysis of options.....	24
6.3. Summary of public submissions.....	24
6.4. Other key issues and impacts raised	30
7. Cost Benefit Analysis (CBA).....	33
7.1. Approach to measuring the impacts of the options.....	33
7.2. Key assumptions used in the analysis	35
7.3. Impact of the proposed options for blood lead levels	39
7.4. Benefits of reducing exposure to lead	43
7.5. Impacts of Option 2 (evidence-based approach).....	45
7.6. Impacts of Option 3 (gender neutral approach).....	48
7.7. Impacts of options for workplace exposure standard (WES) for dusts and fumes of inorganic lead	49
8. Summary of preferred options	52
8.1. Summary of outcomes	52

8.2. Preferred Option – blood lead levels	54
8.3. Preferred Option – workplace exposure standard	55
8.4. Preferred Option – transition period	55
9. Implementation and review	56
9.1. Implementation	56
9.2. Transition period	57
9.3. Review	57
References	58
Appendix A: Glossary	60
Appendix B: Meaning of a lead process	62
Appendix C: Questions asked of stakeholders in the Consultation RIS	63
Appendix D: Common assumptions used in CBA	65
Appendix E: Regulatory Burden Measurement Framework Costings	66

Executive Summary

Lead has a wide range of biological effects, including on the developing foetus and young children. These effects are directly related to the concentration of lead in the affected organ systems.

The regulatory thresholds for workplace lead exposure are higher in Australia than in many other countries. Evidence collected by Safe Work Australia (SWA 2014b) indicates the current blood lead removal levels and workplace exposure standard for dusts and fumes of inorganic lead are not adequate to protect the health and safety of lead process workers.

This Decision RIS aims to assist Ministers responsible for Work Health and Safety in deciding the best way to reduce the potential for adverse health outcomes caused by exposure to lead in the workplace.

In December 2015, Safe Work Australia published a Consultation Regulation Impact Statement (RIS), which proposed several options for decreasing the regulatory thresholds for lead in relation to:

- the threshold for blood lead removal levels and return to lead risk work blood lead levels for males, females not of reproductive capacity, females of reproductive capacity including those who are pregnant or breastfeeding (measured as micrograms of lead per 100 mL of blood; $\mu\text{g}/\text{dL}$), and
- the workplace exposure standard for airborne lead contaminants (dusts and fumes; measured as micrograms of lead per cubic metre of air; mg/m^3).

Options for blood lead removal levels

The Consultation RIS proposed the following options for blood lead removal levels for lead risk workers:

- **Option 1:** Status quo (no changes to mandated blood lead removal levels)
- **Option 2:** Reducing mandated blood lead removal levels and related requirements to reflect epidemiological and toxicological evidence:
 - a 20 $\mu\text{g}/\text{dL}$ (target level) and 30 $\mu\text{g}/\text{dL}$ (removal level) for females not of reproductive capacity and males, and
 - 10 $\mu\text{g}/\text{dL}$ removal level for females of reproductive capacity¹.
- **Option 3:** Gender neutral blood lead removal level to protect the most vulnerable sub-population:
 - a 10 $\mu\text{g}/\text{dL}$ removal level for all workers.

Options for workplace exposure standard

The Consultation RIS proposed the following options for the Australian Workplace Exposure Standard (WES) for dusts and fumes of inorganic lead:

- **Option 1:** Status quo (retain a workplace exposure standard of 0.15 mg/m^3)
- **Option 2:** Reduce the workplace exposure standard to 0.05 mg/m^3
- **Option 3:** Reduce the workplace exposure standard to 0.01 mg/m^3
- **Option 4:** Non-regulatory approach (non-mandatory) work airborne level of 0.15 mg/m^3 , 0.05 mg/m^3 or 0.01 mg/m^3 dependant on the preferred blood lead removal level option.

¹ This will include females who are pregnant and/or breastfeeding.

Regulatory impact analysis and preferred options

Safe Work Australia received 30 responses from industry and interest groups across a wide range of lead process workplaces. Targeted follow-up consultations were also conducted to clarify responses and to fill any information gaps. Data was collected from jurisdictional health departments to assist with quantifying the cost of compliance.

This Decision RIS analyses the options proposed in the Consultation RIS based on both quantitative cost benefit analysis and qualitative analysis of information provided during the consultation process. In accordance with the COAG Best Practice Guidelines, the Decision RIS recommends the options which provide the greatest net benefit to business and the community.

Blood lead removal levels

Option 2: Reduction in mandated blood lead levels

This option was supported by a majority of submissions that indicated a preference. Of the public submissions one did not support this option due to 'severe' financial impacts and one did not believe the option was protective enough.

Submissions from regulators and targeted interviews indicated that approximately 70 per cent of businesses are already meeting the Option 2 proposed thresholds. The key concern around the adoption of this proposal revolved around the process of changing internal target values and the time needed for workers once removed to have blood lead level results below the target levels.

The cost benefit analysis showed:

- quantifiable health benefits of \$5 million per annum which can be reached within 3 years of implementation
- average costs over 10 years of \$2.7 million per annum
- an average benefit over 10 years of \$4.8 million per annum
- an exceedance of benefit over costs over 10 years by a ratio of 1.57 to one.

Workplace Exposure Standard

Option 2: Reduce the workplace exposure standard to 0.05 mg/m³

A majority of submissions that indicated a preference supported reducing the WES for lead to 0.05 mg/m³, regardless of the cost involved with upgrading control measures or changing the frequency of air sampling procedures. One submission noted difficulty in being able to comply with this standard.

The costs for air monitoring conducted in lead process workplaces were difficult to quantify. However, submissions indicated that air monitoring is most often used as part of a control strategy for workplace lead and therefore many of the costs for compliance with the WES were considered to be included in controlling blood lead levels.

The CBA demonstrated that even if additional air monitoring is required to comply with Option 2 (i.e. an increase in frequency), the benefits still outweigh the costs at a ratio of 1.46 to one.

Therefore, Option 2 is considered the preferred option to enable businesses to integrate air monitoring into their workplace lead control strategy and comply with the proposed regulatory requirements.

Implementation and review

Should WHS Ministers agree to the preferred options in this Decision RIS, the model WHS Regulations will be amended to reflect the preferred options; specifically regulations 394, 407, 415 and 417.

The transition period for compliance with the regulatory requirements outlined above is recommended to be two years from adoption.

Review of the adopted change to the workplace lead requirements will be conducted as part of the scheduled review of the model WHS Regulations.

1. Introduction

1.1. About Safe Work Australia

Safe Work Australia is an independent Australian Government statutory agency which is jointly funded by the Commonwealth, state and territory governments through an Intergovernmental Agreement.

Safe Work Australia was established by the *Safe Work Australia Act 2008* (Cth) with primary responsibility to lead the development of policy to improve WHS and workers' compensation arrangements across Australia.

Safe Work Australia does not regulate WHS legislation. The Commonwealth, states and territories retain responsibility for regulating and enforcing WHS laws in their jurisdiction.

Safe Work Australia is governed by a tripartite body comprising 15 Members, including:

- an independent Chair
- nine Members representing the Commonwealth and each state and territory
- two Members representing the interests of workers
- two Members representing the interests of employers, and
- the Chief Executive Officer (CEO) of Safe Work Australia, who is responsible for managing Safe Work Australia's administration and assisting it in the performance of its statutory functions.

Safe Work Australia's role includes:

- monitoring and evaluating the model Work Health and Safety laws to improve safety outcomes, address issues impeding the effective and efficient operation of the laws and remove unnecessary over-regulation, and
- facilitating the development of accessible, effective and practical material to aid understanding and compliance; minimise regulatory cost; and support improved work health and safety outcomes, particularly for small business and individuals.

1.2. Background

In 2009 Safe Work Australia established a tripartite Lead Working Group in response to evidence published by the National Health and Medical Research Centre (NHMRC) and the Australian Institute of Occupational Hygienists (AIOH) on the health effects of lead exposure and associated blood lead levels.

In consultation with this group, Safe Work Australia commenced a program of work to review both the blood lead removal levels and workplace exposure standard, taking into account current toxicological information, overseas trends and revised classification information for lead.

The review consulted a variety of stakeholders including:

- jurisdictional WHS regulators,
- the Australian Chamber of Commerce and Industry (ACCI),
- the Australian Industry Group (Ai Group),
- the Australian Council of Trade Unions (ACTU),
- the National Health and Medical Research Council (NHMRC),
- the Australian Institute of Occupational Hygienists (AIOH),
- the Australasian College of Toxicology and Risk Assessment (ACTRA),
- representatives from major business involved with the production and export of lead,
- the National Industrial Chemicals Notification and Assessment Scheme (NICNAS), and
- the Plastics and Chemicals Industries Association (PACIA).

This work was further supported in 2011 when Safe Work Australia released the model Work Health and Safety Regulations following public consultation. The model Work Health and Safety Regulations Decision RIS noted:

“There were a number of submissions including from employer groups and unions for the blood lead levels proposed within the draft model WHS Regulations to be reviewed as soon as possible to reflect the latest toxicological information and current practicability standards.”

In 2014 Safe Work Australia commissioned an [independent, evidence-based report](#). It included an extensive literature review and referenced over 350 individual reports and documents in support of its findings. The report was peer reviewed by the United States’ National Institute for Occupational Safety and Health (NIOSH) and comment was sought through the Safe Work Australia website. The report recommended reducing both the blood lead removal level and the workplace exposure standard to protect workers from the adverse effects of lead exposure.

1.3. Purpose of this document

This Decision RIS recommends preferred options to improve the level of protection for lead risk workers. It aims to assist policy makers decide what regulatory changes, if any, should be made, and follows on from a Consultation RIS.

This RIS was prepared in accordance with COAG RIS requirements contained in the *COAG Best Practice Regulation Guide*.² Under this guide, a RIS must address seven key elements:

1. The problem/s that needs to be addressed
2. The objectives of government action
3. A range of policy options to address the identified problem/s
4. The likely costs and benefits of the options being considered
5. The consultation undertaken with affected key stakeholders
6. A clear statement as to which is the preferred option and why
7. Information on how the preferred option would be implemented, monitored and reviewed.

1.4. Overview of the document

Chapter 1 – Introduction

Chapter 2 – Background

This chapter outlines what lead is and what it is used for, the toxicological hazard profile of lead, measurement of workplace lead exposures, the regulatory framework for the control of lead in the workplace and how Australia’s requirements compare internationally.

Chapter 3 – Statement of the problem

This chapter outlines the toxicological hazard profile for lead, the recommended limits based on no observed adverse effect levels and evidence of adverse effects at the current legislated workplace levels.

Chapter 4 – Objectives of government action

This chapter outlines the objective of the WHS Regulations in relation to protecting workers against the effects of lead.

Chapter 5 – Consultation

This chapter outlines the consultation process conducted by Safe Work Australia to inform an analysis of the proposed options.

² COAG (2007) [Best Practice Regulation: A guide for ministerial councils and national standard setting bodies](#)

Chapter 6 – Options and analysis

This chapter outlines the options proposed for blood lead removal levels, the workplace exposure standard and the transition periods. This chapter also summarises the submissions and data received and any key issues and impacts raised by stakeholders.

Chapter 7 – Cost Benefit Analysis (CBA)

This chapter outlines the cost benefit analysis for each option.

Chapter 8 – Summary of preferred options

This chapter summarises the options which analysis shows are likely to provide the greatest net benefit to the community, differentiating between those that are expected to have a significant impact on stakeholders and those that will have only a minor impact.

Chapter 9 – Implementation and review

This chapter outlines the next steps in the process should the recommended option be agreed by Ministers, and the likely timeframes and processes for review.

Appendix A – Glossary

Appendix B – Definition of lead process work

Appendix C – Consultation RIS questions

Appendix D – Common assumptions used in CBA

Appendix E – Regulatory Burden Measurement Framework

2. Background

2.1. What is lead and how is it used?

Lead is a naturally occurring metal with properties that make it useful for a wide range of applications including producing and using solder, batteries, x-ray shielding and ammunition.

Solid lead, in itself, presents little or no risk to people. However, when lead is processed in a way that produces lead dust, fumes or mist (e.g. sanding or grinding, heating lead or spraying lead-based coatings) it poses a risk to health. Even small amounts of lead and lead compounds can be toxic when ingested or inhaled.

The use of lead in the developed world has been progressively eliminated or reduced as knowledge has increased about its adverse health effects. In Australia removing lead from petrol and paint has significantly reduced exposure to workers and the general population³. However, the legacy of environmental lead contamination remains in many areas throughout Australia.

2.2. The adverse health effects of lead

Lead has a wide range of biological effects on people, including on the developing foetus, which are directly related to the concentration of lead in the affected organ systems. Biological effects includes nervous system abnormalities, increased blood pressure, heart rate variability, kidney dysfunction, changes in immune system markers, reduced sperm quality and haematological (blood cell) effects.

The toxicity of lead depends on its particle size and solubility, as these parameters determine how easily lead is absorbed; the smaller the particle, the more rapid the absorption therefore the more acute and severe the toxic effect.

The *Review of hazards and health effects of inorganic lead – implications for WHS regulatory policy* (SWA 2014b) lists the adverse effects of most concern as:

- **carcinogenicity:** lead compounds have been classified by the International Agency for Research on Cancer as probable human carcinogens and numerous studies have found links with exposure to lead and cancers including lung, stomach, kidney, brain and oesophageal cancers
- **nervous system effects:** difficulty concentrating, anger, anxiety, depression, hearing loss, panic, balance dysfunction and tremors
- changed **risks for cardiovascular disease** resulting from small, lead associated, increases in blood pressure
- changes in **sperm quality** that may be important for men with a natural tendency towards having low sperm count
- increased risk of **detrimental intellectual development in unborn children**, and
- increased risk of **spontaneous abortion**.

Historically public health authorities have tried to set 'safe' blood lead levels. It now appears no 'safe' threshold can be identified for developmental neurotoxicity, vascular toxicity and other systemic effects. Efforts have shifted to build a better understanding of health effects at different blood level levels (NHMRC 2014).

2.3. Lead exposure in the workplace

Exposure to lead in the workplace occurs *via* two routes—ingestion and inhalation. Absorption of lead through the skin is negligible.

³ On 15 March 2000, the Australian Government announced a phase-out of leaded petrol in Australia under the *National Fuel Quality Standards Act 2000*. On 1 January 2002, that phase-out was completed. Lead was completely banned as an additive to paint in Australia in 2010, although it's usually still present in trace amounts (and still limited to 0.1% and 0.2% for zinc-based paints).

Ingestion of lead at the workplace occurs *via* hand-to-mouth transfer and is a significant route of exposure if a worker's personal hygiene or cleaning of the work area is poor, if workers eat and drink in contaminated areas or if washing and clean areas are not provided.

In a lead risk workplace⁴, workers are exposed to lead particulates in air (dust and fumes) by breathing them in. Once inhaled, lead fumes and some particulates can pass readily through the lung alveolar wall and directly into the blood stream. Thermally generated fumes of lead⁵ are more often involved in worker's high blood lead concentrations.

Once in the body lead binds to red blood cells and circulates the body in the blood. While most is excreted (*via* urine, faeces, sweat, breast milk, nails and hair; and generally within 30 days) some can remain in human tissues and organs. Lead can remain in bones for decades and can represent up to 95% of the body burden (ACGIH 2001).

Blood lead levels in workers can be reduced by removing them from lead risk work, improving ventilation controls and adhering to strict hygiene and housekeeping procedures until their blood lead levels are sufficiently reduced.

2.4. How is workplace lead exposure measured?

The two most common types of monitoring used in Australian workplaces are:

- biological monitoring of workers' blood lead levels, and
- workplace air monitoring for dusts and fumes of inorganic lead.

It has been highlighted through the consultation process that surface wipe analysis is also used by industry to measure and mitigate lead exposure *via* hand-to-mouth ingestion.

2.5. Work Health and Safety legislative requirements

WHS legislation requires businesses to do what is *reasonably practicable* to ensure the health and safety of their workers.

In regards to lead risk work, this requires businesses to eliminate or minimise risks associated with workers' exposure to lead, so far as is reasonably practicable.

Additionally, regulations⁶ place specific requirements around the control of lead exposure in workplaces including:

- confining lead process areas
- restricting activities in lead process areas (e.g. eating, drinking)
- provision of information about health risks of 'lead processes' to workers
- providing amenities (e.g. change rooms and washing facilities)
- laundry requirements for personal protective equipment contaminated with lead (PPE), and
- health monitoring of workers classified 'at risk'; including those for worker removal if prescribed blood lead levels are exceeded (i.e. blood lead removal levels)

Other requirements may include respirator fit testing and clean-shaven policies, the management of worker personal hygiene factors, regular maintenance and cleaning of workplace clothing and personal protective equipment.

⁴ Lead risk work - means work carried out in a lead process that is likely to cause the blood lead level of a worker carrying out the work to exceed:

a) for a female of reproductive capacity — 10 µg/dL (0.48 µmol/L); or

b) in any other case — 30 µg/dL (1.45 µmol/L).

⁵ These fumes contain the highly soluble lead suboxide.

⁶ Except for those in the Australian Capital Territory.

2.6. Biological monitoring of blood lead levels

Australian WHS laws require biological monitoring for blood lead levels in specific circumstances. The frequency of testing increases as blood lead level increases, ranging from every six months to every six weeks. An overview of these requirements is provided in Table 1 and Table 2 below.

Table 1. Prescribed blood lead levels that trigger specific requirements under Australian WHS laws (except in the ACT)

Requirement	Prescribed level	Reference ⁷
Mandatory health monitoring of lead risk workers	a) for a female of reproductive capacity—10 µg/dL (0.48 µmol/L) except in WA—20 µg/dL (0.97 µmol/L) b) in any other case—30 µg/dL (1.45 µmol/L)	Model WHS Regulations, reg 394 Vic: Occupational Health and Safety Regulations 2007 (Vic), reg 4.4.17 WA: Occupational Safety and Health Regulations 1996 (WA), reg 5.53
Removal from lead risk work (blood lead removal level)	<ul style="list-style-type: none"> for females not of reproductive capacity and males—50 µg/dL (2.42 µmol/L) for females of reproductive capacity—20 µg/dL (0.97 µmol/L) for females who are pregnant breastfeeding—15 µg/dL (0.72 µmol/L) 	Model WHS Regulations, reg 415 Vic: Occupational Health and Safety Regulations 2007 (Vic), reg 4.4.23 WA: Occupational Safety and Health Regulations 1996 (WA), reg 5.63
	<i>In WA:</i> Employers must remove the employee from the work if pregnant or breast-feeding (that is, immediately upon notification, which is mandatory in WA). Workers must also be removed if they have had an excessive exposure to lead or are experiencing adverse health effects related to lead exposure	
Return to lead risk work	<i>In all jurisdictions except WA:</i>	Model WHS Regulations, reg 417 Vic: Occupational Health and Safety Regulations 2007 (Vic), reg 4.4.25 WA: Occupational Safety and Health Regulations 1996 (WA), reg 5.64
	<ul style="list-style-type: none"> females not of reproductive capacity and males—40 µg/dL (1.93 µmol/L) for females of reproductive capacity—10 µg/dL (0.48 µmol/L) 	
	<i>In WA:</i> Upon certification by an appointed medical practitioner.	

Table 2. Minimum frequency of testing for workers involved in 'lead risk work' as mandated under WHS laws (except in the ACT)

Requirement	Prescribed frequency		Reference
	Initial	Thereafter	
Frequency of biological monitoring	<i>In all jurisdictions except WA:</i> Before the worker first commences lead risk work One month after commencing lead risk work	<i>In all jurisdictions except WA:</i> Depending on blood lead level, gender and reproductive capacity: every 6 months, 3 months or 6 weeks	Model WHS Regulations, reg 407 Vic: Occupational Health and Safety Regulations 2007 (Vic), reg 4.4.22 WA: Occupational Safety and Health Regulations 1996 (WA), reg 5.59
	<i>In WA:</i> Within the first month of commencing job Then 2 and 6 months after initial monitoring	<i>In WA:</i> At subsequent times as determined by appointed medical practitioner	

⁷ All jurisdictions other than Victoria, Western Australia and the ACT apply Part 7.2 of the model WHS Regulations for lead. While the ACT adopted the model WHS laws, it did not adopt Part 7.1 (hazardous chemicals) or Part 7.2 (lead) of the regulations. Hazardous chemicals are regulated under the Dangerous Substances Act.

2.7. Air monitoring in the workplace: workplace exposure standard for dusts and fumes of inorganic lead

In Australia, workplace exposure standards⁸ are mandatory in all jurisdictions. They are legally enforceable and not qualified by what is '*reasonably practicable*'.⁹ To comply with WHS Regulations, businesses must not exceed the published standard of 0.15 mg/m³ for dusts and fumes of inorganic lead.

Workplace Exposure Standards (WES) are not intended to be used as an alternative to controlling exposure through workplace controls. Air monitoring is a tool to be used as a part of an overall lead exposure control strategy and should not be used in isolation. Air monitoring is an indirect method for determining exposure to lead as it only reflects the amount of lead that is available to inhale within the workers' breathing space and does not represent actual exposure or body burden (lead concentration within the body), nor does it take into account the amount of lead that may be accessible for ingestion.

2.8. Mandatory notifications

Businesses must notify the WHS regulator of lead risk work and if a worker is removed because they have exceeded the blood lead removal level.

In some jurisdictions Public Health laws require pathology laboratories and medical practitioners to notify their jurisdictional Health Department of any blood lead test results > 10 µg/dL. These notifications generally include basic patient identifiers including age, gender and whether the exposure occurred during the course of work.

2.9. Jurisdictional differences

Blood lead removal levels, the workplace exposure standard for lead and related control of lead exposure requirements are mandatory under model WHS laws. Requirements are generally the same in all jurisdictions, subject to the differences outlined in Table 1 and Table 2.

In Australia there are some jurisdictions that have not adopted harmonised regulations for lead.

The Australian Capital Territory has not adopted the lead work provisions of the model WHS Regulations as it has little or no lead risk work.

In 2012 a Western Australian (WA) RIS process for adoption of the model WHS Regulations was undertaken (Marsden Jacob Associates 2012). The final Decision RIS concluded the adoption of the model WHS Regulations relating to lead would not have material impact on WA workplaces, that there were no major transitional issues and therefore recommended adoption.

The Victorian Government also undertook a RIS for the adoption of the model WHS laws (PwC 2012) which did not report significant differences between the model WHS Regulations for lead and the Victorian requirements. However, adoption of the model WHS Regulations was not supported by Victoria.

2.10. International standards

Blood lead removal levels

Safe Work Australia has reviewed leading international standards for blood lead removal levels (See Figure 1). Internationally:

⁸ Exposure standards represent airborne concentrations of individual chemical substances in the worker's breathing zone, which, according to current knowledge, should not cause adverse health effects nor cause undue discomfort to nearly all workers.

⁹ The model WHS Regulations require persons conducting a business or undertaking (PCBU) to:

- ensure that no person is exposed to airborne contaminants above the workplace exposure standard for the chemical (r49), and
- conduct air monitoring if it is not known whether exposure will exceed the exposure standard or if monitoring is necessary to determine if there is a risk to health (r50).

- blood lead removal levels may be mandatory or advisory in nature
- recently established or revised blood lead removal levels are generally less than 50 µg/dL
- countries with levels above 50 µg/dL generally do not have a large lead processing industry
- some countries set a health based blood lead removal level of 30 µg/dL for males and females not of reproductive capacity, and
- many international publications recommend lower blood lead removal levels of 7-25 µg/dL for females of reproductive capacity or females who are pregnant or breastfeeding.

Figure 1 below shows how Australia compares internationally for blood lead removal levels.

Workplace exposure standard for dusts and fumes of inorganic lead

Safe Work Australia identified a range of leading international workplace exposure standards for lead (See Figure 2). Internationally, the standard for lead ranges between 0.04 to 0.15 mg/m³. By comparison, Australia's WES for lead is among the countries with the highest level.

Generally, international publications set the standard for airborne lead contaminants based on the expected blood lead level if inhalation was the primary source of exposure. It is also noted that the blood lead level is considered a more accurate representation of recent lead exposure.

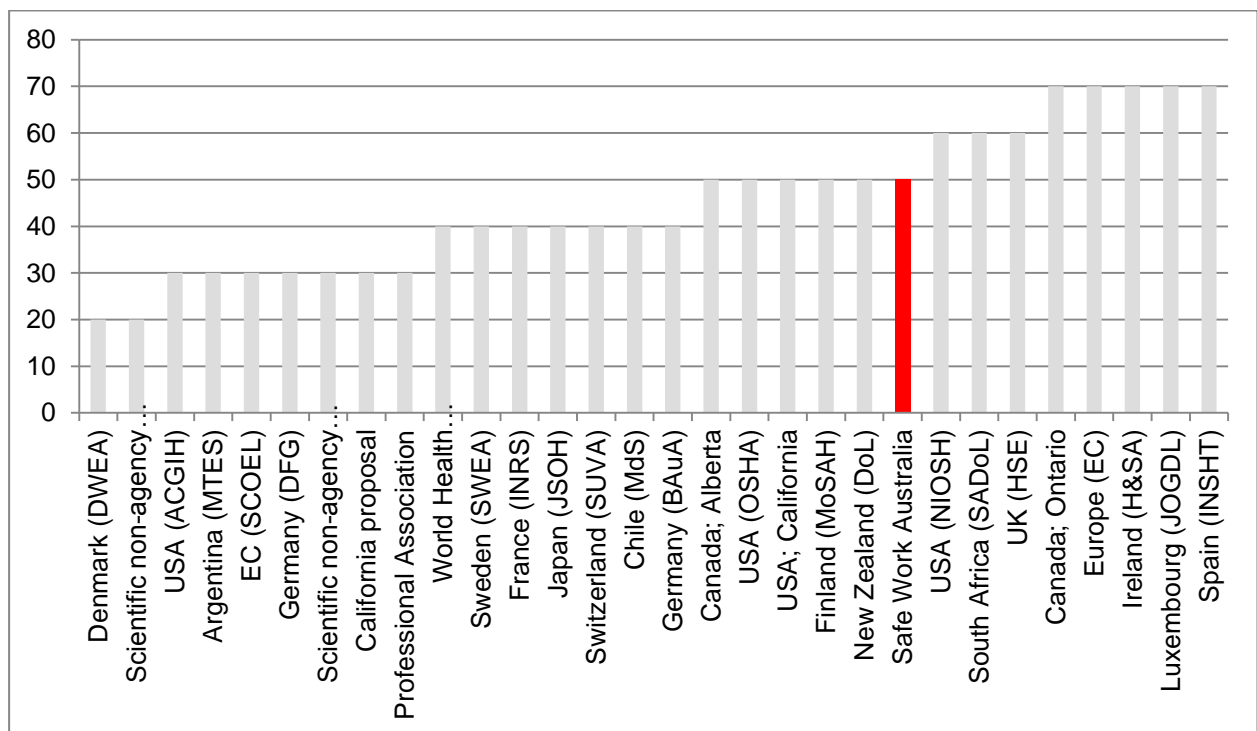


Figure 1. International benchmark – recommended blood lead removal levels for females not of reproductive capacity and males (adapted from SWA 2014b)

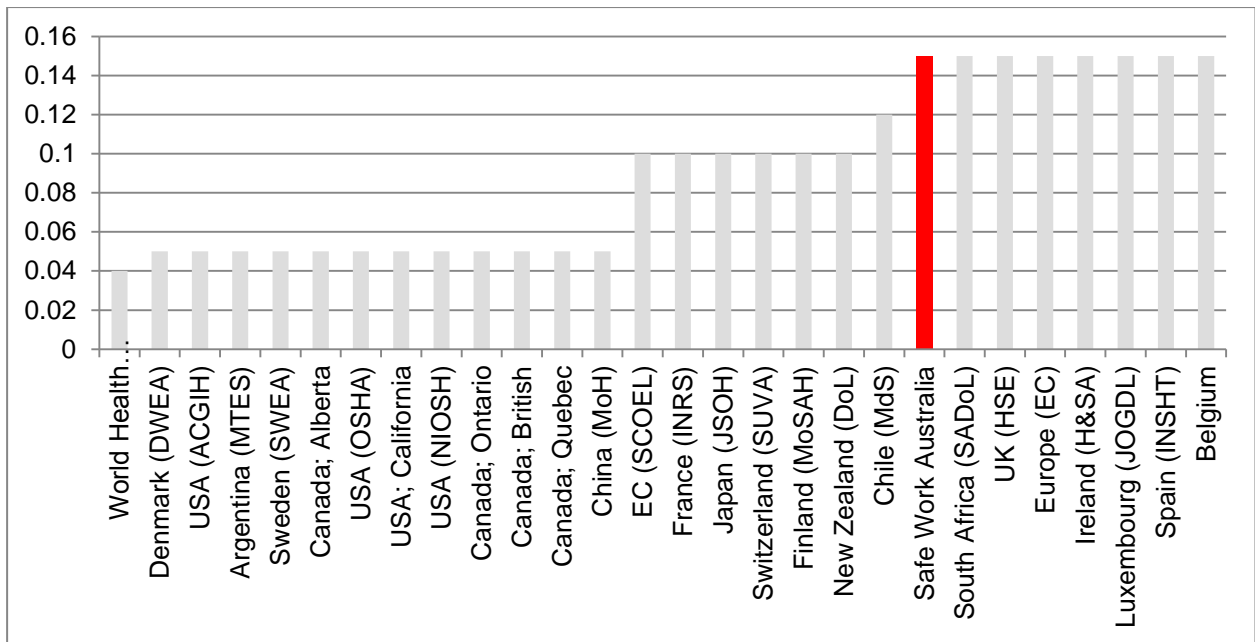


Figure 2. International benchmark – workplace exposure standards for lead (adapted from SWA 2014b)

3. Statement of the problem

Current toxicological and epidemiological evidence suggests that current legislated blood lead removal levels and workplace exposure standard do not adequately protect worker health.

3.1. Toxicological and epidemiological evidence

Blood lead removal levels

Under Australian WHS laws mandatory testing for blood lead levels starts when work carried out in a lead process is likely to cause the blood lead level to exceed:

- for a female of reproductive capacity—10 µg/dL, or
- in any other case—30 µg/dL.

In May 2015 the NHMRC released a Statement (NHMRC 2015a) on the evidence of the effects of lead on human health. This Statement updated the NHMRC previous work and was based on independent scientific evidence. The Statement advised:

“a blood lead level greater than 5 micrograms per decilitre suggests that a person has been, or continues to be, exposed to lead at a level that is above what is considered the average ‘background’ exposure in Australia. If a person has a blood lead level greater than 5 micrograms per decilitre, it is recommended that the source of exposure should be investigated and reduced, particularly if the person is a child or pregnant woman. Identifying and controlling the source of lead exposure will reduce the risk of harm to the individual and to the community.”

In 2014, Safe Work Australia commissioned an independent, evidence-based report ([SWA 2014b](#)) into the health effects of lead. It identified key epidemiological and toxicological studies relevant to setting blood lead removal levels and the workplace exposure standard for lead.

The report identified health endpoints including detrimental effects on the nervous system, increased blood pressure, heart rate variability, kidney dysfunction, changes in immune system markers, reduced sperm quality and haematological effects.

It concluded that most adverse health endpoints are associated with average blood lead levels of > 20 µg/dL. The associations become more evident at mean blood lead levels > 30 µg/dL. Figure 3 illustrates the blood lead levels at which adverse effects are observed.

On the basis of the evidence it was recommended:

- For females of non-reproductive capacity and males:
 - a blood lead removal level of 20 µg/dL, or
 - a target blood lead removal level of 20 µg/dL and mandated blood lead removal level of 30 µg/dL.
- For women of reproductive capacity:
 - a blood lead removal level of 10 µg/dL.

In addition to the health outcomes in Figure 3, studies have shown exposing a foetus to a blood lead level of < 5 µg/dL is associated with impairment of learning capacity and neuropsychological development during childhood. Lead is mobilised from the maternal skeleton during pregnancy, which in turn increases maternal blood lead levels and is transferred to the foetus in the cord blood *via* the placenta. At birth the ratio of maternal blood lead to foetal blood (measured using cord blood) ranges from 0.7 to 1 for maternal blood lead levels of 1.7–8.6 µg/dL (US EPA 2013).

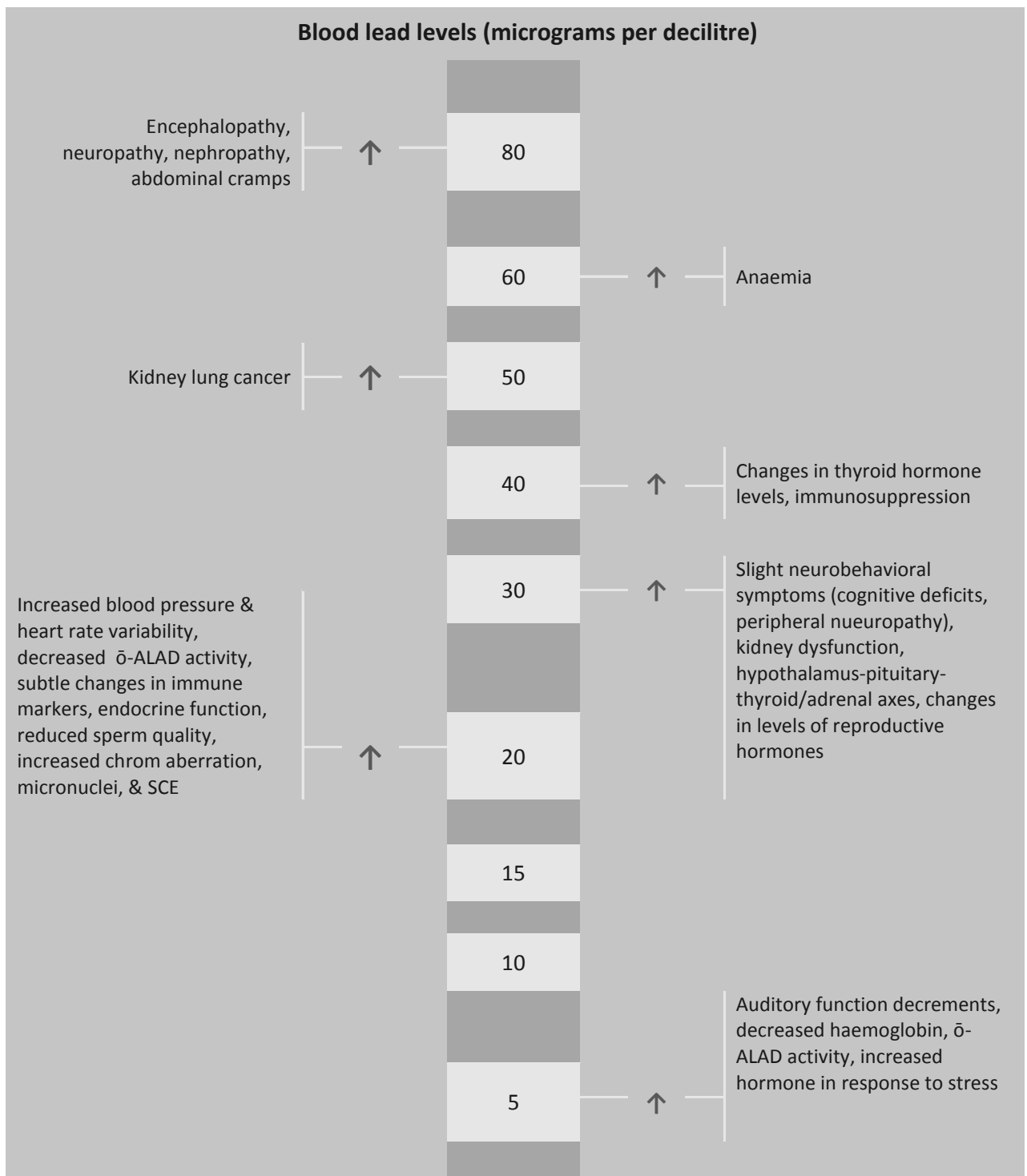


Figure 3. Blood lead response in adults from occupational epidemiology studies (SWA 2014b)*

* Upward arrows indicate the lowest blood lead level at which the health effects were reported in individuals in various studies. Blood lead levels at which people exhibit symptoms vary greatly between individuals. It is possible for people with blood lead levels of 40 µg/dL or more not to exhibit noticeable health effects.

The almost direct relationship of maternal blood lead and foetal blood lead makes it critical that the blood lead levels for females of reproductive capacity be kept as low as possible, and therefore the recommended blood lead removal level be no more than 10 µg/dL (SWA 2014b).

Lead is excreted *via* breast milk at a ratio varying between 0.01- 0.48 times the maternal blood lead level. However, it was concluded that it is not possible based on current knowledge to determine whether lead levels in breast milk poses a risk to children (SWA 2014b; US EPA 2013). Due to this unknown, females who are breastfeeding are treated the same as pregnant females to protect against the developmental effects of lead.

Workplace Exposure Standard for dusts and fumes of inorganic lead

The 2014 report drew on a range of studies to establish a relationship between airborne lead contaminant levels and blood lead levels in exposed workers (Air Slope Factor¹⁰).

At the current mandated workplace exposure standard of 0.15 mg/m³, it was estimated the average blood lead level a worker population would experience is likely to be 30 µg/dL, with an upper limit of ~ 60 µg/dL. Based on the air slope factor modelling, where inhalation is the primary exposure route, a level of 0.05 mg/m³ will correlate to a blood lead level of less than 30 µg/dL in most cases.

Based on the results of these calculations the report recommended a revised workplace exposure standard for dusts and fumes of inorganic lead of 0.05 mg/m³; a third of the current Australian workplace exposure standard and consistent with the level recommended by recently revised international agencies.

3.2. Evidence of adverse health effects from exposure to lead at the workplace

In addition to the updated toxicological hazard profile of lead, Workers' Compensation data provides evidence of adverse health effects being suffered by workers.

The workers compensation data clearly shows that exposure to lead at current regulatory limits is resulting in compensable illness.

Between 2001 and 2014, there were 115 accepted workers compensation injury claims attributed to lead and lead compounds. Accepted claims over this period totalled \$2.57 million dollars with an average 19.3 weeks duration of absence per annum. An outline of claims and related industries is included in Table 3 below. This information was also used to estimate the benefits that would be associated with reducing the number of workers compensation claims, set out in the cost-benefit analysis (chapter 7).

Table 3. Accepted Workers' Compensation claims by year and industry/employer for the period of 2000-2014

Period (year)	Number of claims	Industry of employer* (highest number reported)
2000-2001	20	Manufacturing (10) Construction Retail trade Transport, postal and warehousing Professional, scientific and technical services Administrative and support services Other services
2001-2002	20	Manufacturing (5) Construction Wholesale trade Administrative and support services Public administration and safety Education and training Health care and social assistance Other services

¹⁰ Air slope factor monitoring is modelled assuming inhalation is the primary source of exposure—it does not take exposure *via* ingestion into account.

Period (year)	Number of claims	Industry of employer* (highest number reported)
2002-2003	10	Manufacturing (5) Construction Other services
2003-2004	10	Manufacturing Construction Transport, postal and warehousing Public administration and safety Health care and social services
2004-2005	10	Mining Manufacturing (5) Construction Administrative and support services Health care and social services Other services
2005-2006	5	Manufacturing Construction Wholesale trade Transport, postal and warehousing Administrative and support services Healthcare and social assistance
2006-2007	< 5	Manufacturing Construction
2007-2008	5	Agriculture, forestry and fishing Manufacturing Wholesale trade Retail trade
2008-2009	< 5	Manufacturing Electricity, gas, water and waste services Health care and social assistance
2009-2010	< 5	Mining Manufacturing Construction
2010-2011	< 5	Mining Construction Health care and social services
2011-2012	10	Manufacturing Electricity, gas, water and waste services Construction Wholesale trade
2012-2013	10	Manufacturing (5) Construction Wholesale trade Information, media and telecommunications Professional, scientific and technical services
2013-2014	< 5	Mining Manufacturing
Australia wide total		115

* in no particular order

4. Objectives of government action

The objective is to ensure the model WHS Regulations deliver positive health and safety outcomes to the community, workers and business in the most efficient and effective manner possible.

The objective of this proposal is to reduce the potential for adverse health outcomes caused by exposure to lead in the workplace by:

- improving the regulatory framework in Australia to provide the highest level of protection to all workers, while ensuring practicability for businesses, and
- ensuring WHS policy and practice is based on the best available scientific evidence.

5. Consultation

5.1. Objective of Consultation

Safe Work Australia conducted full public consultation, reaching out to a wide range of stakeholders. The objectives of this consultation process were to:

- fill in the data gaps regarding lead process work and lead risk workers in Australia
- collect data to assist with identifying and quantifying the impacts of changing the regulations for blood lead removal levels and air monitoring for inorganic lead dusts and fumes
- to identify all possible alternatives to the policy proposals and any implementation barriers that had not been previously considered during policy development, and
- provide feedback on the level of support for a proposed option.

5.2. Consultation methods

A comprehensive stakeholder engagement plan was implemented to consult with relevant stakeholders about the proposed regulatory options to manage the adverse health effects of workplace lead exposure.

The stakeholder engagement plan included the release of a Consultation RIS and targeted stakeholder feedback. The Consultation RIS was published on the Safe Work Australia, Office of Best Practice Regulation (OBPR) and business.gov.au websites. Notification of the public comment period and the invitation to submit was promoted through social media channels and *via* an alert to the list of Safe Work Australia email subscribers.

Safe Work Australia also worked with WHS Regulators, national organisations, businesses and associations to promote the consultation process on their respective websites and through their contact lists.

The consultation process sought detailed feedback from stakeholders and businesses to address the lack of available information on the magnitude of lead exposure in workplaces, and the likely impact of the proposed options on Australian industry. The questions asked in the Consultation RIS are outlined in [Appendix D](#).

5.3. Submissions and targeted consultation

The public comment period closed on 27 February 2016. Safe Work Australia received 30 submissions from lead process workplaces and other stakeholders included submissions received on behalf of:

- mining
- foundries
- ammunition manufacturers and handlers
- occupational hygienists
- WHS Regulators
- lead battery manufacturers, recyclers and distributors
- painting and associated trades
- unions
- industry groups
- other lead risk workplaces.

No submissions from sole traders were received. A jurisdictional and business type breakdown of the submissions is outlined in Table 4 below.

Table 4. Summary of submissions received through the Consultation RIS process

Grouping	Submissions received
<i>Jurisdiction</i>	
Multiple/all jurisdictions*	9
Australian Capital Territory	Nil
New South Wales	6
Victoria	4
Western Australia	4
South Australia	4

Grouping	Submissions received
Queensland	5
Northern Territory	Nil
Tasmania	Nil
Commonwealth	4**
<i>Business type</i>	
Sole traders	Nil
Small business (< 20 employees)	1
Medium business (20-199 employees)	4
Large business (≥ 200 employees)	8
Unions	1
Workers and their families	1
Representational organisations	6
Government organisations	8
Work Health and Safety Regulators	4
<i>Industry</i>	
Mining	6
Defence and ammunitions	4
Batteries	3
Painting and associated trades	1
Electronics	1
Milling	1
Smelting/foundry	1

* Responses include business with representation in multiple jurisdictions; therefore the total is larger than the actual number of submissions received

** 3 were submitted by the same Commonwealth Department

Responses received during the consultation process have helped to fill data gaps and inform the preferred policy options. Submissions assisted in developing a complete understanding of the costs and likely impacts which may occur if the requirements for the control of workplace lead exposure are changed under the model WHS Regulations. This included an understanding of the feasibility for businesses to meet the proposed standards, what effects any changes may have on workforce participation, and the cost of any changes to control methods or worker testing processes currently in place.

Additional direct consultation was conducted with key lead risk businesses to clarify impacts and costs for the cost-benefit analysis. Follow up interviews were conducted with a number of the businesses that provided submissions. These encompassed a range of lead process businesses including:

- Mining
- Ammunitions and defence
- Foundry
- Milling
- Consultancies
- Battery manufacturing and recycling, and
- Painting and home renovations.

The purpose of the follow up consultations was to confirm the information provided in submissions and to collect additional information to assist with quantifying the costs and benefits of the proposed options.

As current regulations require notifying the WHS Regulator of health monitoring results and worker removals due to exceeding the blood lead removal level, WHS Regulators provided data on lead risk worker numbers, blood lead levels and the time a worker may be removed from lead risk work.

An analysis of submissions received can be found at Chapter 6 and the information and data collected has been used to inform a course of regulatory action to manage the adverse effects of exposure to workplace lead.

6. Options and analysis

6.1. Options considered

Blood lead removal levels

Under model Work Health and Safety (WHS) laws, biological monitoring (blood lead level testing) is used as the primary method of measuring workplace exposure to lead. The purpose of biological monitoring is to detect any individual who may be at risk of adverse health effects and monitor the effectiveness of the risk management strategies that have been applied.

“At risk workers” must be immediately removed from carrying out lead risk work if their blood lead levels are at or greater than:

- 50 µg/dL for females not of reproductive capacity and males
- 20 µg/dL for females of reproductive capacity, and
- 15 µg/dL for females who are pregnant or breastfeeding.

Once removed, workers cannot return to lead risk work until:

- the blood lead level is less than 40 µg/dL (1.93 µmol/L) for females not of reproductive capacity and males, or
- the blood lead level is less than 10 µg/dL (0.48 µmol/L) for females of reproductive capacity, and
- a registered medical practitioner with experience in health monitoring is satisfied that the worker is fit to return to carrying out lead risk work.

The following options were proposed for blood lead removal levels for lead risk workers:

- **Option 1:** Status quo (no changes to current mandated blood lead removal levels)
- **Option 2:** Reducing current blood lead removal levels and related requirements to reflect epidemiological and toxicological evidence:
 - a 20 µg/dL (target level) and 30 µg/dL (removal level) for females not of reproductive capacity and males, and
 - 10 µg/dL removal level for females of reproductive capacity¹¹.
- **Option 3:** Gender neutral blood lead removal level to protect the most vulnerable sub-population:
 - a 10 µg/dL removal level for all workers.

Both Options 2 and 3 for reducing the blood lead removal level will have flow on effects on related regulations including:

- meaning of lead risk work (regulation 394)
- frequency of biological monitoring (regulation 407), and
- return to lead risk work after removal (regulation 417).

Air monitoring – workplace exposure standard for dusts and fumes of inorganic lead

The Australian mandatory WES for lead is a TWA of 0.15 mg/m³.

There is evidence showing a link between the level of airborne lead contaminants and blood lead levels of exposed people (SWA 2014b). Therefore, if blood lead levels in workers are to be reduced, this standard needs to be reduced proportionately.

Proposed options for the Australian Workplace Exposure Standard (WES) for dusts and fumes of inorganic lead are:

- **Option 1:** Status quo (retain a workplace exposure standard of 0.15 mg/m³)

¹¹ This will include females who are pregnant and/or breastfeeding.

- **Option 2:** Reduce the workplace exposure standard to 0.05 mg/m³
- **Option 3:** Reduce the workplace exposure standard to 0.01 mg/m³ to protect the most vulnerable group
- **Option 4:** Non-regulatory approach (non-mandatory) work airborne level of 0.15 mg/m³, 0.05 mg/m³ or 0.01 mg/m³ dependant on the preferred blood lead removal level option.

Transition period

With the exception of the status quo, the options proposed involve changes to the regulatory framework; therefore appropriate transition periods need to be considered to allow businesses time to comply.

A two year or, alternatively, a four year transition period was proposed during consultation.

6.2. Analysis of options

The analyses of options address the problem of current regulatory limits not being reflective of current toxicological evidence and therefore not protective of worker health and safety.

In considering the options proposed, the likely impact on health and safety of workers and businesses conducting lead risk work, government and the general community have been evaluated. Impacts have been measured:

- Quantitatively – cost benefit analysis has been undertaken and the economic impact has been modelled wherever possible; and
- Qualitatively – anticipated impacts on stakeholders, the community and the environment have been outlined where there was a lack of data to support a quantitative assessment.

6.3. Summary of public submissions and direct consultation

Safe Work Australia received 30 submissions during the three month public comment period which closed on 26 February 2016.

Not all submissions received provided an opinion on the preferred proposed option; some of the submissions purely provided data against the Consultation RIS questions (in [Appendix C](#)).

The data collected allowed a baseline of impacts and costs to build on. It should be noted that the cost-benefit analysis (CBA) did not rely solely on the public submissions but incorporated information gathered in targeted consultation, worker's compensation data from the Safe Work Australia National Data Set for Compensation-based Statistics (NDS) and blood testing data provided by jurisdictions.

Overall, of those submissions that indicated a preference for the proposed options:

- there was a preference for blood lead removal level Option 2 and workplace exposure standard Option 2, and
- there was a lack of support for blood lead removal level Option 3 (gender neutral reduction in mandatory removal level).

The preferred transition period was 2 years to allow time to implement the changes required to comply with the new removal levels.

A summary of submission preferences is outlined in Table 5 below.

Table 5. Summary of preferred options based on consultation feedback

Option	# of submissions	
	For	Against
Blood lead removal levels		
Option 1 (status quo)	1	Not indicated
Option 2	9*	1
Option 3	5	5
Workplace exposure standard		
Option 1 (status quo)	Not indicated	1
Option 2 (0.05 mg/m ³)	7	Not indicated
Option 3 (0.01 mg/m ³)	Not indicated	1
Option 4 (non-regulatory approach)	4	Not indicated

Option	# of submissions
Transition period	
2 years	5
4 years	2

* including suggested amendments to the option

Information from submissions and the subsequent follow-up consultations provided a basis to estimate the costs and benefits associated with the current regulatory requirements. This included the cost of testing the blood-lead levels of lead-process workers, the frequency that these tests are undertaken and the costs associated with removing workers from lead-risk work when they have exceeded the relevant threshold. Information was also provided about the range of measures that businesses use to control lead exposure in the workplace and the cost of these measures.

Blood lead removal level Option 1 (status quo)

Submissions indicated that currently:

- there are 13,285 lead process workers in Australia
- of these, lead risk workers consist of:
 - 7145 males
 - 37 females not of reproductive capacity, and
 - 668 females of reproductive capacity
- businesses generally have a medical practitioner as an employee overseeing health monitoring or outsource their health monitoring needs.

Submissions noted that maintaining the status quo is not expected to provide any additional health benefits for workers and does not reflect current toxicological knowledge.

Many submissions noted that compliance strategies included internal 'buffer' blood lead levels that enabled investigation and removal prior to the mandated notification and removal levels.

One submission did not support any of the options and nominated a precautionary approach in alignment with the NHMRC position (see section 3.1; NHMRC 2015a).

The direct consultations also assisted in confirming the numbers of lead process and lead risk work (as per Table 7) which was used in the cost benefit analysis calculations. These consultations confirmed that many organisations regularly test the blood lead levels of their entire workforce, rather than limiting the testing to workers who directly undertake lead-risk work. This is one reason why the estimated number of lead-workers has increased since the Consultation RIS.

The information collected during the consultations was also used to inform several inputs to the impact analysis, including:

- the cost of blood-lead level tests, which was found to be similar for most businesses (per-test), but is higher for the businesses that undertake more frequent testing
- the costs currently associated with needing to remove workers from lead risk work (although very few workers exceed the current threshold for removal)
- the costs for the business that are associated with conducting a 'review of lead measures' (i.e. in the event a worker has exceeded the relevant threshold), and
- the current costs associated with air-monitoring.

More information on the parameters used in the impact analysis is set out in the following chapter.

Blood lead removal level Option 2

Submissions indicated that:

- approximately two thirds of businesses are already meeting the proposed reduced removal level and do not require a transition period to comply
- the average time required to comply with the proposed reduced removal level is two years (ranging from 0 to seven years)

- businesses may need to increase the number and frequency of blood lead level testing that is currently conducted
- businesses may need to upgrade control measures to comply with reduced blood lead removal levels
- Regulators may initially receive more notifications of worker removals and may need to respond with increased compliance and enforcement activities (for example site visits)
- Regulators noted that based on operational visits many businesses already comply with the proposed reduced standard and/or have appropriate controls in place to comply
- the additional cost to Australian businesses to comply with the proposed reduced removal level is approximately 25% of what is currently spent, and
- this was the preferred option for a majority of submissions that indicated a preference for an option.

One submission from a small business (< 100 workers and < 50 lead risk workers) did not support blood lead removal level Option 2. The submission indicated that the average blood lead level in the business is currently above the blood lead removal level being proposed and implementation of this option would severely impact the business. This submission noted that blood lead level testing costs would triple and more time would need to be allocated for personal hygiene procedures. This submission noted that it would take a minimum of 12 months to promote and maintain hygiene practices to 'come close' to the level proposed.

One submission noted that the reduction in blood lead removal levels outlined in option 2 were not protective enough.

Various amendments to the proposed removal levels were submitted including:

- removal of women of non-reproductive capacity and men at $\geq 40 \mu\text{g/dL}$
- removal of women of non-reproductive capacity and men at $\geq 20 \mu\text{g/dL}$; with return to work at ≤ 15 or $10 \mu\text{g/dL}$
- removal of women of non-reproductive capacity and men at $\geq 30 \mu\text{g/dL}$; with return to work at $\leq 25 \mu\text{g/dL}$
- removal of females of reproductive capacity at $\geq 10 \mu\text{g/dL}$; with return at $\leq 7 \mu\text{g/dL}$

These amendments appeared to be based on pre-existing return to work levels that are currently used by businesses as internal standards or were proposed with no clear justification.

The 2014 toxicology report (SWA 2014b) recommended a no observed adverse effect level (NOAEL) of $20 \mu\text{g/dL}$ for females not of reproductive capacity and males. It recommended that as this was a pragmatic NOAEL; this level should act as a rational precautionary limit for the protection of nearly all workers. Due to the additional effects seen on the developing foetus and in children the removal level of $10 \mu\text{g/dL}$ and return to work level of $5 \mu\text{g/dL}$ were recommended for females of reproductive capacity and those who are pregnant or breastfeeding. As the options proposed by Safe Work Australia were based on the toxicological hazard profile for lead, the amendments proposed in submissions were not further considered in this process.

Submissions also suggested a modified testing frequency (outlined in Table 6 below). Originally the proposed changes to the testing frequency for Option 2 were:

- testing every three months for blood lead levels between 0 and $20 \mu\text{g/dL}$, and
- testing every six weeks for blood lead levels $\geq 20 \mu\text{g/dL}$.

Submissions questioned why the six month frequency period in current regulations was not preserved and proposed to keep the six month testing frequency for females not of reproductive capacity and males at the lower levels of blood lead concentration.

The proposed change to the frequency of testing for females not of reproductive capacity and males has been considered by Safe Work Australia. As the proposed approach is consistent with the currently regulated frequency of testing and the original proposed change to the frequency of testing is considered to offer no additional health benefit, the amended proposal has been accepted and will be modelled in the cost-benefit analysis.

Table 6. Blood lead level testing frequency – original proposal and proposal adopted based on feedback in submissions

Blood lead level (µg/dL)	Frequency of testing	
	Original option 2	Amended option 2
<i>Females of non-reproductive capacity and males</i>		
0-5	Three months	Six months
5-10		Three months
10-20		
20-30	Six weeks	Six weeks
30-40		
40-50		
50 +		
<i>Females of reproductive capacity</i>		
0-5	Three months	Three months
5-10	Six weeks	Six weeks
10-20		

This information was incorporated into the cost benefit analysis of Option 2 in the calculations for the additional costs of health monitoring, which is set out in Chapter 7.

The direct consultations were used to clarify some of the assumptions made in the submissions and to collect additional information for the impact analysis. This included:

- Estimates of the number of workers that would exceed the proposed removal and monitoring thresholds for Option 2. The consultations indicated that only a very small proportion of workers would exceed the proposed removal threshold, which was also confirmed by the analysis of data from health authorities
- Estimates of the direct costs businesses would be likely to incur as a result of introducing Option 2
- Estimates of the effect that the new thresholds would have on the operation of their businesses.

Additional issues raised in the consultations included:

- That it can be more costly for businesses located in remote areas (including large lead smelter and mining businesses) to find replacement workers when a worker is removed for exceeding the relevant blood lead level
- That there is considerable variation between workers in the time it takes for their blood lead levels to return to lower levels, following an increase

The consultations also provided an insight into the way that businesses interpret their regulatory requirements. Several of the businesses consulted indicated that they are constantly looking for ways to reduce the blood lead levels of their workforce, regardless of regulated limits. While others indicated they rely on the regulations as a guide for what is 'safe' for their workers.

Blood lead removal level Option 3

Submissions indicated that this option:

- is not cost effective; many were unable to quantify the cost required to meet this level
- would substantially increase:
 - the number of workers that require blood lead level monitoring,
 - the number of tests required per year, per worker
 - the requirement to upgrade and/or install new controls
- could not be implemented by businesses in either of the transition periods proposed
- would financially cripple many businesses
- would have a significant increase in the number of notifications to Regulators and result in a significant increase in compliance and enforcement activities.

This option was supported by five submissions that indicated a preference. The submissions that supported this option did so based on health effects and did not provide further information on costs to implement this change in industry.

This option was not supported by five industry submissions due to the financial and productivity costs associated with upgrading controls and changing work processes. Industry submissions indicated that this option would have such an enormous impact that businesses would not be able to continue lead process work or would need to move lead processes offshore.

The submissions did not provide enough information to quantify the costs associated with Option 3. In follow-up consultations with lead businesses confirmed it was not possible to quantify these costs, as the changes would most likely result in the closure of their business.

Some businesses indicated that Option 3 would only have a minimal impact because they are already at or near the proposed thresholds.

However, many other businesses stated that it was unlikely they would ever be able to comply with the proposed thresholds for Option 3. This included many of the large and very large lead manufacturers, smelters and mines. In consultations, these businesses indicated that, to comply with Option 3, their lead processes would need to be completely re-engineered. The businesses were not sure if this was feasible, but if it was, it would cost tens or even hundreds of millions to implement. The business indicated that they would not be able to bear this cost and therefore Option 3 would most likely result in the closure of their business.

Workplace exposure standard Option 1 (status quo)

Submissions indicated that currently:

- air monitoring for inorganic lead dusts and fumes is conducted by a majority of businesses conducting lead process work
- air monitoring for inorganic lead dusts and fumes is undertaken on a business-by-business basis and frequency's include ad hoc, weekly, fortnightly, annually, bi-annually or as an on-going process, and
- approximately half of businesses have reviewed, updated or installed further controls due to air monitoring data.

It was raised in one submission that while the business complied with blood lead level requirements, it struggled with meeting the workplace exposure standard. The business was in the process of continuous equipment review and upgrade and noted it would be difficult to meet any further reduction of the WES.

Air monitoring should not be used as a control for workplace lead. WES should be used as a tool within a lead control strategy. It was unclear whether the costings provided for air monitoring in submissions was included in the costings for control measures for blood lead removal levels. It has been noted that there may be some double costing within the responses.

Direct consultations assisted in confirming the use of air monitoring in the lead industry, how air monitoring is applied and the relative cost of the current requirements. These consultations indicated that there are significant differences in the amount of air monitoring being undertaken by businesses for example:

- some businesses spend much less effort than others on monitoring airborne lead levels, by the nature their work i.e. airborne lead is not a source of exposure for their workforce, and
- some businesses undertake frequent monitoring, while others only undertake monitoring when there are changes in lead processes.

Workplace exposure standard Option 2 (reduce the WES to 0.05 mg/m³)

Submissions indicated that:

- to meet this proposed requirement there would be an increased cost to business due to increased frequency of air monitoring required and the introduction of new controls
- this was the preferred option for a majority of submissions that indicated a preference.

Submissions noted that additional costs of compliance with a reduced standard including increased air monitoring, development and upgrade of engineering resources (ventilation, air extraction, dust suppression systems) and restructuring of work schedules to change exposure frequency.

Many submissions supported reducing the WES for dusts and fumes of inorganic lead to better represent current toxicological knowledge. It was noted by some that further reduction would provide greater protection but would most likely not be practical or feasible. A submission from a Regulator noted that operational activities indicated that many businesses have adequate safety management systems in place to protect workers at this level.

Submissions from Regulators noted that this option may involve increased site inspections and audits. Regulators noted that any changes to the mandated standard would also include an information and education component.

The direct consultations confirmed that Option 2 would result in additional costs for businesses and provided additional information for estimating these costs (set out in the following chapter). The consultations showed that, in some cases, businesses had inadvertently double-counted some of the costs associated with the WES. This is because they do not draw a distinction between the costs incurred controlling airborne lead levels and the blood lead levels of their workforces.

Many of the businesses consulted see meeting the thresholds for WES Option 2 as a prerequisite, necessary for achieving the thresholds for Option 2 for blood lead levels. Therefore, businesses did not identify additional benefits associated with this option in excess of those already identified for blood lead level Option 2.

Workplace exposure standard Option 3 (reduce the WES to 0.01 mg/m³)

Submissions indicated that:

- a majority of the businesses indicated that there would be an increased cost due to increased frequency of air monitoring required, an increase in the size of the area considered to be 'at risk' of exceeding the exposure standard and the requirement to introduce new controls, and
- many businesses were unable to quantify the cost required to comply with this exposure standard.

Some submissions noted that this level was already being reached. Other submissions noted that due to the primary route of exposure being ingestion, a change in the WES for lead would not impact their control processes.

Submissions from Regulators noted that this option will involve increased site inspections and audits.

Workplace exposure standard Option 4 (non-regulatory approach)

A vast majority of the submissions that provided information for this option indicated that there would be no change to:

- how they conduct air monitoring
- the costs of conducting air monitoring, or
- the ease or burden of compliance.

Submissions that supported a change to the status of the WES for dusts and fumes of lead did so for various reasons including:

- WES do not represent a hard line of safe and unsafe
- WES should be applied as part of a suite of risk management tools, and
- blood lead level testing is a more appropriate and accurate reflection of exposure from all routes.

Transition periods

Submissions indicated a preference for a two year transition period which was consistent with the time nominated to comply with Option 2 for blood lead removal levels and workplace exposure standard.

Some submissions nominated a transition period of 4 years or more due to provide the time to evaluate, update or replace and review control strategies for compliance. One submission noted preference for a phased transition period as part of a suite of risk management approaches.

Generally, the larger the reductions in either blood lead removal level or WES the longer the transition period proposed.

Some submissions however, noted no requirement for a transition period for Option 2 (blood lead removal levels and WES) as these standards were already being reached. One submission noted that Option 3 (both blood lead removal level and WES) was currently being reached in a majority of lead risk areas.

The option of a phased reduction in the mandatory standards was raised in one submission.

Direct consultations did not provide any additional information to that provided in the public submissions.

6.4. Other key issues and impacts raised

Rural or remote areas

In the consultation RIS, stakeholders were requested to raise any particular difficulties in meeting health monitoring requirements if they were located in rural or remote areas. Key issues noted for rural or remote businesses included:

- access to NATA accredited services for testing of health monitoring (and air monitoring) samples
- additional costs due to travel for outsourced health monitoring services
- trade skills shortages impacting the capability of business to backfill removed workers, and
- additional travel and accommodation costs for backfilling a position or role due to work being conducted in a remote, rural or regional areas.

Capacity for larger sized businesses

Originally, it was expected that the larger businesses conducting lead process work would have better capacity to backfill removed workers (availability of skilled workers, smaller training costs, availability of non-lead risk work placements), and therefore would have an overall reduced cost of removal compared to smaller businesses.

However, based on information collected it appears this is not the case for lead process businesses. Many of the larger lead process businesses operate out of remote, rural or regional areas and therefore backfilling the places left from workers removed due to excessive blood lead levels may require flying in or relocating trained workers therefore losing any cost advantage. It was noted that in some cases there was no availability to backfill a position due to skills shortages. The assessment of the costs and benefits (Chapter 7) has therefore applied the same cost assumptions for small and large businesses.

Impacts on small businesses

Information from submissions confirmed that the majority of the lead workforce is employed in either large mining or smelter operations or medium to large manufacturing businesses.

However, there are also a range of small businesses where workers may be exposed to lead. These include painters (from working with lead paint), automotive repairers (from lead in car radiators), glass tradespersons (from lead-lighting work) and those working on defence platforms. For small businesses, many of the costs associated with controlling lead exposure are similar to large business (e.g. blood testing, hygiene controls and use of PPE). Data from Victoria

indicated that only 30 per cent of small businesses would be affected by the changes proposed in Option 2, which has been included in the cost benefit analysis.

Areas with environmental lead contamination

Businesses operating in areas with high levels of environmental lead contamination have indicated a more significant impact to reducing the blood lead removal levels. Many of these businesses have highly detailed control strategies, health monitoring processes, supervising occupational practitioners on staff and prescriptive hygiene and housekeeping procedures.

Due to environmental exposure to lead outside of the workplace, some workers already have blood lead levels above the proposed action limits. It was also indicated that in areas with environmental lead contamination, reducing workers' blood lead levels to the allowable return to work level would take a significant amount of time. This feedback, as well as data collected from health authorities, has been used to inform the assumptions in Chapter 7 about the length of time that workers would need be removed from lead-risk work, if they exceed the relevant removal threshold.

Closure of businesses or movement offshore

Submissions raised the concern that reducing the mandatory lead standards would have an effect on competition in the industry on a world stage. It was noted that many of Australia's trading partners operate in environments where blood lead removal levels are higher than those mandated in Australia. An impact noted by several submissions for Option 3 (with the largest reduction in blood lead removal level and exposure standard) would result in closure of the business or moving specific lead risk tasks offshore where the regulatory environment is more lenient.

On comparison with Figure 1 in section 2.10 of this report, it can be seen that this concern is valid. Australia is within the international group at the higher end of the blood lead removal levels. If the blood lead removal level is reduced to 30 µg/dL for females not of reproductive capacity and males it will be among the countries with the second lowest mandated levels.

The cost benefit analysis will account for the costs indicated by submissions and directed interviews and where appropriate discuss the potential impact of closure or moving offshore.

Protecting women of reproductive capacity

Some submissions noted that due to effects on the developing foetus and young children protecting women of reproductive capacity, women who are or intend to be pregnant and women who are breastfeeding should be a high priority for businesses.

Controlling exposure to lead *via* hand-to-mouth

Submissions indicated that hand-to-mouth ingestion of lead is a primary exposure route at the workplace.

Detailed case-studies showing the difference in blood lead levels of workers before and after implementation of strict hygiene and cleaning procedures demonstrate that control mitigation measures may not need to be highly expensive or technical to make a considerable difference. Effective hygiene and housekeeping measures that can be implemented at a lead process workplace include:

- strict rules regarding no food and drink in lead process areas
- hand and face washing procedures
- 'clean' and 'dirty' areas
- correct removal, laundering or disposal of PPE, and
- specific cleaning products and practices.

The case studies provided also indicated that air monitoring is not necessarily required to be conducted in some workplaces. Responses indicated that some workplaces have negligible airborne lead contaminants and therefore air monitoring is not considered a useful tool to measure to workplace lead. It was raised that surface wiping for lead was a more useful (and cost-effective) tool for predicting exposure and assessing the effectiveness of control measures.

It is unclear from responses whether alternative control measures and measures of exposure were considered in the costings of upgrading controls should the standards be reduced.

Workplace Exposure Standards

Submissions noted that while air monitoring is important to indicate airborne levels of inorganic lead in specific workplaces, they represent an indirect prediction of exposure. Many submissions noted that the primary route of exposure in modern workplaces is ingestion *via* hand-to-mouth movements and the blood lead level of workers is an accurate indicator of recent exposure from all possible routes.

Responses also indicated that while WES should be reflective of international best practice and current knowledge, they should really only be used as a complementary tool to assess whether control measures are effective.

Some WHS Regulators noted that WES are not well understood by businesses and are generally not used properly as part of risk assessment. Responses raised concerns that highlighting the WES for inorganic lead may lead to businesses focussing on controlling airborne lead contaminants rather than using a holistic risk management strategy.

Perceived cost versus actual cost

Direct consultation conducted during this process suggested that in some cases responses were reflective of perceived cost rather than actual cost.

Many lead process workplaces test more workers than is actually required by regulation. In some cases all staff are regularly tested for blood lead levels – even those who may not be in direct contact with the lead work areas (e.g. reception staff). And while this is commendable for the protection of the broader workforce, it appears that responses have costed for the entire lead process workforce (and possibly even more) rather than the cost for lead risk workers.

Many lead process workplaces have detailed lead control strategies with target levels well below those that are regulated to ensure they remain compliant. It appears that responses may have costed for maintaining internal target blood lead levels rather than the proposed regulatory levels.

It is also unclear whether the costs for air monitoring for airborne contaminants of lead were separated from the overall costs of a workplace lead control strategy and double costing may have occurred.

WHS Regulators noted that air monitoring and the use of WES in the workplace are not well understood and are therefore generally not applied correctly in many cases. As air monitoring may be being carried out unnecessarily, it is unclear if the cost of air monitoring accurately reflects the cost of compliance.

Due to this issue the cost benefit analysis (CBA) is not based solely on the information provided in submissions. As part of the CBA, direct consultation was conducted with targeted interviews of key stakeholders and direct engagement with jurisdictional Health Departments to clarify costs presented and impacts that were raised as part of the public consultation process.

7. Cost Benefit Analysis (CBA)

This chapter builds on the information submitted during the public comment period and sets out an assessment of the costs and benefits of each of the options identified in Chapter 6 to determine the option with the greatest net benefit to the community. The chapter is an update of the analysis presented in the Consultation RIS.

7.1. Approach to measuring the impacts of the options

The approach used to assess the proposed options is a Cost-Benefit Analysis (CBA).

CBA is an analytical tool that can be used to measure the economic and social impact of government action and measure the 'net social benefits' that action might produce. CBA requires that all major costs and benefits of a proposal be quantified in monetary terms. This allows the outcomes for a range of options to be translated into comparable terms in order to facilitate evaluation and decision making.

For this Decision RIS, the CBA has focussed on producing an estimate of the change in compliance costs and the risk of adverse health effects associated with each of the options. These have been estimated for the base case (Option 1: Status quo) and for each of the alternative options for blood lead levels (Options 2 and 3) and workplace exposure standard (Options 2, 3 and 4). The quantification of compliance costs has focussed on areas of difference between the options. The analysis of health impacts has focussed on how the proposed options may contribute to either an increase or a decrease in health costs associated with occupational lead exposure.

Key sources of evidence for the analysis

The analysis in this chapter incorporates information provided in the responses to the Consultation RIS, follow-up consultations with affected businesses, information provided by health agencies about occupational lead exposure and other desktop research.

Responses to the Consultation RIS

A total of 30 submissions were provided in response to Safe Work Australia's Consultation RIS. These submissions were provided by a combination of businesses conducting lead-risk work, occupational hygienists, unions, government agencies and regulators. A summary of these consultations is set out in Chapter 6 of this document. Directed follow up interviews were conducted with a number of the businesses that provided submissions. These interviews confirmed and clarified the information provided in submissions, and collected additional information to assist with quantifying the costs and benefits of the proposed options.

Data from health agencies

Blood lead biological monitoring data was requested from health agencies in jurisdictions that collect this data. In the time available, Western Australia, Victoria, Queensland and New South Wales' Health Departments provided useful data sets to inform the analysis in this RIS:

- The Western Australian data contains approximately 6,700 blood lead test results from 2,500 workers from 2005 to 2016. The Western Australian data includes a unique 'identifier', which has allowed us to measure changes in blood lead levels of individuals between tests.
- The Victorian data contains approximately 5,500 blood lead test results from 1,300 workers from 2010 to 2015. The Victorian data also includes a unique identifier, which has allowed us to measure changes in blood lead levels of individuals between tests.
- The Queensland data contains approximately 4,300 blood lead test results from approximately another 1,500 workers, including 880 unique workers in 2015. Around 80% of the Queensland data relates to the lead mining and smelting operations in and around Mount Isa.
- The New South Wales data contains approximately 8,700 blood lead level test results from approximately 3,000 workers from 2010 to 2016. This includes 814 unique workers in 2015.

The Western Australian data includes all workers' tests results. However, the Victorian, Queensland and New South Wales data only contained tests where the blood lead level was greater than 10 µg/dL (test results below this level are not recorded).

Data from worker's compensation claims

Worker's compensation data from the Safe Work Australia National Data Set for Compensation-based Statistics (NDS) was sourced to inform the cost (and savings) of worker's compensation claims due to exposure to lead (outlined in Table 3).

Analytical approach

The benefits and costs of the proposed changes to blood lead levels and workplace exposure standards have been assessed separately. The interactions between these are discussed at the end of this chapter.

The analysis combines both the information received during public comment and the direct consultation with key stakeholders with the data collected from jurisdictional health departments.

Changes to blood lead levels

The analysis of the costs and benefits of the proposed options for blood lead levels has focussed on the additional compliance costs and health benefits of the proposed changes. The compliance costs that businesses incur have been identified based on the information provided in submissions and in follow-up consultations. They include:

- increasing the frequency of worker's blood lead level testing
- increased administration and reporting costs (e.g. reporting test results to government)
- removing workers who exceed the blood lead level thresholds
- implementing additional lead controls, and
- the time taken to review control measures.

The blood lead test results provided by Western Australia, Victoria, Queensland and New South Wales provide a strong set of data to estimate the increase in the frequency of testing and the likely number of workers that would need to be removed from lead-risk work if Options 2 or 3 were implemented. However, there is less certainty about the cost of the changes that businesses would need to make to become compliant with the proposed options. This is discussed in detail later in the chapter.

In addition, it is expected there would be an increase in costs related to the compliance activities of work health and safety regulators, whose role it would be to ensure employers comply with the new requirements.

The principal benefit from the proposed changes to the model WHS Regulations would be a reduction in the blood lead levels of lead-risk workers, which is expected to lead to benefits for workers through reduced incidence of the following adverse health conditions:

- cancer
- effects on the nervous system
- increased blood pressure
- heart rate variability
- kidney dysfunction
- change in immune system markers
- low sperm quality
- haematological effects
- neurobehavioral symptoms (cognitive defects, peripheral neuropathy), and
- changes in thyroid and reproductive hormone levels.

Lead risk workers bear many of the costs associated with these adverse health conditions. However, there can also be flow on effects to the workers families and the community.

There are also many examples where the presence of lead process work has resulted in contamination in the surrounding environment. Efforts to reduce worker's blood lead levels may have a secondary effect of reducing this type of contamination in the future.

The CBA has primarily considered the economic benefits that would follow from a reduction in the incidence of lead-related diseases and illnesses. This includes reductions in financial costs such as health system expenditure, increased productivity, transfer costs and non-financial costs (e.g. 'burden of disease'). The CBA has built on the SWA Report (2014b), to quantify and then

monetise (estimate the dollar value of) the benefits of reducing workers blood lead levels. However, due to variations in the availability of data on the links between high blood lead levels and the conditions listed above, the analysis has focussed on quantifying the impacts of reductions in only four conditions:

- liver cancer
- oesophageal cancer
- stroke, and
- ischemic heart disease.

Analysis of these four lead-related conditions provides a good indication of the minimum quantum of benefits from reducing occupational lead exposure and a good basis to quantitatively compare the benefits of the proposed options with their costs. The other health benefits of reducing blood lead levels are discussed qualitatively.

Changes to workplace exposure standard

The analysis of the proposed changes to the WES has followed the same process as outlined above. The additional compliance costs for businesses that would be associated with the proposed options have been quantified based on information provided by lead businesses.

The concentration of airborne lead contaminants (dusts and fumes) is an indirect indicator of the potential for adverse health impacts (i.e. if it subsequently enters a worker's body). Modelling undertaken in the SWA Report (2014b) and evidence published by other international agencies indicates there is a correlation between the concentration of lead contaminants in the air and blood lead levels when inhalation is the primary source of exposure.

Therefore, there is an interaction between the benefits of any reduction to blood lead level thresholds and the WES for dusts and fumes of inorganic lead. This may result in double-counting some health benefits.

Therefore, the additional health benefits resulting from a reduction in the WES for lead contaminants has been assessed qualitatively, focussing on the interaction with blood lead levels.

Sensitivity testing of the overall results has also been conducted, which includes a proportional increase in the costs directly associated with undertaking air monitoring.

7.2. Key assumptions used in the analysis

Additional information collected for the CBA has been used to update some of the assumptions presented in the Consultation RIS, these relate to the size of the industry, the costs associated with compliance and the health costs associated with occupational lead exposure.

Size of the industry

The Consultation RIS included estimates of the total number of workers undertaking lead risk work, based on the current definition in the model WHS Regulations. The estimates were provided by WHS Regulators in some states and territories, based on the number of notifications of lead risk work they had received. This data was then extrapolated to provide an estimate of the total number of workers undertaking lead risk work in Australia. This came to a total of 1,676 workers.

Submissions to the Consultation RIS and additional data from health agencies (which was available for four states) shows that there is a much larger number of workers who are exposed to some level of lead in the workplace than those estimated in the Consultation RIS, even though not all of these workers are considered to be undertaking 'lead risk work' under the current definition, but whose blood lead levels are regularly tested. This is a more relevant population for measuring the impacts of the proposed regulatory changes and appeared consistent with the numbers of lead risk workers outlined in public comment submissions. Using this updated definition, the total size of the Australia's lead-risk workforce has been estimated at 9,893 workers. The calculation of this figure is set out in Table 7.

Table 7. Updated estimate of the size of Australia's lead-risk workforce

Jurisdiction	Workers undertaking lead risk work	Workers regularly tested for blood lead levels	Data from health authorities	Industries not incl. in submissions or CRIS	Estimate of total workers used for CBA
	(1)	(2)	(3)	(4)	(5)
Commonwealth	69				69
New South Wales	510	615	814		814
Victoria	459	45	986		986
Queensland	198	5,411	3,051	228	5,639
Western Australia	303	244	361		361
South Australia	100	1,855		77	1,932
Tasmania	37			23	60
Australian Capital Territory	0			20	20
Northern Territory	0			12	12
Total	1,676	8,170	5,212	360	9,893

Notes: (1) Estimate from regulators and health agencies used in the 2015 Consultation RIS (CRIS)
(2) Based on numbers provided in submissions and subsequent consultations
(3) Data provided for NSW, Vic, Qld and WA (incl. estimate of likely number of Vic and Qld tests < 10 µg/dL)
(4) Health data from Victoria showed there were some lead-exposed workers from occupations, which were generally under-counted in the Consultation RIS (e.g. painting, plumbing, and decorating).
(5) Either (3) (if available) or the greater of (1) and (2), plus (4). This column includes an estimate of the number of these workers in other States and Territories (where lead testing data wasn't available), based on the relative size of their workforce (additional total = 1138 workers).

It was estimated in the Consultation RIS that there are around 582 businesses undertaking lead-risk work in Australia. Of these businesses, there are approximately five with more than 500 workers (mines and smelters) who are regularly exposed to lead (see Table 8 below).

There are likely to be around 100 medium to large businesses (including many manufacturers, recyclers) and probably around 500 small businesses (including radiator repairers, lead lighters, painters and other trades persons).

Table 8. Indicative number of lead businesses, by number of workers

Businesses	Persons working with lead	Approximate number of businesses
Very large businesses	500+	5
Medium and large business	20-500	100
Small businesses	<20	500

Cost parameters

Submissions to the Consultation RIS provided information about the costs of complying with the current requirements of the model WHS regulations and estimates of the additional costs that would be incurred for the options proposed.

Blood lead level testing

Most organisations currently undertake blood lead level testing of their workforce onsite, using an occupational health nurse, who will typically visit a work site during business hours to conduct the test. The sample is usually then sent to a pathology provider and the results sent back to the employer. The typical costs involved in this process are:

- costs associated with undertaking the test (e.g. employing an occupational nurse or having one attend the workplace)
- pathology costs, and
- the time taken by the worker to have their test.

Estimates provided by businesses for the cost of each test varied from \$30 to over \$100.

The average cost has been estimated at \$55 per test, plus approximately 20 minutes of lost productive time, which has been valued at \$31 (including on-costs) based on an estimate of the average earnings in lead-risk workplaces.

Therefore, the total estimated cost is \$86 per test.

Removal of workers from lead-risk work

When a worker is removed from lead risk work, either as a result of exceeding the relevant mandatory removal levels or a more stringent level applied by the employer, the worker will usually be assigned to other non-lead risk duties within the organisation. The costs associated with this can include:

- training the removed worker to perform their new duties
- training another worker to perform the duties of the removed worker
- any differences in the wage rates of the two tasks, and
- reduced productivity while the two workers become proficient in their new roles.

The quantum of these costs can vary depending on the role the removed worker was performing and the business they work for. Where the removed worker was performing a highly skilled role or was working in a remote area, the costs can be higher.

Large businesses, such as lead smelters and mining operations, may have greater capacity to move workers between lead-risk and non-lead risk roles. This can reduce the costs associated with removing workers. However, feedback has indicated that these businesses are generally located regional, rural or remote areas, which then has an offsetting effect on the predicted reduced costs due to additional travel costs for back filling a position or the inability to backfill a vacated position due to skills shortages. Taking these factors into account, the costs of removing workers from lead risk work is assumed to be similar for all businesses regardless of their size.

The costs of removing a worker are also driven by the length of time the worker is removed from lead risk work. Businesses reported that it can take between one week and six months for a removed worker's blood lead levels to fall back below the relevant thresholds. Businesses reported that it generally takes longer for the blood lead levels of older workers with extensive industry experience to reduce than younger workers or those newer to the industry. This can contribute to higher costs, as older workers often undertaking the most skilled work. The most common length of time that a worker is removed from lead risk work is two months.

The cost of removing a worker from lead risk work is estimated to be \$3,240. This is based on businesses needing to:

- undertake three hours of training for both the removed worker (to undertake their new role) and their replacement
- pay a 10 per cent wage premium paid for an average of two months that a worker is removed, and
- a modest estimate of lost productivity.

The calculations behind these figures are shown in Table 9 and Table 10 below.

Table 9. Calculation of wage rates for the lead workforce

Wage costs	Value	Assumptions
Average wage costs (per hour)	\$53.41	Based on ABS wage figures, for the industries that make up the lead workforce
Non-wage labour on-costs and overheads	75%	This rate is consistent with the guidance note on the Regulatory Burden Measurement Framework from the OBPR
Total wage costs (per hour)		\$93.46

Table 10. Calculation of the cost of removing workers from lead-risk work

Wage costs	Value	Assumptions
Training costs (12 hrs)	\$1,120	Based on providing an average of 3 hrs of training to the removed worker and their replacement, as well as the trainer's time (i.e. 3 hrs x 4 people).
Additional wages (10% for two months)	\$1,620	An estimate of the extra wages that businesses pay when workers are removed from lead risk worker (e.g. as a result of paying their replacement casual rates, or temporary higher duties), incurred for
Lost productivity	\$500	Represents the lost productivity while the removed worker and their replacement become proficient in their new roles
Total costs per removed worker		\$3,240

Many businesses have highlighted that they only have a very limited number of non-lead risk jobs to reassign workers to. If a large number of workers were reassigned at the same time they would most likely not be able to find another role for all them. Hence, the business case has assumed the additional wage costs and productivity losses from removing workers will be 50 per cent higher for Option 2 and 100 per cent higher for Option 3 (see Table 11 below).

Table 11. Estimated cost of removing workers from lead-risk work, blood lead level Options 1, 2 and 3

Costs of removing workers	Option 1	Option 2	Option 3
Training costs	\$1,120	\$1,120	\$1,120
Additional wage costs <i>Change from base case</i>	\$1,620	\$2,430 +50%	\$3,240 +100%
Productivity losses <i>Change from base case</i>	\$500	\$750 +50%	\$1,000 +100%
Total costs	\$3,240	\$4,300	\$5,360

Reviewing lead control measures

The model WHS regulations require a review of lead control measures under certain circumstances, including when a worker's blood lead levels have exceeded the relevant removal thresholds.

The scale and scope of these reviews can involve a full review of all possible sources of lead exposure in the workplace; but are more likely to involve a review of the specific circumstances that led to the worker's blood lead levels exceeding the relevant threshold (e.g. failure to follow hygiene procedures) and subsequent liaison with the relevant WHS Regulator.

Only a small number of workers exceed the current removal levels each year (around six), so there is limited information available about the costs of conducting the subsequent review of measures. Based on feedback from the industry, for the purposes of the CBA, these costs are assumed to be around \$2,000 per worker who exceeds the relevant threshold. This includes around 16 hours of time spent investigating the exceedance and meeting with regulators and \$500 of fixed costs, such as additional testing that may be required.

Based on feedback from Regulators, they are also assumed to spend around 25 hours of work in relation notifications and compliance activities to each workplace (which may require travel to remote locations), at a further cost of approximately \$2,000 per case. This amount is based on the Australian Bureau of Statistics public sector average weekly earnings series (cat no. 6302.0), with the addition of on-costs (calculated as per Table 9).

Costs associated with controlling lead exposure

The methods and costs of controlling occupational lead exposure vary considerably, depending on the type of lead-risk work an organisation is undertaking. However, the common ongoing or operational costs include:

- Basic Personal Protective Equipment (PPE), such as face masks, coats and gloves
- More advanced PPE such as respirators or coveralls

- Laundering of all lead-contaminated clothing
- Washing or hosing down surfaces, including the hiring or employment of cleaners whose specific role is to clean for lead residues
- Using vacuums with high efficiency particulate air (HEPA) filters
- Controlling exposure to settled lead dust, including surface wipe testing, training for workers in basic hygiene and housekeeping (washing hands, washing clothes, eating and drinking habits), and
- additional refresher training that is often provided to workers with high blood lead level test results.

Other one-off or capital costs that were identified by businesses as being associated with controlling occupational lead exposure included:

- Installing or upgrading:
 - Wash facilities;
 - Extraction fans and their bag houses;
 - Dust suppression sprinklers; and
- Fully enclosing or automating lead risk work.

The costs of these measures varied greatly depending on the scale of the lead-risk work being undertaken. For example, the cost of upgrading extraction fans at a small radiator repair or leadlight window may be several thousands of dollars; whereas the cost of changing bags in a bag house at a larger production facility can be in excess of \$100,000 per change. The costs involved with automating or enclosing lead risk processes at major mining or smelter operations could cost in the hundreds of millions of dollars.

7.3. Impact of the proposed options for blood lead levels

Blood lead level Option 2

Some lead businesses have indicated they already meet the thresholds proposed for Option 2 and therefore there would be no change in ongoing expenditure if this option was implemented. However, others indicated they would need to increase their ongoing expenditure or make capital investments to improve lead processes to comply. In direct consultations, some businesses indicated that if Option 2 was implemented, they would make changes to their operations to ensure workers blood lead levels were well-below the new removal level.

Based on public feedback from Regulators and confirmed by direct consultation, it has been assumed that all very large businesses would incur some costs as a result of Option 2, and only 30 per cent of small, medium and large businesses would incur costs. The remaining 70 per cent of businesses are assumed to be unaffected by the reduction in blood lead levels specified by Option 2. This assumption is further confirmed by Victorian data from 2015, which showed that only 30 per cent of businesses undertaking lead risk work had reported having at least one worker with a blood lead level above the 30 µg/dL removal level proposed for Option 2.

Blood lead level Option 3

Submissions and interviews with businesses have indicated that Option 3 would require significant changes.

In many cases, businesses have indicated it would either not be possible to comply with the blood lead levels proposed for Option 3, or that the cost of doing so would be so prohibitive as to result in the closure of the business. In many of these cases, the business was unable to provide an estimate of the costs of meeting the requirements because the targets were deemed to be infeasible. It is assumed all businesses undertaking lead risk work would be affected by Option 3.

The table below (Table 12) sets out the basis of the cost assumptions that have used for the CBA. The Option 2 costs would only apply to the 30 per cent of businesses assumed to be impacted by the changes.

Table 12. Estimated increase in operating and capital costs to comply with blood lead level options 2 and 3

Cost type	Option 2	Option 3
Increase in operating costs		
Very large businesses	\$100,000*	Not feasible
Medium and large business	\$5,000	Not feasible
Small businesses	\$1,000	Not feasible
Capital expenditure (implementation costs)		
Very large businesses	\$1 million*	\$100 million +
Medium and large business	\$20,000	\$1 million
Small businesses	\$5,000	\$10,000
Percentage of businesses affected		
Very large businesses	100%	100%
Medium and large business	30%	100%
Small businesses	30%	100%

* There are up to five very large businesses which employ around two-thirds of the lead-risk workforce. Some of these large businesses have reported significant compliance costs associated with implementing Option 2, but the available data from health agencies indicates they are largely already compliant. For example, there were 550 mining workers tested in Qld in 2015, of which only two had a test with a blood lead level above the 30 µg/dL removal level proposed for Option 2. This would suggest the businesses may have over-estimated their costs. However, if the costs were as high as some have suggested, businesses have an option of seeking an exemption from their WHS regulator, which may be used in some cases.

Increase in the frequency of blood lead level testing

Based on the available blood lead test results in 2015, the average lead-risk worker is required by the regulations to be tested approximately 2.13 times per year. This would increase to 3.01 times if Option 2 is implemented. It would almost triple to 6.01 times if Option 3 is implemented.

However, in submissions to the Consultation RIS, many businesses indicated that they undertake blood lead level testing more frequently than they are required to, so the actual increase in costs required to be compliant will be less than this. The testing frequencies modelled are outlined in Table 13

Table 13. Estimated increase in the frequency of blood lead level testing

Blood lead level (µg/dL)	Estimated frequency of test results	Frequency of testing (per annum), males and FNRC*		
		Option 1	Option 2	Option 3
0-5	55%	Six months	Six months	Three months
5-10	18%		Three Months	Six weeks
10-20	15%		Six weeks	
20-30	6%			
30-40	4%	Three months	Six weeks	
40-50	1%	Six weeks		
50+	0%			
Tests per worker, per year (average)		2.13	3.01	6.01
Implied increase in tests (%)			42%	183%
Actual estimated increase in tests (%)			28%	122%

* Females not of reproductive capacity

Lead risk work is dominated by males, who make up an estimated 90-95 per cent of the workforce. Information provided in submissions from lead businesses indicates that about one-quarter of the females undertaking lead-risk work are not of reproductive capacity, meaning that around 94 per cent of the workforce is subject to the regulatory requirements for testing that are outlined in Table 13.

Number of workers removed from lead risk work

The figures below show the highest blood lead test result recorded for each worker tested in Western Australia, Victoria (Figure 4), Queensland and New South Wales (Figure 5) in 2015 (in µg/dL). This data can be used to estimate the number of workers that would have need to be removed from lead risk work in those states if Options 2 or 3 had been in place at that time.

The Western Australian data shows that no workers exceeded the 50 µg/dL removal limit in 2015; whereas 16 would have exceeded the 30 µg/dL removal limit proposed for Option 2 and 104 workers would have exceeded the limit for Option 3 (29 per cent of all lead workers).

In Victoria, only one worker exceeded the 50 µg/dL removal limit in 2015, whereas 51 would have exceeded the 30 µg/dL removal limit proposed for Option 2 and 284 workers would have exceeded the limit for Option 3. It is not known what proportion of lead risk workers in Victoria this would equate to, as Victoria does not collect test results of less than 10 µg/dL;

The Queensland data shows that one worker exceeded the 50 µg/dL removal limit in 2015, whereas 19 would have exceeded the 30 µg/dL removal limit proposed for Option 2 and 879 workers would have exceeded the limit for Option 3. It is not known what proportion of lead risk workers in Queensland this would equate to, but it is estimated to be around the same proportion as for Western Australia (i.e. around 30 per cent).

The New South Wales data shows that three workers exceeded the 50 µg/dL removal limit in 2015; whereas 38 would have exceeded the 30 µg/dL removal limit proposed for Option 2 and 780 workers would have exceeded the limit for Option 3. Because New South Wales health authorities do not collect test results of less than 10 µg/dL, it is not known what proportion of lead risk workers in New South Wales this would equate to.

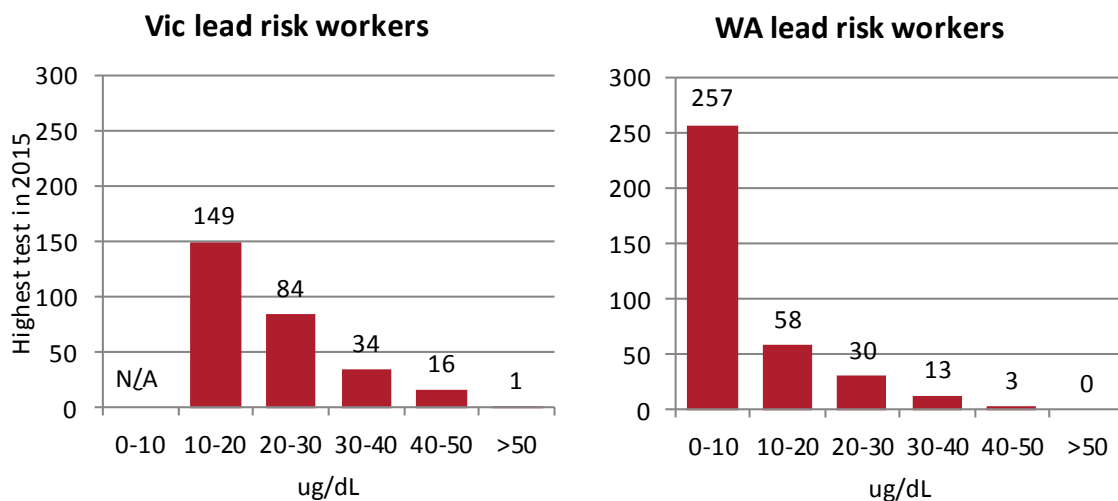


Figure 4. Victorian and WA worker blood lead test results by highest test in 2015

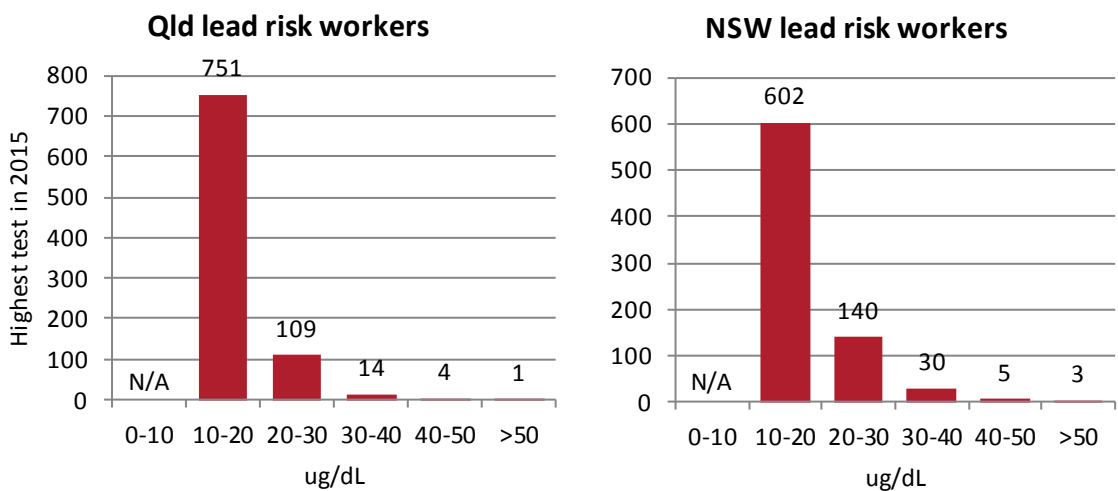


Figure 5. Queensland and NSW worker blood lead test results by highest test in 2015

Overall, the data from the four jurisdictions shows that 124 of the 2,300 workers tested in 2015 would have exceeded the 30 µg/dL removal limit proposed for Option 2. This is equivalent to

5.5 per cent of the workers tested (noting that only Western Australia records test results of less than 10 µg/dL).

If Option 3 had been in place, 2,047 workers would have exceeded the 10 µg/dL removal limit at least once in 2015.

The data is consistent with the industry information provided in responses to questions raised in the Consultation RIS with businesses generally indicating that they were largely compliant with the limits proposed for Option 2, but that a significant proportion of their workforce would exceed the removal levels for Option 3.

Evidence from submissions, direct consultation and collected data

Mining and smelter operations make up a significant proportion of Australia's lead industry employing an estimated 2,400 workers who are regularly tested for lead exposure.

These businesses all provided submissions, which indicate that the average blood lead levels of their workforce are likely to be higher on average than the figures shown above. For example:

- A Queensland mining business indicated that of their total workforce of 5,400, 21 (0.4 per cent) would exceed the removal level proposed for Option 2, but 1,300 (24.1 per cent) would exceed the removal level for Option 3. Similar figures are seen in the 2015 blood lead data provided by the Queensland Health Department which showed that in 550 mining workers tested; only two had test results with a blood lead level above the 30 µg/dL removal level proposed for Option 2
- A NSW mining business employing a workforce of approximately 400 indicated that 10 to 20 per cent of their workforce would need to be removed from lead-risk work for Option 2, but up to 95 per cent of their workforce would exceed the removal level for Option 3. The available NSW blood lead data does not always identify the industry of the worker, but suggests that the proportion of workers who would exceed the removal level proposed in Option 2 is just under five per cent, and
- A South Australian smelter, employing approximately 1,750 workers, indicated they would need to remove up to five workers (0.3 per cent of the workforce) for exceeding the 30 µg/dL limit proposed in Option 2, but much of the workforce would exceed the limit for Option 3.

These businesses all have a higher number of workers with blood lead levels of between 10 µg/dL and 30 µg/dL than businesses in Victoria and Western Australia. The reasons given for this include the long history of lead industry at the sites (which has resulted in environmental contamination and therefore higher blood lead levels for the surrounding population in the area) and a typically long-serving workforce with many years of lead exposure (which has resulted in an increased body burden due to accumulation of lead in bones and other organs).

The health data provided for workers in Western Australia, Victoria, Queensland and New South Wales accounts for approximately 80 per cent of lead process workers in Australia. This data has been extrapolated to form an estimate of the total number of lead process workers that would exceed the removal thresholds proposed for Options 2 and 3 (i.e. the remaining 20 per cent of lead process workers; see Table 14 below). Overall, the data shows that around six workers currently exceed the 50 µg/dL limit each year, while 157 would exceed the limit proposed for Option 2 (1.5 per cent of the estimated workforce). Based on the current data, around 2,600 workers would exceed the 10 µg/dL proposed for Option 3, equivalent to around 25 per cent of the workforce.

Table 14. Estimated change in the number of workers (males and females not of reproductive capacity) removed from lead-risk work per annum dependent on the proposed option

Workers removed	Option 1 (≥ 50 µg/dL)	Option 2 (≥ 30 µg/dL)	Option 3 (≥ 10 µg/dL)
Number of workers removed	6	157	2,596
Increase from the base case (number of workers)	-	151	2,590

Source: based on health data provided for workers in Western Australia, Victoria, Queensland and New South Wales

7.4. Benefits of reducing exposure to lead

Evidence of the health effects of lead exposure

The review of the health effects of inorganic lead exposure commissioned by SWA in 2014 (SWA 2014b) found that lead can result in a wide range of biological effects depending on the level and duration of exposure. These included adverse effects on the nervous system, cardiovascular system, blood, kidneys, liver, endocrine system, immune system and reproductive system. It also found links between high levels of lead in blood and certain cancers.

The report found that most health effects observed with exposure to lead have been associated with blood lead levels of more than 20 µg/dL; with stronger associations found for blood lead levels above 30 µg/dL.

Calculating the economic effects of reduced lead exposure

The economic effects associated with reducing some of the adverse medical conditions associated with occupational lead exposure include:

- **Health system expenditure** – including the cost of running hospitals, primary care and pharmaceuticals as well as other areas of health system expenditure
- **Productivity costs** – including the person’s productivity losses (temporary and long-term absenteeism), premature mortality and the value of informal care
- **Other financial costs** – including all other government and non-government programs and out-of-pocket expenses (such as formal care, aids, transport and accommodation costs associated with receiving treatment)
- **Transfer costs** – including the deadweight loss (DWL) associated with government transfers, such as taxation revenue forgone, welfare and disability payments, and
- **Non-financial costs** – including pain, suffering and premature death (collectively referred to as the burden of disease).

There are a number of difficulties in quantifying and then monetising all of the health benefits that would occur from reducing occupational lead exposure.

Firstly, there is often no direct link between occupational lead exposure and the adverse health conditions identified above, only an increased likelihood of the condition occurring, sometimes many years after the period of occupational exposure. As a result, it can be difficult to find data that attributes the adverse health conditions to lead, or more specifically to occupational lead exposure.

Secondly, there are significant differences between the approaches, assumptions and controls used in the research that was reviewed in the SWA Report (2014b), which makes combining the results of this research to calculate an overall reduction in adverse health impacts impossible.

The approach adopted for the CBA has been to focus on a sub-set of the findings of the SWA Report (2014b), where there is enough evidence to calculate the incidence of a disease or illness, with and without high levels of lead exposure (broadly defined as blood lead levels of more than 20 to 30 µg/dL) and where there is also existing evidence of the overall costs associated with that disease or illness (see Figure 6 below).

For each disease or illness:

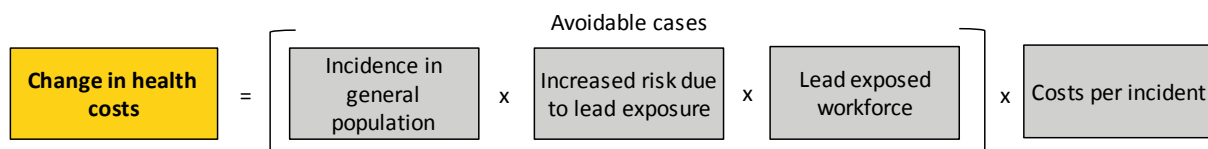


Figure 6. Approach to calculating the health benefits of reduced lead exposure

This information was able to be obtained for four of the conditions identified in the SWA Report (2014b) namely liver cancer, oesophageal cancer, stroke and ischemic heart disease.

Table 15 below uses the current incidence of these conditions in Australia (sourced from the Australian Institute of Health and Welfare) and either the Risk Ratio (RR) or the increased

likelihood of the condition due to high lead levels (sourced from the 2014 SWA Report) to estimate the number of each condition that could have been avoided per year had lead levels been lower.

The financial and non-financial costs of the conditions have been estimated from three publicly available reports about the economic costs of disease undertaken by Access Economics, Cost of Cancer in NSW (p.127); The Economic Impact of Stroke in Australia (p.40) and The Economic Costs of Heart Attack and Chest Pain (p. 58) (2006, 2009 and 2013). These estimates represent the Present Value (PV) per case. They are calculated using similar methodologies and include all of the health system, productivity, transfer and non-financial costs discussed above.

Table 15. Benefits associated with reducing occupational lead exposure

Medical condition		Liver cancer	Oesophageal cancer	Stroke	Ischemic heart disease
Incidence information					
Overall incidence	(1)	11.3	9.5	210	600
Increase with lead exposure	(2)	(RR) 2.17	(RR) 2.40	↑ likelihood 15%	↑ likelihood 10%
Incidence with lead	(3)	24.5	22.8	241	660
Population impacted	(4)	9,893	9,893	9,893	9,893
Avoidable cases per annum	(5)	1.31	1.32	3.12	5.94
Cost information					
Financial costs per case	(6)	\$114,500	\$114,500	N/A	\$22,000
Non-financial costs	(7)	\$851,600	\$851,600	N/A	\$182,000
Total costs per case	(8)	\$966,100	\$966,100	\$129,199	\$204,000
Adjustment of costs for inflation					
Year of cost estimation		2006	2006	2012	2009
CPI at time of estimation	(9)	85.9	85.9	101.8	92.9
CPI at March 2016	(10)	108.2	108.2	108.2	108.2
Increase in CPI	(11)	26%	26%	6%	16%
Costs in 2016 dollars	(12)	\$1,216,000	\$1,216,000	\$137,000	\$236,000
Total avoidable costs per annum					
Avoidable costs	(13)	\$1,588,000	\$1,600,000	\$427,000	\$1,401,000
Total annual health benefits	(14)	\$5,016,000			

RR = risk ratio

(1) Rate per 100,000, sourced from the AIHW

(2) Sourced from SWA (2014b)

(3) = (1) × (2)

(4) Sourced from earlier population estimates

(5) = (3) × (4)

(6) and (7) Access Economics (2006, 2009 and 2013)

(8) = (6) + (7)

(9) and (10) Sourced from the ABS' Consumer Price Index

(11) = (9) / (8) – 1

(12) = (8) × (11)

(13) = (5) × (12)

Overall, the table shows that the annual health benefits from reducing high lead levels could be in the order of \$5 million per annum for these four conditions. For the purposes of the CBA, this figure provides a useful minimum reference point for assessing the costs and benefits of the options.

There are a number of assumptions underpinning this analysis. It is predicted that the total annual health benefits would be much greater if there was enough evidence to quantify potential savings associated with all of the conditions that high lead levels have been associated with.

The majority of the medical evidence reviewed which linked lead exposure to adverse health impacts found effects at blood lead levels of more than 20 µg/dL; with stronger associations found for blood lead levels above 30 µg/dL. The report indicated the additional benefits for Option 3 would only be marginal, but there is not enough evidence to quantify the additional impacts.

Workers compensation costs

In addition to the medical costs identified above, data has been able to be extracted by Safe Work Australia from the National Data Set for Compensation-Based Statistics (NDS), showing

the number of accepted workers compensation claims made in relation to injuries or diseases from 'lead and lead compounds'.

This data shows that, over the past 15 years there have been an average of eight lead related workers compensation claims per year. The average weeks of work lost through one of these claims is 5.6 and the average workers compensation costs per claim are almost \$26,000.

Overall, the total cost associated with these claims, including the value of lost earnings, is estimated to be \$367,000 per annum.

7.5. Impacts of blood lead level option 2

The following section sets out the impacts of Option 2 for blood lead levels. The impacts have been modelled over a 10 year period, using a real discount rate of seven per cent.

Compliance costs

Using the assumptions outlined in this chapter, the following costs have been identified for Option 2:

- additional blood lead level testing will cost \$560,000 per annum in the first year, declining by five per cent per annum, as the effects of the option take force and the blood lead levels of workers decline
- the increased cost of removing workers with blood lead levels above 30 µg/dL will be \$650,000 in the first year, declining by 10 per cent per annum
- costs associated with reviewing lead exposure measures (following the removal of a worker for exceeding the 30 µg/dL threshold) will be a further \$300,000 per annum for businesses, also declining by 10 per cent per annum, and
- other costs for businesses associated with complying with Option 2 will include \$6.35 million to implement control measures necessary to comply with the new requirements (spread over two years) and ongoing costs of \$650,000 per annum.

Health benefits

The quantifiable benefits associated with Option 2 are in excess of \$5.3 million per annum. This includes:

- quantifiable health benefits of \$5 million per annum, which can be reached over three years, and
- implementation of Option 2 can reduce costs associated with workers compensation claims by 80 per cent from current levels saving a further \$290,000 per annum.

This option would also provide a range of additional health benefits for lead-exposed workers that could not be quantified reliably in the CBA including from reduced incidence of problems associated with the nervous system, blood, kidneys, liver, endocrine system, immune system and reproductive system.

Overall impacts of Option 2

Using the assumptions outlined above:

- the average costs of Option 2 over 10 years has been calculated at \$2.7 million per annum
- the average benefit of Option 2 over 10 years has been estimated at \$4.8 million per annum, and
- the total, quantifiable benefits over 10 years are estimated to exceed the costs by a ratio of 1.57 to one.

The 10 year costs and benefits of Option 2 are presented in Figure 7.

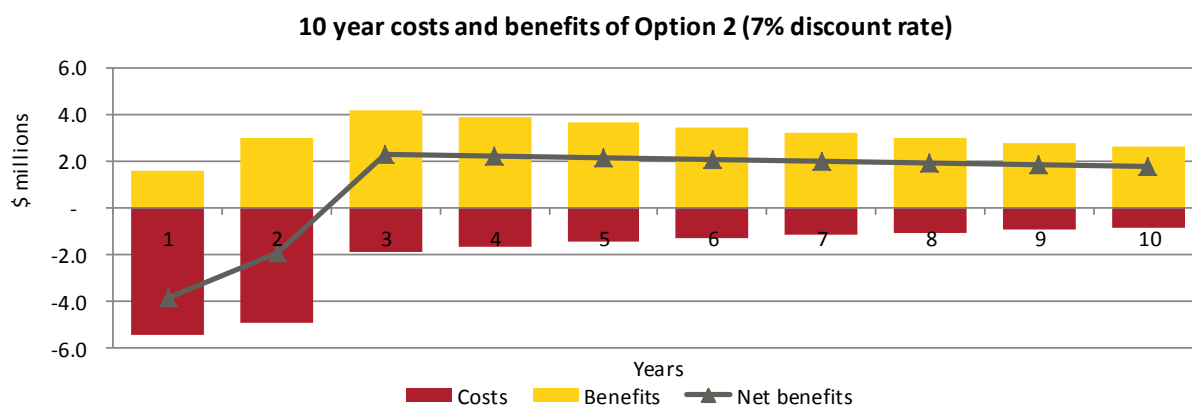


Figure 7. Ten year costs and benefits associated with Option 2

Strengths and weaknesses of the analysis

The quantitative analysis of this option has been undertaken using the best available data, but the analysis still relies on a number of assumptions about its costs and benefits. The strengths and weaknesses of these assumptions are discussed below.

Blood lead testing costs and worker removal costs

We can be fairly confident of the estimate of the total costs associated with additional blood lead level testing and removing workers from lead risk work. The results of all blood lead level tests in four states were provided for the CBA, representing around 80 per cent of the lead-risk workforce. This was extrapolated to form an Australia-wide estimate of what would have occurred if Option 2 had been in place in 2015.

This data clearly showed that only about one per cent of the lead risk workforce have exceeded the 30 µg/dL threshold for removal in 2015, and also shows the maximum number of blood tests that would need to be performed for this option.

Data from submissions and subsequent consultations provided a strong basis for estimating the unit costs associated with increasing blood lead level testing and the removal of workers from lead risk work.

Ongoing and capital costs

Due to the diversity in the nature of lead-risk work, and the starting point of businesses undertaking this type of work, businesses reported a wide range of estimates of the capital and ongoing costs that would be associated with implementing Option 2.

However, Victorian data showed that only 30 per cent of lead-risk businesses in 2015 had a worker with a test of greater than the proposed threshold for removal (the data from other states did not identify the worker's employer), so it is possible that some businesses have over-estimated these costs.

The CBA is particularly sensitive to the cost estimates associated with the small number of very large lead-risk businesses. Based on the data available, only a very small proportion of workers at these businesses would have exceeded the 30 µg/dL removal limit in 2015.

After consulting with these businesses, it appears that a significant proportion of the costs they have estimated would be associated with lowering the removal level to this amount, are based on the business applying a further buffer between the blood lead levels of their workforce and the regulatory requirement. Not all of these costs can therefore be attributed to the regulatory change.

Health benefits and reduced workers compensation benefits

There is some uncertainty about the monetary value of the health benefits that can be derived from reducing blood lead levels. Values could only be calculated for four of the illnesses and diseases which high blood lead levels have been associated with.

For these four conditions (liver cancer, oesophageal cancer, stroke and ischemic heart disease), there is good evidence supporting the estimate of the costs per case, but assumptions have needed to be made about the extent that the reduction would contribute to a reduction in their incidence.

The figures presented in the CBA should be considered to be illustrative of the minimum level of health benefits that would be realised from reducing worker's blood lead levels. If additional evidence could have been found to quantify the costs associated with all of the adverse health conditions that have been associated with high blood lead levels, then the estimate of the health benefits would likely be much higher.

Break-even analysis

Overall, the CBA is most sensitive to assumptions about increases capital and ongoing costs associated with the change and also the monetary value medical benefits associated with reduction in lead levels.

Sensitivity analysis of the figures above has been undertaken, to illustrate the number of adverse illnesses and diseases that would need to be avoided for the benefits of the option to exceed the costs (using the weighted cost of each case of illness or disease). This approach is otherwise known as a break even analysis.

The weighted cost of each case of lead related illness or disease has been estimated at \$0.4 million (including financial and non-financial costs). The costs associated with implementing Option 2 average \$2.7 million over 10 years, which means the implementation of this option would have to result in six avoided cases of these injuries or illnesses per year, across a lead risk workforce of approximately 10,000 for the benefits to exceed the costs. The analysis in this report show this is likely to be achieved across the four conditions where there was sufficient evidence to quantify the benefits of reducing blood lead levels (i.e. liver cancer, oesophageal cancer, stroke and ischaemic heart disease).

Sensitivity to discount rate assumptions

In addition to the seven per cent 'central' discount rate used for the CBA, Option 2 has also been assessed using real discount rates of three per cent and 10 per cent.

For both of the rates, the benefits of Option 2 are estimated to exceed the costs (by a ratio of 1.68 to one for a three per cent discount rate and by a ratio of 1.49 to one for a 10 per cent discount rate). This suggests the CBA is not sensitive to decisions about the discount rate.

Distribution of impacts on industry

Over 10 years, it is estimated that the largest share of the costs from Option 2 (72 per cent, or \$18 million) will be borne by very large businesses (i.e. mines and smelters), as these businesses employ the majority of lead process workers. An estimated 15 per cent of costs (\$3.7 million) will be borne by medium and large businesses and 13 per cent (\$3.3 million) will be borne by small businesses.

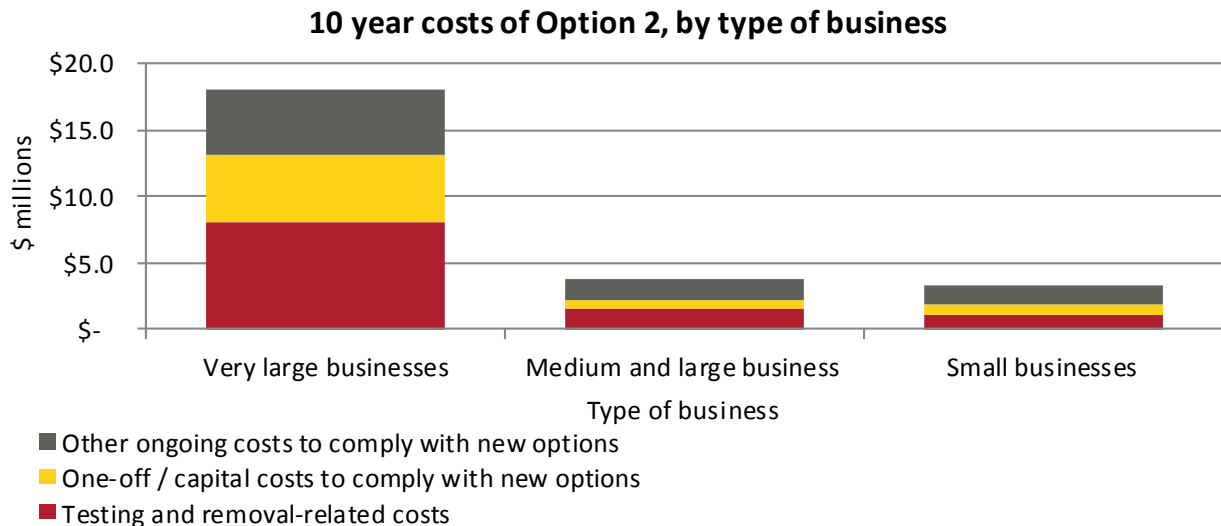


Figure 8. 10 year costs of Option 2, by type of business

7.6. Impacts of blood lead level option 3

The following section outlines the impacts of Option 3 for the reduction of blood lead removal levels.

Many lead process businesses did not provide an estimate of the costs associated this option, because they did not think it would be economically feasible, instead indicating that it would result in either the business closing or relocating to a country with less stringent requirements. It has not been possible to calculate the net impacts of this option. Therefore, the impacts have been assessed using a combination of quantitative and qualitative analysis.

Compliance costs

Using the assumptions outlined in this chapter, the following costs and benefits have been identified for Option 3:

- businesses would need to increase the frequency of the blood lead level testing of their workforce by more than double at a cost \$3.1 million per annum (six times the increase for Option 2);
- nearly 2,600 workers with blood lead levels above 10 µg/dL (about one-quarter of the lead risk workforce) would need to be removed from lead risk work. This would cost an estimated \$14 million per annum, based on the current blood lead levels of the workforce (19 times the increase for Option 2). It is doubtful these costs would actually be incurred, as it is more likely to result in the closure of many lead-related businesses or their relocation off-shore, and
- the capital costs associated with this option could not be quantified, but are estimated to be very high. Many businesses indicated that they could not become compliant with the standards proposed for Option 3 either at all or without completely re-engineering processes; at a cost in the millions for many small and medium sized businesses and in the hundreds of millions for many of the larger businesses.

Health effects

The 2014 Report (SWA 2014b), which reviewed the most current literature on health impacts associated with lead exposure, found most health effects observed with occupational exposure to lead have been associated with blood lead levels of more than 20 µg/dL, with stronger associations found for blood lead levels above 30 µg/dL.

Some of the literature reviewed identified associations between adverse health effects and blood lead levels around the level proposed for Option 3 (i.e. 10 µg/dL). Effects included nervous system abnormalities, blood conditions and stress.

Overall the literature suggested the greatest health gains were likely to be from reducing the higher-levels of lead in blood to 20 or 30 µg/dL and there are likely to be diminishing returns from adopting a target level below this.

Therefore, the health benefits from the reduction of the blood lead removal levels to 10 µg/dL are not considered to be significantly different to those of Option 2.

Overall impacts of Option 3

Overall, the costs of Option 3 are estimated to exceed the benefits by a substantial amount.

The evidence collected for the CBA shows that the costs associated with this option increase exponentially compared to Option 2; but there are diminishing incremental increases in health benefits. Industry feedback on this option was overwhelmingly negative, with many businesses indicating that it would not be feasible for them to meet the lead levels proposed in the option.

7.7. Impacts of options for workplace exposure standard (WES) for dusts and fumes of inorganic lead

As noted earlier in the RIS, the main duties for a person conducting a business or undertaking that relate to airborne dusts and fumes of inorganic lead exposure are:

- ensure no one at the workplace is exposed to airborne contaminants of lead above the workplace exposure standard
- conduct air monitoring if it is not known whether exposure will exceed the exposure standard or monitoring is necessary to determine if there is a risk to health
- assess and manage risks from airborne contaminants, and
- record keeping.

Air monitoring is only required if the workplace exposure standard is exceeded or to check that the control measures in place are effective. Air monitoring should only be used as a part of an overall workplace lead control strategy and is not considered to be a control measure in itself.

Evidence from submissions

Some lead-related businesses provided evidence in their submissions about how they comply with the current WES (Option 1) and the potential impacts of changes (Options 2, 3 and 4).

Based on the evidence provided by the businesses, air monitoring is considered the main additional cost of complying with the WES (i.e. in addition to the other costs the business incurs controlling levels of lead in blood).

Air monitoring is undertaken by some businesses on a regular basis (ranging from weekly to every two years) and by others on an ad hoc basis (for example often following a change in a lead process to check the effectiveness of control measures).

The estimated costs of current air monitoring activities ranged from \$900,000 per annum (for a very large business) to around \$5,000 per occurrence (more of representative of the costs incurred by ad hoc air monitoring undertaken by medium sized businesses). The costs for small businesses are less clear; however it is unlikely many of these businesses undertake frequent air monitoring.

The Victorian RIS for Hazardous Substances Regulations (2000) reported that only five per cent of businesses use air monitoring to gauge whether or not a WES had been exceeded. Regulator submissions noted that air monitoring is not well understood by industry and therefore not applied correctly in many circumstances.

Overall, businesses reported that the additional costs of air monitoring were less than 10 per cent of the total costs associated with controlling lead exposure at their workplace.

For many businesses monitoring and controlling the level of lead in air is seen as an essential part of an overall lead control strategy. However, for some businesses airborne lead is not considered the main source of their workforce's exposure to lead.

Businesses identified some additional costs associated with monitoring the level of lead in air as a result of implementing either Option 2 or Option 3. For many businesses, these costs were

identified as corresponding with Options 2 and 3 for blood lead levels. Responses noted that the control measures used to reduce the concentration of airborne lead contaminants would be the same as those applied to the corresponding option for blood lead levels and therefore there is no additional cost to those outlined for the options for blood lead levels.

There was mixed of support from submissions for the different WES options:

- some businesses supported no change to the current WES (Option 1)
- generally, businesses that supported option 2 for blood lead removal levels also supported a corresponding lowering of the WES (Option 2), and
- there was little support for Option 3, which like Option 3 for blood lead levels, was seen as unachievable and cost prohibitive.

Some responses supported a non-mandatory approach to controlling lead in air (Option 4), on the basis that it was an indirect measure of the level of lead exposure than biological monitoring. However, nearly all industry submissions indicated that they would not change their current level of air monitoring, nor would they change their control approaches should the status of the WES change.

Treatment of costs and benefits in the CBA for WES

It is difficult to accurately quantify the costs imposed by air monitoring for airborne contaminants of lead. As such, the CBA for the options for the WES for airborne contaminants of lead has included discussion around qualitative costs and benefits. Where solid data was available quantitative analysis was conducted.

It is important to avoid double-counting the costs associated with options for the WES and the costs associated with options for blood lead removal levels.

Many of the compliance costs identified in business' submissions to the Consultation RIS related to controlling both the level of lead in air and in blood. As discussed in Chapter 6, due to the idea of 'perceived' costs by industry, it is unclear whether businesses have costed accurately for compliance with air monitoring requirements.

Almost all businesses identified that there would be no decrease in air monitoring activities or change in control strategy (and therefore costs) associated with a change in WES status.

Option 2 –reduction of WES to 0.05 mg/m³

For many businesses there will be no increase in costs associated with the WES Option 2 if Option 2 for blood lead levels is also implemented.

The CBA has included an increase in costs proportional to the current estimate of spending on air monitoring (i.e. an additional 10 per cent as discussed above), which would be the equivalent of an additional \$231,000 per annum.

It is doubtful that the blood lead levels targeted for Option 2 (20 to 30 µg/dL) could be achieved in workplaces where inhalation is the primary source of exposure without a corresponding decrease in the levels of lead in air. However, as there is only an indirect link between lead in air and lead in blood and no further health benefits have been assumed for this option.

With the inclusion of these additional costs to those outlined for Option 2 for blood lead levels, the benefits for Option 2 still exceed the costs, with a 10 year ratio of quantifiable benefits to costs of 1.46 to one.

Although there is some uncertainty around how to attribute the additional costs associated with changes to the WES, these costs would need to be substantially higher than those described above before the benefit to cost ratio of this option was below one. Based on the analysis conducted for the CBA this is considered unlikely.

Option 3 –reduction of WES to 0.01 mg/m³

As with Option 3 for the lead in blood, this option was not seen as viable.

As with Option 3 for blood lead levels, this option would likely only provide a relatively small additional decrease in workers lead in blood levels (and therefore health effects), compared to Option 2.

Although the costs associated with this option could not be quantified, they are still expected to significantly exceed the benefits.

Option 4 – a non-regulatory WES for dusts and fumes of inorganic lead

Industry indicated that there would be no change to how workplace lead is managed if the status of the WES for dusts and fumes of inorganic lead were changed.

Therefore, no additional health cost or benefit will be seen other than those outlined in this RIS. As no clear benefit has been identified to support the change from a mandatory WES for lead, the current status (mandatory) is recommended to be retained.

A regulatory impact process is currently underway for the status of all the published workplace exposure standards and a change in status may be indicated through this process.

8. Summary of preferred options

Blood lead removal levels, workplace exposure standards for lead and related requirements have been regulated under Australian WHS laws without change for many years. The specific requirements for blood lead level testing (removal, levels, return to work levels and testing frequency) and the workplace exposure standard for dusts and fumes of inorganic lead have been considered for amendment in this regulatory impact assessment process.

These standards are considered outdated and evidence indicates they do not provide adequate protection to the majority of workers and especially females of reproductive capacity, those who are pregnant and those who are breastfeeding. It is important they are revised and updated to ensure better health outcomes for workers undertaking lead risk work.

The options proposed in this Decision RIS put forward a number of regulatory approaches for bringing these standards up-to-date with the toxicological profile for lead and into line with international best practice.

8.1. Summary of outcomes

Blood lead levels

Option 1 – not preferred

Based on consultation feedback and the toxicological implications of retaining current blood lead removal levels, maintaining the status quo is not the preferred option for the management of lead risk work. This option is not considered to protect workers from the adverse health effects of lead, and will not deliver positive health benefits or a net benefit to the community.

Option 2 – PREFERRED

Analysis of submissions **supported** a change in the regulatory requirements for lead risk work. This option was supported by a majority of submissions that indicated a preference; only one submission did not support this option due to 'severe' financial impacts.

Regulator submissions and targeted interviews indicated that approximately 70 per cent of businesses are already meeting the proposed thresholds. The key concern around the adoption of this option revolved around the process of changing internal target values and the time needed for workers once removed to reach blood lead level results below the target levels.

The CBA showed:

- quantifiable health benefits of \$5 million per annum which can be reached within 3 years of implementation
- average costs over 10 years of \$2.7 million per annum
- an average benefit over 10 years of \$4.8 million per annum, and
- an exceedance of benefit over costs over 10 years by a ratio of 1.57 to one.

This option will change the level at which health monitoring is triggered, the frequency of testing, the blood lead removal and return to work level as outlined in Chapter 9.

Option 3 – not preferred

Analysis of submissions revealed a lack of support for this option by industry, with five submissions citing this option as unviable due to practicality and financial reasons. It is noted that five submissions supported this option based on it providing the maximum protection of health. However, the submissions supporting Option 3 were not from companies currently undertaking biological monitoring and financial impact data or discussion around workplace impacts were not provided.

Targeted interviews with industry mirrored the public submissions, with businesses stating that financial costs were so extreme that they could not be calculated. Interviewees noted that if this option were to be adopted there would be a very high risk of business closure or work being moved off-shore to countries with less stringent requirements.

Quantifying the costs and benefits for this option in the CBA was impractical. However, based on consultation feedback and an understanding of the degree of change in work practices required

to comply with this option it was estimated that the costs would exceed the benefits by a substantial amount.

Workplace Exposure Standard

WES Option 1 – not preferred

Based on consultation feedback and the toxicological implications of retaining the current workplace exposure standard for lead, maintaining the status quo is not the preferred option.

Submissions indicated that the current WES for lead was not reflective of international best practice and should be updated.

WES Option 2 – PREFERRED

Analysis of submissions **supported** reducing the WES for lead to 0.05 mg/m³.

Of the submissions received that indicated a preference, a majority supported this change regardless of the cost involved with upgrading control measures or changing the frequency of air sampling procedures.

There were no submissions that did not support his option.

The costs for air monitoring conducted in lead process workplaces were difficult to quantify. However, submissions indicated that air monitoring is most often used as part of a control strategy for workplace lead and therefore many of the costs for compliance with the WES were considered to be included in estimated costs for controlling blood lead levels.

Submissions and targeted consultation confirmed that the frequency of air monitoring will increase from the base case (Option 1), and this assumption was built into the CBA to quantify the impact of this option.

The CBA has indicated that even if there is additional air monitoring required to comply with Option 2; the benefits still outweigh the costs at a ratio of 1.46 to one.

Therefore Option 2 is considered the preferred option to enable businesses to integrate air monitoring into their workplace lead control strategy and comply with the proposed regulatory requirements.

WES Option 3 – not preferred

This option was supported by one submission and not supported by two submissions. The submissions that did not support this option did so due to practicality and financial impacts.

Again, submissions indicated that costs for this option were not able to be quantified as complying with this standard was considered either financially unviable or unachievable.

The costs for this Option were unable to be quantified for the CBA. However, as with Option 3 for blood lead levels, the costs for complying with this option are expected to far exceed the benefits.

WES Option 4 – not preferred/deferred

This option of a non-regulatory approach to the WES for lead was supported by four submissions.

Submissions indicated that as the WES for lead is generally used as part of an overall lead control strategy, there would be no change to current risk mitigation measures and it would not make meeting regulation any easier or harder if the status of the workplace exposure standard changed.

Submissions revealed concern that the current mandatory status of the WES gave air monitoring too much emphasis, and when controlling for workplace lead exposure, a WES should be used by professionals as part of an overall control strategy. It was also noted that there are other effective ways of measuring potential lead exposures including surface wipe analysis.

The CBA did not identify any quantifiable benefits (monetary or health) and therefore a change in status for the WES for dusts and fumes of inorganic lead is not recommended.

A separate review process is currently being undertaken to propose and decide upon the status of all workplace exposure standards and a decision regarding the workplace exposure standard for lead may be indicated within that process.

Transitional arrangements

The submissions received indicated varying transition timelines, generally dependent on the scale of the change proposed.

The transitional periods required for implementation of blood lead removal levels Option 2 ranged from immediate/negligible to seven years; for Option 3 the transitional periods ranged from two to 10 years.

Based on responses received, the average time for implementation of Option 2 was two years. The cost benefit analysis demonstrated overall benefits for Option 2 after two years of implementation (Figure 7). Thus, an implementation period of two years is recommended as preferred.

8.2. Preferred Option – blood lead levels

Submissions and direct consultation indicated a preference for Option 2.

The CBA for Option 2 showed a quantifiable benefit over 10 years with a benefit to cost ratio of 1.51 to one.

Therefore the preferred option for management of workplace lead through blood lead level monitoring is considered to be Option 2:

Reducing mandated blood lead removal levels and related requirements to reflect epidemiological and toxicological evidence:

- a 20 µg/dL (target level) and 30 µg/dL (removal level) for females not of reproductive capacity and males, and
- 10 µg/dL removal level for females of reproductive capacity¹².

With a testing frequency of:

(a) For females not of reproductive capacity and males:

- (i) If the last blood lead level of less than 10 µg/dL (0.48 µmol/L)—6 months after the last biological monitoring of the worker; or
- (ii) If the last monitoring shows a blood lead level of 10 µg/dL (0.48 µmol/L) or more but less than 20 µg/dL (0.97 µmol/L)—3 months after the last biological monitoring of the worker; or
- (iii) If the last monitoring shows a blood lead level of 20 µg/dL (0.97 µmol/L) or more—6 weeks after the last biological monitoring of the worker

(b) For females of reproductive capacity:

- (i) If the last blood lead level of less than 5 µg/dL (0.24 µmol/L)—3 months after the last biological monitoring of the worker; or
- (ii) If the last monitoring shows a blood lead level of 5 µg/dL (0.24 µmol/L) or more but less than 10 µg/dL (0.48 µmol/L)—6 weeks after the last biological monitoring of the worker.

Workers may return to lead risk work if the worker's blood lead level is less than:

- For females not of reproductive capacity and males—20 µg/dL (0.97 µmol/L); or
- For females of reproductive capacity—5 µg/dL (0.24 µmol/L).

¹² Including those who are pregnant and/or breastfeeding

8.3. Preferred Option – workplace exposure standard

Submissions and direct consultation indicated a preference for Option 2. As compliance approaches for the workplace exposure standard are considered to be a part of the control strategy for management of blood lead levels, the CBA combined the relative costs and benefits. The CBA showed a quantifiable benefit over 10 years with a benefit to cost ratio of 1.4 to one.

Therefore the preferred option for the workplace exposure standard is considered to be:

Chemical name	CAS No.	TWA (mg/m ³)
Lead, inorganic dusts & fumes (as Pb)	7439-92-1	0.05

No quantifiable benefit was found for changing the mandatory nature of the WES for lead, therefore is it not recommended to change the status of the WES at this time.

8.4. Preferred Option – transition period

Submissions indicated an average time of two years for complying with Option 2. A two year transition period was also the preferred period in responses received.

The CBA for the preferred Option for blood lead levels showed a benefit starting in year three post implementation.

Therefore the preferred transition period is recommended to be two years.

9. Implementation and review

9.1. Implementation

Should WHS Ministers agree to the preferred options in this Decision RIS, the model WHS Regulations will be amended to the following (changes are in **bold**):

394 Meaning of *lead risk work*

In this Part *lead risk work* means work carried out in a lead process that is likely to cause the blood lead level of a worker carrying out the work to exceed:

- (a) for a female of reproductive capacity—**5 µg/dL (0.24 µmol/L)**; or
- (b) in any other case—**20 µg/dL (0.97 µmol/L)**.

407 Frequency of biological monitoring

(1) A person conducting a business or undertaking at a workplace must arrange for biological monitoring of each worker who carries out lead risk work for the person to be carried out at the following times:

- (a) for females not of reproductive capacity and males:
 - (i) if the last blood lead level of less than **10 µg/dL (0.48 µmol/L)**—6 months after the last biological monitoring of the worker; or
 - (ii) if the last monitoring shows a blood lead level of **10 µg/dL (0.48 µmol/L) or more but less than 20 µg/dL (0.97 µmol/L)**—3 months after the last biological monitoring of the worker; or
 - (iii) If the last monitoring shows a blood lead level of **20 µg/dL (0.97 µmol/L) or more**—6 weeks after the last biological monitoring of the worker
- (b) for females of reproductive capacity:
 - (i) If the last blood lead level of less than **5 µg/dL (0.24 µmol/L)**—3 months after the last biological monitoring of the worker; or
 - (ii) if the last monitoring shows a blood lead level of **5 µg/dL (0.24 µmol/L) or more but less than 10 µg/dL (0.48 µmol/L)**—6 weeks after the last biological monitoring of the worker.

415 Removal of a worker from lead risk work

(1) A person conducting a business or undertaking for which a worker is carrying out lead risk work must immediately remove the worker from carrying out lead risk work if the following health monitoring:

- (a) biological monitoring of the worker shows that the worker's blood lead level is, or is more than:
 - (i) for females not of reproductive capacity and males—**30 µg/dL (1.45 µmol/L)**;
or
 - (ii) for females of reproductive capacity—**10 µg/dL (0.48 µmol/L)**; or
- (b) the registered medical practitioner who supervised the health monitoring recommends that the worker be removed from carrying out the lead risk work; or
- (c) there is an indication that a risk control measure has failed and, as a result, the worker's blood lead level is likely to reach the relevant level for the worker referred to in paragraph (a).

417 Return to lead risk work after removal

(3) The person conducting the business or undertaking must ensure that the worker does not return to carrying out lead risk work until:

(a) the worker's blood lead level is less than:

- (i) for females not of reproductive capacity and males—**20 µg/dL (0.97 µmol/L)**;
or
- (ii) for females of reproductive capacity—**5 µg/dL (0.24 µmol/L)**; and

(b) a registered medical practitioner with experience in health monitoring is satisfied that the worker is fit to return to carrying out lead risk work.

9.2. Transition period

The transition period for compliance with the regulatory requirements outlined above will be two years from adoption.

9.3. Review

Review of the adopted change to the workplace lead requirements will be conducted as part of the scheduled review of the model WHS Regulations.

References

- Access Economics (2006) (for the Cancer Council NSW): Cost of Cancer in NSW; accessed at: http://www.cancercouncil.com.au/wp-content/uploads/2010/11/costofcancer_costs.pdf
- Access Economics (2009) (for Eli Lilly): The economic costs of heart attack and chest pain (Acute Coronary Syndrome); accessed at: [https://www.bakeridi.edu.au/Assets/Files/FullReport%20-%20the%20economic%20costs%20of%20heart%20attack%20and%20chest%20pain%20\(emiilable.pdf](https://www.bakeridi.edu.au/Assets/Files/FullReport%20-%20the%20economic%20costs%20of%20heart%20attack%20and%20chest%20pain%20(emiilable.pdf)
- Access Economics (2013) (for the National Stroke Foundation): The economic impact of stroke in Australia; accessed at: https://strokefoundation.com.au/What-we-do/Research/Economic_impact_of_stroke_in_Australia
- American Conference of Governmental Industrial Hygienists (ACGIH) (2015): TLVs® and BEIs® with 7th Edition Documentation, Cincinnati, USA.
- Australian Capital Territory Government (2016): Work Health and Safety Regulation 2011
- Australian Institute of Occupational Hygienists (AIOH) (2009): AIOH Position Paper: Inorganic Lead and Occupational Health Issues; AIOH Exposure Standards Committee; Tullamarine; accessed at: <https://www.aioh.org.au/documents/item/11>
- Centers for Disease Control and Prevention (CDC) (2005): Preventing Lead Poisoning in Young Children; U.S. Department of Health and Human Services; Atlanta; accessed at: <http://www.cdc.gov/nceh/lead/publications/PrevLeadPoisoning.pdf>
- Deutsche Forschungsgemeinschaft (2015): List of MAK and BAT Values 2015; accessed at: <http://onlinelibrary.wiley.com/book/10.1002/9783527695539>
- European Commission (EC) (2002): Recommendation from the Scientific Committee on Occupational Exposure Limits for lead and its inorganic compounds; SCOEL/SUM/83
- Marsden Jacob Associates (2012) *Regulatory Impact Statement, Model Work Health and Safety Regulations and Codes of Practice in Western Australia*
- New South Wales Government (2011): Work Health and Safety Regulation 2011
- NHRMC (2014): Evaluation of evidence related to exposure to lead; accessed at: <https://www.nhmrc.gov.au/guidelines-publications/eh58>
- NHRMC (2009): Information Paper – Blood Lead Levels for Australians; rescinded May 2015
- NHMRC (2015a): NHMRC Statement: Evidence on the Effects of Lead on Human Health; accessed at <https://www.nhmrc.gov.au/guidelines-publications/eh58>
- NHMRC (2015b): Information Paper: Evidence on the Effects of Lead on Human Health; accessed at <https://www.nhmrc.gov.au/guidelines-publications/eh58>
- Northern Territory Government (2012): Work Health and Safety (National Uniform Legislation) Regulations
- PriceWaterhouseCoopers Australia (PwC) (2012): Impact of the proposed national Model Work Health and Safety Laws in Victoria; accessed at: http://www.rcsa.com.au/documents/RCSA%20submissions/Impact_of_the_proposed_national_model_work_health_and_safety-PwC.pdf
- Queensland Government (2016): Work Health and Safety Regulation 2011
- Safe Work Australia (2011a): Model Work Health and Safety Act 2010; Canberra

Safe Work Australia (2011b): Decision Regulation Impact Statement for National Harmonisation of Work Health and Safety Regulations and Codes of Practice; Canberra

Safe Work Australia (2013a): Workplace Exposure Standards for Airborne Contaminants; Canberra

Safe Work Australia (2013b): Guidance on the Interpretation of Workplace Exposure Standards for Airborne Contaminants. Canberra

Safe Work Australia (2014a): Model Work Health and Safety Regulations 2011; Canberra

Safe Work Australia (SWA) (2014b): Review of Hazards and Health Effects of Inorganic Lead – Implications for WHS Regulatory Policy; Canberra; accessed at: <http://www.safeworkaustralia.gov.au/sites/SWA/about/Publications/Documents/871/Review-hazards-health-effects-inorganic-lead-report.pdf>

South Australian Government (2016): Work Health and Safety Regulations 2012

Tasmanian Government (2012): Work Health and Safety Regulations 2012

The Victorian WorkCover Authority's Regulatory Impact Statement on the Occupational Health and Safety (Lead) Regulations 2000; accessed at: <http://www.vcec.vic.gov.au/Regulation-Review/Search-for-a-RIS/2006-07>

US EPA (2013): Integrated science assessment for lead; United States Environmental Protection Agency; EPA/600/R-10/075F. June 2013; accessed at: <http://cfpub.epa.gov/ncea/isa/recordisplay.cfm?deid=255721>.

Victorian Government (2007): Occupational Health and Safety Regulations 2007

Western Australian Government (1996): Occupational Safety and Health Regulations 1996

World Health Organization (1980): Recommended Health-Based Limits in Occupational Exposure to Heavy Metals; Technical Report Series 647; Geneva

World Health Organization (2000): Air quality guidelines for Europe; 2nd Edition; WHO regional publications. European series ; No. 91; Copenhagen

Appendix A: Glossary

Acronyms

Acronym	Description
ACGIH	American Conference of Governmental Industrial Hygienists
BLRL	Blood Lead Removal Level
COAG	Council of Australian Governments
FRC	Females of Reproductive Capacity
FNRC	Females Not of Reproductive Capacity
mg/m ³	Milligrams per metre cubed
NHMRC	National Health and Medical Research Council
NOHSC	National Occupational Health and Safety Commission
OBPR	Office of Best Practice Regulation
P/BF	Pregnant and or Breast Feeding
RIS	Regulation Impact Statement
TWA	Time Weighted Average
µg/dL	Micrograms per decilitre
µg/m ³	Micrograms per metre cubed
µmol/L	Micromoles per litre
WES	Workplace Exposure Standard
WHS	Work Health and Safety

Definitions

8-hour Time-weighted average (TWA) means the maximum average airborne concentration of a substance when calculated over an eight-hour working day, for a five-day working week.

Biological monitoring means:

- a) the measurement and evaluation of a substance, or its metabolites, in the body tissue, fluids or exhaled air of a person exposed to the substance; or
- b) blood lead level monitoring.

Blood lead level means the concentration of lead in whole blood expressed in micromoles per litre (µmol/L) or micrograms per decilitre (µg/dL).

Blood lead level monitoring means the testing of the venous or capillary blood of a person by a laboratory accredited by the National Association of Testing Authorities (NATA), under the supervision of a registered medical practitioner, to determine the blood lead level.

Blood lead removal level means a confirmed blood lead level at which a worker must immediately be removed from carrying out lead risk work.

Female of reproductive capacity - means a female other than a female who provides information stating that she is not of reproductive capacity.

Health monitoring (in reference to lead) - means monitoring the person to identify changes in the person's health status because of exposure to lead. Health monitoring includes: demographic, medical and occupational history, physical examination, and biological monitoring.

Lead means lead metal, lead alloys, inorganic lead compounds and lead salts of organic acids.

Lead process – see [Appendix B](#)

Lead process area means a workplace or part of a workplace where a lead process is carried out.

Lead risk work - means work carried out in a lead process that is likely to cause the blood lead level of a worker carrying out the work to exceed:

- a) for a female of reproductive capacity — 10 µg/dL (0.48 µmol/L); or
- b) in any other case — 30 µg/dL (1.45 µmol/L).

Workplace exposure standard means an exposure standard in Safe Work Australia's *Workplace Exposure Standard for Airborne Contaminants* (2013). An exposure standard represents the airborne concentration of a particular substance or mixture that must not be exceeded. The exposure standard for lead is in the form of an 8-hour time-weighted average (TWA).

Conversions

1 µg/m³ = 0.001 mg/m³ (1000 micrograms in one milligram)

1 µg/dL = ~0.05 µmol/L (µg/dL × 0.0483 (conversion factor for lead))

1 µmol/L = ~21 µg/dL (µg/dL × 20.72 (molecular weight of lead per decilitre))

Interpretation

This Decision RIS should be read with:

- Part 7.2 of the [model Work Health and Safety \(WHS\) Regulations](#), published on the Safe Work Australia website
- the Safe Work Australia publication [Workplace Exposure Standards for Airborne Contaminants](#), 18 April 2013, published on the Safe Work Australia website
- the report [Review of hazards and health effects of inorganic lead – implications for WHS regulatory policy](#), July 2014, published on the Safe Work Australia website
- the Consultation Regulatory Impact Statement [Proposed amendments to work health and safety requirements for inorganic lead](#), December 2015, published on the Safe Work Australia website

Appendix B: Meaning of a lead process

Model WHS Regulations (2014) Part 7.2 Division 1

r392: A **lead process** consists of any of the following carried out at a workplace:

- (a) work that exposes a person to lead dust or lead fumes arising from the manufacture or handling of dry lead compounds;
- (b) work in connection with the manufacture, assembly, handling or repair of, or parts of, batteries containing lead that involves the manipulation of dry lead compounds, or pasting or casting lead;
- (c) breaking up or dismantling batteries containing lead, or sorting, packing and handling plates or other parts containing lead that are removed or recovered from the batteries;
- (d) spraying molten lead metal or alloys containing more than 5% by weight of lead metal;
- (e) melting or casting lead alloys containing more than 5% by weight of lead metal in which the temperature of the molten material exceeds 450°C;
- (f) recovering lead from its ores, oxides or other compounds by thermal reduction process;
- (g) dry machine grinding, discing, buffing or cutting by power tools alloys containing more than 5% by weight of lead metal;
- (h) machine sanding or buffing surfaces coated with paint containing more than 1% by dry weight of lead;
- (i) a process by which electric arc, oxyacetylene, oxy gas, plasma arc or a flame is applied for welding, cutting or cleaning, to the surface of metal coated with lead or paint containing more than 1% by dry weight of lead metal;
- (j) radiator repairs that may cause exposure to lead dust or lead fumes;
- (k) fire assays if lead, lead compounds or lead alloys are used;
- (l) hand grinding and finishing lead or alloys containing more than 50% by dry weight of lead;
- (m) spray painting with lead paint containing more than 1% by dry weight of lead;
- (n) melting lead metal or alloys containing more than 50% by weight of lead metal if the exposed surface area of the molten material exceeds 0.1 square metre and the temperature of the molten material does not exceed 450°C;
- (o) using a power tool, including abrasive blasting and high pressure water jets, to remove a surface coated with paint containing more than 1% by dry weight of lead and handling waste containing lead resulting from the removal;
- (p) a process that exposes a person to lead dust or lead fumes arising from manufacturing or testing detonators or other explosives that contain lead;
- (q) a process that exposes a person to lead dust or lead fumes arising from firing weapons at an indoor firing range;
- (r) foundry processes involving:
 - (i) melting or casting lead alloys containing more than 1% by weight of lead metal in which the temperature of the molten material exceeds 450°C; or
 - (ii) dry machine grinding, discing, buffing or cutting by power tools lead alloys containing more than 1% by weight of lead metal;
- (s) a process decided by the regulator to be a lead process under regulation 393 of the model Work Health and Safety Regulations.

Appendix C: Questions asked of stakeholders in the Consultation RIS

Section of the Consultation RIS	Question
5.4 Lead risk work	How many workers does your business currently employ?
	How many of these workers are classified as undertaking lead risk work?
	Of those lead risk workers how many are: <ul style="list-style-type: none"> • Females not of reproductive capacity • Females of reproductive capacity • Males
Blood lead removal levels	
7.1 BLL Option 1 – Maintain the status quo (base case)	How do you administer health monitoring? <ul style="list-style-type: none"> • Medical practitioners hired directly (employed by the business) • Health monitoring outsourced • Other- please provide details
	What are the costs associated with managing worker blood lead levels? (Including both direct and indirect costs). You should take into consideration: <ul style="list-style-type: none"> • Biological and health monitoring (e.g. blood tests, pathology expenses, costs for medical practitioners and other staff) • Removal of lead risk workers • Administrative and notification requirements (e.g. record keeping, notifying the regulator) • Training (e.g. staff time off, costs of facilitator) • PPE and engineering controls
	Any information you may have on blood lead removal levels, frequencies for testing or other hazard/risk control methods that are stricter than or exceed those prescribed in the regulations would be appreciated. If you are located in a rural or remote area or face particular difficulties in meeting health monitoring requirements we are interested to hear more.
7.3 Summary of changes to the regulations for Option 2	If BLL Option 2 is implemented, how much would the change cost your business? For example would you need to undertake more health monitoring more often for more workers? Please provide details of transitional and ongoing costs per year if possible. If your business already meets the standards in BLL Option 2 then the cost is Nil.
	Based on your current knowledge of blood lead levels in your workplace would you need to: <ul style="list-style-type: none"> • Increase blood lead level monitoring? • Put in place new controls, or improve existing controls to maintain levels?
	How long would it take you to make the changes needed to meet the new blood lead levels?
7.5 Summary of changes to the regulations for Option 3	If BLL Option 3 is implemented, how much would the change cost your business? For example would you need to undertake more health monitoring more often for more workers? Please provide details of transitional and ongoing costs per year if possible.
	Based on your current knowledge of blood lead levels in your workplace, to meet the level of 10 µg/dL for all workers, would you need to: <ul style="list-style-type: none"> • Increase blood lead level monitoring? • Put in place new controls, or improve existing controls to meet these levels?
	How long would it take you to make the changes needed to meet the new blood lead levels?
Workplace exposure standard	
9.1 WES Option 1 – Status quo	How often do you undertake air monitoring for lead levels? For example: regularly or on an ad hoc basis.
	How much does ensuring compliance with exposure standards cost your business? You should take into consideration:

Section of the Consultation RIS	Question
	<ul style="list-style-type: none"> • Air monitoring costs (e.g. equipment) • Staffing costs (e.g. in-house occupational hygienist, external consultant) <p>Have you needed to implement controls because of a high or increasing airborne lead contamination levels?</p>
9.2 WES Option 2 – Evidence-based approach	<p>Comment is sought on whether this option is reasonably practicable. In particular detailed information is sought about compliance costs for this option, including information about:</p> <ul style="list-style-type: none"> • whether businesses already meet or exceed the proposed standard • how difficult the proposed standard would be to meet (e.g. technical feasibility), and • whether existing controls could be used to meet the proposed standard (e.g. ventilation). <p>If WES Option 2 is implemented, how much would the change cost your business per year? Please provide details of transitional and ongoing costs if possible. If your business already meets the standards in WES Option 2 then the cost is Nil.</p> <p>Based on your knowledge of meeting the current requirements, to meet the level of 0.05 mg/m³ would you need to:</p> <ul style="list-style-type: none"> • Increase the monitoring on your workplace? • Increase other any other controls to maintain levels?
9.3 WES Option 3 – Most protective	<p>There is uncertainty as to whether this option is reasonably practicable. Comments are sought on this point.</p> <p>If WES Option 3 is implemented, how much would the change cost your business per year? Please provide details of transitional and ongoing costs if possible.</p> <p>Based on your knowledge of meeting the current requirements, to meet the level of 0.01 mg/m³ would you need to:</p> <ul style="list-style-type: none"> • Increase the monitoring on your workplace? • Increase other any other controls to maintain levels?
9.4 WES Option 4 – Non-regulatory approach	<p>Based on your knowledge of meeting the current requirements, to meet the requirement of managing health and safety risks so far as is reasonably practicable without a prescribed WES, would you need to:</p> <ul style="list-style-type: none"> • Change the way you approach air monitoring in your workplace? • Would this reduce your costs? • Do you think it would be harder or easier to comply with blood lead level requirements if the exposure standard was non mandatory?

Appendix D: Common assumptions used in CBA

Assumption	Value	Description
Population assumptions:		
Lead process workers	9,893	The total number of lead process workers in Australia
Businesses	Very large: 5 Medium to large: 100 Small: 500	The total number of businesses undertaking lead-risk work
Workers exceeding removal thresholds	BLL Option 1: 6 BLL Option 2: 157 BLL Option 3: 2,596	Based on 2015 blood lead level tests, the number of workers who would exceed the relevant threshold for removal under Options 1-3,
Blood lead testing frequencies	Current: 2.35 Option 2: 3 Option 3: 6	The number of times lead process workers are tested each year
Cost assumptions		
Wage rates	\$93 per hour	The average wage rate of lead-process work, including the 75 per on-costs required by OBPR
Blood lead tests	\$86 per test	Includes testing costs of \$55 per test, plus \$31 of lost productive time
Removing workers	Option 1: \$3,240 Option 2: \$4,300 Option 3: \$5,360	The average cost of removing a worker who exceeds the relevant removal threshold under each option
Review of measures	\$2,000	The cost associated with undertaking a review of lead exposure measures, following the removal of a worker
Other removal costs	\$2,000	Regulator costs associated with investigation and follow-up after a worker is removed
Increases in operating costs (by business)	Very large: \$100k M-large: \$5,000 Small: \$1,000	The annual increases in operating costs associated with Option 2 (Option 3 was not considered feasible, so could not be quantified)
Increases in capital costs (by business)	Very large: \$1m M-large: \$20k Small: \$5k	The capital costs associated with Option 2 (Option 3 was not considered feasible, so could not be quantified)
Timing of capital costs	2 years	Capital costs are assumed to be incurred evenly over two years
Business affected by Option 2	30%	The proportion of businesses that will incur additional costs associated with Options 2 and 3 (other businesses do not have workers who exceed the relevant removal threshold)
Additional costs due to changes in the WES	Option 2: 10% Option 3: unfeasible	The cost of increasing the WES, relative to other costs associated with Option 2.
Benefits		
Health benefits	\$5 million	Minimum value of annual health benefits from Option 2
Workers compensation benefits	\$293,000	Value of avoided workers compensation costs from Option 2

Appendix E: Regulatory Burden Measurement Framework Costings

The Regulatory Burden Measurement (RBM) Framework applies to new regulations or changes to existing regulations and requires any additional regulatory costs they impose on businesses, community organisations and individuals be quantified. The Commonwealth is attributed fifty percent of the regulatory burden cost.

NOTE: The numbers reflected in the table below may not necessarily replicate the numbers in the cost benefit analysis.

Activity	Additional cost per annum (total across lead industry)
<i>Blood lead level Option 2</i>	
Notify regulator of lead risk work	\$1000
Undertake health monitoring ¹	\$723,000
Remove workers who exceed the mandated blood lead level from lead risk work ²	\$1,994,000
Capital expenditure ³	\$515,000
Air monitoring activities – WES Option 2 – 0.05 mg/m ³	\$231,000
BUSINESS COST PER ANNUM OVER 10 YEARS	\$3,464,000
<i>Blood lead level Option 3</i>	
Notify regulator of lead risk work	\$1000
Undertake health monitoring ¹	\$3,188,000
Remove workers who exceed the mandated blood lead level from lead risk work ²	\$34,247,000
Capital expenditure ⁴	\$60,500,000
Air monitoring activities – WES Option 3 – 0.01 mg/m ³	\$64,244,000
BUSINESS COST PER ANNUM OVER 10 YEARS	\$162,180,000
Agency (OBPR ID)	Cost Offset (total savings per annum)
Employment portfolio (17063)	\$21.2 million
Are all new costs offset?	
<input checked="" type="checkbox"/> Yes, costs are offset	
<input type="checkbox"/> No, costs are not offset	
<input type="checkbox"/> Deregulatory—no offsets required	
Total (Change in costs [preferred option] – Cost offset)	— \$ 17.7 million

¹ including cost of testing and time lost to take test

² including cost to business of removal as outlined in Chapter 6 and notification of the regulator

³ implementation (capital) costs of \$5.15 million averaged over 10 years

⁴ implementation (capital) costs of \$605 million averaged over 10 years