



Lead in plumbing products in contact with drinking water

Consultation Regulation Impact Statement 2020

The Australian Building Codes Board has developed this Consultation Regulation Impact Statement, which accords with the requirements of Best Practice Regulation: *A Guide for Ministerial Councils and National Standard Setting Bodies*, as endorsed by the Council of Australian Governments in 2007. Its purpose is to inform interested parties and to assist the Australian Building Codes Board in its decision making on proposed amendments to the National Construction Code.

The Australian Building Codes Board

The Australian Building Codes Board (ABCB) is a joint initiative of all levels of government in Australia, together with the building industry. Its mission is to oversee issues relating to health, safety, amenity and sustainability in building. The ABCB promotes efficiency in the design, construction and performance of buildings through the National Construction Code, and the development of effective regulatory and non-regulatory approaches. The Board aims to establish effective and proportional codes, standards and regulatory systems that are consistent between states and territories. For more information see [the ABCB website](#).

Consultation

This is a consultation document where interested parties are invited to provide comment on any matter raised in this Regulatory Impact Statement (RIS). A series of consultation questions have been provided throughout the document and respondents are encouraged to address these items to assist in the development of a Final RIS. All submissions and comments will be published unless they are marked 'commercial-in-confidence'. However, any contact details you provide within your submission will be redacted prior to the submission being published.

The ABCB Office will review all comments received and incorporate stakeholder information and data into the regulatory analysis, as appropriate. The RIS will be revised in the light of stakeholder comments and will be forwarded to the Board as an input into its decision-making.

The Consultation RIS can be downloaded from the ABCB website at abcb.gov.au/consultation/regulation-impact-analysis/consultation-ris (click on the link to “Lead in Plumbing Products RIS”).

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Glossary

| Term | Meaning |
|--------------------------------|---|
| Accredited Testing Laboratory | An organisation accredited by the National Association of Testing Authorities (NATA) to undertake the relevant tests; or An organisation outside Australia accredited by an authority to undertake the relevant tests and is recognised by NATA through a mutual recognition agreement. |
| Deemed-to-Satisfy Provisions | Provisions which are deemed to satisfy the Performance Requirements. |
| Disability Adjusted Life Year | A summary measure of population health that accounts for both mortality and nonfatal health consequences. |
| Low Lead | A plumbing product or material in contact with drinking water calculated using a weighted average lead content of not more than 0.25%, verified in the form of either— <ol style="list-style-type: none">a test report provided by an Accredited Testing Laboratory, in accordance with NSF/ANSI 372; ora WaterMark licence if it includes compliance with NSF/ANSI 372. |
| Performance Requirement | A requirement which states the level of performance which a Performance Solution or Deemed-to-Satisfy Solution must meet. |
| Performance Solution | A method of complying with the Performance Requirements other than by a Deemed-to-Satisfy Solution. |
| WaterMark Certification Scheme | The ABCB scheme for certifying and authorising plumbing and drainage products. |
| Weighted average | Calculated across the wetted surface area of a pipe, pipe fitting and plumbing fixture. |
| Wetted surface area | Calculated by the total sum of diameter (D) in contact with drinking water. |

Acronyms

| Abbreviation | Full Name |
|--------------|---|
| ABCB | Australian Building Codes Board |
| ADWG | Australian Drinking Water Guidelines |
| AMRIA | Australian Metal Recycling Industry Association |
| AS | Australian Standard |
| AS/NZS | Australian and New Zealand Standard |
| AWQC | Australian Water Quality Centre |
| CDA US | Copper Development Association Incorporated, McLean, Virginia |
| CHO | Chief Health Officer |
| COAG | Council of Australian Governments |
| DALY | Disability Adjusted Life Year |
| DTS | Deemed-to-Satisfy |
| EPA | Environmental Protection Agency (US) |
| FPAA | Fire Protection Association Australia |
| IGA | Intergovernmental Agreement |
| IRCC | Inter-jurisdictional Regulatory Collaboration Committee |
| JAS-ANZ | Joint Accreditation System of Australia and New Zealand |
| NCC | National Construction Code |
| NHMRC | National Health and Medical Research Council |
| NUO | Network Utility Operator |
| OBPR | Office of Best Practice Regulation |
| pH | Potential of Hydrogen |
| PCA | Plumbing Code of Australia |
| PCH | Perth Children's Hospital |
| RIS | Regulation Impact Statement |
| TMV | Thermostatic Mixing Valve |
| µg | Micrograms |
| VSLY | Value of Statistical Life Year |
| WHO | World Health Organisation |
| WMCS | WaterMark Certification Scheme |
| WSAA | Water Services Association of Australia |

Introduction

The use of lead (Pb) in the manufacture of plumbing products has been common practice for many centuries. It is most commonly found in copper alloys, such as brass and bronze, where a small amount is added to provide malleability. These alloys are frequently used as components of plumbing products in contact with drinking water.

A recent survey by the Australian Building Codes Board (ABCB) of the Australian plumbing industry indicated that 90% of all plumbing products in contact with drinking water contain lead to differing extents.

The allowable amount of lead varies depending on the plumbing product and is regulated in Australia through both manufacturing standards and via the adoption of the Australian and New Zealand Standard (AS/NZS) 4020 *Testing of Products for Use in Contact with Drinking Water*. It is a requirement of the National Construction Code (NCC) Volume Three that lead water levels not exceed 10 micrograms (μg) per litre (L) of water when tested in accordance with the Standard.¹ This requirement was first introduced in 1991 and has contributed to a measurable reduction of lead exposure from drinking water in Australia.

Lead has long been recognised as a cumulative toxicant and there is no blood lead level which is considered safe.² Once lead enters the blood, it is distributed to organs such as the brain, kidneys, liver and bones. At high lead exposure, lead has been known to cause coma, convulsion and death. The health impacts of lead are most profound in children under 4 years of age and pregnant women.

At blood lead levels which were previously considered safe, lead is now known to be associated with a spectrum of health consequences which include reduced intelligence quotient (IQ), behavioural changes (such as reduced attention span and increased antisocial behaviour), anaemia, hypertension, renal impairment, immunotoxicity and toxicity to reproductive organs. These effects are believed to be irreversible and have resulted in both the World Health Organisation (WHO) and the

¹ Australian/New Zealand Standard 4020 (2018) Table 2: Maximum Allowable Concentrations of Metals. Page 15. SAI Global.

² World Health Organisation (2018) Lead poisoning and health. ><https://www.who.int/news-room/fact-sheets/detail/lead-poisoning-and-health> Accessed 4 June 2020.

National Health and Medical Research Council (NHMRC) encouraging governments to eliminate non-essential uses of lead.^{3,4}

People can be exposed to lead from ingestion of airborne dust, water, food and soil. The most common source of lead in drinking water is caused by lead leaching from plumbing products from within the premises.⁵

To mitigate the risk associated with lead exposure in Australia, drinking water is routinely tested for the presence of metals, including lead, by Network Utility Operators. Such intervention is effective and Australian drinking water supplied to the premises is ranked in the top 15% for water quality in the world. Hence, where lead is present in drinking water in quantities above that permitted by AS/NZS 4020, the likely cause is plumbing products in contact with drinking water from within the property.

This Consultation RIS considers whether reducing lead content in plumbing products in contact with drinking water can have a measurable impact on reducing the lead content in drinking water and blood lead levels, particularly in the vulnerable population.

Plumbing products in contact with drinking water have received negative attention for their potential to leach lead. In 2016, the Perth Children's Hospital (PCH) was found to have lead leaching from in-line fittings within the drinking water supply exceeding 10 µg/L. A study in New South Wales in the same year also found that 8% of 212 homes studied presented lead levels that exceeded 10 µg/L.⁶

Incidences of high lead levels in drinking water have resulted in the issuing of advice from the Environmental Health Standing Committee (enHealth) encouraging occupants to draw water each morning before use for a period of 30 seconds.⁷ It has also led to the ABCB undertaking a project to investigate options to address the issue, including the commissioning of a report in 2018 by Macquarie University, *Lead in*

³ World Health Organisation (2019) 'Lead'. >https://www.who.int/ipcs/assessment/public_health/lead/en/ Accessed 6 June 2020.

⁴ NHMRC (2015) 'Evidence on the effects of lead on human health' ><https://www.nhmrc.gov.au/about-us/publications/evidence-effects-lead-human-health> Accessed 6 June 2020.

⁵ US Environmental Protection Agency (2019) 'Basic Information about Lead in Drinking Water' ><https://www.epa.gov/ground-water-and-drinking-water/basic-information-about-lead-drinking-water>< Accessed 2 August 2020.

⁶ Tests involved the sampling of first-draw water in the morning, when water had been in contact with fittings overnight.

⁷ enHealth (2018) 'enHealth Guidance Statement Lead in drinking water from some plumbing products' [https://www.health.gov.au/internet/main/publishing.nsf/content/A12B57E41EC9F326CA257BF0001F9E7D/\\$File/Lead-plumbing-products-Guidance-Statement-July2018.pdf](https://www.health.gov.au/internet/main/publishing.nsf/content/A12B57E41EC9F326CA257BF0001F9E7D/$File/Lead-plumbing-products-Guidance-Statement-July2018.pdf) . Accessed 5 July 2020.

Plumbing Products and Materials, which evaluated the extent lead is used in the manufacture of plumbing products and materials in contact with drinking water in Australia.⁸

In May 2019, a Lead in Plumbing Products forum was convened by the ABCB with representatives of plumbing manufacturers, chairpersons of Standards Australia's technical committees responsible for the relevant product standards, enHealth and plumbing suppliers and retailers. During the forum, participants considered the need to further reduce lead levels in plumbing products and a survey of attendees revealed that 92% agreed that lead content in plumbing products in contact with drinking water should be reduced.

Current interventions that seek to reduce lead content in drinking water have been shown to be successful. These include water treatment by pH adjustment and orthophosphate dosing to reduce lead solubility, which can reduce dissolved lead concentrations but not eliminate the problem. The most effective intervention is the reduction of lead content through the use of low lead plumbing products and materials.⁹

Internationally, regulations pertaining to the use of lead in plumbing products in contact with drinking water have undergone reform in recent years. In 2014, USA federal legislation commenced that was designed to substantially reduce the lead content of plumbing fixtures and fittings in contact with drinking water. The prescribed legislation requires a maximum limit of 0.25% lead calculated across the wetted surfaces of a pipe, pipe fitting, plumbing fitting and fixture and 0.2% lead for solder and flux on newly manufactured or installed products.¹⁰ The new requirements resulted in a substantial reduction from the previously permissible maximum lead content of 8% and reflects the lowest lead level content which is technically achievable. This was enacted as part of the response to the Maximum Contaminant Level Goal (MCLG) of zero being set by the (US) Environmental Protection Agency (EPA). Sweden¹¹ and Canada¹² have

⁸ Taylor, M. Harvey, P. & Morrison, A. *Lead in Plumbing Products and Materials*. Macquarie University, NSW, Australia. ISBN: 978-1-74138-468-0

⁹ For brass products, it is not possible to achieve zero percent lead due to small trace amounts in the raw materials.

¹⁰ (US) Environmental Protection Agency, *Use of Lead Free Pipes, Fittings, Fixtures, Solder and Flux for Drinking Water* (2017) ><https://www.epa.gov/dwstandardsregulations/use-lead-free-pipes-fittings-fixtures-solder-and-flux-drinking-water> Accessed 29 May 2019.

¹¹ Boverket's Building Regulations 2019 (Sweden), Chapter 6.62.

¹² Government of Canada, *Guidelines for Canadian Drinking Water Quality: Guideline Technical Document – Lead*.

also recently reduced the permissible lead water level below that of the Australian limit (10 µg/L).

Water testing standards internationally have also improved, resulting in some stakeholders suggesting that the test methods used in Australia with respect to lead are now out-dated, inconsistent with international practice and do not reflect how lead enters the water supply.^{13,14} The test methods for lead within AS/NZS 4020 have not substantially changed since the introduction of the test in 1991.¹⁵

Many factors influence the variability of lead in water. These factors include; the materials used in the plumbing system; the age of the plumbing system and its complexity; introduced chemicals; water quality fluctuations (pH) and behavioural factors, such as usage patterns, flow rates and stagnation. Some of these variables are not reflected in the AS/NZS 4020 testing regime.

The most critical factor influencing the level of lead in drinking water is the lead content in the plumbing product itself. Laboratory testing has shown that lead leaches from copper alloy plumbing products in contact with drinking water. This occurs through a long-term process known as dezincification and is causing instances of non-compliance with the acceptable maximum set by Australian plumbing regulations. The short-term release of lead through the dissolution of a leaded film (a by-product of the manufacturing process) is also believed to be causing non-compliances in practice where plumbing products in contact with drinking water are not adequately rinsed after machining by the manufacturer.

Purpose and Scope

This Consultation RIS considers whether reducing lead content in plumbing products in contact with drinking water can have a measurable impact on reducing the lead content in drinking water and blood lead levels, particularly in the vulnerable population.

The scope of this Consultation RIS is focused on plumbing products in contact with drinking water from within the premises only. Other plumbing products (i.e. products

¹³Tallowood Rise Water Consulting (2020) Potential changes to AS/NZS 4020: Testing for lead leaching.

¹⁴ Taylor, M. Harvey, P. & Morrison, A. Lead in Plumbing Products and Materials. Macquarie University.

¹⁵ Test methods originated in AS 3855 – 1991 which has now been withdrawn and replaced with AS/NZS 4020 – 2018.

not in contact with water intended for drinking) and the infrastructure of Network Utility Operators (NUOs) is not within scope of this analysis. NUO infrastructure is excluded on the basis that there is no evidence to indicate high levels of lead leaching into the drinking water supply up to the point of connection to the premises. The focus is also on new products and does not include the premature replacement of existing plumbing products.

Comments on the Consultation RIS

All interested parties are encouraged to provide responses to the questions listed throughout the document. Responses can be submitted via the ABCB's [Consultation Hub](#) until 11:59 pm 1 March 2021.

Problem

Nature of the Problem

The nature of the problem relates to the inclusion of lead in the manufacture of plumbing products in contact with drinking water. This results in a risk of lead leaching into the drinking water supply at higher levels than permitted by Australian and international standards, with potential health consequences when drinking water is consumed.

The nature of the problem contains three elements:

- the inclusion of lead in the manufacture of brass and other copper alloy plumbing products in contact with drinking water, primarily to facilitate the machining of products;
- the mechanisms of short-term and long-term release of lead into drinking water from leaded plumbing products, through surface films and dezincification; and
- the health consequences of drinking water containing low levels of lead and its impact on the population, when consumed.

Lead in plumbing products in contact with drinking water

Lead is currently permitted in small proportions in the raw materials used to manufacture some plumbing products in contact with drinking water. It is used to improve a product's malleability and corrosive resistance properties, and is a particularly useful lubricant that assists in the machining of new products. In its most common form in plumbing products, lead is mixed with copper (Cu) and zinc (Zn) to form brass. It is also used in the manufacture of other copper alloys such as bronze.

A recent industry survey revealed that approximately 90% of copper alloy plumbing products sold in Australia contain lead to some extent. The exact lead content of products varies by component, although some products contain up to 6% lead as a proportion of raw material.¹⁶

¹⁶ Taylor, M. Harvey, P. & Morrison, A. Lead in Plumbing Products and Materials. Macquarie University. Page 13.

The types of copper alloy products in contact with drinking water which contain lead include:

- Fittings.
- Valves.
- Fittings on stainless steel braided hoses.
- Taps.
- Mixers.
- Appliances.
- Water heaters.
- Water dispensers (boiling and cooling units).

Some products may contain lead, but are not within scope of this analysis.

These include:

- Residential fire sprinklers.
- Fire-fighting equipment.
- Irrigation.
- Appliances, including washing machines and dishwashers.
- Commercial boilers (associated with HVAC systems).
- Toilets.
- Emergency deluge showers, eyewash and eye-face wash equipment.
- Showers for bathing.
- Recycled water systems (such as residential dual pipe reuse systems or dual reticulation systems).

These exclusions reflect the low likelihood of water from these products being consumed for drinking purposes.

Consultation Question:

1. Is the scope of products listed above appropriate?

If no, please explain why products should be included or excluded.

Lead leaching into drinking water

Lead release from copper alloy plumbing products in contact with drinking water can occur differently over the short and long term.

Short-term lead release

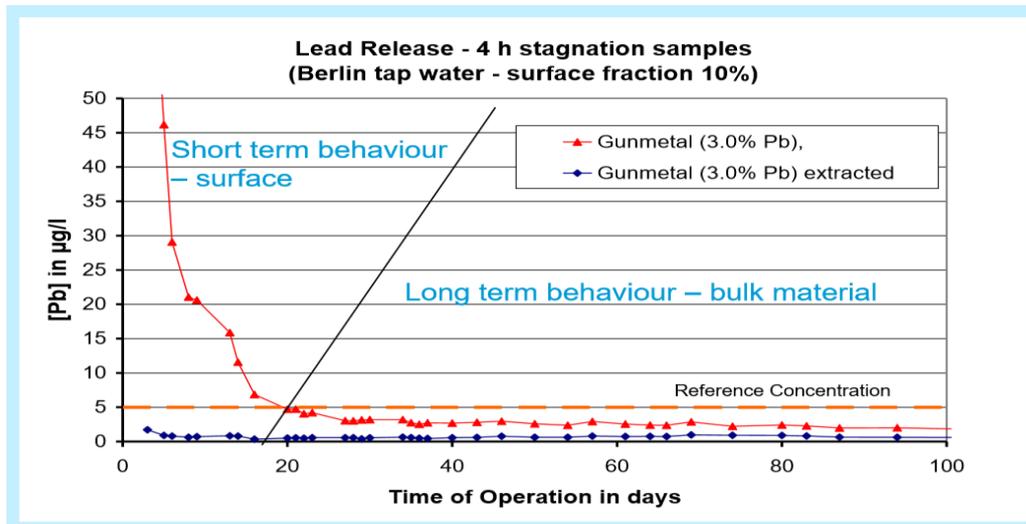
The short-term release of lead is the result of dissolution of machining film which forms immediately after the manufacture of some products. Most lead that is found within the first 30 days is surface lead.¹⁷ However, short term release can continue to occur up to 3 months of operation.¹⁸ Applying monochloramine (NH₂Cl) as a disinfectant of products following manufacturing can reduce the likelihood of this film being present. A 0.5 µm thick Pb film nearly completely dissolves in a NH₂Cl solution.¹⁹ Figure 1 shows the release of lead from a typical brass plumbing product in contact with drinking water. The short-term release of lead is thought to be completely preventable by correctly rinsing products after manufacture.

¹⁷ Elfland C., Scardina P., Edwards M. (2010) Lead-contaminated water from brass plumbing devices in new buildings. J. Am. Water Works Assoc. Pages 102:66–76.

¹⁸ 4MS Joint Management Committee (2016). Acceptance of metallic materials used for products in contact with drinking water: 4MS Common Approach; Part A – Procedure for the acceptance Part B – 4MS Common Composition List-2nd Revision: 07.03.2016 Bundesministerium für Gesundheit (Deutschland).

¹⁹ Switzer, J. A., et al. (2006). "Evidence that monochloramine disinfectant could lead to elevated Pb levels in drinking water." Environmental Science and Technology 40(10): 33843387.

Figure 1: Lead released from copper alloy plumbing products in contact with drinking water²⁰

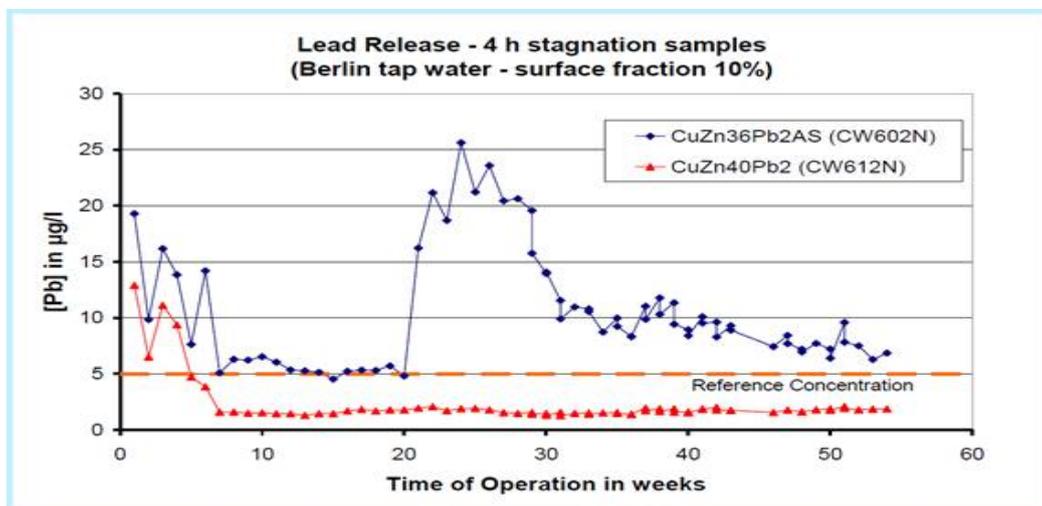


Source: Rapp (2015)

Long-term lead release

The causes of long-term lead leaching into drinking water are well studied. With time, zinc in brass is preferentially lost relative to copper.²¹ This process is known as dezincification. The effect of dezincification is shown by Figure 2.

Figure 2: Effects of dezincification on lead releasing from the bulk alloy²²



²⁰ Rapp, T. (2015) Materials and Products in Contact with Drinking Water Section II 3.4 Distribution of Drinking Water. Presentation notes available from: https://www.kupferinstitut.de/fileadmin/user_upload/kupferinstitut.de/de/Documents/techUnterstuetzung/4MS/2015/08_-_4MS_approach_for_metallic_materials_-_Rapp.pdf

²¹ Maynard, J. Mast, D. & Kwan, P. (2008) Kinetics of lead release from brass faucets and water meters.

²² Rapp, T. (2015) Materials and Products in Contact with Drinking Water Section II 3.4 Distribution of Drinking Water. Presentation notes available from: https://www.kupferinstitut.de/fileadmin/user_upload/kupferinstitut.de/de/Documents/techUnterstuetzung/4MS/2015/08_-_4MS_approach_for_metallic_materials_-_Rapp.pdf

Source: Rapp (2015)

The above figure shows the lead leaching rate of a common brass product over time.²³ After 20 weeks, lead is released at high levels as a direct result of dezincification; that is, lead leaching due to zinc being preferentially lost to copper within the bulk alloy containing lead. There are a number of factors that influence the occurrence and rate of dezincification.

These factors include:

- The surface characteristics of the product in contact with water. These characteristics will change over time dependant on the metal composition and water chemistry. The initial release of the surface lead film is followed by corrosion reactions which may produce a protective surface film or may lead to dezincification and continued release of lead from the body of the material.
- The presence of chlorine. High chlorine concentration usually increases metal release. However, these levels are not common or permitted by the ADWG.
- The velocity of the water within the plumbing system. Increased flow rates have been shown to speed up the dezincification process.

A report by the Water Industry Research Limited in the United Kingdom in 2016 on long-term testing of brass fittings found:

- The majority of copper alloy fittings exhibited a steady, but low, rate of metal leaching throughout the year.
- The yields of lead from combinations of some fittings had the potential to result in lead concentrations being higher than permitted in a random daytime sample. This occurred when stagnation was 8 hours or greater and when high lead content fittings were exposed to non-phosphate dosed waters.
- All low lead fittings tested showed significantly less lead and nickel leaching compared with their leaded copper alloy counterparts.
- Neither seasonal or stagnation temperatures appeared to significantly contribute to the leaching for the metals.

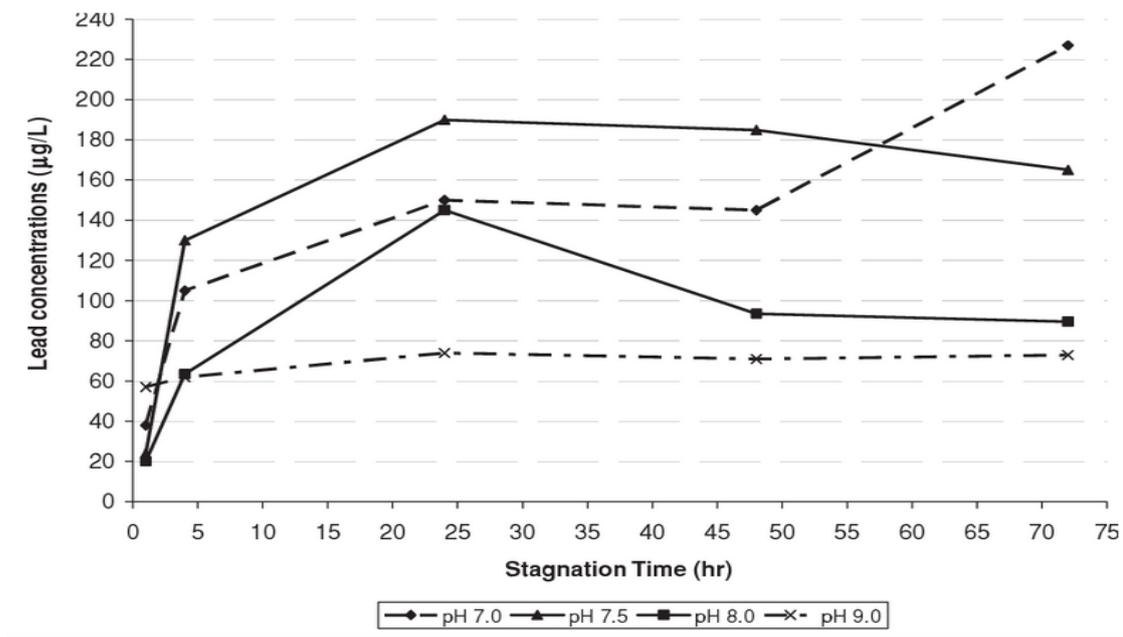
²³ CW 602 is a common type of brass used in Australia.

Parameters affecting lead release

The release of lead is known to be affected by stagnation time and the pH level of the water. The stagnation time that water is in contact with the surface has a significant effect on the concentration of lead in water. The lead concentration initially increases rapidly in stagnant water for at least 24 hours, but then slows until saturation, as shown in Figure 3. Stagnation times in household plumbing are usually less than 24 hours, which is within the timeframe of increasing lead release.

The degree of leaching is affected by the variations in water chemistry – particularly pH and alkalinity. This is also shown in Figure 3.

Figure 3: Lead leaching from stagnant water from a common brass plumbing product²⁴



Source: Tam & Elefsiniotis (2009)

The above figure indicates that lead leaching from plumbing products generally reaches its peak after 24 hours of stagnation for most water types and reaches a short-run equilibrium state thereafter.²⁵ The degree of leaching is largely affected by the variations in pH and alkalinity. At a pH around neutrality, an increase in alkalinity

²⁴ Tam, Y S, Elefsiniotis P. (2009) Corrosion control in water supply systems: Effect of pH, alkalinity, and orthophosphate on lead and copper leaching from brass plumbing. *Journal of Environmental Science and Health Part A*. (44), 1251-1260.

²⁵ Schock, M. R. Scheckel, K. G. DeSantis, M. Gerke, T. In *Mode of occurrence, treatment, and monitoring significance of tetravalent lead*, Water Quality Technology Conference, Quebec, Canada, 2005.

promotes metal dissolution, while for a pH of 9.0, the effect of alkalinity on leaching is marginal. The ADWG sets a pH regulatory target of 6.5 - 8.5. Less than 6.5, water may be corrosive, while above 8.5, scale (water hardness) and taste may be impacted.²⁶

Baseline lead levels in Australian drinking water

Australian drinking water is of high quality. An Environmental Performance Index developed by Yale University ranks Australian drinking water 21 out of 180 countries, placing it in the top 15% of drinking water quality in the world.²⁷

The base level of lead in Australian drinking water, that is, the lead levels from the water source, including its transport through the NUO infrastructure, is very low. A Joint Monitoring Programme Report undertaken by the WHO and the United Nations International Children's Fund (UNICEF) in 2017 found that the proportion of the population using safely managed supplies of drinking water for Australian urban areas is 99%.²⁸ The compliance levels of rural supplies in Australia are not known due to the lack of aggregate data on a national level.

Drinking water in Australia is routinely tested for the presence of metals, including lead, to ensure continued compliance with the ADWG. NUO's conduct their own daily assessments of water quality, against the ADWG, and take action should levels cross thresholds. They report annually on these levels, and these reports are in turn assessed for compliance with the guidelines.²⁹

Water is also treated with zinc orthophosphate, which is used to inhibit corrosion. It is particularly effective at inhibiting lead leaching because it reduces lead solubility in waters of both low and high alkalinity. Zinc orthophosphate limits the release of lead, copper and iron from metal surfaces by forming a microscopic protective film on these surfaces, and through electrochemical passivation.³⁰

Based on the available information, the baseline level of lead in drinking water supplied by NUO's in Australia contains less than 1 µg/L. However, fluctuations may occur in

²⁶ Australian Drinking Water Guidelines (2011) Chapter 10. Page 188.

²⁷ Yale University (2020) Environmental Performance Index. ><https://epi.envirocenter.yale.edu/epi-country-report/AUS>< Accessed 26 April 2020.

²⁸ Hasan, T. (2019) 'Determining safe drinking water'. Water e-Journal Vol 4 No 2 2019.

²⁹ Global Open Data Index (2016) Water Quality – Australia. ><https://index.okfn.org/place/au/water/> Accessed 21 April 2020.

³⁰ Australian Drinking Water Guidelines (2011) Page 1102.

areas in close proximity to mining sites or lead smelters. These levels compare well with many developed countries.³¹

Hence, where lead is present in drinking water in quantities above that permitted by AS/NZS 4020, the likely cause is plumbing products in contact with drinking water from within the property.

Cases of lead leaching into drinking water in Australia

There have been a number of highly publicised incidences of lead being found in Australian drinking water exceeding 10 µg/L in recent years. Some examples are provided below.

Perth Children's Hospital

In 2016, testing of the drinking water system at the new Perth Children's Hospital (PCH) found concentrations of lead greater than those permitted by AS/NZS 4020.

A report issued by the Chief Health Officer (CHO) in 2017 considered that:³²

- The source of lead was from brass fittings that had undergone a process of dezincification.
- Many of the brass fittings were located within the Thermostatic Mixing Valve (TMV) Assembly Boxes, which were located in close proximity to drinking water outlets.
- Phosphate treatment had been partially, but not sufficiently, effective in reducing lead levels.

The investigators also considered that there were additional mechanisms other than the initial leaching of lead from new surfaces which contributed to the problem. Dezincification was the likely cause and this was supported by a small sample study of brass fittings from the TMV Assembly Boxes by Curtin University.³³ Some components of the TMV Assembly Boxes lacked identifying markings required for certification under the WaterMark Certification Scheme (WMCS), leading to questions about the source, quality and compliance of the fittings.

³¹ World Health Organisation (2009) Lead in Drinking Water: Background document for development of WHO Guidelines for Drinking-water Quality. Page 2.

³² WA Department of Health (2017) 'Report on Perth Children's Hospital Potable Water Chief Health Officer Review'.

³³ Curtin University (2017) 'Analysis of Brass Fittings Collected 12/07/17 from Potable Water System of the New Perth Children's Hospital'.

The history of the hospital's plumbing system was also examined including chlorination flushing and phosphate treatment. The investigators suspected that chlorination may have contributed to the high rates of dezincification and associated lead leaching. However, records were not available to confirm the contact time or concentration of chlorine used during commissioning of the plumbing system.

Spiral Spring Mixer Taps

In 2017, the Queensland Building and Construction Commission reported a popular type of mixer tap released up to 15 times the permissible level of lead. However, independent tests by the retailer showed the product to be compliant with lead levels permitted by AS/NZS 4020 when tested by an accredited AS/NZS 4020 testing laboratory. Queensland Health sought advice from NATA on the inconsistency of the results. NATA could not identify anything that would account for the difference in the original results.

Public water fountains

In 2018, a random sample of public water fountains were found to have lead concentrations in excess of 10 µg/L in Geelong, Victoria.³⁴ The evidence indicated that lead levels had accumulated in the drinking water because the drinking fountains were infrequently used and the resulting stagnation caused lead to leach from the brass fittings.

Lead content from drinking fountains in the Borough of Queenscliffe and Warrnambool, Victoria, was also found to be at levels higher than 10 µg/L following testing of water fountains in the same year. Testing revealed levels of lead and nickel above the acceptable amount specified in the ADWG in water from six public drinking fountains in the Borough of Queenscliffe and two public drinking fountains in Warrnambool.^{35,36}

³⁴ ABC (2018) 'Geelong water fountains shut off water fountains shut off over unsafe lead levels' ><https://www.abc.net.au/news/2018-05-16/geelong-water-fountains-shut-off-over-unsafe-lead-levels/9768252> Accessed 15 June 2020.

³⁵ Council News (2018) 'Public drinking fountains re-open' ><https://www.councilnews.com.au/2018/10/2348970-public-drinking-fountains-to-re-open>< Accessed 15 June 2020.

³⁶ The Standard (2018) 'Drinking taps shut off after elevated lead levels detected' ><https://www.standard.net.au/story/5456354/drinking-taps-shut-off-after-slightly-elevated-lead-levels-detected/#:~:text=Residents%20may%20notice%20that%20Warrnambool%27s,Lake%20Pertobe%2C%20parks%20and%20A%20quazone.<> Accessed 4 September 2020.

Water Meters

Following an investigation into two children (siblings) with high blood lead levels, a sampling program for lead at point of delivery was undertaken by a water supply operator in Queensland. While water was found to not be the source of lead for the children, lead was detected in water samples taken at the water meters of some control properties.

Investigations into this issue are ongoing with a report being prepared by the NUO after investigations are complete. Existing water meters are also being replaced with low lead alternatives where high levels of lead have been found. Queensland Health also understands at least one other local government area has replaced existing water meters with low lead meters. While water meters are not covered by the Plumbing Code of Australia and do not need Watermark Certification, they are expected to comply with AS/NZS 4020 in Queensland.

Impacts of lead exposure on human health

Lead is a cumulative toxicant and there is no blood lead level which is considered safe.³⁷ Once lead enters the blood, it is distributed to organs such as the brain, kidneys, liver and bones. At high exposure, lead has been known to cause coma, convulsion and death.

Chronic exposure causes haematological effects, such as anaemia, or neurological disturbances, including headache, irritability, lethargy, convulsions, muscle weakness, ataxia, tremors and paralysis. Acute exposures may cause gastrointestinal disturbances (anorexia, nausea, vomiting, abdominal pain), hepatic and renal damage, hypertension and neurological effects (malaise, drowsiness, encephalopathy).³⁸

Children are particularly vulnerable to the neurotoxic effects of lead and even low levels of exposure can cause serious and, in some cases, irreversible neurological damage. The potential for adverse effects of lead exposure is greater for children than for adults because the intake of lead per unit of body weight is higher, lead absorption

³⁷ World Health Organisation (2018) Lead poisoning and health. > <https://www.who.int/news-room/fact-sheets/detail/lead-poisoning-and-health> Accessed 4 September 2020.

³⁸ World Health Organisation (2010) "Exposure to Lead: A Major Public Health Concern."><https://www.who.int/ipcs/features/lead..pdf> Accessed 18 May 2020.

in the gastrointestinal tract is higher, the blood-brain barrier is not yet fully developed and neurological effects occur at lower levels than in adults.³⁹

At blood lead levels which were previously considered safe, lead is now associated with reduced intelligence quotient (IQ). Behavioural changes such as reduced attention span and increased antisocial behaviour, anaemia, hypertension, renal impairment, immunotoxicity and toxicity to reproductive organs have also been established from blood lead levels of 10 µg/dL and above. These effects are believed to be irreversible.

The most critical effect of lead in young children is on that of the developing nervous system. Subtle effects on intelligence quotient (IQ) are expected from blood lead levels at least as low as 5 µg/dL and the effects gradually increase with increasing levels of lead in blood. Lead exposure has also been linked epidemiologically to attention deficit disorder and aggression.⁴⁰

Evidence from the NHMRC on the effects of lead on human health

In 2015, the NHMRC released a report on the effects of lead on human health. After considering the evidence and taking into account the quality and design of the studies, the Lead Working Committee made the following conclusions about the health effects on the population with blood lead levels less than 10 µg/dL:⁴¹

“While the body of evidence indicates that there may be an association between blood lead levels and health effects in some population groups, there is not enough high-quality evidence (i.e. results of studies that were well-designed, well-conducted and well-reported) to conclude that a blood lead level less than 10 micrograms per decilitre was the causing factor for any health effects that were observed.

The available evidence suggests that blood lead levels between 5 micrograms and 10 micrograms per decilitre are associated with reduced IQ and academic achievement in children. The relative contribution of lead in causing reduced IQ is unknown. Certain populations of children may be affected by other factors (e.g. socioeconomic status, education, parenting style, diet, or exposure to other substances) that put them at greater risk,

³⁹ WHO (2007) Blood lead levels in children. Copenhagen, World Health Organization Regional Office for Europe, European Environment and Health Information System (Fact Sheet No. 4.5; http://www.enhis.org/object_document/o4738n27387.html). Accessed 19 May 2020.

⁴⁰ IARC (2006). Summaries & evaluations: Inorganic and organic lead compounds. Lyon, International Agency for Research on Cancer (IARC Monographs for the Evaluation of Carcinogenic Risks to Humans, Vol. 87.

⁴¹ NHMRC (2015). NHMRC Information Paper: Evidence on the Effects of Lead on Human Health. Page 18.

making it difficult to know how much blood lead levels between 5 micrograms and 10 micrograms per decilitre may contribute to reduced IQ.”

Despite the uncertainty of these findings, NHMRC and the experts from the Lead Working Committee had sufficient concerns about the health impacts to issue the NHMRC Statement: Evidence on the effects of lead on human health (2015) (the Statement).⁴² The Statement recommends that exposure to lead should be eliminated as much as possible to reduce the risk of harm to the individual and the community. It is also recommended that if an individual has a blood lead level greater than 5 µg/dL the source of lead exposure should be identified and reduced, particularly if the person is a child or a pregnant woman. The Lead Working Committee had expertise in public and environmental health, health risk management, toxicology and paediatric medicine. The Statement was endorsed by NHMRC Council, which includes the Chief Health and Medical Officers from the states and territories.

The findings of the NHMRC are important for two reasons. Firstly, they show there may be an association between low level lead exposure and health impacts and more high-quality evidence could reveal a causal relationship. Secondly, the findings demonstrate that quantifying the health impacts below a blood lead level of 10 µg/dL will be difficult and may not reflect the true impacts based on the uncertainty of health impacts below this threshold. This doesn't mean, however, the impacts do not exist.

Regulatory interventions in Australia

National regulatory intervention

Due to the consequences of high-level lead exposure, there have been several significant regulatory interventions over the past two decades to reduce lead levels in Australia.

These interventions include:

- Lead no longer being added to petrol since 2002. Lead is permitted in unleaded petrol up to 0.5 mg/L (500 µg/L) when tested to ASTM D3237.⁴³

⁴² enHealth (2018) 'enHealth Guidance Statement Lead in drinking water from some plumbing products' [https://www.health.gov.au/internet/main/publishing.nsf/content/A12B57E41EC9F326CA257BF0001F9E7D/\\$File/Lead-plumbing-products-Guidance-Statement-July2018.pdf](https://www.health.gov.au/internet/main/publishing.nsf/content/A12B57E41EC9F326CA257BF0001F9E7D/$File/Lead-plumbing-products-Guidance-Statement-July2018.pdf) Accessed 3 December 2020.

⁴³ Department of Agriculture, Water and Environment (2020) Petrol fuel quality standard ><https://www.environment.gov.au/protection/fuel-quality/standards/petrol>< Accessed 12 June 2020.

- The amount of lead in house paints was limited to 1% in 1965, 0.25% in 1992 and 0.1% in 1997.⁴⁴
- The amount of lead in water was limited to 10 µg/L of water in 1991 via the ADWG.
- Regulations now restrict or prevent the use of lead in consumer goods (e.g. toys, cosmetics, ceramics, medicines) and the importation of products that contain lead.⁴⁵

The above regulatory interventions show that reducing the amount of lead has occurred across a range of products and consumables, including drinking water. A common theme of each intervention is not prescribing lead to be absolute zero. This is done on the basis that very small trace amounts of lead will exist which cannot be eliminated.

These national interventions have resulted in a measurable decline in lead exposure in Australia, significantly lowering the background levels of lead and blood lead levels of the general population. Despite this reduction, public health experts, including Australia's Chief Medical Officer, continue to recommend:

“Australians take every opportunity to limit potential exposure from all sources”.⁴⁶

⁴⁴ Department of Agriculture, Water and Environment (2020) Lead in house paint > <https://www.environment.gov.au/protection/chemicals-management/lead/lead-in-house-paint>< Accessed 12 June 2020.

⁴⁵ NHMRC Information Paper: Evidence on the Effects of Lead on Human Health.

⁴⁶ Department of Health (2018) Statement from Australia's Chief Medical Officer, Professor Brendan Murphy, on lead in drinking water from some plumbing products and the enHealth Guidelines ><https://www.health.gov.au/news/statement-from-australias-chief-medical-officer-professor-brendan-murphy-on-lead-in-drinking-water-from-some-plumbing-products-and-the-enhealth-guidelines-0>< Accessed 22 May 2020.

State-based regulatory intervention

In 2019, the Victorian School Building Authority announced that all new schools and school upgrade works must exclude any plumbing product containing lead. Any piping, tapware or fittings that hold or distribute drinking water, or form part of a water source where a child could fill a cup or drink bottle for consumption, must be comprised of products that either: do not contain lead, or do not allow contact between brass containing lead and water, where appropriate products are available on the Australian market.⁴⁷ This requirement is embedded in new procurement rules for new schools and school upgrades.

This recent change in Victoria highlights the desire for use of low lead products in the Australian market and the ability to further reduce lead exposure beyond that currently prescribed by plumbing regulations.

Regulatory framework for plumbing products in contact with drinking water

The manufacture of plumbing products in contact with drinking water is regulated in Australia through Volume Three of the NCC and the WMCS.

National Construction Code

The NCC is Australia's primary set of technical design and construction provisions for buildings. As a performance-based code, it sets the minimum required level for safety, health, amenity, accessibility, sustainability and liveability of certain buildings.

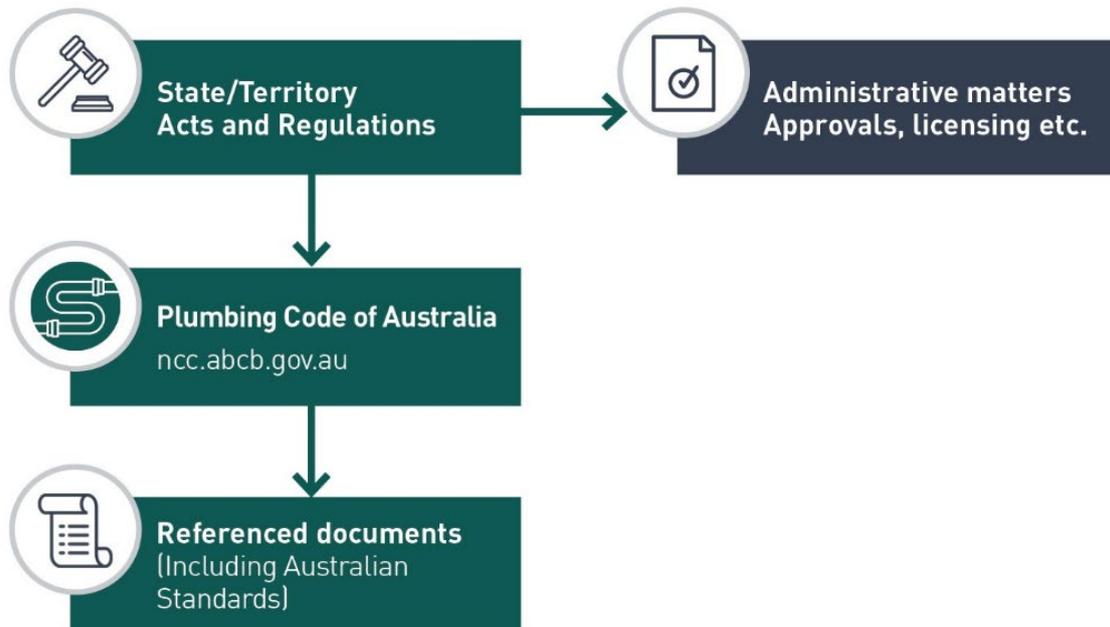
NCC Volume Three, the Plumbing Code of Australia (PCA), contains technical requirements for the design and construction for plumbing and drainage systems in new and existing buildings. The PCA applies to these systems in all building classifications whenever plumbing work is carried out. The PCA additionally applies to sites where water services are constructed independent of buildings.

The PCA is given legal effect by relevant legislation in each state and territory. This legislation prescribes that plumbing practitioners are to fulfil any technical requirements that are required to be satisfied under the PCA when undertaking plumbing and drainage installations.

⁴⁷ Victorian School Building Authority (2020) 'Building Quality Standards Handbook' ><https://www.education.vic.gov.au/Documents/school/principals/infrastructure/vsba-building-quality-handbook.pdf>< Page 121. Accessed 4 September 2020.

Each state and territory's legislation consists of an Act of Parliament and subordinate legislation which empowers the regulation of certain aspects of building work or plumbing and drainage installations, and contains the administrative provisions necessary to give effect to the legislation. Refer to Figure 4 for the current regulatory framework.

Figure 4: Plumbing Regulatory Framework



WaterMark Certification Scheme

The WMCS is a mandatory certification scheme for plumbing and drainage products to ensure they are fit-for-purpose and appropriately authorised for use in plumbing and drainage installations. Not all plumbing and drainage products require WaterMark certification and authorisation, with some products listed on the WaterMark Schedule of Excluded Products. Under the WMCS, products must comply with the specified product specifications, which in most cases references the requirements of AS/NZS 4020.⁴⁸

Regardless of the requirement for certification under the WMCS, or the content of the referenced product specification, compliance to AS/NZS 4020 is a requirement for all products in contact with drinking water through its reference in A5.3 of the PCA.

⁴⁸ Some plumbing products not in contact with drinking water require WaterMark Certification but do not require compliance with AS/NZS 4020.

Australian and New Zealand Standard (AS/NZS) 4020 Testing of Products for Use in Contact with Drinking Water

AS/NZS 4020 specifies requirements for products in contact with drinking water. The standard aims to assess the impact of a product on the quality of drinking water and requires that products be tested by exposure to test water. This standard requires testing for a range of metals, including lead.

Duplicate samples of the product being tested are exposed to test water for 24 hours and the metal concentration measured for the two test extracts. If any of the metals exceed the specified concentration limits for metals and organics in leachate specified in the ADWG, further extracts are prepared by exposing both samples to an extra six sequential periods, including four 24-hour periods, one 72-hour period, and concluding with another 24-hour period (9 days in total). Fresh test water is used for each period. The seventh extract is analysed. The amount of specified metals in the first and/or final extracts, after applying a scaling factor if applicable, shall not exceed the specified values taken from the ADWG. If the limit for any metal is exceeded in the final extract from any of the duplicate samples, the product shall be deemed unsuitable for contact with drinking water, unless a further three samples are examined and the mean of the specified metals in their final extracts do not exceed the limits specified.

Material and Product Specifications

In addition to the AS/NZS 4020 water quality test, the WMCS also references a number of product specifications which must be complied with in the production of products. These set limits on the amount of lead that can be within the raw materials and are included in Attachment C.

Regulatory intervention internationally

The following information has been prepared as a summary of the current state of international regulation for prescribing lead in plumbing products in contact with drinking water.

Austria

The permissible amount of lead in drinking water is legislated through the Austrian Drinking Water Ordinance which has set a limit of 10 µg/L since 2013.⁴⁹ Previously, the lead limit in drinking water was 50 µg/L prior to 2003 and 25 µg/L from 2004 to 2013.

Plumbing products in contact with drinking water are required to undergo assessment and comply with the national standard ÖNORM B 5014 Parts 1, 2 and 3: 'Sensory and chemical requirements and testing of materials in contact with drinking water'.⁵⁰

Although there is no explicit limit in the amount of lead in plumbing material, if the amount of lead in the material exceeds 0.02% (by mass), only up to 50% of the allowed limit, i.e. 5 µg/L of lead, is permitted.

Canada

Newly published changes to NSF/ANSI/CAN 61 set a maximum acceptable concentration of 1 µg/L of lead in drinking water. Previously, the lead limit was 5 µg/L, which was set in March 2019.⁵¹ Under the new requirements, certification of products to the more stringent criteria is optional for the next three years to allow manufacturers time to comply.⁵² In addition, Canada also regulates 'lead-free' requirements for plumbing components. The primary standard pertaining to brass fittings is CSA B125.3 (plumbing fittings), which adopts the 0.25% lead maximum for wetted surfaces. This requirement is within the National Plumbing Code of Canada and enforceable since December 2013.

Germany

The requirements of drinking water are regulated through the Drinking Water Ordinance, which has set a 10 µg/L maximum amount of lead in drinking water since 2013.⁵³ Previously, the lead limit in drinking water was 40 µg/L in the late 1990s and 25 µg/L thereafter.

⁴⁹ The Austrian Drinking Water Ordinance (Austria), 2001.

⁵⁰ Ordinance on Building Materials List ÖA (Austria), 2019.

⁵¹ Government of Canada, Guidelines for Canadian Drinking Water Quality: Guideline Technical Document – Lead.

⁵² World Plumbing Council (2020) "New criteria for drinking water standard tightens lead leaching allowance for plumbing products. ><https://www.worldplumbing.org/https-www-globenewswire-com-news-release-2020-09-22-2097163-0-en-new-criteria-in-drinking-water-standard-tightens-lead-leaching-allowance-for-plumbing-products-html/>. Accessed 31 October 2020.

⁵³ (Germany) Ordinance on the Quality of Water Intended for Human Consumption. Accessed 26 May 2020.

The maximum usable quantities of lead in products in contact with drinking water are limited in the 'Assessment Basis for Metallic Materials in Contact with Drinking Water' issued by the Federal Environmental Agency. This document is adopted through the Drinking Water Ordinance and was produced by the 4MS Initiative of which Germany is a member.⁵⁴

Japan

The Ministry of Health, Labor and Welfare has jurisdiction over the drinking water quality standards for lead and has set a maximum of 10 µg/L since 2003.⁵⁵ Previously, the lead limit in drinking water was 100 µg/L prior to 1992 and 50 µg/L from 1992 to 2003.⁵⁶ Plumbing products in contact with drinking water are required to be tested and there are two main categories with different permissible limits of lead leaching.⁵⁷ The first category pertains to endpoint devices such as faucets and has a maximum discharge of not more than 7 µg/L of lead. The second category pertains to products installed midway through the supply system such as valves and joints, and is not to discharge more than 10 µg/L of lead.

Netherlands

The Netherlands legislates the amount of lead permissible in drinking water in the Drinking Water Decree, which sets the limit to 10 µg/L. Netherlands previously reviewed the regulation of lead in plumbing in 2010.

Within the Drinking Water Decree, further requirements are given towards the composition of an alloy & impurities that may contain a metal. In Annex A, Section 2.8.2 of the Government Gazette 2011, 11911, it states for plumbing products such as fittings which are of copper alloy composition with a certain percentage of lead, the contact surface is limited to a maximum of 10% of the total contact surface of drinking water installations.⁵⁸

⁵⁴ Federal Ministry of Health (2018) Contents of Drinking Water Ordinance, ><https://www.bundesgesundheitsministerium.de/en/topics/drinking-water-ordinance.html>< Accessed 26 May 2020.

⁵⁵ Ministry of Health, Labour and Welfare (2015) Drinking Water Quality Standards in Japan >https://www.mhlw.go.jp/english/policy/health/water_supply/dl/4a.pdf Accessed 26 May 2020.

⁵⁶ Ministry of Health (2002) Labour and Welfare, Ministerial Ordinance No. 43.

⁵⁷ Estelle, A. (2016) Drinking water lead regulations: impact on the brass value chain, Materials Science and Technology, vol.32, no.17, p. 1763-1770

⁵⁸ The State Secretary for Infrastructure and the Environment, Government Gazette (2011) 11911 (Regulation of materials and chemicals for drinking and hot tap water).

New Zealand

Potable water is regulated by the Ministry of Health. It has prescribed a maximum of 10 µg/L of lead in drinking water since 2005.⁵⁹

The New Zealand Building Code regulates water intended for human consumption. The point of use lead concentrations is controlled through the Building Code clause G12 which refer to AS/NZS 4020:2005, AS/NZS 3500.1 and AS/NZS 3500.4 as a means of compliance.⁶⁰ For lead, the maximum allowable leached into the drinking water is 10 µg/L, as per AS/NZS 4020:2005.

Norway

In Norway, the lead content of water at the tap is regulated by the Food Safety Authority. The limit of lead in drinking water for Norway is 10 µg/L, and is based on the implementation of EU Drinking Water Directive in Norwegian regulation. For plumbing products, the Nordic product rules No. 4 (NKB 4), set in 1986, currently prescribes a maximum lead value of 20 µg/L.⁶¹

Singapore

Singapore's drinking water quality is regulated by the Environment Public Health (EPH) (Quality of Piped Drinking Water) Regulations 2008.⁶² The drinking water standards are set out under the EPH Regulations. All metallic material in contact with water shall comply with the test outlined in Appendix H - Extraction of Metals, and the maximum allowable concentration of metals as listed in AS/NZS 4020:2005.⁶³ For lead, the maximum allowable concentration in drinking water is 10 µg/L, as stated in Table 2 of AS/NZS 4020:2005.

Spain

The amount of lead permissible in drinking water is established by law in Royal Decree 140/2003. The lead concentration set by the legislation since 2014 is not to exceed 10 µg/L in drinking water. Previously, the lead limit was 50 µg/L prior to 2003 and 25 µg/L from 2004 to 2013.

⁵⁹ Ministry of Health (2008) Drinking-Water Standards for New Zealand 2005.

⁶⁰ Ministry of Business (2014) Innovation & Employment, Acceptable Solutions and Verification Methods for New Zealand Building Clause G12 Water Supplies.

⁶¹ C. J. Engelsen (2016) Short term leaching of Pb from products in contact with drinking water.

⁶² PUB, Drinking Water Quality (2018) <https://www.pub.gov.sg/watersupply/waterquality/drinkingwater>. Accessed 26 May 2020.

⁶³ PUB (2019) Stipulation of Standards & Requirements for Water Fittings for Use in Potable Water Service Installations.

Sweden

The Swedish Boverket's Building Regulations (BBR) contains the permissible amount of dissolved lead in drinking water. Chapter 6.62 relates to tap water installations and states the amount of dissolved lead in water from taps where drinking normally occurs, should not exceed 5 µg/L when tested in accordance with NKB 4.⁶⁴ For materials in contact with drinking water, the amount of lead should not exceed 5 µg/L when tested in accordance with SS-EN 15664. The BBR have not provided a recommended limit value for lead in materials that are in contact with drinking water.⁶⁵ Sweden last reviewed the regulations for lead in plumbing in 2014.

United Kingdom

In the UK, the legal drinking water standards are set in the European Drinking Water Directive (Directive 98/83/EC).⁶⁶ The Directive limits the amount of lead in drinking water to 10 µg/L. The limit of 10 µg/L (previously 50 µg/L set in EU Directive 80/778EEC)⁶⁷ was established in 1998 when members of the EU were to reduce lead in drinking water to 25 µg/L by 2005 and 10 µg/L by 2013.⁶⁸

In England, water fittings are to conform to the Water Supply (Water Fittings) regulations 1999.⁶⁹ In Scotland, the legal requirements for plumbing materials in contact with drinking water are covered in the Scottish Water Byelaws.⁷⁰ Both England and Scotland require water fittings to bare an appropriate CE marking in accordance with the Directive, or conform to an appropriate harmonised British Standard. The relevant British Standard concerning the leaching of metals in plumbing products is BS EN 15664.⁷¹ In addition to the Regulations, the 4MS Initiative, of which the UK is a member, has agreed on collaboration in the harmonization of tests for the hygienic suitability of products in contact with drinking water.⁷² The 4MS Initiative has produced

⁶⁴ (Sweden) Boverket's Building Regulations (2019) Chapter 6.62.

⁶⁵ The Swedish National Board of Housing, Building and Planning (2014) Impact Assessment BBR: Amendments to the Swedish National Board of Housing, Building and Planning's Building Regulations (BBR) – Sections 1, 5, 6, 7 and 8.

⁶⁶ Drinking Water Inspectorate (2017) What are the drinking water standards? <http://dwi.defra.gov.uk/consumers/advice-leaflets/standards.pdf>. Accessed 16 May 2020.

⁶⁷ The Council of the European Union (1980) Council Directive 80/778/EEC.

⁶⁸ The Council of the European Union (1998) Council Directive 98/83/EC.

⁶⁹ Drinking Water Inspectorate (2019) Guidance to Water Companies. <http://www.dwi.gov.uk/stakeholders/guidance-and-codes-of-practice/wswq/intro.pdf>. Accessed 16 May 2020.

⁷⁰ (Scotland) Water Supply (Water Fittings) Byelaw (2014) Accessed 16 May 2020.

⁷¹ Drinking Water Inspectorate (2019) Annex 2.3 – British Standards BS EN & BS on the Influence of Materials on Water Intended for Human Consumption ><http://www.dwi.defra.gov.uk/drinking-water-products/approved-products/Annex2.pdf>< Accessed 16 May 2020.

⁷² German Environment Agency, Approval and Harmonization – 4MS Initiative (2017) ><https://www.umweltbundesamt.de/en/topics/water/drinking-water/distributing-drinking-water/approval-harmonization-4ms-initiative> Accessed 17 May 2020.

the Part B – 4MS Common Composition List. The document lists the composition of low leaching metals and limits the amount of lead in each accepted metallic material.⁷³

United States

The US Environmental Protection Agency (EPA) set the standard of drinking water through the Safe Drinking Water Act (SDWA). The SDWA does not allow a person to 'use any pipe, plumbing fitting or fixture or any solder after June 1986, in the installation or repair of i) any public water system; or ii) any plumbing in a residential or non-residential facility providing water for human consumption, that is not lead-free'.⁷⁴ The current definition of lead-free is a maximum weighted average of 0.25% lead calculated across the wetted surface area of a pipe, pipe fitting, plumbing fitting and fixture, and 0.2% lead for solder and flux. The standard was set at 0.25% weighted average in recognition that it is not possible to source 100% lead-free raw material. Small trace amounts of lead are permitted, consistent with the requirements for paint, fuel and other regulated goods. This amount is considered the lowest lead content achievable without having significant consequences on the copper alloy supply chain.

In addition, newly published changes to NSF/ANSI/CAN 61 set a maximum acceptable concentration of 1 µg/L of lead in drinking water. Previously, the lead limit was 5 µg/L. Under the new requirements, certification of products to the more stringent criteria is optional for the next three years to allow manufacturers time to comply.⁷⁵

Summary of international comparisons

The maximum lead content of drinking water in Australia is consistent with the majority of other jurisdictions compared (Germany, Netherlands, New Zealand, Singapore, Spain and the United Kingdom). Five jurisdictions (Austria, Canada, Japan, Sweden and the United States) have lower lead level thresholds prescribed by water quality standards and only one jurisdiction (Norway) has a higher allowance. The mix of regulation type is also consistent with Australia and is implemented either through product standards or water quality testing standards, or in some cases, a combination of both.

⁷³ 4MS Initiative (2019) Acceptance of Metallic Materials Used for Products in Contact with Drinking Water.

⁷⁴ (US) Safe Drinking Water Act (2018) s1417.

⁷⁵ World Plumbing Council (2020) "New criteria for drinking water standard tightens lead leaching allowance for plumbing products. ><https://www.worldplumbing.org/https-www-globenewswire-com-news-release-2020-09-22-2097163-0-en-new-criteria-in-drinking-water-standard-tightens-lead-leaching-allowance-for-plumbing-products-html/>. Accessed 31 October 2020.

Consultation Questions:

2. Do you agree with the description of the nature of the problem?
3. Are there any other characteristics of the nature of the problem which should be described?

Please explain your answers.

Extent of the Problem

The extent of the problem is influenced by three factors:

- The amount of new leaded plumbing products in contact with drinking water sold each year;
- The extent to which lead is leached into drinking water from point of discharge plumbing fittings and fixtures; and
- The extent of health impacts associated with using leaded plumbing products in contact with drinking water.

Number of products installed in Australia

The Australian market for copper alloy plumbing products in contact with drinking water has been estimated with the assistance of the Plumbing Products Industry Group (PPIG) and the Australian Industry Group (AIG). Table 1 reflects those products in contact with drinking water and the volume of products impacted by any change to the permissible lead content.

Table 1: Annual sales data of leaded copper alloy plumbing products in contact with drinking water

| Product type | Units (annual sales) | Definition |
|---|----------------------|---|
| Fittings | 45 million | |
| Valves | 13 million | Includes pressure and temperature valves, pressure limiting valves, isolating valves, ball valves and in-line valves. |
| Fittings of stainless-steel braided hoses | 12 million | Includes hoses connected to mixers. |
| Taps | 1 million | |
| Mixers | 3 million | |
| Water heaters | 700,000 | Heated water systems. |
| Residential water filtration | 150,000 | |
| Water dispensers | 20,000 | Includes water coolers, bubblers and refrigerators with chilled water dispensers. |

Despite low lead copper alloy plumbing products being available in the Australian market, higher production costs result in these products being comparatively more expensive than their leaded equivalent. As such, low lead copper alloy products contribute to less than 10% of all units sold in Australia.⁷⁶

Extent lead is present in Australian drinking water

Lead contamination of drinking water occurs almost exclusively through contact with materials or fittings which contain lead. This has been validated by laboratory testing which shows that plumbing products in contact with drinking water can leach lead. The extent to which this is a problem at a population level is difficult to measure as no such studies have been conducted in Australia. However, an assessment by the WHO found that 20% of total lead intake is attributable to water consumption with the other 80% coming from food, dirt and dust.⁷⁷ The US EPA also estimates that drinking water can make up 20% of a person's total lead intake with higher contributions found in children.⁷⁸

It is known through data from the annual reports of NUOs that the lead levels of drinking water supplied to the premises is very low. A review of metropolitan NUO data in each jurisdiction revealed that lead content was less than 1 µg/L. There could be exceptions to these levels, however, the vast majority of drinking water supplied to the point of connection to a property (generally the water meter) from NUO infrastructure, meets or is significantly less than the level required by the ADWG. Hence, where lead content is found at end-use fixtures, it is likely to be the result of leaching from plumbing products in contact with the drinking water from within the premises.

Limited sampling from within the premises occurs nationwide and there is a lack of awareness by consumers in identifying the presence of lead due to it being odourless, colourless and tasteless when consumed. Therefore, the extent that lead is leaching into Australian drinking water from copper alloy plumbing products is difficult to estimate and likely to be under-reported.

⁷⁶ ABCB (2019) Lead in Plumbing Products Forum Survey. 89% of industry stakeholders felt that lead-free products made up 10% of all annual sales in Australia.

⁷⁷ World Health Organisation (2011) Background document for development of WHO Guidelines for Drinking-water Quality.

⁷⁸ Environmental Protection Association (2019) 'Basic Information about Lead in Drinking Water' ><https://www.epa.gov/ground-water-and-drinking-water/basic-information-about-lead-drinking-water> Accessed 24 June 2020.

Data on lead contamination of drinking water in Australia includes the following:

- Analysis of 212 first draw drinking water samples in NSW homes found that 56% of samples contained detectable concentrations of lead. Of total samples, 8% exceeded 10 µg/L. If this percentage was representative of the problem nationally, approximately 800,000 homes would be impacted.⁷⁹
- From 2000 to 2019, NUO Sydney Water received 755 complaints where the lead content of the water was subsequently tested. Approximately 10% of complaints contained a lead level which exceeded the 10 µg/L limit required by the ADWG.
- Between October 2017 and May 2020, samples from 272 individual drinking water sources in 21 of the 29 local government areas in Tasmania found approximately 30% had lead content in excess of 10 µg/L. First drawn samples in excess of the ADWG ranged from 10.1 to 1,300 µg/L with a median value of 19.3 µg/L.
- In 2018, a study on newly installed water meters in Australia found that they had the potential to leach lead above 10 µg/L. Stagnation time and source water characteristics impacted the concentration of lead in first draw water.⁸⁰ Lead levels were reduced to compliant levels following flushing.

Based on the limited data samples, the extent to which lead is leaching into drinking water in excess of that permitted by AS/NZS 4020 could be greater than or equal to 8% within the existing building stock.

Consultation Questions:

4. Are you aware of any studies on the occurrence of lead leaching into Australian drinking water from within the premises?
5. Do you have data on the extent lead levels in drinking water exceed 10 µg/L?

⁷⁹ Based on a stock of 10 million dwellings.

><https://www.abs.gov.au/ausstats/abs@.nsf/Lookup/by%20Subject/2071.0~2016~Main%20Features~Snapshot%20of%20Australia,%202016~2>< Accessed 4 June 2020

⁸⁰ McDonald, S. Elliot, B. & Bee Quek, S (2018) 'Investigation into lead leaching from a water meter.

Health impacts of lead in drinking water

Globally

The health consequences as a result of lead exposure both in Australia and internationally is significant. In 2004, 143,000 deaths and a loss of almost 9 million disability adjusted life years (DALYs) were attributed to lead exposure worldwide, representing 0.6% of the total global burden of disease.⁸¹ Health related consequences were primarily from lead-associated adult cardiovascular disease and mild intellectual disability in children.⁸² Epidemiological studies have also linked high blood lead levels with cancer, stroke and hypertension.

Fortunately, there is a global effort to reduce the amount of lead sources. This includes a sizeable reduction in lead exposure from lead-based paint, fuel and consumer goods such as toys, make-up and food.⁸³

Australia

Australia has achieved a 51% reduction in lead exposure since 1990.⁸⁴ This is largely due to interventions aimed at reducing the use of lead in commonly used products and consumables. The reduction of lead related health effects is shown in Figure 5. Based on the current trend, further reductions could also be expected over time.

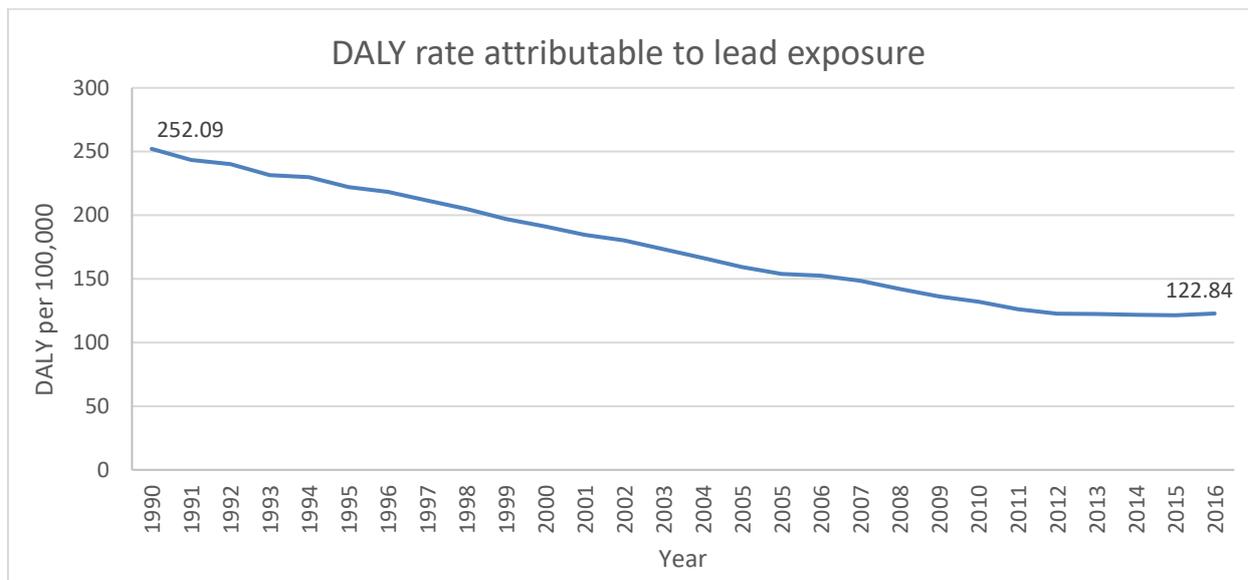
⁸¹ World Health Organisation (2011) Brief guide to analytical methods for measuring lead in blood. Accessed 21 April 2020. > https://www.who.int/ipcs/assessment/public_health/lead_blood.pdf

⁸² World Health Organisation (2010) Exposure to lead: A major public health concern. Page 3.

⁸³ World Health Organisation (2011) Background document for development of WHO Guidelines for Drinking-water Quality.

⁸⁴ The Institute of Health Metrics and Evaluation (2019) Global burden of disease. Australia: All causes attributable to lead exposure, both sexes, all ages. Based on the all ages rate.

Figure 5: DALY rate (all ages) per 100,000 (1990 to 2017)



Source: Global Burden of Disease Database – Institute for Health Metrics and Evaluation

Blood Lead Levels in the Australian Population

Most people in Australia will have some level of lead in their blood because of the small amounts of lead found throughout the environment. Exposure to these small amounts of lead is considered to make up the 'background' level of exposure.

There are limited studies on blood lead levels within the Australian population. No such studies have been undertaken on the extent lead in drinking water contributes to blood lead levels as studies are typically focused on populations with exposure through other means, such as residing in close proximity to lead smelters or working in industries involving the use of lead.

Two Victorian studies provide an indication of blood lead levels in children and in adults in the general population.

Adults

In 2013, the results of a population-based cross-sectional health measurement survey of 3,622 adults in Victoria between 2009 and 2010 revealed that the geometric mean and median blood lead levels from the adult (18 years – 75 years) sample were 1.45 µg/dL and 1.04 µg/dL respectively. Elevated blood lead levels (≥ 10 µg/dL) were identified in 0.7% of participants. Additionally, 1.8% of participants were identified with blood lead levels between 5 to < 10 µg/dL. These results are shown in Table 2. The

geometric mean blood lead level was significantly higher for males, compared with females. Blood lead levels increased significantly with age for both sexes reflecting the cumulative effect of lead entering the body.⁸⁵

Table 2: Blood lead levels in Victorian adults (2009 to 2010)

| Sample | Geometric mean (µg/dL) | Median BLL (µg/dL) | 5 to < 10 µg/dL | ≥ 10 µg/dL |
|--------|------------------------|--------------------|-----------------|------------|
| 3,622 | 1.45 | 1.04 | 1.8% | 0.7% |

Source: Kelsall, L.M, et al. (2013)

Children

A similar study of infants in Victoria from 2010 to 2013⁸⁶ found the median blood lead level of 523 children was 0.8 µg/dL and the geometric mean blood lead level after propensity weighting was 0.97 µg/dL. This result was lower than in previous Australian surveys and recent surveys indicated that no children had levels above 5 µg/dL. These results are shown in Table 3.

Table 3: Blood lead levels in Victorian children (2009 to 2010)

| Sample | Geometric mean (µg/dL) | Median blood lead level (µg/dL) | > 5 µg/dL |
|--------|------------------------|---------------------------------|-----------|
| 523 | 0.97 | 0.8 | 0% |

Source: Symeonides, C, et al. (2020)

Additional studies

One South Australian study⁸⁷ of blood lead levels of children in Port Pirie, the location of one of the world’s largest lead and zinc smelters, found that in 2018, the geometric mean of blood lead levels was 4.2 µg/dL. This average had decreased by 0.3 µg/dL compared to the same reporting period in the previous year. The average blood lead level of children aged 24 months was 5.8 µg/dL, which increased by 0.4 µg/dL compared to the same reporting period in the previous year. The geometric mean

⁸⁵ Kelsall, L.M., de Gooyer, T.E., Carey, M., Vaughan, L. and Ansari, Z. (2013) Blood lead levels in the adult Victorian population: results from the Victorian Health Monitor. *Australian and New Zealand Journal of Public Health*, 37: 233-237. doi:10.1111/1753-6405.12064.

⁸⁶ Symeonides, C., Vuillermin, P., D Sly, P., Collier, F., Lynch, V., Falconer, S., Pezic, A., Wardrop, N., Dwyer, T., Ranganathan S. & Ponsonby, A. (2020) Pre-school child blood lead levels in a population-derived Australian birth cohort: the Barwon Infant Study. *Medical Journal of Australia*.

⁸⁷ SA Health (2018) Port Pirie Blood Lead levels: Analysis of blood lead levels for the first nine months of 2018 (1 January – 30 September 2018)

blood lead level for two-year-old children is considered to be a robust indicator of trends in lead exposure for the whole population of Port Pirie.

A similar study was conducted in 2006 by Queensland Health in Mount Isa of children between one and four years old. Children were recruited by invitation. The 400 recruited for the study were found to be representative of the general population of one to four-year old's in Mount Isa in terms of age, sex and indigenous status. Results of the study indicated that the geometric mean blood lead level for the group of children sampled was 5.0 µg/dL, with a minimum value of 1.3 µg/dL and maximum value of 31.5 µg/dL. Forty-five children (11.3% of those in the study group) had blood lead levels greater than or equal to 10 µg/dL. Of these, two children had blood lead levels greater than 20 µg/dL.⁸⁸

Conclusions on blood lead levels

There is continued research into the effects of low lead levels on population health outcomes in Australia. Although the average 'background' blood lead level among Australians is not known with certainty, the average level is estimated to be less than 5 µg/dL based on a comprehensive review of the evidence by the NRHMC in 2015. This level is lower than the level of exposure for previous generations as the presence of lead in the environment is slowly decreasing over time.⁸⁹ A blood lead level greater than 5 µg/dL 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.⁹⁰ At levels below 5 µg/dL, the health impacts of lead are not easily quantifiable.

Data on blood lead levels exceeding 5 µg/dL is not collected nationally and is instead collected separately by each state and territory. The ABCB approached the Environmental Health Standing Committee (enHealth) to obtain data of elevated blood lead levels from state and territory health departments. Queensland, Tasmania, Victoria and Western Australia were the only jurisdictions able to respond. Data from these jurisdictions is shown in Tables 4 to 10. It should be noted that due to changes

⁸⁸ Queensland Health (2006) >https://www.health.qld.gov.au/__data/assets/pdf_file/0036/428868/mtisa-lead-report-2006-07.pdf Accessed 1 August 2020.

⁸⁹ NHMRC (2015) Effects of Lead on Human Health.

⁹⁰ NSW Department of Health (2018) Lead in Blood Control Guideline. ><https://www.health.nsw.gov.au/Infectious/controlguideline/Pages/lead.aspx> Accessed 22 May 2020.

in reporting requirements, data on elevated blood lead levels exceeding 5 µg/dL is only available from 2016.

Table 4: Blood lead levels exceeding 5 µg/dL in Victoria (new cases)

| Exposure Type | 2016* | 2017 | 2018 |
|------------------|-------|------|------|
| Non-occupational | 35 | 59 | 70 |
| Occupational | 103 | 135 | 123 |
| Unknown | 35 | 40 | 39 |
| Total | 173 | 234 | 232 |

Source: Department of Health and Human Services (Victoria)

Note: * Part year from 4 April 2016.

Table 5: Blood lead levels exceeding 5 µg/dL in Victoria 2016* to 2018 (non-occupational only)

| Blood Lead Level (µg/dL) | Number of non-occupational cases |
|--------------------------|----------------------------------|
| 5-9 µg/dL | 90 |
| 10-14 µg/dL | 35 |
| 15-19 µg/dL | 15 |
| 20-24 µg/dL | 9 |
| 25-29 µg/dL | 3 |
| 30-34 µg/dL | 2 |
| 35-39 µg/dL | 1 |
| 40-44 µg/dL | 1 |
| 45-50 µg/dL | 0 |
| > 50 µg/dL | 8 |
| Total | 164 |

Source: Department of Health and Human Services (Victoria)

Note: * Part year from 4 April 2016.

Table 6: Blood lead levels exceeding 5 µg/dL in Queensland

| Exposure Type | 2016 | 2017 | 2018 | 2019* |
|------------------|-------|-------|-------|-------|
| Non-occupational | 228 | 237 | 223 | 187 |
| Occupational | 1,103 | 3,144 | 3,601 | 4,036 |
| Unknown | 13 | 21 | 28 | 75 |
| Total | 1,344 | 3,402 | 3,852 | 4,298 |

Source: Queensland Health

Note: * Part year to August 2019.

Table 7: Blood lead levels exceeding 5 µg/dL in Queensland 2016 to 2019 (non-occupational only)

| Blood Lead Level (µg/dL) | Number of non-occupational cases |
|--------------------------|----------------------------------|
| 5-9 µg/dL | 560 |
| 10-19 µg/dL | 231 |
| ≥ 20 µg/dL | 84 |
| Total | 875 |

Source: Queensland Health

Table 8: Blood lead levels exceeding 5 µg/dL in Tasmania

| Exposure Type | 2016 | 2017 | 2018 | 2019 |
|------------------|------|------|------|------|
| Non-occupational | 16 | 12 | 13 | 8 |
| Occupational | 47 | 65 | 65 | 39 |
| Unknown | 3 | 4 | 5 | 14 |
| Total | 66 | 81 | 83 | 61 |

Source: Department of Health (Tasmania)

Table 9: Blood lead levels exceeding 5 µg/dL in Tasmania 2016 to 2019 (non-occupational only)

| Blood Lead Level (µg/dL) | Number of non-occupational cases |
|--------------------------|----------------------------------|
| 5-9 µg/dL | 38 |
| 10-19 µg/dL | 9 |
| ≥ 20 µg/dL | 2 |
| Total | 49 |

Source: Department of Health (Tasmania)

Table 10: Blood lead levels exceeding 5 µg/dL in Western Australia

| Exposure Type: Non-occupational | 2016 | 2017 | 2018 | 2019 |
|--|---------------|------|-------------|-------------|
| 5-9 µg/dL | Not available | 19 | 21 | 17 |
| 10-29 µg/dL | Not available | 8 | 24 | 29 |
| ≥ 30 µg/dL | Not available | 0 | < 5 | < 5 |
| Exposure Type: occupational | 2016 | 2017 | 2018 | 2019 |
| 5.1-10.0 µg/dL | 121 | 103 | 131 | 131 |
| 10.1-20.0 µg/dL | 98 | 118 | 167 | 160 |
| 20.1-30.0 µg/dL | 61 | 112 | 90 | 51 |
| ≥ 30.1 µg/dL | 63 | 66 | 25 | 5 |
| Total | > 343 | 426 | ≥ 459 ≤ 462 | ≥ 394 ≤ 397 |

Sources: Occupational data: Department of Mines, Industry Regulation and Safety (Western Australia).

Non-occupational data: Department of Health (Western Australia).

As can be shown by the above data, instances of non-occupational lead exposure where 5 µg/dL is exceeded is rare, and represents 0.0046% of residents in Queensland, 0.0010% of residents in Victoria, 0.0015% in Western Australia and 0.0023% of residents in Tasmania in 2018.⁹¹ However, these findings only reflect instances where testing has been undertaken. As such, this data may substantially understate the frequency of elevated blood lead levels within the general population. The ABCB approached a large pathology company to obtain data on blood lead levels within the general population, however, the company was unable to fulfil the request.

Disability Adjusted Life Year Estimates

In the absence of national data, the Global Burden of Disease (GBD) database is the most comprehensive effort to collect data to measure epidemiological levels and trends worldwide and provides a tool to quantify health loss from hundreds of

⁹¹ Australian Bureau of Statistics (2020) 'Australian Demographic Statistics, Dec 2019' Category 3101.0 ><https://www.abs.gov.au/AUSSTATS/abs@.nsf/DetailsPage/3101.0Dec%202019?OpenDocument>< Accessed 26 August 2020.

diseases, injuries and risk factors.⁹² According to the GBD, the total health consequence of lead exposure in Australia, was estimated to be 30,956 DALYs in 2017. That is, 0.13% of total DALYs attributable to lead exposure globally⁹³ or 0.69% of total DALYs (all causes) in Australia.⁹⁴ These results are consistent with the problem being isolated to a minority within the population.

DALYs attributable to lead in drinking water is a subset of total DALYs attributable to lead. It is not known what proportion lead in drinking water contributes to the problem overall, however, an assessment by the WHO found that up to 20% of total lead intake is attributable to water consumption.⁹⁵ This contribution has also been supported by the Environmental Protection Agency (US).

If the relationship between lead consumption from all sources and total DALYs is linear⁹⁶, this would represent 6,191 DALYs in 2017.

Limitations of the GBD

The lead exposure indicator is the best available metric on quantifying the health effects of lead in drinking water.

While the GBD is the leading epidemiological study on environmental risks, several limitations in this indicator are worth noting. First, measuring lead exposure is a burdensome process, and the GBD must draw upon sparse datasets of blood and bone samples. Interpolation of exposure levels introduces uncertainty into the final DALY rate estimates. Second, the collection of tissue samples faces a number of challenges, including unknown contaminants, lack of quality assurance, and the short half-life of lead in blood. The GBD also makes assumptions when linking lead exposure to actual health outcomes and the distribution of diseases and death across populations.

⁹² Institute for Health Metrics and Evaluation (2019) About GHDx. > <http://ghdx.healthdata.org/about-ghdx> Accessed 25 September 2020.

⁹³Based on 305.88 DALYs per 100,000 and a global population of 7,547,858,900 in 2017.

⁹⁴ Based on a report from the Australian Institute of Health and Welfare which reported total DALYs in 2015 to be 4.75 million.

⁹⁵ World Health Organisation (2011) Background document for development of WHO Guidelines for Drinking-water Quality. Page 3.

⁹⁶ Lead absorption rates from consumption of water, food, dust is not known.

Summary of the nature and extent of the problem

The nature of the problem can be summarised as the use of lead in the manufacture of plumbing products in contact with drinking water and lead leaching from these plumbing products into drinking water both over the short and long term. The problem of lead leaching is directly attributable to two issues; a leaded film which exists immediately after the manufacturing of some new plumbing products and the process of dezincification over the life of the product causing lead leaching from the bulk alloy.

The presence of lead in drinking water is directly attributable to the presence of lead within copper alloy plumbing products in contact with the drinking water. Hence, any regulatory intervention that aims to reduce lead in drinking water should involve removal from the source (the bulk alloy).

Current regulatory interventions have proven effective at reducing lead exposure with a measurable decline in health-related consequences over the last 30 years. This trend is likely to continue in the absence of any additional regulatory interventions. However, lead exposure from drinking water will not reduce until such time lead is not used in the manufacture of plumbing products in contact with drinking water.

The extent of the current problem is difficult to quantify. This is both in terms of quantifying the extent to which lead is leaching into drinking water and the extent to which lead is absorbed by the body. Recent studies, albeit small in sample size, indicate the extent of the problem could be 8% or higher in terms of water quality. For blood lead levels, contemporary instances where 5 µg/dL have been exceeded would be considered rare, based on available data, at a rate of less than 0.01% of residents in Queensland, Tasmania, Victoria and Western Australia. However, this rate is likely to be an understatement of the problem as it only includes where testing for lead has occurred. At a population level, limited studies on blood lead levels are somewhat inconclusive. One study in Victoria revealed a 1.8% frequency of elevated blood lead levels exceeding 5 µg/dL within adults, while another Victorian study indicated no cases of elevated blood lead levels exceeding 5 µg/dL in children. However, there are several studies that identify the problem of elevated blood lead levels in areas in close proximity to lead smelters. These areas present higher risks to individuals and, as such, regulatory intervention should aim to reduce the cumulative health effects of lead exposure from all sources, including drinking water.

In the absence of national population data on blood lead levels, the GBD database indicates that lead continues to be a problem in Australia with an estimated DALY rate of 30,956 in 2017. It is not known with certainty the extent to which lead in drinking water contributes to this rate. However, studies from the US indicate lead in drinking water could contribute up to 20% of all health consequences. This would amount to 6,191 DALYs in 2017 and represent 0.14% of the total burden of disease in Australia. This level is consistent with the extent of the problem being isolated to a minority within the population and small relative to all other causes of disease.

Consultation Questions:

6. Do you agree with the description of the extent of the problem?
7. Do you have data on the frequency of elevated blood lead levels in Australia?
8. Do you have any other information or data that may assist in describing the extent of the problem?

Please explain your answers.

Objective

A core goal of the NCC is to address safety and health in the design, construction and performance and liveability of buildings. In relation to drinking water, the NCC requires a drinking water system have a safe drinking water supply that minimises adverse impacts on building occupants⁹⁷ and the water service system is fit-for-purpose and does not create significant risks or any likely outcome of personal illness, loss, injury or death.⁹⁸ The NCC achieves this goal by adopting standards that minimise occupants' exposure to hazardous chemicals and metals.

Hence, the objective of this RIS is to evaluate whether the permissible lead content in plumbing product and material specifications should be reduced given the risk of lead leaching from plumbing products in contact with drinking water.

This objective aligns with the goal of reducing lead use to non-essential levels in all goods and consumables, including drinking water.

Options

The Council of Australian Governments (COAG) 'Principles of Best Practice Regulations Guidelines' requires that regulations are effective and proportional to the problem and there is no regulatory or non-regulatory option that would generate higher net benefits. This is also reflected in the ABCB's Intergovernmental Agreement (IGA).⁹⁹

Having regard for these principles, there are three options presented for consideration:

Option 1: Retain the status quo

The status quo is the default choice for decision-makers in considering alternatives to achieve the objectives. Where the incremental impacts of other options would result in more costs than benefits, or would be ineffective in addressing the problem or achieving the objectives, the RIS will conclude in favour of the status quo.

⁹⁷ Functional Statements Part BF.1 and BF2 NCC Volume Three.

⁹⁸ Manual for the WaterMark Certification Scheme, 2016, ABCB p 23.

⁹⁹ ABCB Inter-governmental agreement (2017). ><https://abcb.gov.au/Resources/Publications/Corporate/2020-intergovernmental-agreement>< Accessed 7 December 2020.

Option 2: Require all products in contact with drinking water to contain 0.25% or less lead content

This option would set a reduced maximum allowable lead content within plumbing products in contact with drinking water of 0.25% or less when calculated using a weighted average against the wetted surface area and evaluated against NSF/ANSI 372.

This option would result in a change to the 'Evidence of Suitability' criteria within the Plumbing Code of Australia. A complete description of the changes and an explanation can be found at Attachment A.

Option 3: Promote the use of low lead products through an industry led labelling scheme and recommend changes to government procurement standards

As an alternative to a regulatory option, the establishment of an industry led labelling scheme which assists consumers distinguish between low lead products and leaded products could be developed. This would provide better information to consumers on which products are being installed and allow consumers to make informed decisions about which products they choose to purchase and install.

This option would also recommend changes to state and territory and federal government procurement standards to require the use of low lead plumbing products in government owned buildings. This would help transition a move to low lead plumbing products by increasing the demand for such products.

Alternative Regulatory Option

In addition to the above options, an alternative regulatory option was considered in the development of this Consultation RIS. This option would result in changes being made to the current testing requirements for lead in AS/NZS 4020. This consideration was in response to an outcome of the 2019 Lead in Plumbing Products forum where some participants recommended that the problem be addressed via AS/NZS 4020 and not changes to the product and material standards.

Following the forum, a report was commissioned by the ABCB to investigate what changes to AS/NZS 4020 could be made to better reflect the range of variables affecting drinking water in Australia.¹⁰⁰

The report recommended:

- expanding the test for lead from a single water type to three types to cover the range of water quality in Australia; and,
- expanding the duration of the test from 9 days to 8 weeks to better observe lead leaching from the bulk alloy.

The recommendations aimed to better align Australian testing requirements with the European testing standards. However, further consultation with industry groups and AS/NZS 4020 accredited testing laboratories revealed several challenges with implementing this option.

Specific concerns raised were:

- The testing of lead is currently one of many metals within AS/NZS 4020. While testing of lead could be separated in a future Standard, this would result in the test being duplicated (for lead and all other metals) and then tripled (to reflect three water types instead of a single water type). Industry groups and accredited testing laboratories indicated this would add significant cost and time to the process, without any clear benefit.
- There are distinct differences between the current Australian testing requirements and the European requirements. The European Standard

¹⁰⁰ Tallowood Rise Water Consulting (2020) Potential changes to AS/NZS 4020: Testing for lead leaching.

EN 15664 is a material-based standard, whereas the Australian Standard is product specific. This results in significantly more testing being required under the current Australian Standard which, if amended, would place significant stress on accredited testing laboratories and manufacturers in meeting the new requirements.

- Lead leaching from the bulk alloy is likely to take much longer than 8 weeks to observe. A study in Europe found that lead leaching from the bulk alloy was most pronounced after 25 weeks in use. This is reflected in the European Standard EN 15664, which requires a minimum of 26 weeks in testing and extended to up to 52 weeks if the product fails after the initial period.
- The capacity of the accredited testing laboratories to re-test all products within a specified period would be challenging, with laboratories indicating that a minimum 5 year transition would be required.
- Testing of larger plumbing products with three water types is difficult in practice. Often products are tested with mains water and so finding suitable alternative water sources may be difficult, particularly for larger products such as water heaters. Advice from one accredited testing laboratory also indicated that new products are normally supplied as a single unit. So, requiring three units (to allow testing with three water types) would place greater burden on the manufacturer at the time of product certification.

For the above reasons, this option has been discontinued from further analysis.

Consultation Questions:

9. Are there any other feasible options to address the problem?
10. Do you agree with the alternative regulatory option (changes to the current testing requirements) being discontinued as a feasible option?

Please explain your answers.

Impact Analysis

This section provides an assessment of the incremental costs and benefits associated with Option 2 and Option 3 when compared with the status quo baseline.

Option 1: Retain the status quo

The impacts of the status quo are those reflected in the problem section of this RIS:

- Plumbing products in contact with drinking water will continue to be allowed to contain small amounts of lead (up to 6% lead for some products).
- Instances of lead levels above those permitted by AS/NZS 4020 will also likely continue to occur.

The status quo will be regarded as the baseline. Where the incremental impacts of each option result in a net cost, the status quo will be recommended.

Option 2: Require all products in contact with drinking water to contain a maximum lead content of 0.25%.

Costs

The costs of Option 2 are difficult to quantify. There are a number of product categories impacted by this option and within each product category exists a subset of many product types which range in size and value.

The product categories and annual sales are shown in Table 11.

Table 11: Product categories and annual sales

| Product type | Units (annual sales) |
|---|----------------------|
| Fittings | 45 million |
| Valves | 13 million |
| Fittings of stainless-steel braided hoses | 12 million |
| Taps | 1 million |
| Mixers | 3 million |
| Appliances | 500,000 |
| Water heaters | 700,000 |
| Residential water filtration | 150,000 |
| Water dispensers | 20,000 |

Notes:

1. All data is annual sales data.
2. All products contain lead and are subject to the WaterMark Certification Scheme.
4. Pipes are excluded on the basis they would meet proposed low lead requirements.

As shown in Table 11, Option 2 will impact over 75 million plumbing product units intended for installation in contact with drinking water annually, with 77% of the impacted units being valves and fittings.

A representative subset of product types was determined, which broadly reflect each product category, with assistance from PPI Group and the AI Group. These product types are shown in Attachment B. The proportion of each product type sold within each product category was then estimated using industry sales data. Finally, the cost increase for each product type was estimated based on the price of a low lead alternative, or the change experienced in the US in percentage terms applied to current costs provided by a national Australian plumbing retailer.

There is limited information on the price difference between plumbing products and low lead alternatives. Estimates reflect broad agreement between sources on changes experienced in the US following the transition to low lead products, ABCB's desktop review, and advice of participants at the ABCB's Lead in Plumbing Products forum. The cost implications of Option 2 are shown in Table 12.

Table 12: Incremental aggregate costs of Option 2

| Product Category | Annual Cost |
|---|------------------------|
| Fittings | \$35,595,900 |
| Valves | \$93,383,388 |
| Fittings of stainless-steel braided hoses | \$18,780,000 |
| Taps and combinations | \$4,990,000 |
| Mixers | \$79,312,500 |
| Water heater systems | \$8,212,575 |
| Residential water filtration systems | \$29,745,000 |
| Water dispensers | \$9,899,447 |
| Annual cost | \$279,918,810 |
| Present Value cost | \$2,103,654,870 |

As shown by the above table, the cost of Option 2 is \$280 million annually or \$2.1 billion in Present Value terms, using a discount rate of 7% over 10 years.

This cost will need to be considered against the expected benefits of transitioning to low lead plumbing products as well as the goal of reducing the use of lead to non-essential levels.¹⁰¹

The price increases for each product type includes costs borne by manufacturers in sourcing new raw material containing low lead, upgrading of equipment and re-tooling to machine low lead plumbing products and the associated testing that will be required to demonstrate compliance with the new requirements.

The difference in material cost may decrease over time (as a result of an increase in supply and demand of low lead brass). However, it is not known at what rate or time period this reduction would occur. As such, taking a conservative approach to calculating costs, reductions over time have not been assumed as part of calculating the central estimate, but rather tested under the heading of 'Sensitivity Analysis'.

Benefits

The benefits of Option 2 are also difficult to quantify. Research has not revealed any recent cost-benefit analyses which quantify the benefits of reducing low lead exposure from drinking water. Further, the available studies and data used to derive the benefits of reducing low lead exposure more broadly were not collected for the specific purpose of this analysis and are small in sample size. On this basis, the consideration of future regulatory interventions would benefit from national sampling of blood lead levels (particularly in children) and water lead levels. Greater quantification of the health impacts of low lead exposure from drinking water in Australia would also benefit policy setting and standards writing bodies such as the ABCB.

Health benefits

Health benefits have been quantified using information from the GBD database which reports the DALYs attributable to lead exposure in Australia. The composition of the DALY rate in Australia is shown in Table 13.

¹⁰¹ World Health Organisation (2019) 'Lead'. >https://www.who.int/ipcs/assessment/public_health/lead/en/ Accessed 6 June 2020.

Table 13: Composition of the DALY rate in Australia attributable to lead exposure¹⁰²

| Disease | Rate per 100,000 (lower bound) | Rate per 100,000 (central) | Rate per 100,000 (upper bound) | Proportion of total DALYs |
|--|--------------------------------|----------------------------|--------------------------------|---------------------------|
| Rheumatic heart disease | 0.17 | 0.44 | 0.96 | 0.36% |
| Ischemic heart disease | 31.29 | 59.27 | 90.13 | 48.25% |
| Hypertensive heart disease | 1.33 | 4.57 | 10.91 | 3.72% |
| Stroke | 14.25 | 27.48 | 42.16 | 22.37% |
| Atrial fibrillation and flutter | 3.36 | 6.10 | 9.38 | 4.97% |
| Aortic aneurysm | 0.92 | 1.79 | 2.78 | 1.46% |
| Peripheral artery disease | 0.38 | 1.03 | 2.12 | 0.84% |
| Endocarditis | 0.30 | 0.65 | 1.1 | 0.53% |
| Non-rheumatic valvular heart disease | 0.65 | 1.33 | 2.24 | 1.08% |
| Other cardiovascular and circulatory diseases | 1.66 | 3.49 | 5.85 | 2.84% |
| Cardiomyopathy and myocarditis | 0.65 | 1.43 | 2.65 | 1.16% |
| Chronic kidney disease | 5.77 | 10.33 | 15.65 | 8.41% |
| Idiopathic developmental intellectual disability | 0.81 | 4.93 | 10.90 | 4.01% |
| Total | 61.54 | 122.84 | 196.83 | 100% |

¹⁰² Unpublished data from the (US) Institute of Health Metric and Evaluation (2020). University of Washington.

The majority of the burden of disease from lead exposure in Australia is linked to ischemic heart disease, stroke and chronic kidney disease. These conditions represent nearly 80% of the total burden associated with lead exposure. While health literature typically associates these conditions with high lead exposure, the cumulative effect (i.e. lead exposure from multiple sources) is important when considering further regulatory intervention. Individuals who are already exposed to high levels of lead (e.g. through their environment or occupation) are at greater risk from lead exposure from drinking water than individuals who are not. Therefore, reducing the compounding effect of lead exposure in Australia is the basis of current regulatory intervention and is reflected in the goal of reducing lead use to non-essential levels in all goods and consumables, including drinking water.

The GBD database presents a DALY range for the total lead exposure in Australia. Based on the range of health consequences, the total health related benefits are estimated in Table 14. These benefits have been calculated using the Value of Statistical Life Year (VSLY) and reflects the population’s willingness to pay to avoid such diseases.¹⁰³

Table 14: Total annual cost of lead exposure in Australia (2019)

| | Lower bound estimate | Central estimate | Upper bound estimate |
|---|----------------------|------------------|----------------------|
| Total lead exposure annually | \$3,063,275,219 | \$6,114,603,963 | \$9,797,602,556 |
| Exposure from drinking water annually (20% of total exposure) | \$612,655,044 | \$1,222,920,793 | \$1,959,520,511 |

Notes:

1. Total lead exposure is calculated by using the corresponding DALY rates for each bound. A rate of 61.54, 122.84 and 196.83 has been used for the lower, central and upper bounds respectively.
2. Value of Statistical Life Year has been calculated at \$197,528 in 2019 dollars.

¹⁰³ Department of Prime Minister and Cabinet (2014) 'Best Practice Regulation Guidance Note Value of Statistical Life Year'. > https://www.pmc.gov.au/sites/default/files/publications/Value_of_Statistical_Life_guidance_note.pdf< Accessed 28 August 2020.

Under Option 2, the problem will reduce gradually over time at the rate new plumbing products are installed and existing plumbing products are replaced. The timeframe for the natural replacement of plumbing products is unlikely to be accurately estimated as there are several influences on replacement rates.

These influences include:

- The extent retrofitting, refurbishment or change of use occurs within the existing building stock.
- The rate new buildings replace existing older buildings (i.e. the building stock renewal rate).
- The rate plumbing products reach their end of design life or are replaced voluntarily (e.g. for aesthetic reasons).

As a result of the difficulty in accounting for these influences, a simplifying assumption that 5% of plumbing products are replaced each year (i.e. twice within a building's assumed life) equates broadly to all plumbing products being replaced within 20 years. The benefit of this option is shown in Table 15.

Table 15: Present Value benefits of Option 2

| | Lower bound estimate | Central estimate | Upper bound estimate |
|-----------------------------------|----------------------|------------------|----------------------|
| Total annual benefit of Option 2 | \$30,632,752 | \$61,146,040 | \$97,976,026 |
| Present Value benefit of Option 2 | \$2,609,592,853 | \$5,209,008,549 | \$8,346,541,457 |

Notes:

1. Present Values have been calculated over 20 years using a 7% discount rate.
2. The effectiveness of the option is based on a replacement and installation rate of 5% per year.

Under this option, the benefits range between \$2.6 billion and \$8.3 billion in Present Value terms. Given the large variation in the results, key parameters, including the rate of change, have been tested under the heading of "Sensitivity Analysis".

Based on an expected cost of \$2.1 billion in Present Value terms, the option demonstrates a net benefit under all scenarios, and demonstrates a net benefit of \$3.1 billion in Net Present Value terms under the central estimate.

Sensitivity Analysis

A sensitivity analysis has been conducted on the Present Values by varying the key parameters around the central analysis of Option 2.

The sensitivity analysis has been undertaken in the following areas noting:

- A real discount rate of 7% has been used in the quantitative analysis, and sensitivity will be tested from a lower bound of 3% to an upper bound of 11%.
- The rate of change of new plumbing products replacing existing plumbing products is not known with certainty. As such, a low (2%) and high (7%) rate of change will be tested.
- With the introduction of new requirements impacting the entire plumbing copper alloy industry, there is the possibility of positive economies of scale being achieved over time. The sensitivity analysis will test a 10% and 20% reduction in input costs over 10 years.
- The contribution lead in drinking water makes to total health consequences is assumed to be up to 20% based on limited studies from the US. The sensitivity analysis will test a 50% reduction of health benefits from the central analysis (i.e. a 10% contribution to total health effects from lead in drinking water).

Table 16 shows the conclusions of the sensitivity analysis in Net Present Value terms.

Table 16: Sensitivity analysis of Option 2

| Parameter | Present Value Cost | Present Value Benefit | Net Present Value |
|---|--------------------|-----------------------|-------------------|
| Discount rate – low (3%) | \$2,459,397,156 | \$8,232,492,925 | +\$5,773,095,769 |
| Discount rate – high (11%) | \$1,829,842,568 | \$3,533,194,662 | +\$1,703,352,094 |
| Rate of replacement – low (2%) | \$2,103,654,870 | \$2,083,603,419 | -\$20,051,451 |
| Rate of replacement – high (7%) | \$2,103,654,870 | \$7,292,611,968 | +\$5,188,957,098 |
| Reduction in the cost of inputs – 10% over 10 years | \$2,020,643,154 | \$5,209,008,549 | +\$3,188,365,395 |
| Reduction in the cost of inputs – 20% over 10 years | \$1,937,631,439 | \$5,209,008,549 | +\$3,271,377,110 |
| Lead in drinking water contribution to total health effects – low (10%) | \$2,103,654,870 | \$2,606,504,274 | +\$502,849,404 |

The sensitivity analysis of key parameters indicates that Option 2 demonstrates a net benefit in most scenarios. The exception is where the rate of change is low (that is, total annual sales data represents less than 2% of new installation and replacement). This scenario is unlikely given the average life expectancy of most plumbing products in contact with drinking water is less than or equal to 20 years in most cases.

Unintended Consequences

Any unintended consequences of regulatory options need to be considered by the Consultation RIS. This includes both the manufacturing and health implications associated with the substitute for lead. Experience from the US shows the likely substitutes for lead will be silicon or bismuth which display similar, but not identical, machinability characteristics.

Substitutes for lead

The manufacturing implications of using silicon or bismuth will be an overall decrease in the machinability of copper alloy materials. A study in 2012, found that by increasing the silicon content from 1% to 4%, resulted in an increased tool wear by 40%,

machined surface roughness by 25%, and the cutting force reducing by 50%.¹⁰⁴ This cost to manufacturers is implicit in the estimated costs of Option 2.

From a health perspective, silicon and bismuth present less risk when compared to lead. Silicon is the principal component of glass, cement ceramics and is also an important constituent of some steels and a major ingredient in bricks. Elemental raw silicon and its intermetallic compounds are currently used as alloy integrals to provide more resistance to copper and other metals. Silicon concentrates in no particular organ of the body, but is found mainly in connective tissues and skin. Silicon is non-toxic in all its natural forms.¹⁰⁵ It is a common additive to manufacturing low lead brass plumbing products internationally.

Use of bismuth in the manufacture of copper alloy products is less examined from a machinability perspective. However, from a health perspective it is considered one of the less heavy metals. There are no known health consequences associated with the use of bismuth in products in contact with drinking water and it is a common additive in the manufacture of plumbing products in meeting the requirements for low lead in the US.

Substitutes for copper alloy

An unintended consequence of Option 2 could be the substitution of copper alloy products with other products made from different materials. This fall in demand could occur if prices rise (as a consequence of using a low lead material) beyond a point accepted by the market. In this event, a shift could occur towards use of other materials which are currently permitted by the PCA, such as cross-linked polyethylene, stainless steel or composite materials.

As there are no formal studies available, the Copper Development Association Inc., McLean, Virginia (CDA US) were contacted in developing this Consultation RIS for information on the impact low lead provisions had on the copper alloy market in the US.

¹⁰⁴ Mohamed A.Taha, Nahed A.El-Mahallawy, Rawia M.Hammouda, Tarek M.Moussa, Mohamed H.Gheith (2012) 'Machinability characteristics of lead free-silicon brass alloys as correlated with microstructure and mechanical properties' Ain Shams Engineering Journal Volume 3, Issue 4, December 2012, Pages 383-392

¹⁰⁵ Lennotech (2020) Chemical properties of silicon - Health effects of silicon - Environmental effects of silicon. ><https://www.lennotech.com/periodic/elements/si.htm>< Accessed 15 June 2020.

CDA US advised that the regulatory change created significant disruption in the market and the brass supply chain, which resulted in a near immediate substitution away from brass/bronze products.

Further information received from the CDA US, via the International Copper Association Australia, shows that the demand for brass plumbing rods declined by approximately 50% since the requirements for low lead products were first introduced. This fall in demand was a direct consequence of the changes.

Given the experience in the US, substitution away from copper alloy plumbing products in contact with drinking water needs to be considered by Australian decision makers.

For commercial buildings, where copper water service lines are common, copper alloy fittings are predominantly used. In these instances, the demand for copper alloy fittings is expected to remain as there are no close substitutes for copper alloy products in this segment of the market.

For residential buildings, use of cross-linked polyethylene piping is common in Australia. A high majority of these installations use copper alloy fittings. In these instances, the demand for copper alloy fittings is also expected to remain static, as familiarity and availability of products is also an important consideration of plumbing practitioners when choosing which products to install.

The possibility of substitution, similar to the US experience, is most likely to occur where copper water service lines are used in residential buildings, where copper fittings can replace copper alloy fittings such as brass. In these instances, the demand for copper alloy is more likely to fall as the price of copper alloy products increase. This scenario represents a smaller proportion of all installations relative to the US experience, as use of copper water service lines represent approximately 30% of all residential plumbing installations in Australia, lower than that installed in the US.

From a cost-benefit analysis perspective, this substitution effect would decrease the cost of Option 2 and 3 (as consumers and plumbing practitioners will meet the requirements through more cost-effective means by selecting cheaper substitute products). However, decision makers should have regard to the impacts to the copper alloy industry.

The effect of using materials other than copper alloy on human health has also been questioned by some stakeholders in the development of this Consultation RIS. However, there are few relevant studies on the health consequences of other materials currently deemed fit-for-use through the PCA. As such, there is no available evidence to suggest there are adverse health effects from other substitute materials.

Impacts on the recycling of brass

Option 2 may impact the ability to recycle copper alloy in the manufacture of new plumbing products intended for contact with drinking water. This is due to higher amounts of lead being present which would prevent the material's reuse in the manufacture of plumbing products intended for contact with drinking water. This wouldn't, however, impact the ability for the material to be used for plumbing products not in contact with drinking water or for other uses.

In developing this Consultation RIS, advice was sought from the Australian Metal Recycling Industry Association (ARIMA) on the impacts of low lead requirements on the ability to recycle copper alloy materials. ARIMA advised that it was common practice to use scrap brass as a substitute for new metal to reduce the cost of manufacturing new materials. Consequently, as available scrap brass in the future will contain higher concentrations of lead than that permitted, the demand for scrap brass by Australian smelters will fall.

ARIMA advised that this fall in demand would be softened by two factors:

1. Brass is used in the manufacture of products which are not used in plumbing products in contact with drinking water (e.g. electrical, architectural, fluid transfer industries and plumbing products not in contact with drinking water). Therefore, the production of these types of products need not be affected.
2. There are now very few brass smelters in operation in Australia and the majority of scrap brass is exported to countries which may not require low lead brass. Therefore, the demand for scrap brass as an exportable good need not be affected.

Based on the above factors, ARIMA believe that if new regulations were to come into effect, there would be an initial local oversupply of recycled brass which would drive down the local price of scrap brass. However, based on price fluctuations within the

industry being common, this wouldn't result in a large demand shock as scrap brass would continue to be a useful recycled material, particularly as an exportable good.

Lead leaching from low lead products

Small studies conducted by the Australian Water Quality Centre (AWQC) have observed higher levels of lead leaching from low lead plumbing products when compared to higher leaded products. When conducting further studies, lead levels fluctuated based on whether the product had been acid rinsed. Acid rinsed products complied with the AS/NZS 4020 requirements whereas water rinsed products failed. These findings are consistent with reports in the US which found some lead-free products still leached high concentrations of lead.

Although this unintended consequence is counter intuitive with the objectives of the changes, it highlights the importance of the correct finishing of products after manufacture. The findings of the AWQC support the need for the continued testing and certification of plumbing products in contact with drinking water by accredited testing laboratories to ensure adequate rinsing processes are reflected in the certification process.

Consultation Questions:

11. Are you aware of any health consequences associated with using substitutes for lead in the manufacture of plumbing products in contact with drinking water?
12. Do you have any comments on the factors that influence product selection?
13. Are there any other unintended consequences not considered relevant to implementing Option 2?

Please explain your answers.

Option 3: Promote the use of low lead products through an industry led labelling scheme and recommend changes to government procurement standards

Costs

This option would involve the development of an industry led labelling scheme. Costs incurred from implementing this measure would be voluntary and involve

manufacturers of low lead products suitably identifying their products in the Australian market.

Labelling of lead-free products is a mandatory requirement of US plumbing regulation. As such, the cost of implementing this measure could be assumed minor on the basis that labelling of low lead products occurs under the status quo.

However, because there is no single compliance mark used, lead-free markings vary and depend on which of the eight American National Standards Institute accredited third-party certifiers a manufacturer employs. The use of “lead-free” as a term is also misleading as trace amounts of lead are still permitted in the manufacture of plumbing products in the US. On this basis, ensuring products are uniformly labelled and correct terminology is used will help consumers decide which products they select.

If implemented, the development of labelling requirements would be led by industry and facilitated by an industry/government working group established by the ABCB.

This option would also allow changes to state and territory government and federal government procurement standards to require the use of low lead plumbing products in contact with drinking water for all government-owned buildings when installed or replaced.

In 2019, the value of building work done by the public sector was 11.25% of the total value of building work undertaken.¹⁰⁶ As such, this analysis assumes the cost of this option to be 11.25% of the total cost of Option 2. This results in a cost of \$31.5 million annually or \$237 million in Present Value terms.

Benefits

The effectiveness of labelling influencing private decision making will be limited based on the voluntary nature of the option. This is both in terms of the decision to label products as low lead by manufacturers and the decision by consumers to select low lead products.

A barrier to the effectiveness of labelling could be the split incentives which may exist between those who pay and those to whom the benefits accumulate. For example, investors or owners of rental properties may seek to reduce capital costs by installing

¹⁰⁶ ABS (2020) Catalogue8752.0 'Building Activity, Australia, March 2020. Table 12.

lowest cost plumbing products at construction or at replacement. Similarly, purchasing decisions for plumbing products 'behind the wall' are driven by different incentives and may not involve an owner.

Effectiveness under this option would therefore be assisted by changes to government procurement rules, thus increasing demand and the market's transition to a greater uptake of low lead plumbing products.

Despite the existence of these split incentives, providing greater information to consumers will promote the use of low lead products in some instances. The extent this would occur is unquantifiable based on available information, although considered low.

Like Option 2, the benefits of reducing low lead exposure is not known with certainty but assumed to be 11.25% of total exposure based on the contribution public sector expenditure contributes to overall expenditure.

Hence, the benefits of Option 3 are estimated to be \$6.9 million annually or \$586 million in Present Value terms using a 7% discount rate over 20 years. This results in a net benefit of \$349 million in Net Present Value terms if Option 3 was to be implemented.

Consultation Questions:

14. What is your preferred option and why?

Please explain your answers.

Business compliance costs

Business compliance costs are assessed under the following checklist:

- Notification – businesses will not be required to report certain events.
- Education – businesses will be required to keep abreast of regulatory requirements.
- Permission – businesses will not need to seek permission to conduct an activity.
- Purchase cost – businesses may be required to purchase items such as new manufacturing equipment. This impact is embedded into the impacts of Option 2.
- Record keeping – businesses will not be required to update their records.
- Enforcement – businesses will not incur additional costs when cooperating with audits or inspections.
- Publication and documentation – businesses will not incur costs of producing documents for third parties.
- Procedural – businesses will not incur cost of a non-administrative nature.
- Other – businesses will not incur any other costs other than those identified by the analysis.

Regulatory burden

The Australian Government has introduced the 'Guide to Regulation', which discusses the importance of cutting red tape.

A key principle for Australian Government policy makers in the Guide to Regulation is that:

The cost burden of new regulation must be fully offset by reductions in existing regulatory burden.

All regulatory costs, whether arising from new regulations or changes to existing regulation, must be quantified using the Regulatory Burden Measurement framework. The framework must also be used for quantifying offsetting regulatory savings, where applicable.

As measured in accordance with the framework, the regulatory offset required to implement Option 2 would be a total of \$210 million annually. The Commonwealth's share of this is \$23.4 million annually.¹⁰⁷

Governments of the states and territories are not required under COAG policy to identify regulatory offsets. Some jurisdictions may have their own mechanisms regarding regulatory offsets, which would be a matter for those jurisdictions to consider.

¹⁰⁷ Regulatory burden has been calculated in accordance with the RBM framework. Annual burden calculated by dividing the Present Value costs by 10 and then dividing the total annual burden by 9 to reflect the Commonwealth's contribution to the decision making.

Consultation

Consultation is the cornerstone of the ABCB's commitment to create a contemporary and relevant NCC that delivers good societal outcomes for health, safety, amenity and sustainability in the built environment. This must be achieved in the context of good regulatory practice that evaluates the costs and benefits to society, as per the objective of the ABCB's Intergovernmental Agreement. The ABCB recognises the value of engaging constructively with the community and industry in order to achieve this.

Lead in Plumbing Products Forum

On 23 May 2019, the ABCB convened a Lead in Plumbing Products forum which was hosted by Standards Australia. The attendees of the forum were representatives of:

- Consumer Electronics Suppliers Australia
- Bunnings Group
- Reece Group
- Master Plumbers Association - Australia
- Master Plumbers Association - New Zealand
- Hydraulic Consultants Association of Australasia
- PPI Group
- AI Group
- enHealth
- Australian Association of Certifying Authorities
- Accredited testing laboratories
- Brassware Association Queensland
- Representatives of Standards Australia's technical committees:
- PL-021 - PVC, ABS and Polyamide Pipe Systems
- PL-006 - Polyolefin Pipe Systems
- WS-028 - Design and Installation of Buried Flexible Pipes
- WS-027 - Drinking Water Treatment Systems
- WS-026 - Valves Primarily for use in Warm and Hot Water Systems
- WS-022 - Valves for Waterworks Purposes
- WS-001 - Water and Gas Fittings
- EL-020 - Electric Water Heating Appliances
- WS-016 - Cast Iron Pressure and Pipe Fittings
- CH-034 - Materials in Contact with Drinking Water
- WS-003 - Sanitary Plumbing Fixtures

The forum provided useful information on the current market, range of products, impacts (costs) of reducing lead and the feasibility of options. The survey and discussion revealed a high level of support for reducing lead in plumbing products. The forum discussed products in general terms noting individual products more likely to be manufactured within Australia include valve manufacturing and storage water heaters. Instantaneous water heaters and flexible connectors are predominantly imported.

For affected products, a reduction of lead in brass material inputs increases machining time and wear, resulting in higher material costs and lower batch sizes. In general, prices would be expected to increase as a result of compliance with lower lead levels. As a highly competitive plumbing market these would be reflected in retail costs.

For the regulatory option, transition periods were acknowledged as an important factor in enabling:

Affected manufacturers to:

- test
- purchase equipment
- source raw materials

Suppliers to:

- consider their response to the range of products
- undertake testing and certification
- forward ordering (up to 6 months in advance)
- allow throughput of old stock (in warehousing, branches and customers).

The consensus was a minimum of three years from enactment (to prepare and allow for throughput of remaining stock).

Comments on the Consultation RIS

The ABCB invites interested parties to provide comment on all aspects of this Consultation RIS. Responses to the consultation questions will be particularly helpful in developing the Final Decision RIS. Responses are invited until 11:59 pm 1 March 2021 and can be submitted via the ABCB's [Consultation Hub](#).

Conclusion

Following a number of highly publicised incidences of lead being found in drinking water exceeding 10 µg/dL, the ABCB has been tasked with investigating the use of lead in the manufacture of plumbing products in contact with drinking water.

The use of lead is currently permitted in the manufacture of plumbing products in contact with drinking water. It is most commonly found in small amounts when mixed with other metals to create copper alloys such as brass and bronze. Current product and material standards allow up to 6% lead content, and laboratory testing of plumbing products in contact within drinking water has shown that lead leaches from these products.

Current regulatory intervention aimed at reducing lead exposure has been effective in Australia with a 51% reduction in health consequences since 1990. This is largely due to interventions aimed at reducing the use of lead in commonly used products and consumables such as paint, fuel, drinking water and toys. Despite these improvements, health authorities, including the WHO and the NHMRC continue to encourage governments to eliminate all non-essential uses of lead.

There is limited available data on the impacts of reducing low lead exposure in Australia. Policy setting and standards writing bodies, such as the ABCB, would benefit from health authorities examining the water lead levels from within premises or properties in Australia and the blood lead levels within the general population. Available studies indicate that the problem of lead in drinking water from within premises or properties could be equal to or greater than 8%.

In the absence of national data on the health consequences of lead in drinking water, the GBD database shows that lead exposure continues to be a problem in Australia and attributes the health burden of lead exposure to be between 15,508 and 49,601 DALYs in 2017, with a central estimate of 30,956 DALYs. The large range coupled with the uncertainty of drinking water's contribution reflects the limitations of the GBD as an indicator, and this analysis acknowledges that specific studies, which examine the health consequences of lead in Australian drinking water, may derive narrower quantitative conclusions.

The extent to which lead in drinking water contributes to this rate is not known with certainty, however, studies from the US show that drinking water could contribute up

to 20% of the total exposure. Based on these findings the estimated DALYs attributable to lead in drinking water is estimated to be 6,191 DALYs annually.

Three options are presented for consideration in this Consultation RIS:

- Option 1: Retain the status quo. This option is regarded as the baseline.
- Option 2: Require all products in contact with drinking water to contain a maximum lead content of 0.25%.
- Option 3: Promote the use of low lead products through an industry led labelling scheme and recommend changes to government procurement standards.

The impacts of Option 2 are very large, both in costs and benefits. This reflects the number of products impacted by the proposed changes and the price difference between leaded copper alloy products and low lead copper alloy products (which result from higher production costs). The cost of this option is estimated to be \$2.1 billion in Present Value terms.

Further regulatory intervention aimed at reducing lead exposure from drinking water will not be immediate and exposure from drinking water is expected to gradually fall, as existing plumbing products in contact with drinking water are replaced by new products over time.

Having regard for the replacement rate, and using the central estimates of GBD database, the benefits of Option 2 are estimated to be in the range of \$2.6 billion and \$8.3 billion, with a central estimate of \$5.2 billion in Present Value terms. Option 2 demonstrates an overall net benefit of \$3.1 billion in Net Present Value terms under the central assumptions and is robust when sensitivity analysis of key parameters is undertaken, with strong net benefits in all but one scenario.

Option 3 has less overall impact and is a subset of Option 2. The costs of Option 3 are estimated to be \$237 million and the benefits to be \$586 million in Present Value terms, with a net benefit of \$349 million in Net Present Value terms.

As Option 2 has large impacts, particularly to the supply chain of copper alloy plumbing products in contact with drinking water, a suitable transitional period should be considered in consultation with industry. In contrast, transitional arrangements may not be required for Option 3, which while it could be implemented sooner, would be

driven by any change in the demand driven by changes to government procurement rules.

As Option 2 demonstrates the highest net benefit, this option is recommended by this Consultation RIS.

Implementation and Review

If decision makers support changes to the PCA, the provisions will be included in NCC 2022. As a matter of policy, proposed changes to the PCA are released in advance of implementation to allow time for familiarisation and education and for industry to modify its practices to accommodate the changes. This would be expected to occur in mid-2021. It is also anticipated that the ABCB, in association with state and territory plumbing administrations and industry organisations, would conduct information and awareness raising practices.

If the preferred option is implemented, this will have significant impact on the copper alloy plumbing product supply chain in terms of sourcing suitable raw material, upgrading equipment and the need for retesting with both the new provisions and retesting to AS/NZS 4020. As such, a suitable transition period is required.

There are two possible regulatory mechanisms for transitioning to low lead plumbing products in contact with drinking water:

- via the PCA which is amended every 3 years; or,
- via the renewal of a product's WaterMark certificate. Products are currently required to renew their certification every 5 years.

Accredited testing laboratories and industry groups have expressed preference with aligning the commencement of the new requirements with the WMCS. This would result in a 5-year transition period.

However, following advice received at the 2019 Lead in Plumbing Products forum and in effort to align the implementation of the new requirements with the NCC's amendment cycle, a 3-year transition period is proposed. Proposing a shorter transition period also recognises benefits of moving towards low lead plumbing products in contact with drinking water.

The expectation within the 3-year transition period is that manufacturers adjust manufacturing processes within the first 18 months of implementation, allowing an additional 18 months to sell existing product within the market.

Should a 3-year transition period be agreed to by decision makers, products which are certified within the next two years (i.e. before the new requirements are introduced in NCC 2022) will also incur the cost of recertification before their 5-year certification expires. It is not known how many products will be certified over the next two years. However, it could be up to 2/5th of products if an even distribution of certification occurs. Feedback is being sought on the implications of this from industry's perspective through this Consultation RIS.

Decision makers will consider the appropriate timeframe for transitional arrangements having regard to the responses received to this Consultation RIS.

A specific review of the preferred option is not planned following its implementation. The NCC is amended on a three-year cycle and the ABCB maintains regular and extensive consultative relationships with a wide range of stakeholders. It relies on this process to identify emerging concerns, and through these relationships can evaluate the effectiveness of the requirements over time.

Consultation Questions:

15. Do you agree that a transition period is required?
 16. If yes, is a 3-year or 5-year transition period preferred?
- Please explain your answers.

Attachment A

Proposed changes to Plumbing Code of Australia

Option 2 would result in the following changes to the Evidence of Suitability criteria:

A2.2 Evidence of Suitability

(1) Any product that is intended for use in contact with drinking water must—

- (a) comply with the relevant requirements of AS/NZS 4020, verified in the form of either—
 - i. a test report provided by an ~~certification body or Accredited Testing Laboratory~~, in accordance with AS/NZS 4020; or
 - ii. a *WaterMark licence* issued in accordance with (2), if it includes compliance with AS/NZS 4020; and
- (b) have a weighted average lead content of no more than 0.25% verified in the form of either—
 - i. a test report provided by an Accredited Testing Laboratory, in accordance with NSF/ANSI 372; or
 - ii. a WaterMark licence issued in accordance with (2), if it includes compliance with NSF/ANSI 372.

Explanation of changes

NSF/ANSI 372 is an American National Standard that establishes a standardised methodology for the determination and verification of product compliance to minimise lead contaminants.

The NSF/ANSI 372 standard includes:

- A maximum weighted lead content of 0.25% (0.2% for solders and fluxes).
- A formula for calculating the weighted average lead content of each product prior to testing.
- Specific procedures for testing products for lead content.
- Verification test requirements.

NSF/ANSI 372 addresses the lead content of a product and, to ensure compliance is achieved, it is proposed to require certification by an Accredited Testing Laboratory or certification body.

Conformance to an extraction or leaching test standard, AS/NZS 4020, would remain.

In accordance with the Governing Requirements (A1.4) the NCC over-rides any differences between it and its primary or secondary referenced document. The required limits of product and material specifications could be amended to align with this requirement post adoption of NCC 2022.

For the purposes of Option 2, low lead is defined as:

Low lead – a plumbing product or material in contact with drinking water calculated using a weighted average lead content of no more than 0.25%.

The following definitions are proposed to be included in the NCC:

Weighted average – calculated across the wetted surface area of a pipe, pipe fitting and plumbing fixture.

Wetted surface area – calculated by the total sum of diameter (D) in contact with drinking water.

How to calculate the wetted surface area

A worked example of how to calculate the weighted average lead content of a plumbing product is shown in Table A1.

Table A1: NSF/ANSI 372 – 2016 Annex A (Informational) Example of weighted average lead content calculation

| Component no. | Wetted surface area 1 (total = $\sum D$) | Ratio wetted surface area | % lead content | % lead contribution |
|---------------|---|---------------------------|----------------|-----------------------|
| 1 | 1,142.27 | 0.0453 | 0 | 0.0000 |
| 2 | 4,472.17 | 0.1774 | 0.25 | 0.0444 |
| 3 | 157.58 | 0.0063 | 0.55 | 0.0034 |
| 4 | 1,013.50 | 0.0402 | 0.25 | 0.0101 |
| 5 | 382.60 | 0.0152 | 0 | 0.0000 |
| 6 | 695.74 | 0.0276 | 0 | 0.0000 |
| 7 | 425.85 | 0.0169 | 0 | 0.0000 |
| 8 | 16,915.63 | 0.6711 | 0.02 | 0.0134 |
| | 25,205.34 | | | <u>0.0713%</u> |

Notes:

1. This example assumes that there are eight components in the one product with varying degrees of wetted surface area.

2. The wetted surface area is measured by the total sum of diameter (D) in contact with drinking water. That is, the length of the pipe or fitting in contact with drinking water multiplied by its diameter.
3. The ratio wetted surface area is the wetted surface area of the component divided by the total wetted surface area of all components.
4. The percentage of lead contribution is calculated by multiplying the ratio of wetted surface area by the percentage of lead content (e.g. $0.1774 \times 0.25 = 0.0444$).

From NSF/ANSI 372:

4.2 Formula for determining weighted average lead content

The following formula shall be used when calculating the weighted average lead content of products:

$$WLC = \sum_{c=1}^n \left(LC_c \times \left[\frac{WSA_c}{WSA_t} \right] \right)$$

where;

- WLC = weighted average lead content of product
- LC_c = maximum lead content of the c^{th} component
- WSA_c = wetted surface area of the c^{th} component
- WSA_t = total wetted surface area of all components
- n = number of wetted components in product

NOTE — An example calculation of the weighted average lead content of a product is provided in Annex A.

Attachment B

Table B1: Representative Product Types and Categories

| Product Type |
|--|
| Fittings |
| Extension M & F 15mm x 50mm brass |
| Socket hex brass 20mm |
| Socket M & F red brass hex 20mm x 15mm |
| Elbow F & F brass 15mm |
| Cap brass 20mm |
| All thread nipple brass 15mm x 150mm |
| Elbow F & F brass 20mm |
| Plug hex square brass 15mm |
| All thread nipple brass 20mm x 300mm |
| Union barrel M & F brass 20mm |
| Elbow M & F brass 25mm |
| Elbow F & F brass 20mm |
| Plug hex square brass 20mm |
| Brass screwed tube 15mm x 600mm |
| Bush reducing brass 15mm x 25mm |
| Valves |
| Water meter including kit 20mm |
| M & F right angle ball valve 20mm |
| Y strainer 50mm |
| Brass Inline M & F cistern cock 15mm |
| Expansion control valve 15mm |
| Spring check valve 25mm |
| TMV 20mm |
| Brass ball valve 50mm F & F |
| Brass ball valve 20mm plain |
| Brass tempering valve 15mm |
| Compact PRV limiter 20mm |
| Brass duo non-return valve 15mm |
| Dual check valve 20mm |
| Brass RPZ valve 25mm |
| Stainless Steel Hoses |
| 15mm S/S 300mm long |
| 15mm S/S 450mm long |
| 15mm S/S 600mm long |
| 15mm S/S 1000mm long |

| Product Type |
|---|
| Taps and Combinations |
| Hose tap plain 15mm |
| Mini isolation cock plain 15mm |
| Taps other |
| Mixers |
| Kitchen mixers |
| Basin mixers |
| Shower mixer chrome |
| Shower bath mixer chrome |
| Sink with vegetable spray chrome |
| Water Heater Systems |
| Continuous Flow Gas |
| 17ltr/min Gas wall instant |
| 20ltr/min Gas wall instant |
| 26ltr/min Gas wall instant |
| Gas Storage |
| 130ltr/min Gas storage |
| 170ltr/min Gas storage |
| Heat Pump |
| 170ltr Heat pump electric |
| 280ltr Heat pump electric |
| Solar |
| 315ltr Solar H/W split system |
| Electric Storage |
| 20ltr HWS electric |
| 50ltr HWS electric |
| 80ltr HWS electric |
| 125ltr HWS electric |
| 160ltr HWS electric |
| 250ltr HWS electric |
| 315ltr HWS electric |
| 400ltr HWS electric |
| Mechanical Continuous Flow |
| Residential Water Filtration |
| Above sink or counter top filtration system |
| POU cartridge under sink filtration |
| POU twin housing under sink system |
| POU RO system |
| POE filtration system |
| POE water softener |
| Water Dispensers |
| Under sink cold water (unchilled/chilled) |
| Under sink hot and cold (entry level/mid-level) |

Attachment C

List of material and product standards impacted by the proposed changes can be found in Table C1.

Table C1: Current Material Specifications

| Australian Standard | Maximum allowable lead content |
|--|--|
| AS 1565: Copper and copper alloys — Ingots and castings | Castings comprise less than 4.5% |
| AS/NZS 1568: Copper and copper alloys— Forging stock and forgings | Hot pressing (forgings) less than 3.5% |
| AS/NZS 1567: Copper and copper alloys— Wrought rods, bars and sections | Rod for machined parts less than 3.5% |
| AS/NZS 1572: Copper and copper alloys— Seamless tubes for engineering purposes | Tubular component (typically outlets) 5% |

The selection of the copper grade used to manufacture plumbing products is set out by each corresponding product standard. This is shown below in Table C2.

Table C2: Plumbing Product Standards containing maximum lead content levels

| Product | Standard | Component | Copper Alloy Grade | Allowable lead |
|--------------------------------|---------------|---|--------------------|----------------|
| Gate Valves – Metal Seated | AS/NZS 2638.1 | Spindle Seal Retainer, Gate, Gate Nut, Seat Rings | C83600 | 4% - 6% |
| Gate Valves – Resilient Seated | AS/NZS 2638.2 | Spindle Seal Retainer, Gate Nut | C83600 | 4% - 6% |
| Spring Valves | AS 3952 | Dome | C83600 | 4% - 6% |
| Non-return Valves | AS 4794 | Disc, Seat Rings | C83600 | 4% - 6% |

| Product | Standard | Component | Copper Alloy Grade | Allowable lead |
|---------------------------------------|-------------|--|--------------------|----------------|
| Butterfly Valves | AS 4795.1 | Disc, Bearings | C95810 | 0.05% |
| | AS 4795.2 | | C92710 | 4% - 6% |
| | AS 5612 | | C93500 | - |
| | | | C93700 | - |
| Air Valves | AS 4956 | Seat | C83600 | 4% - 6% |
| Tapping Bands | AS 4793 | Body, Outlet | C83600 | 4% - 6% |
| | | | C48600 | 2.5% - 6% |
| Meters | AS 3565 | Body | Not specified | N/A |
| Ball Valves | AS 4796 | Body | C37710 | 1% - 3% |
| | | | C83600 | 4% - 6% |
| Automatic Control Valves | AS 5081 | Piston, Guide Bushings, Pilot Valve Body, Plug | C90250 | 0.3% |
| | | | C83600 | 4% - 6% |
| | | | C93500 | - |
| Ferrules | AS/NZS 3718 | Body | Not specified | N/A |
| | AS 3496 | | | |
| Bronze Gate Valves | AS 1628 | Body | Not specified | N/A |
| Copper Pipe – Main to Meter | AS 1432 | Pipe | C12200 | Nil |
| Miscellaneous Fittings and Connectors | AS 3688 | Body | Not specified | N/A |

Source: WSA (2020)