# Tetraalkyl lead compounds: Environment tier II assessment

**11 April 2014**

## CAS Registry Numbers: 1762-27-2, 1762-26-1, 78-00-2, 75-74-1, 1762-28-3, 68610-17-3.



## Preface

This assessment was carried out by staff of the National Industrial Chemicals Notification and Assessment Scheme (NICNAS) using the Inventory Multi-tiered Assessment and Prioritisation (IMAP) framework.

The IMAP framework addresses the human health and environmental impacts of previously unassessed industrial chemicals listed on the Australian Inventory of Chemical Substances (the Inventory).

The framework was developed with significant input from stakeholders and provides a more rapid, flexible and transparent approach for the assessment of chemicals listed on the Inventory.

Stage One of the implementation of this framework, which lasted four years from 1 July 2012, examined 3000 chemicals meeting characteristics identified by stakeholders as needing priority assessment. This included chemicals for which NICNAS already held exposure information, chemicals identified as a concern or for which regulatory action had been taken overseas, and chemicals detected in international studies analysing chemicals present in babies' umbilical cord blood.

Stage Two of IMAP began in July 2016. We are continuing to assess chemicals on the Inventory, including chemicals identified as a concern for which action has been taken overseas and chemicals that can be rapidly identified and assessed by using Stage One information. We are also continuing to publish information for chemicals on the Inventory that pose a low risk to human health or the environment or both. This work provides efficiencies and enables us to identify higher risk chemicals requiring assessment.

The IMAP framework is a science and risk-based model designed to align the assessment effort with the human health and environmental impacts of chemicals. It has three tiers of assessment, with the assessment effort increasing with each tier. The Tier I assessment is a high throughput approach using tabulated electronic data. The Tier II assessment is an evaluation of risk on a substance-by-substance or chemical category-by-category basis. Tier III assessments are conducted to address specific concerns that could not be resolved during the Tier II assessment.

These assessments are carried out by staff employed by the Australian Government Department of Health and the Australian Government Department of the Environment and Energy. The human health and environment risk assessments are conducted and published separately, using information available at the time, and may be undertaken at different tiers.

This chemical or group of chemicals are being assessed at Tier II because the Tier I assessment indicated that it needed further investigation.

For more detail on this program please visit: www.nicnas.gov.au.

## Disclaimer



Acronyms & Abbreviations

## Grouping Rationale

This Tier II assessment considers the environmental risks associated with industrial uses of the five closely related tetraalkyl lead compounds:

Plumbane, diethyldimethyl- (Diethyldimethyl lead)
Plumbane, ethyltrimethyl- (Ethyltrimethyl lead)
Plumbane, tetraethyl- (Tetraethyl lead)
Plumbane, tetramethyl- (Tetramethyl lead)
Plumbane, triethylmethyl- (Triethylmethyl lead)

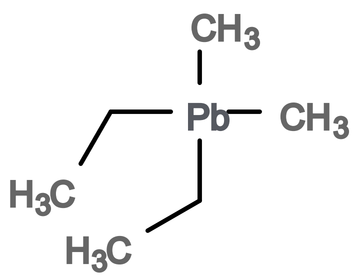
The risk assessment of these chemicals has been conducted as a group because these five discrete organolead compounds have high structural similarity and they are therefore expected to have comparable physical and chemical properties. They are also known to have a common and exclusive industrial use as fuel additives. Based on these considerations, the chemicals in this group are each expected to have common environmental exposure pathways and closely similar environmental fate and ecotoxicity profiles.

Furthermore, the expected use of all chemicals in this group is subject to the restrictions set out under the *Fuel Quality Standards Act 2000* (the Fuel Quality Standards Act) (Cwlth). Tetraethyl lead and tetramethyl lead are also subject to trade restrictions due to their listing on Annex III of the *Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade* (the Rotterdam Convention).

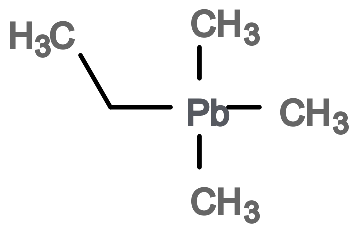
This group assessment also includes plumbane, ethyl methyl derivatives (CAS RN: 68610-17-3). This is an unknown or variable composition, a complex product of a chemical reaction, or a biological material (UVCB) substance on the Inventory which is a mixture of all five of the discrete tetraalkyl lead compounds in this group. This substance has also been used as a fuel additive and is appropriate to include in the group assessment because of the similarity in structure and properties of each of the discrete members of the group.

References to tetraalkyl lead compounds in this assessment refer to the above listed chemicals only, unless otherwise specified.

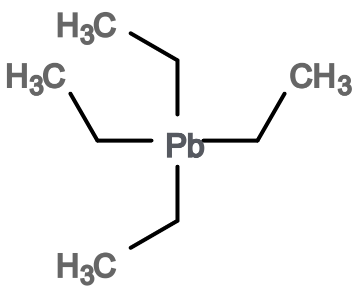
## Chemical Identity

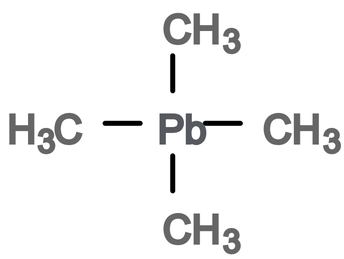
| | |
|---|---|
| CAS RN | 1762-27-2 |
| Chemical Name | Plumbane, diethyldimethyl- |
| Synonyms | Diethyldimethyl lead<br>Diethyl(dimethyl)plumbane |
| Structural Formula |  |
| Molecular Formula | $C_6H_{16}Pb$ |
| Molecular Weight (g/mol) | 295.39 |
| SMILES | C(C)[Pb](C)(C)CC |

| | |
|---|---|
| CAS RN | 1762-26-1 |
| Chemical Name | Plumbane, ethyltrimethyl- |

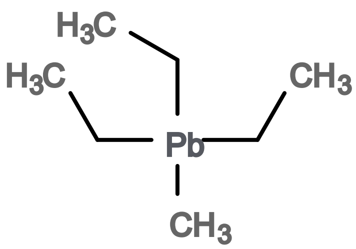
| | |
|---|---|
| Synonyms | Ethyltrimethyl lead<br>Ethyl(trimethyl)plumbane |
| Structural Formula |  |
| Molecular Formula | $C_5H_{14}Pb$ |
| Molecular Weight (g/mol) | 281.37 |
| SMILES | C(C)[Pb](C)(C)C |

| | |
|---|---|
| CAS RN | 78-00-2 |
| Chemical Name | Plumbane, tetraethyl- |
| Synonyms | Tetraethyl lead (TEL)<br>Tetraethylplumbane |
| Structural Formula | |

| | |
|---|---|
| |  |
| Molecular Formula | $C_8H_{20}Pb$ |
| Molecular Weight (g/mol) | 323.45 |
| SMILES | C(C)[Pb](CC)(CC)CC |

| | |
|---|---|
| CAS RN | 75-74-1 |
| Chemical Name | Plumbane, tetramethyl- |
| Synonyms | Tetramethyl lead (TML)<br>Tetramethylplumbane |
| Structural Formula |  |
| Molecular Formula | $C_4H_{12}Pb$ |

| | |
|---|---|
| Molecular Weight (g/mol) | 267.34 |
| SMILES | C[Pb](C)(C)C |

| | |
|---|---|
| CAS RN | 1762-28-3 |
| Chemical Name | Plumbane, triethylmethyl- |
| Synonyms | Triethylmethyl lead<br>Triethyl(methyl)plumbane |
| Structural Formula |  |
| Molecular Formula | $C_7H_{18}Pb$ |
| Molecular Weight (g/mol) | 309.42 |
| SMILES | [Pb](C)(CC)(CC)CC |

| | |
|---|---|
| CAS RN | 68610-17-3 |
| Chemical Name | Plumbane, ethyl methyl derivatives |

| | |
|---|---|
| Synonyms | Tetraethyl lead, tetramethyl lead redistribution mixture |
| Structural Formula | Not provided. This substance is an equilibrium mixture of all five of the discrete tetraalkyl lead substances shown above. |

## Physical and Chemical Properties

The physical and chemical property data for tetramethyl lead and tetraethyl lead were retrieved from the databases included in the OECD QSAR Toolbox and the United States National Library of Medicine Hazardous Substances Data Bank (LMC, 2013; US NLM, 2013).

Limited experimental physical and chemical property data are available for the mixed ethyl and methyl tetraalkyl lead chemicals in the group. However, tetramethyl lead and tetraethyl lead represent the two structural end members of this group, and the physical and chemical properties of the remaining chemicals are therefore expected to fall within the range of values presented below:

| Chemical | Tetramethyl lead | Tetraethyl lead |
|---|---|---|
| Physical Form | Liquid | Liquid |
| Melting Point | -27.5°C (exp.) | -136°C (exp.) |
| Boiling Point | 110°C decomposes (exp.) | 202°C decomposes (exp.) |
| Vapour Pressure | 3470 Pa (exp.) | 34.7 Pa (exp.) |
| Water Solubility | 15 mg/L (exp.) | 0.29 mg/L (exp.) |
| Ionisable in the Environment? | No | No |
| log $K_{ow}$ | 2.97 (exp.) | 4.15 (exp.) |

## Import, Manufacture and Use

## Australia

Historically, tetraalkyl lead compounds have been used in Australia as fuel additives. However, a phase out of the use of lead based additives in petrol for on-road applications in Australia was completed in 2002 (Australian Government, 2005).

Nevertheless, some tetraalkyl lead compounds are still used in some fuels, in accordance with the Fuel Quality Standards Act. A survey of tetramethyl lead and tetraethyl lead use in Australia in 2005 found that approximately 250 tonnes of tetraethyl lead was imported for use in aviation gasoline (Avgas), with around 18 tonnes of the chemical subsequently exported. A smaller quantity (less than 100 kg) of tetraethyl lead was also imported in fuel for use in sport vehicles (including cars, motorcycles and boats), and vintage cars. Tetramethyl lead was not reported to be used in Australia (Australian Government, 2005).

No specific Australian use, import or manufacturing information has been identified for the remaining tetraalkyl lead compounds in this group.

## International

Tetraalkyl lead compounds have historically been widely used as fuel additives, where they function as anti-knock agents or octane improvers (US NLM, 2013).

Although use has decreased due to the recognition of the neurotoxicity of lead compounds and the environmental pollution caused by their use, these chemicals are still used in some fuels. The most significant use of tetraalkyl lead compounds is in aviation gasoline for piston-engine aircraft, with some use also occurring in fuels for competition vehicles, boats, and some machinery and equipment such as tractors. Some countries still rely on leaded petrol in motor vehicles (Government of Canada, 2014; UNEP, 2014a).

Based on the available information, all chemicals in this group are still used in the European Union. Tetraethyl lead is registered under the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) legislation for use at between 1000 and 10 000 tonnes per annum (ECHA, 2014). All other chemicals have been pre-registered under the legislation.

The volume information from the United States of America (USA) is similar, with over 700 tonnes of tetraethyl lead produced in 2012. No current production and use data were available for the remaining chemicals in the group (US EPA, 2013a).

A large amount of research has been conducted internationally to find a viable alternative to leaded aviation gasoline. In December 2013, Shell Aviation announced that a lead-free replacement for aviation gasoline had been developed. The new fuel is currently undergoing regulatory approval in the European Union and USA (Shell, 2013).

# Environmental Regulatory Status

## Australia

The lead content of petrol is controlled in Australia by the *Fuel Standard (Petrol) Determination 2001*(the Petrol Standard) under the Fuel Quality Standards Act. The Petrol Standard prohibits the supply of petrol that contains more than 5 mg/L of lead. Suppliers may apply to the Australian Government Minister for the Environment for an approval to vary the petrol standard, allowing the limited supply of fuels containing lead. The petrol standard does not extend to aviation gasoline for use in aircraft (Australian Government Department of the Environment, 2014a; Commonwealth of Australia, 2001 ).

The introduction and export of tetraethyl lead and tetramethyl lead is also controlled under the *Industrial Chemicals (Notification and Assessment) Regulations 1990*(Cwlth). The introduction of tetramethyl lead is prohibited unless approval is sought from the Director of NICNAS, with approval also required for the introduction of tetraethyl lead unless the chemical is to be used in aviation gasoline or approval has been granted under the Fuel Quality Standards Act. In addition, export of either of these chemicals requires approval from the Director of NICNAS (Commonwealth of Australia, 1990).

Lead and lead compounds are subject to reporting under the Australian National Pollutant Inventory (NPI). Under the NPI, emissions of lead and lead compounds are required to be reported annually by facilities that use or emit more than 10 tonnes of lead or lead compounds, burn more than 2000 tonnes of fuel, consume more than 60 000 megawatt hours of electricity (excluding lighting and motive purposes), or have an electricity rating of 20 megawatts during a reporting year (Australian Government Department of the Environment, 2013a). Emissions may be intentional, accidental or incidental releases arising through industrial processes. Additionally, emissions of lead and lead compounds from diffuse sources, such as lawn mowers and wood heaters, are also periodically estimated by state environment authorities. Diffuse emissions data are updated much less frequently than facility data (Australian Government Department of the Environment, 2013b).

## United Nations

Tetraethyl lead and tetramethyl lead are listed on Annex III of the Rotterdam Convention (UNEP & FAO, 1998). The Rotterdam Convention aims to facilitate sharing of chemical information to promote shared responsibility for the international trade of certain hazardous chemicals. Of the 193 United Nations countries, 153 have ratified the Rotterdam Convention, including Australia. The European Union is also a party to the convention (UNEP & FAO, 2014).

## OECD

No chemicals in this group have been sponsored for assessment under the Cooperative Chemicals Assessment Programme (CoCAP). However, diethyldimethyl lead, tetraethyl lead and tetramethyl lead have been identified as High Production Volume chemicals by the OECD. High Production Volume chemicals are used at more than 1000 tonnes per annum in at least one member country (OECD, 2012; 2013).

## Canada

The lead content of petrol used in Canada is controlled under the *Regulations Respecting Concentrations of Lead and Phosphorus in Gasoline* of the *Canadian Environmental Protection Act 1999*. The Regulations prohibit the production, importation or sale of petrol containing more than 5 mg/L of lead, excluding fuel used in aircraft and competition vehicles (Government of Canada, 2014).

## European Union

The lead content of most fuels used in road vehicles, mobile machinery, tractors and recreational craft in the European Union is controlled under *Directive 2009/30/EC of the European Parliament and of the Council*. Petrol must not contain more than 5 mg/L of lead (European Commission, 2009).

Tetraethyl lead has been identified as a Substance of Very High Concern under the REACH legislation due to its reproductive toxicity. The chemical is currently listed on the Candidate List for Eventual Inclusion in Annex XIV to REACH (ECHA, 2012). Once included in Annex XIV to REACH (the Authorisation List), use of the chemical may be severely restricted.

## United States of America

The supply of petrol that contains lead or lead additives for use in road motor vehicles (excluding competition vehicles) is prohibited in the USA under the *Clean Air Act 1970* (US EPA, 2013b).

Alkyl lead compounds have been identified as priority persistent, bioaccumulative and toxic (PBT) chemicals by the United States Environmental Protection Agency (US EPA). A National Action Plan to manage these chemicals was published in 2002. As a result, the US EPA developed a voluntary partnership with the National Association for Stock Car Automobile Racing (NASCAR) to work towards removing alkyl lead compounds from racing fuels (US EPA, 2002).

The US EPA is also currently determining the extent to which lead emissions from aircraft engines endanger public health and welfare. A final finding is expected in mid to late 2015 (US EPA, 2010; 2012).

# Environmental Exposure

The major remaining industrial use of tetraalkyl lead compounds in Australia is as additives in aviation gasoline, with some minor uses in specialty fuel applications as approved by the Australian Government Minister for the Environment under the Fuel Quality Standards Act.

The major fraction of tetraalkyl lead compounds used in fuels will be decomposed into inorganic oxidation products following combustion in engines. The predominant route of release for tetraalkyl lead compounds used in fuels is expected to be through evaporation from unburned fuel, and losses during fuel transfer (e.g. filling of fuel tanks) and from spills (Harrison and Laxen, 1978).

# Environmental Fate

## Partitioning

Tetraalkyl lead compounds are expected to partition to the atmosphere if released from industrial use.

The measured Henry's Law constant for partitioning of tetraethyl lead from water into air is 57 600 Pa-$m^3$/mol (LMC, 2013), indicating that the chemical is highly volatile from water and moist soil. The calculated Henry's Law constants for the analogous chemicals in this group (not presented) indicate similar partitioning behaviour (US EPA, 2008). An estimated organic carbon normalised adsorption coefficient ($K_{OC}$) of 1300 is also available for tetraethyl lead (ECHA, 2014), indicating low mobility in soil. However, evaporative losses are expected to dominate the partitioning behaviour in soil for this group of chemicals.

Calculations with a standard multimedia partitioning (fugacity) model assuming exclusive release into air predict 100% partitioning to the air compartment for all tetraalkyl lead compounds in this group (US EPA, 2008). This is expected to be the predominant route of environmental release for the chemicals in this group.

## Degradation

Tetraalkyl lead compounds ultimately degrade to inorganic lead compounds in the environment.

Tetraalkyl lead compounds undergo rapid primary degradation in the atmosphere by photo-oxidation and direct photolysis. The calculated half-lives for indirect photo-oxidation of tetramethyl and tetraethyl lead are 18.2 hours and 2.6 hours, respectively (US EPA, 2008). These calculations are supported by available measured data (LMC, 2013), and are expected to encompass the predicted oxidation half lives of the other tetraalkyl lead compounds in this group. Degradation of tetraalkyl lead compounds in the atmosphere yields some ionic trialkyl lead compounds which are more stable to photo-oxidation than the parent substances (ECB, 2000; 2008; Harrison and Laxen, 1978).

In water, tetraalkyl lead compounds undergo photodegradation and hydrolysis to form ionic trialkyl lead compounds. These intermediate trialkyl lead compounds degrade to dialkyl and alkyl leads over a period of days to weeks, eventually forming inorganic lead compounds (ECB, 2008).

Experimental data show that, when kept in darkness, tetraethyl lead in water experiences 50% degradation to triethyl lead in two to five days, with up to 97% of the parent compound degraded in 29 days. Under natural lighting conditions, 99% degradation has been observed in 15 days. A further study found tetraethyl lead to undergo complete degradation to inorganic lead within 14 days in soil (ECB, 2000; 2008).

The most important pathway for degradation of tetraalkyl lead compounds is during fuel combustion. In this process, tetraalkyl lead compounds are oxidised to inorganic lead compounds, which are subsequently emitted with the exhaust gases (Harrison and Laxen, 1978).

## Bioaccumulation

Tetraalkyl lead compounds have a low to moderate bioaccumulation potential in aquatic biota.

Extensive experimental bioaccumulation data are available for tetraethyl lead in aquatic species. Multiple measured bioconcentration factors (BCFs) range from 3 for the freshwater mussel *Elliptio complanata* after 14 days exposure, to 650 for the shrimp *Crangon crangon* after exposure for 96 hours. Two BCFs of 18 140 and 17 600 have been reported for the oyster *Crassostrea virginica* after exposures of 96 hours and 84 days, respectively. However, it appears that these studies were conducted using a technical fuel product rather than tetraalkyl lead itself, and therefore these values are not considered representative. A smaller set of bioaccumulation data is available for tetramethyl lead, with BCFs ranging from 20 for *C. crangon* to 170 for the marine mussel *Mytilus edulis* after 96 hours exposure (ECB, 2000; LMC, 2013).

### Transport

Tetraalkyl lead compounds are unlikely to undergo long range transport in the environment. However, inorganic lead compounds, which are the products of combustion of leaded gasoline, can be transported in the atmosphere associated with particulate matter.

Based on the expected rapid photodegradation of tetraalkyl lead compounds in the atmosphere, these substances are not expected to undergo long range transport through the atmosphere. The initial products of primary photo-oxidation of tetraalkyl lead compounds, including the more stable ionic trialkyl lead compounds, will be removed from the atmosphere by natural process such as wet (with rain) deposition (ATSDR, 2007).

Inorganic lead compounds released by combustion of leaded gasoline or produced by photodegradation of tetraalkyl lead compounds will be associated with particulate matter in the atmosphere (ATSDR, 2007). The atmospheric transport of lead associated with particles may occur over local, national or regional distances. After a residence time of days to weeks in the atmosphere, this particulate matter will be deposited onto the surface of terrestrial or aquatic environments by wet or dry (without rain) deposition (UNEP, 2010; von Storch, et al., 2003).

## Predicted Environmental Concentration (PEC)

A PEC was not calculated for tetraalkyl lead compounds.

Industrial use of tetraalkyl lead compounds is predominantly expected to result in decomposition and emission of inorganic lead compounds to the atmosphere. Comparatively minor emissions of the parent tetraalkyl lead compounds to the atmosphere may be expected from unburned fuel or losses during fuel transfer operations (Hewitt and Harrison, 1986).

The decomposition of tetraalkyl lead compounds during industrial use is expected to result in environmental emissions of inorganic lead compounds. In 2011-2012, over 80 million litres of aviation gasoline was supplied in Australia. Assuming aviation gasoline lead concentrations between 0.56 and 0.85 grams per litre, it can be estimated that approximately 40 to 70 tonnes of lead in lead compounds is released to the environment per year due to the decomposition of tetraalkyl lead compounds in aviation gasoline (BREE, 2013; Shell, 2011a; 2011b).

Information available to the Australian Government Department of the Environment suggest that additional emissions of lead compounds from use of tetraalkyl compounds for further speciality fuel applications should not be expected to exceed one quarter of a tonne per annum. Therefore, in total, industrial use of tetraalkyl lead compounds is expected to release up to 70 tonnes of lead, in the form of various lead compounds, to the environment annually.

National emissions data from the NPI indicate that the total industry reported emission of lead to the environment was approximately 350 tonnes in 2011-12. However, industrial emissions data held by the NPI are expected to underestimate some lead emissions, including those from piston engine aircraft, due to the reporting framework and requirements (Australian Government Department of the Environment, 2014b; 2014c; Environment Australia, 2003). Nevertheless, based on the data presented here, it can be estimated that emissions of lead compounds resulting from the industrial use of tetraalkyl lead compounds may constitute as much as one sixth of Australia's annual industrial lead emissions.

Environmental concentrations of lead compounds are routinely monitored in Australia. Based on the available data, atmospheric lead concentrations are typically below 0.05 micrograms per cubic metre (μg/m$^3$) (DSEWPaC, 2011). Various studies have shown mean Australian soil lead concentrations to be between 4.7 and 437 milligrams per kilogram (mg/kg). However, these studies may include results from contaminated sites (Markus and McBratney, 2001). Analyses of lead concentrations in environmental water samples are less common, but a lead concentration of 0.005 milligrams per litre (mg/L) can generally be assumed for drinking water (noting possible contamination of drinking water due to water infrastructure) (WHO, 2011). Numerous factors, such as the bioavailability of lead compounds in water and soil, must be considered when evaluating the environmental significance of these reported lead levels (ANZECC, 2000).

# Environmental Effects

# Effects on Aquatic Life

Tetraalkyl lead compounds are expected to cause toxic effects at low concentrations in aquatic organisms across multiple trophic levels.

### Acute toxicity

The following median lethal concentrations (LC50s) and median effective concentrations (EC50s) for model organisms across three trophic levels for (a) tetramethyl lead and (b) tetraethyl lead were reported in the databases included in the OECD QSAR Toolbox and cited in the International Uniform Chemical Information Database (IUCLID) Dataset for tetraethyl lead (ECB, 2000; LMC, 2013). Note that all studies were conducted using salt water species:

| Taxon | Endpoint | Method |
| --- | --- | --- |
| Fish | (a) 96 h LC50 = 0.039 mg/L | Experimental<br>*Pleuronectes platessa* (European plaice)<br>Flow-through |
| | (b) 48 h LC50 = 0.065 mg/L | Experimental<br>*Dicentrarchus labrax* (European seabass)<br>Static |
| Invertebrates | (a) 96 h LC50 = 0.085 mg/L<br>(b) 96 h LC50 = 0.027 mg/L | Experimental<br>*Crangon crangon* (Caridean shrimp)<br>Flow-through |

| Taxon | Endpoint | Method |
|---|---|---|
| Algae | (a) 48 h EC50 = 1.65 mg/L<br>(b) 48 h EC50 = 0.15 mg/L | Experimental<br>*Dunaliella tertiolecta* (Green algae)<br>Static<br>Reduction in photosynthesis observed |

Due to the structural similarity of tetraalkyl lead compounds, the ecotoxicity of all chemicals in this group is expected to be represented by the range of values presented here.

### Chronic toxicity

There are no suitable data available to evaluate the chronic effects of these compounds on aquatic organisms.

## Effects on Terrestrial Life

Limited data are available to evaluate the toxicity of tetraalkyl lead compounds to terrestrial life. Available LD50s for oral toxicity of tetraethyl lead range from 24.6 to 107 mg/kg for the Japanese quail (*Coturnix japonica*) and mallard duck (*Anas platyrhynchos*), respectively, suggesting moderate toxicity (LMC, 2013). However, these studies are not expected to be relevant to environmental exposures of tetraalkyl lead compounds, as these chemicals are expected to partition to the atmosphere and therefore inhalation should be considered the primary route of exposure.

## Predicted No-Effect Concentration (PNEC)

The PNEC for tetraalkyl lead compounds in the air compartment was not calculated as there are currently insufficient suitable data available to evaluate the effects of these chemicals on terrestrial organisms.

The PNECs for tetraalkyl lead compounds in the water, soil and sediment compartments were not calculated as these chemicals are not expected to be released to, or significantly partition to, these compartments as a result of typical industrial use.

## Categorisation of Environmental Hazard

The categorisation of the environmental hazards of tetraalkyl lead compounds according to domestic environmental hazard thresholds is presented below (EPHC, 2009; NICNAS, 2013):

## Persistence

Not Persistent (not P). Based on the short atmospheric lifetimes of tetramethyl lead and tetraethyl lead, all chemicals in this group are categorised as not Persistent.

## Bioaccumulation

Not Bioaccumulative (not B). As measured bioconcentration factors for tetramethyl lead and tetraethyl lead do not exceed the domestic environmental threshold for bioaccumulation, all chemicals in this group are categorised as not Bioaccumulative.

## Toxicity

Toxic (T). Based on the multiple acute ecotoxicity endpoint values below 1 mg/L available for tetramethyl lead and tetraethyl lead, all chemicals in this group are categorised as Toxic.

## Summary

Plumbane, diethyldimethyl-; plumbane, ethyltrimethyl-; plumbane, tetraethyl-; plumbane, tetramethyl; plumbane, triethylmethyl and plumbane, ethyl methyl derivatives are all categorised as:

- Not P
- Not B
- T

# Risk Characterisation

Risk quotients (RQs) have not been calculated for these chemicals.

Industrial use of tetraalkyl lead compounds results in the release of lead compounds to the environment in the form of the parent organolead compounds and various inorganic degradation products.

Anthropogenic emissions of lead compounds to the environment are acknowledged to be of concern, both domestically and internationally, due to the persistence, bioaccumulation and toxicity of inorganic lead compounds. Although many are naturally occurring, all lead compounds are well recognised environmental pollutants due to their various toxic effects on humans, plants, animals and microorganisms. Most notably, high exposure to lead compounds can cause neurological defects and reproductive toxicity. Furthermore, the inherent persistence of many lead compounds and their potential for bioaccumulation has resulted in lead pollution becoming a concern worldwide (UNEP, 2010; 2014b).

# Key Findings

Tetraalkyl lead compounds are used in Australia in aviation gasoline and some other specialty fuel applications. Industrial use of these chemicals results in the degradation of the parent compounds and subsequent release of inorganic lead compounds to the environment. Small releases of the parent compounds are also expected.

The Fuel Quality Standards Act controls emissions of lead compounds from petrol by limiting the concentration of lead allowed in fuel sold in Australia. However, significant emissions of lead compounds still occur due to the use of tetraalkyl lead compounds in applications exempted from the standards or approved by the Australian Government Minister for the Environment. Based on this analysis, current industrial uses of tetraalkyl lead compounds are of potential concern to the environment.

Tetraalkyl lead compounds are not PBT substances according to domestic environmental hazard criteria.

# Recommendations

It is recommended that the Australian Government Department of the Environment review existing controls under the *Fuel Quality Standards Act 2000* (Cwlth) with a view to considering any improvements or additional actions that could be undertaken to minimise emissions of lead compounds to the environment as a result of the use of tetraalkyl lead compounds.

# Environmental Hazard Classification

In addition to the categorisation of environmental hazards according to domestic environmental thresholds presented above, the classification of the environmental hazards of plumbane, diethyldimethyl-; plumbane, ethyltrimethyl-; plumbane, tetraethyl-; plumbane, tetramethyl; plumbane, triethylmethyl and plumbane, ethyl methyl derivatives according to the third edition of the United Nations' Globally Harmonised System of Classification and Labelling of Chemicals (GHS) is presented below (UNECE, 2009):

| Hazard | GHS Classification (Code) | Hazard Statement |
|---|---|---|
| Acute Aquatic | Category 1 (H400) | Very toxic to aquatic life |
| Chronic Aquatic | Category 1 (H410) | Very toxic to aquatic life with long lasting effects |

Plumbane, tetraethyl- and plumbane, tetramethyl- were both classified as Aquatic Acute 1 based on their measured acute toxicity to fish and aquatic invertebrates, which provided acute toxicity end points well in excess of the classification threshold of 1 mg/L for both compounds. The acute toxicity classification for the mixed ethyl and methyl plumbanes in this group was assigned by interpolation from the measured acute aquatic toxicity for the two structural end-members of this group.

The five discrete tetraalkyl lead substances in this group were classified as Aquatic Chronic 1 based on the measured (or interpolated) acute aquatic toxicity values taking into account the lack of rapid ultimate degradability in water for these substances and their low to moderate bioaccumulation potential in aquatic organisms.

The classification of the UVCB substance, plumbane, ethyl methyl derivatives, was based on the fact that it is an equilibrium mixture of five discrete tetraalkyl lead compounds, all of which have been classified as Aquatic Acute 1 and Aquatic Chronic 1.

# References

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