Ethane, 1,2-dibromo-: Environment tier II assessment

18 September 2014

CAS Registry Number: 106-93-4.

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.

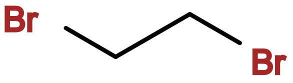
For more detail on this program please visit: www.nicnas.gov.au.

Disclaimer

NICNAS has made every effort to assure the quality of information available in this report. However, before relying on it for a specific purpose, users should obtain advice relevant to their particular circumstances. This report has been prepared by NICNAS using a range of sources, including information from databases maintained by third parties, which include data supplied by industry. NICNAS has not verified and cannot guarantee the correctness of all information obtained from those databases. Reproduction or further distribution of this information may be subject to copyright protection. Use of this information without obtaining the permission from the owner(s) of the respective information might violate the rights of the owner. NICNAS does not take any responsibility whatsoever for any copyright or other infringements that may be caused by using this information.

Acronyms & Abbreviations

Chemical Identity

Synonyms	Ethylene dibromide (EDB) 1,2-Dibromoethane
Structural Formula	
Molecular Formula	$C_2H_4Br_2$
Molecular Weight (g/mol)	187.86

SMILES	C(Br)CBr

Physical and Chemical Properties

The physical and chemical property data for ethane, 1,2-dibromo- (or ethylene dibromide) were retrieved from the databases included in the OECD QSAR Toolbox (LMC, 2013).

Physical Form	Liquid
Melting Point	9.9°C (exp.)
Boiling Point	132°C (exp.)
Vapour Pressure	1490 Pa (exp.)
Water Solubility	3910 mg/L (exp.)
Ionisable in the Environment?	No
log K_{ow}	1.96 (exp.)

Import, Manufacture and Use

Australia

No specific Australian use, import, or manufacturing information has been identified.

The chemical is listed under Schedule 7 of the *Standard for the Uniform Scheduling of Medicines and Poisons No. 4* of the *Poisons Standard 2013* (Cwlth). The conditions associated with the listing recommend that the chemical is only available for use by authorised or licensed persons (Commonwealth of Australia, 2013).

The chemical has had use as a pesticide in Australia (APVMA, 2014). Pesticide use of the chemical is beyond the scope of this assessment as this is not considered an industrial use under the *Industrial Chemicals (Notification and Assessment) Act 1989*. However, for information purposes, it is noted that there are currently no pesticide products containing ethylene dibromide registered for use in Australia (APVMA, 2014).

International

Ethylene dibromide has historically been used as a fumigant for the treatment of pests internationally. In addition, the chemical has had a range of industrial uses, including as a chemical intermediate, specialty solvent and component of gauge fluids. It was also widely used as an additive in leaded petrol where it functions as a lead scavenger (US NLM, 2013).

Today, the chemical appears primarily used as an additive in leaded fuels, such as aviation gasoline (US EPA, 2008b; 2014b). Ethylene dibromide is used in aviation gasoline at a concentration of approximately 90 grams per 100 grams of lead, and at half this concentration in other fuels (Falta, 2004). The chemical is used solely as a lead scavenger in Canada. In 2000, between 10 and 100 tonnes of the chemical was imported into Canada for this purpose (Environment Canada, 2013a).

The chemical is also registered under the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) legislation in the European Union for use as a fuel additive. However, the chemical is further registered for use as a chemical intermediate in the manufacture of chemicals, including pharmaceuticals. Between 1000 and 10 000 tonnes of the chemical is expected to be used for these purposes per annum in the European Union (ECHA, 2014a).

Less than 1000 tonnes of the chemical was manufactured in, or imported into, Japan in the 2011/12 financial year. Similar upper limits on the introduction volumes for this chemical are evident in earlier reporting periods (NITE, 2014).

Environmental Regulatory Status

Australia

Ethylene dibromide is subject to reporting under the Australian National Pollutant Inventory (NPI), where it is listed as 1,2-dibromoethane. Under the NPI, emissions of ethylene dibromide are required to be reported annually by facilities that use or emit more than 10 tonnes 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 the chemical 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

Ethylene dibromide is listed 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). The Rotterdam Convention aims to facilitate sharing of chemical information to promote shared responsibility for the international trade of certain hazardous chemicals. However, the listing of ethylene dibromide refers to pesticide use only and is not applicable to the trade of the chemical for industrial uses (UNEP, 1998).

OECD

The chemical was sponsored by Canada under the Cooperative Chemicals Assessment Programme (CoCAP). The second Cooperative Chemicals Assessment Meeting (CoCAM) in 2012 agreed that the chemical possessed properties indicating a hazard to human health and the environment (OECD, 2012).

Canada

The chemical was categorised as Persistent (P), not Bioaccumulative (not B) and Inherently Toxic to the Environment (iT_E) by Environment Canada during the Categorization of the Domestic Substances List (DSL) (Environment Canada, 2013b). A subsequent screening assessment found the chemical to be persistent but to not be entering the environment in quantities that had a harmful effect on the environment, or that constituted a danger to the environment or human health. The assessment recommended the application of the Significant New Activity provision of the *Canadian Environmental Protection Act, 1999* to use of the chemical (Environment Canada, 2012; 2013a).

European Union

The chemical is not listed on the Candidate List for Eventual Inclusion in Annex XIV, Annex XIV (the Authorisation List) or Annex XVII (the List of Restrictions) of the REACH legislation. Therefore, the chemical is not subject to authorisation or restriction in regards to industrial use, and is not currently identified by the European Union as a Substance of Very High Concern (ECHA, 2013; 2014b; 2014c).

United States of America

Use of ethylene dibromide in the United States of America (USA) in most mining, utilities and manufacturing facilities, as well as select others, is subject to reporting under the Toxics Release Inventory (TRI). Facilities must report emissions of ethylene dibromide to the United States Environmental Protection Agency (US EPA) if the facility manufactures or processes more than 25 000 pounds of the chemical (approximately 11 tonnes), or otherwise uses more than 10 000 pounds (approximately 4.5 tonnes) of the chemical in a reporting year (US EPA, 2012; 2014c; 2014d).

Environmental Exposure

In 2011–2012, over 80 million litres of aviation gasoline was supplied in Australia (BREE, 2013). It has been estimated that this volume of aviation gasoline would contain up to 70 tonnes of lead in the form of the anti-knock chemical, tetraethyl lead (CAS RN: 78-00-2) (NICNAS, 2014). Based on the typical mass ratio of ethylene dibromide to lead in aviation gasoline (0.9:1), it can be estimated that up to 63 tonnes of ethylene dibromide may be used in aviation gasoline in Australia annually.

The NPI reported that 63 kg of ethylene dibromide was emitted to the Australian environment by industry in 2011–12. Two petroleum refineries reported emissions of the chemical in this period (Australian Government Department of the Environment, 2014b). It is noted that these data do not necessarily indicate that the chemical has been used for industrial purposes in these facilities, as the emissions may have been a by-product of industrial processes. Further, emissions of the chemical from some sources, such as aircraft, may be underestimated due to the reporting framework and requirements (Australian Government Department of the Environment, 2014a; Environment Australia, 2003).

Emissions of ethylene dibromide during use as a fuel additive are expected to be low because the chemical functions as a lead scavenger and is intended to be decomposed during fuel combustion. The degradation product of combustion reacts with lead oxide to form more volatile inorganic lead compounds (such as lead dibromide) which are emitted with the exhaust gases (Harrison and Laxen, 1978; Li, 1982). The expectation of low emissions of the chemical from use in fuels is supported by work conducted by the US EPA, which has estimated emissions of ethylene dibromide from mobile sources, such as aircraft, to be zero (Environment Canada, 2013a). Therefore, the predominant route of release for the chemical is expected to be evaporation during formulation, from unburned fuel and loss during filling of tanks.

Environmental Fate

Partitioning

Ethylene dibromide is expected to partition to the atmosphere when released from industrial uses.

Ethylene dibromide is a neutral organic chemical which is readily soluble in water and highly volatile. The measured Henry's Law constant for the partitioning of ethylene dibromide from water to air is 65.9 Pa-m^3/mol at 25°C (LMC, 2013), indicating that the chemical is moderately volatile from water and moist soil. Measured organic carbon normalised adsorption coefficient (K_{OC}) values for the chemical range from log K_{OC} 0.314 to 1.65 (LMC, 2013), which indicates that it is very highly mobile in soil. However, evaporative losses are expected to dominate the partitioning behaviour of the chemical in soil.

Calculations with a standard multimedia partitioning (fugacity) model assuming equal and continuous distributions to air, water and soil compartments (Level III approach) predict that the chemical will mainly partition to the soil compartment (42%), with less partitioning to the water compartment (32%) and air compartment (26%). However, with sole release to the atmosphere, the model predicts that 97% of the chemical will remain in the air compartment (US EPA, 2008a). The latter scenario is expected to be the more likely route of release of the chemical to the environment from industrial uses.

Degradation

Ethylene dibromide is slow to degrade in the environment.

The processes responsible for the degradation of ethylene dibromide in the atmosphere depend strongly on the geographical location of emissions and the season. Emissions in the tropics are more likely to result in the chemical passing through the troposphere to reach the stratosphere, where photolysis may occur (Hossaini, et al., 2012; WMO, 2014). As emission locations move away from the tropics, oxidation by hydroxyl radicals is considered to be the major degradation process. The most recent estimate of the lifetime for the chemical in the troposphere based on removal by indirect photo-oxidation is 70 days (WMO, 2011).

The chemical is also not expected to be rapidly degradable in water or soil, with 0% degradation observed in 14 days in a ready biodegradation study conducted in accordance with OECD Test Guideline (TG) 301 C. However, the chemical is considered inherently biodegradable under anaerobic conditions, with 99.9% degradation observed in 17 days in a study conducted in accordance with OECD TG 311 (LMC, 2013).

The most important degradation pathway for industrial uses of ethylene dibromide involves decomposition of the chemical through combustion of liquid transport fuels. During combustion of fuels, ethylene dibromide is decomposed to hydrogen bromide which serves as source of bromide ions. The bromide ion is necessary to form lead dibromide upon reaction with lead oxide, which is produced through the combustion of tetraalkyl lead compounds that are added to fuel as anti-knock agents. Lead dibromide is more volatile than lead oxide and is subsequently emitted with exhaust gases (Harrison and Laxen, 1978; Li, 1982). As a lead compound, this product of combustion is considered environmentally hazardous (UNEP, 2014). However, the hazard posed by this combustion product is due to the formation of particulate ionic lead compounds.

Bioaccumulation

Ethylene dibromide is not expected to bioaccumulate in aquatic biota.

Measured bioconcentration factor (BCF) values of 3.2 to 14.9 L/kg were available for the fish *Cyprinus carpio* (LMC, 2013). Based on these data, the chemical is expected to have a low potential for bioaccumulation in the aquatic environment.

Transport

Ethylene dibromide is expected to undergo long range transport.

The elevated background levels of the chemical in air far from potential industrial release sources is often attributed to the long range transport of the chemical (eg. Woodruff, et al., 1998). It is noted that the chemical may have natural sources (US EPA, 2014a) which may confound these observations. However, based on the long lifetime of the chemical in the atmosphere, ethylene dibromide is expected to undergo long range transport in the environment.

Predicted Environmental Concentration (PEC)

A PEC was not calculated for this chemical, as a significant body of high quality environmental monitoring data for ethylene dibromide is available from multiple sites around the world.

Multiple air monitoring studies conducted in the USA and Canada, including those in the vicinity of airports, have failed to detect the chemical in air at concentrations above the limit of detection for the method used (BAAQMD, 2012; Golder Associates, 2011; MPCA, 2006). A 2005 study using a method with a lower detection limit found the air concentration of the chemical in Ottawa, Canada to be on the order of 0.01 micrograms per cubic metre (μg/m^3) (Zhu, et al., 2005). However, it should be noted that these data do not discriminate between chemical released due to industrial use and chemical released from other sources.

Although significant quantities of ethylene dibromide are not expected to be released to, or partition to, the water compartment as a result of current industrial use, the chemical may be present in groundwater due to historical use. Groundwater contamination with ethylene dibromide has occurred in many locations globally, predominately due to the use of the chemical as a pesticide, but with some contributions from leakages from storage tanks containing leaded fuel (US EPA, 1990). Leakages from fuel storage tanks are now a well recognised potential source of groundwater pollution and modern tanks are designed to minimise the risk of leaks (see Standards Australia, 2004).

A study conducted in 1990 reported that typical concentrations of ethylene dibromide in groundwater in Australia ranged between 0.03 and 0.2 micrograms per litre (μg/L) (WHO, 2004). More recent data are not available, but concentrations of the chemical in groundwater are expected to have decreased due to a reduction in dispersive uses. A study conducted in the USA has found ethylene dibromide concentrations in groundwater declined by 60% over four years in the absence of further environmental emissions of the chemical (CalEPA, 2003).

Environmental Effects

Effects on the Atmosphere

The potential for ethylene dibromide to significantly contribute to ozone depletion or global warming is expected to be low.

Volatile halogenated organic chemicals with long atmospheric lifetimes can contribute to the depletion of the ozone layer due to the release of reactive halogen species in the stratosphere. Generally, the potential for ethylene dibromide to reach the stratosphere is expected to be limited, based on the lifetime for the chemical in the troposphere. However, if the chemical is released in the tropics, convective transport may deliver the chemical more directly into the lower stratosphere. There is growing evidence to suggest that the so-called very short-lived substances (VSLS) may contribute to halogen loads in the stratosphere in this way (Hossaini, et al., 2012; WMO, 2011; 2014). It is noted that the atmospheric lifetime of ethylene dibromide is considered short only by comparison with the very long lifetimes associated with ozone depleting chemicals which have now been phased out of use because of their adverse effects on the ozone layer.

The impact of ozone depleting chemicals on the stratospheric ozone layer is typically reported in terms of the ozone depletion potential (ODP) metric. However, this concept is traditionally considered inappropriate for short-lived gases (WMO, 2011; 2014) and an ODP for ethylene dibromide is not available. Therefore, the impact of the chemical on stratospheric ozone cannot be quantitatively determined in this assessment. However, based on the available data, the World Meteorological Organization currently concludes that changes in VSLS emissions will likely cause only small changes in stratospheric ozone in the near future (WMO, 2014).

Halocarbons with long atmospheric lifetimes can also contribute to global warming by absorbing radiation emitted from Earth and thus trapping the energy in the atmosphere (radiative forcing). The amount of global warming that can be caused by a substance is typically reported in terms of the global warming potential (GWP) metric. However, this concept is also traditionally considered inappropriate for short-lived gases (WMO, 2011), and a GWP for ethylene dibromide is not available. Therefore, the amount of global warming caused by the chemical cannot be quantitatively determined in this assessment. However, the global warming potential of the chemical is not expected to be significant based on the current scientific understanding of this process.

Effects on Aquatic Life

Ethylene dibromide causes acute toxic effects at moderate concentrations in aquatic organisms across multiple trophic levels. The chemical has high chronic toxicity to fish.

Acute toxicity

The following median lethal concentration (LC50) and median effective concentration (EC50) values for model organisms across three trophic levels were published by Kszos et al. (2003) and referenced in the databases included in the OECD QSAR Toolbox (LMC, 2013):

Taxon	Endpoint	Method
Fish	96 h LC50 = 1.13 mg/L	Experimental *Oncorhynchus mykiss* (Rainbow trout) OECD TG 203
Invertebrates	48 h LC50 = 3.61 mg/L	Experimental *Ceriodaphnia dubia* (Water flea) Modified US EPA Method
Algae	72 h EC50 = 25.9 mg/L	Experimental *Pseudokirchneriella subcapitata* (Green algae) OECD TG 201 Reduced growth rate observed

Chronic toxicity

The following no-observed-effect concentration (NOEC) value for a model organism was obtained from data published by Hawkins et al. (1998):

Taxon	Endpoint	Method
Fish	97 d NOEC = 0.034 mg/L	Experimental *Oryzias latipes* (Japanese Medaka) Flow-through Carcinogenicity observed (liver, bile duct, gall bladder)

The high chronic toxicity of the chemical to fish is supported by an earlier study which found a significantly increased occurrence of lymphoma in *O. latipes* exposed to ethylene dibromide at concentrations between 0.1 and 18 milligrams per litre (mg/L) for three months (Battalora, et al., 1990).

Effects on Terrestrial Life

Ethylene dibromide causes acute toxic effects after both ingestion and inhalation in terrestrial organisms across multiple trophic levels. The chemical also exhibits chronic inhalation toxicity in rodents and insects.

Acute toxicity

The following dietary exposure median lethal dose (LD50) and inhalation LC50 values for terrestrial model organisms were obtained from the databases included in the OECD QSAR Toolbox (LMC, 2013). Inhalation studies were performed using ethylene dibromide vapour:

Taxon	Endpoint	Method
Birds	LD50 = 130 mg/kg bw	Experimental *Coturnix coturnix* (Common quail) Single oral dose
Rodents	LD50 = 140 mg/kg bw	Experimental Rat (species not specified) OECD TG 401; single oral dose
	LC50 > 1.54×10^6 µg/m^3 (1.54 mg/L)	Experimental Rat (species not specified) Inhalation, exposed for 4 hours
Insects	LC50 = 5.65×10^6 µg/m^3 (5.65 mg/L)	Experimental *Callosobruchus chinensis* (Bean weevil), adults Inhalation, single exposure, reported as LD50

Chronic toxicity

The following inhalation no observed effect level (NOEL) values for terrestrial model organisms were obtained from the databases included in the OECD QSAR Toolbox (LMC, 2013). Studies were performed using ethylene dibromide vapour:

Taxon	Endpoint	Method

Taxon	Endpoint	Method
Rodents	NOEL = 23 × 10^3 µg/m^3 (0.023 mg/L)	Experimental Rat (Fischer 344 strain) OECD TG 413; inhalation, multiple exposures Multiple toxic effects observed
Insects	NOEL = 1.2 × 10^6 µg/m^3 (1.2 mg/L)	Experimental *Rhyzopertha dominica* (Lesser grain borer), adults Inhalation, exposed daily for 36 days Reproductive toxicity observed

Predicted No-Effect Concentration (PNEC)

A PNEC was not calculated for the chemical.

Ethylene dibromide is expected to be primarily released to or partition to the air compartment as a result of current industrial uses in Australia. A PNEC for the air compartment has not been calculated because there is currently no recognised method for establishing quantitative toxicity thresholds for inhalation exposure of non-human terrestrial organisms (ECB, 2003).

The PNEC for the chemical in the water, soil and sediment compartments was not calculated as ethylene dibromide is not expected to be released to, or significantly partition to, these compartments as a result of current industrial uses.

Categorisation of Environmental Hazard

The categorisation of the environmental hazards of ethane, 1,2-dibromo- according to domestic environmental hazard thresholds is presented below (EPHC, 2009; NICNAS, 2013):

Persistence

Persistent (P). Based on the atmospheric lifetime of 70 days, the chemical is categorised as Persistent.

Bioaccumulation

Not Bioaccumulative (Not B). Based on the available measured BCF values for fish, the chemical is categorised as Not Bioaccumulative.

Toxicity

Toxic (T). Based on the fish 97 d NOEC of 0.034 mg/L, the chemical is categorised as Toxic.

Summary

Ethane, 1,2-dibromo- is categorised as:

- P
- Not B
- T

Risk Characterisation

Risk quotients (RQs) have not been calculated for this chemical.

The chemical has the potential to cause toxic effects in terrestrial organisms by inhalation, and also has some potential to be released to air from industrial uses in Australia. However, based on available international environmental air-monitoring data, the chemical is not expected to be present in air in Australia at a concentration above 0.01 µg/m^3. This air concentration is several orders of magnitude below the concentrations of ethylene dibromide in air observed to result in chronic toxicity in terrestrial animals exposed by inhalation. Based on this analysis, emissions of ethylene dibromide from current industrial uses in Australia are not expected to pose a significant risk to the terrestrial environment.

Based on the currently available scientific data regarding the ozone depleting and global warming potential of comparatively short-lived bromine-containing gases in the atmosphere, ethylene dibromide is not expected to pose an unreasonable risk to the air compartment.

The risks to the water, soil and sediment compartments are expected to be low as the chemical is not expected to be released to, or significantly partition to, these compartments as a result of industrial use.

Based on the available data, current industrial uses of ethylene dibromide as a fuel additive are not expected to pose an unreasonable risk to the environment.

Key Findings

Australian use and exposure information for this chemical is limited. The main industrial application of ethylene dibromide in Australia is expected to be as a fuel additive, primarily in aviation gasoline. Emissions from this use are expected to be limited to evaporative losses associated with fuel transfer operations or spills. Quantities of the chemical released by this route will partition to the air compartment where the chemical is degraded primarily by indirect photo-oxidation. Assuming concentrations of ethylene dibromide in air are similar to those determined internationally, use of the chemical as a fuel additive is not expected to pose a concern to the environment.

The chemical is not a PBT substance according to domestic environmental hazard criteria.

Recommendations

Industrial uses of ethylene dibromide in applications which result in minimal environmental emissions (for example, use as an aviation gasoline additive) are not expected to pose a concern to the environment. No further assessment is required.

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 ethane, 1,2-dibromo- 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 2 (H401)	Toxic to aquatic life
Chronic Aquatic	Category 1 (H410)	Very toxic to aquatic life with long lasting effects

Ethane, 1,2-dibromo- is classified as Aquatic Acute Category 2 based on the measured acute toxicity values available for fish and aquatic invertebrates. These values demonstrate toxicity within the range of the classification thresholds of 1–10 mg/L.

The classification of the chemical as Aquatic Chronic Category 1 is based on the persistence of the chemical in water and the chronic toxicity value available for fish, which demonstrates toxicity below the classification threshold of 0.1 mg/L.

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