Tetramethylammonium hydroxide and its pentahydrate: Human health tier II assessment

28 June 2019

Chemicals in this assessment

Chemical Name in the Inventory	CAS Number
Methanaminium, N,N,N-trimethyl-, hydroxide	75-59-2
Methanaminium, N,N,N-trimethyl-, hydroxide, pentahydrate	10424-65-4

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

ACRONYMS & ABBREVIATIONS

Grouping Rationale

The chemicals in this group are forms of tetramethylammonium hydroxide. Similar health hazard profile is expected.

The chemicals in this group have similar reported uses.

The following acronyms and their corresponding CAS numbers will be used in this assessment:

- TMAH (CAS No. 75-59-2); and
- TMAH, pentahydrate (CAS No. 10424-65-4).

Import, Manufacture and Use

Australian

The National Pollutant Inventory (NPI) holds data for all sources of the chemicals in Australia.

The following Australian site-limited uses were reported from safety data sheets (SDS) from various Australian companies:

- as ion exchange agents;
- in chemical synthesis; and
- in photolithography.

The following non-industrial uses have been identified for quaternary ammonium compounds in Australia:

- preservatives in sedative and analgesic veterinary products; and
- in hospital grade disinfectants.

International

The following international uses have been identified through the European Union (EU) Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) dossiers; the Organisation for Economic Co-operation and Development Screening information data set International Assessment Report (OECD SIAR); Galleria Chemica; the Substances and Preparations in Nordic countries (SPIN) database; the United States (US) Personal Care Products Council International Nomenclature of Cosmetic Ingredients (INCI) Dictionary; the OECD High Production Volume chemical program (OECD HPV); the OECD Screening Information Initial Targeted Assessment Profile (OECD SIAR); the US Environmental Protection Agency's Aggregated Computer Toxicology Resource (ACToR); the US National Library of Medicine's Hazardous Substances Data Bank (HSDB); and International Programme in Chemical safety (IPCS report):

The chemicals have reported commercial uses, including:

- in plating and surface treating agents;
- as process regulators;
- as processing aids;
- as developers or etchant in semiconductor and photoelectric industries;
- as buffers, titrants and ion pair-reagents; and
- as surface active agents in electronics.

The chemicals have reported site-limited uses, including:

- as ion exchange agents;
- in chemical synthesis; and
- in photolithography.

Restrictions

Australian

These chemicals are covered by the group entry for QUATERNARY AMMONIUM COMPOUNDS in Schedules 5 and 6 of the Poisons Standard—the Standard for the Uniform Scheduling of Medicines and Poisons (SUSMP, 2019):

Schedule 6:

'QUATERNARY AMMONIUM COMPOUNDS except:

a) when separately specified in these Schedules;

b) when included in Schedule 5;

c) dialkyl or dialkoyl quaternary ammonium compounds where the alkyl or alkoyl groups are derived from tallow or hydrogenated tallow or similar chain length (C16/C18) sources; or

d) in preparations containing 5 per cent or less of such quaternary ammonium compounds.'

Schedule 5:

'QUATERNARY AMMONIUM COMPOUNDS in preparations containing 20 per cent or less of quaternary ammonium compounds except:

a) when separately specified in these Schedules;

b) dialkyl or dialkoyl quaternary ammonium compounds where the alkyl or alkoyl groups are derived from tallow or hydrogenated tallow or similar chain length (C16/C18) sources; or

c) in preparations containing 5 per cent or less of such quaternary ammonium compounds.'

Schedule 6 chemicals are described as 'Substances with a moderate potential for causing harm, the extent of which can be reduced through the use of distinctive packaging with strong warnings and safety directions on the label'. Schedule 6 chemicals are labelled with 'Poison' (SUSMP, 2019).

Schedule 5 chemicals are described as 'Substances with a low potential for causing harm, the extent of which can be reduced through the use of appropriate packaging with simple warnings and safety directions on the label.' Schedule 5 chemicals are labelled with 'Caution' (SUSMP, 2019).

International

No known restrictions specific to these chemicals have been identified.

Quaternary ammonium compounds are listed in the Canadian Identification of Risk Assessment Priorities (IRAP) as substances recommended for further scoping/problem formulations (Galleria Chemica).

Existing Worker Health and Safety Controls

Hazard Classification

The chemicals are not listed on the Hazardous Chemical Information System (HCIS) (Safe Work Australia).

Exposure Standards

Australian

No specific exposure standards are available.

International

The following exposure standards are identified for the chemicals in this group (Galleria Chemica):

Temporary Emergency Exposure Limit (TEELs) defined by the US Department of Energy (DOE) for TMAH are reported as:

TEEL-1= 0.0093 mg/m^3;

TEEL-2= 0.1 mg/m^3;

TEEL-3= 0.62 mg/m^3.

TEELs for TMAH pentahydrate are reported as (Galleria Chemica):

TEEL-1= 0.019 mg/m³;

TEEL-2= 0.2 mg/m³;

TEEL-3= 1.2 mg/m³.

Health Hazard Information

Tetramethylammonium hydroxide (TMAH; CAS No. 75-59-2) is strongly basic (with pH of 13.61 at 10 % in water), colourless to straw-coloured liquid, with a strong ammonia-like odour. It is known to be highly toxic if ingested or skin contact occurs. TMAH only exists in a relatively stable solid form as the pentahydrate (CAS No. 10424-65-4). Both these chemicals completely dissociate in water forming tetramethylammonium and hydroxyl ions. The toxicity of tetramethylammonium salts, including the chemicals in this assessment, is generally due to the presence of the tetramethylammonium cation. Tetramethylammonium chloride (CAS No. 75-57-0; TMAC) is considered to be a good analogue for tetramethylammonium toxicity (OECD, 2006, REACHb). Therefore, in absence of toxicity data for the chemicals in this group, available data for TMAC was used as a read-across for these chemicals. This report should be read in conjunction with the IMAP Human Health Tier II report for tetramethylammonium halides (NICNAS).

Toxicokinetics

TMAH is completely dissociated as the tetramethylammonium ion (TMA) in vivo. Elimination occurs mainly via the urinary route (OECD, 2006).

The absorption of the tetramethylammonium ion (TMA) was investigated using an in situ loop and an in vitro everted sac method in rat jejunum. Male Wistar rats were anaesthetised and the abdomen was opened along the midline to create an intestinal loop in the upper jejunum. The jejunal loop was then removed and everted by a stainless steel probe. A dose of 0.5 mL of 0.2 nM solution of 14C-labelled tetramethylammonium was administered to the jejunal loop via an in vitro everted sac method. Absorption was very rapid, with more than 80 % of the administered dose transferred into the blood stream within 1 hour (OECD, 2006).

In an in vivo study, male Wistar rats were anaesthetised and were made to respire artificially by tracheal intubation. A dose of 4 µmol of TMAI (an analogue chemical, tetramethylammonium iodide; CAS No. 75-58-1) in a 0.2 mL saline solution was administered in the femoral vein as a bolus injection. Fractions of TMA ions excreted via the biliary, urinary and intestinal routes were 0.6 %, 96.6 % and 2.6 %, within 2 hours post injection. Chromatographic analysis suggested that the TMA cation was not metabolised (OECD, 2006).

Acute Toxicity

Oral

The chemicals have very high oral acute toxicity based on results from animal tests following oral exposure. The median lethal dose (LD50) in rats is 34–50 mg/kg bw. Hazard classification is warranted (see **Recommendation** section).

Sprague Dawley (SD) rats (n=5/sex/dose) were treated once with TMAH (20 % solution in water) by gavage at doses of 10, 15, 23, 34 and 50 mg/kg bw for male rats and 23 mg/kg bw for female rats. In males, mortalities were recorded as 1/5 males at 34 mg/kg bw and 4/5 at 50 mg/kg bw/day. In females, no mortality was recorded. Observed sub-lethal effects included hypothermia, incomplete eyelid opening or closure, ataxic gait, decrease in locomotor activity, salivation, irregular and slow breathing (bradypnoea) and clonic convulsions in treated animals at 23 mg/kg bw and higher. The LD50 was determined to be between 34–50 mg/kg bw for males (OECD, 2006; REACHa).

In an acute oral study conducted similar to OECD Test Guideline (TG) 401, Wistar rats (n=5/sex/dose) were orally administered with homogeneous 25 % aqueous solution of TMAH at 50 or 500 mg/kg bw (equivalent to 12.5 or 125 mg/kg bw of pure TMAH). Mortality observed was 0 males and females at 50 mg/kg bw; and 5/5 males and 4/5 females at 500 mg/kg bw. Pathological examination showed stomach haemorrhages in all dead animals, and 2 animals with liver protruded through the diaphragm. The

LD50 was determined to be >50 mg/kg bw and <500 mg/kg bw for 25 % aqueous solution (corresponding to 12.5–125 mg/kg bw for pure TMAH) (REACHa).

In an oral study conducted according to OECD TG 425, female Wistar rats were administered TMAH (25 % aqueous solution) by gavage at doses of 55, 175 or 550 mg/kg bw (corresponding to 13.75, 43.75 and 137.5 mg/kg bw TMAH). Mortalities recorded were 0 at 55 mg/kg bw; 3/4 at 175 mg/kg bw and 1/1 at 550 mg/kg bw. Red areas on mucosal lining of the stomach were observed in all dead animals. An LD50 of 175 mg/kg bw (equivalent to 43.5 mg/kg bw for pure substance) was established (REACHa).

Corrosive substances can show severe effects under the conditions of acute toxicity testing. However, the non-corrosive analogue, tetramethylammonium chloride (TMAC; CAS No: 75-57-0), has similar LD50 values which can be attributed to the TMA cation.

In a study based on OECD TG 425, female Wistar rats were given TMAC (10 % concentration in water) by gavage at doses of 17.5, 55 or 175 mg/kg bw. Mortality observed was 0/1 (17.5 mg/kg bw); 1/2 (55 mg/kg bw) and 2/2 (175 mg/kg bw). Observed effects included convulsions, tremors, sagging eyelids, wet nose/mouth area, flaccid muscle tone, prostration, lethargy, spasms, ataxia and closed eyes. Necropsy of 1 treated, surviving animal showed abnormalities in the pancreas, kidneys and ovaries. The LD50 was determined to be 55 mg/kg bw (REACHb).

In another acute oral study, female SD rats were orally administered single doses of TMAC (15 % aqueous solution) at 300, 550 or 2000 mg/kg bw. Mortality was only observed in 3/3 females at 2000 mg/kg bw. Clinical signs observed were: abnormal physical signs including prostration, lethargy, few faeces, chromorhinorrhea (discharge of pigmented secretion from the nose) and wetness of the anogenital area. An LD50 of 1146 TMAC (15 % aqueous solution) mg/kg bw, equivalent to 171.9 mg TMAC was calculated (REACHb).

Dermal

The chemicals have very high acute dermal toxicity based on results from animal tests following dermal exposure. The dermal LD50 of TMAH in rats is 112 mg/kg bw, warranting hazard classification (see **Recommendation** section).

In a dermal study similar to OECD TG 402, SD rats (n=15/sex/dose) were exposed (occlusive dermal exposure) to TMAH (25 % aqueous solution in water) at doses of 50, 100 or 125 mg/kg bw for females and 100 mg/kg bw for males. Mortality observed was 0 (50 mg/kg bw); 2/5 (100 mg/kg bw) and 3/5 (125 mg/kg bw) for females and 0 (100 mg/kg bw) for males. An acute dermal LD50 value of 112 mg/kg bw was reported with observed clinical signs including hypoactivity, irregular respiration, narrow palpebral fissures and tonic-clonic convulsions (OECD, 2006; REACHa).

Topical application of 25 % aqueous solution of TMAH to Wistar rats at doses of 50, 200, 1000 or 2000 mg/kg bw resulted in adverse effects including sagging eyelids, closed eyes, lethargy, flaccid muscle tone, ataxia, tremors and coma. Mortality observed for females was 0/5 (50 mg/kg bw); 5/5 (200 mg/kg bw); 3/3 (1000 mg/kg bw) and 3/3 (2000 mg/kg bw) and males: 0/5 (50 mg/kg bw) and 3/5 (200 mg/kg bw). Necropsy showed abnormal changes in skin and mottled kidneys and all surviving animals were reported with mottled kidneys and skin effects including irreversible oedema and eschar. The acute dermal LD50 was determined to be between 50–200 mg/kg bw for 25 % aqueous solution (corresponding to 12.5–50 mg/kg bw for pure substance) (REACHa).

Corrosive substances can show severe effects under the conditions of acute toxicity testing. However, the non-corrosive analogue, tetramethylammonium chloride (TMAC; CAS No: 75-57-0), has similar LD50 values which can be attributed to the TMA cation.

Inhalation

No data are available for the chemicals.

Corrosion / Irritation

Corrosivity

Based on the studies performed in accordance with OECD TG 404 and OECD TG 435 and due to the strong alkaline nature (pH 13.6) of the chemicals in this group, these chemicals are considered to be corrosive to rabbit skin, warranting hazard classification (see **Recommendation** section).

In a skin irritation study (OECD TG 404) in New Zealand White rabbits (n=3), 0.5 mL of 2.38 % aqueous solution of TMAH elicited a severe, irreversible dermal reaction with necrosis in 1 animal (REACHa).

TMAH is classified as Packing Group II for transport (ADR/DOT) based on experimental results from Corrositex testing (OECD TG 435) and is classified as hazardous with hazard category 'Corrosive to skin – Category 1B' (REACHa).

In another study in guinea pigs (strain and sex not specified), TMAH pentahydrate caused a severe corrosive reaction to the skin at doses of 25–1000 mg/kg bw (OECD, 2006).

Observation in humans

The positive data for corrosivity are supported by the human case reports detailed below.

Three of 4 workers dermally exposed to 25 % TMAH died from cardiac arrest shortly after exposure. Observed adverse effects included chemical burns, dermal pain, skin rashes, coma, dyspnoea, hyperglycaemia, leucocytosis and metabolic acidosis (Lin et al., 2010).

In another case report, a maintenance worker was accidentally dermally exposed to 2.38 % TMAH. The chemical caused chemical burns, multiple shallow ulcers, spot haemorrhages, general weakness, salivation, dyspnoea, limb paralysis, severe muscle twitching, vomiting and poor gag reflex, leucocytosis and hyperglycaemia. The authors concluded that tetramethylammonium cation may be responsible for the systemic toxicities of TMAH in these studies (Lin et al., 2010).

Sensitisation

Skin Sensitisation

No data are available.

Repeated Dose Toxicity

Oral

The results from an oral repeat dose toxicity study indicated limited changes in food consumption and heart weight. These effects don’t meet the classification criteria for repeat dose toxicity.

In a 28-day oral gavage study (OECD TG 407), SD rats (n=5/sex/dose) were dosed with TMAH at 0, 5, 10 or 20 mg/kg bw/day by gavage. A no observed adverse effect level (NOAEL) of 5 mg/kg bw/day for males and 10 mg/kg bw/day for females was reported. Effects observed at 10 and 20 mg/kg bw/day included: significant decrease in food consumption in male and females animals and decreases in absolute and relative heart weight (not dose-dependent and in male animals only) (OECD, 2006; REACHa).

In a 90-day study, TMAC was administered orally to Charles River (Crl:WI(Han)) rats (n= 10/sex/dose) at 0, 3, 10 or 30 mg/kg bw/day for 90 days. Two treated males at 30 mg/kg bw/day died during the study. Dose-dependent, clinical signs seen in the surviving treated animals included lethargy, hunched and/or flat posture, piloerection and ptosis. Statistically significant lower body weight gain was seen in high dose males, while high dose females showed statistically significantly increased relative and absolute liver weights and lower thymus weights. Histopathological examination showed hepatocellular hypertrophy in 4 /10

females at 3 and 10 mg/kg bw/day and in 8/10 females at 30 mg/kg bw/day. Thymus atrophy was seen in all treated females at 30 mg/kg bw/day. A no observed adverse effect level (NOAEL) of 10 mg/kg bw/day was determined (REACHb).

Dermal

Based on the data available, repeated dermal exposure to the chemicals is associated with short-term local effects.

In a 4-week dermal study (OECD TG 410) in SD rats (n=10/sex/dose), TMAH (25 % aqueous solution) was applied to dorsal skin at 0, 2.5, 5.5, 10, 30 or 50 mg/kg bw/day for 28 days. Mortality was recorded as 10/10 males and females at 50 mg/kg bw/day on day 1 and 8/10 males and females at 30 mg/kg bw/day (2/8 on day 1 and other 6/8 between days 1 and 14). Clinical signs reported in animals that died during the study were hypoactivity, ptosis, ataxia, tremors, dyspnoea and convulsions. Erythema, oedema and/or scabbing was observed in treated animals. Significant decrease in mean corpuscular haemoglobin concentration in females at 10 mg/kg bw/day and significant decrease in food consumption in 2 males at 30 mg/kg bw/day were observed. No changes in the body weight gain or absolute and relative organ weights were reported. Pathological examination of the dead animals at 30 mg/kg bw/day showed red or dark pigmented lungs with correlated pulmonary congestion. Necrosis was reported at the application site in 9/10 males and 8/10 females at 30 mg/kg bw/day and 1/10 animals/sex at 10 mg/kg bw/day and 1/10 female rat at 5.5 mg/kg bw/day. Microscopic skin findings included dose dependent exudative scab, squamous epithelial hyperplasia and inflammation at all doses tested. Thymic lymphoid necrosis with incidence of vacuolation in the liver and hepatocellular eosinophilic intracytoplasmic material with hepatocyte necrosis was reported at 30 mg/kg bw/day. The NOAEL for local effects was 5.5 mg/kg bw/day for males and 2.5 mg/kg bw/day for females. The NOAEL for systemic toxicity was established at 10 mg/kg bw/day for both males and females (OECD, 2006; REACHa).

Inhalation

No data are available.

Genotoxicity

Based on the available in vitro studies, the chemicals in this group are not considered to be genotoxic.

Negative results were observed in a bacterial reverse mutation assay (OECD TG 471) in *Salmonella typhimurium* strains TA98, TA100, TA1535 and TA1537, and in *Escherichia coli* WP2 *uvr*A at concentrations up to 1250 µg/plate, with and without metabolic activation (OECD, 2006; REACHa).

In a mammalian chromosome aberration test (OECD TG 473) in Chinese hamster lung (CHL/IU) cells, TMAH was negative in the induction of chromosomal aberrations at concentrations between 228–910 µg/mL (OECD, 2006; REACHa).

In a mammalian cell gene mutation (OECD TG 476) in L5178Y mouse lymphoma cells, TMAH at concentrations up to 1812 µg/mL, with and without metabolic activation, gave negative results (REACHa).

Carcinogenicity

No data are available.

Reproductive and Developmental Toxicity

Based on the limited information available, the chemicals in this group are not expected to cause any reproductive or developmental toxicity at any doses tested.

In a reproductive/developmental toxicity screening test conducted in accordance with OECD TG 421, SD rats (10/sex/dose) were dosed with TMAH at 0, 1, 5 or 20 mg/kg bw/day by gavage. Males were dosed from 14 days prior to mating (32 days including mating) and females were dosed from 14 days prior to mating through gestation and weaning (40–57 days). Decrease

in food consumption and locomotor activity were observed in parental animals at 20 mg/kg bw/day. No treatment-related effects on parental reproductive or foetal developmental parameters were observed up to 20 mg/kg bw/day. The NOAEL for reproductive and developmental toxicity was 20 mg/kg bw/day (highest dose tested) (OECD, 2006; REACHa).

Risk Characterisation

Critical Health Effects

The critical health effects for risk characterisation include systemic acute health effects (acute toxicity from oral and dermal exposure) and local effects (corrosivity).

Public Risk Characterisation

Given the uses identified for these chemicals, it is unlikely that the public will be exposed. Hence, the public risk from these chemicals is not considered to be unreasonable.

The chemicals are currently listed on Schedule 5 and 6 of the SUSMP for 'QUATERNARY AMMONIUM COMPOUNDS'. At concentrations greater than 5 %, a number of warning statements, first aid instructions and safety directions apply. The current controls are considered adequate to minimise the risk to public health posed by any potential use in domestic and cosmetic products.

Occupational Risk Characterisation

During product formulation, oral and dermal exposure may occur, particularly where manual or open processes are used. These could include transfer and blending activities, quality control analysis, and cleaning and maintaining equipment. Worker exposure to the chemicals at lower concentrations could also occur while using formulated products containing the chemicals. The level and route of exposure will vary depending on the method of application and work practices employed.

Given the critical systemic acute and local health effects, the chemicals could pose an unreasonable risk to workers unless adequate control measures to minimise oral and dermal exposure are implemented. The chemicals should be appropriately classified and labelled to ensure that a person conducting a business or undertaking (PCBU) at a workplace (such as an employer) has adequate information to determine the appropriate controls.

The data available support an amendment to the hazard classification in the HCIS (Safe Work Australia) (refer to **Recommendation** section).

NICNAS Recommendation

Assessment of these chemicals are considered to be sufficient, provided that the recommended amendment to the classification is adopted, and labelling and all other requirements are met under workplace health and safety and poisons legislation as adopted by the relevant state or territory.

Regulatory Control

Public Health

Products containing the chemicals should be labelled in accordance with state and territory legislation (SUSMP, 2019).

Work Health and Safety

The chemicals are recommended for classification and labelling aligned with the Globally Harmonized System of Classification and Labelling of Chemicals (GHS) as below. This does not consider classification of physical hazards and environmental hazards.

From 1 January 2017, under the model Work Health and Safety Regulations, chemicals are no longer to be classified under the Approved Criteria for Classifying Hazardous Substances system.

Hazard	Approved Criteria (HSIS)[a]	GHS Classification (HCIS)[b]
Acute Toxicity	Not Applicable	Toxic if swallowed - Cat. 3 (H301) Toxic in contact with skin - Cat. 3 (H311)
Irritation / Corrosivity	Not Applicable	Causes severe skin burns and eye damage - Cat. 1 (H314)

[a] Approved Criteria for Classifying Hazardous Substances [NOHSC:1008(2004)].

[b] Globally Harmonized System of Classification and Labelling of Chemicals (GHS) United Nations, 2009. Third Edition.

[*] Existing Hazard Classification. No change recommended to this classification

Advice for consumers

Products containing the chemicals should be used according to the instructions on the label.

Advice for industry

Control measures

Control measures to minimise the risk from oral and dermal exposure to the chemicals should be implemented in accordance with the hierarchy of controls. Approaches to minimise risk include substitution, isolation and engineering controls. Measures required to eliminate, or minimise risk arising from storing, handling and using a hazardous chemical depend on the physical form and the manner in which the chemicals are used. Examples of control measures that could minimise the risk include, but are not limited to:

- using closed systems or isolating operations;
- using local exhaust ventilation to prevent the chemicals from entering the breathing zone of any worker;
- minimising manual processes and work tasks through automating processes;
- work procedures that minimise splashes and spills;
- regularly cleaning equipment and work areas; and
- using protective equipment that is designed, constructed, and operated to ensure that the worker does not come into contact with the chemicals.

Guidance on managing risks from hazardous chemicals are provided in the *Managing risks of hazardous chemicals in the workplace—Code of practice* available on the Safe Work Australia website.

Personal protective equipment should not solely be relied upon to control risk and should only be used when all other reasonably practicable control measures do not eliminate or sufficiently minimise risk. Guidance in selecting personal protective equipment can be obtained from Australian, Australian/New Zealand or other approved standards.

Obligations under workplace health and safety legislation

Information in this report should be taken into account to help meet obligations under workplace health and safety legislation as adopted by the relevant state or territory. This includes, but is not limited to:

- ensuring that hazardous chemicals are correctly classified and labelled;
- ensuring that (material) safety data sheets ((M)SDS) containing accurate information about the hazards (relating to both health hazards and physicochemical (physical) hazards) of the chemicals are prepared; and
- managing risks arising from storing, handling and using a hazardous chemical.

Your work health and safety regulator should be contacted for information on the work health and safety laws in your jurisdiction.

Information on how to prepare an (M)SDS and how to label containers of hazardous chemicals are provided in relevant codes of practice such as the *Preparation of safety data sheets for hazardous chemicals—Code of practice* and *Labelling of workplace hazardous chemicals—Code of practice*, respectively. These codes of practice are available from the Safe Work Australia website.

A review of the physical hazards of these chemicals has not been undertaken as part of this assessment.

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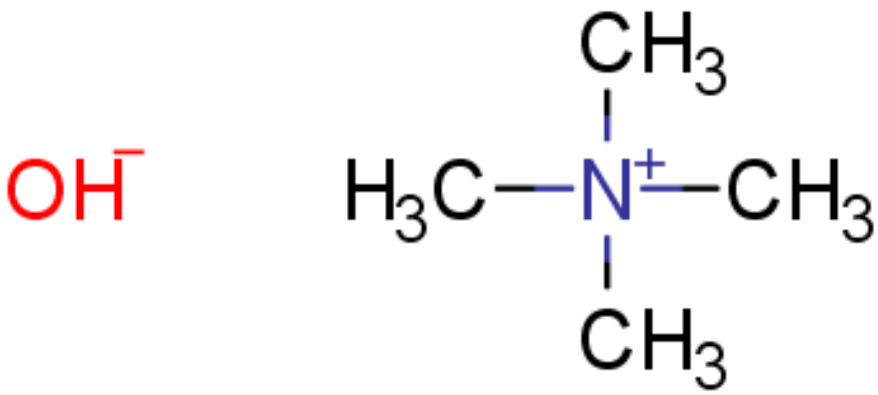
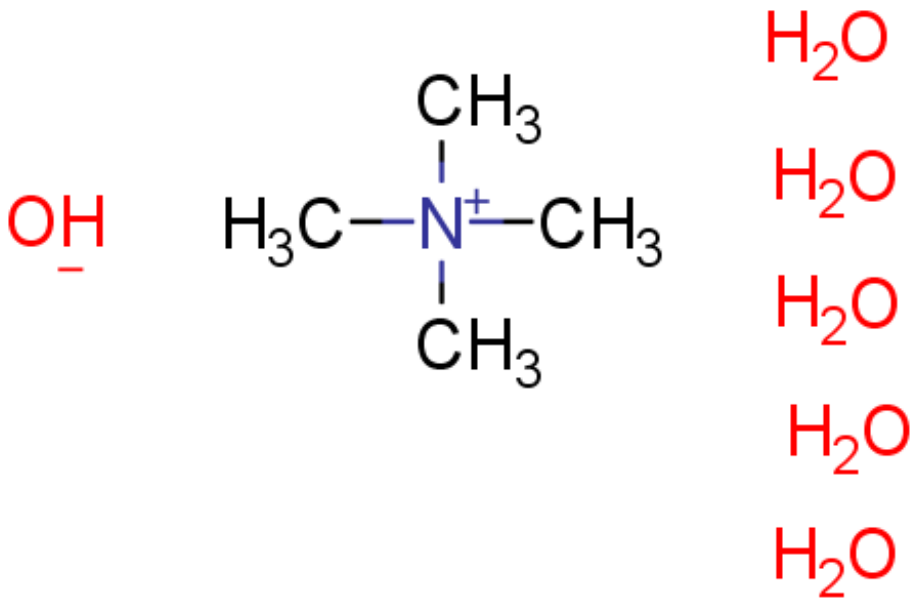
Last Update 28 June 2019

Chemical Identities

Chemical Name in the Inventory and Synonyms	**Methanaminium, N,N,N-trimethyl-, hydroxide** tetramethylammonium hydroxide (TMAH) N,N,N-trimethylmethanaminium, hydroxide
CAS Number	75-59-2
Structural Formula	
Molecular Formula	C4H12N.HO
Molecular Weight	91.1

Chemical Name in the Inventory and Synonyms	**Methanaminium, N,N,N-trimethyl-, hydroxide, pentahydrate** tetramethylammonium hydroxide, pentahydrate TMAH, pentahydrate
CAS Number	10424-65-4

Structural Formula	
Molecular Formula	C4H12N.5H2O.HO
Molecular Weight	181.2

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