Ammonia

(Public consultation draft - April 2026)

GUIDELINE

Based on aesthetic considerations (corrosion of copper pipes and fittings), the concentration of ammonia (measured as total ammonia) in drinking water should not exceed 0.5 mg/L.

No health-based guideline value is set for ammonia.

GENERAL DESCRIPTION

Ammonia (NH_3) (CAS 7664-41-7) dissolves rapidly in water to form an equilibrium mixture of free ammonia and the ammonium cation (NH_4^+). It may be present in unchlorinated drinking water due to contamination of source water or through microbial metabolism. Ammonia is used in conjunction with chlorine to form monochloramine to disinfect water supplies. When used in this manner, some ammonia residual will still be present in the water, particularly if the chlorinator is not operating properly. Refer to Information Sheet 1.4 Chloramines for further details.

Ammonia can be used commercially in animal feeds and fertilisers, and in the manufacture of fibres, plastics and explosives. Ammonia products are widely used as cleaning agents and food additives (EFSA 2012; WHO 2003). Ammonia may also be used for hydrogen storage in coming years (SLR 2022a).

Most uncontaminated source waters have ammonia concentrations below 0.2 milligram per litre (mg/L) (EFSA 2012). High concentrations (greater than 10 mg/L) have been reported where water is contaminated with animal waste. Ammonia can be an important indicator of pollution as it can be formed as an intermediate product in the breakdown of nitrogen-containing organic compounds, or of urea from human or animal excrement (EFSA 2012; WHO 2003). Ammonia in water can result in the corrosion of copper pipes and fittings, causing copper stains on sanitary ware. It is also an energy source for some microorganisms, and can support nuisance growths of bacteria and algae, often with a resultant increase in the nitrite concentration (WHO 2003).

The principal route of exposure to ammonium is dietary, whereas the principal route of exposure to ammonia is primarily air-borne. Estimated intakes of ammonium in humans, from drinking water with ammonium levels of 0.5 to 5 mg/L are approximately three orders of magnitude lower than the no-effect levels reported in experimental animals, and therefore do not indicate a health concern (EFSA 2012). According to ATSDR (2004) and WHO (2003), daily intakes of ammonia from food and drinking water are 18 mg, <1 mg from inhalation and <1 mg from cigarette smoking (20 cigarettes per day). In contrast, approximately 4000 mg of ammonia per day is produced endogenously in the human intestine (WHO 2003).

The taste threshold for ammonium (35 mg/L) and odour threshold for ammonia (1.5 mg/L) in drinking water are below concentrations associated with adverse effects (SLR 2022b).

TYPICAL VALUES IN AUSTRALIAN DRINKING WATER

In major Australian reticulated drinking water supplies, concentrations of ammonia range from 0.005 to 0.37 mg/L but are generally less than 0.02 mg/L (SLR 2022b). At concentrations above 0.2 mg/L, ammonia has been shown to interfere with chlorine disinfection (WHO 2003) and operational monitoring should be in place to ensure levels are controlled.

TREATMENT OF DRINKING WATER

Ammonia concentrations in drinking water supplies can be reduced by chemical or biological oxidation of ammonia to nitrate. Other methods identified include ion exchange, membrane filtration (such as reverse osmosis) and air stripping (Health Canada 2013).

Ammonia in source water can contribute to formation of chloramines, where chloramination is used to provide a more stable disinfectant in long distribution systems.

MEASUREMENT

Commercial analytical methods for ammonia can measure at or below the guideline value of 0.5 mg/L with several Australian commercial laboratories noting a standard limit of determination of 0.01 mg/L (SLR 2022b). However, limits of determination can vary by jurisdiction depending on the methods used.

The concentration of ammonia in water can be determined by a number of methods including colorimetric, titrimetric and potentiometric techniques or ion selective electrodes.

For determination of low concentrations, the phenate colorimetric method is commonly used (APHA 4500-NH3 Part C 1997; US EPA Method 1690 2001; US EPA Method 350.1 1983). The Nessler method (APHA 4500-NH3 1997; US EPA Method 350.2 1983) is also an established approach. The limit of determination for these methods is between 0.05 mg/L and 0.1 mg/L (SLR 2022b). Alternatively, the ammonia selective electrode method can be used (APHA 4500-NH3 Part D 1997; US EPA Method 350.3 1983) with a limit of determination of 0.03 mg/L (ATSDR 2004). Both the phenate colorimetric and ammonia selective electrode methods determine the free ammonia and ammonium ion measured as total ammonia (NH_3 + NH_4^+).

Where interferences are present or greater precision is necessary, a preliminary distillation step is required to be undertaken, where the sample is mixed with borate buffer (US EPA Method 1689, 2001 ion selective probe; APHA 4500-NH3 Part B 1997). The limit of determination for this method is 0.1 mg/L.

HEALTH CONSIDERATIONS

Ammonia is an important metabolite in humans and animals. It is formed in the liver by the deamination of amino acids, and in the gastrointestinal tract by the breakdown of food by enzymes and bacterial flora.

Only an extremely small proportion of the ammonia absorbed in the gastrointestinal tract originates directly from food or water. The major part is formed as a by-product of the breakdown of food. Almost all ammonia is absorbed. It is then transported to the liver and used mostly in the urea cycle.

An extensive review and summary of the human and animal toxicity data for ammonia and ammonium hydroxide is available (NICNAS 2014).

Gastrointestinal illnesses and metabolic acidosis have been reported in humans exposed acutely to high doses of ammonium chloride. Ammonia has a toxic effect on humans only if the intake becomes higher than the detoxification capacity of the body. At doses above 32 mg ammonium per kilogram body weight per day (mg/kg bw/day), ammonium chloride influences the metabolism by shifting the acid-base equilibrium, affecting glucose tolerance and reducing tissue sensitivity to insulin. The toxicity of ammonium chloride is mainly driven by the release of hydrochloric acid during the metabolism of ammonium into urea, leading to hyperchloremic metabolic acidosis (EFSA 2012; NICNAS 2013; WHO 2003). Individuals who suffer from severe liver or kidney disease and those with hereditary urea cycle disorders may be more sensitive to ammonia exposure (SLR 2022b).

Based on the available evidence, ammonia, ammonium hydroxide and ammonium chloride are regarded as posing low carcinogenic and mutagenic concern at environmental exposure levels (NICNAS 2013, 2014). The International Agency for Research on Cancer (IARC) has not evaluated or classified ammonia for carcinogenicity.

Evidence from rodent studies provide some indication that ammonia, when tested at concentrations of 8.4 mg/L and 100 mg/L, may act with cancer-causing compounds to increase the incidence of tumours (US EPA 2005; Tsujii et al. 1995; Uzvölgyi and Boján 1985). However, ammonium hydroxide administered as a 0.3% solution (3000 mg/L) in drinking water did not result in an increased incidence of cancer in mice over a lifetime (US EPA 2005; Toth 1972); notably this concentration is greater than 1400 times the ammonia aesthetic-based guideline value of 0.5 mg/L.

DERIVATION OF GUIDELINE

Ammonia concentrations above 0.5 mg/L may corrode copper pipes and fittings or result in nuisance growths of microorganisms (SLR 2022b). Concentrations of ammonia that may cause health effects are unlikely to occur in drinking water supplies; accordingly, no health-based guideline value is set.

REVIEW HISTORY

This fact sheet was developed based on a review of the available evidence completed in 2021 (SLR 2022a,b) (refer to the relevant Administrative Report for more information).

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