Salts of boric acid: Human health tier II assessment

30 June 2017

Chemicals in this assessment

Chemical Name in the Inventory	CAS Number
Boron sodium oxide (B4Na2O7)	1330-43-4
Boric acid (H2B4O7), dipotassium salt	1332-77-0
Boric acid (HBO2), sodium salt	7775-19-1
Boric acid (HBO2), sodium salt, tetrahydrate	10555-76-7
Boron potassium oxide (B5KO8)	11128-29-3
Boric acid, sodium salt, pentahydrate	11130-12-4
Boric acid, (H2B4O7), calcium salt (1:1)	12007-56-6
Ammonium boron hydroxide oxide ((NH4)B4(OH)O6)	12007-57-7
Ammonium boron oxide ((NH4)2B4O7)	12007-58-8
Boron strontium oxide (B4SrO7)	12007-66-8
Ammonium boron oxide ((NH4)B5O8)	12007-89-5
Boric acid (HB5O8), sodium salt	12007-92-0
Boric acid, (H2B8O13), disodium salt	12008-41-2
Boron potassium oxide(B4K2O7), tetrahydrate	12045-78-2
Boron sodium oxide (B4Na2O7), hydrate (1:?)	12267-73-1
Boric acid, potassium salt	12712-38-8
Boric acid (HBO2), barium salt	13701-59-2

Chemical Name in the Inventory	CAS Number
Boric acid (HBO2), calcium salt	13701-64-9
Boric acid (HBO2), magnesium salt	13703-82-7
Boric acid (HBO2), potassium salt	13709-94-9
Boric acid (H3BO3), sodium salt	13840-56-7
Boric acid (H3BO3), potassium salt	20786-60-1
Boric acid (H3BO3), compound with 2-aminoethanol	26038-87-9
2-Propanol, 1-amino-, compound with boric acid (H3BO3)	26038-90-4
Boric acid (H3BO3), compound with 2,2'-iminobis[ethanol]	67952-33-4
Boric acid (H3BO3), compound with 1-amino-2-propanol (1:1)	68003-13-4
Boric acid (H3BO3), compound with 2-aminoethanol (1:1)	68586-07-2
Boric acid (H3BO3), compound with 2-aminoethanol (1:3)	68797-44-4

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**

ACRONYMS & ABBREVIATIONS

Grouping Rationale

The chemicals in this group are salts of boric acid (metals, ammoniums and amines). The salts dissociate in solution to form the different species of boric acid and their respective cations. Boric acid is a very weak acid with a pKa of 9.2 and exists primarily as the undissociated acid (H_3BO_3) in aqueous solutions at physiological pH and acidic pH at low concentrations (NICNASb). While the individual cations, anions and organic acids may vary in toxicological properties, boric acid is expected to drive the toxicity of these chemicals, hence, they are grouped together for human health risk assessment (NICNASb; NICNASc; NICNASd; REACHa; REACHb; REACHc; REACHd). The chemicals in this group have similar reported uses.

The free amines in the following borate compounds: boric acid (H_3BO_3), compound with 2,2'-iminobis[ethanol] (CAS No. 67952-33-4), boric acid (H_3BO_3), compound with 1-amino-2-propanol (1:1) (CAS No. 68003-13-4), boric acid (H_3BO_3), compound with 1-amino-2-propanol (CAS No. 26038-90-4), boric acid (H_3BO_3), compound with 2-aminoethanol (CAS No. 26038-87-9) and boric acid (H_3BO_3) compound with 2-aminoethanol (1:3) (CAS No. 68797-44-4) may be acutely toxic (NICNASa; NICNASe). Studies suggest that the method by which they induce acute toxicity is by way of their strong alkalinity, which causes corrosive effects such as severe local damage to the gastrointestinal tract (NICNASe; REACHe). However, the cations of these amines are not basic and do not have corrosive potential, or corresponding acute toxicity.

The metal ions in this group are generally considered as safe (NICNAS), while the ammonium cation is an essential component in human metabolic processes. Barium ions are acutely toxic at high concentrations (ATSDR, 2007); however, boric acid (HBO_2), barium salt (CAS No. 13701-59-2) is relatively insoluble in biological fluids and is therefore not considered to pose any additional toxicological risk compared with the other compounds in this assessment.

Import, Manufacture and Use

Australian

The following Australian industrial uses were reported under previous mandatory and/or voluntary calls for information, for sodium borate, anhydrous (CAS No. 1330-43-4) and sodium borate, pentahydrate (CAS No. 11130-12-4).

Reported commerical uses, including:

- in flame retardants and fire-preventing agents;
- in flux agents for casting; and
- as construction materials additives.

Sodium borate, pentahydrate (CAS No. 11130-12-4) is listed on the 2006 High Volume Industrial Chemicals List (HVICL) with a total reported volume of between 1000 and 9999 tonnes.

The National Pollutant Inventory (NPI) holds data for all sources of environmental release of boron and its compounds in Australia.

No specific Australian use, import, or manufacturing information has been identified for other members of this group.

International

The following international uses have been identified through the European Union (EU) Registration, Evaluation and Authorisation of Chemicals (REACH) dossiers; Galleria Chemica; the Substances and Preparations in the Nordic countries (SPIN) database; the European Commission Cosmetic Ingredients and Substances (CosIng) database; the United States (US) Personal Care Product Council International Nomenclature of Cosmetic Ingredients (INCI) Dictionary; and the US National Library of Medicine's Hazardous Substances Data Bank (HSDB).

The chemicals have reported cosmetic use including as:

- buffering agents (CAS Nos. 1330-43-4, 1332-77-0, 26038-87-9; 26038-90-4); and
- viscosity controlling agents (CAS No. 68003-13-4).

The chemicals have reported domestic uses including in:

- cleaning/washing agents;
- colouring agents;
- corrosion inhibitors; and
- surface treatments.

Three chemicals of this group (CAS Nos. 1330-43-4, 1332-77-0, 12008-41-2) have been reported to be present in a range of domestic products including various home maintenance products (including for landscape/yard) with concentrations up to 30 % (Household Products Database, US Department of Health and Human

Services).

The chemicals have reported commercial uses including:

- in anti-freezing agents;
- in fixing agents;
- in lubricants and additives;
- as photographic chemicals;
- in reprographic agents;
- in construction material additives;
- in flux agents for casting;
- in soldering agents;
- in wood fire-proofing;
- in manufacturing glazes and enamels; and
- in artificially ageing wood.

The chemicals (CAS Nos. 67952-33-4, 68003-13-4, 68797-44-4, 26038-87-9) have reported commercial uses including in metal working fluids.

The chemicals have reported site-limited uses including as a heat transferring agent.

The following non-industrial uses have been identified internationally for chemicals in this group in:

- pharmaceutical preparations (antiseptic/astringent);
- non-agricultural pesticides and preservatives; and
- food/feedstuff flavourings and nutrients.

Restrictions

Australian

Although no known restrictions have been identified for the chemicals in this group, boric acid (excluding its salts) and borax are listed in the *Poisons Standard* (Standard for the Uniform Scheduling of Medicines and Poisons—SUSMP, 2016) in Schedule 5 (NICNASa; NICNASb).

Schedule 5 chemicals are labelled with 'Caution'. These are 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.

The majority of chemicals in this group (CAS Nos. 1330-43-4, 1332-77-0, 11128-29-3, 11130-12-4, 12007-89-5, 12008-41-2, 13840-56-7) (including boric acid and borax) are also listed in Schedule 4 for non-industrial uses.

International

The majority of chemicals in this group (CAS Nos. 1330-43-4, 1332-77-0, 11128-29-3, 11130-12-4, 12007-89-5, 12008-41-2, 13840-56-7, 13701-64-9, 12007-56-6) are listed on the following (Galleria Chemica):

- EU Regulation (EC) No 1223/2009 of the European Parliament and of the Council of 30 November 2009 on cosmetic products—Annex III—List of substances which cosmetic products must not contain except subject to the restrictions laid down.

The chemicals (CAS Nos. 1330-43-4, 13701-64-9, 12007-56-6, 13701-59-2) are listed on the Health Canada List of prohibited and restricted cosmetic ingredients (The Cosmetic Ingredient "Hotlist") (Galleria Chemica).

The Scientific Committee on Consumer Safety (SCCS) has recently concluded that substances such as borates, tetraborates, and octaborates as well as other boric acid salts/esters (MEA-borate, MIPA-borate, potassium borate, trioctyldodecyl borate and zinc borate reported in the CosIng database) produce boric acid following contact with water. Therefore, as these compounds have chemical, biological and toxicological properties similar to boric acid, the general restrictions applicable to boric acid for safe use in cosmetic products should apply to the whole group of borates (SCCS, 2013).

Existing Worker Health and Safety Controls

Hazard Classification

Sodium borate, anhydrous (CAS No. 1330-43-4), tetraboron disodium heptaoxide, hydrate (CAS No. 12267-73-1) and orthoboric acid, sodium salt (CAS No. 13840-56-7) are classified as hazardous, with the following hazard categories and hazard statements for human health in the Hazardous Chemical Information System (HCIS) (Safe Work Australia):

- Reproductive toxicity – category 1B; H360FD (May damage fertility. May damage the unborn child).

Exposure Standards

Australian

Sodium borate, anhydrous (CAS No. 1330-43-4) has an exposure standard of 1 mg/m^3 time weighted average (TWA).

International

The following exposure standards are identified (Galleria Chemica):

- Sodium borate, anhydrous (CAS No. 1330-43-4) has a time weighted average (TWA) exposure limit of 1 mg/m^3 in Canada, 5 mg/m^3 in Switzerland, and 2 mg/m^3 in Spain. The chemical also has a short-term exposure limit (STEL) of 3 mg/m^3 in Canada, 5 mg/m^3 in in Switzerland, and 6 mg/m^3 in Spain.
- Sodium borate, pentahydrate (CAS No. 11130-12-4) has a TWA exposure limit of 2 mg/m^3 in Canada and Spain, and 1 mg/m^3 in Switzerland. The chemical also has an STEL of 6 mg/m^3 in Canada and Spain, and 3 mg/m^3 in in Switzerland.
- Magnesium borate (CAS No. 13703-82-7) has an exposure limit of 1-2 mg/m^3 TWA in countries such as Canada, Malaysia and the USA.
- Magnesium borate (CAS No. 13703-82-7) also has an STEL of 6 mg/m^3 in countries such as Canada and the USA.

Health Hazard Information

The chemicals in this group are boron-containing compounds; their toxicity is driven predominantly by boron. Undissociated boric acid is the main species present in mammalian blood following exposure to simple inorganic borates such as boric acid and borax. This is also true for the chemicals in this group as these chemicals will also dissolve to form undissociated boric acid (H_3BO_3) in dilute aqueous solutions at physiological and acidic pH.

Limited information is available in the literature to assess the toxicity of chemicals in this group. Since inorganic borate toxicity is driven predominantly by boron, the toxicokinetics and toxicological effects of inorganic borates, including the chemicals in this group, are expected to be similar on a boron-equivalent basis. Therefore, the data obtained from studies on other boron-containing inorganic borates, such as boric acid, borax and zinc borates, have been read across for this assessment. Zinc borate is not considered an appropriate analogue for reproductive and developmental toxicity as it has been proposed that zinc has a protective effect on the reproductive toxicity of borates (NICNASd). The cations in each of these salts are considered to be of low toxicity (NICNAS, 2013; NICNASa).

Boron has been postulated to be an essential nutrient and an acceptable daily intake (ADI) of 0.32 mg/kg bodyweight (bw)/day has been assigned to the chemical. This ADI would equal 22.4 mg boron/day for a 70 kg adult human (Australian Government Department of Health, 2008).

Toxicokinetics

As stated above, undissociated boric acid is the main species present in mammalian blood following exposure to simple inorganic borates, including borax and boric acid. The toxicokinetics of simple inorganic borates, including borax and boric acid, is similar in rats and humans with respect to absorption, distribution, and metabolism. The major difference between animals and humans is in renal clearance, which is approximately three times faster in rats than in humans (NICNASb; NICNASc).

Simple inorganic borates are readily and completely absorbed in humans and animals following oral administration; inhalational absorption is also assumed to be 100 %, as a worst case scenario. Dermal absorption through intact skin is very low in all species and a dermal absorption rate of 0.5 % is assumed, although penetration though damaged or abraded skin has been demonstrated. Absorbed boric acid is distributed rapidly and evenly throughout the body water in humans and animals and is not further metabolised due to the high energy required (523 kJ/mol) to break the B–O bond. There is no evidence of boric acid accumulation in humans or animals. Boric acid is excreted rapidly with a half-life of <24 hours in humans and animals and is mainly excreted in the urine (>90 %), regardless of the exposure route (NICNASb; NICNASc).

Acute Toxicity

Oral

Limited data are available on the chemicals in this group. Information available on sodium borate, anhydrous (CAS No. 1330-43-4), boric acid (CAS No. 10043-35-3), borax (CAS No. 1303-96-4) and zinc borates suggests that the chemicals in this group are likely to have low acute toxicity in animal tests following oral exposure. The median lethal dose (LD50) in rats for the tested chemicals in the group and the analogues is >2000 mg/kg bw. The boric acid amine salts are also expected to have low acute oral toxicity (>2000 mg/kg bw) (REACHe) .

Observed sub-lethal effects included soft faeces, soiled anogenital area, lethargy, hunched posture, and an unkempt appearance for sodium borate (CAS No. 1330-43-4); central nervous system (CNS) depression, ataxia and convulsions for boric acid (CAS No. 10043-35-3) and borax (CAS No. 1303-96-4); mucoid diarrhoea, faecal stains, urine stains, unkempt fur, and serosanguinous discharge around the nose or mouth for zinc borates (unspecified CAS number) (EU RAR, 2009; NICNASb; NICNASc; NICNASd).

Dermal

No data are available on the chemicals in this group.

Information available on the analogues, boric acid (CAS No. 10043-35-3), borax (CAS No. 1303-96-4) and on zinc borates indicates that the chemicals in this group are likely to have low acute toxicity in animal tests following dermal exposure. The dermal LD50 in rats is >2000 mg/kg bw for each of these analogues. It is also noted that the dermal absorption through intact skin is very low (dermal absorption rate of 0.5 % is assumed for borates) (see **Toxicokinetics** section) (NICNASb; NICNASc; NICNASd).

Inhalation

No data are available on the chemicals in this group.

Information available on the analogues boric acid (CAS No. 10043-35-3), borax (CAS No. 1303-96-4) and zinc borates indicates that the chemicals in this group are likely to have low acute toxicity in animal tests following inhalational exposure.

The reported median lethal concentration (LC50) in rats is >2 mg/L for boric acid (CAS No. 10043-35-3) and borax (CAS No. 1303-96-4); and >4.95 mg/L for zinc borates (unspecified CAS number). Observed sub-lethal effects included ocular discharge, nasal discharge, wet fur, hunched posture, piloerection and laboured respiration (NICNASb; NICNASc; NICNASd).

Observation in humans

There is a large database of accidental or intentional poisoning incidents with borates in humans. A review of more than 700 cases of acute boric acid exposures in adults and children found 88.3 % of cases were without symptoms. Although the report provided only limited information on dose response, dose ranges of 0.1–55 g and 0.01–89 g of boric acid were reported for symptomatic and asymptomatic cases, respectively (Litovitz et al., 1988).

There are case reports of lethal oral exposures to humans involving accidental or intentional ingestion of high doses of boric acid. While oral lethal doses for boric acid have been quoted as 2–3 g for infants, 5–6 g for children, and 15–30 g for adults, the data are largely unsubstantiated. Further difficulty in making an appropriate quantitative judgment about a lethal dose was also noted due to medical intervention in most cases. Following ingestion of a formula accidentally prepared with a 2.5 % aqueous solution of boric acid, five infants became lethargic, developed vomiting and diarrhoea, and died within three days of exposure (estimated dose of 4.5–14 g boric acid). Deaths have also occurred in a 77-year-old man following ingestion of 30 g of boric acid and in a 45-year-old man following ingestion of approximately 280 g of boric acid. In both instances, clinical signs were similar: vomiting, diarrhoea, erythema, cyanotic extremities, acute renal failure, cardiopulmonary hypertension and death from heart failure (NICNASb).

Corrosion / Irritation

Respiratory Irritation

The limited data indicate that the chemicals in this group are unlikely to be specific respiratory irritants. No hazard classification is warranted.

Nasal and ocular discharge was noted in inhalation studies in rats exposed to boric acid (CAS No. 10043-35-3) (see **Acute toxicity: Inhalation** section). Ocular discharge and or nasal discharge persisted in most animals after being removed from the exposure chamber. All animals recovered by day seven (NICNASb).

An airway sensory irritation respiratory depression study of boric acid conducted in male Swiss-Webster mice concluded that boric acid is unlikely to be a respiratory irritant. Although it was not possible to achieve an aerosol concentration high enough to result in a 50 % respiratory depression (RD50) in mice, the highest concentration of boric acid with acceptable control of the aerosol concentration (1096 mg/m^3) resulted in an RD of 19 %. The RD50 was concluded to be >1096 mg/m^3 for boric acid. A 9 % reduction in respiratory rate was recorded at an exposure concentration of 221 mg/m^3 (Kirkpatrick, 2010). Given that significant respiratory depression is only observed at levels above the nuisance dust limit (10 mg/m^3), it is unlikely the chemicals in this group are specific respiratory irritants.

Skin Irritation

Although the appropriate data are limited, the available information on the analogues, boric acid (CAS No. 10043-35-3), borax (CAS No. 1303-96-4), and on zinc borates, indicate that the chemicals in this group are not likely to be skin irritants (NICNASb; NICNASc; NICNASd).

Boric acid (CAS No. 10043-35-3) and borax (CAS No. 1303-96-4) did not cause skin irritation when applied (500 mg) to rabbit skin. While a 5 mL solution of 10 % boric acid (CAS No. 10043-35-3) also produced no skin irritation in rabbits, a similar strength solution of borax (CAS No. 1303-96-4) caused very mild skin irritation. Zinc borate (unspecified CAS number) was also not a skin irritant when applied to rabbits skin (NICNASb; NICNASc; NICNASd).

Eye Irritation

Limited data are available on the chemicals in this group.

In an eye irritation study, potassium pentaborate (CAS No. 11128-29-3) (0.1g) was placed in the conjunctival sac of the right eye of each of the three New Zealand White (NZW) rabbits and treated eyes were rinsed with water 24 hours after administration of the test substance. The untreated left eye of each rabbit served as a control. As significant eye irritation scores were not observed in any animal throughout the study, the chemical was classified as non-irritant to the eyes (REACHc).

Slight eye irritant effects were reported in animal studies for the analogues: boric acid (CAS No. 10043-35-3); borax (CAS No. 1303-96-4) and on zinc borates. The reported effects were not sufficient to warrant a hazard classification for the chemicals in this group (NICNASb; NICNASc; NICNASd).

Reversible conjunctival redness, chemosis, and minor effects on the iris were noted in New Zealand White rabbits following application (100 mg) of boric acid (CAS No. 10043-35-3) into one eye of each of rabbit. Reversible conjunctival redness, chemosis, and effects on the cornea and iris were also noted in rabbits with borax (CAS No. 1303-96-4). The crystalline nature of the chemical was thought to be potentially responsible for the irritation (NICNASb; NICNASc).

Eye irritation was also observed in rabbits exposed to zinc borate (CAS No. 12767-90-7) (0.083 g), with maximum total irritation scores for individual animals being 8–33/100. Corneal changes were observed only in 2/6 animals and cleared by day 10 after exposure in both animals; iris lesions were observed only in 1/6 and cleared by day 10; and conjunctival redness was the main lesion, which cleared by day 13 (NICNASd).

Zinc borate (CAS No. 12767-90-7) (0.1 mL) caused moderate conjunctival irritation in the eyes of all animals, which cleared by day two after exposure. There was no corneal opacity or iritis. In another eye irritation study in rabbits with zinc borate (100 mg), irritant effects were confined to mild conjunctivitis in each rabbit which completely subsided in four rabbits within 72 hours after exposure. A maximum mean total score of 0.66/110 was noted at 72 hours (NICNASd).

Observation in humans

No adverse effects have been reported on human eyes following many years of occupational exposure to zinc borates under normal industrial use (NICNASd).

Observation in humans

There are reports of respiratory effects in humans of boron-containing compounds.

Acute respiratory effects have been extensively documented in workers after inhaling boric acid, boron oxide, and other borates (including borax) as dusts. Effects include nasal and eye irritation, throat irritation, coughing and breathlessness. No effects on lung function were observed and the effects identified by workers were ‘chemaesthetic’ (caused by the activation of sensory receptors). These effects were regarded as sensory irritant effects that would typically be seen in normal populations in the absence of respiratory hypersensitivity.

It was also concluded that these effects are most likely due to the physical exposure to the dust of these chemicals rather than a specific irritant chemical effect. As these effects were not considered a ‘serious irritation to the respiratory tract’ and were most likely due to a physical effect, this supports the notion that no hazard classification for respiratory irritation is warranted (NICNASb; NICNASc).

Sensitisation

Skin Sensitisation

Although no information is available on the skin sensitisation potential of chemicals in this group, based on the available information on the analogues, the chemicals are not likely to be skin sensitisers (NICNASb; NICNASc; NICNASd).

In skin sensitisation tests (Buehler) conducted in guinea pigs (male/female) according to the Organisation for Economic Co-operation and Development (OECD) test guideline (TG) 406 (skin sensitisation), borax (CAS No. 1303-96-4) and boric acid (CAS No. 10043-35-3) did not cause skin sensitisation following applications with a 95 % concentration, moistened with distilled water to enhance skin contact, during both the induction and challenge phases (NICNASb; NICNASc).

Zinc borate (CAS No. 138265-88-0) did not cause skin sensitisation in studies conducted according to OECD TG 406. In the first study (Buehler test), Hartley guinea pigs were induced and challenged with the chemical at 75 % w/v in distilled water. In the second study (maximisation test), Dunkin–Hartley guinea pigs were induced (intradermally) with zinc borate (unspecified CAS number) at a 1 % concentration followed by a topical application of the chemical at 50 %. The animals were challenged with 25 % of the chemical (NICNASd).

Observation in humans

No evidence of skin or respiratory sensitisation in humans occupationally exposed to borates has been reported (NICNASb; NICNASc).

Repeated Dose Toxicity

Oral

No data are available for the chemicals in this group.

The available information on boron-containing compounds indicates that the chemicals in this group are not likely to cause serious damage to health from repeated oral exposure. It is noted that the main target for repeated dose oral toxicity for boron are the testes, leading to adverse reproductive and developmental effects. Adverse haematological effects indicating increased red blood cell destruction have also been commonly noted as signs of boron toxicity (NICNASb; NICNASc).

An overall no observed adverse effect level (NOAEL) of 17.5 mg boron/kg bw/day (equivalent to 155 mg borax/kg bw/day) has been determined from a two-year study of borax in rats, for clinical effects and the testicular atrophy observed at the highest dose. The lowest observed adverse effect level (LOAEL) was stated as 58.5 mg boron/kg bw/day (equivalent to 516 mg borax/kg bw/day) (NICNASb; NICNASc; NICNASd).

In a repeated dose toxicity study, Sprague Dawley (SD) rats (35/sex/group) were fed borax (CAS No. 1303-96-4) in the diet at doses of 0, 117, 350, or 1170 ppm boron, or as 0, 52, 155, 516 mg borax/kg bw/day (equivalent to 0, 5.9, 17.5 and 58.5 mg boron/kg bw/day), for two years. Reduction in body weight was observed in males and females in the highest dose group, accompanied by decreased food consumption. Clinical signs of toxicity were observed in animals of the highest dose groups. Testicular atrophy and atrophied seminiferous epithelium were seen in the highest dose males at six, 12, and 24 months. Testes weights and testes:body-weight ratios were also significantly ($p<0.05$) decreased. An NOAEL of 155 mg/kg bw/day of borax (equivalent to 17.5 mg boron/kg bw/day) was determined following 24 months of exposure, based on clinical effects and the testicular atrophy observed at the highest dose (NICNASb).

In another repeated dose toxicity study, SD rats (10/sex/group) were fed borax or boric acid in the diet at doses of 0, 52.5, 175, 525, 1750, and 5250 ppm boron for 13 weeks (equivalent to 0, 2.6, 8.8, 26, 88, and 260 mg boron/kg bw/day). Similar effects were observed for both borax and boric acid. The chemical caused 100 % mortality at the highest dose. Clinical signs of toxicity were observed in animals at the two highest doses. Microscopic examination revealed complete testicular atrophy at 1750 ppm in all males and partial testicular atrophy at 525 ppm boron in four males. A 90-day NOAEL of 175 ppm boron (equivalent to 8.8 mg boron/kg bw/day) was established in this study, based on clinical signs of toxicity and testicular atrophy (NICNASb; NICNASc).

Dermal

No data are available.

Inhalation

No data are available.

Observation in humans

In addition to numerous acute poisoning incidents with boric acid (CAS No. 10043-35-3) (see **Acute toxicity: Observation in humans** section), some data are also available on effects from repeated doses of boric acid or borax as treatments for medical conditions. Multiple oral and dermal exposures resulted in a variety of symptoms including dermatitis, alopecia, loss of appetite, nausea, vomiting, diarrhoea and focal or generalised CNS effects or convulsions (NICNASb; NICNASc).

Exposures ranging from 4–30 g (estimated average daily ingestion of 0.143–0.429 g) of borax have been reported in seven infants (aged 6–16 weeks) from using pacifiers coated with a borax and honey mixture for 4–10 weeks. Toxicity manifested as generalised, or alternating focal seizure disorders, irritability and gastrointestinal disturbances (NICNASc).

Genotoxicity

Although the appropriate data are limited, the available information on boric acid (CAS No. 10043-35-3) and boron metal compounds (zinc borates) indicates that the chemicals in this group are not likely to have a mutagenic or genotoxic potential (EU RAR, 2009; NICNASb; NICNASc; NICNASd).

Sodium borate (CAS No. 1330-43-4) did not cause gene mutations in the *Salmonella typhimurium* preincubation assay (WHO, 1998).

Boric acid (CAS No. 10043-35-3) also tested negative in several in vitro tests and also in an in vivo mouse bone marrow micronucleus chromosome aberration test. It was concluded that boric acid did not have mutagenic or genotoxic potential (NICNASb).

Zinc borate (unspecified CAS number) tested negative in several in vitro tests such as bacterial reverse mutation tests with *S. typhimurium* strains and in vitro mammalian cell gene mutation tests with mouse lymphoma L5178Y cells (NICNASd).

Carcinogenicity

Limited data are available on the chemicals in this group. Available information on other inorganic borates and on zinc borates indicates that the chemicals in this group are not likely to have a carcinogenic potential. The chemicals in this group are also not considered to have a mutagenic or genotoxic potential (see **Genotoxicity** section) (EU RAR, 2009; NICNASb; NICNASc; NICNASd).

Boric acid (CAS No. 10043-35-3) and borax (CAS No. 1303-96-4) did not show any evidence of carcinogenicity in SD rats and B6C3F1 mice in chronic and carcinogenicity studies. In a carcinogenicity study, boric acid (CAS No. 10043-35-3) was administered to B6C3F1 mice in the diet at 0, 2500, 5000 ppm (equivalent to 0, 446, 1150 mg boric acid/kg bw/day) for two years. There was no evidence of carcinogenicity in the study and the testicular effects noted were related to reproductive and developmental toxicity. The NOAEL for carcinogenicity was equivalent to 1150 mg boric acid/kg bw/day (201 mg boron/kg bw/day), the highest dose tested (NICNASb; NICNASc).

In another chronic/carcinogenicity study, borax (CAS No. 1303-96-4) was fed to SD rats in their diet at doses of 0, 117, 350 or 1170 ppm boron, or as 0, 52, 155, 516 mg borax/kg bw/day (equivalent to 0, 5.9, 17.5 and 58.5 mg boron/kg bw/day) for two years in the chronic study. An NOAEL of 155 mg/kg bw/day of borax (equivalent to 17.5 mg boron/kg bw/day) was determined, based on clinical effects and the testicular atrophy observed at the highest dose. No evidence of carcinogenicity was observed (NICNASc).

Reproductive and Developmental Toxicity

Some members of this group (CAS Nos. 1330-43-4, 12267-73-1, 13840-56-7) are classified as hazardous for reproductive and developmental toxicity—Category 1B; H360FD (May damage fertility. May damage the unborn child) in the HCIS (Safe Work Australia).

No data are available regarding reproductive or developmental effects of chemicals in this group in animals and humans, although there are studies on the analogues boric acid and borax. Boric acid (CAS No. 10043-35-3) is classified as a hazardous for reproductive and developmental toxicity—Category 1B; H360FD (May damage fertility. May damage the unborn child) in the HCIS (Safe Work Australia).

While the appropriate data are not available for chemicals in this group, information on boron-containing compounds (boric acid) in animals is sufficient to support classification for all chemicals in this group (see **Recommendation** section) (NICNASb; NICNASc; NICNASd).

The testes and the developing foetus have been identified as the most sensitive targets of boron toxicity in animal studies, with the rat being the most sensitive species. The reported testicular effects included reduced organ weight and organ:body weight ratio; atrophy and degeneration of the spermatogenic epithelium; impaired spermatogenesis; and reduced fertility. The reported developmental effects included high prenatal mortality; reduced foetal body weight; and malformations and variations of the eyes, CNS, cardiovascular system and axial skeleton. The NOAEL for fertility of 100 mg/kg bw/day of boric acid (equivalent to 17.5 mg boron/kg bw/day) has been determined from two-year and three-year generational studies in rats, based on testicular effects. The critical NOAEL for developmental effects has been determined as 55 mg/kg bw/day of boric acid (equivalent to 9.6 mg boron/kg bw/day) in rats (NICNASb; NICNASc).

Observation in humans

Epidemiological studies of worker exposure and general populations with high environmental boron showed no reproductive or developmental effects. In studies of Chinese and Turkish workers and in populations living in areas with high environmental levels of boron, semen parameters were evaluated in both studies, as semen analysis is the most sensitive indicator for testicular toxicity in humans. Even though a mean boron intake of up to 125 mg boron/day (over 100 times greater than the average daily exposure of the general population) was determined for the highest exposed Chinese group, adverse testicular effects were not seen. Turkish workers also did not show any adverse testicular effects despite a high mean calculated daily boron exposure (14.45 ± 6.57 mg boron/day) in the exposed group (SCCS, 2010; NICNASb).

Other epidemiological studies of exposure to workers and general populations with high environmental boron showed no reproductive or developmental effects. The higher levels of zinc in the soft tissue of humans have been postulated to have a protective effect against boron toxicity. There was limited evidence of a reduction in reproductive and developmental toxicity for zinc borate compared with boric acid in laboratory studies (SCCS, 2010; Bureau for Chemical Substances, 2013; NICNASb; NICNASc; NICNASd).

The above epidemiological studies have also been considered recently as part of the opinion on harmonised classification and labelling of boric acid (CAS No. 10043-35-3) at the EU level. The highest occupational exposure levels of boron in the two occupational cohorts and in the environmental exposed cohorts were much lower than the animal studies (15-135 times lower than the animal LOAEL for fertility effects and 7-66 times lower than the animal LOAEL for developmental toxicity). At those exposure levels in epidemiological studies, assuming a similar sensitivity of humans as in the four laboratory species studies, it is unlikely that any adverse effects on human male fertility would have been observed. It was also noted that effects on female fertility and prenatal developmental effects were not investigated as part of the epidemiological studies. Therefore, the stated epidemiological studies do not sufficiently address the relevance of the animal toxicity data to humans at similar dose levels as causing toxicity in experimental animals. It was concluded that human data showing no clear evidence of reproductive toxicity do not contradict the animal data (ECHA, 2014).

Other Health Effects

Neurotoxicity

Although no data are available regarding the neurological effects of chemicals in this group in animals and humans, the available information on the analogue boric acid indicates that these chemicals are not likely to have neurotoxic properties. It is also noted that even though CNS depression has been reported in cases of human poisoning with boric acid (CAS No. 10043-35-3) at very high doses, there was no indication that boric acid has neurotoxic properties (NICNASb; NICNASc; NICNASd).

Boric acid (CAS No. 10043-35-3) at a single oral (gavage) dose of 2000 mg/kg bw to SD rats (10/sex/dose) was not neurotoxic. Although a 16 % decrease in total body weight gain was noted in the treatment group, compared with the control group at the end of the study, there were no mortalities and no clinical signs of toxicity. Functional observations and motor activity evaluations did not show any evidence of neurotoxicity. Neurohistopathological findings were also negative (NICNASb).

Gross or microscopic effects on the brain were not observed in rats exposed to various quantities and durations of boron oxide (aerosol): concentrations of 470 mg boron oxide/m^3 (73 mg boron/m^3) for 10 weeks; 175 mg boron oxide/m^3 (27 mg boron/m^3) for 12 weeks; and 77 mg boron oxide/m^3 (12 mg boron/m^3) for 24 weeks (NICNASb).

Risk Characterisation

Critical Health Effects

The critical health effects for risk characterisation include reproductive and developmental toxicity.

Although the available animal data show clear evidence of reproductive and developmental toxicity, epidemiological studies of workers and general populations exposed to boron show no reproductive or developmental effects. However, there are limitations in the human studies (See **Reproductive and Developmental Toxicity: Observation in humans** section). The available human data are not sufficient to invalidate the animal data.

Public Risk Characterisation

Although the use of chemicals in this group in cosmetic and domestic products in Australia is not known, chemicals in this group have reported limited cosmetic and domestic uses overseas (see **Import, manufacture and use** section).

The SCCS has recently concluded that substances such as borates, tetraborates, and octaborates as well as other boric acid salts/esters (MEA-borate, MIPA-borate, potassium borate, trioctyldodecyl borate and zinc borate reported in the CosIng database) produce boric acid following contact with water (see **Restrictions: International** section) (SCCS, 2013). While these chemicals are expected to be less frequently used than boric acid and borax (NICNASb; NICNASc), similar, although more limited, cosmetic and domestic uses are reported internationally.

Therefore, the general restrictions applicable to boric acid for safe use in cosmetic products should apply to the whole group of borates (SCCS, 2013).

Occupational Risk Characterisation

During product formulation, oral, dermal and inhalation exposure of workers to the chemicals in this group can occur, particularly where manual or open processes are used. These might 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 health effects, the chemicals in this group could pose an unreasonable risk to workers unless adequate control measures to minimise oral, dermal and inhalation exposure to the chemical are implemented. The chemicals should be appropriately classified and labelled to ensure that a person conducting a business or undertaking at a workplace (such as an employer) has adequate information to determine appropriate controls.

The available data support an amendment to the hazard classification in HCIS (see **Regulatory control: Occupational health and safety** section) (see **Recommendation** section).

NICNAS Recommendation

Further risk management is required. Sufficient information is available to recommend that risks to public health and safety from the potential use of the chemical in cosmetics and/or domestic products be managed through changes to poisons scheduling, and risks for workplace health and safety be managed through changes to classification and labelling.

Assessment of the chemical is considered to be sufficient provided that risk management recommendations are implemented and all requirements are met under workplace health and safety and poisons legislation as adopted by the relevant state or territory.

Regulatory Control

Public Health

It is recommended that an amendment to the current entry for boric acid and borax in the SUSMP be considered. The current entry for boric acid and borax 'excludes salts of boric acid' (see **Restrictions: Australia** section). It is recommended that 'excluding its salts' be removed from SUSMP entry for boric acid and borax.

Consideration should be given to the following points:

- although use in cosmetic and domestic products in Australia is not known, these chemicals have reported cosmetic and domestic uses overseas;
- all borates, including salts of boric acid, produce boric acid following contact with water; and
- undissociated boric acid is the main species present in the blood of mammals following exposure to inorganic borates, including chemicals in this group.

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.

Note:

While the reproductive and developmental toxicity classification (Category 1B; H360FD) is already listed on the HCIS for some members of this group (CAS Nos. 1330-43-4, 12267-73-1, 13840-56-7), these classifications should be applied to all members of this group.

Hazard	Approved Criteria (HSIS)[a]	GHS Classification (HCIS)[b]
Reproductive and Developmental Toxicity	Not Applicable	May damage fertility. May damage the unborn child - Cat. 1B (H360FD)

[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 in this group should be used according to the instructions on the label.

Advice for industry

Control measures

Control measures to minimise the risk from oral, dermal and inhalation 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 which could minimise the risk include, but are not limited to:

- using closed systems or isolating operations;
- health monitoring for any worker who is at risk of exposure to the chemicals, if valid techniques are available to monitor the effect on the worker's health;
- air monitoring to ensure control measures in place are working effectively and continue to do so;
- 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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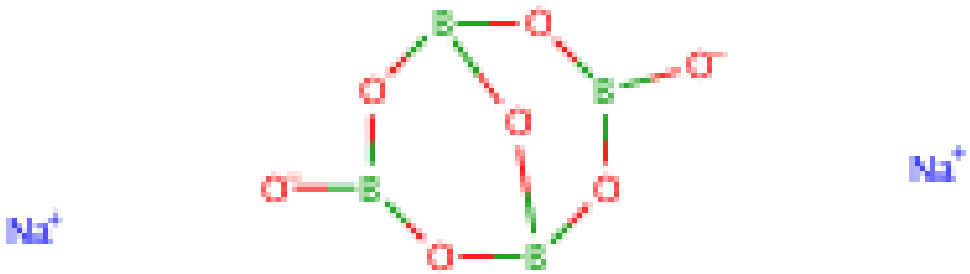
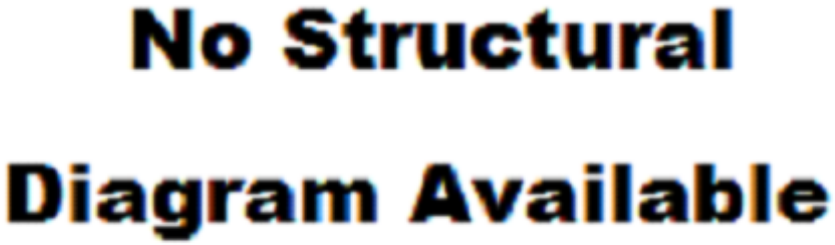
Last Update 30 June 2017

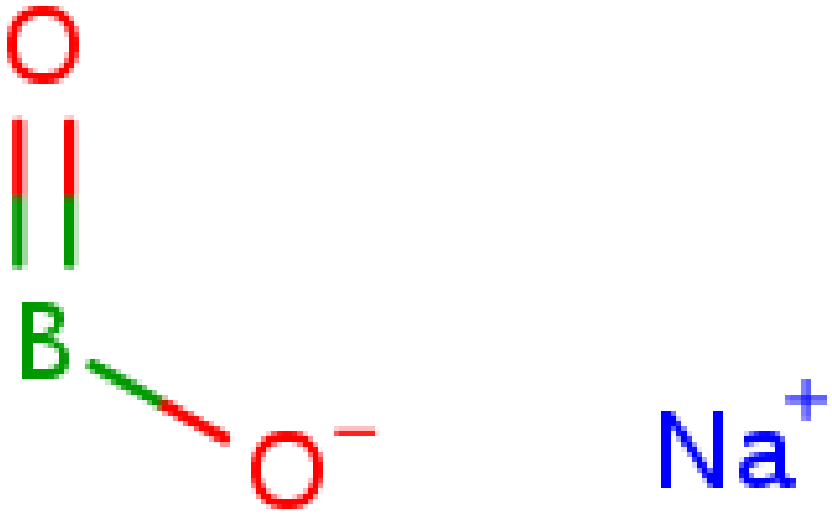
Chemical Identities

Chemical Name in the Inventory and Synonyms	**Boron sodium oxide (B4Na2O7)** boron sodium oxide (B4Na2O7) sodium borate disodium tetraborate sodium borate anhydrous disodium tetraborate, anhydrous
CAS Number	1330-43-4
Structural Formula	
Molecular Formula	B4Na2O7
Molecular Weight	201.22

Chemical Name in the Inventory and Synonyms	**Boric acid (H2B4O7), dipotassium salt** dipotassium tetraborate

	boron potassium oxide (B4K2O7) potassium tetraborate potassium borate dipotassium tetraborate
CAS Number	1332-77-0
Structural Formula	
Molecular Formula	B4K2O7
Molecular Weight	313.4

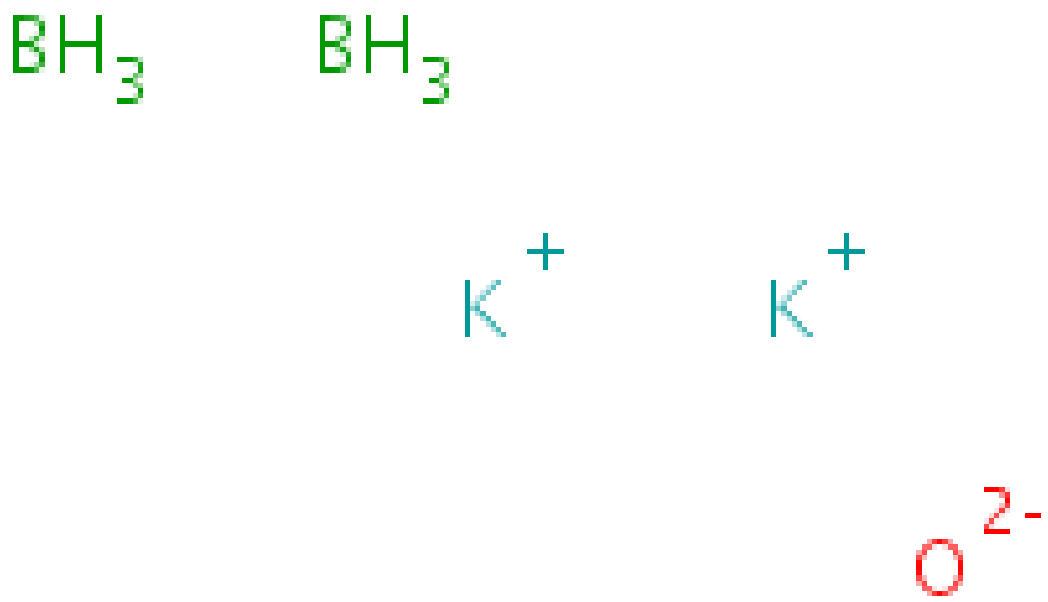
Chemical Name in the Inventory and Synonyms	**Boric acid (HBO2), sodium salt** sodium borate (HBO2Na) boric acid (HBO2), sodium salt
CAS Number	7775-19-1
Structural Formula	



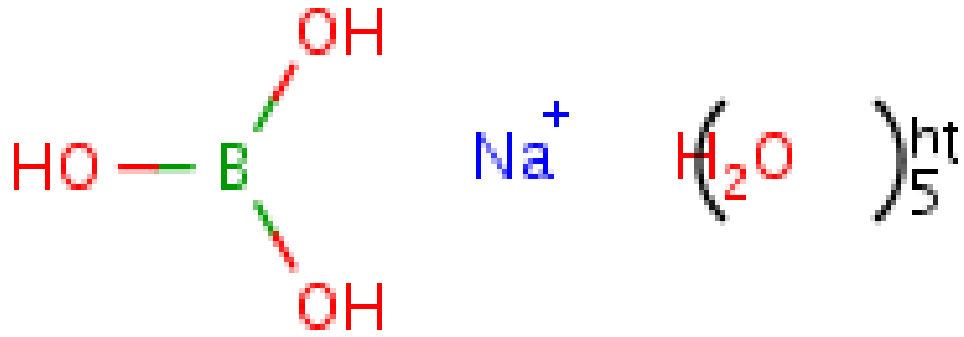
Molecular Formula	BHO2.Na
Molecular Weight	65.799

Chemical Name in the Inventory and Synonyms	**Boric acid (HBO2), sodium salt, tetrahydrate** sodium metaborate, tetrahydrate
CAS Number	10555-76-7
Structural Formula	**No Structural Diagram Available**

Molecular Formula	BHO2.4H2O.Na
Molecular Weight	137.86

Chemical Name in the Inventory and Synonyms	**Boron potassium oxide (B5KO8)** potassium pentaborate boric acid (HB5O8), potassium salt
CAS Number	11128-29-3
Structural Formula	
Molecular Formula	B5KO8
Molecular Weight	121.9

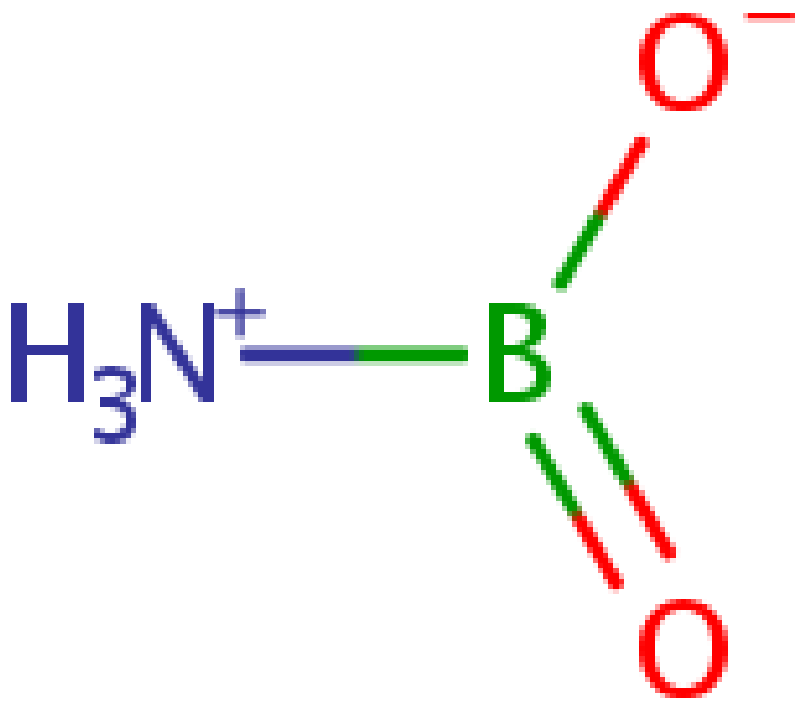
Chemical Name in the Inventory and Synonyms	**Boric acid, sodium salt, pentahydrate** sodium borate, pentahydrate
CAS Number	11130-12-4
Structural Formula	

	
Molecular Formula	Unspecified
Molecular Weight	174.9

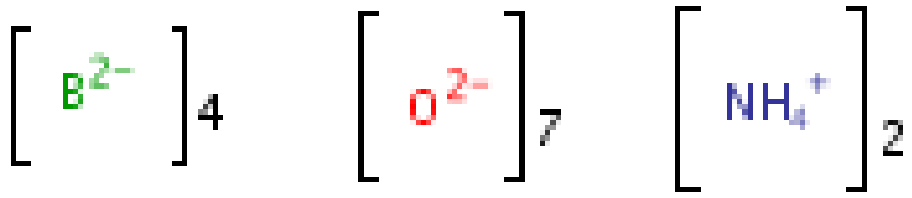
Chemical Name in the Inventory and Synonyms	**Boric acid, (H2B4O7), calcium salt (1:1)** boron calcium oxide, B4CaO7 calcium tetraborate
CAS Number	12007-56-6
Structural Formula	

	
Molecular Formula	B4CaO7
Molecular Weight	237.85

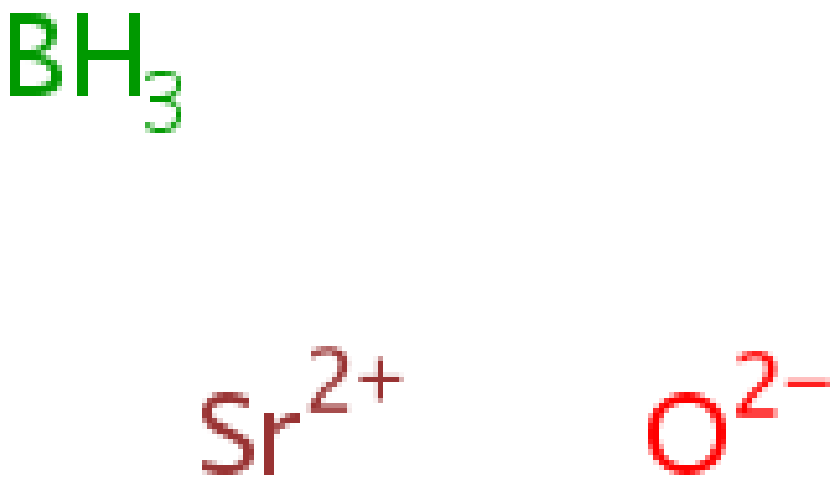
Chemical Name in the Inventory and Synonyms	**Ammonium boron hydroxide oxide ((NH4)B4(OH)O6)** boric acid (H2B4O7), monoammonium salt ammonium hydrogentetraborate ammonium boron hydroxide oxide ((NH4)B4(OH)O6)
CAS Number	12007-57-7
Structural Formula	

	
Molecular Formula	B.H4N.HO.O
Molecular Weight	59.8397

Chemical Name in the Inventory and Synonyms	**Ammonium boron oxide ((NH4)2B4O7)** boric acid (H2B4O7), diammonium salt diammonium tetraborate ammonium boron oxide ((NH4)2B4O7)
CAS Number	12007-58-8
Structural Formula	

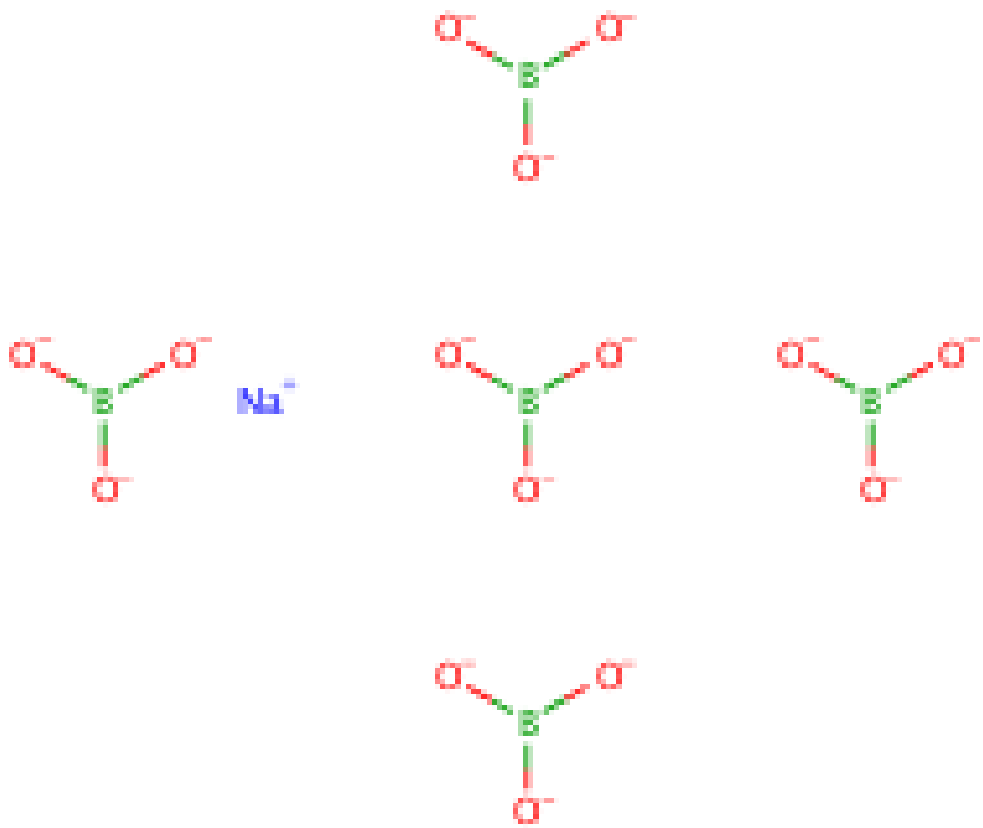
	
Molecular Formula	B4H8N2O7
Molecular Weight	191.3142

Chemical Name in the Inventory and Synonyms	**Boron strontium oxide (B4SrO7)** strontium tetraborate
CAS Number	12007-66-8
Structural Formula	

	
Molecular Formula	B.O.Sr
Molecular Weight	117.454

Chemical Name in the Inventory and Synonyms	**Ammonium boron oxide ((NH4)B5O8)** diammonium decaborate boric acid, (HB5O8), ammonium salt ammonium pentaborate (NH4B5O8) ammonium borate (NH4B5O8)
CAS Number	12007-89-5
Structural Formula	**No Structural Diagram Available**

Molecular Formula	B.H4N.O
Molecular Weight	312.1

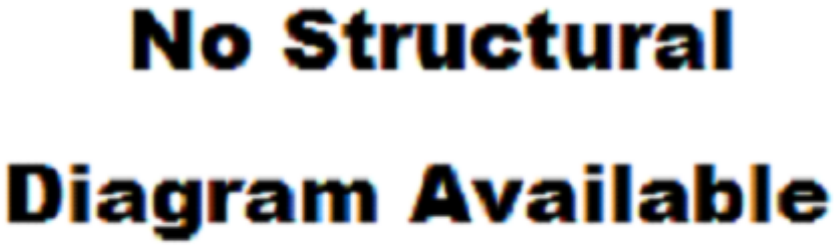
Chemical Name in the Inventory and Synonyms	**Boric acid (HB5O8), sodium salt** boron sodium oxide (B5NaO8)
CAS Number	12007-92-0
Structural Formula	
Molecular Formula	B5NaO8
Molecular Weight	317.03

Chemical Name in the Inventory and Synonyms	**Boric acid, (H2B8O13), disodium salt** boron sodium oxide (B8Na2O13) disodium octaborate disodium octaborate tetrahydrate
CAS Number	12008-41-2
Structural Formula	

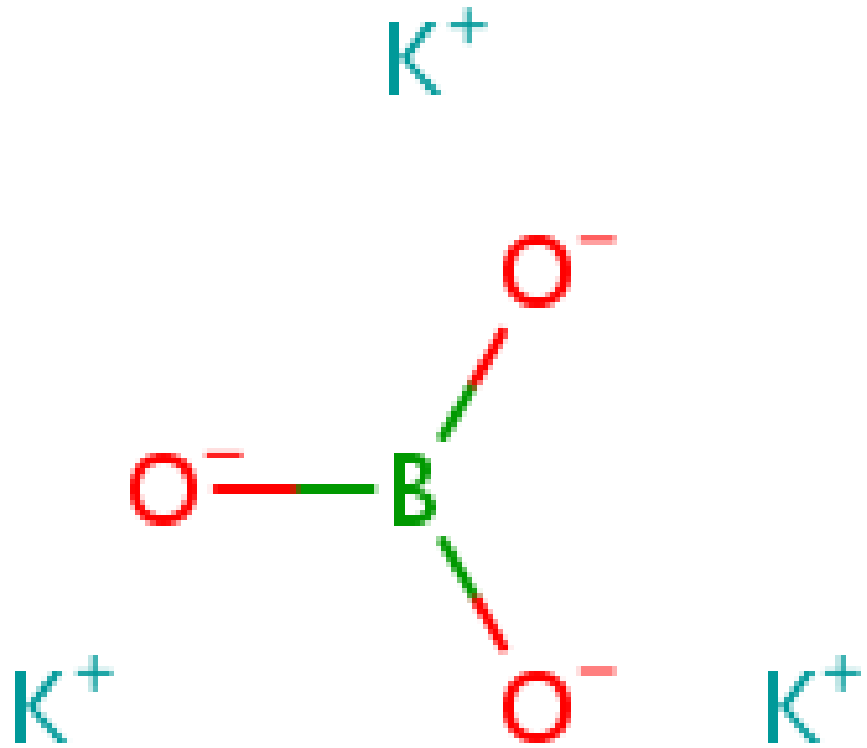
	No Structural Diagram Available
Molecular Formula	B8Na2O13
Molecular Weight	516.5

Chemical Name in the Inventory and Synonyms	**Boron potassium oxide(B4K2O7), tetrahydrate** boric acid (H2B4O7), dipotassium salt, tetrahydrate potassium tetraborate tetrahydrate
CAS Number	12045-78-2
Structural Formula	

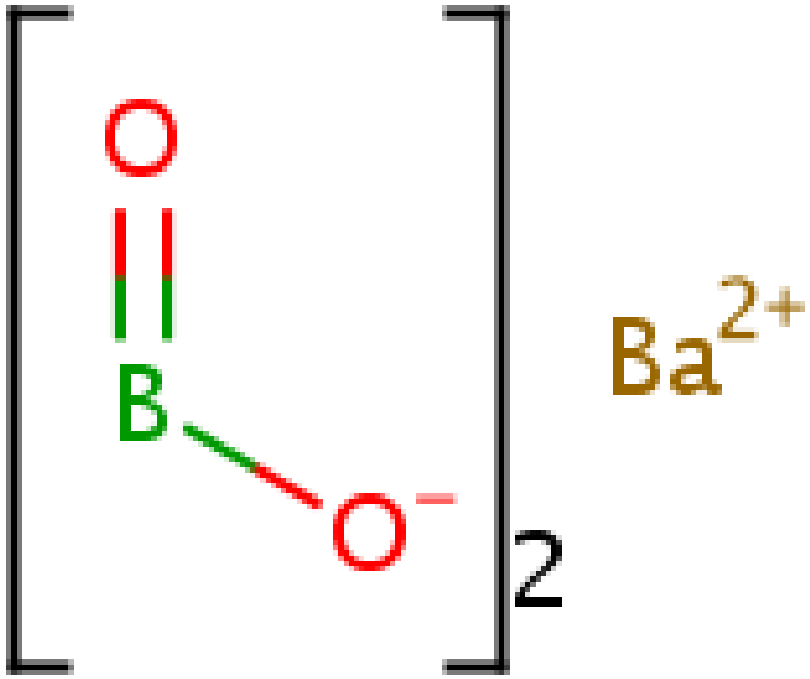
Molecular Formula	B4K2O7.4H2O
Molecular Weight	305.4922

Chemical Name in the Inventory and Synonyms	**Boron sodium oxide (B4Na2O7), hydrate (1:?)** tetraboron disodium heptaoxide, hydrate boric acid (H2B4O7), disodium salt, hydrate
CAS Number	12267-73-1
Structural Formula	
Molecular Formula	B4Na2O7.xH2O
Molecular Weight	219.2

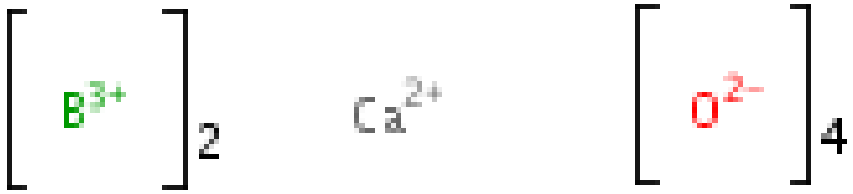
Chemical Name in the Inventory and Synonyms	**Boric acid, potassium salt** potassium borate
CAS Number	12712-38-8
Structural Formula	

	
Molecular Formula	Unspecified
Molecular Weight	176.102

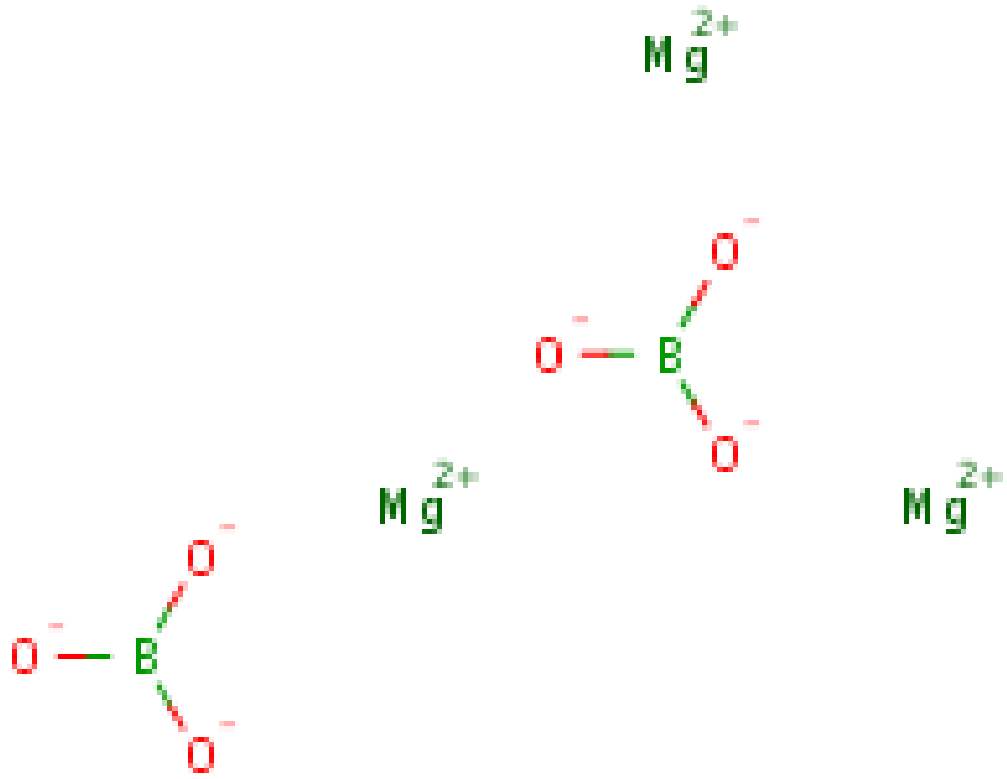
Chemical Name in the Inventory and Synonyms	**Boric acid (HBO2), barium salt** barium metaborate
CAS Number	13701-59-2
Structural Formula	

	
Molecular Formula	BHO2.1/2Ba
Molecular Weight	222.948

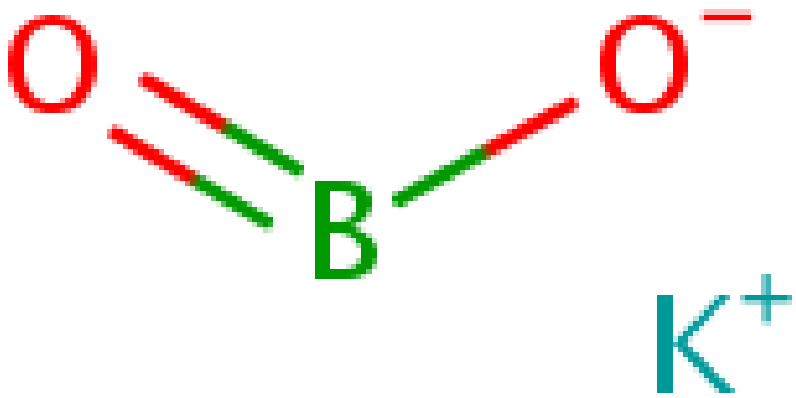
Chemical Name in the Inventory and Synonyms	**Boric acid (HBO2), calcium salt** diboron calcium tetraoxide
CAS Number	13701-64-9
Structural Formula	

	
Molecular Formula	BHO2.1/2Ca
Molecular Weight	125.696

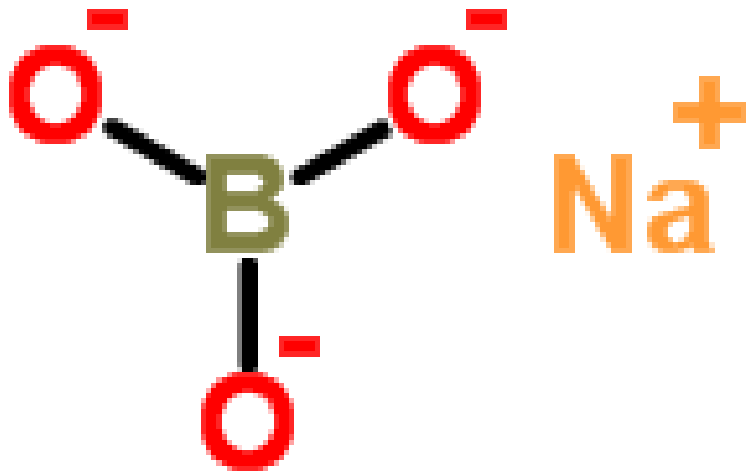
Chemical Name in the Inventory and Synonyms	**Boric acid (HBO2), magnesium salt** magnesium borate magnesium metaborate
CAS Number	13703-82-7
Structural Formula	

	
Molecular Formula	BHO2.1/2Mg
Molecular Weight	190.53

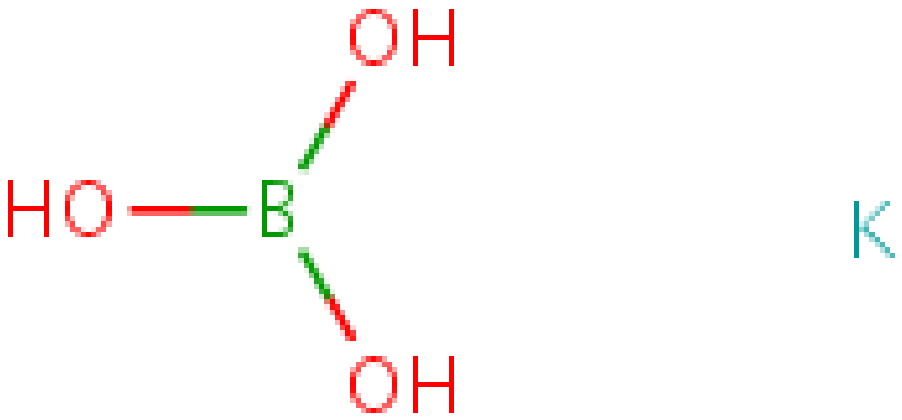
Chemical Name in the Inventory and Synonyms	**Boric acid (HBO2), potassium salt** potassium metaborate
CAS Number	13709-94-9
Structural Formula	

	
Molecular Formula	BHO2.K
Molecular Weight	81.907

Chemical Name in the Inventory and Synonyms	**Boric acid (H3BO3), sodium salt** orthoboric acid, sodium salt
CAS Number	13840-56-7
Structural Formula	

	
Molecular Formula	BH3O3.xNa
Molecular Weight	81.8

Chemical Name in the Inventory and Synonyms	**Boric acid (H3BO3), potassium salt**
CAS Number	20786-60-1
Structural Formula	

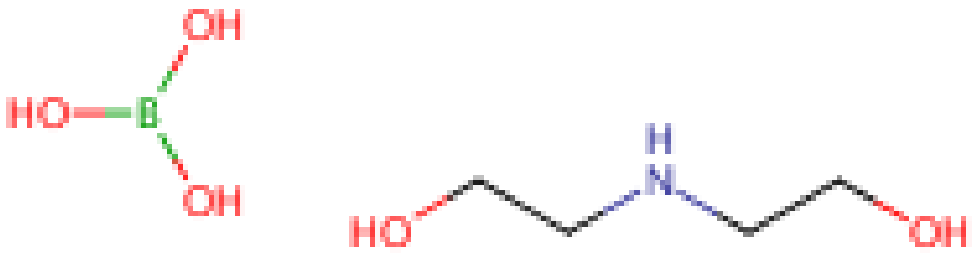
	
Molecular Formula	BH3O3.xK
Molecular Weight	100.93

Chemical Name in the Inventory and Synonyms	**Boric acid (H3BO3), compound with 2-aminoethanol** monoethanolamine, boric acid salt
CAS Number	26038-87-9
Structural Formula	**No Structural Diagram Available**

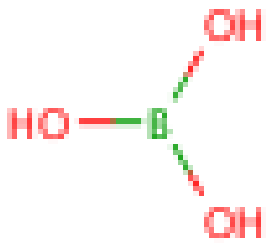
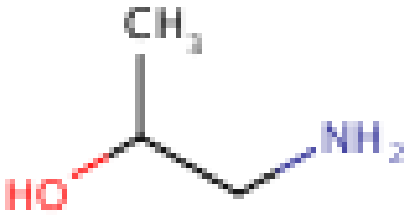
Molecular Formula	C2H7NO.xBH3O3
Molecular Weight	

Chemical Name in the Inventory and Synonyms	**2-Propanol, 1-amino-, compound with boric acid (H3BO3)** boric acid, monoisopropanolamine salt 1-aminopropan-2-ol, compound with orthoboric acid orthoboric acid isopropanolamine salt boric acid (H3BO3), compound with 1-amino-2-propanol
CAS Number	26038-90-4
Structural Formula	
Molecular Formula	C3H9NO.xBH3O3
Molecular Weight	

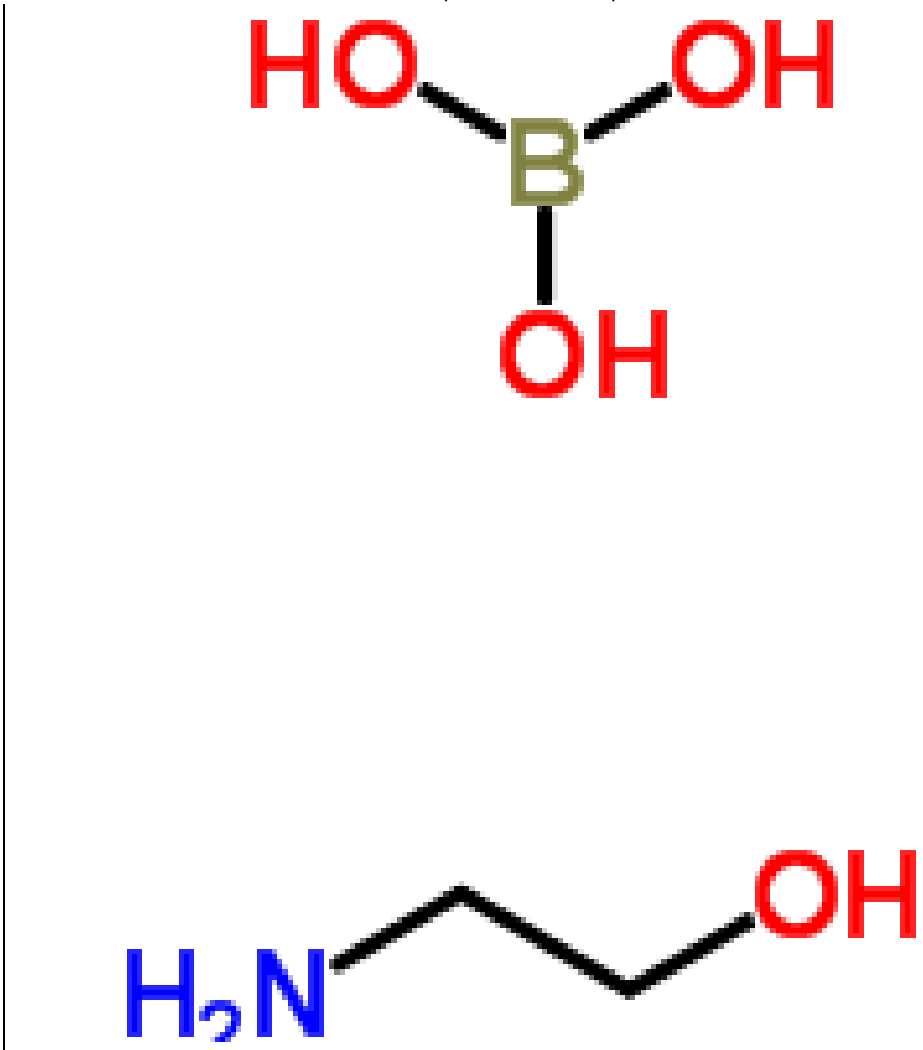
Chemical Name in the Inventory and Synonyms	**Boric acid (H3BO3), compound with 2,2'-iminobis[ethanol]** boric acid, diethanolamine salt diethanolamine borate
CAS Number	67952-33-4
Structural Formula	

	
Molecular Formula	C4H11NO2.xBH3O3
Molecular Weight	166.968

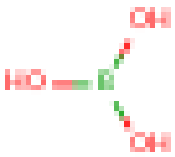
Chemical Name in the Inventory and Synonyms	**Boric acid (H3BO3), compound with 1-amino-2-propanol (1:1)** 2-hydroxypropylammonium orthoborate
CAS Number	68003-13-4
Structural Formula	

	 
Molecular Formula	C3H9NO.BH3O3
Molecular Weight	136.942

Chemical Name in the Inventory and Synonyms	**Boric acid (H3BO3), compound with 2-aminoethanol (1:1)** boric acid, monoethanolamine salt (1:1) (2-hydroxyethyl)ammonium dihydrogen orthoborate MEA borate
CAS Number	68586-07-2
Structural Formula	

	
Molecular Formula	C2H7NO.BH3O3
Molecular Weight	122.9

Chemical Name in the Inventory and Synonyms	**Boric acid (H3BO3), compound with 2-aminoethanol (1:3)** boric acid, monoethanolamine salt (1:3)
CAS Number	68797-44-4
Structural Formula	

	 
Molecular Formula	C2H7NO.1/3BH3O3
Molecular Weight	245.082

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