SAFER CONSUMER PRODUCTS

CALIFORNIA DEPARTMENT OF TOXIC SUBSTANCES CONTROL

Technical Document for the Proposal to Add Certain Acids and Bases to the Candidate Chemicals List

April 16, 2025

Prepared by

Department of Toxic Substances Control

Safer Consumer Products Program

California Environmental Protection Agency

Department of Toxic Substances Control

CalEPA California Environmental Protection Agency

TABLE OF CONTENTS

1. EXECUTIVE SUMMARY

The Department of Toxic Substances Control (DTSC) proposes to add a list 12 acids and bases to its Candidate Chemicals List. This proposal is based on findings that there is potential for exposure to these chemicals from consumer products and that these exposures may contribute to or cause significant or widespread adverse impacts, both to humans and to environmental organisms. We have determined that Californians may be exposed to these acids and bases found in some personal care and cleaning products. Sensitive subpopulations such as workers and young children may be especially vulnerable to these impacts. This document explains the rationale for this proposal.

Manufacturers adjust the acidity or alkalinity of their products for a variety of purposes, and they can add a wide range of acids or bases to do so. For example, sodium hydroxide, also known as lye, is a corrosive chemical used in hair straightening products to break hair's disulfide bonds. While sodium hydroxide is already a Candidate Chemical, other bases, such as lithium hydroxide, that may be used for similar functions and that exhibit similar hazards are not. Similarly, there are many acids, such as chromic acid, that are not currently on DTSC's Candidate Chemicals List that are added to consumer products and may harm people using these products, as well as bystanders.

We have identified 12 acids and bases that have the potential to cause adverse impacts but are not yet on our Candidate Chemicals List. Exposure to these chemicals can cause a range of adverse impacts to the skin, respiratory tract, digestive tract, and eyes. Based on these findings, we propose adding these 12 acids and bases—potassium hydroxide, lithium hydroxide, calcium hydroxide, ammonium hydroxide, ammonium thioglycolate, guanidine carbonate, ammonium bisulfite, sodium hypochlorite, and ethanolamine, chromic acid, sulfamic acid, and oxalic acid — to DTSC's Candidate Chemicals List.

Listing a chemical or chemical class as a Candidate Chemical does not place regulatory obligations on chemical or product manufacturers that use it. However, it does give DTSC the option of regulating the chemical or class in specific consumer products in the future, based on certain findings. Under the Safer Consumer Products Regulations, DTSC may list a consumer product containing one or more Candidate Chemicals as a Priority Product if it finds evidence for potential exposures to the Candidate Chemical(s) in the product and potential significant or widespread adverse impacts from those exposures. Priority Product manufacturers have several options for complying with such a regulation, including evaluating whether there are safer alternatives to the Chemical(s) of Concern in their product.

2. CHEMICAL DEFINITIONS

DTSC proposes to add 12 acids and bases to the Candidate Chemicals List (Table 1). These chemicals are either currently used as ingredients in personal care and cleaning products or are potentially regrettable substitutes to current ingredients.

Table 1. Identifiers of chemicals proposed to be added to the Candidate Chemicals List.

Chemical Name	Chemical Formula	IUPAC Name	CAS Number	EC Number	Synonyms	Ref.
Potassium hydroxide	KOH or HKO	Potassium hydroxide	1310-58-3	215-181-3	Potash; potash lye; potassium hydrate	NIH (2024a)
Lithium hydroxide	LiOH or HLiO	Lithium hydroxide	1310-65-2	215-183-4	lithium hydrate; lithium hydroxide anhydrous; lithiumhydroxid	NIH (2024b)
Calcium hydroxide	$Ca(OH)_2$ or CaH_2O_2	Calcium dihydroxide	1305-62-0	215-137-3	slake lime; hydrated lime; lime hydrate; lime water; hydralime; carboxide	NIH (2024c)
Ammonium hydroxide	H_5NO or NH_4OH	Ammonium hydroxide	1336-21-6	215-647-6	Ammonia aqueous; ammonia water; aquammonia; aqua ammonia; household ammonia; ammoniumhydro -xid	NIH (2024d), U.S. EPA (2024a)
Ammonium thioglycolate	$C_2H_4O_2SH_3N$ or $C_2H_7NO_2S$	Ammonium sulfanylace-tate	5421-46-5	226-540-9	ammonium mercaptoacetate; thioglycolic acid ammonium salt; ammonium 2-mercaptoacetate	NIH (2024e), U.S. EPA (2024b)
Guanidine carbonate	$C_3H_{12}N_6O_3$	Carbonic acid guanidine	593-85-1	209-813-7	guanidine carbonate salt; bisguanidinium carbonate;	NIH (2024f)

Chemical Name	Chemical Formula	IUPAC Name	CAS Number	EC Number	Synonyms	Ref.
					diguanidinium carbonate; guanidinium carbonate	
Ammonium bisulfite	$H_3N.H_2O_3S$ or NH_4HSO_3 or H_5NO_3S	Ammonium hydrogen sulfite	10192-30-0	233-469-7	Ammonium hydrogen sulfite; azanium hydrogen sulfite; monoammonium sulfite; ammonium acid sulfite	NIH (2024h), U.S. EPA (2024c)
Sodium hypochlorite	NaClO or ClNaO	Sodium hypochlor-ite	7681-52-9	231-668-3	Chlorine base compound; Antiformin; Clorox; Household bleach; hypochlorous acid, sodium salt	NIH (2024h), U.S. EPA (2024d)
Ethanolamine	C_2H_7NO or $H_2NCH_2CH_2OH$	2-aminoethan-1-ol	141-43-5	205-483-3	Monoethanol-amine; 2-aminoethanol; 2-Hydroxyethyla-mine	NIH (2024i)
Chromic acid	CrH_2O_4	Dihydroxido-[bis(oxido)]-chromium	7738-94-5	231-801-5	Chromic(VI) acid; dihydroxy(di-oxo)chromium; Acide chromique	NIH (2024j), U.S. EPA (2024e)
Sulfamic acid	H_3NO_3S or HSO_3NH_2 or NH_2SO_3H	Sulfamic acid	5329-14-6	226-218-8	Amidosulfonic acid; Sulphamic acid; Aminosulfonic acid; Amidosulfuric acid; Imidosulfonic acid	NIH (2024k)
Oxalic acid	$C_2H_2O_4$ or $(COOH)_2$	Oxalic acid	144-62-7	205-634-3	Ethanedic acid; Aktisal; Aquisal	NIH(2024l)

3. POTENTIAL FOR ADVERSE IMPACTS

3.1. Hazard Traits, Toxicological and Environmental Endpoints That Are the Basis for This Listing

Reference: California Code of Regulations, title 22, section 69502.2(b)(1)

The hazard traits and environmental or toxicological endpoints summarized in this section are defined in the SCP Regulations section 69501.1, subdivisions (a)(36) and (a)(33), respectively, both of which refer to the Office of Environmental Health Hazard Assessment's Green Chemistry Hazard Trait Regulations (California Code of Regulations, title 22, chapter 54). These include exposure potential and toxicological and environmental hazard traits.

Based on current evidence, acids and bases, as listed in Table 1, all have hazard traits associated with dermatotoxicity or ocular toxicity. In addition, some of the 12 acids and bases have other hazard traits including respiratory toxicity, carcinogenicity, neurotoxicity, systemic toxicity, developmental toxicity, reproductive toxicity, genotoxicity, endocrine disruption, and aquatic toxicity. Acids and bases that will completely ionize when dissolved in water are most likely to be corrosive, causing serious tissue damage by destroying cellular structure. Corrosivity is a hazard trait most associated with reactivity in biological systems, which can also fall under other organ or tissue specific hazard traits such as dermatotoxicity or respiratory toxicity (California Code of Regulations, tit. 22, § 69403.15).

We used the U.S. Environmental Protection Agency (EPA)'s Hazard Comparison Dashboard (HCD) to generate preliminary hazard estimates for the four acids and eight bases listed above (Table 2). The HCD aggregates chemical hazard information from multiple publicly available sites, databases, and sources, including U.S. federal and state sources and international bodies (Vegosen and Martin 2020). The HCD implements a tailored approach based on the GreenScreen® method and organizes data sources into authoritative or screening sources. Authoritative sources have a higher level of confidence because they are "generated by recognized experts, often as part of a government regulatory process to identify chemicals and known associated hazards" (Clean Production Action 2018; Vegosen and Martin 2020). Predictive source lists are from quantitative structure-activity relationship (QSAR) model estimates that are integrated into the HCD to fill data gaps (Vegosen and Martin 2020). A single hazard score for each endpoint of concern is based on a trumping scheme where the most conservative value (very high [vH] > high [H] > medium [M] > low [L]) from the most authoritative score determines the final score (Vegosen and Martin 2020). Hazard endpoint definitions and score criteria are based primarily on the Globally Harmonized System of Classification and Labelling of Chemicals (GHS) (Vegosen and Martin 2020). These hazard scores provided are estimates and should not be regarded as final hazard determinations (Vegosen and Martin 2020).

Table 2. Summary of selected hazard score outputs from the HCD. These scores are based on empirical or modeled data (U.S. EPA 2024f). Key: Low (L), Moderate (M), High (H), Very High (vH)

Chemicals	Inhalation Acute Mammalian Toxicity	Dermal Acute Mammalian Toxicity	Skin Sensit-ization	Skin Irritation	Eye Irritation	Acute Aquatic Toxicity	Chronic Aquatic Toxicity
Potassium hydroxide	-	-	-	vH	vH	L	L
Lithium hydroxide	vH	L	-	vH	vH	H	M
Calcium hydroxide	-	-	-	vH	vH	L	L
Ammonium hydroxide	-	-	-	vH	vH	vH	vH
Ammonium thioglycolate	vH	H	H	H	H	M	-
Guanidine carbonate	-	L	-	H	H	M	M
Ammonium bisulfite	L	L	-	vH	vH	H	-
Sodium hypochlorite	L	L	L	vH	vH	vH	vH
Ethanolamine	M	M	H	vH	vH	L	M
Chromic acid	vH	vH	H	vH	vH	M	vH
Sulfamic acid	L	L	-	H	H	M	M
Oxalic acid	M	M	-	vH	vH	L	-

Hazard Traits of the Specified Acids and Bases

Potassium Hydroxide

Potassium hydroxide is corrosive and irritating to both the skin and eyes (ECHA 2024a). The European Chemicals Agency (ECHA) categorizes potassium hydroxide as corrosive under the Globally Harmonized System Globally Harmonized System of Classification and Labelling of Chemicals (GHS), "H314: Causes severe skin burns and eye damage" (ECHA 2024a). At concentrations between about 0.5% to 2.0%, potassium hydroxide is considered to be an irritant, and at 2.0% it is characterized as corrosive (CIR 2021; ECHA 2024a).

Dermal exposure to potassium hydroxide has shown evidence of adverse effects in animal and human studies. A 1977 *in vivo* skin irritation study by Vernot et al. used the Draize test,[1] exposing rabbits to 1% and 2% potassium hydroxide for four hours. The chemical was applied on exposed skin on the back and

[1] *A standardized acute toxicity procedure that is used to test for ocular or dermal irritation in rabbits by assigning a score to the observed damage after exposure to a chemical or substance.*

side of the animal (ECHA 2024a). No corrosivity was observed at 1% potassium hydroxide, but at 2% potassium hydroxide was classified as a corrosive based on two out of the six rabbits experiencing severe skin damage (ECHA 2024a). Another skin irritation study classified potassium hydroxide as a corrosive in treated human skin cultures (Epidermal model and Skin²ZS1301 model) to 10% potassium hydroxide for two hours (ECHA 2024a). A study that treated reconstructed human epidermis to 5% potassium hydroxide observed skin irritation after 15 minutes, and corrosivity after one hour (El Ghalbzouri et al. 2008; ECHA 2024a).

Ocular exposure to potassium hydroxide has shown evidence of adverse effects in animal studies. An eye irritation study conducted in rabbits following the Organization of Economic Co-operation and Development (OECD) guideline 405 found that potassium hydroxide irritates or causes corrosivity in the eyes after either 5 minutes or 24-hours in a dose dependent manner (Johnson, Lewis and Wagner 1975; ECHA 2024a).

There is strong evidence from authoritative agencies, screenings, and scientific literature that supports the irritating and corrosive nature and adverse effects of potassium hydroxide in skin and eyes. Potassium hydroxide merits inclusion on DTSC's Candidate Chemicals List based on potential for dermatotoxicity, ocular toxicity, and reactivity in biological systems.

Lithium Hydroxide

Lithium hydroxide is identified as a potential corrosive and irritant to the skin and eyes (ECHA 2024b).

An *in vitro* membrane barrier skin corrosion test following OECD guideline 435 found that lithium hydroxide was corrosive in less than 30 minutes (concentration not specified) (ECHA 2024b).

Inhalation exposure to lithium hydroxide has shown sufficient evidence to support adverse effects in animal studies. A four-hour acute inhalation study following OECD guideline 403 conducted in rats (nose-only) resulted in an LC_{50} greater than 3.4 mg/L (3,400 mg/m³ air). Severe necrosis of the snout and other clinical signs such as alopecia (hair loss), decreased locomotion, diarrhea, oral discharge, squinting eyes, and swollen snout were some of the effects observed (ECHA 2024b).

Exposure to lithium hydroxide has shown sufficient evidence to support adverse effects in aquatic animal studies. A short term toxicity study following OECD test guideline 203 exposed zebrafish (age not specified) for 96 hours to 12.5 mg/L, 25 mg/L, 50 mg/L, 100 mg/L and 200 mg/L of lithium hydroxide in a 20 L fish tank (ECHA 2024b). The study determined an LC_{50} of 62.2 mg/L (ECHA 2024b). In a 48-hour short term toxicity study following OECD guideline 202 exposed *Daphnia magna* to 4.6 mg/L, 10 mg/L, 21 mg/L, 46 mg/L and 100 mg/L lithium hydroxide under static conditions with and without a pH adjustment of eight (ECHA 2024b). By observing the mobility of the *Daphnia magna* post

exposure, the calculated EC_{50}-value[2] with the pH adjustment was 60.1 mg/L, and without the pH adjustment the EC_{50} was 33.5 mg/L, parallel to the LC_{50} values of 60.1 mg/L and 34.3 mg/L, respectively (ECHA 2024b).

There is strong evidence from authoritative agencies and scientific literature that supports the corrosive nature and adverse effects of lithium hydroxide to the skin, eyes, and respiratory tract. In addition to its aquatic toxicity, lithium hydroxide exhibits dermatotoxicity, ocular toxicity, reactivity in biological systems, respiratory toxicity, and wildlife survival impairment, which merits inclusion on DTSC's Candidate Chemicals List.

Calcium Hydroxide

Calcium hydroxide is an irritant to the skin and eyes and can cause skin burns (NIOSH 2019a).

Dermal exposure to calcium hydroxide has shown evidence of adverse effects in animal and human studies. An acute dermal irritation or corrosion study following OECD guideline 404 treated the skin of rabbits to 0.5 g of calcium hydroxide in putty form (60% water, 40% calcium hydroxide) in a gauze patch (2.5 X 2.5 cm) for three minutes, one hour, and four hours initially, followed by a confirmatory 4-hour test. The study observed swelling and redness in all the treated animals, classifying calcium hydroxide as an irritant but not as a corrosive (ECHA 2024c). Another study treated rabbits with 2.5 g/kg bodyweight of calcium hydroxide on a semi-occluded patch for 24-hours, resulting in an $LD_{50} > 2.5$ g/kg bodyweight (CIR 2021; ECHA 2024c). A case study of a worker exposed to wet cement that contained calcium hydroxide for several hours resulted in skin corrosion and irritation (Rados 2005; ECHA 2024c). No skin sensitization data was available for animals or humans (ECHA 2024c).

Ocular exposure to calcium hydroxide has shown evidence of adverse effects in animal and human studies. Calcium hydroxide was observed to be an eye irritant in an *in vitro* eye irritation test exposing chicken eggs (Chorion-Allantois membrane) to 250 mg calcium hydroxide for 15 minutes (ECHA 2024c). Another study dosed the eyes of rabbits with 10% calcium hydroxide (pH=9) for one hour and observed serious eye lesions and irreversible effects, classifying calcium hydroxide as an eye irritant (CIR 2021; ECHA 2024c). In a human case report, a child accidently exposed to calcium hydroxide experienced corneal alkali burns and eye irritation (Schmidt et al. 2008; ECHA 2024c).

---

[2] *EC_{50}-value: effective concentration 50 value; the concentration of a bioactive chemical that induces a response halfway between the baseline and maximum response after exposure.*

There is strong evidence from authoritative agencies and scientific literature that supports the corrosive nature and adverse effects of calcium hydroxide. Calcium hydroxide merits inclusion on DTSC's Candidate Chemicals List, based on dermatotoxicity and ocular toxicity.

Ammonium Hydroxide

Ammonium hydroxide is an irritant to the skin and eyes and can cause skin burns (ECHA 2024d). Under GHS, ammonium hydroxide has been assigned the hazard phrases "H314: Causes severe skin burns and eye damage", and "H400: Very toxic to aquatic life" (ECHA 2024d).

Ammonium hydroxide vapors may cause laryngeal oedema, inflammation of the respiratory tract, and pneumonia when inhaled at a high concentration (IPCS 2018). Animals exposed to about 57.43 ppm ammonium hydroxide for 114 days experienced no mortalities or signs of toxicity (Coon et al. 1970; CIR 2018), while 13 of 515 rats and 4 of 15 guinea pigs exposed to 671 ppm ammonium hydroxide for 90 days died (OECD 2008; CIR 2018).

Dermal exposure to ammonium hydroxide has shown evidence of adverse effects in animal and human studies. Rabbits exposed dermally to 10% and 20% ammonium hydroxide showed skin corrosion at the 20% concentration (OECD 2008; CIR 2018). Another study exposed rabbits to 10% and 12% ammonium hydroxide for four hours, resulting in skin corrosion at 12% but not at 10% solution (CIR 2018; ECHA 2024e). An *in vitro* skin irritation study exposed reconstructed human skin culture to undiluted ammonium hydroxide (30% active material in neat substance), which showed histologic evidence of epidermal necrosis classifying ammonium hydroxide as corrosive (Perkins, Osborne and Johnson 1996; CIR 2018). A study that exposed adult volunteers to 50% solution of ammonium hydroxide observed mild discomfort and tiny blisters. The solution was applied dermally in 30-minute intervals (Grove, Duncan and Kligman 1982; CIR 2018).

Ocular exposure to ammonium hydroxide has shown evidence of adverse effects in animal and human studies. The Draize test was performed in rabbits exposing the eye to 0.3%, 1%, 2.5%, 3%, and 10% ammonium hydroxide. Conjunctivitis (inflammation of the conjunctiva), and other signs of ocular irritation were observed at 1% to 10% ammonium hydroxide (Murphy et al. 1982; CIR 2018). An *in vitro* skin irritation study incubated human corneal endothelial cell cultures in ammonium hydroxide and observed severe ocular irritation having an ED_{50} of 3.9×10^{-3} M (Goldberg 1983; CIR 2018).

There is sufficient evidence from authoritative agencies and scientific literature that supports the corrosive nature and adverse effects of ammonium hydroxide. Ammonium hydroxide merits inclusion on DTSC's Candidate Chemicals List, based on its dermatotoxicity, ocular toxicity, respiratory toxicity, and reactivity in biological systems.

Ammonium Thioglycolate

Ammonium thioglycolate is identified as a potential skin and eye irritant, is a skin sensitizer, and is harmful to aquatic life (ECHA 2024f).

There is limited dermatotoxicity data available for exposure to ammonium thioglycolate in humans and experimental animals. An acute dermal irritation study, which followed OECD guideline 404, exposed rabbits to 71.5% ammonium thioglycolate on a semi-occlusive dressing for a duration of four hours, resulting in slight irritation (ECHA 2024f). In a skin sensitization study, a total of 240 volunteers were treated with 14.4% ammonium thioglycolate in repeated insult patch tests.[3] A total of 20 volunteers withdrew from the study for reasons unrelated to the treatment. Volunteers were initially treated with ammonium thioglycolate in a semi-occlusive patch for 24 hours, alternating exposure days for a week, followed by 48 hours of non-treatment (ECHA 2024f). The test procedure was repeated for a total of nine applications. Of 220 volunteers, 12 experienced reactions during initial exposure and seven experienced reactions after repeated exposure (ECHA 2024f). Two other repeated insult patch tests exposed volunteers to 18% ammonium thioglycolate, resulting in very mild to moderate skin irritation in 27% and 47% of volunteers; between both studies only one volunteer experience moderate-grade induced allergic contact dermatitis (ECHA 2024f).

In animal studies, ocular exposure to ammonium thioglycolate has shown evidence of adverse effects. Ocular irritation studies in rabbits treated with ammonium thioglycolate (concentrations ranging from 5% to 17%) in permanent waving solutions and lotions found varying results, from moderate ocular irritation at 5.8%, 7.0%, 7.2%, 8.3%, and 17.5% of ammonium thioglycolate, to no ocular irritation at 5%, 7%, 7.1%, and 10.98% of ammonium thioglycolate [Consumer Product Testing Company, Inc; Applied Biological Laboratories, Inc; Bio-Technics Laboratories, Inc; Hill Top Testing Services, Inc; and Micro-Bio Testing and Research Laboratories, Inc as reviewed in (CIR 2009)]. Although the severity of ocular irritation does not appear to be dependent on concentration, these studies used solutions and lotions that were a mixture of chemicals, having potential for cross reactions. An acute eye irritation study following OECD guideline 405 exposed rabbits to 71% solution of ammonium thioglycolate for 72 hours and observed very slight to moderate conjunctival reactions, including chemosis, redness, and purulent (pus) discharge (ECHA 2024f).

There is limited inhalation toxicity data available for exposure to ammonium thioglycolate. A screening from the Safe Work Australia's Hazardous Chemical Information System (HCIS), categorized ammonium thioglycolate as, "H335: May cause respiratory irritation", and "H330: Fatal if inhaled" (Safe Work

---

[3] *Repeat insult patch test: a 6-week clinical study conducted to evaluate a product's potential to cause irritation, sensitization or allergic reactions when applied to the skin.*

Australia 2021a). Sensitive populations, such as asthmatics, exposed to ammonium thioglycolate mist experienced difficulty breathing, uncontrollable coughs, pharyngeal irritation, blocked nasal passages and nasal drip (CIR 2009).

There is moderate evidence from authoritative agencies and in the scientific literature that supports the adverse effects of ammonium thioglycolate in both general and sensitive populations. Ammonium thioglycolate merits inclusion on DTSC's Candidate Chemicals List, based on its dermatotoxicity, ocular toxicity, and respiratory toxicity.

Guanidine Carbonate

Guanidine carbonate has been identified as a potential eye irritant that may cause serious eye damage (ECHA 2024g). The New Zealand EPA classifies guanidine carbonate as a "H315: Causes skin irritation"(New Zealand EPA 2024a).

Ocular exposure to guanidine carbonate has shown evidence of adverse effects in animal studies. In an eye irritation study following OECD guideline 405, a single dose of 0.1 mL of guanidine carbonate to the conjunctival sac of one eye in rabbits was administered and the animals were examined for up to 21 days after (ECHA 2024g). All animals showed signs of irreversible corneal alterations, in addition to redness, severe swelling, and mucopurulent ocular discharge (ECHA 2024g).

An OECD guideline approved skin irritation study in rabbits, and a skin sensitization study in guinea pig both showed no evidence or signs of irritation, sensitization, or general toxicity to the skin (ECHA 2024g).

Although data are limited, there is sufficient evidence from authoritative agencies that support the adverse effects of guanidine carbonate. Guanidine carbonate merits inclusion on DTSC's Candidate Chemicals List, based on its ocular toxicity.

Ammonium Bisulfite

Ammonium bisulfite is a potential eye irritant, and may be a skin sensitizer in humans (ECHA 2024h). The New Zealand EPA classifications of ammonium bisulfite are "H318: Causes serious eye damage", and "H314: Causes severe skin burns and eye damage" (New Zealand EPA 2024b).

There is limited toxicity data available for animal and human exposure to ammonium bisulfite. In a human case study, a woman who regularly dyed her hair for many years one day experienced itching of the scalp, which later developed into itching, redness, and inflammation of her cheeks and forehead (Nassif 2006; ECHA 2024h). Patch testing of 2% ammonium bisulfite, which was an ingredient in the hair dye, was identified as the cause of the skin sensitization (Nassif 2006; ECHA 2024h). However, skin irritation, skin sensitization, and eye irritation studies have not documented adverse effects in animals exposed to ammonium bisulfite (ECHA 2024h).

Although data are limited, there is still some evidence from authoritative agencies and scientific literature that supports the adverse effects of ammonium bisulfite. Ammonium bisulfite merits inclusion on DTSC's Candidate Chemicals List, based on its ocular toxicity and dermatotoxicity.

Sodium Hypochlorite

Sodium hypochlorite is irritating to the skin and eyes and may damage dermal tissue, causing skin burns. Under the GHS, sodium hypochlorite has been assigned the hazard phases "H314: Causes severe skin burns and eye damage", "H318: Causes serious eye damage", "H400: Very toxic to aquatic life", and "H410: Very toxic to aquatic life with long lasting effects" (ECHA 2024i).

Dermal exposure to sodium hypochlorite has shown evidence of adverse effects in animal studies. An *in vivo* skin irritation study following OECD guideline 404 exposed rabbits and guinea pigs dermally to 5.25% sodium hypochlorite for four hours, resulting in reversible redness and swelling (ECHA 2024i). Another *in vivo* skin irritation study exposed rabbits to 12.5% sodium hypochlorite for 24-hours with a 72-hour observation period (ECHA 2024i). All exposed animals experience redness and swelling that persisted throughout the 72 hours observation period (ECHA 2024i). An *in vivo* skin sensitization study following OECD guideline 406 repeatedly exposed guinea pigs to 40% sodium hypochlorite in a Buehler test, resulting in no signs of skin sensitization (ECHA 2024i).

Ocular exposure to sodium hypochlorite has shown evidence of adverse effects in animal studies. An acute eye irritation study following OECD guideline 405 exposed rabbits to 0.1 mL of sodium hypochlorite for 30 seconds, then rinsed the exposed eyes for 10 seconds, before beginning the observation period over several days (ECHA 2024i). The study reported ocular irritation in all exposed animals (ECHA 2024i). Another eye irritation study exposing monkeys and rabbits to 5.5% sodium hypochlorite observed signs of irritation in both species, with monkeys having a faster recovery post exposure compared to rabbits (ECHA 2024i).

Sodium hypochlorite is unstable in aqueous solutions and will rapidly undergo hydrolysis (ECHA 2024i). When evaluating the aquatic toxicity of sodium hypochlorite, the Predicted No-Effect Concentrations (PNECs) or safe exposure level is 0.0021 mg/L when exposed to algal biomass (Pratt et al. 1988; ECHA 2024i). Sodium hypochlorite is a proposed acute and chronic aquatic toxicant at concentrations greater than or equal to 2.5% (ECHA 2024i).

There is strong evidence from authoritative agencies and scientific literature that supports the adverse effects of sodium hypochlorite. Sodium hypochlorite merits inclusion on DTSC's Candidate Chemicals List, based on its dermatotoxicity and ocular toxicity.

Ethanolamine

Ethanolamine is corrosive and irritating to both skin and eyes. Under the GHS, ethanolamine is classified as a skin corrosive and has been assigned the hazard phrases "H314: Causes severe skin

burns and eye damage", "H312: Harmful in contact with skin","H332: Harmful if inhaled", and "H302: Harmful if swallowed" (ECHA 2024j; U.S. EPA 2024g).

Dermal exposure to ethanolamine has shown evidence of adverse effects in animal and human studies. A skin irritation or corrosion study following OECD guideline 404 exposed rabbits to an unspecified amount of ethanolamine for increments up to 20 hours, which resulted in necrosis on the exposed skin (ECHA 2024k). Another skin irritation study exposed rabbits to 20% ethanolamine in a water solution for four hours, resulting in severe damage to the skin, including necrosis (ECHA 2024k). Ethanolamine is not considered a skin sensitizer in animals; however, it may be a sensitizer or allergen to humans (Lessmann et al. 2009; ECHA 2024k). The Maximale Arbeitsplatz-Konzentration (MAK) commission, also known as the Permanent Senate Commission for the Investigation of Health Hazards of Chemical Compounds in the Work Area, has identified ethanolamine as a sensitizer to the skin (Publisso 2024). NITE cites a report of an occupational exposure to vapors from ethanolamine used as a corrosion inhibitor for metals over 1-3 years; allergic skin disease and eczema were reported in 104 exposed workers (NITE 2024).

Ocular exposure to ethanolamine has shown evidence of adverse effects in animal studies. An eye irritation study following OECD guideline 405 exposed rabbits to five or 50 µL of neat ethanolamine, with both doses resulting in severe eye damage, including corneal injury, iritis, bloody discharge, and necrosis (ECHA 2024k). Another study in rabbits exposed the eyes to a 20% solution of ethanolamine prior to immediately flushing the eyes with tap water (ECHA 2024k). This experiment resulted in moderate corneal opacity, swelling, and redness; however, all findings were reversible within four days post application (ECHA 2024k).

Inhalation exposure to ethanolamine in guinea pigs resulted in no adverse effects when observed for respiratory sensitization (ECHA 2024k). An occupational inhalation exposure of 8% ethanolamine vapors from detergent in hot water resulted in allergic responses of shortness of breath and asthma, in addition to irritation of the nose, throat, and lungs (Savonius et al. 1994; CIR 2015).

There is strong evidence from authoritative agencies and scientific literature that supports the corrosive nature and adverse effects of ethanolamine. Ethanolamine merits inclusion on DTSC's Candidate Chemicals List, based on its dermatotoxicity, ocular toxicity, and respiratory toxicity.

Chromic Acid

Authoritative listings indicate chromic acid is corrosive and irritating to skin and eyes, a sensitizer, and potential reproductive and developmental toxicant. Additionally, chromic acid is an aquatic toxicant. (Safe Work Australia 2021b; ECHA 2024l).

Most evidence for chromic acid's hazard traits is based on other substances that have similar chemical properties. Chromic acid, H_2CrO_4, is a collection of compounds generated by the acidification of

chromate and dichromate anions or the dissolving of chromium trioxide in sulfuric acid (Greenwood and Earnshaw 1998). Chromic acid also contains hexavalent chromium, which is one of the more toxic chromium atoms due to its greater ability to enter cells and higher redox potential (ATSDR 2016).

A worker dermally exposed to chromic acid (concentration not reported) as a result of an industrial accident experienced extensive skin burns (ATSDR 2016). In another occupational case study, a worker was exposed to chromic acid for approximately 10 minutes, experiencing multiple skin ulcers on his legs (Lin et al. 2009; ATSDR 2016).

There is sufficient evidence from authoritative agencies and scientific literature that supports the corrosive nature and adverse effects of chromic acid. Chromic acid merits inclusion on DTSC's Candidate Chemicals List, based on its dermatotoxicity and reactivity in biological systems.

Sulfamic Acid

Sulfamic acid, also known as sulphamidic acid, is both a skin and eye irritant with additional concerns of corrosion when inhaled, ingested, or in contact with the skin (ECHA 2024m; NOAA 2025a). Under the GHS hazard, sulfamic acid has been assigned the hazard phrases "H319: Causes serious eye irritation", "H315: Causes skin irritation", and "H412: Harmful to aquatic life with long lasting effects" (ECHA 2024m).

Dermal exposure to sulfamic acid has shown evidence of adverse effects in animal and human studies. In an OECD guideline approved skin irritation study, rabbits experienced slight irritation and swelling after a four hour exposure to 500 mg of 100% sulfamic acid (ECHA 2024m). Another study that exposed rabbits to 0.5 g (500 mg) sulfamic acid for four hours showed no signs of skin corrosion (ECHA 2024m). An older human skin irritation study applied 4% aqueous sulfamic acid to the anterior surface of one arm several times a day for five days in a row, which resulted in slight irritation to the skin (Ambrose 1943; ECHA 2024m). There is no evidence showing sulfamic acid as a skin or respiratory sensitizer in humans or in animals (ECHA 2024m).

Ocular exposure to sulfamic acid has shown evidence of adverse effects in animal studies. An eye irritation study conducted in rabbits following OECD guideline 405 found that sulfamic acid irritates the eyes after 100 mg was exposed in one eye (ECHA 2024m). In an older study, rabbits experienced moderate conjunctivitis and edema (swelling) after exposure to 4% aqueous sulfamic acid (Ambrose 1943; ECHA 2024m).

There is moderate evidence from authoritative agencies and scientific literature that supports the corrosive nature and adverse effects of sulfamic acid. Sulfamic acid merits inclusion on DTSC's Candidate Chemicals List, based on its dermatotoxicity, ocular toxicity, and reactivity in biological systems.

Oxalic Acid

Oxalic acid is corrosive and irritating to both skin and eyes (NIOSH 2019b; ECHA 2024n; NOAA 2025b). Under the GHS, oxalic acid has been assigned the hazard phrases "H312: Harmful in contact with skin", and "H302: Harmful if swallowed" (ECHA 2024n). The New Zealand EPA classifies oxalic acid as a "H314: Causes severe skin burns and eye damage" (New Zealand EPA 2024c).

Dermal exposure to oxalic acid has shown evidence of adverse effects in animal studies. Rabbits dermally exposed to 1:10 solution and 1:30 solution of oxalic acid exhibited redness, bloodshot skin and hardened skin (ECHA 2024n; New Zealand EPA 2024c). The study concluded that a 1:10 solution of oxalic acid in rabbits will result in strong irritation, but an exposure greater than a 1:10 solution will result in skin corrosivity (ECHA 2024n; New Zealand EPA 2024c). There is no evidence showing oxalic acid as a skin or respiratory sensitizer in humans or in animals (ECHA 2024n).

Ocular exposure to oxalic acid has shown evidence of adverse effects in animal studies. In an OECD guideline approved eye irritation study, rabbits experienced irreversible effects on the eyes after exposure to oxalic acid (concentration not specified) (ECHA 2024n). Another eye irritation study exposed rabbits to 100 mg oxalic acid and concluded that oxalic acid was extremely irritating in the eyes of rabbits (Guillot et al. 1982; ECHA 2024n).

Reported by the U.S. Coast Guard in the Chemical Hazard Response Information System, oxalic acid in the form of dust or as a solution can cause severe burns to the eyes, skin, or mucous membranes (NOAA 2025b). Repeated or prolonged dermal exposure to oxalic acid may cause dermatitis and slow-healing ulcers (Von Burg 1994; NOAA 2025b). Ingestion of oxalic acid has resulted in nausea, shock, collapse, convulsions, and death (Von Burg 1994; NOAA 2025b).

There is strong evidence from authoritative agencies and scientific literature that supports the corrosive nature and adverse effects of oxalic acid. Oxalic acid merits inclusion on DTSC's Candidate Chemicals List, based on its dermatotoxicity, ocular toxicity, and reactivity in biological systems.

3.2. Populations That May Be Adversely Impacted

Reference: California Code of Regulations, Title 22, section 69502.2(b)(1)(A)(6) and 69502.2(b)(1)(B)

This section identifies specific populations of humans and environmental organisms that may be harmed if exposed to the chemical. Sensitive subpopulations, environmentally sensitive habitats, endangered and threatened species, and impaired environments in California have special consideration, as they may be more vulnerable.

These acids and bases are widely available and may result in harm to humans and the environment. Workers and persons of African descent have the potential to be disproportionately impacted by the

acids and bases listed in Table 1 because of the types of products these chemicals are used in, such as personal care products and occupational and household cleaning products.

Several bases (potassium hydroxide, lithium hydroxide, calcium hydroxide, ammonium thioglycolate, and guanidine carbonate) are used in hair relaxers and hair straightening products (Miranda-Vilela, Botelho and Muehlmann 2014; Sishi, Van Wyk and Khumalo 2019; EWG 2024a). Consumers and hair salon workers who apply hair relaxers and hair straightening products that contain one or more of these chemicals experience dermal exposures that may cause harm. These products are known to cause irritant contact dermatitis as well as scalp burns (Needle et al. 2024). Exposures start young; children and teens, especially girls of African descent, may begin using these products as early as four years old, potentially heightening long-term health risks (Wright et al. 2011; Dodson et al. 2021). These bases have widespread uses in other personal care products, for example, moisturizers and skin treatments; facial cleansers; and hair products, such as shampoo, conditioner, and coloring (EWG 2024b).

Personal care products are not the only source of exposure to the acids and bases covered by this proposal. The bases ammonium hydroxide and sodium hypochlorite, as well as the acids ammonium bisulfite, chromic acid, sulfamic acid, and oxalic acid, are widespread in cleaning products used by consumers and in occupational settings (NIH 2024g; NIH 2024j; NIH 2024k; NIH 2024l). For example, two of these acids—sulfamic acid and oxalic acid—are primarily used in cleaning products. Workers in the cleaning and sanitation occupations may be disproportionately exposed to these chemicals and may be more likely to experience illness or injury as a result. According to 2022 data from the U.S. Bureau of Statistics, 41% of the 3.6 million people employed as janitors, maids, and building and household cleaners in the United States were of Hispanic descent, 17% were of African descent, and 4% were of Asian descent. Additionally, 59% of these workers were women (U.S. Bureau of Labor Statistics 2023). Besides cleaning workers, children—also a sensitive subpopulation—may be exposed to acids in cleaning products through incidental ingestion (Pacini et al. 2023) or when adults use household cleaning products in their vicinity (Parks et al. 2020).

4. EXPOSURE INFORMATION THAT IS THE BASIS FOR THIS LISTING

Reference: California Code of Regulations, title 22, sections 69502.2(b)(2)

The SCP Regulations direct the Department to evaluate reliable information demonstrating the occurrence, or potential occurrence, of exposures to the chemical.

Identifying a hazardous agent's exposure pathways is a crucial step in illuminating its potential to produce adverse effects in a receptor population. The elements of a complete exposure pathway for a hazardous agent include an emission source, the media in which it moves, the location of exposure, an exposure route, and a receptor species (U.S. EPA 2016a).

4.1. Production

With the exceptions of lithium hydroxide and chromic acid, all the acids and bases discussed in this document are included on U.S. EPA's list of high production volume (HPV) chemicals (Table 8). The HPV list includes only chemicals produced in, or imported into, the United States in quantities of one million pounds per year or more (U.S. EPA 2024h). High production volume indicates greater potential for exposure to people and release to the environment.

Table 3. Acids and bases listed as High Production Volume chemicals by U.S. EPA (U.S. EPA 2024h) and examples of known uses from the PubChem database (NIH 2024m).

Chemical	CASRN	Known Uses
Potassium hydroxide	1310-58-3	Solvent, food additives, buffer, oxidizing/reducing agent, pH regulating agent, conductive agent, pigment, adsorbents and absorbent, ion exchange agent
Calcium hydroxide	1305-62-0	pH regulating agent, surfactant, oxidizing/reducing agent, dehydrating agent
Ammonium hydroxide	1336-21-6	Denaturant, buffering, binder, oxidizing/reducing agent, pH regulating agent, adsorbents and absorbents, bleaching agent
Ammonium thioglycolate	5421-46-5	Reducing, depilatory
Guanidine carbonate	593-85-1	Buffering, skin conditioning, pH regulating agent, pH adjuster
Ammonium bisulfite	10192-30-0	Preservative, oxidizing/reducing agent, bleaching agent
Sodium hypochlorite	7681-52-9	Bleaching agent, oxidizing agent, pH regulating agent, adsorbents and absorbents, pigment, disinfectant
Ethanolamine	141-43-5	Dye, etching agent, buffering, solvent, pH regulating agent, binder, absorbent, intermediate
Sulfamic acid	5329-14-6	Additive, anti-scaling agent, descaler, pH regulating agent, adsorbents and absorbents
Oxalic acid	144-62-7	pH regulating agent, fragrance, photosensitive chemicals, reducing agent

4.2. Potential Sources of Exposure

Reference: California Code of Regulations, title 22, section 69502.2(b)(1)(A)(2)

Multiple sources of exposure to the chemical may increase the potential for significant or widespread adverse impacts.

The acids and bases discussed in this document are present in numerous consumer products, which increases the potential for exposure to people and releases to the environment. Acids and bases have

been used as buffering agents, cleaning agents, and as ingredients in personal care products. All the proposed acids and bases listed in Table 1, section 2, are on U.S. EPA's Chemical Product Database (CPDat), which maps consumer goods, the chemicals they contain, and their usage or function (U.S. EPA 2016b). CPDat provides an insight into the acids and bases likely found in products that could lead to exposure, even if their prevalence is not known. As an example, according to CPDat, potassium hydroxide is used in many products, including cleaning products and home maintenance care products (U.S. EPA 2024i).

5. POTENTIAL FOR WIDESPREAD ADVERSE IMPACTS

Reference: California Code of Regulations, title 22, section 69502.2(b)(1)(C)

The SCP Regulations instruct the Department to give special consideration to the potential for a chemical to contribute to or cause widespread adverse impacts.

DTSC has determined that potassium hydroxide, lithium hydroxide, calcium hydroxide, ammonium hydroxide, ammonium thioglycolate, guanidine carbonate, ammonium bisulfite, sodium hypochlorite, ethanolamine, chromic acid, sulfamic acid and oxalic acid meet the criteria for inclusion on the Candidate Chemical List (CCR, Title 22, section 69502.2(b)):

(1) There is potential for these chemicals to contribute to or cause adverse impacts.
(2) There is reliable information demonstrating potential or actual exposures to these chemicals.

Based on their hazard endpoints and ubiquity in consumer products, we have determined that the adverse impacts caused by exposure to these chemicals may be widespread. Most are present on the U.S. EPA's HPV List, indicating widespread use (U.S. EPA 2024h). The bases discussed in this document—potassium hydroxide, lithium hydroxide, calcium hydroxide, ammonium hydroxide, and ammonium thioglycolate—are found in a wide variety of personal care products, including hair relaxers, hair straightening products, and facial moisturizers and treatments (EWG 2024b). The acids discussed in this document are widely used in both cleaning and personal care products.

These acids and bases have the potential to contribute to or cause widespread adverse impacts to people who use, or are exposed to, consumer products that contain them. Their hazards include corrosivity, dermatotoxicity, ocular toxicity, and respiratory toxicity. Exposure to these acids and bases can cause chemical burns upon contact with the skin, eyes, and respiratory tract. Some of these chemicals have also been linked to carcinogenicity, neurotoxicity, systemic toxicity, developmental toxicity, reproductive toxicity, genotoxicity, endocrine disruption, and aquatic toxicity.

Many of the acids and bases discussed in this document share the same toxicological endpoints such as skin irritation and burns, and ocular irritation. Using multiple consumer products that contain one or more of these chemicals may exacerbate the potential for harm to people and the environment.

Additionally, there is a dose-response relationship where exposure to higher concentrations of acids or bases may increase the severity of the adverse effect; for example, an increase in skin or ocular irritation may occur (OECD 2008; ATSDR 2016).

Considering their potential for exposure and their corrosivity, dermatotoxicity, ocular toxicity, respiratory toxicity, carcinogenicity, neurotoxicity, systemic toxicity, developmental toxicity, reproductive toxicity, genotoxicity, endocrine disruption, and/or aquatic toxicity, the proposed acids and bases have the potential to lead to widespread adverse impacts in California, particularly affecting sensitive subpopulations. DTSC considered the extent and reliability of information to substantiate this determination. Where possible, we relied on data from authoritative bodies and published papers. Based on this determination, we propose adding potassium hydroxide, lithium hydroxide, calcium hydroxide, ammonium hydroxide, ammonium thioglycolate, guanidine carbonate, ammonium bisulfite, sodium hypochlorite, ethanolamine, chromic acid, sulfamic acid and oxalic acid, as defined herein, to the DTSC Candidate Chemicals List.

REFERENCES

Ambrose AM. (1943). Studies on the physiological effects of sulfamic acid and ammonium sulfamate. Journal of Industrial Hygiene and Toxicology. 25(1):26–28.

ATSDR. (2016). Chromium | Toxicological Profile | ATSDR. Available at: https://wwwn.cdc.gov/TSP/ToxProfiles/ToxProfiles.aspx?id=62&tid=17. Accessed 17 Jan 2025.

CIR. (2009). Final Amended Report on the Safety Assessment of Ammonium Thioglycolate, Butyl Thioglycolate, Calcium Thioglycolate, Ethanolamine Thioglycolate, Ethyl Thioglycolate, Glyceryl Thioglycolate, Isooctyl Thioglycolate, Isopropyl Thioglycolate, Magnesium Thioglycolate, Methyl Thioglycolate, Potassium Thioglycolate, Sodium Thioglycolate, and Thioglycolic Acid. Available at: https://journals.sagepub.com/doi/epdf/10.1177/1091581809339890. Accessed 22 Nov 2024.

CIR. (2015). Safety Assessment of Ethanolamine and Ethanolamine Salts as Used in Cosmetics. International Journal of Toxicology. 34(2_suppl):84S-98S. doi: 10.1177/1091581815596439.

CIR. (2018). Safety Assessment of Ammonia and Ammonium Hydroxide as Used in Cosmetics. Available at: https://cir-reports.cir-safety.org/cir-ingredient-status-report/?id=aec980d8-8abe-4a50-93f7-8b30bda27def. Accessed 21 Jan 2025.

CIR. (2021). Safety Assessment of Inorganic Hydroxides as Used in Cosmetics. Cosmetic Ingredient Review Panel (CIR). SAGE Publications Inc. Available at: https://doi.org/10.1177/10915818211018381.

Clean Production Action. (2018). GreenScreen for Safer Chemicals Hazard Assessment Guidance. Available at: https://www.greenscreenchemicals.org/images/ee_images/uploads/resources/GreenScreen_Guidance_v1_4_2018_01_Final.pdf.

Coon RA et al. (1970). Animal inhalation studies on ammonia, ethylene glycol, formaldehyde, dimethylamine, and ethanol. Toxicology and Applied Pharmacology. 16(3):646–655. doi: 10.1016/0041-008x(70)90069-4.

Dodson RE et al. (2021). Personal care product use among diverse women in California: Taking stock study. Journal of Exposure Science & Environmental Epidemiology. 31(3):487–502. doi: 10.1038/s41370-021-00327-3.

ECHA. (2024a). Potassium hydroxide. Registration Dossier. European Chemicals Agency (ECHA). Available at: https://chem.echa.europa.eu/100.013.802/dossier-view/c6ac857e-9432-4f17-8a03-ac0f9aa2394b/IUC5-109f1472-557c-4c74-afec-97cc6561b90b_de23184f-5cd3-49fd-873d-c3cede58cc40?searchText=1310-58-3. Accessed 25 Oct 2024.

ECHA. (2024b). Lithium hydroxide. Registration Dossier. European Chemicals Agency (ECHA). Available at: https://chem.echa.europa.eu/100.013.804/dossier-view/e8b8cf27-522a-4411-828f-

f3d69d2a275b/a3448c78-b453-4129-b026-2ca225920b6d_916daec9-a66a-483a-aec9-d8180abc98df. Accessed 24 Oct 2024.

ECHA. (2024c). Calcium dihydroxide. Registration Dossier. European Chemicals Agency (ECHA). Available at: https://echa.europa.eu/registration-dossier/-/registered-dossier/16187/7/9/1. Accessed 6 Jan 2025.

ECHA. (2024d). Ammonium hydroxide. Registration Dossier. European Chemicals Agency (ECHA). Available at: https://echa.europa.eu/registration-dossier/-/registered-dossier/7510/2/1. Accessed 9 Dec 2024.

ECHA. (2024e). Ammonia, anhydrous. Registration Dossier. European Chemicals Agency (ECHA). Available at: https://echa.europa.eu/registration-dossier/-/registered-dossier/15557. Accessed 22 Jan 2025.

ECHA. (2024f). Ammonium mercaptoacetate. Registration Dossier. European Chemicals Agency (ECHA). Available at: https://echa.europa.eu/registration-dossier/-/registered-dossier/11373/2/1. Accessed 7 Jan 2025.

ECHA. (2024g). Diguanidinium carbonate. Registration Dossier. European Chemicals Agency (ECHA). Available at: https://echa.europa.eu/registration-dossier/-/registered-dossier/13132/2/1. Accessed 1 Nov 2024.

ECHA. (2024h). Ammonium hydrogensulphite. Registration Dossier. European Chemicals Agency (ECHA). Available at: https://echa.europa.eu/registration-dossier/-/registered-dossier/14587/7/4/1. Accessed 15 Nov 2024.

ECHA. (2024i). Sodium hypochlorite. Registration Dossier. European Chemicals Agency (ECHA). Available at: https://echa.europa.eu/registration-dossier/-/registered-dossier/15516/1/1. Accessed 22 Jan 2025.

ECHA. (2024j). Ethanolamine- C&L Inventory. Available at: https://echa.europa.eu/information-on-chemicals/cl-inventory-database/-/discli/details/60615. Accessed 16 Dec 2024.

ECHA. (2024k). 2-aminoethanol. Registration Dossier. European Chemicals Agency (ECHA). Available at: https://chem.echa.europa.eu/100.004.986/dossier-view/bbbc7157-d338-419d-b0e9-fe9687bc18d4/6b09017e-c58c-3daf-9045-bdca3ebda85b_8e662a50-3341-44c9-b87c-95c6879731ee. Accessed 24 Oct 2024.

ECHA. (2024l). Chromic acid. Substance Information. European Chemicals Agency (ECHA). Available at: https://echa.europa.eu/substance-information/-/substanceinfo/100.028.910. Accessed 15 Jan 2025.

ECHA. (2024m). Sulphamidic acid. Registration Dossier. European Chemicals Agency (ECHA). Available at: https://echa.europa.eu/registration-dossier/-/registered-dossier/14842/7/4/1. Accessed 15 Nov 2024.

ECHA. (2024n). Oxalic acid. Registration Dossier. European Chemicals Agency (ECHA). Available at: https://chem.echa.europa.eu/100.005.123/dossier-view/0e3c3a7e-e238-43c5-bc68-854d3212df1b/3e176da7-6f25-43cb-9b50-821310a152b2_1ca2d2ac-bca7-4b33-9cad-726c20cae003?searchText=Oxalic%20acid. Accessed 15 Nov 2024.

El Ghalbzouri A et al. (2008). Leiden reconstructed human epidermal model as a tool for the evaluation of the skin corrosion and irritation potential according to the ECVAM guidelines. Toxicology in Vitro. 22(5):1311–1320. doi: 10.1016/j.tiv.2008.03.012.

EWG. (2024a). EWG Skin Deep Database. Guanidine Carbonate. Environmental Working Group (EWG). in: EWG. Available at: http://www.ewg.org/skindeep/ingredients/702749-GUANIDINE_CARBONATE/. Accessed 17 Oct 2024.

EWG. (2024b). EWG Skin Deep Database. Enivronmental Working Group (EWG). in: EWG. Available at: http://www.ewg.org/skindeep/. Accessed 5 Nov 2024.

Goldberg A. (1983). Alternative methods in toxicology. Mary Ann Liebert Incorporated.

Greenwood NN and Earnshaw A. (1998). Chemistry of the Elements. Elsevier, ISBN: 0-08-050109-5.

Grove GL, Duncan S and Kligman AM. (1982). Effect of ageing on the blistering of human skin with ammonium hydroxide. British Journal of Dermatology. 107(4):393–400. doi: 10.1111/j.1365-2133.1982.tb00382.x.

Guillot JP et al. (1982). Evaluation of the ocular-irritation potential of 56 compounds. Food and Chemical Toxicology: An International Journal Published for the British Industrial Biological Research Association. 20(5):573–582. doi: 10.1016/s0278-6915(82)80066-5.

IPCS. (2018). Ammonium hydroxide- International Programme on Chemical Safety (IPCS) INCHEM- ICSC 0215 - AMMONIUM HYDROXIDE (10%-35% solution). Available at: https://www.inchem.org/documents/icsc/icsc/eics0215.htm. Accessed 9 Dec 2024.

Johnson GT, Lewis TR and Wagner WD. (1975). Acute toxicity of cesium and rubidium compounds. Toxicology and Applied Pharmacology. 32(2):239–245. doi: 10.1016/0041-008X(75)90216-1.

Lessmann H et al. (2009). Skin sensitizing properties of the ethanolamines mono-, di-, and triethanolamine. Data analysis of a multicentre surveillance network (IVDK) and review of the literature. Contact Dermatitis. 60(5):243–255. doi: 10.1111/j.1600-0536.2009.01506.x.

Lin CC et al. (2009). Acute severe chromium poisoning after dermal exposure to hexavalent chromium. Journal of the Chinese Medical Association: JCMA. 72(4):219–221. doi: 10.1016/S1726-4901(09)70059-0.

Miranda-Vilela AL, Botelho AJ and Muehlmann LA. (2014). An overview of chemical straightening of human hair: technical aspects, potential risks to hair fibre and health and legal issues. International Journal of Cosmetic Science. 36(1):2–11. doi: 10.1111/ics.12093.

Murphy JC et al. (1982). Ocular irritancy responses to various pHs of acids and bases with and without irrigation. Toxicology. 23(4):281–291. doi: 10.1016/0300-483X(82)90067-1.

Nassif A. (2006). Ammonium bisulfite contact dermatitis: face eczema due to a bleaching ointment used during hair-dying. Contact Dermatitis. 55(2):124. doi: 10.1111/j.0105-1873.2006.0866j.x.

Needle CD et al. (2024). Safety of chemical hair relaxers: A review article. JAAD Reviews. 2:50–56. doi: 10.1016/j.jdrv.2024.09.001.

New Zealand EPA. (2024a). Guanidine carbonate- Chemical Classification and Information Database (CCID) | EPA. Available at: https://www.epa.govt.nz/database-search/chemical-classification-and-information-database-ccid/view/6E33197D-DB4A-4AA1-98A6-87154B6234E2. Accessed 6 Dec 2024.

New Zealand EPA. (2024b). Ammonium bisulphite- Chemical Classification and Information Database (CCID) | EPA. Available at: https://www.epa.govt.nz/database-search/chemical-classification-and-information-database-ccid/view/12AF082D-E2B8-478D-B1AD-989D458DF2D6. Accessed 15 Nov 2024.

New Zealand EPA. (2024c). Oxalic acid- Chemical Classification and Information Database (CCID) | EPA. Available at: https://www.epa.govt.nz/database-search/chemical-classification-and-information-database-ccid/view/FC858637-B53D-4F4A-93EB-96F0A2DEBFBB. Accessed 15 Nov 2024.

NIH. (2024a). PubChem database. Potassium Hydroxide. National Institutes of Health (NIH). Available at: https://pubchem.ncbi.nlm.nih.gov/compound/14797. Accessed 31 Oct 2024.

NIH. (2024b). PubChem database. Lithium Hydroxide. National Institutes of Health (NIH). Available at: https://pubchem.ncbi.nlm.nih.gov/compound/3939. Accessed 31 Oct 2024.

NIH. (2024c). PubChem database. Calcium Hydroxide. National Institutes of Health (NIH). Available at: https://pubchem.ncbi.nlm.nih.gov/compound/6093208. Accessed 31 Oct 2024.

NIH. (2024d). PubChem database. Ammonium Hydroxide. National Institutes of Health (NIH). Available at: https://pubchem.ncbi.nlm.nih.gov/compound/14923. Accessed 31 Oct 2024.

NIH. (2024e). PubChem database. Ammonium Thioglycolate. National Institutes of Health (NIH). Available at: https://pubchem.ncbi.nlm.nih.gov/compound/21534. Accessed 31 Oct 2024.

NIH. (2024f). PubChem database. Guanidine carbonate. National Institutes of Health (NIH). Available at: https://pubchem.ncbi.nlm.nih.gov/compound/11650. Accessed 31 Oct 2024.

NIH. (2024g). PubChem database. Ammonium Bisulfite. National Institutes of Health (NIH). Available at: https://pubchem.ncbi.nlm.nih.gov/compound/10441651. Accessed 31 Oct 2024.

NIH. (2024h). PubChem database. Sodium Hypochlorite. National Institutes of Health (NIH). Available at: https://pubchem.ncbi.nlm.nih.gov/compound/23665760. Accessed 31 Oct 2024.

NIH. (2024i). PubChem database. Monoethanolamine. National Institutes of Health (NIH). Available at: https://pubchem.ncbi.nlm.nih.gov/compound/700. Accessed 24 Oct 2024.

NIH. (2024j). PubChem database. Chromic acid. National Institutes of Health (NIH). Available at: https://pubchem.ncbi.nlm.nih.gov/compound/24425. Accessed 31 Oct 2024.

NIH. (2024k). PubChem database. Sulfamic acid. National Institutes of Health (NIH). Available at: https://pubchem.ncbi.nlm.nih.gov/compound/5987. Accessed 31 Oct 2024.

NIH. (2024l). PubChem database. Oxalic Acid. National Institutes of Health (NIH). National Institutes of Health (NIH). Available at: https://pubchem.ncbi.nlm.nih.gov/compound/971. Accessed 31 Oct 2024.

NIH. (2024m). PubChem database. Acid and Bases. Nationale Institutes of Health (NIH). Available at: https://pubchem.ncbi.nlm.nih.gov/. Accessed 20 Mar 2024.

NIOSH. (2019a). NIOSH Pocket Guide to Chemical Hazards. Calcium hydroxide. Centers for Disease Control and Prevention (CDC), National Institute for Occupational Safety and Health (NIOSH). Available at: https://www.cdc.gov/niosh/npg/npgd0092.html. Accessed 6 Jan 2025.

NIOSH. (2019b). NIOSH Pocket Guide to Chemical Hazards. Oxalic acid. Centers for Disease Control and Prevention (CDC), National Institute for Occupational Safety and Health (NIOSH). Available at: https://www.cdc.gov/niosh/npg/npgd0474.html. Accessed 24 Jan 2025.

NITE. (2024). 2-Aminoethanol. National Institute of Technology and Evaluation (NITE). Chemical Management Field. GHS Information. Available at: https://www.chem-info.nite.go.jp/chem/english/ghs/m-nite-141-43-5e.html. Accessed 6 Jan 2025.

NOAA. (2025a). Sulfamic Acid. CAMEO Chemicals. National Oceanic and Atmospheric Administration (NOAA). Available at: https://cameochemicals.noaa.gov/chemical/4560. Accessed 24 Jan 2025.

NOAA. (2025b). Oxalic Acid. CAMEO Chemicals. National Oceanic and Atmospheric Administration (NOAA). Available at: https://cameochemicals.noaa.gov/chemical/8966. Accessed 24 Jan 2025.

OECD. (2008). Ammonium hydroxide CAS No. 1336-21-6. Final Assessment Report. Organization for Economic Co-operation and Development (OECD). Available at: https://hpvchemicals.oecd.org/UI/SIDS_Details.aspx?key=eddc0a6e-2c11-4a7d-8fd0-32080871a8ba&idx=0. Accessed 22 Jan 2025.

Pacini A et al. (2023). Unintentional pediatric exposures to household cleaning products: a cross-sectional analysis of the National Poison Data System (2000–2015). Journal of Occupational Medicine and Toxicology (London, England). 18:16. doi: 10.1186/s12995-023-00384-4.

Parks J et al. (2020). Association of use of cleaning products with respiratory health in a Canadian birth cohort. CMAJ : Canadian Medical Association Journal. 192(7):E154–E161. doi: 10.1503/cmaj.190819.

Perkins MA, Osborne R and Johnson GR. (1996). Development of an in vitro method for skin corrosion testing. Fundamental and Applied Toxicology: Official Journal of the Society of Toxicology. 31(1):9–18.

Pratt JR et al. (1988). Effects of chlorine on microbial communities in naturally derived microcosms: Population and community level responses to environmental perturbations. Environmental Toxicology and Chemistry. 7(9):679–687. doi: 10.1002/etc.5620070902.

Publisso. (2024). List of MAK and BAT Values | Publisso. Available at: https://series.publisso.de/sites/default/files/documents/series/mak/lmbv/Vol2024/Iss2/Doc002/mbwl_2024_eng.pdf. Accessed 6 Jan 2025.

Rados J. (2005). Caustic reaction caused by cement. Acta Dermatovenerologica Croatica : ADC.

Safe Work Australia. (2021a). Hazardous Chemical Information System- Ammonium thioglycolate. Available at: https://hcis.safeworkaustralia.gov.au/HazardousChemical/Details?chemicalID=50. Accessed 15 Nov 2024.

Safe Work Australia. (2021b). Hazardous Chemical Information System- Chromic acid. Available at: https://hcis.safeworkaustralia.gov.au/HazardousChemical/Details?chemicalID=998. Accessed 15 Nov 2024.

Savonius B et al. (1994). Occupational asthma caused by ethanolamines - Savonius - 1994 - Allergy - Wiley Online Library. Available at: https://onlinelibrary.wiley.com/doi/abs/10.1111/j.1398-9995.1994.tb00791.x?sid=nlm%3Apubmed. Accessed 9 Dec 2024.

Schmidt SM et al. (2008). Corneal Injury Due to a Calcium Hydroxide Containing Food Preparation Product (“Cal”). Pediatric Emergency Care. 24(7):468. doi: 10.1097/PEC.0b013e31817de2d3.

Sishi VNB, Van Wyk JC and Khumalo NP. (2019). The pH of lye and no-lye hair relaxers, including those advertised for children, is at levels that are corrosive to the skin. South African Medical Journal. (12):941–946. doi: 10.7196/SAMJ.2019.v109i12.14010.

U.S. Bureau of Labor Statistics. (2023). Labor Force Statistics from the Current Population Survey. Available at: https://www.bls.gov/cps/cpsaat11.htm. Accessed 17 Jul 2023.

U.S. EPA. (2016a). EPA EcoBox Tools by Exposure Pathways - Exposure Pathways In ERA. United States Environmental Protection Agency (U.S. EPA). Available at: https://www.epa.gov/ecobox/epa-ecobox-tools-exposure-pathways-exposure-pathways-era. Accessed 31 Jan 2023.

U.S. EPA. (2016b). Chemical and Products Database (CPDat). Downloaded data searched by chemical names of acids and bases. United States Environmental Protection Agency (U.S. EPA). Available

at: https://www.epa.gov/chemical-research/chemical-and-products-database-cpdat. Accessed 9 Dec 2024.

U.S. EPA. (2024a). CompTox Chemicals Dashboard. Ammonium hydroxide. United States Environmental Protection Agency (U.S. EPA). Available at: https://comptox.epa.gov/dashboard/chemical/details/DTXSID4020080. Accessed 19 Nov 2024.

U.S. EPA. (2024b). CompTox Chemicals Dashboard. Ammonium thioglycolate. United States Environmental Protection Agency (U.S. EPA). Available at: https://comptox.epa.gov/dashboard/chemical/details/DTXSID2027599. Accessed 19 Nov 2024.

U.S. EPA. (2024c). CompTox Chemicals Database. Ammonium bisulfite. United States Environmental Protection Agency (U.S. EPA). Available at: https://comptox.epa.gov/dashboard/chemical/details/DTXSID1050462. Accessed 19 Nov 2024.

U.S. EPA. (2024d). CompTox Chemicals Dashboard. Sodium hypochlorite. United States Environmental Protection Agency (U.S. EPA). Available at: https://comptox.epa.gov/dashboard/chemical/details/DTXSID8021276. Accessed 19 Nov 2024.

U.S. EPA. (2024e). CompTox Chemicals Dashboard. Chromic(VI) acid. United States Environmental Protection Agency (U.S. EPA). Available at: https://comptox.epa.gov/dashboard/chemical/details/DTXSID8034455. Accessed 19 Nov 2024.

U.S. EPA. (2024f). Cheminformatics- Hazard Comparison Dashboard (HCD). United States Environmental Protection Agency (U.S. EPA). Available at: https://www.epa.gov/comptox-tools/cheminformatics. Accessed 16 Dec 2024.

U.S. EPA. (2024g). CompTox Chemicals Dashboard. Ethanolamine. United States Environmental Protection Agency (U.S. EPA). Available at: https://comptox.epa.gov/dashboard/chemical/properties/DTXSID6022000. Accessed 19 Nov 2024.

U.S. EPA. (2024h). High Production Volume List. CompTox Chemicals Dashboard. United States Environmental Protection Agency (U.S. EPA). Available at: https://comptox.epa.gov/dashboard/chemical-lists/EPAHPV. Accessed 13 Mar 2024.

U.S. EPA. (2024i). The Chemical and Products Database. Potassium hydroxide. CASRN: 1310-58-3. United States Environmental Protection Agency (U.S. EPA). in: Scientific Data. Available at: https://comptox.epa.gov/chemexpo/chemical/DTXSID5029633/. Accessed 11 Dec 2024.

Vegosen L and Martin TM. (2020). An automated framework for compiling and integrating chemical hazard data. Clean Technologies and Environmental Policy. 22(2):441–458. doi: 10.1007/s10098-019-01795-w.

Von Burg R. (1994). Oxalic acid and sodium oxalate. Journal of Applied Toxicology: JAT. 14(3):233–237. doi: 10.1002/jat.2550140315.

Wright DR et al. (2011). Hair care practices and their association with scalp and hair disorders in African American girls. Journal of the American Academy of Dermatology. 64(2):253–262. doi: 10.1016/j.jaad.2010.05.037.

APPENDIX A: REPORT PREPARATION

Preparers and Contributors

Armeen Etemad, M.S., P.E. – Hazardous Substances Engineer – Safer Consumer Products Program

Veneese J.B. Evans, Ph.D. – Associate Toxicologist – Safer Consumer Products Program

Ravi Kang, M.S. – Environmental Scientist – Safer Consumer Products Program

Brooke Alyse Manor, M.P.H. – Environmental Scientist – Safer Consumer Products Program

Tiglath Moradkhan, M.S. – Environmental Scientist – Safer Consumer Products Program

Lizette Romano, M.P.H. – Environmental Scientist – Safer Consumer Products Program

Reviewers

André Algazi – Branch Manager, Product Evaluation Unit – Safer Consumer Products Program

Jamaih Belk – Hazardous Substances Engineer – Safer Consumer Products Program

Nick Brunner – Information Officer I (Specialist) – Office of Communications

Simona Bălan, Ph.D. – Branch Manager, Regulations and Policy Unit – Safer Consumer Products Program

Robin Christensen – Deputy Director – Safer Consumer Products Program

Michael Ernst, P.E. – Supervisor, Market Research Unit – Safer Consumer Products Program

David Grealish – Graphic Designer III – Office of Communications

Christine Papagni, M.S. – Supervisor, Product Evaluation Unit – Safer Consumer Products Program

Alex Troeller – Senior Environmental Scientist (Specialist) – Safer Consumer Products Program