

MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY

INTEROFFICE COMMUNICATION

TO: Sodium hydroxide (CAS # 1310-73-2)

FROM: Doreen Lehner, Air Quality Division, Toxics Unit

SUBJECT: Screening level for Sodium hydroxide (CAS # 1310-73-2)

DATE: March 30, 2017

The Initial Threshold Screening Level (ITSL) for sodium hydroxide is 8 µg/m³ with a 1-hour averaging time. The previous ITSL established on 9/14/1992 was 20 µg/m³ (1-hour averaging time).

Sodium hydroxide (CAS # 1310-73-2) [NaOH] is also known as lye and caustic soda. It is an odorless, highly caustic, white solid which is available as pellets, flakes, granules, and in solution of different concentrations. Sodium hydroxide has a molecular weight of 39.9971 g/mol, it readily dissolves in water producing large amounts of heat that could cause a safety threat, and it also readily absorbs moisture and carbon dioxide in the air. Sodium hydroxide feels slippery when in contact with the skin and is a strong irritant, with a reaction similar to a strong acid. Sodium hydroxide is a severe irritant of the eyes, mucous membranes, and skin. Sodium hydroxide is odorless; therefore, odor provides no warning of hazardous concentrations. Due to its low cost, sodium hydroxide is widely used: in many industries as a strong chemical base in the manufacture of pulp and paper, chemicals, plastics, rayon, cellophane, explosives, textiles, drinking water, soaps, detergents, and drain cleaners; in revitalizing acid in petroleum refining; as a paint remover; in dehorning cattle; in relaxers to help straighten hair (becoming less popular due to chemical burns); in steps for peeling fruits and vegetables; in processing cocoa and chocolate; thickening of ice cream; poultry scalding; in soda processing; as a soak for olives to turn them black; to coat soft pretzels and bagels to give them a chewy texture; in etching and electroplating; in metal descaling; and in batteries.

The following references or databases were searched to identify data to determine the screening level: U.S. Environmental Protection Agency (EPA) Integrated Risk Information System (IRIS), National Institute for Occupational Safety and Health (NIOSH) Registry for Toxic Effects of Chemical Substances (RTECS), American Conference of Governmental and Industrial Hygienists (ACGIH) Threshold Limit Values (TLV), Michigan Department of Environmental Quality (DEQ) library, International Agency for Research on Cancer (IARC) Monographs, Chemical Abstract Service (CAS) Online (searched 2/10/17), National Library of Medicine (NLM) - Toxline, and National Toxicology Program (NTP) Status Report.

Table 1. Sodium Hydroxide Toxicity Benchmarks and Candidate ITSLs.

Available Benchmark Type	Value ($\mu\text{g}/\text{m}^3$)	Candidate ITSL	Candidate ITSL Averaging Time
Cal/EPA Acute REL	$8 \mu\text{g}/\text{m}^3$	$8 \mu\text{g}/\text{m}^3$	1-hour
OSHA PEL (8-hour TWA – Ceiling limit)	$2,000 \mu\text{g}/\text{m}^3$	PEL/100 = $20 \mu\text{g}/\text{m}^3$	8-hour
ACGIH TLV – Ceiling	$2,000 \mu\text{g}/\text{m}^3$	TLV/100 = $20 \mu\text{g}/\text{m}^3$	1-hour
NIOSH REL – Ceiling	$2,000 \mu\text{g}/\text{m}^3$	REL/100 = $20 \mu\text{g}/\text{m}^3$	1-hour
AIHA ERPG-1	$500 \mu\text{g}/\text{m}^3$	Not determined	1-hour

Cal/EPA set an acute inhalation reference exposure level (REL) at $8 \mu\text{g}/\text{m}^3$ for a 1-hour exposure based on subjective complaints of eye, skin, and respiratory irritation in occupationally exposed workers. In the key study, Ott et al. (1977) investigated 291 workers chronically exposed to caustic (sodium hydroxide) dust for periods of up to 30 years or more. There were “subjective reports of mild to moderate-severe irritation of the eyes and skin, as well as respiratory irritation” (Cal/EPA, 2008). Earlier unpublished industrial hygiene studies from the 1950s measured sodium hydroxide in the air and compared the air measurements to subjective worker responses. Ott et al. (1977) reported that “the industrial hygienist estimated the time weighted average (TWA) concentrations of caustic dust at that time to be as high as $2 \text{ mg}/\text{m}^3$ for janitors, $1.5 \text{ mg}/\text{m}^3$ for flaker operators, 0.5 to $1 \text{ mg}/\text{m}^3$ for other jobs in Production Area II and approximately $0.5 \text{ mg}/\text{m}^3$ for most jobs in Production Area I” (Ott et al., 1997). In the late 1950’s, the sodium hydroxide production line was changed from an open air production process to a closed system, which improved worker conditions. The process was totally automated in 1975. Even though there was no trend of increased mortality associated with long term exposure to sodium hydroxide, there were acute hazards of exposure to the caustic dust. The lowest observed adverse effect level (LOAEL) of $0.5 \text{ mg}/\text{m}^3$ was determined using a duration of an 8-hour work shift. Cal/EPA used an uncertainty factor (UF) of 60: UF of 6 for LOAEL to NOAEL extrapolation; UF of 1 for interspecies uncertainty (study on humans); and an UF of 10 for susceptible human populations. This gives an acute REL of $8 \mu\text{g}/\text{m}^3$ which Cal/EPA states is protective against mild adverse effects.

The Occupational Safety and Health Administration (OSHA) set a permissible exposure limit (PEL) of $2 \text{ mg}/\text{m}^3$ for sodium hydroxide as an 8-hour time-weighted average ceiling limit, based on the American Council of Governmental Industrial Hygienists (ACGIH) and National Institute for Occupational Safety and Health (NIOSH) recommended limits. OSHA considered the irritant effects resulting from exposure to sodium hydroxide material impairments of health. The 8-hour PEL is the highest level of exposure an employee may be exposed to without incurring the risk of adverse health effects. This value is for workers and may be divided by 100 to be presumed to be protective for the general population including sensitive subgroups.

ACGIH set a threshold limit value-ceiling (TLV-C) of 2 mg/m^3 , which should not be exceeded at any time and, “is recommended, based on a concentration that produces noticeable, but not excessive, ocular and upper respiratory tract irritation” (ACGIH, 2001). “Depending upon the concentration, sodium hydroxide aerosol can be a severe irritant of the eyes, mucous membranes, and skin; the caustic dust of sodium hydroxide is irritating to the upper respiratory tract. The recommended TLV is intended to minimize the potential for excessive ocular and upper respiratory tract irritation. Prolonged exposure to high concentrations of sodium hydroxide can cause ulceration of nasal passages and severe eye and skin injury. Sufficient data were not available to recommend skin, SEN, or carcinogenicity notations” (ACGIH, 2001). As for OSHA PELs, this value is also for workers and may be divided by 100 to be presumed to be protective for the general population including sensitive subgroups.

NIOSH set a recommended exposure limit (REL) of 2 mg/m^3 ceiling for sodium hydroxide, which should not be exceeded at any time. As with the OSHA PEL and the ACGIH TLV-C above, these values are derived for workers and may be divided by 100 to be presumed to be protective for the general population including sensitive subgroups. This was the basis for the previous ITSL of $20 \text{ } \mu\text{g/m}^3$ (1-hour averaging time).

American Industrial Hygiene Association (AIHA) set an Emergency Response Planning Guideline (ERPG-1) of 0.5 mg/m^3 for sodium hydroxide. “The primary focus of the ERPGs is to provide guideline levels for once-in-a-lifetime, short-term (typically 1 hour) exposures to airborne concentrations of acutely toxic, high-priority chemicals” (AIHA, 2013). ERPG-1 is considered “the maximum airborne concentration below which it is believed nearly all individuals could be exposed for up to 1 hour without experiencing more than mild, transient adverse health effects or without perceiving a clearly defined objectionable odor” (AIHA, 2013). There is no readily available documentation as to how this value was determined. Also, as this value is for a one-time exposure, it may be inappropriate to use this benchmark for determining a screening level for sodium hydroxide.

The Cal/EPA acute REL of $8 \text{ } \mu\text{g/m}^3$ (1-hour averaging time) was adopted as the ITSL because it is recently derived, it is well documented and justified, and it provides an appropriate level of protection. Therefore, the ITSL for sodium hydroxide is $8 \text{ } \mu\text{g/m}^3$ with a 1-hour averaging time.

References:

ACGIH. 2001. TLVs and BEIs Based on the Documentation of the Threshold Limit Values for Chemical Substances and Physical Agents & Biological Exposure Indices. ACGIH Worldwide Signature Publications.

Act 451 of 1994, Natural Resources and Environmental Protection Act and Air Pollution Control Rules, Michigan Department of Environmental Quality.

AIHA. 2013. 2013 ERPG/WEEL Handbook. AIHA Guideline Foundation. Available online at: <https://www.aiha.org/get-involved/AIHAGuidelineFoundation/EmergencyResponsePlanningGuidelines/Documents/ERPGIntroText.pdf>

Cal/EPA (California Environmental Protection Agency). 2008. Acute Reference Exposure Levels. Technical Supporting Document for Noncancer RELs, Appendix D2. Acute Toxicity Summary Sodium Hydroxide (caustic soda, caustic flake, white caustic, soda lye, lye, sodium hydroxide) CAS Registry Number: 1310-93-2. Available online at: <https://oehha.ca.gov/media/downloads/cnr/appendixd2final.pdf>

Ott MG, Gordon HL, and Schneider EJ. Mortality among employees chronically exposed to caustic dust. J Occup Med 1977; 19:813-816.