

# Chlorine

7782-50-5

---

## Hazard Summary

Chlorine is a commonly used household cleaner and disinfectant. Chlorine is a potent irritant to the eyes, the upper respiratory tract, and lungs. Chronic (long-term) exposure to chlorine gas in workers has resulted in respiratory effects, including eye and throat irritation and airflow obstruction. No information is available on the carcinogenic effects of chlorine in humans from inhalation exposure. A National Toxicology Program (NTP) study showed no evidence of carcinogenic activity in male rats or male and female mice, and equivocal evidence in female rats, from ingestion of chlorinated water. EPA has not classified chlorine for potential carcinogenicity.

---

Please Note: The main sources of information for this fact sheet are EPA's Integrated Risk Information System (IRIS) (2), which contains information on oral chronic toxicity and the RfD, The California Environmental Protection Agency's (CalEPA's) Technical Support Document for the Determination of Noncancer Chronic Reference Exposure Levels (3), and EPA's Drinking Water Criteria Document for Chlorine, Hypochlorous Acid and Hypochlorite Ion (1).

## Uses

- Chlorine is a commonly used household cleaner and disinfectant. It is widely used as an oxidizing agent in water treatment and chemical processes. It is also used in the bleaching process of wood pulp in pulp mills. (8)

## Sources and Potential Exposure

- Workers may be exposed to chlorine in industries where it is produced or used, particularly in the food and paper industries. In addition, persons breathing air around these industries may be exposed to chlorine. (1)
- Exposure to chlorine may also occur through drinking water and swimming pool water, where it is used as a disinfectant. (2)
- Accidental releases are another potential source of chlorine exposure. (3)

## Assessing Personal Exposure

- No data were located regarding detection of personal exposure to chlorine.

## Health Hazard Information

### Acute Effects:

- Chlorine is a potent irritant in humans to the eyes, the upper respiratory tract, and the lungs. Several acute (short-term) studies have reported the following effects: tickling of the nose at 0.014 to 0.054 parts per million (ppm); tickling of the throat at 0.04 to 0.097 ppm; itching of the nose and cough, stinging, or dryness of the nose and throat at 0.06 to 0.3 ppm; burning of the conjunctiva and pain after 15 minutes at 0.35 to 0.72 ppm; and discomfort ranging from ocular and respiratory irritation to coughing, shortness of breath, and headaches above 1.0 ppm. (4)
- Higher levels of chlorine have resulted in the following effects in humans: mild mucous membrane irritation at 1 to 3 ppm; chest pain, vomiting, dyspnea, and cough at 30 ppm; and toxic pneumonitis and pulmonary

edema at 46 to 60 ppm. (3)

- Chlorine is extremely irritating to the skin and can cause severe burns in humans. (3)
- Acute animal tests in rats and mice have shown chlorine to have high acute toxicity via inhalation. (6)

#### Chronic Effects (Noncancer):

- Workers chronically exposed to chlorine gas have exhibited respiratory effects, such as eye and throat irritation, and airflow obstruction. (8)
- Animal studies have reported decreased body weight gain, eye and nose irritation, and nonneoplastic lesions and respiratory epithelial hyperplasia from chronic inhalation exposure to chlorine. (4,8)
- The Reference Dose (RfD) for chlorine is 0.1 milligrams per kilogram body weight per day (mg/kg/d) based on no observed adverse effects in rats. The RfD is an estimate (with uncertainty spanning perhaps an order of magnitude) of a daily oral exposure to the human population (including sensitive subgroups) that is likely to be without appreciable risk of deleterious noncancer effects during a lifetime. It is not a direct estimator of risk but rather a reference point to gauge the potential effects. At exposures increasingly greater than the RfD, the potential for adverse health effects increases. Lifetime exposure above the RfD does not imply that an adverse health effect would necessarily occur. (2)
- EPA has medium confidence in the RfD based on (1) medium to high confidence in the principal study because relevant endpoints in two animal species were examined after prolonged exposure by an appropriate route, but an effect level was not observed in this study and higher levels may not be practicable due to taste aversion, and (2) medium confidence in the database because information is available for rats and mice on the noncarcinogenic toxicity of oral exposure to chlorine for subchronic periods. Developmental and reproductive toxicity of chlorine have been examined in rats and mice, but with suboptimal studies; due to the chemical relationship between chlorine and monochloramine, reproductive and developmental studies for monochloramine may be used to satisfy data gaps for chlorine. (2)
- EPA has not established a Reference Concentration (RfC) for chlorine. (2)
- CalEPA has established a chronic reference exposure level of 0.00006 milligrams per cubic meter (mg/m<sup>3</sup>) based on respiratory epithelial lesions in rats. The CalEPA reference exposure level is a concentration at or below which adverse health effects are not likely to occur. (8)

#### Reproductive/Developmental Effects:

- No information is available on the developmental or reproductive effects of chlorine in humans or animals via inhalation exposure.
- Animal studies have demonstrated no evidence of reproductive or developmental effects from ingestion exposure to chlorine. (2)
- Since chlorine is highly reactive, uptake at sites such as the ovaries and testes which are remote from the respiratory tract, is anticipated to be minimal. (2)

#### Cancer Risk:

- No information is available on the carcinogenic effects of chlorine in humans from inhalation exposure.
- Several human studies have investigated the relationship between exposure to chlorinated drinking water and cancer. These studies were not designed to assess whether chlorine itself causes cancer, but whether trihalomethanes or other organic compounds occurring in drinking water as a result of chlorination are associated with an increased risk of cancer. These studies show an association between bladder and rectal cancer and chlorination byproducts in drinking water. (5)
- An NTP study reported no evidence of carcinogenic activity in male rats or male and female mice, and equivocal evidence, based on an increase in mononuclear cell leukemia, in female rats, from ingestion of chlorinated or chloraminated water. (9)
- EPA has not classified chlorine for carcinogenicity. (2)

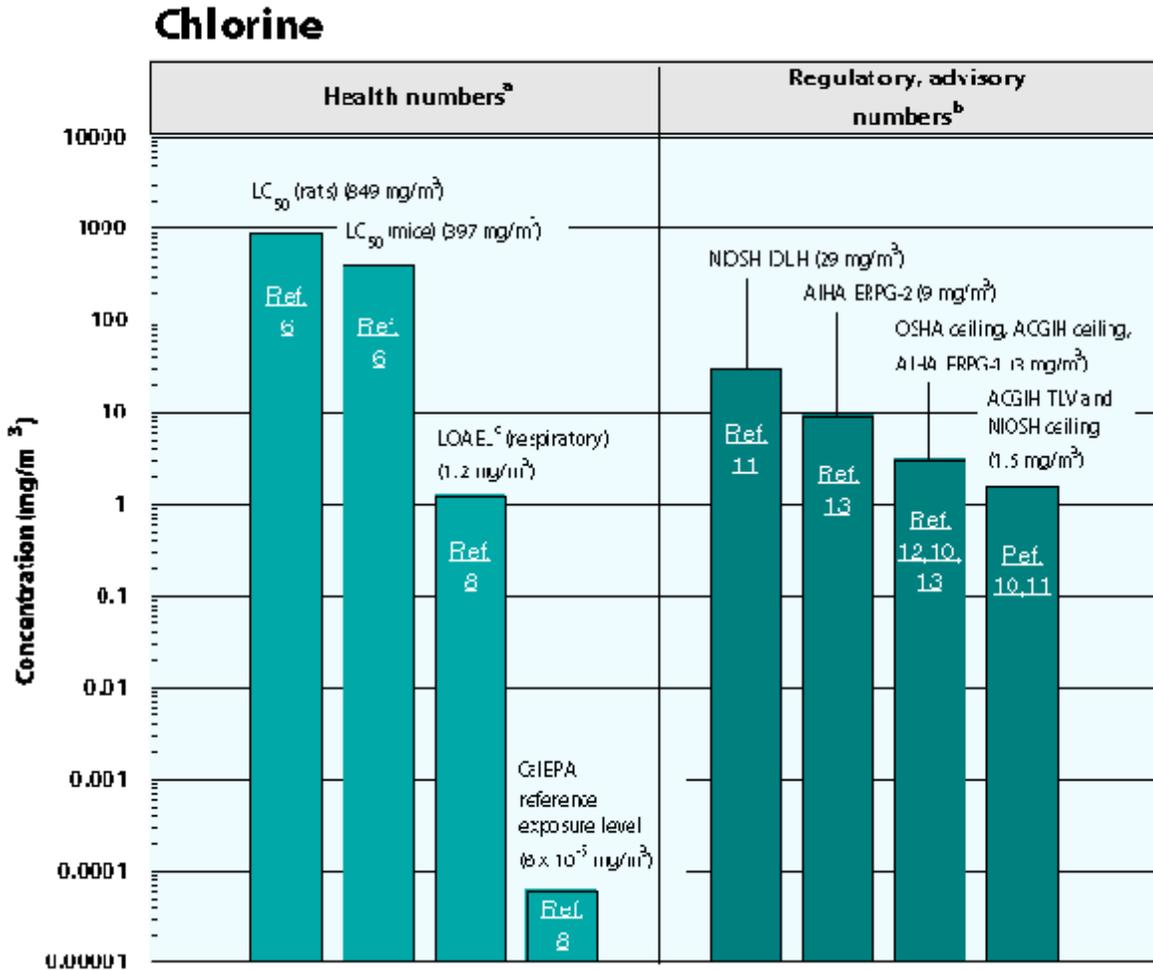
## Physical Properties

- Chlorine is a greenish–yellow gas that is slightly soluble in water. (4)
- Chlorine has a suffocating odor; the odor threshold is 0.31 ppm. (7)
- The chemical formula for chlorine is Cl<sub>2</sub>, and its molecular weight is 70.90 g/mol. (4)

Conversion Factors:

To convert concentrations in air (at 25°C) from ppm to mg/m<sup>3</sup>:  $\text{mg/m}^3 = (\text{ppm}) \times (\text{molecular weight of the compound}) / (24.45)$ . For chlorine: 1 ppm = 2.9 mg/m<sup>3</sup>.

Health Data from Inhalation Exposure



AIHA ERPG--American Industrial Hygiene Association's emergency response planning guidelines. ERPG 1 is the maximum airborne concentration below which it is believed nearly all individuals could be exposed up to one hour without experiencing other than mild transient adverse health effects or perceiving a clearly defined objectionable odor; ERPG 2 is the maximum airborne concentration below which it is believed nearly all individuals could be exposed up to one hour without experiencing or developing irreversible or other serious health effects that could impair their abilities to take protective action.

ACGIH TLV--American Conference of Governmental and Industrial Hygienists' threshold limit value expressed as a time-weighted average; the concentration of a substance to which most workers can be exposed without adverse effects.

ACGIH ceiling--American Conference of Governmental and Industrial Hygienists' threshold limit value ceiling; the concentration of a substance that should not be exceeded during any part of the working exposure.

LC<sub>50</sub> (Lethal Concentration<sub>50</sub>)--A calculated concentration of a chemical in air to which exposure for a specific

length of time is expected to cause death in 50% of a defined experimental animal population.

LOAEL--Lowest-observed-adverse-effect level.

NIOSH IDLH -- National Institute of Occupational Safety and Health's immediately dangerous to life or health concentration; NIOSH recommended exposure limit to ensure that a worker can escape from an exposure condition that is likely to cause death or immediate or delayed permanent adverse health effects or prevent escape from the environment.

NIOSH ceiling --National Institute of Occupational Safety and Health's recommended exposure limit ceiling; the concentration that should not be exceeded at any time.

OSHA ceiling --Occupational Safety and Health Administration's permissible exposure limit ceiling value; the concentration of a substance that should not be exceeded at any time.

The health and regulatory values cited in this factsheet were obtained in December 1999.

<sup>a</sup> Health numbers are toxicological numbers from animal testing or risk assessment values developed by EPA.

<sup>b</sup> Regulatory numbers are values that have been incorporated in Government regulations, while advisory numbers are nonregulatory values provided by the Government or other groups as advice. OSHA numbers are regulatory, whereas NIOSH, ACGIH, and AIHA numbers are advisory.

<sup>c</sup> This LOAEL is from the critical study used as the basis for California EPA's reference exposure level.

Summary created in April 1992, updated in January 2000.

## References

1. U.S. Environmental Protection Agency. Drinking Water Criteria Document for Chlorine, Hypochlorous Acid and Hypochlorite Ion. (External Review Draft.) Environmental Criteria and Assessment Office, Office of Health and Environmental Assessment, Cincinnati, OH. 1992.
2. U.S. Environmental Protection Agency. [Integrated Risk Information System \(IRIS\) on Chlorine](#). National Center for Environmental Assessment, Office of Research and Development, Washington, DC. 1999.
3. U.S. Department of Health and Human Services. Hazardous Substances Data Bank (HSDB, [online database](#)). National Toxicology Information Program, National Library of Medicine, Bethesda, MD. 1993.
4. E.J. Calabrese and E.M. Kenyon. [Air Toxics and Risk Assessment](#). Lewis Publishers, Chelsea, MI. 1991.
5. R.D. Morris, A. Audet, I.F. Angelillo, T. C. Chalmers, and F. Mosteller. Chlorination, Chlorination by-products, and cancer: A meta-analysis. *American Journal of Public Health*, 82(7):955-977. 1992.
6. U.S. Department of Health and Human Services. [Registry of Toxic Effects of Chemical Substances](#) (/li>
7. J.E. Amore and E. Hautala. Odor as an aid to chemical safety: Odor thresholds compared with threshold limit values and volatilities for 214 industrial chemicals in air and water dilution. *Journal of Applied Toxicology*, 3(6):272-290. 1983.
8. [California Environmental Protection Agency \(CalEPA\)](#). Air Toxics Hot Spots Program Risk Assessment Guidelines: Part III. Technical Support Document for the Determination of Noncancer Chronic Reference Exposure Levels. SRP Draft. Office of Environmental Health Hazard Assessment, Berkeley, CA. 1999.
9. National Toxicology Program (NTP). [Toxicology and Carcinogenesis Studies of Chlorinated Water \(CAS Nos. 7782-50-5 and 7681-52-9\) and Chloraminated Water \(CAS No. 10599-90-3\) \(Deionized and Charcoal-Filtered\) in F344/N Rats and B6C3F1 Mice \(Drinking Water Studies\)](#). TR-392. 1992.
10. American Conference of Governmental Industrial Hygienists (ACGIH). 1999 TLVs and BEIs. Threshold Limit Values for Chemical Substances and Physical Agents. Biological Exposure Indices. Cincinnati, OH. 1999.
11. National Institute for Occupational Safety and Health (NIOSH). [Pocket Guide to Chemical Hazards](#). U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention. Cincinnati, OH. 1997.
12. Occupational Safety and Health Administration (OSHA). Occupational Safety and Health Standards, Toxic and Hazardous Substances. Code of Federal Regulations. 29 CFR 1910.1000. 1998.
13. American Industrial Hygiene Association (AIHA). [The AIHA 1998 Emergency Response Planning Guidelines and Workplace Environmental Exposure Level Guides Handbook](#). 1998.