

# Tetrachloroethylene (Perchloroethylene)

127-18-4

---

## Hazard Summary

Tetrachloroethylene is widely used for dry-cleaning fabrics and metal degreasing operations. Effects resulting from acute (short term) high-level inhalation exposure of humans to tetrachloroethylene include irritation of the upper respiratory tract and eyes, kidney dysfunction, and neurological effects such as reversible mood and behavioral changes, impairment of coordination, dizziness, headache, sleepiness, and unconsciousness. The primary effects from chronic (long term) inhalation exposure are neurological, including impaired cognitive and motor neurobehavioral performance. Tetrachloroethylene exposure may also cause adverse effects in the kidney, liver, immune system and hematologic system, and on development and reproduction. Studies of people exposed in the workplace have found associations with several types of cancer including bladder cancer, non-Hodgkin lymphoma, multiple myeloma. EPA has classified tetrachloroethylene as likely to be carcinogenic to humans.

---

Please Note: The main sources of information for this fact sheet are EPA's Integrated Risk Information System (IRIS) (2), which contains information on inhalation chronic toxicity and the RfC, oral chronic toxicity and the RfD, and the carcinogenic effects of tetrachloroethylene; and the Agency for Toxic Substances and Disease Registry's (ATSDR's) Toxicological Profile for Tetrachloroethylene. (1)

## Uses

- Tetrachloroethylene is used for dry cleaning and textile processing, as a chemical intermediate, and for vapor degreasing in metal-cleaning operations. (1)

## Sources and Potential Exposure

- Over the past few decades, concentrations of tetrachloroethylene detected in ambient air have declined with reductions in the use of tetrachloroethylene. (2)
- Tetrachloroethylene has also been detected in drinking water supplies from contaminated groundwater sources. (2)
- Occupational exposure to tetrachloroethylene primarily occurs in industries using the chemical (e.g., many dry cleaning facilities) and at industries manufacturing the chemical. New dry cleaning technologies and practices introduced over the past couple of decades result in substantially reduced occupational exposure (1, 2)

## Assessing Personal Exposure

- Tetrachloroethylene can be measured in the breath, and breakdown products of tetrachloroethylene can be measured in the blood and urine. (1)

## Health Hazard Information

### Acute Effects:

- Effects resulting from acute, inhalation exposure of humans to tetrachloroethylene vapors include irritation of the upper respiratory tract and eyes, kidney dysfunction, and at lower concentrations, neurological effects, such as reversible mood and behavioral changes, impairment of coordination, dizziness, headache, sleepiness, and unconsciousness. (1, 2)
- Animal studies have reported effects on the liver, kidney, and central nervous system (CNS) from acute inhalation exposure to high levels of tetrachloroethylene. (1, 2)
- Acute animal tests in mice have shown tetrachloroethylene to have low toxicity from inhalation and oral exposure. (1)

#### Chronic Effects (Noncancer):

- The major effects from chronic inhalation exposure to tetrachloroethylene in humans are neurological effects, including sensory symptoms such as headaches, impairments in cognitive and motor neurobehavioral functioning and color vision decrements. Other effects noted in humans, generally at higher exposures, include liver damage, kidney effects, immune and hematologic effects, and on development and reproduction. (1, 2)
- Animal studies have reported effects on the liver, kidney, and CNS from chronic inhalation exposure to tetrachloroethylene. (1, 2)
- EPA has calculated a Reference Concentration (RfC) of 0.04 milligrams per cubic meter (0.04 mg/m<sup>3</sup>) based on neurotoxicity in occupationally-exposed adults. The RfC is an estimate (with uncertainty spanning perhaps an order of magnitude) of a continuous inhalation 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 an estimator of risk but rather a reference point to gauge the potential for effects. At exposures increasingly greater than the RfC, the potential for adverse health effects increases. Lifetime exposure above the RfC does not imply that an adverse effect would necessarily occur. (2)
- The Reference Dose (RfD) for tetrachloroethylene is 0.006 milligrams per kilogram body weight per day (mg/kg/d) based on neurotoxicity in occupationally-exposed adults. 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 for 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 both the RfC and RfD values overall. Although EPA's confidence in the evidence of neurotoxicological hazard is high, EPA has medium rather than high confidence in the study estimates they were based on because they were derived from a LOAEL rather than a NOAEL and data were insufficient for dose-response modeling; additionally, the studies focus on occupational subjects and lack data to characterize potential susceptibility and variability across humans. EPA has medium confidence in the database due to limitations in both the available human and animal database (4)

#### Reproductive/Developmental Effects:

- Some adverse reproductive effects, such as menstrual disorders, altered sperm structure, and reduced fertility, have been reported in studies of workers occupationally exposed to tetrachloroethylene. However, the evidence is inconclusive. (2)
- Some studies of residents exposed to drinking water contaminated with tetrachloroethylene and other solvents during pregnancy suggest an association of tetrachloroethylene exposure with birth defects, however firm conclusions cannot be drawn due to several limitations of these studies. (2)
- Increased fetal resorptions and effects to the fetus have been reported in animals exposed to high levels of tetrachloroethylene by inhalation. (2)

## Cancer Risk:

- Studies of dry cleaning workers exposed to tetrachloroethylene have shown associations between exposure to tetrachloroethylene and several types of cancer, specifically bladder cancer, non-Hodgkin lymphoma and multiple myeloma. There is also limited evidence suggestive of associations with esophageal, kidney, cervical and breast cancer. (2)
- Animal studies have reported an increased incidence of liver tumors in mice, from inhalation and gavage (experimentally placing the chemical in the stomach) exposure, and kidney and mononuclear cell leukemias in rats, via inhalation exposure. (1,2)
- EPA has classified tetrachloroethylene as likely to be carcinogenic to humans by all routes of exposure based on suggestive evidence in epidemiological studies and conclusive evidence in rats (mononuclear cell leukemia) and mice (increased incidence of liver tumors). The International Agency for Research on Cancer (IARC) has classified tetrachloroethylene as probably carcinogenic to humans (Group 2A).
- EPA uses mathematical models, based on animal or human studies, to estimate the probability of a person developing cancer from breathing air containing a specified concentration of a chemical. EPA calculated an inhalation unit risk estimate of  $2.6 \times 10^{-7} (\mu\text{g}/\text{m}^3)^{-1}$ . EPA estimates that, if an individual were to continuously breathe air containing tetrachloroethylene at an average of  $4 \mu\text{g}/\text{m}^3$  ( $4 \times 10^{-3} \text{ mg}/\text{m}^3$ ) over his or her entire lifetime, that person would theoretically have no more than a one-in-a-million increased chance of developing cancer as a direct result of breathing air containing this chemical. Similarly, EPA estimates that continuously breathing air containing  $40 \mu\text{g}/\text{m}^3$  ( $4 \times 10^{-2} \text{ mg}/\text{m}^3$ ) would result in not greater than a one-in-a-hundred thousand increased chance of developing cancer, and air containing  $400 \mu\text{g}/\text{m}^3$  ( $4 \times 10^{-1} \text{ mg}/\text{m}^3$ ) would result in not greater than a one-in-ten thousand increased chance of developing cancer. For a detailed discussion of confidence in the potency estimates, please see IRIS.
- EPA calculated an oral cancer slope factor of  $0.0021 (\text{mg}/\text{kg}/\text{d})^{-1}$  based on extrapolation from inhalation dose-response data. (2)

## Physical Properties

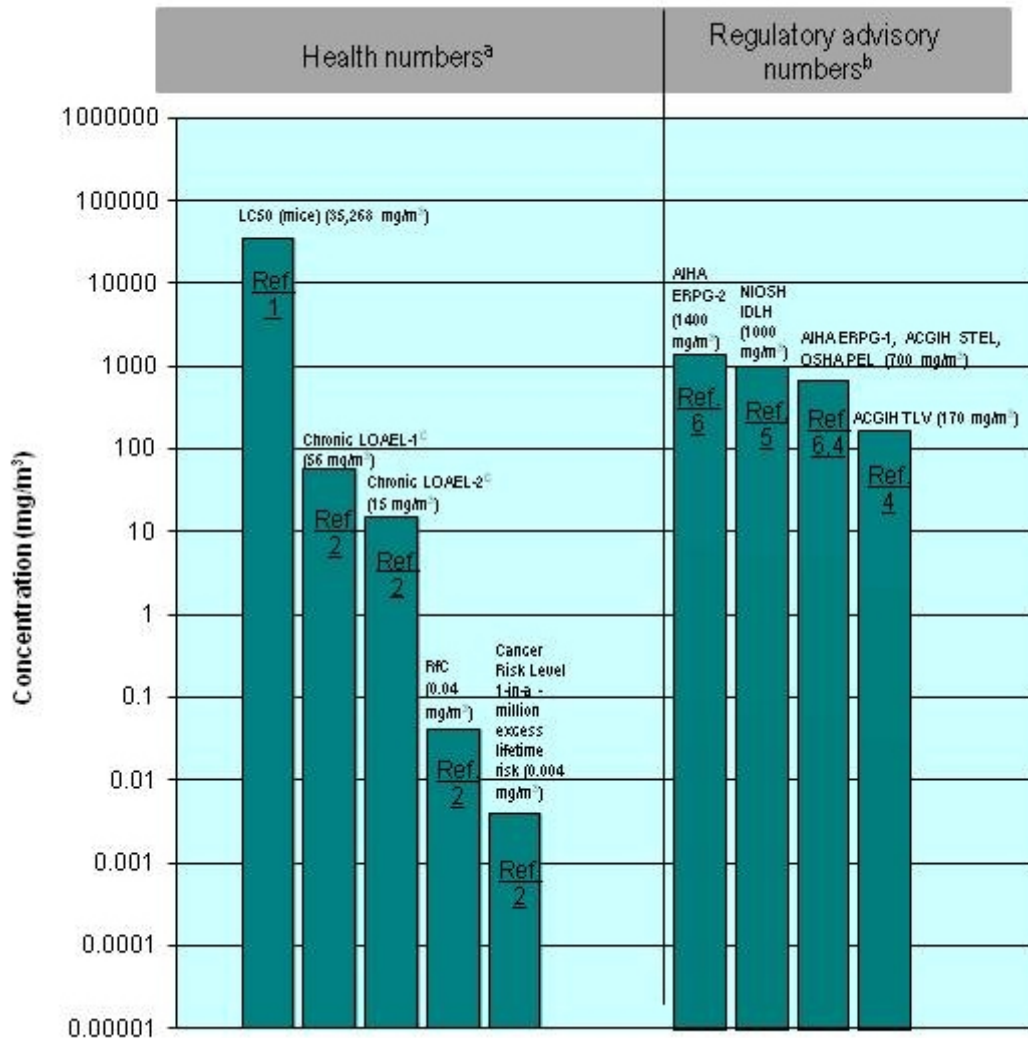
- Tetrachloroethylene is a nonflammable colorless liquid with a sharp sweet odor; the odor threshold is 1 ppm. (1)
- The chemical formula for tetrachloroethylene is  $\text{C}_2\text{Cl}_4$ , and the molecular weight is 165.83 g/mol. (1)
- The vapor pressure for tetrachloroethylene is 18.47 mm Hg at 25 °C, and it has a log octanol/water partition coefficient ( $\log K_{ow}$ ) of 3.40. (1)

---

## Conversion Factors:

To convert concentrations in air (at 25 °C) from ppm to  $\text{mg}/\text{m}^3$ :  $\text{mg}/\text{m}^3 = (\text{ppm}) \times (\text{molecular weight of the compound}) / (24.45)$ . For tetrachloroethylene:  $1 \text{ ppm} = 6.78 \text{ mg}/\text{m}^3$ . To convert concentrations in air from  $\mu\text{g}/\text{m}^3$  to  $\text{mg}/\text{m}^3$ :  $\text{mg}/\text{m}^3 = (\mu\text{g}/\text{m}^3) \times (1 \text{ mg}/1,000 \mu\text{g})$ .

## 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.

LC50 (Lethal Concentration50) – 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.

ACGIH STEL – American Conference of Governmental and Industrial Hygienists' recommended short-term exposure limit; a 15-minute TWA exposure which should not be exceeded at any time during a workday.

OSHA PEL – Occupational Safety and Health Administration's permissible exposure limit expressed as a time-

weighted average; the concentration of a substance to which most workers can be exposed without adverse effect averaged over a normal 8-h workday or a 40-h workweek.

The health and regulatory values cited in this factsheet were obtained in 2012.

<sup>a</sup> Health numbers are toxicological numbers from human studies, 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> The LOAELs for neurological effects are from the two principal studies on which the RfC is based.

Summary created in April 1992, updated January 2000

## References

1. Agency for Toxic Substances and Disease Registry (ATSDR). *Toxicological Profile for Tetrachloroethylene (Update)*. U.S. Public Health Service, U.S. Department of Health and Human Services, Atlanta, GA. 1997.
2. U.S. Environmental Protection Agency. *Integrated Risk Information System (IRIS) on Tetrachloroethylene*. National Center for Environmental Assessment, Office of Research and Development, Washington, DC. 2012.
3. National Institute for Occupational Safety and Health (NIOSH). *Control of Exposure to Perchloroethylene in Commercial Drycleaning*. Publication Number 97-154. 1997.
4. American Conference of Governmental and Industrial Hygienists (ACGIH). *2009 Guide to Occupational Exposure Values*. ACGIH, Cincinnati, OH. 2009.
5. 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. 2007.
6. American Industrial Hygiene Association (AIHA). *The AIHA 2011 Emergency Response Planning Guidelines and Workplace Environmental Exposure Level Guides Handbook*. 2011.