

Perchloroethylene - A Common Air Pollutant

Background

Perchloroethylene (C_2Cl_4 , CAS number: 127-18-4) — also known as PERC or tetrachloroethylene — is a chlorinated volatile organic compound (VOC) often found in the indoor and outdoor air. Sources of perchloroethylene in the indoor air include metal and stone cleaners, lubricants, stain removers, adhesives, and solvent based paints and sealants. Perchloroethylene emissions have been measured from various electronic equipment, most likely as a result of cleaning processes on components.

Perchloroethylene is commonly used as a dry-cleaning solvent, and dry-cleaned clothes and furnishings are often the primary source of indoor emissions.

Indoor levels up to $150 \mu\text{g}/\text{m}^3$ can be reached. Because of its suspected toxicity, the use of perchloroethylene in dry cleaning is being reduced due to voluntary change or regulation, and indoor levels are expected to decrease. Recent data show that perchloroethylene is often found in the air of newly constructed buildings with levels typically ranging from $5\text{-}20 \mu\text{g}/\text{m}^3$.

Health Concerns

Perchloroethylene exposure can occur through inhalation, dermal contact, and ingestion. Indoor exposure often leads to irritation of the eyes and upper respiratory tract, headaches, and dizziness. More chronic long-term exposure, which happens most frequently in occupational situations, can lead to more significant health impacts. These include liver and kidney damage, adverse reproductive effects, and reduced cognitive performance. Currently, perchloroethylene is classified as



a probable carcinogen due to evidence of increased risk of mononuclear cell leukemia and liver tumor development after exposure.

Acceptable Exposure Levels

There are no regulated standards for acceptable indoor levels in nonindustrial environments such as homes, offices, and schools. Below is a list of some U.S. and global organizations with recommended exposure limits/odor thresholds (Table 1).

TABLE 1: PERCHLOROETHYLENE EXPOSURE AND EMISSION STANDARDS

Organization or Standard	Application	Exposure Limit	Additional Information
CA 01350 Specification	Product emissions	17.5 µg/m ³	CDPH SM 01350 sets allowable concentrations that emission levels from building products and materials must meet within 14 days after installation. Certification programs like CHPS, GREENGUARD gold, and BIFMA have adopted this requirement.
American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE)	General air/ Indoor air	35 µg/m ³	ASHRAE defines indoor air quality (IAQ) requirements for VOCs as general guidance for building design, diagnostics, and ventilation system design in ASHRAE 189.1.
California Office of Environmental Health Hazard Assessment (OEHHA)	General air/ Indoor air	REL: 35 µg/m ³ (chronic)	Reference exposure levels (RELs) address non-cancer health effects of volatile organic compounds (VOCs) and provide concentrations below which these health effects have been observed in studies.
The United States Environmental Protection Agency (U.S. EPA)	Inhalation and oral exposure	RfC: 0.04 mg/m ³ RfD: 0.006 mg/kg/day for nervous and respiratory systems	The U.S. EPA maintains the Integrated Risk Information System (IRIS), a database of information on noncancer and cancer health effects that may result from exposure to various substances in the environment, based on toxicological reviews. IRIS has a reference concentration for inhalation exposure (RfC) and a reference dose for oral exposure (RfD). RfD is an estimate of a daily exposure to the human population that is likely to be without an appreciable risk of deleterious effects during a lifetime.
CDC's Agency for Toxic Substances and Disease Registry (ATSDR)	General air/ Indoor air	MRL Inhalation: 0.006 ppm or 0.04 mg/m ³ (chronic) MRL Oral: 0.008 mg/kg/day (acute)	The CDC's Agency for Toxic Substances and Disease Registry (ATSDR) has developed Minimal Risk Levels (MRLs) which estimate the daily level to which a substance may be exposed without the likelihood of adverse, non-cancer health effects. MRLs are derived for acute (1 - 14 days), intermediate (>14 - 364 days), and chronic (365 days and longer) exposure durations.

Organization or Standard	Application	Exposure Limit	Additional Information
California The Division of Occupational Safety and Health (Cal/OSHA)	Occupational	PEL: 25 ppm (169.6 mg/m ³)	California has the most extensive list of occupational exposure limits of all states in the US reported as permissible exposure limit (PEL).
American Conference of Governmental Industrial Hygienists (ACGIH)	Occupational	TLV (TWA): 25 ppm (169.6 mg/m ³)	Threshold Limit Values (TLV@s) are guidelines for the level of exposure that the typical worker can be exposed to without adverse health effects. They are not quantitative estimates of risk at different exposure levels or by different routes of exposure.
Occupational Safety and Health Administration (OSHA)	Occupational	PEL (TWA): 100 ppm (678.2 mg/m ³)	Permissible exposure limits (PELs) are how OSHA defines the maximum concentration of chemicals to which a worker may be exposed. PELs are defined in two ways: STEL (15-minute time-weighted average not to be exceeded) or an 8-hour total weight average (TWA), which is an average value of exposure over an eight-hour work shift.

REFERENCES:

1. National Center for Biotechnology Information. *PubChem Compound Summary for CID 31373, Tetrachloroethylene*, 2022.
2. Guyton, K. Z.; Hogan, K. A.; Siegel Scott, C.; Cooper, G. S.; Bale, A. S.; Kopylev, L.; Barone Jr., S.; Markis, S. L.; Glenn, B.; Subramaniam, R. P.; Gwinn, M. R.; Dzubow, R. C.; Chiu, W. A. Human Health Effects of Tetrachloroethylene: Key Findings and Scientific Issues. *Environmental Health Perspectives* **2014**, 122 (4). <https://doi.org/10.1289/ehp.1307359>.
3. Nijhuis, N.; Loh, M.; Harrison, P. Tetrachloroethylene. In WHO Guidelines for Indoor Air Quality: Selected Pollutants; *World Health Organization: Geneva*, 2010.
4. Tetrachloroethylene | Toxzone | ATSDR. https://www.atsdr.cdc.gov/sites/toxzone/tetrachloroethylene_toxzone.html (accessed 2022-08-08).
5. Goodman, J. E.; Ticknor, R. C.; Zhou, J. Systematic Review of Perchloroethylene and Non-Hodgkin's Lymphoma. *Global Epidemiology* **2022**, 4 (100077). <https://doi.org/10.1016/j.gloepi.2022.100077>.

