TECHNICAL BRIEF

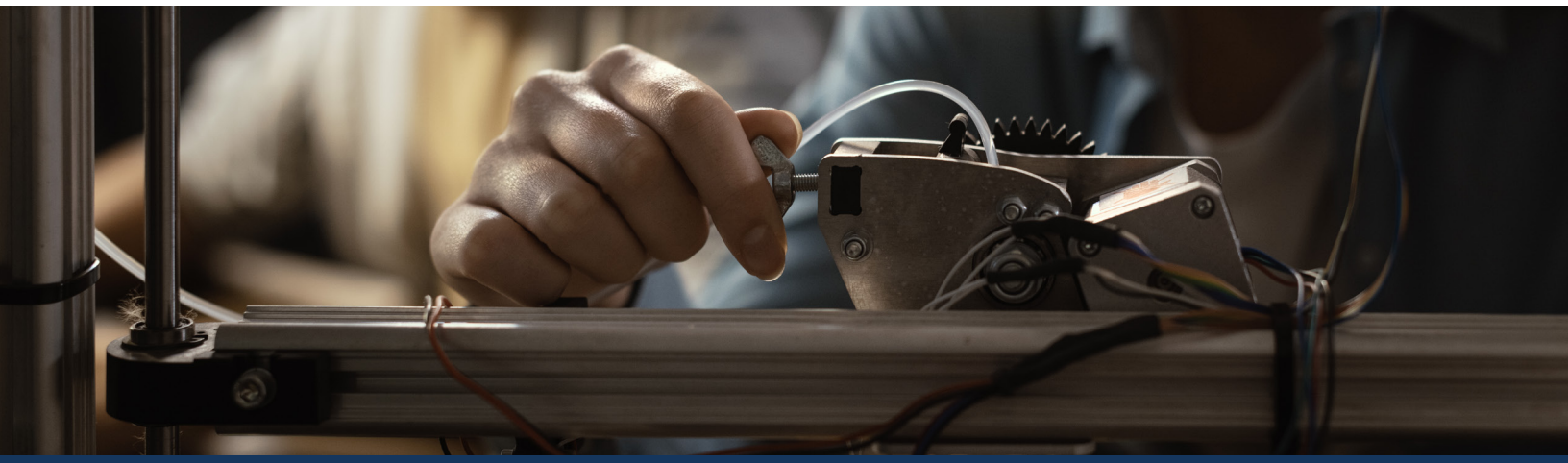
Tetrahydrofuran—A Common Air Pollutant

Background

Tetrahydrofuran (C_4H_8O, CAS Number 109-99-9), also known as THF, 1,4-Epoxybutane, or Oxolane, is a colorless volatile organic compound (VOC) that readily vaporizes at room temperature. THF is a solvent used in the preparation of resins, adhesives, paints, printing inks, and plastics composites and is also used as a wetting agent for textiles. It can be found in the indoor air, resulting from emissions of various consumer products containing composite plastics, polymers, and adhesives. THF is a cyclic ether with an ethereal or acetone-like odor. The odor threshold for THF is between 2 – 7 ppm. THF is frequently found in the emissions of operating electronic equipment including 3D printers and various printing processes where inks and plastics are used. A common indoor air level of THF is less than 10 $\mu g/m^3$.

Health Concerns

THF is absorbed and systemically distributed throughout the body by multiple routes of exposure. The primary exposure route for THF in environmental and occupational settings is via inhalation but dermal and ingestion exposures may occur as well. The average level of THF found in blood samples of U.S. residents is 0.103 ng/ml. THF vapors are irritating to the eyes and respiratory tract and cause headaches, dizziness, and nausea. At high exposure levels, THF can cause depression of the central nervous system, which may cause incapacitation. Dermal exposures lead to skin irritation and removal of skin lipids. The International Agency for Research on Cancer (IARC) classifies THF as a group 2B, a possible human carcinogen, based on studies that have confirmed the carcinogenic potential of THF in laboratory animals. THF was recently added to California Proposition 65 as a carcinogen.



Acceptable Exposure Levels

Exposure limits for THF in the occupational environment are based on flammability.

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 for various applications. **(Table 1)**

Table 1. *Tetrahydrofuran Exposure Limits*

ORGANIZATION OR STANDARD	APPLICATION	EXPOSURE LIMIT	ADDITIONAL INFORMATION
Ausschuss zur gesundheitlichen Bewertung von Bauprodukten (AgBB) Committee for Health-related Evaluation of Building Products	Indoor air	0.5 mg/m^3 (0.17 ppm)	The toxicological evaluation of substances emitted from building products is based on the determination of concentration levels below which there is no reason to expect adverse effects (LCI – Lowest Concentration of Interest).
United States Environmental Protection Agency (U.S. EPA)	Indoor/Outdoor air	2 mg/m^3 (0.67 ppm)	Reference Concentrations (RfC) represent concentrations to which healthy people may be exposed to throughout their lives with no deleterious acute health impacts on target organ systems. The RfC for THF is based on changes in liver size, weight, and central nervous system impacts observed in animal studies.
National Institute of Occupational Safety and Health (NIOSH)	Occupational/ Indoor air	2000 ppm (5900 mg/m^3)	Immediate Danger to Life and Health (IDLH) air concentration is based on 10% of the lower explosive limit.
Occupational Health and Safety Administration (OSHA-PEL)	Occupational/ Indoor air	200 ppm (590 mg/m^3)	Permissible exposure limit (PEL) is an OSHA regulatory value based on an average 8-hour exposure in occupational settings that represents the highest level of exposure without increasing risk of adverse health impacts for most employees.

National Institute of Occupational Safety and Health (NIOSH-REL)	Occupational/ indoor air	200 ppm (590 mg/m^3)	Recommended Exposure Limits (RELs) are health-based guidance values promulgated by NIOSH that represent average 10-hour occupational exposure levels set to protect employees from hazardous substances and conditions in the occupational environment.
American Conference of Governmental Industrial Hygienists (ACGIH- TLV)	Occupational/ Indoor air	TLV – 50 ppm (148 mg/m^3) TLV-STEL- 100 ppm (2950 mg/m^3)	Threshold Limit Values (TLVs) are created as regulatory guidance levels for 8-hour average exposure levels that are not anticipated to impact the health of employees. Threshold Limit Values – Short Term Exposure Limits (TLV-STELs) are 15-minute average exposure levels that should not be exceeded during a workday.
California The Division of Occupational Safety and Health (Cal/OSHA)	Occupational/ Indoor air	Cal/OSHA PEL – 200 ppm (590 mg/m^3) Cal/OSHA PEL STEL – 250 ppm (735 mg/m^3)	Cal/OSHA Permissible Exposure Limits (PELs) are created as regulatory guidance levels for 8-hour average exposure levels that are not anticipated to impact the health of employees. Threshold Limit Values – Short Term Exposure Limits (PEL-STELs) are 15-minute average exposure levels that should not be exceeded during a workday.
California Proposition 65	Toxic enforcement	Not applicable	Tetrahydrofuran listed as a chemical as known by the State of California to cause cancer.

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