

# Naphthalene - A Common Air Pollutant

## Background

Naphthalene (C<sub>10</sub>H<sub>8</sub>, CAS number: 91-20-3) is a polycyclic aromatic volatile organic compound (VOC) often found in the indoor and outdoor air.

*It is easily recognized because of its "mothball-like" smell and the fact that it has a very low odor threshold in the air (reported to be as low as 1 µg/m<sup>3</sup>).*

Naphthalene can be found in the emissions from numerous consumer products and building materials such as paints and coatings, plastic and carpet flooring systems, adhesives, air fresheners, disinfectants and insecticides. Indoor levels are typically low, less than 10 µg/m<sup>3</sup> but levels up to 300 µg/m<sup>3</sup> have been measured and are associated with new construction activities, furnishing materials, electronics and use of certain disinfectants. Naphthalene is a combustion byproduct and is found in the emissions of fires and cigarette smoking. Outdoors, it is primarily associated with vehicular exhaust and industrial sources. Recent research has indicated that new indoor sources include 3D printing and the infiltration of wildfire smoke.

## Health Concerns

Naphthalene exposure commonly occurs via inhalation, ingestion, and dermal contact, leading to various adverse health effects depending on the dosage and route of exposure. Indoor exposures are often noted by odor and lead to respiratory irritation, headache and nausea.



Acute or sub-chronic exposure to naphthalene is associated with skin (dermal contact) and respiratory irritation (inhalation), gastrointestinal distress (ingestion), eye damage (dermal contact), liver damage (inhalation or dermal contact), and hemolytic anemia (oral or inhalation). Further, neurologic symptoms such as headache, lethargy, confusion, and tremor can occur from high doses or repeated exposure to naphthalene. Chronic exposure to naphthalene is associated with health outcomes including respiratory hyperplasia and inflammation, cataracts, and retinal hemorrhage. Currently, naphthalene is listed as a possible human carcinogen (IARC group 2B), which can be associated with laryngeal and intestinal cancer development after chronic exposure. However, there is limited data to establish a causal effect of chronic naphthalene exposure on human cancer development.

## 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 for various applications (Table 1).

**TABLE 1: NAPHTHALENE EXPOSURE AND EMISSION STANDARDS**

Organization or Standard	Application	Exposure Limit	Additional Information
The United States Environmental Protection Agency (U.S. EPA)	Inhalation and oral exposure	<b>RfC:</b> 3 µg/m <sup>3</sup> <b>RfD:</b> 0.02 mg/kg/day for nervous and respiratory systems	The U.S. EPA maintains the Integrated Risk Information System (IRIS), a database on 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	<b>MRL Inhalation:</b> 0.0007 ppm or 3.67 µg/m <sup>3</sup> (chronic) <b>MRL Oral:</b> 0.6 (acute), 0.6 (intermediate) mg/kg/day	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.
CA 01350 Specification	Product emissions	4.5 µg/m <sup>3</sup>	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	9 µg/m <sup>3</sup>	ASHRAE defines indoor air quality (IAQ) requirements for VOCs as general guidance for building design, diagnostics, and ventilation system design in ASHRAE 189.1.
U.S. Green Building Council Leadership in Environment and Energy Design (LEED)	Indoor air	9 µg/m <sup>3</sup>	The LEED rating system specifies maximum acceptable concentrations for the clearance testing of air levels before a building or school is occupied.
California Office of Environmental Health Hazard Assessment (OEHHA)	General air/ Indoor air	REL = 9 µg/m <sup>3</sup> (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.

Organization or Standard	Application	Exposure Limit	Additional Information
Ausschuss zur gesundheitlichen Bewertung von Bauprodukten (AgBB)	General air/ Indoor air	LCI = 10 µg/m <sup>3</sup>	Ausschuss zur gesundheitlichen Bewertung von Bauprodukten (AgBB) sets Lowest Concentration of Interest (LCI) for VOC emissions from building products.
California The Division of Occupational Safety and Health (Cal/OSHA)	Occupational	PEL = 0.1 ppm (0.52 mg/m <sup>3</sup> )	California has the most extensive list of occupational exposure limits of all states in the U.S. reported as permissible exposure limit (PEL).
National Institute of Occupational Safety and Health (NIOSH)	Occupational	REL = 10 ppm (52.4 mg/m <sup>3</sup> )	NIOSH recommended exposure limits (RELs) are intended to limit exposure to hazardous substances in workplace air to protect worker health.
American Conference of Governmental Industrial Hygienists (ACGIH)	Occupational	TLV = 10 ppm (52.4 mg/m <sup>3</sup> )	Threshold Limit Values (TLV <sup>®</sup> 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	TWA = 10 ppm (52.4 mg/m <sup>3</sup> )	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:

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