



## Residential Indoor Air Quality Guideline

# TOLUENE

### Physical and chemical properties

Toluene is a clear, colourless liquid with a sweet, pungent odour. It is produced commercially, primarily through the catalytic conversion of petroleum or recovered as a by-product of the coke oven industry.

Molecular formula	C <sub>6</sub> H <sub>5</sub> CH <sub>3</sub>
Molecular weight	92.13 g/mol
Vapour pressure	28.7 mm Hg at 25°C
Boiling point	110.6°C
Conversion factor	1 ppm = 3.77 mg/m <sup>3</sup>

### Sources and Concentrations in Indoor Environments

A review of toluene sources and concentrations has been published by the World Health Organization (World Health Organization 1985). Exposure to toluene is generally via indoor air (United States Environmental Protection Agency 1992; Hodgson 2000; Kim, Harrad and Harrison 2001; Hodgson and Levin 2003; Won et al. 2005; Héroux et al. 2008). Indoor sources of toluene include building materials (e.g., solvent- and water-based adhesives, floor coverings, paint, chipboard), consumer and automotive products (e.g., cleaners, polishes, adhesive products, oils, greases, lubricants), and environmental tobacco smoke. In attached garages, toluene generated by running engines or by product storage may also infiltrate into the indoor environment.

Canadians' exposure to toluene is attributed predominantly to indoor air, because indoor air levels generally exceed ambient air levels, and because of the greater time spent indoors.

Median concentrations of toluene measured in Canadian residences range from 5.5 to 24.7 µg/m<sup>3</sup> (0.0055 to 0.0247 mg/m<sup>3</sup>) and average concentrations from 11.5 to 34.4 µg/m<sup>3</sup> (0.0115 to 0.0344 mg/m<sup>3</sup>) (Zhu et al. 2005; Héroux et al. 2008; Health Canada 2010b; Health Canada 2010c). Peak concentrations can reach values one to two orders of magnitude higher.

### Health Effects

Exposure to toluene has been shown to cause eye, nose, and throat irritation as well as headaches, dizziness, and feelings of intoxication. It has also been linked to neurological effects including poorer performances in tests of short-term memory, attention and concentration, visual scanning, perceptual motor speeds, and finger dexterity in the completion of physical tasks as well as negative effects on colour vision and auditory capacity.

In controlled exposure studies, healthy adults exposed to toluene for 4.5 to 7 hours reported increased eye, nose, and throat irritation as well as headaches, dizziness or feelings of intoxication at concentrations ranging from 189 to 566 mg/m<sup>3</sup> (Andersen, Lundqvist and Molhave 1983; Baelum et al. 1990), but not at 38 or 151 mg/m<sup>3</sup> (Andersen, Lundqvist and Molhave 1983).

Several occupational studies have reported effects of toluene on neurobehavioural endpoints (tests of manual dexterity, visual competency, and attention span) at concentrations ranging from 264 to 441 mg/m<sup>3</sup> (Foo, Phoon and Lee 1988; Foo, Jeyaratnam and Koh 1990; Boey, Foo and Jeyaratnam 1997; Eller, Netterstrom and Laursen 1999; Kang et al. 2005). No effects were seen at concentrations ranging from 75 to 113 mg/m<sup>3</sup> (Kang et al. 2005), nor was any difference seen between exposed workers (98 mg/m<sup>3</sup>) and a reference group (11 mg/m<sup>3</sup>) (Seeber et al. 2004; Seeber et al. 2005).

In general, results from animal studies are consistent with data obtained in occupational and controlled human exposure studies. There is evidence of airway inflammation and immunologic response in mice exposed to toluene as well as degeneration in the olfactory and respiratory epithelium of the nasal cavity, and hearing loss and neurological deficits in rats exposed to toluene. Similarities between the effects observed in animal studies and those seen in human studies strengthen the biological plausibility of a link between exposure to toluene and observed outcomes.

### Assessment under the *Canadian Environmental Protection Act, 1999 (CEPA 1999)*

Toluene was previously assessed as part of the First Priority Substances List (PSL1) Assessments under the 1988 *Canadian Environmental Protection Act* in 1992–1993. Toluene was considered as not entering the environment in a quantity or under conditions that may be harmful to the environment, or that may constitute a danger to the environment on which life depends or to human life or health.

On April 27, 2007, the Government of Canada released the Regulatory Framework for Air Emissions, which is a national plan to develop and implement regulations and other measures to reduce air emissions. As part of this plan, Health Canada, in consultation with provincial and territorial health departments, developed a priority list of indoor air contaminants that were national in scope and required government action. Through this process, toluene was identified as an indoor air priority pollutant.

## RESIDENTIAL INDOOR AIR QUALITY GUIDELINE FOR TOLUENE

A short-term exposure limit was derived based on a no observed adverse effect level (NOAEL) of 151 mg/m<sup>3</sup> from the study by Andersen et al. (1983) of healthy adult volunteers exposed for seven hours to toluene, and screened for neurologically-related symptoms (headaches, dizziness, intoxication). Applied to this NOAEL was an uncertainty factor of 10 (3.16 for pharmacokinetics and 3.16 for pharmacodynamics) to account for the potential differences in sensitivity among individuals.

A long-term exposure limit was derived from an NOAEL of 98 mg/m<sup>3</sup> from the studies by Seeber et al. (2004; 2005) of printing shop workers exposed for more than 20 years to toluene, and screened for neurobehavioural endpoints (attention span, psychomotor function, memory). This value was then adjusted to account for the difference in the duration of exposure for people in a workplace compared to a residence (i.e., from 8 hours/day, 5 days/week to 24 hours/day, 7 days/week). Applied to this value was an uncertainty factor of 10 (3.16 for pharmacokinetics and 3.16 for pharmacodynamics) to account for the potential differences in sensitivity among individuals.

The recommended short- and long-term maximum exposure limits for toluene are presented in the table below, along with the critical health effects on which they were based. The averages over 8- and 24-hour sampling times are recommended as appropriate indicators of short- and long-term exposure levels, respectively. Exposure to indoor air concentrations above these limits may result in potential health effects.

### Residential Maximum Exposure Limits for Toluene

EXPOSURE LIMIT	CONCENTRATION		CRITICAL EFFECT
	mg/m <sup>3</sup>	ppm	
Short-term	15	4.0	Neurologically-related symptoms (headaches, dizziness, and feelings of intoxication)
Long-term	2.3	0.6	Neurobehavioural test results

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