This fact sheet was created in 2000; some of the information may be out-of-date. NPIC is not planning to update this fact sheet. More pesticide fact sheets are available here. Please call NPIC with any questions you have about pesticides at 800-858-7378, Monday through Friday, 8:00 am to 12:00 pm PST.

NPTN General Fact Sheets are designed to answer questions that are commonly asked by the general public about pesticides that are regulated by the U.S. Environmental Protection Agency (U.S. EPA). This document is intended to be helpful to professionals and to the general public for making decisions about pesticide use.

Methyl Bromide

(Technical Fact Sheet)

Please refer to the **General Fact Sheet** for less technical information.

The Pesticide Label: Labels provide directions for the proper use of a pesticide product. *Be sure to read the entire label before using any product.* A signal word, on each product label, indicates the product's potential hazard.

CAUTION - low toxicity **WARNING - moderate toxicity** **DANGER - high toxicity**

What is methyl bromide?

- Methyl bromide is a broad spectrum fumigant used as an acaricide, fungicide, herbicide, insecticide, nematicide, and rodenticide (1). Methyl bromide was introduced as an insecticide in 1932 and was first registered in the United States in 1961 (1, 2).

- Methyl bromide is used primarily as a soil fumigant with secondary uses for perishable commodities and treatment of closed structures (3). The U.S. Environmental Protection Agency (EPA) has classified methyl bromide as a "Restricted Use Pesticide," i.e., a pesticide that may be purchased and used only by certified applicators or persons under their direct supervision (1). This classification is due to the acute toxicity of methyl bromide. See the **Pesticide Label** box above.

- Methyl bromide is a colorless, non-flammable gas that has no distinct odor except at high concentrations (4). Methyl bromide is a volatile chemical with a boiling point of 3.6 ^{o}C and a vapor pressure of 1,420 mmHg at 20 ^{o}C (5).

- The use of methyl bromide is currently being phased out by the U.S. EPA following U.S. obligations under the Montreal Protocol on Substances that Deplete the Ozone Layer (6). Beginning January 1, 2005, production and use of methyl bromide will cease in the U.S., except for emergency and critical use exemptions (6). For more information regarding the phase out of methyl bromide, visit the U.S. EPA Methyl Bromide Phase Out web site (http://www.epa.gov/docs/ozone/mbr/mbrqa.html).

- Methyl bromide is produced naturally and synthetically. The major emission sources in the environment are the oceans, biomass burning, and fumigation use (7, 8). The contribution of anthropogenic methyl bromide sources to global sources is currently unknown, but estimates range from 20-70% (9).

How does methyl bromide work?

- Manufacturers formulate methyl bromide as a pressurized liquid that converts to a gas upon pressure release (10). The gas diffuses to fill air spaces in enclosed areas and penetrates cracks, crevices, and pores in wood and soil (10). To be effective, a suitable concentration of methyl bromide must be contained at the application site for a sufficient period of time. Pesticide applicators cover fumigation sites with plastic tarpaulins or tents to confine the gas (10, 11). Methyl bromide dissipates from the application site after the procedure is complete (5, 11, 12, 13).

- Researchers believe that methyl bromide is directly toxic to cells because it damages multiple cellular sites (8, 14). Methyl bromide binds to DNA, lipids and proteins (8, 14).

Laboratory Testing: Before pesticides are registered by the U.S. EPA, they must undergo laboratory testing for short-term and long-term health effects. Laboratory animals are purposely fed high enough doses to cause toxic effects. These tests help scientists judge how these chemicals might affect humans, domestic animals, and wildlife in cases of overexposure. When pesticide products are used according to the label directions, toxic effects are not likely to occur because the amount of pesticide that people and pets may be exposed to is low compared to the doses fed to laboratory animals.

What are some products that contain methyl bromide?

- Brom-O-Gas®
- M B C
- M-B-R
- Meth-O-Gas®
- Terr-O-Gas®
- Other products not listed here

How toxic is methyl bromide?

Animals

- Methyl bromide is moderately toxic when ingested. The acute oral LD50 in rats is 214 mg/kg (1). See boxes on **Laboratory Testing**, **Toxicity Category,** and **LD50/LC50**.

- In short-term inhalation studies, methyl bromide is low in toxicity to mice [4 hr LC50 = 1,575 mg/m^3 (406 ppm)]* and very low in toxicity to rats [4 hr LC_{50} = 3,034 mg/m^3 (782 ppm)] (8).

LD50/LC50: A common measure of acute toxicity is the lethal dose (LD50) or lethal concentration (LC50) that causes death (resulting from a single or limited exposure) in 50 percent of the treated animals. LD50 is generally expressed as the dose in milligrams (mg) of chemical per kilogram (kg) of body weight. LC50 is often expressed as mg of chemical per volume (e.g., liter (L)) of medium (i.e., air or water) the organism is exposed to. Chemicals are considered highly toxic when the LD50/LC50 is small and practically non-toxic when the value is large. However, the LD50/LC50 does not reflect any effects from long-term exposure (i.e., cancer, birth defects, or reproductive toxicity) that may occur at levels below those that cause death.

- In a subchronic inhalation study, researchers exposed male and female mice to methyl bromide 6 hours a day, 5 days a week for 13 weeks at air concentrations of 0, 29, 58, 117, or 234 mg/m^3 (0, 7.5, 15, 30, or 60 ppm). They detected decreased body weights at 234 mg/m^3 and detected no toxic effects at the lower concentrations (8).

- In a chronic study, researchers exposed dogs to methyl bromide-fumigated food for one year at doses of 0, 0.06, 0.13, or 0.28 mg/kg/day in males and 0, 0.07, 0.12, or 0.27 mg/kg/day in females. They determined no observable adverse effect levels (NOAELs) of 0.28 mg/kg/day for male dogs and 0.27 mg/kg/day for female dogs (15).

Toxicity Category

	High Toxicity (*Danger*)	**Moderate Toxicity (*Warning*)**	**Low Toxicity (*Caution*)**	**Very Low Toxicity (*Caution*)**
Oral LD50	Less than 50 mg/kg	50 - 500 mg/kg	500 - 5000 mg/kg	Greater than 5000 mg/kg
Dermal LD50	Less than 200 mg/kg	200 - 2000 mg/kg	2000 - 5000 mg/kg	Greater than 5000 mg/kg
Inhalation LC50	Less than 0.05 mg/l	0.05 - 0.5 mg/l	0.5 - 2 mg/l	Greater than 2 mg/l
Eye Effects	Corrosive	Irritation persisting for 7 days	Irritation reversible within 7 days	Minimal effects, gone within 24 hrs
Skin Effects	Corrosive	Severe irritation at 72 hours	Moderate irritation at 72 hours	Mild or slight irritation

*Note : 1000 mg/m^3 = 1 mg/L
: Parts per million (ppm) = [(mg/m^3) x (24.45)]/(94.9)
: 24.45 = conversion factor 94.9 = Molecular weight of methyl bromide

- Animal studies demonstrate that the target organs for methyl bromide include the brain, kidney, nasal cavity, heart, adrenal gland, liver, testes, and lung (8, 17). Researchers have observed a steep dose-response curve in animal studies, i.e., a large increase in toxicity occurs with a small increase in dose (2, 8).

Humans

- Human experience and use history indicate that inhalation exposure to methyl bromide is highly toxic (1). Methyl bromide is corrosive to both the skin and eyes (1).

- The symptoms associated with methyl bromide poisoning may include headaches, nausea, vomiting, visual disturbances, malaise, confusion, loss of coordination, slurred speech, and skin, eye, and respiratory irritation (2, 8, 18, 19). In severe poisonings, paralysis, convulsions, coma, and death may occur (2, 8, 18, 19). Signs of methyl bromide poisoning are often delayed and may lag from only a few minutes to 48 hours post exposure (2, 8, 19).

- Researchers have suggested that low-level, chronic exposure to methyl bromide affects the nervous system, but the evidence supporting chronic toxicity is inconclusive (2, 19, 20, 21).

Does methyl bromide cause reproductive or teratogenic effects?

Animals

- Researchers exposed male and female rats to methyl bromide by inhalation at air concentrations of 0, 12, 117, or 350 mg/m^3 (0, 3, 30, or 90 ppm) for 6 hours a day, 5 days a week during premating, gestation, and lactation periods for two generations. Exposure to methyl bromide did not affect fertility but did decrease the body weights of parental rats and reduce the growth of progeny. The NOAELs for adult and progeny rats were 117 and 12 mg/m^3, respectively (22).

- Researchers exposed pregnant rabbits to methyl bromide by inhalation at air concentrations of 0, 78, 155, or 311 mg/m^3 (0, 20, 40, or 80 ppm) for 6 hours a day on gestation days 6-19. They observed an increased incidence of fused sternebrae and malformations in embryos at a level (311 mg/m^3) that produced maternal signs of nervous system toxicity and a decrease in the maternal body weight or body weight gain (8, 22).

Humans

- Data are not available from occupational exposure, accidental poisonings, or epidemiological studies regarding the reproductive and developmental toxicity of methyl bromide.

Is methyl bromide a carcinogen?

Animals

- Researchers administered methyl bromide by oral gavage (stomach tube) to male and female rats at doses of 0, 0.4, 2, 10, or 50 mg/kg for 5 days per week for 13 weeks. The rats displayed an increased incidence of forestomach cancer at 50 mg/kg (23). Researchers reevaluated the study and concluded that the effects were inflammation and increased cell growth, not cancer (8, 22).

- Male and female mice exposed by inhalation to methyl bromide at concentrations of 0, 10, 33, or 100 ppm (approximately 0, 39, 128, or 388 mg/m^3) for 6 hours per day, 5 days per week for up to 103 weeks displayed no evidence of cancer (17).

- Researchers often use studies designed to test for mutagenicity to screen chemicals for carcinogenicity. Evidence exists to classify methyl bromide as a mutagen (24).

Humans

- The U.S. EPA has classified methyl bromide as a group D carcinogen (25). This classification denotes that methyl bromide is not classifiable as to human carcinogenicity (25). See box on **Cancer**.

- In a study of male chemical workers, methyl bromide exposure was suggested as the common factor in two fatal cases of testicular cancer, but researchers could not reach definitive conclusions due to confounding factors (22).

Cancer: The U.S. EPA has strict guidelines that require testing of pesticides for their potential to cause cancer. These studies involve feeding laboratory animals large *daily* doses of the pesticide over most of the lifetime of the animal. Based on these tests, and any other available information, EPA gives the pesticide a rating for its potential to cause cancer in humans. For example, if a pesticide does not cause cancer in animal tests at large doses, then the EPA considers it unlikely the pesticide will cause cancer in humans. Testing for cancer is not done on human subjects.

- A study of fumigation workers generated evidence that DNA damage may be associated with methyl bromide exposure (26).

What is the environmental fate and behavior of methyl bromide?

- Methyl bromide volatilizes into air from soil and water (5).

- Methyl bromide contributes to stratospheric ozone depletion (6, 7). Researchers estimate that the lifetime of methyl bromide in the atmosphere ranges from 0.8 to 2 years (27).

- The volatilization half-life for methyl bromide from surface water ranges from 3.1 hours to 5 days (5). The degradation half-life of methyl bromide in water ranges from 20 to 38 days, depending on temperature and pH (5). See box on **Half-life**.

Half-life is the time required for half of the compound to degrade.

1 half-life	**=**	**50% degraded**
2 half-lives	**=**	**75% degraded**
3 half-lives	**=**	**88% degraded**
4 half-lives	**=**	**94% degraded**
5 half-lives	**=**	**97% degraded**

Remember that the amount of chemical remaining after a half-life will always depend on the amount of the chemical originally applied.

- Volatilization of methyl bromide from surface soil is rapid, with a half-life ranging from 0.2 to 0.5 days (5). The degradation half-life of methyl bromide in soil ranges from 31-55 days (28). Methyl bromide has a low affinity to bind to soils but is not considered a major contaminant of ground water (29).

What effects does methyl bromide have on wildlife?

- No data are available on the direct effects of methyl bromide on birds and wild mammals (8).

- Methyl bromide is considered low in toxicity to fish. In a 96 hour study, the LC_{50} values for freshwater (bluegill sunfish) and saltwater (tidewater silversides) fishes were 11 and 12 mg/L, respectively (8). In a separate study, the LC_{50} (4 hour) for carp was 17 mg/L (8). Studies indicate that methyl bromide will not significantly bioconcentrate in fish (8, 29).

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