Sources of Exposure

**General Populations**
- The levels of exposure to ethylene oxide in the environment are generally low; levels may be higher near places where ethylene oxide is produced or used.
- Ethylene oxide also enters the environment as a byproduct of tobacco smoke and when gas or diesel fuel are burned.
- Ethylene oxide is naturally formed by the oxidation of ethylene (which is also naturally formed by oxidation processes and the activity of intestinal bacteria). Therefore, the body naturally contains a certain amount of ethylene oxide, although it is very reactive and is rapidly metabolized and eliminated.

**Occupational Populations**
- Workers involved in the production or use of ethylene oxide may be exposed by breathing it in the workplace or getting it on the skin.

## Toxicokinetics and Normal Human Levels

### Toxikokinetiks
- Ethylene oxide is readily absorbed following inhalation or oral exposure.
- Absorbed ethylene oxide is widely distributed in the body.
- Ethylene oxide readily attaches to proteins and DNA.
- Ethylene oxide is readily metabolized and excreted rapidly, mostly in the urine.

### Normal Human Levels
- National survey of the U.S. general population conducted in 2015–2016 measured ethylene oxide hemoglobin adduct concentrations. The geometric mean values were 27.0 pmol/g hemoglobin in the nonsmoking population and 186 pmol/g hemoglobin in the cigarette-smoking population.

### Biomarkers
- Several biomarkers of exposure have been identified for ethylene oxide. These include the hemoglobin adduct HOEtVal (hydroxylated N-terminal valine), a DNA adduct, and the urinary metabolite, HEMA (5’-2-hydroxyethyl]mercapturic acid). The hemoglobin and DNA adducts are specific to ethylene oxide, whereas HEMA is a metabolite for several compounds.
- There are no biomarkers of effects that would be specific to ethylene oxide exposure.

## Environmental Levels

### Air
- Outdoor air: Air concentrations of ethylene oxide ranged from 0.136 μg/m³ (0.075 ppb) to 0.407 μg/m³ (0.224 ppb) in samples taken from October 2018 to September 2019 from 18 National Air Toxics Trend Stations and Urban Air Toxics Monitoring Networks.
- Indoor air: Not usually detected, but levels as high as 4 μg/m³ (2.2 ppb) were found in 1 out of 50 residences sampled.

### Sediment and Soil
- No data.

### Water
- Surface water: Not usually detected, but a concentration of 2 mg/L was reported in effluent from a chemical plant.
- Ground water: No data.
- Drinking water: No data.

## Reference
### Ethylene Oxide is Manmade
- Ethylene oxide is a colorless gas with a sweet, ether-like odor.
- Ethylene oxide is mostly used to produce other chemicals such as ethylene glycol.
- A small percentage of ethylene oxide produced is used in the sterilization or fumigation of certain equipment (particularly medical equipment), cosmetics, and food.

### Ethylene Oxide in the Environment
- Ethylene oxide breaks down slowly in air.
- Ethylene oxide in water or soil would likely evaporate rapidly, hydrolyze, or biodegrade.

### Routes of Exposure
- **Inhalation** – Most likely route of exposure for the general population and workers involved in ethylene oxide production or use.
- **Oral** – Not a likely route of significant human exposure to ethylene oxide.
- **Dermal** – A possible route of exposure for workers involved in ethylene oxide production or use.

### Health Effects
- Workers exposed to high levels of ethylene oxide in the air for short periods of time had lung irritation.
- Workers exposed to lower levels of ethylene oxide for various times reported having effects such as headaches, memory loss, numbness, nausea, and vomiting.

### Health effects are determined by the dose (how much), the duration (how long), and the route of exposure.

### Minimal Risk Levels (MRLs)

#### Inhalation
- An acute-duration (up to 14 days) inhalation MRL of 0.4 ppm was derived for ethylene oxide.
- An intermediate-duration (15–364 days) inhalation MRL of 0.02 ppm was derived for ethylene oxide.
- No chronic-duration inhalation MRL was derived for ethylene oxide.

#### Oral
- No acute-duration oral MRL was derived for ethylene oxide.
- No intermediate-duration oral MRL was derived for ethylene oxide.
- No chronic-duration oral MRL was derived for ethylene oxide.

### Children’s Health
- Children exposed to ethylene oxide would be expected to experience effects similar to those expected in adults.

### Based on limited data, there is some evidence that exposure to ethylene oxide can cause a pregnant woman to lose a pregnancy.

### Irritation in airway passages, nervous system effects, and reproductive effects were reported in experimental animals that breathed ethylene oxide during several months to years.

### Kidney effects and anemia (low amount of red blood cells) have also been reported in animals that inhaled ethylene oxide for several months.

### Higher risks of some blood and breast cancers have been reported in workers exposed to ethylene oxide.

### Leukemia, brain tumors, lung tumors, and other cancers were found in mice and rats that breathed ethylene oxide.

### The Department of Health and Human Services (HHS) has determined that ethylene oxide is known to be a human carcinogen. The U.S. Environmental Protection Agency (EPA) has concluded that inhalation exposure to ethylene oxide is carcinogenic to humans.