### Sources of Exposure

#### General Populations
- Exposure may occur by inhaling contaminated air or smoke from cigars or cigarettes.
- Exposure to very low levels via drinking water is possible but likely insignificant to health.
- Individuals living near hazardous waste sites and landfills may be exposed to higher amounts in air and drinking water.

#### Occupational Populations
- Occupational exposure occurs in individuals working in facilities where vinyl chloride is produced or used.
- Welding polyvinyl chloride is also a source of occupational exposure.
- Occupational exposure occurs primarily via the inhalation route of exposure.

### Toxicokinetics and Biomonitoring

#### Toxicokinetics
- Inhalation absorption of vinyl chloride in humans is rapid. Volunteers exposed to low concentrations retained about 42% of the inhaled amount.
- There are no data regarding oral or dermal absorption in humans.
- There are no data regarding distribution of vinyl chloride in humans.
- In animals, vinyl chloride metabolites were found in the liver, kidney, spleen, and brain.
- Vinyl chloride metabolism in humans is attributed to the P-450 monoxygenases in the liver. Metabolism of vinyl chloride is saturable.
- Intermediates are detoxified primarily via glutathione conjugation and excreted in the urine as cysteine derivatives.
- Excretion of metabolites occurs mainly in the urine at low exposures. At high doses, where metabolic saturation occurs, vinyl chloride is exhaled as the parent compound.
- Vinyl chloride does not accumulate in the body.

#### NHANES Biomonitoring
- No data are available

### Biomarkers/Environmental Levels

#### Biomarkers
- Vinyl chloride in exhaled air can be used as a biomarker of recent exposure, but is of limited utility for low-level exposures and must be measured shortly after exposure.
- Urinary levels of thiodiglycolic acid, a major metabolite of vinyl chloride, have been used to monitor occupational exposure to vinyl chloride, but it is not specific for exposure to vinyl chloride.

#### Environmental Levels

**Air**
- In 2013, background levels (24-hour maximum concentrations) of vinyl chloride were 0.005–2.37 ppbv at sites where vinyl chloride was detected (EPA's Air Quality System).

**Water**
- Analysis of surface water samples revealed levels below the lower quantification limit of 0.02 μg/L. The median concentration in groundwater samples was 1.1 μg/L between 1985 and 2001.

**Sediment and Soil**
- Vinyl chloride is rarely detected in soil and sediment samples, and the levels tend to be below quantification.

### Reference

### Chemical and Physical Information

**Vinyl Chloride is a Gas**
- Vinyl chloride is a manufactured substance, but it can be formed in the environment when other chlorinated substances are degraded by microorganisms.
- It is a gas at room temperature with a mild sweet odor.
- Vinyl chloride can exist as liquid under pressure or at low temperatures.
- It burns easily and is unstable at high temperatures.
- Vinyl chloride is only slightly soluble in water, but it is soluble in most common organic solvents.
- The main use of vinyl chloride is in the manufacture of polyvinyl chloride (PVC), a polymer used to make a variety of plastic products including pipes, wire and cable coatings, and packaging materials.

### Routes of Exposure

- **Inhalation** – The primary route of exposure for the general population and workers.
- **Oral** – No significant vinyl chloride exposure is expected from ingestion of drinking water.
- **Dermal** – Possible route of exposure for workers.

### Vinyl Chloride in the Environment

- Vinyl chloride can be released into the environment (mainly the air) during its production or use.
- In the air, it is degraded by reaction with photochemically-generated hydroxyl radicals; its half-life is about 1–2 days.
- Liquid vinyl chloride evaporates easily. Vinyl chloride in water or soil evaporates rapidly if it is near the surface.
- Vinyl chloride can migrate to groundwater. In anaerobic groundwater, degradation occurs slowly.
- Vinyl chloride is also mobile in soil and susceptible to leaching.
- Vinyl chloride does not accumulate in plants or in animals.

### Relevance to Public Health (Health Effects)

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

#### Minimal Risk Levels (MRLs)

**Inhalation**
- An MRL of 0.5 ppm has been derived for acute-duration inhalation exposure (≤14 days).
- An MRL of 0.02 ppm has been derived for intermediate-duration exposure (15–364 days).
- A chronic-duration inhalation MRL was not derived for vinyl chloride.

**Oral**
- No acute- or intermediate-duration oral MRLs were derived for vinyl chloride.
- An MRL of 0.003 mg/kg/day has been derived for chronic-duration exposure (≥365 days).

### Health Effects

- Long-term exposure of workers has resulted in alterations in the liver ranging from hypertrophy and hyperplasia to hepatocellular degeneration.
- Studies of workers who inhaled vinyl chloride over many years have shown an increased incidence of liver cancer.
- The Department of Health and Human Services (HHS) has categorized vinyl chloride as “known to be a human carcinogen.”
- The U.S. Environmental Protection Agency (EPA) has categorized it as a “known human carcinogen” by the inhalation route; carcinogenic by the oral route; and likely to be carcinogenic by the dermal route.
- The International Agency for Research on Cancer (IARC) concluded that vinyl chloride is “carcinogenic to humans” (Group 1).

#### Health Effects

- Acute, high-level exposure to vinyl chloride can produce headache, dizziness, drowsiness, and loss of consciousness. Extremely high-levels can be lethal.
- Exposure of workers to high levels of vinyl chloride has resulted in altered blood flow in the hands.

#### Children’s Health

- Children may be exposed vinyl chloride in PVC-based toys; however, amounts may be insignificant.
- Vinyl chloride can cross the placenta and enter the blood of the fetus.
- Animal studies suggest that infants and young children might be more susceptible than adults to vinyl-chloride induced cancer.