## Drinking Water Quality: Tetrachloroethene (PCE) Contaminant Levels

<table>
<thead>
<tr>
<th>Type of EPHT Indicator</th>
<th>Hazard, Exposure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measures</td>
<td>Level of Contaminant in Finished Water</td>
</tr>
<tr>
<td></td>
<td>1. Yearly distribution of number of Community Water Systems (CWS) by maximum PCE concentration (cut-points: 0-&lt;1, 1-&lt;2, 2-&lt;5, 5+ µg/L PCE).</td>
</tr>
<tr>
<td></td>
<td>2. Yearly distribution of number of CWS by mean PCE concentration (cut-points: 0-&lt;1, 1-&lt;2, 2-&lt;5, 5+ µg/L PCE).</td>
</tr>
<tr>
<td></td>
<td>3. Average Concentration of PCE, by Year.</td>
</tr>
</tbody>
</table>

### Potential Population Exposure to Contaminants in Finished Water

- Yearly distribution of number of people served by CWS by maximum PCE concentration (cut-points: 0-<1, 1-<2, 2-<5, 5+ µg/L PCE).
- Yearly distribution of number of people served by CWS by mean PCE concentration (cut-points: 0-<1, 1-<2, 2-<5, 5+ µg/L PCE).

### Derivation of Measures

PCE measures will be developed from water system attribute and water quality data stored in state Safe Drinking Water Act (SDWA) databases such as the Safe Drinking Water Information System (SDWIS/State). Data will be cleaned and transformed to a standard format. Analytical results of drinking water samples (usually taken at entry points to the distribution system or representative sampling points after treatment) will be used in conjunction with information about each CWS (such as service population and latitude and longitude of representative location of the CWS service area) to generate the measures.

### Units

PCE, µg/L

### Geographic Scope

State and Community Water System

### Geographic Scale

The finest detail will be the approximate point location of the community water distribution system represented by water withdrawal point, water distribution extents, principal county served, or principal city served.

### Time Period

2000-Most Recent Year Available

### Time Scale

Calendar year

### Rationale

**Tetrachloroethene (PCE) and Public Health**

Tetrachloroethene (PCE) is a volatile halogenated short-chain hydrocarbon. Tetrachloroethene is used in dry cleaning, metal cleaning, the synthesis of other chemicals, and household products such as water repellants, silicone lubricants, and spot removers. PCE is produced and used in high volumes in the U.S. and has been detected in urban and ambient air and occasionally in soils and drinking water most likely contaminated by industrial discharge (Moran et al., 2007; Rowe et al., 2007). Because of its volatility, this solvent does not persist in the soil or water following the discontinuation of contamination.

Inhalation is the most common exposure route for the general population including indoor sources from paints, adhesives, and cleaning solutions. Volatilization from contaminated water (e.g., shower water) as well as the use of household products containing this solvent can result in higher indoor than outdoor air concentrations (ATSDR, 1997; Martin et al.,...
Nearby dry cleaning establishments, industries producing PCE, and contaminated waste disposal sites can also contribute to human exposure (Armstrong and Green, 2004; ATSDR, 1997 and 2000; Schreiber et al., 1993; Wallace et al., 1991). Drinking water may contribute to exposure when underground drinking water supplies have been contaminated. Workers in industries such as dry cleaning, aircraft maintenance, electronics manufacturing, and chemical production may be exposed by inhalation or by dermal contact with PCE. The EPA has established drinking water standards and other environmental standards for PCE, and the FDA regulates PCE and trichloroethene as indirect food additives. Workplace standards have been established by OSHA, and ACGIH has recommended occupational guidelines and biological exposure indices for monitoring workers. Human health effects from PCE at low environmental doses or at biomonitored levels from low environmental exposures are unknown. PCE is well absorbed by ingestion and inhalation, and animal studies have demonstrated that liquid forms can be dermally absorbed. Following absorption, part of the solvent dose is excreted into expired air; for PCE, about 97-99% of the dose is eliminated unmetabolized into expired air, though it has an elimination half-life of several days (ATSDR 1997; Monster, 1986). The retained solvent can undergo hepatic metabolism. PCE is metabolized to trichloroacetic acid and trichloroethanol, which are eliminated in the urine. Accidental or intentional high dose acute exposure by ingestion or inhalation can result in loss of motor coordination, somnolence, and unconsciousness. Inhaling high doses of PCE may also produce cardiac arrhythmias attributed to enhanced sensitivity to catecholamines. High dose acute exposure to PCE has resulted in reversible kidney impairment, and prolonged, low level PCE exposure has been associated with altered renal enzyme excretion and liver enlargement (ATSDR, 1997). Chronic occupational exposure to PCE may be associated with mild degrees of neurological impairments, including reaction times, verbal skills, cognitive ability, and motor function (Armstrong and Green, 2004). Various epidemiologic studies of chronic PCE exposure in dry cleaning workers found increased incidences of esophageal and cervical cancers and non-Hodgkins lymphoma, but confounding exposures (e.g., other solvents and trichloroethene) were likely (IPCS, 2006). In animal studies, PCE-induced kidney and liver tumors and caused leukemia (IARC, 1995). IARC classifies PCE as a probable human carcinogen, and NTP classifies it as reasonably anticipated to be a human carcinogen (IARC, 1995; NTP, 2004). Additional information about these solvents is available from ATSDR at: http://www.atsdr.cdc.gov/toxprofiles/index.asp.

In an analysis of occurrence data from the EPA 6 Year Review of National Primary Drinking Water Regulations, PCE was detected in 1,262 systems serving close to 32 million people (EPA, 2009). Concentrations of PCE were greater than the MCL in 241 systems serving close to 15 million people. PCE was the fifth highest occurring regulated volatile organic chemical found based on the percent of detections found from the 6 Year Review data (EPA, 2009).

**Biomonitoring Information**

Levels of halogenated solvents in blood reflect recent exposure. In the NHANES 2003-2004 subsample, the level of blood PCE for adults at the 75th percentile of the U.S. population appear similar to the levels at the 75th percentile reported for non-smoking adults in a subsample of NHANES 1999-2000 participants (CDC, 2009; Lin et al., 2008) and were similar or slightly less than levels reported in a nonrepresentative subsample of the earlier NHANES III (1988-1994) (Ashley et al., 1994; Churchill et al., 2001). A recent study of low income, urban children in the Midwest reported slightly lower median PCE levels (Sexton et
Comparatively higher blood levels of PCE and trichloroethene have been noted for urban and industrial residential settings than for rural settings (Barkley et al., 1980; Begerow et al., 1996; Brugnone et al., 1994). Residing near dry-cleaning facilities or storing recently dry-cleaned clothes at home can contribute to increased blood PCE levels (Begerow et al., 1996; Popp et al., 1992). In contrast, PCE blood levels in occupationally exposed workers have been reported to be many thousand times higher than the general population (Begerow et al., 1996; Furuki et al., 2000; Monster et al., 1983). The occupational biological exposure index associated with an 8-hour exposure of 25 ppm is 500 µg/L PCE in blood (ACGIH, 2007). Non-occupational exposures are usually well below this level. Finding a measurable amount of any of these solvents in blood does not mean that the level of the solvent causes an adverse health effect. Biomonitoring studies of blood halogenated solvents can provide physicians and public health officials with reference values so that they can determine whether or not people have been exposed to higher levels of halogenated solvents than levels found in the general population. Biomonitoring data can also help scientists plan and conduct research on exposure and health effects.

**Sources of PCE**

The major source of PCE in drinking water is discharge from factories and dry cleaners. A federal law called the Emergency Planning and Community Right to Know Act requires facilities in certain industries, which manufacture, process, or use significant amounts of toxic chemicals, to report annually on their releases of these chemicals. For more information on the uses and releases of chemicals in your state, contact the Community Right-to-Know Hotline: (800) 424-9346 (EPA, 2010).

**PCE Regulation and Monitoring**

The EPA limits the amount of PCE that may be present in drinking water to 5 parts of PCE per billion parts of water (5 ppb), or 5 ug/L.

<table>
<thead>
<tr>
<th>Use of Measure</th>
<th>These measures can assist by addressing the following surveillance functions:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• Distribution measures provide information on the number of CWS and the number of people potentially exposed to PCE at different concentrations.</td>
</tr>
<tr>
<td></td>
<td>• Maximum concentrations provide information on the peak potential exposure to PCE at the state level.</td>
</tr>
<tr>
<td></td>
<td>• Mean concentrations at the CWS level provide information on potential exposure at a smaller geographic scale.</td>
</tr>
</tbody>
</table>

| Limitations of The Measure | The current measures are derived for CWS only. Private wells may be another source of population exposure to PCE. Transient non-community water systems, which are regulated by EPA, also may be an important source of PCE exposure. Measures do not account for the variability in sampling, numbers of sampling repeats, and variability within systems. Concentrations in drinking water cannot be directly converted to exposure, because water consumption varies by climate, level of physical activity, and between people (EPA 2004). Due to errors in estimating populations, the measures may overestimate or underestimate the number of affected people. |

| Data Sources | Iowa Department of Natural Resources |

| Limitations of Data Sources | Ground water systems may have multiple wells with different PCE concentrations that serve different parts of the population. Compliance samples are taken at each entry point to the |
distribution system. In systems with separate wells serving some branches or sections of the distribution system, the system mean would tend to underestimate the PCE concentration of people served by wells with higher PCE concentrations. Exposure may be higher or lower than estimated if data from multiple entry points for water with different PCE levels are averaged to estimate levels for the PWS.

### Related Indicators

| Public Water Use |

### References

1. ACGIH. TLVs and BEIs Based on the documentation of the threshold limit values for chemical substances and physical agents and biological exposure indices. 2007. Signature Publications. Cincinnati OH. p.104.


