TRICHLOROETHENE (TCE) IN INDOOR AND OUTDOOR AIR

AUGUST 2015 FACT SHEET

This fact sheet answers questions about a chemical called trichloroethene (TCE), which is widely used to remove grease from manufactured products. It provides information on health effects seen in humans exposed to TCE in air. It also provides information about the New York State Department of Health's guideline of 2 micrograms of TCE per cubic meter of air (2 mcg/m^3) or 0.002 milligrams of TCE per cubic meter of air (0.002 mg/m^3). The fact sheet focuses on the health risks from air exposures because the primary route of exposure for most people in New York State is via indoor air.

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1. WHAT IS TRICHLOROETHENE?[1]

Trichloroethene is a human-made clear, colorless liquid that has a somewhat sweet odor similar to ether or chloroform, but it is volatile, meaning it readily evaporates at room temperature into air. It is used as a solvent to remove grease from metal during the manufacture of variety of products, including building/furniture materials, fixtures, fabricated metal, and electric/electronic equipment. Trichloroethene also is used as a paint stripper, adhesive solvent, as an ingredient in paints and varnishes, and in the manufacture of other chemicals. Other names for trichloroethene include TCE and trichloroethylene. TCE will be used in the rest of this fact sheet.

2. HOW CAN PEOPLE BE EXPOSED TO TCE?

People may be exposed to TCE in air, water, and food. Exposure can also occur when TCE or material containing TCE (for example, soil) gets on the skin. For most people, almost all TCE exposure is from indoor air.

TCE gets into air when it is released from industrial facilities and when it evaporates from areas where chemical wastes are stored or disposed. People living in homes located near TCE sources may be exposed to higher levels of TCE than most other people. Groundwater near these areas may become contaminated if TCE is improperly dumped or leaks into the ground. People may be exposed if they drink the contaminated water or if TCE evaporates from contaminated drinking water into indoor air during cooking, showering, and bathing. They may also be exposed if TCE evaporates from the groundwater, enters soil vapor (air spaces between soil particles), and migrates through the foundation and into the indoor air of an overlying building. This process is called soil vapor intrusion. TCE also may get into indoor air when TCE-containing products (for example, glues, adhesives, paint removers, spot removers, and metal cleaners) are used. Indoor air TCE concentrations may increase if people use TCE-containing products in poorly ventilated areas.

3. HOW CAN TCE ENTER AND LEAVE THE BODY?

If people inhale air containing TCE, some of the TCE is exhaled unchanged from the lungs and back into the air. Much of the TCE is taken into the body through the lungs and is passed into the blood, which carries it to other parts of the body. The liver changes most of the TCE in the blood into other compounds,

[1] For a "plain language" version of this fact sheet, see the fact sheet "Important Information on Trichloroethene (TCE) in Indoor and Outdoor Air" available at http://www.health.ny.gov/environmental/chemicals/trichloroethene/.

called breakdown products, most of which are excreted in the urine within a week or so. However, some of the TCE and its breakdown products can be stored in the fat or the liver, and it may take several weeks after exposure stops before almost all of them leave the body.

4. WHAT ARE THE CONCENTRATIONS OF TCE IN INDOOR AND OUTDOOR AIR?

Background Concentrations in Air

Indoor Air

Background indoor air concentrations of chemicals such as TCE are the concentrations measured in buildings in the absence of a local, external environmental source of the chemical. In the absence of such a source, the presence of the chemical in the air of the building is due to its release from products in the building. We used several sources of information on background concentrations of TCE in indoor air collected across the US and in NY and other states (Adgate et al., 2004; Dawson and McAlary, 2009; NYSDOH, 2005, 2014; USEPA, 2001, 2011b, 2015a; Weisel et al., 2005). Overall, the results indicate background concentrations are almost always 1 micrograms per cubic meter of air (1 mcg/m^3) or less when a local, external TCE source is not present.

Outdoor Air

Background outdoor air concentrations of TCE are the concentrations measured in the absence of a known local point-source of TCE. Various NYS studies provide data on TCE outdoor air background concentrations (NYSDEC, 2000, 2002; NYSDOH, 2005, 2014). Collectively, the results indicate background concentrations are almost always 1 mcg/m^3 or less when a local, point-source of TCE source is not present.

Workplace Air Concentrations

TCE air concentrations in workplaces where TCE is manufactured or used are substantially higher than background concentrations. Bakke et al. (2007) reported that the average TCE workplace air concentration across all U.S. industries and over four decades (1950s to 1980s) was 210,000 mcg/m^3. Hein et al. (2010) reviewed the literature (1940 to 2001) and reported the average workplace air concentrations in various industries and occupations ranged from 1.1 mcg/m^3 to 5.9 million mcg/m), with a median of 38,000 mcg/m^3. ATSDR (1997, 2013) reported that the majority of published data on workplace air concentrations showed average concentrations ranging from less than 270,000 mcg/m^3 to 540,000 mcg/m^3.

5. WHAT KINDS OF HEALTH EFFECTS CAN BE CAUSED BY EXPOSURE TO TCE IN AIR?

Information on the health effects of TCE largely comes from studies where people were exposed to air levels much higher than the background levels commonly found in indoor or outdoor air (for example, 90,000 to 807,000 mcg/m^3). In humans, TCE can cause effects on the central nervous system (CNS), liver, kidneys, reproductive and immune systems, and may affect fetal development during pregnancy. Studies in animals show similar kinds of effects. In this fact sheet, we focus on those health effects of greatest concern, largely because they are considered the most sensitive or most serious human health responses to TCE exposures (i.e., CNS effects, developmental and reproductive effects, and cancer).

For all of the different kinds of health effects, the potential for a person to actually experience a health effect depends on several factors, including the amount of exposure, the frequency of exposure, and the duration of the exposure. It also depends on the characteristics of the exposed person, such as age, sex, diet, family traits, lifestyle, genetic background, the presence of other chemicals in their body (for example, alcohol, prescription drugs), and general state of health. Although difficult to quantify, these differences can affect how people will respond to a given exposure. This is known as sensitivity. Differences in sensitivity should be kept in mind when reading the following information on the human health effects of TCE.

Short-Term Exposure

TCE was once used as an anesthetic during surgery. The primary effects of short-term exposure to TCE in air are on the CNS. Exposure to 590,000 mcg/m^3 for eight hours or less reduced performance on neurobehavioral tests of perception, reaction time, memory, and learning. Symptoms of CNS effects, including headaches, lightheadedness, sleepiness, and fatigue, were common in volunteers exposed to 1,100,000 mcg/m^3 for 7 hours/day for 5 days. Also reported were eye, nose, and throat irritation.

A few studies have reported an increased risk for harmful effects on human development, including fetal heart defects, in the offspring of women who lived in areas with elevated concentrations of TCE in indoor air or drinking water. Due to the limitations of the studies, including poor or no quantitative exposure estimates, we do not know if the observed effects on fetal development in humans were caused by TCE or some other factor. Some, but not all, studies in rats, indicate that TCE exposure can cause heart defects in rat pups exposed *in utero* when the mother was exposed during pregnancy.

Long-Term Exposure

Long-term exposure to high concentrations of TCE in workplace air has caused a variety of effects on the CNS, including effects on nerve function, behavior, vision, hearing, muscle control, memory, ability to think, and other symptoms, such as headache and dizziness.

Some human studies have reported associations between TCE exposure and effects on the reproductive system. For women, reported effects include more difficulty getting pregnant and menstrual cycle disturbances. For men, reported effects have included changes in sperm quality/quantity, hormonal function, and reproductive behavior. These studies suggest, but do not prove, that the reproductive effects were caused by TCE and not by some other factor or factors.

Lastly, epidemiological studies provide convincing evidence of a cause-effect relationship between TCE exposure and cancer. The strongest evidence comes from several well-designed studies that found increased risks of kidney cancer among workers exposed to TCE during the degreasing of metal parts, with more limited evidence for non-Hodgkin's lymphoma (NHL) and liver cancer. In laboratory studies, TCE caused cancer at several sites (kidneys, liver, and lymphoid tissues) in rats and mice when they ingested or inhaled high doses almost daily for a lifetime. Based on human and animal data, the United States Environmental Protection Agency (USEPA) classifies TCE as "carcinogenic to humans by all routes of exposure."

6. WHAT IS THE NEW YORK STATE DEPARTMENT OF HEALTH (NYSDOH) GUIDELINE FOR TCE IN AIR?

After considering the potential health effects of TCE, the background concentrations of TCE in air, and the ability and reliability of the analytical techniques used to measure TCE in air, NYSDOH recommends that the TCE concentration in air not exceed 2 mcg/m^3. This determination also considers continuous exposure for months or as long as a lifetime and sensitive populations (for example, children, pregnant women). Three other ways of expressing this guideline are 0.002 milligrams per cubic meter of air (0.002 mg/m^3), 0.4 parts per billion (ppb) or 0.0004 parts per million (ppm). This replaces the previous guideline of 5 mcg/m^3 (NYSDOH, 2006).

7. WHY WAS THE TCE AIR GUIDELINE REDUCED FROM 5 MCG/M^3 TO 2 MCG/M^3?

NYSDOH reduced its air guideline because of new information on the toxicity of TCE. In 2011, the USEPA (2011a, 2015b) recommended a reference concentration (RfC), of 2 mcg/m^3 and an air unit risk of

4.8 x 10^{-6} per mcg/m^3. An RfC is the level of a chemical in air that is unlikely to cause harmful noncancer health effects in people, even after a lifetime of continuous exposure. An air unit risk is a measure of the potency of a chemical to cause cancer. The air unit risk for TCE means that 4.8 excess cancers are estimated to develop per 1,000,000 people continuously exposed to TCE in air for a lifetime at a concentration of 1 mcg/m^3. Another way to express this value is to say that an air concentration of 0.21 mcg/m^3 is associated with an estimated excess cancer risk of 1 x 10^{-6} (also expressed as one-in-one million), assuming continuous, lifetime exposure.

The NYSDOH replaced its old RfC and unit risk with USEPA's RfC and unit risk after determining that the USEPA values were (1) based on toxicity information not available when NYSDOH derived its RfC and unit risk and issued the guideline of 5 mcg/m^3; (2) scientifically strong; and (3) adequately protective of the public health. The new RfC is lower than the old NYSDOH guideline, which raised concerns because it has been the past practice of NYSDOH to set a guideline for a chemical at an air concentration that is equal to or less than its RfC. Lowering the guideline also would lower the estimated excess cancer risk associated with lifetime, continuous exposure to the guideline. Consequently, the guideline was reduced to 2 mcg/m^3.

8. HOW IS THE GUIDELINE USED?

The guideline is used to help guide decisions regarding the urgency of efforts to reduce TCE exposure. At TCE air levels above the guideline, the higher the level, the greater the urgency to take action to reduce exposure. But as with any chemical in indoor air, the NYSDOH always recommends taking action to reduce exposure when the air concentration of a chemical is above background, even if it is below the guideline.

Indoor air concentrations substantially above the guideline clearly indicate a significant TCE source and the need for action to reduce exposure. In particular, NYSDOH has concerns about exposure during pregnancy, particularly during the first trimester, to air concentrations higher than 20 mcg/m^3 because the major steps of heart development occur during this period and TCE may be a risk factor for fetal heart defects in humans. Thus, NYSDOH recommends taking immediate and effective action to reduce exposure when an air concentration is equal to, or above 20 mcg/m^3. In all cases, the specific recommended action depends on a case-by-case evaluation of the situation.

9. SHOULD I BE CONCERNED ABOUT HEALTH EFFECTS IF I AM EXPOSED TO TCE LEVELS SLIGHTLY ABOVE THE GUIDELINE?

The guideline is not a bright line between TCE concentrations that cause health effects and those that do not. The guideline was set at an air concentration that is lower than air concentrations known to cause, or suspected of causing, effects in humans and animals. Thus, exposure to concentrations above, but near the guideline, is not expected to cause health effects in people. In addition, the guideline is based on the assumption that people are continuously exposed to TCE in air all day, every day for months or as long as a lifetime. Continuous exposure is rarely true for most people, who, if exposed, are more likely to be exposed for a part of the day, part of a week, or part of their lifetime.

10. WHEN SHOULD I OR MY CHILDREN SEE A PHYSICIAN?

If you believe you, your children, or others you know have signs or symptoms that you think are caused by TCE exposure, see a physician. Tell the physician about the signs/symptoms and about when, how and for how long you think you and/or your children were exposed to TCE.

11. IS THERE A MEDICAL TEST THAT CAN TELL ME IF I HAVE BEEN EXPOSED TO TCE?

TCE can be measured in people's breath and blood soon after they are exposed, and levels generally reflect recent exposures (for example, within the past week or so). TCE breakdown products can be measured in the urine and blood for up to several weeks after exposure to TCE stops. However, the tests for breakdown products cannot determine if you have been exposed only to TCE because exposure to other chemicals can produce the same breakdown products in the urine and blood as TCE. These tests are not routinely done by most clinical laboratories.

Finding a measurable amount of any of these chemicals in breath, blood, or urine does not mean that the levels have or will cause adverse health effects. The results can be used to compare to levels in people without a known source of TCE exposure (i.e., the general population) or to levels found in workers exposed to much greater amounts of TCE. Your physician should discuss these test results with you.

12. WHERE CAN I GET MORE INFORMATION?

If you have any questions about the information in this fact sheet, would like to know more about TCE, or are concerned that you may be exposed to elevated levels of TCE, please call the New York State Department of Health at 1-518-402-7800 or 1-800-458-1158, send an e-mail to btsa@health.ny.gov, or write to us at the following address.

New York State Department of Health
Bureau of Toxic Substance Assessment
Corning Tower, Room 1743
Empire State Plaza,
Albany, NY 12237

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