1. PUBLIC HEALTH STATEMENT

This public health statement tells you about carbon tetrachloride and the effects of exposure to it.

The Environmental Protection Agency (EPA) identifies the most serious hazardous waste sites in the nation. These sites are then placed on the National Priorities List (NPL) and are targeted for long-term federal clean-up activities. Carbon tetrachloride has been found in at least 430 of the 1,662 current or former NPL sites. Although the total number of NPL sites evaluated for this substance is not known, the possibility exists that the number of sites at which carbon tetrachloride is found may increase in the future as more sites are evaluated. This information is important because these sites may be sources of exposure and exposure to this substance may harm you.

When a substance is released either from a large area, such as an industrial plant, or from a container, such as a drum or bottle, it enters the environment. Such a release does not always lead to exposure. You can be exposed to a substance only when you come in contact with it. You may be exposed by breathing, eating, or drinking the substance, or by skin contact.

If you are exposed to carbon tetrachloride, many factors will determine whether you will be harmed. These factors include the dose (how much), the duration (how long), and how you come in contact with it. You must also consider any other chemicals you are exposed to and your age, sex, diet, family traits, lifestyle, and state of health.

1.1 WHAT IS CARBON TETRACHLORIDE?

Carbon tetrachloride is a clear liquid that evaporates very easily. Most carbon tetrachloride that escapes to the environment is therefore found as a gas. Carbon tetrachloride does not easily burn. Carbon tetrachloride has a sweet odor, and most people can begin to smell it in air when the concentration reaches 10 parts carbon tetrachloride per million parts of air (ppm). It is not

known whether people can taste it or, if they can, at what level. Carbon tetrachloride is a manufactured chemical and does not occur naturally in the environment,

Carbon tetrachloride has been produced in large quantities to make refrigeration fluid and propellants for aerosol cans. Since many refrigerants and aerosol propellants have been found to affect the earth's ozone layer, the production of these chemicals is being phased out. Consequently, the manufacture and use of carbon tetrachloride has declined a great deal.

In the past, carbon tetrachloride was widely used as a cleaning fluid (in industry and dry cleaning establishments as a degreasing agent, and in households as a spot remover for clothing, furniture, and carpeting). Carbon tetrachloride was also used in fire extinguishers and as a fumigant to kill insects in grain. Most of these uses were discontinued in the mid-1960s. Until recently, carbon tetrachloride was used as a pesticide, but this was stopped in 1986.

Further information on the properties and uses of carbon tetrachloride can be found in Chapters 4, 5, and 6.

1.2 WHAT HAPPENS TO CARBON TETRACHLORIDE WHEN IT ENTERS THE ENVIRONMENT?

Because carbon tetrachloride evaporates easily, most of the compound released to the environment during its production and use reaches the air, where it is found mainly as a gas. It can remain in air for several years before it is broken down to other chemicals. Small amounts of carbon tetrachloride are found in surface water. Because it evaporates easily, much of it will move from surface water to the air within a few days or weeks. However, it may be trapped in groundwater for longer periods. Carbon tetrachloride is not expected to stick to soil particles. If spilled onto the ground, much of it will evaporate to the air. Some of it may also go into groundwater, where it can remain for months before it is broken down to other chemicals. It is not expected to build up in fish. We do not know if it builds up in plants.

Further information on what happens to carbon tetrachloride in the environment may be found in Chapters 5 and 6.

1.3 HOW MIGHT I BE EXPOSED TO CARBON TETRACHLORIDE?

Very low background levels of carbon tetrachloride are found in air, water, and soil because of past and present releases. Concentrations in air of 0.1 part carbon tetrachloride per billion parts of air (ppb) are common around the world, with somewhat higher levels often found (0.2–0.6 ppb) in cities. Carbon tetrachloride is also found in some drinking water supplies, usually at concentrations less than 0.5 ppb. Exposure to levels of carbon tetrachloride higher than these typical "background" levels is likely to occur only at specific industrial locations where carbon tetrachloride is still used or near chemical waste sites where emissions into air, water, or soil are not properly controlled. Exposure at such sites could occur by breathing carbon tetrachloride present in the air, by drinking water contaminated with carbon tetrachloride, or by getting soil contaminated with carbon tetrachloride on the skin. Young children may also be exposed if they eat soil that contains carbon tetrachloride. Carbon tetrachloride has been found in water or soil at about 26% of the waste sites investigated under Superfund, at concentrations ranging from less than 50 to over 1,000 ppb.

People who work with carbon tetrachloride are likely to receive the greatest exposure to the compound. The National Institute for Occupational Safety and Health (NIOSH) estimates that 58,208 workers are potentially exposed to carbon tetrachloride in the United States. The average daily intake of carbon tetrachloride for the general population is estimated to be 0.1 microgram (µg per kg of body weight). The estimated average daily amount that the general population may drink in water is 0.01 µg per kg of body weight.

Further information on the ways that humans can be exposed to carbon tetrachloride is presented in Chapter 6.

1.4 HOW CAN CARBON TETRACHLORIDE ENTER AND LEAVE MY BODY?

Carbon tetrachloride can enter your body through your lungs if you breathe air containing carbon tetrachloride, or through your stomach and intestines if you swallow food or water containing carbon tetrachloride. Carbon tetrachloride can also pass through the skin into the body. When you inhale carbon tetrachloride, over 30–40% of what you inhale enters your body, where most of it temporarily accumulates in body fat. Some can enter the kidney, liver, brain, lungs, and skeletal muscle. When you drink water contaminated with carbon tetrachloride, about 85–91% of it can enter your body. Much of the compound that enters your body when you breathe it or drink water contaminated with it leaves your body quickly, and a lot of it can be found in your breath within a few hours. Animal studies have shown that under differing conditions, 34–75% of carbon tetrachloride leaves the body in expired air, 20–62% leaves the body in feces, and only low amounts leave the body in the urine. Animal studies also suggest that it may take weeks for the remainder of the compound in the body to be eliminated, especially that which has entered the body fat. Most of the carbon tetrachloride is eliminated from your body unchanged, but some of it may be changed to other chemicals before removal from the body (for example, chloroform, hexachloroethane, and carbon dioxide). Chloroform and hexachloroethane may themselves cause harmful effects.

Further information on how carbon tetrachloride enters and leaves the body is presented in Chapter 3.

1.5 HOW CAN CARBON TETRACHLORIDE AFFECT MY HEALTH?

Scientists use many tests to protect the public from harmful effects of toxic chemicals and to find ways for treating persons who have been harmed.

One way to learn whether a chemical will harm people is to determine how the body absorbs, uses, and releases the chemical. For some chemicals, animal testing may be necessary. Animal testing may also help identify health effects such as cancer or birth defects. Without laboratory animals, scientists would lose a basic method for getting information needed to make wise

decisions that protect public health. Scientists have the responsibility to treat research animals with care and compassion. Scientists must comply with strict animal care guidelines because laws today protect the welfare of research animals.

Most information on the health effects of carbon tetrachloride in humans comes from cases where people have been exposed to relatively high levels of carbon tetrachloride, either only once or for a short period, for example, by accidental poisoning or by working with the chemical in a confined space without ventilation. Experiments have not been performed on the effects of long-term exposure of humans to low levels of carbon tetrachloride, so the human health effects of such exposures are not known.

The liver is especially sensitive to carbon tetrachloride since it contains a large amount of the enzymes that change the form of the chemical. Some of the breakdown products may attack cell proteins, interfering with the functions of the liver cells. Products that attack cell membranes may result in the death of the cells. In mild cases, the liver becomes swollen and tender, and fat builds up inside the organ. In severe cases, liver cells may be damaged or destroyed, leading to a decrease in liver function. Such effects are usually reversible if exposure is not too high or too long.

The kidney is also sensitive to carbon tetrachloride. Less urine may be formed, leading to a buildup of water in the body (especially in the lungs) and buildup of waste products in the blood. Kidney failure often was the main cause of death in people who died after very high exposure to carbon tetrachloride. Long-term breathing exposure to carbon tetrachloride worsened age-related kidney disease in rats.

Fortunately, if injuries to the liver and kidney are not too severe, these effects eventually disappear after exposure stops. This is because both organs can repair damaged cells and replace dead cells. Function usually returns to normal within a few days or a few weeks after the exposure has stopped.

After exposure to high levels of carbon tetrachloride, the nervous system, including the brain, is affected. Such exposure can be fatal. The immediate effects are usually signs of intoxication, including headache, dizziness, and sleepiness perhaps accompanied by nausea and vomiting. These effects usually disappear within 1–2 days after exposure stops. In severe cases, stupor or even coma can result, and permanent damage to nerve cells can occur.

Carbon tetrachloride also causes effects on other tissues of the body, but these are not usually as common or important as the effects on the liver, kidney, and brain.

There have been no studies of the effects of carbon tetrachloride on reproduction in humans, but studies in rats showed that long-term inhalation may cause decreased fertility.

Studies in animals have shown that swallowing or breathing carbon tetrachloride over a period of years increases the frequency of liver tumors. Mice breathing carbon tetrachloride also developed tumors of the adrenal gland. Studies have not been performed to determine whether swallowing or breathing carbon tetrachloride causes tumors in humans, but it should be assumed that carbon tetrachloride could produce cancer. The Department of Health and Human Services (DHHS) has determined that carbon tetrachloride may reasonably be anticipated to be a carcinogen (i.e., cause cancer). The International Agency for Research on Cancer (IARC) has classified carbon tetrachloride in Group 2B, possibly carcinogenic to humans. EPA has determined that carbon tetrachloride is a probable human carcinogen.

Many reported cases of carbon tetrachloride toxicity are associated with drinking alcohol. The frequent drinking of alcoholic beverages increases the danger of organ damage from carbon tetrachloride exposure. This enhanced effect has been shown in situations in which a group of workers were exposed to carbon tetrachloride in air, but only those who were heavy consumers of alcohol became ill.

Further information on the health effects of carbon tetrachloride may be found in Chapter 3.

1.6 HOW CAN CARBON TETRACHLORIDE AFFECT CHILDREN?

This section discusses potential health effects in humans from exposures during the period from conception to maturity at 18 years of age.

Children and adults may be exposed to low levels of carbon tetrachloride in drinking water. Small children who live near factories that produce or use carbon tetrachloride could accidentally eat some of the chemical by putting dirty hands in their mouths, but the amount of carbon tetrachloride in the soil is thought to be too low to be harmful. Carbon tetrachloride is no longer used in consumer products, but children could breathe in vapors if households are still using old supplies.

It is not known if the way in which carbon tetrachloride is absorbed into and eliminated from the body is different in children than it is in adults, but the processes are likely to be similar. Compared to adults, young children have lower amounts of the enzyme that converts carbon tetrachloride to a harmful chemical. The health effects of carbon tetrachloride have not been studied in children, but they are likely to be similar to those seen in adults exposed to the chemical.

There is no direct evidence that maternal exposure to carbon tetrachloride has a harmful effect on the fetus in humans. A few human survey-type studies suggest that maternal drinking water exposure to carbon tetrachloride might possibly be related to certain birth defects, such as low birthweight and small size at birth. Information from animal studies indicates that carbon tetrachloride may cause early fetal deaths, but does not cause birth defects in babies surviving to term. However, these animal studies did not test for neurological damage in exposed newborn babies.

One study calculated that carbon tetrachloride is likely to pass from the maternal circulation into breast milk. Thus, it is possible that children could be exposed to carbon tetrachloride from breast feeding, but the levels of exposure are likely to be low.

Further information on the health effects of carbon tetrachloride in children may be found in Chapter 3.

1.7 HOW CAN FAMILIES REDUCE THE RISK OF EXPOSURE TO CARBON TETRACHLORIDE?

If your doctor finds that you have been exposed to substantial amounts of carbon tetrachloride, ask whether your children might also have been exposed. Your doctor might need to ask your state health department to investigate.

Although most consumer uses of carbon tetrachloride have been banned, children may be exposed to carbon tetrachloride in old consumer household cleaning products. Removing these old containers will reduce your family's risk of exposure to carbon tetrachloride. Household chemicals should be stored out of the reach of children to prevent accidental poisonings and skin burns. Always store household chemicals in their original containers. Never store household chemicals in containers that children would find attractive to eat and drink from, such as old soda bottles. Keep your poison control center's number next to your phone.

Sometimes older children sniff household chemicals in an attempt to get high. Your children may be exposed to carbon tetrachloride by intentionally inhaling products containing it. Talk with your children about the dangers of sniffing chemicals.

Further information on reducing the risk of exposure to carbon tetrachloride can be found in Chapter 3.

1.8 IS THERE A MEDICAL TEST TO DETERMINE WHETHER I HAVE BEEN EXPOSED TO CARBON TETRACHLORIDE?

Several very sensitive and specific tests can detect carbon tetrachloride in exposed persons. The most convenient way is simply to measure carbon tetrachloride in exhaled air, but carbon tetrachloride can also be measured in blood, fat, or other tissues. Because special equipment is

needed, these tests are not routinely performed in doctors' offices, but your doctor can refer you to where you can obtain such a test. Although these tests can show that a person has been exposed to carbon tetrachloride, the test results cannot be used to reliably predict whether any bad health effects might result. Because carbon tetrachloride leaves the body fairly quickly, these methods are best suited to detecting exposures that have occurred within the last several days.

Further information on how carbon tetrachloride can be measured in exposed humans is given in Chapter 7.

1.9 WHAT RECOMMENDATIONS HAS THE FEDERAL GOVERNMENT MADE TO PROTECT HUMAN HEALTH?

The federal government develops regulations and recommendations to protect public health. Regulations *can* be enforced by law. The EPA, the Occupational Safety and Health Administration (OSHA), and the Food and Drug Administration (FDA) are some federal agencies that develop regulations for toxic substances. Recommendations provide valuable guidelines to protect public health, but *cannot* be enforced by law. The Agency for Toxic Substances and Disease Registry (ATSDR) and the National Institute for Occupational Safety and Health (NIOSH) are two federal organizations that develop recommendations for toxic substances.

Regulations and recommendations can be expressed as “not-to-exceed” levels, that is, levels of a toxic substance in air, water, soil, or food that do not exceed a critical value that is usually based on levels that affect animals; they are then adjusted to levels that will help protect humans. Sometimes these not-to-exceed levels differ among federal organizations because they used different exposure times (an 8-hour workday or a 24-hour day), different animal studies, or other factors.

Recommendations and regulations are also updated periodically as more information becomes available. For the most current information, check with the federal agency or organization that

provides it. Some regulations and recommendations for carbon tetrachloride include the following:

To protect the general public from exposure to carbon tetrachloride, the federal government has limited or banned the use of this compound in most common household products and fire extinguishers, and has discontinued its use as a pesticide. To protect workers who use carbon tetrachloride while on the job, the OSHA has set a maximum concentration limit in workplace air of 10 ppm for an 8-hour workday over a 40-hour work week. EPA has also set limits on how much carbon tetrachloride can be released from an industrial plant into waste water and is preparing to set limits on how much carbon tetrachloride can escape from an industrial plant into outside air. To ensure that drinking water supplies are safe, EPA has set a Maximum Contaminant Level (MCL) for carbon tetrachloride of 5 parts per billion (ppb), based on analytical detection limits in drinking water. Because carbon tetrachloride is possibly carcinogenic to humans, a Maximum Contaminant Level Goal (MCLG) of zero has been proposed. More detailed information on federal and state regulations regarding carbon tetrachloride may be found in Chapter 8.

1.10 WHERE CAN I GET MORE INFORMATION?

If you have any more questions or concerns, please contact your community or state health or environmental quality department, or contact ATSDR at the address and phone number below.

ATSDR can also tell you the location of occupational and environmental health clinics. These clinics specialize in recognizing, evaluating, and treating illnesses that result from exposure to hazardous substances.

Toxicological profiles are also available on-line at www.atsdr.cdc.gov and on CD-ROM. You may request a copy of the ATSDR ToxProfiles™ CD-ROM by calling the toll-free information

and technical assistance number at 1-888-42ATSDR (1-888-422-8737), by e-mail at atsdric@cdc.gov, or by writing to:

Agency for Toxic Substances and Disease Registry
Division of Toxicology
1600 Clifton Road NE
Mailstop F-32
Atlanta, GA 30333
Fax: 1-770-488-4178

Organizations for-profit may request copies of final Toxicological Profiles from the following:

National Technical Information Service (NTIS)
5285 Port Royal Road
Springfield, VA 22161
Phone: 1-800-553-6847 or 1-703-605-6000
Web site: http://www.ntis.gov/