

## 1. PUBLIC HEALTH STATEMENT

This statement was prepared to give you information about white phosphorus and white phosphorus smoke and to emphasize the human health effects that may result from exposure to it. The Environmental Protection Agency (EPA) identifies the most serious hazardous waste sites as in the nation. These sites make up the National Priorities List (NPL) and are the sites targeted for long-term federal clean-up activities. White phosphorus has been found in at least 77 of 1,430 current or former NPL sites. However, the total number of NPL sites evaluated is not known. As more sites are evaluated, the number of sites at which white phosphorus is found may increase. This is important because exposure to white phosphorus may harm you and because these sites are sources of human exposure to white phosphorus.

When a substance is released from a large area, such as an industrial plant, or from a container, such as a drum or bottle, it enters the environment. This 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 substances containing the substance or by skin contact with it.

If you are exposed to a substance such as white phosphorus, many factors will determine whether harmful health effects will occur and what the type and severity of those health effects will be. These factors include the dose (how much), the duration (how long), the route or pathway by which you are exposed (breathing, eating, drinking, or skin contact), the other chemicals to which you are exposed, and your individual characteristics such as age, sex, nutritional status, family traits, lifestyle, and state of health.

### 1.1 WHAT ARE WHITE PHOSPHORUS AND WHITE PHOSPHORUS SMOKE?

Pure white phosphorus is a colorless-to-white waxy solid, but commercial white phosphorus is usually yellow. Therefore, it is also known as yellow phosphorus. White phosphorus is also called phosphorus tetramer and has a garlic-like smell. In air, it catches fire at temperatures

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10-15 degrees above room temperature. Because of its high reactivity with oxygen in air, white phosphorus is generally stored under water. White phosphorus does not occur naturally.

Industries produce it from naturally occurring phosphate rocks.

White phosphorus is used mainly for producing phosphoric acid and other chemicals. These chemicals are used to make fertilizers, additives in foods and drinks, cleaning compounds, and other products. Small amounts of white phosphorus have been used as rat and roach poisons and in fireworks. In the past, white phosphorus was used to make matches, but another chemical with fewer harmful health effects has since replaced it.

In the military, white phosphorus is used in ammunitions such as mortar and artillery shells, and grenades. When ammunitions containing white phosphorus are fired in the field, they burn and produce smoke. The smoke contains some unburnt phosphorus, but it mainly has various burned phosphorus products. In military operations, such smoke is used to conceal troop movements and to identify targets or the locations of friendly forces. White phosphorus munitions are intended to burn or firebomb the opponents, in other words, to effectively produce widespread damage but not kill the enemy.

You will find more information on the physical properties and uses of white phosphorus and white phosphorus smoke in Chapters 3 and 4 of this profile.

### 1.2 WHAT HAPPENS TO WHITE PHOSPHORUS AND WHITE PHOSPHORUS SMOKE WHEN IT ENTERS THE ENVIRONMENT?

White phosphorus enters the environment when industries make it or use it to make other chemicals and when the military uses it as ammunition. It also enters the environment from spills during storage and transport. Because of the discharge of waste water, white phosphorus is likely to be found in the water and bottom deposits of rivers and lakes near facilities that make or use it. It may also be found at sites where the military uses phosphorus-containing ammunition during training exercises. Rainwater washout of these sites may contaminate nearby waterways and their bottom deposits. Hazardous waste sites that contain white phosphorus are also

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potential sources of exposure to people. However, because white phosphorus reacts very quickly with oxygen in the air, it may not be found far away from sources of contamination.

The fate of white phosphorus smoke is similar to the fate of reaction products of white phosphorus vapor in air. White phosphorus vapor in air reacts with oxygen and is changed to relatively harmless chemicals within minutes. However, particles in the air may have a protective coating that makes them unreactive for a longer time. White phosphorus reacts mainly with oxygen in water and may stay in water for hours to days. However, chunks of white phosphorus coated with protective layers may stay in water and soil for years if oxygen levels in the water and soil are very low.

In water with low oxygen, white phosphorus may react with water to form a compound called phosphine. Phosphine is a highly toxic gas and quickly moves from water to air. Phosphine in air is changed to less harmful chemicals in less than a day. In water, white phosphorus builds up slightly in the bodies of fish. The other chemicals in white phosphorus smoke are mainly changed to relatively harmless chemicals in water and soil. White phosphorus may stay in soil for a few days before it is changed to less harmful chemicals. However, in deeper soil and the bottom deposits of rivers and lakes where there is no oxygen, white phosphorus may remain for several thousand years. White phosphorus binds moderately to soil and typically doesn't move deep in soil with oxygen-depleted rainwater.

Chapter 5 provides more information about the fate and movement of white phosphorus in the environment.

### 1.3 HOW MIGHT I BE EXPOSED TO WHITE PHOSPHORUS AND WHITE PHOSPHORUS SMOKE?

You may be exposed to white phosphorus by breathing in air that contains white phosphorus or by swallowing water or food contaminated with it. White phosphorus has rarely been found in air. Therefore, unless you are near military facilities during training exercises that use white phosphorus ammunition, exposure to it by breathing air will be insignificant. White phosphorus

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has not been found in drinking water or any food other than fish caught in contaminated water and game birds from contaminated areas. The maximum level found was 207 milligrams of white phosphorus per kilogram (207 mg/kg) in the muscle of channel catfish caught from the Yellow Lake in Pine Bluff, Arkansas. Some people are exposed to low levels of white phosphorus by eating contaminated food. People who work in industries that produce or use white phosphorus, people who eat contaminated fish or game birds, and people who live near phosphorus-containing waste sites may be exposed to white phosphorus at higher levels than the rest of the population. Other than exposure of certain workers at the Pine Bluff Arsenal in Arkansas, very few studies exist that have information on exposure to high levels of white phosphorus.

Most known cases of fatal or severe exposure to white phosphorus resulted from adults or children accidentally or deliberately swallowing rat poisons or fireworks or handling munitions containing white phosphorus. Other known instances of severe exposure of workers were a result of accidents in white phosphorus loading plants. People, particularly those in the military who use phosphorus-containing ammunitions, may be exposed to white phosphorus smoke during warfare, training exercises, and accidents.

### **1.4 HOW CAN WHITE PHOSPHORUS AND WHITE PHOSPHORUS SMOKE ENTER AND LEAVE MY BODY?**

White phosphorus can enter your body when you breathe air containing white phosphorus. We do not know if white phosphorus in your lungs will enter the blood. White phosphorus can also enter your body when you eat food or drink water containing white phosphorus or when you are burned by it. We do not know if white phosphorus can enter your body through skin that has not been cut or burned. If it enters your body when you eat, drink, or are burned, white phosphorus enters the blood rapidly. We do not know if it changes into other compounds in the blood. Most of the white phosphorus that enters your body leaves in urine and feces after several days. White phosphorus smoke can enter your lungs when you breathe air containing it. When that happens, we do not know if it will enter your blood or how it will leave your body. For more information, please read Chapter 2.

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### **1.5 HOW CAN WHITE PHOSPHORUS AND WHITE PHOSPHORUS SMOKE AFFECT MY HEALTH?**

Breathing in white phosphorus can cause you to cough or develop a condition known as phossy jaw that involves poor wound healing in the mouth and a breakdown of the jaw bone. Damage to the blood vessels of the mouth has been observed in rats breathing air containing white phosphorus. Most of what is known about the health effects of breathing this compound is from studies of workers. Current levels of white phosphorus in workplace air are much lower than in the past. If you eat or drink a small amount of white phosphorus (less than one teaspoon), you may vomit; have stomach cramps; have liver, heart, or kidney damage; become extremely drowsy; or die. Most of what is known about the health effects of eating or drinking white phosphorus is from reports of people eating rat poison or fireworks that contained it. White phosphorus is no longer found in rat poison or fireworks. The levels of it that you might be exposed to in food or water are much lower than the levels that were in rat poison or fireworks. We do not know if more serious health effects will occur in people who eat or drink white phosphorus-containing substances for a long time. If burning white phosphorus touches your skin, it will burn you. If you are burned with white phosphorus, you may also develop heart, liver, and kidney damage. We do not know if it can cause cancer or birth defects, or if it affects the ability of people to have children. Because of the lack of cancer studies on animals or people, the EPA has determined that white phosphorus is not classifiable as to human carcinogenicity (that is, whether or not it causes cancer). If you breathe white phosphorus smoke, you may damage your lungs and throat. We do not know how white phosphorus smoke can affect your health if it gets on your skin. For more information, please read Chapter 2.

### **1.6 IS THERE A MEDICAL TEST TO DETERMINE WHETHER I HAVE BEEN EXPOSED TO WHITE PHOSPHORUS AND WHITE PHOSPHORUS SMOKE?**

There are no medical tests to tell if you have been exposed to white phosphorus or its smoke. However, the health effects that can follow exposure may lead your physician to suspect exposure. For more information, please read Chapters 2 and 6.

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### **1.7 WHAT RECOMMENDATIONS HAS THE FEDERAL GOVERNMENT MADE TO PROTECT HUMAN HEALTH?**

EPA requires industry to report spills of white phosphorus of more than 1 pound. White phosphorus levels in workplace air are regulated by the Occupational Safety and Health Administration (OSHA), and recommendations for safe levels have been made by the National Institute for Occupational Safety and Health (NIOSH) and the American Conference of Governmental Industrial Hygienists (ACGIH). All three organizations set the inhalation exposure limit for white phosphorus in the workplace during an 8-hour workday at 0.1 milligram per cubic meter of air ( $\text{mg}/\text{m}^3$ ). There are no federal government recommendations for white phosphorus smoke. More information can be obtained from Chapter 7.

### **1.8 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:

Agency for Toxic Substances and Disease Registry  
Division of Toxicology  
1600 Clifton Road NE, Mailstop E-29  
Atlanta, Georgia 30333  
(404) 639-6000

This agency can also provide you with information on the location of occupational and environmental health clinics. These clinics specialize in the recognition, evaluation, and treatment of illness resulting from exposure to hazardous substances.