PUBLIC HEALTH STATEMENT
DDT, DDE, and DDD

CAS#: DDT 50-29-3
DDE 72-55-9
DDD 72-54-8

Division of Toxicology **September 2002**

This Public Health Statement is the summary chapter from the Toxicological Profile for DDT, DDE, and DDD. It is one in a series of Public Health Statements about hazardous substances and their health effects. A shorter version, the ToxFAQs™ is also available. This information is important because this substance may harm you. The effects of exposure to any hazardous substance depend on the dose, the duration, how you are exposed, personal traits and habits, and whether other chemicals are present. For more information, call the ATSDR Information Center at 1-888-422-8737.

This public health statement tells you about DDT, DDE, and DDD and the effects of exposure.

The Environmental Protection Agency (EPA) identifies the most serious hazardous waste sites in the nation. These sites make up the National Priorities List (NPL) and are the sites targeted for long-term federal cleanup activities. DDT, DDE, and DDD have been found in at least 442 of the 1,613 current or former NPL sites. However, the total number of NPL sites evaluated for these substances is not known. As more sites are evaluated, the sites at which DDT, DDE, and DDD are found may increase. This information is important because exposure to these substances may harm you and because these sites may be sources of exposure.

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 are 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 DDT, DDE, and DDD, many factors determine whether you'll be harmed. These factors include the dose (how much), the duration (how long), and how you come in contact with them. You must also consider the other chemicals you're exposed to and your age, sex, diet, family traits, lifestyle, and state of health.

While this document is specifically focused on the primary forms or isomers of DDT, DDE, and DDD (namely p,p'-DDT, p,p'-DDE, and p,p'-DDD), other isomers of these compounds will be discussed when appropriate. In some cases, the term DDT will be used to refer to the collection of all forms of DDT, DDE, and DDD. Should this not be clear from the context, the term ΣDDT (Σ is used to mean sum of) will be used.

1.1 WHAT ARE DDT, DDE, AND DDD?

DDT (1,1,1-trichloro-2,2-bis(p-chlorophenyl)ethane) is a pesticide that was once widely used to control insects on agricultural crops and insects that carry diseases like malaria and typhus, but is now used in only a few countries to control malaria. Technical-grade DDT is a mixture of three forms, p,p'-DDT (85%), o,p'-DDT (15%), and o,o'-DDT (trace amounts). All of these are white, crystalline, tasteless, and almost odorless solids. Technical grade DDT may also contain DDE (1,1-dichloro-2,2-bis(p-chlorophenyl)ethylene) and DDD (1,1-dichloro-2,2-bis(p-chlorophenyl)ethane) as contaminants. DDD was also used to kill pests,

but to a far lesser extent than DDT. One form of DDD (o,p'-DDD) has been used medically to treat cancer of the adrenal gland. Both DDE and DDD are breakdown products of DDT.

DDT does not occur naturally in the environment. After 1972, the use of DDT was no longer permitted in the United States except in cases of a public health emergency. It is, however, still used in some other areas of the world, most notably for controlling malaria. The use of DDD to kill pests has also been banned in the United States.

1.2 WHAT HAPPENS TO DDT, DDE, AND DDD WHEN THEY ENTER THE ENVIRONMENT?

Before 1973 when it was banned, DDT entered the air, water, and soil during its production and use as an insecticide. DDT is present at many waste sites, including NPL sites; releases from these sites might continue to contaminate the environment. Most DDT in the environment is a result of past use; DDD was also used as a pesticide to a limited extent in the past. DDT still enters the environment because of its current use in other areas of the world. DDE is only found in the environment as a result of contamination or breakdown of DDT. DDD also enters the environment during the breakdown of DDT.

Large amounts of DDT were released into the air and on soil or water when it was sprayed on crops and forests to control insects. DDT was also sprayed in the environment to control mosquitos. Although the use of DDT is no longer permitted in the United States, DDT may be released into the atmosphere in other countries where it is still manufactured and used, including Mexico. DDT, DDE and DDD may also enter the air when they evaporate from contaminated water and soil. DDT, DDE, and DDD in the air will then be deposited on land or surface water. This cycle of evaporation and deposition may be repeated many times. As a result, DDT, DDE, and DDD can be carried long distances in the atmosphere. These chemicals have been found in bogs, snow, and animals in the Arctic and Antarctic regions, far from where they were ever used. Some DDT may have entered the soil from waste sites. DDT, DDE, and DDD may occur in the atmosphere as a vapor or be attached to solids in air. Vapor phase DDT, DDE, and DDD may break down in the atmosphere due to reactions caused by the sun. The half-life of these chemicals in the atmosphere as vapors (the time it takes for one-half of the chemical to turn into something else) has been calculated to be approximately 1.5-3 days. However, in reality, this half-life estimate is too short to account for the ability of DDT, DDE, and DDD to be carried long distances in the atmosphere.

DDT, DDE, and DDD last in the soil for a very long time, potentially for hundreds of years. Most DDT breaks down slowly into DDE and DDD, generally by the action of microorganisms. These chemicals may also evaporate into the air and be deposited in other places. They stick strongly to soil, and therefore generally remain in the surface layers of soil. Some soil particles with attached DDT, DDE, or DDD may get into rivers and lakes in runoff. Only a very small amount, if any, will seep into the ground and get into groundwater. The length of time that DDT will last in soil depends on many factors including temperature, type of soil, and

whether the soil is wet. DDT lasts for a much shorter time in the tropics where the chemical evaporates faster and where microorganisms degrade it faster. DDT disappears faster when the soil is flooded or wet than when it is dry. DDT disappears faster when it initially enters the soil. Later on, evaporation slows down and some DDT moves into spaces in the soil that are so small that microorganisms cannot reach the DDT to break it down efficiently. In tropical areas, ΣDDT may disappear in much less than a year. In temperate areas, half of the ΣDDT initially present usually disappears in about 5 years. However, in some cases, half of the ΣDDT initially present will remain for 20, 30, or more years.

In surface water, DDT will bind to particles in the water, settle, and be deposited in the sediment. DDT is taken up by small organisms and fish in the water. It accumulates to high levels in fish and marine mammals (such as seals and whales), reaching levels many thousands of times higher than in water. In these animals, the highest levels of DDT are found in their adipose tissue. DDT in soil can also be absorbed by some plants and by the animals or people who eat those crops.

1.3 HOW MIGHT I BE EXPOSED TO DDT, DDE, AND DDD?

People in the United States are exposed to DDT, DDE, and DDD mainly by eating foods containing small amounts of these compounds. Although not common today, exposure to DDT could also occur through inhalation or absorption through the skin during the handling or application of DDT. Even though DDT has not been used in this country since 1972, soil may still contain some DDT that may be taken up by plants and eaten by animals and people. DDT from contaminated water and sediment may be taken up by fish. The amount of DDT in food has greatly decreased since DDT was banned and should continue to decline. In the years 1986 to 1991, the average adult in the United States consumed an average of 0.8 micrograms (a microgram is a millionth of a gram) of DDT a day. Adults consumed slightly different amounts based on their age and sex. The largest fraction of DDT in a person's diet comes from meat, poultry, dairy products, and fish, including the consumption of sport fish. Leafy vegetables generally contain more DDT than other vegetables, possibly because DDT in the air is deposited on the leaves. Infants may be exposed by drinking breast milk.

DDT or its breakdown products are still present in some air, water, and soil samples. However, levels in most air and water samples are presently so low that exposure is of little concern. DDT levels in air have declined to such low levels that it often cannot be detected. In cases where DDT has been detected in air, it is associated with air masses coming from regions where DDT is still used or from the evaporated DDT from contaminated water or soil. p,p'-DDT and p,p'-DDE concentrations measured in air in the Great Lakes region in 1990 reached maximum levels of 0.035 and 0.119 nanograms (a nanogram is a billionth of a gram) of chemical per cubic meter of air (ng/m^3), respectively. Levels were generally much lower, especially during the winter months. In 1995-1996, soils in the corn belt, where DDT was heavily used in the past, contained on the average about 10 nanograms of DDT in a

gram of soil. In recent years, most surface water has not contained detectable amounts of DDT.

People who work or live around NPL sites or work with contaminated soil or sediment would most likely be exposed by accidentally swallowing soil, having skin contact with the soil, inhaling DDT vapor, or breathing in DDT in dust.

1.4 HOW CAN DDT, DDE, AND DDD ENTER AND LEAVE MY BODY?

Today in the United States, DDT, DDE, or DDD enters the body mainly when a person eats contaminated food. The actual amounts of DDT, DDE, and DDD absorbed from foods depends on both the concentration of chemical in the food and the amount of food eaten. Small amounts of DDT, DDE, and DDD may also be breathed in and absorbed into the body. DDT, DDE, and DDD are often attached to particles too large to pass very far into the lungs after air containing them is breathed. These particles are more likely to be carried upward in the mucus of the air passages and swallowed than for the DDT to be absorbed in the lungs. DDT, DDE, and DDD do not enter the body through the skin very easily.

Once inside the body, DDT can break down to DDE or DDD. DDE and DDD, in turn, break down to other substances (called metabolites). DDT, DDE, and DDD are stored most readily in fatty tissue, especially DDE. Some of these stored amounts leave the body very slowly. Levels in fatty tissues may either remain relatively the same over time or even increase with continued exposure. However, as exposure decreases, the amount of DDT in the body also decreases. DDT metabolites leave the body mostly in urine, but may also leave by breast milk and pass directly to nursing infants.

1.5 HOW CAN DDT, DDE, AND DDD AFFECT MY HEALTH?

Eating food with large amounts (grams) of DDT over a short time would most likely affect the nervous system. People who swallowed large amounts of DDT became excitable and had tremors and seizures. They also experienced sweating, headache, nausea, vomiting, and dizziness. These effects on the nervous system went away once exposure stopped. The same type of effects would be expected by breathing DDT particles in the air or by contact of the skin with high amounts of DDT. Tests in laboratory animals confirm the effect of DDT on the nervous system.

No effects have been reported in adults given small daily doses of DDT by capsule for 18 months (up to 35 milligrams [mg] every day). People exposed for a long time to small amounts of DDT (less than 20 mg per day), such as people who worked in factories where DDT was made, had some minor changes in the levels of liver enzymes in the blood. A study in humans showed that increasing concentrations of p,p'-DDE in human breast milk were associated with reductions in the duration of lactation. An additional study in humans found that as the DDE levels in the blood of pregnant women increased, the chances of having a pre-term baby also increased. It should be mentioned, however, that the levels of DDE in the blood at which this was noticed were higher than those currently found in women from the general population in the United

States, but not higher than those that may be found in women in countries where DDT is still being used.

To protect the public from the harmful effects of toxic chemicals and to find ways to treat people who have been harmed, scientists use many tests.

One way to see if a chemical will hurt people is to learn how the chemical is absorbed, used, and released by the body; for some chemicals, animal testing may be necessary. Animal testing may also be used to identify health effects such as cancer or birth defects. Without laboratory animals, scientists would lose a basic method to get information needed to make wise decisions to protect public health. Scientists have the responsibility to treat research animals with care and compassion. Laws today protect the welfare of research animals, and scientists must comply with strict animal care guidelines.

Animal studies show that long-term exposure to moderate amounts of DDT (20-50 mg per kilogram [kg] of body weight every day) may affect the liver. Tests in animals also suggest that short-term exposure to DDT and metabolites in food may have a harmful effect on reproduction. In addition, we know that some breakdown products of DDT can cause harmful effects on the adrenal gland. This gland is situated near the kidney and produces hormones (substances produced by organs and released to the bloodstream to regulate the function of other organs).

Studies in animals have shown that oral exposure to DDT can cause liver cancer. Studies of DDT-exposed workers did not show increases in deaths or cancers. Based on all of the evidence available, the Department of Health and Human Services has determined that DDT is reasonably anticipated to be a human carcinogen. Similarly, the International Agency for Research on Cancer (IARC) has determined that DDT is possibly carcinogenic to humans. EPA has determined that DDT, DDE, and DDD are probable human carcinogens.

1.6 HOW CAN DDT, DDE, AND DDD AFFECT CHILDREN?

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

Children can be exposed to DDT, DDE, or DDD by eating food or drinking breast milk contaminated with these compounds. DDT is a pesticide, and even though it has not been used in this country since 1972, soil has small amounts and, under certain conditions, contaminated soil transfers DDT to crops. Children can be exposed also by eating food imported from countries where DDT is still being used. Because of their smaller weight, intake of an equivalent amount of DDT by children and adults would result in a higher dose (amount of DDT ingested per kilogram of body weight) in children than in adults. In the United States between 1985 and 1991, the average 8½-month-old infant consumed 4 times as much DDT for each pound of body weight than the average adult. However, the amounts of DDT consumed were much smaller than the amounts that have been tested in studies in animals.

DDT from the mother can enter her unborn baby through the placenta. DDT has been found in amniotic fluid, human placentas, fetuses, and umbilical cord blood. DDT has been measured in human milk; therefore, nursing infants are also exposed to DDT. In most cases, however, the benefits of breast-feeding outweigh any risks from exposure to DDT in mother's milk. Nevertheless, women with unusually high amounts of DDT or metabolites in their bodies (compared to background amounts measured in the general population) should be informed of the potential exposure of the fetus if they become pregnant and the potential risks of breast-feeding.

We do not know whether children differ from adults in their susceptibility to health effects from DDT. There are few studies of young children exposed to DDT. A child who drank DDT in kerosene only once vomited and had tremors and convulsions and eventually died; however, we do not know how much of this was caused by the kerosene. Adults who swallowed DDT in much greater amounts than those found in the environment had effects on their nervous systems. The same harmful effects will probably happen to young children if they eat food or drink liquids with large amounts of DDT. However, because DDT is no longer used or made in the United States, such exposure is not likely to happen. Two studies have shown a higher dose of DDT is needed to kill newborn and young rats than adult rats. In one study, when the dose was divided up and given over 4 days, the same dose of DDT killed rats of all ages.

There is no evidence that exposure to DDT at levels found in the environment causes birth defects in people. One study in U.S. children 12 to 14 years of age found that boys whose mothers had higher DDE levels in their bodies when they were pregnant were taller than those whose mothers had lower DDE levels. A study of German children found that girls with higher DDE in the blood at 8 years of age were shorter than those with lower DDE levels. The reason for the discrepancy between the two studies is unknown. Studies in animals have shown that DDT given during pregnancy can slow the growth of the fetus. Exposure to DDT or its metabolites during development may change how the reproductive and nervous systems work. This seems to be caused by the property of DDT or its metabolites to mimic the action of natural hormones. Male rats exposed to the DDT breakdown product, p,p'-DDE, as fetuses or while nursing, showed changes in the development of their reproductive system. One study found that the beginning of puberty is delayed in male rats given relatively high amounts of p,p'-DDE as juveniles. Also, one study showed that exposure of mice to DDT during the first weeks of life resulted in neurobehavioral problems when tests were done later in life. These studies raise concerns that exposure to DDT early in life might cause harmful effects that remain or begin long after exposure has stopped.

1.7 HOW CAN FAMILIES REDUCE THE RISK OF EXPOSURE TO DDT, DDE, AND DDD?

If your doctor finds that you have been exposed to significant amounts of DDT, DDE, and DDD, ask whether your children might also be exposed. Your

doctor might need to ask your state health department to investigate.

At this time, most people are exposed to DDT and its breakdown products as a result of eating foods or drinking liquids that may be contaminated with small amounts of DDT. DDT is a pesticide, but it was banned in the United States in 1972. However, because of its chemical characteristics, it has stayed in the environment and low levels of DDT may be present in foods (i.e., fruits, vegetables, meat, and fish) for many years. Studies have shown that cooking will reduce the amount of DDT in fish. Many other countries still use DDT; therefore, food brought into the United States from these countries may contain DDT. The Food and Drug Administration (FDA) analyzes a wide variety of imported food items (coffee, tropical fruits, etc.) as well as domestic products to insure that pesticide residues are below FDA tolerances. DDT has been found in both root and leafy vegetables. DDT attaches to the roots of plants, but it does not easily move to other parts of the plants. DDT in the air can be deposited on to the surfaces of plants. Washing fruits and vegetables before eating them is a healthful practice.

You and your children may be exposed to DDT by eating certain types of fish or wildlife caught from certain locations. Some states, Native American tribes, and U.S. territories have issued fish and wildlife advisories to warn people about DDT-contaminated fish and turtles. Each state, Native American tribe, or U.S. territory sets its own criteria for issuing fish and wildlife advisories. A fish advisory will specify which bodies of water have restrictions. The advisory will tell you what type and sizes of fish are of concern. The advisory may completely ban eating fish or tell you to limit your meals of a certain fish type. For example, an advisory may tell you to eat a certain type of fish no more than once a month. The advisory may tell you only to eat certain parts of the fish or turtle and how to prepare or cook the fish or turtle to decrease your exposure to DDT. The fish or wildlife advisory may be stricter to protect pregnant women, nursing mothers, and young children. To reduce your children's exposure to DDT, obey fish and wildlife advisories. Information on fish and wildlife advisories in your state is available from your state health or natural resources department. Signs may also be posted in certain fishing areas.

1.8 IS THERE A MEDICAL TEST TO DETERMINE WHETHER IHAVE BEEN EXPOSED TO DDT, DDE, AND DDD?

DDT, DDE, and DDD can be measured in fat, blood, urine, semen, and breast milk. Samples of blood and urine are easy to get, and levels in these samples may help show the amount of exposure. These tests are not readily available at your doctor's office, but your doctor can tell you where they can be done. Tests may show low, moderate, or excessive exposure to these compounds. However, such tests cannot show the exact amount of DDT, DDE, or DDD to which a person was exposed, or predict the chance of health effects in the person.

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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. Federal agencies that develop regulations for toxic substances include the Environmental Protection Agency (EPA), the Occupational Safety and Health Administration (OSHA), and the Food and Drug Administration (FDA). Recommendations provide valuable guidelines to protect public health but cannot be enforced by law. Federal organizations that develop recommendations for toxic substances include the Agency for Toxic Substances and Disease Registry (ATSDR) and the National Institute for Occupational Safety and Health (NIOSH).

Regulations and recommendations can be expressed in not-to-exceed levels in air, water, soil, or food that are usually based on levels that affect animals; then they are adjusted to help protect people. Sometimes these not-to-exceed levels differ among federal organizations because of different exposure times (an 8-hour workday or a 24-hour day), the use of different animal studies, or other factors.

Recommendations and regulations are also periodically updated 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 DDT, DDE, and DDD include the following:

All uses of DDT were banned by EPA in 1972, except in cases of public health emergencies. DDT was banned because the chemical was building up in the environment and possibly hurting wildlife. Also, some cancer tests in laboratory animals showed positive results. Although DDT is no longer used in the United States, federal regulations still control the amounts of DDT allowed in food and water.

OSHA states that workers may not be exposed to amounts of DDT greater than 1 milligram of DDT per cubic meter of air (1 mg/m^3) for an 8-hour workday, 40-hour work week. EPA estimates that drinking 2 liters of water per day containing 0.59 nanograms of DDT per liter of water (1 nanogram is one billionth of a gram) and eating 6.5 grams of fish and shellfish per day (from waters containing 0.59 nanograms DDT per liter) would be associated with an increased lifetime cancer risk of one in one million. Fish and shellfish tend to concentrate DDT from the surrounding water in their tissues. FDA has set action levels for DDT/DDE/DDD; these are limits at or above which FDA will take legal action to remove products from the market.

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:

Agency for Toxic Substances and Disease Registry
Division of Toxicology
1600 Clifton Road NE, Mailstop F-32
Atlanta, GA 30333

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Information line and technical assistance:

Phone: 888-422-8737
FAX: (770)-488-4178

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

To order toxicological profiles, contact:

National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161
Phone: 800-553-6847 or 703-605-6000

Reference

Agency for Toxic Substances and Disease Registry (ATSDR). 2002. Toxicological Profile for DDT, DDE, DDD. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.