

1. PUBLIC HEALTH STATEMENT

This public health statement tells you about *n*-hexane 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. *n*-Hexane has been found in at least 60 of the 1,467 current or former NPL sites. However, the total number of NPL sites evaluated for this substance is not known. As more sites are evaluated, the sites at which *n*-hexane is found may increase. This information is important because exposure to this substance 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 *n*-hexane, 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 it. You must also consider the other chemicals you're exposed to and your age, sex, diet, family traits, lifestyle, and state of health.

1.1 WHAT IS *n*-HEXANE?

n-Hexane is a chemical made from crude oil. Pure *n*-hexane is a colorless liquid with a slightly disagreeable odor. It evaporates very easily into the air and dissolves only slightly in water. *n*-Hexane is highly flammable, and its vapors can be explosive.

Pure *n*-hexane is used in laboratories. Most of the *n*-hexane used in industry is mixed with similar chemicals in products known as solvents. Common names for some of these solvents are "commercial hexane," "mixed hexanes," "petroleum ether," and "petroleum naphtha." An older

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name for these types of solvents is “petroleum benzine.” Several hundred million pounds of *n*-hexane are produced in the United States each year in the form of these solvents. The major use for solvents containing *n*-hexane is to extract vegetable oils from crops such as soybeans. They are also used as cleaning agents in the printing, textile, furniture, and shoemaking industries. Certain kinds of special glues used in the roofing and the shoe and leather industries also contain *n*-hexane. Several consumer products contain *n*-hexane. For example, gasoline contains about 1-3% *n*-hexane. *n*-Hexane is also present in rubber cement. You will find further information about the properties and uses of *n*-hexane in Chapters 3 and 4 of this profile.

1.2 WHAT HAPPENS TO *n*-HEXANE WHEN IT ENTERS THE ENVIRONMENT?

n-Hexane enters the air, water, and soil during its manufacture and use. Wastes containing *n*-hexane are sometimes disposed of in landfills. *n*-Hexane can enter the environment from these landfills. *n*-Hexane also enters the environment from accidental spills during transport and leaks from storage containers.

n-Hexane evaporates very easily into the air. Once in the air, *n*-hexane can react with oxygen and be broken down. *n*-Hexane released into the air is broken down in a few days.

If *n*-hexane is spilled into a lake or river, a very small portion will dissolve in the water, but most will float on the surface. The *n*-hexane will then evaporate into the air. The *n*-hexane dissolved in the water can be broken down by certain types of bacteria, although it is not known how long this takes.

If *n*-hexane is spilled on the ground, much of it will evaporate into the air before it penetrates the soil. Any *n*-hexane that penetrated the soil would probably be broken down by bacteria. If *n*-hexane leaks from an underground storage tank, it will float on the groundwater, rather than mixing with it since *n*-hexane is lighter than water.

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n-Hexane is not stored or concentrated by plants, fish, or animals. You will find more information about what happens to *n*-hexane in the environment in Chapter 5 of this profile.

1.3 HOW MIGHT I BE EXPOSED TO *n*-HEXANE?

Since gasoline contains *n*-hexane, almost everyone is exposed to small amounts of *n*-hexane in the air. The *n*-hexane in gasoline is released into the air at service stations and in automobile exhaust. Some people may also be exposed by spilling gasoline on their skin. The concentration of *n*-hexane in the air in Chicago was recently measured and contained 2 parts *n*-hexane per 1 billion parts air (2 ppb). *n*-Hexane has generally not been found in most foods or drinking water, so you are not likely to be exposed by eating or drinking. Because cooking oils are processed with solvents containing *n*-hexane, very small amounts may be present in these products. However, the amounts in cooking oil are too low to have any effect on people.

People living near hazardous waste sites containing *n*-hexane or near its manufacturing, processing, or storage facilities could potentially be exposed. Because of the chemical properties of *n*-hexane, the most likely way a person would be exposed is by breathing in air contaminated with *n*-hexane. A less likely way for a person to be exposed is by drinking contaminated private well water.

You may be exposed to *n*-hexane if you use products containing it at work. This exposure will mainly be by breathing in air containing *n*-hexane, but you can also be exposed through your skin by contact with substances containing *n*-hexane. Some occupational groups that may be exposed to *n*-hexane include refinery workers, shoe and footwear assembly workers, laboratory technicians, workers operating or repairing typesetting and printing machinery, construction workers, carpet layers, carpenters, auto mechanics and gas station employees, workers in plants manufacturing tires or inner tubes, and workers in air transport and air freight operations. Exposure can also occur in the home if products containing *n*-hexane are used without proper ventilation.

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1.4 HOW CAN *n*-HEXANE ENTER AND LEAVE MY BODY?

n-Hexane can enter your body through your lungs if it is in the air you breathe. It can also enter your body through your stomach and intestines if it is in your drinking water or food, or through your skin if you come into contact with it. How much *n*-hexane enters your body depends on how long you are exposed and the amount to which you are exposed.

Once you inhale *n*-hexane, it goes into your bloodstream and is carried to all the organs in your body. Enzymes in your liver break down *n*-hexane. If you are exposed to high concentrations of *n*-hexane over a long period, one of these breakdown products may cause damage to your nervous system. Most of these breakdown products leave your body in the urine within a day or two. *n*-Hexane and its breakdown products are not stored in your body.

1.5 HOW CAN *n*-HEXANE AFFECT MY HEALTH?

Almost all the people known to have had their health affected by exposure to *n*-hexane used it at work. In the 1960s and early 1970s several outbreaks of nerve disorders occurred among shoe workers in Japan and Italy. Doctors determined the disease was caused by the workers breathing air containing high concentrations of *n*-hexane. The *n*-hexane came from glues and solvents the workers used in assembling the shoes. In one group of workers in Japan, it was estimated that the workers who became ill had been breathing air containing 500-2,500 parts *n*-hexane per million parts air (500-2500 ppm) for 8-14 hours a day for 6 months to several years. The first symptom that the affected workers had was a feeling of numbness in their feet and hands. This was followed by muscle weakness in the feet and lower legs. If exposure continued, the symptoms grew worse. In some workers, paralysis of the arms and legs developed. When the affected workers were examined by doctors, the nerves controlling the muscles in their arms and legs were found to be damaged. The medical term for this condition is "peripheral neuropathy" (peripheral means outside the brain and spinal cord; neuropathy means nerve damage). Fortunately, once the workers were removed from exposure to *n*-hexane they recovered within 6 months to a year, although some of the more severely affected did not fully recover for 1-2 years.

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Poor ventilation of the work area was a major factor in all of these cases. Workers who became ill usually worked in their homes or in very small workshops. Since the 1970s workplace ventilation has been improved and levels of *n*-hexane in the air have been lower. There have been very few cases of nerve damage from *n*-hexane since 1980. A few people have also suffered nerve damage from “sniffing” products containing *n*-hexane. Like cases in the workplace, the number of cases due to sniffing has fallen since the 1970s.

It is not known if oral or skin exposure to *n*-hexane can cause these effects in people. There have been very few documented exposures to *n*-hexane by these routes in people.

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.

When rats are exposed to *n*-hexane in the air, they show signs of damage to their nervous systems very similar to those seen in people who became ill after workplace exposure. As in people, these effects in rats depend on the concentrations of *n*-hexane in air and how long exposure lasts.

Studies in rats showed that a breakdown product of *n*-hexane (called 2,5-hexanedione) causes the nerve damage, not *n*-hexane itself. Testing for 2,5-hexanedione in the urine can be used to determine if a person has been exposed to potentially harmful amounts of *n*-hexane. Studies in rats also showed that *n*-hexane can cause nerve damage when given orally in very large doses.

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At very high levels of *n*-hexane in air (1,000-10,000 ppm), signs of damage to sperm-forming cells in male rats occurred. Damage to the lungs occurred in rabbits and mice. People have rarely been exposed to these high levels of *n*-hexane, so it is not known if these effects would occur in people.

It is not known if exposure to *n*-hexane can affect fertility in people. Experiments done with animals that were fed or breathed in *n*-hexane did not show any effect on fertility.

There is no evidence that exposure to *n*-hexane increases the risk of cancer in people. No reliable information is available on whether *n*-hexane causes cancer in animals. In an animal experiment with commercial hexane (which contains *n*-hexane), an increase in liver cancer was found in female mice after exposure for 2 years. No increase was found in male mice or in rats of either sex. Commercial hexane is a mixture, and we do not know what parts of the mixture caused the cancer in the female mice. *n*-Hexane has not been characterized for carcinogenicity by the Department of Health and Human Services (DHHS), the International Agency for Research on Cancer (IARC), or the Environmental Protection Agency (EPA).

1.6 HOW CAN *n*-HEXANE AFFECT CHILDREN?

This section discusses potential health effects from exposures during the period from conception to maturity at 18 years of age in humans. Potential effects on children resulting from exposures of the parents are also considered.

Harmful effects from exposure to *n*-hexane have mainly occurred in adults. This is because most known cases have occurred in workers. However, it is probable that if children were exposed to *n*-hexane at levels that cause harmful effects in adults, similar effects would occur. We do not know whether children differ from adults in their susceptibility to health effects from *n*-hexane exposure. Only a few animal studies have compared the effects of *n*-hexane between adults and young animals. In these studies, the young animals were somewhat less likely to have harmful

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effects on their nervous system from breathing *n*-hexane than the adults, but more likely to die from a large oral dose.

Experiments in rats and mice have shown little effect of *n*-hexane exposure on the development of the fetus. It is probable that *n*-hexane and its breakdown products can cross the placenta and also be excreted in breast milk, but no accurate measurements have been made in people. *n*-Hexane and its breakdown products have been detected in the fetus when pregnant rats were exposed to *n*-hexane.

1.7 HOW CAN FAMILIES REDUCE THE RISK OF EXPOSURE TO *n*-HEXANE?

If your doctor finds that you have been exposed to significant amounts of *n*-hexane, ask whether your children might also be exposed. Your doctor might need to ask your state public health department to investigate.

Certain products used in the home may contain *n*-hexane, for example, some quick-drying glues and cements used in hobbies. These products should be kept out of the reach of children and only used with proper ventilation. Always store household chemicals in their original, labeled containers. Never store household chemicals in containers children would find attractive to eat or drink from, such as old soda bottles. Keep your Poison Control Center's number by the phone.

Sometimes older children sniff household chemicals in an attempt to get "high." Your children may be exposed to *n*-hexane by inhaling products containing it. Talk with your children about the dangers of sniffing chemicals. Sniffing products containing *n*-hexane has caused paralysis of the arms and legs in teenagers in the United States and Europe.

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1.8 IS THERE A MEDICAL TEST TO DETERMINE WHETHER I HAVE BEEN EXPOSED TO *n*-HEXANE?

If you have been exposed to harmful amounts of *n*-hexane, the amount of one of its breakdown products (2,5-hexanedione) will probably be increased in your urine. Your doctor will have to send a sample to a specialized laboratory. This test can only detect *n*-hexane exposure occurring within 2-3 days before the test, since 2,5-hexanedione leaves the body within a few days after exposure.

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 *n*-hexane include the following:

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OSHA has set a Permissible Exposure Limit (PEL) of 500 ppm for *n*-hexane in workplace air. A court decision struck down a proposed PEL of 50 ppm. Damage to nerves has been found in people at 500 ppm. The American Conference of Governmental Industrial Hygienists (ACGIH) recommends a Threshold Limit Value (TLV) of 50 ppm.

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 E-29
Atlanta, GA 30333

* Information line and technical assistance

Phone: 1-888-42-ATSDR (1-888-422-8737)
Fax: (404) 639-6315 or -6324

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

