

1. PUBLIC HEALTH STATEMENT

This public health statement tells you about aluminum and the effects of exposure.

The Environmental Protection Agency (EPA) has identified 1,445 hazardous waste sites as the most serious in the nation. These sites make up the National Priorities List (NPL) and are targeted for long-term federal clean-up activity. Aluminum has been found in at least 427 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 aluminum 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 can be exposed to a substance only when you come in contact with it by breathing, eating, touching, or drinking.

If you are exposed to aluminum many factors determine whether you'll be harmed. These factors include the dose (how much), the duration (how long), the form (which chemical compound), 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.

WHAT IS ALUMINUM?

Aluminum is the most abundant metal and the third most abundant element, after oxygen and silicon, in the earth's crust. It is widely distributed and constitutes approximately 8 percent of the earth's surface layer. However, aluminum is a very reactive element and is never found as the free metal in nature. It is found combined with other elements, most commonly with oxygen, silicon, and fluorine. These "chemical compounds" are commonly found in soil, minerals (e.g., sapphires, rubies, turquoise), rocks (especially igneous rocks), and clays. These are the natural

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forms of aluminum rather than the silvery metal. The metal is obtained from aluminum-containing minerals, primarily bauxite. Small amounts of aluminum are even found in water in dissolved or ionic form. (Ions are atoms, collections of atoms, or molecules containing a positive or negative electric charge.) The most commonly found ionic forms of aluminum are complexes formed with hydroxy (hydrogen attached to oxygen) ions.

Aluminum metal is light in weight and silvery-white in appearance. We are most familiar with aluminum in beverage cans, pots and pans, airplanes, siding and roofing, and foil. The reason why aluminum metal is so durable is that the aluminum atoms on the surface of the metal quickly combine with oxygen in the air to form a thin, strong, and protective coating of aluminum oxide or alumina. Since pure aluminum is very soft, aluminum is often mixed with small amounts of other metals to form aluminum alloys, which are stronger and harder.

Aluminum compounds are used in many diverse and important industrial applications such as alums in water-treatment and alumina in abrasives and furnace linings. They are found in consumer products such as antacids, astringents, buffered aspirin, food additives, and antiperspirants. Powdered aluminum metal is often used in explosives and fireworks. To learn more about the properties and uses of aluminum see Chapters 3 and 4.

WHAT HAPPENS TO ALUMINUM WHEN IT ENTERS THE ENVIRONMENT?

Aluminum occurs naturally in soil, water, and air. It is redistributed or moved by natural and human activities. High levels in the environment can be caused by the mining and processing of its ores and by the production of aluminum metal, alloys, and compounds. Small amounts of aluminum are released into the environment from coal-fired power plants and incinerators. Virtually all food, water, and air contain some aluminum which nature is well adapted to handle.

Aluminum cannot be destroyed in the environment. It can only change its form or become attached or separated from particles. Aluminum particles released from power plants and other combustion processes are usually attached to very small particles. Aluminum contained in

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wind-borne soil is generally found in larger particles. These particles settle to the ground or are washed out of the air by rain. Aluminum that is attached to very small particles may stay in the air for many days. Most aluminum will ultimately end up in the soil or sediment. Aluminum in soil is taken up into plants, which are eaten by animals. Aluminum is not known to bioconcentrate up the food chain and therefore, vegetables, fruits, fish, and meat will not generally contain high concentrations of aluminum. An exception is tea plants which can accumulate aluminum. Because of the toxicity of dissolved aluminum to many aquatic organisms, including fish, these animals would die before the amount of aluminum in the animal became very high.

Most aluminum-containing compounds do not dissolve much in water unless the water is acidic. However, when acid rain falls, aluminum compounds in the soil may dissolve and enter lakes and streams. Since the affected bodies of water are often acidic themselves from the acid rain, the dissolved aluminum does not combine with other elements in the water and settle out as it would under normal (i.e., non-acidic) conditions. In this situation, abnormally high concentrations of aluminum may occur. For more information on aluminum in the environment, see Chapter 5.

HOW MIGHT I BE EXPOSED TO ALUMINUM?

Aluminum is found naturally in the environment. You are always exposed to some aluminum by eating food; drinking water, ingesting medicinal products like certain antacids and buffered analgesics that contain aluminum, or breathing air. You may also be exposed by skin contact with soil, water, aluminum metal, antiperspirants, food additives (e.g., some baking powders) or other substances that contain aluminum. Analytical methods used by scientists to determine the levels of aluminum in the environment generally do not determine the specific form of aluminum present. Therefore, we do not always know the form of aluminum a person may be exposed to. Similarly, we do not know what forms of aluminum are present at hazardous waste sites. Some forms of aluminum may be insoluble or so tightly attached to particles or embedded in minerals that they are not taken up by plants and animals. Other forms, such as those found in acidic lakes, may be taken up by plants and animals and, therefore, be more hazardous.

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Aluminum is the most abundant metal in the earth's crust. Its concentration in soils varies widely, ranging from about 0.07 percent by weight or 700 parts per million parts of soil (ppm) to over 10 percent by weight or 100,000 ppm, and the typical concentration is about 7.1% by weight or 71,000 ppm.

Levels of aluminum in the air generally range from 0.005 to 0.18 nanograms (1 nanogram ng, equals a billionth of a gram) of aluminum per cubic meter of air (0.005-0.18 ng/m³), depending on location, weather conditions, and the level of industrial activity in the area. Most of the aluminum in the air is in the form of small suspended particles of soil (dust). Aluminum levels in urban and industrial areas can range from 0.4 to 10 ng/m³. The amount of aluminum you breathe in a day is much less than you consume in food. You may breathe in higher levels of aluminum in dust if you live in areas where the air is dusty, where aluminum is mined or processed into aluminum metal or near certain hazardous waste sites.

The concentration of aluminum in natural waters is generally below 0.1 parts of aluminum per million parts of water (0.1 ppm) unless the water is very acidic. People generally consume very little aluminum from drinking water. Drinking water is sometimes treated with aluminum salts, but even then aluminum levels generally do not exceed 0.1 ppm although several cities have 0.4 to 1 ppm of aluminum in their drinking water. Unprocessed foods like fresh fruits, vegetables, and meat contain very little aluminum. However aluminum compounds may be added to foods (e.g., baking powder) during processing. Foods such as processed cheese and cakes may contain moderate amounts of aluminum as a result of its addition during processing. Soy-based infant formula may also contain moderate amounts of aluminum. An adult eats about 7 to 9 milligrams (1 milligram equals a thousandth of a gram) of aluminum per day in their food. People are exposed to aluminum in some cosmetics such as deodorants and in pharmaceuticals such as antacids, buffered aspirin, and intravenous fluids. The amount of aluminum ingested in antacids is as much as 200 milligram per tablet. For more information on how you might be exposed to aluminum see Chapter 5.

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1.4 HOW CAN ALUMINUM ENTER AND LEAVE MY BODY?

When you eat aluminum in your food or drink it in liquids, very little goes from your stomach into your bloodstream. Most aluminum leaves your body quickly in the feces. The small amount of aluminum that does enter the bloodstream leaves in the urine. You breathe in very little aluminum from the air, and very little can enter your body through the skin. To learn more, see Chapter 2.

1.5 HOW CAN ALUMINUM AFFECT MY HEALTH?

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.

Exposure to aluminum is usually not harmful. Aluminum occurs naturally in many foods. Factory workers who breathe large amounts of aluminum dusts can have lung problems, such as coughing or changes that show up in chest X-rays. The use of breathing masks and controls on the levels of dust in factories have eliminated this problem. Some workers who breathe aluminum dusts or aluminum fumes have decreased performance in some tests that measure functions of the nervous system. Some people who have kidney disease store a lot of aluminum in their bodies. The kidney disease causes less aluminum to be removed from the body in the urine. Sometimes these people developed bone or brain diseases that doctors think were caused by the excess aluminum. Some studies show that people exposed to high levels of aluminum may develop Alzheimer's disease, but other studies have not found this to be true. We do not

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know for certain whether aluminum accumulation is a result of the disease or its cause. People may get skin rashes from the aluminum compounds in some underarm antiperspirants.

Rats and hamsters showed signs of lung damage after breathing very large amounts of aluminum as chlorohydrate or pure metal dust. Some animals died when they were given very large amounts of aluminum in water, and others gained less weight than normal. Animals exposed to aluminum appeared weaker and less active in their cages, and were less responsive to loud noises.

We do not know if aluminum will affect reproduction in people. Aluminum does not appear to affect reproduction in animals. Aluminum has not been shown to cause cancer in animals. To learn more about the health effects of aluminum exposure, see Chapter 2.

1.6 HOW CAN ALUMINUM 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.

Children may be exposed to high levels of aluminum in drinking water. Brain and bone disease have been seen in children with kidney disease. Bone disease has also been seen in children taking some medicines containing aluminum. Animals exposed to aluminum appeared weaker and less active in their cages, and some movements appeared less coordinated than animals not exposed to aluminum. In addition, aluminum also made some animals unusually sensitive to high temperature. These effects are similar to those seen in adults. It does not appear that children are more sensitive than adults.

We do not know if aluminum will cause birth defects in people. Birth defects have been seen in animals. Effects on the nervous system have been seen in the newborn babies of animals exposed to aluminum in the diet.

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There does not appear to be any difference between children and adults in terms of how much aluminum will enter the body, where aluminum can be found in the body, and how fast aluminum will leave the body. Aluminum from the mother can enter her unborn baby through the placenta. Aluminum is found in breast milk, but only a small amount of this aluminum will enter the infant's body through breastfeeding.

1.7 HOW CAN FAMILIES REDUCE THE RISK OF EXPOSURE TO ALUMINUM?

If your doctor finds that you have been exposed to significant amounts of aluminum, ask your doctor if children may also be exposed. When necessary your doctor may need to ask your state Department of Public Health to investigate.

The most important way families can lower exposures to aluminum is to know about the sources of aluminum that may affect their health and lessen their exposure to these sources. Since aluminum is so common and widespread in the environment, we cannot avoid exposure to aluminum. In addition, exposure to the low levels of aluminum that are naturally present in food and water and the forms of aluminum that are present in dirt and aluminum pots and pans is generally not harmful. Eating large amounts of processed food containing aluminum additives, cooking acid food in aluminum pots, or taking aluminum-containing drugs is the most common way that families may be exposed to high levels of aluminum. Of these sources, avoiding taking large quantities of soluble forms of aluminum such as aluminum-containing antacids and buffered aspirin is the best way to reduce exposure to aluminum. In addition, the products should have child-proof caps so that children will not accidentally eat them. Families should also be aware that soy-based infant formula may contain high levels of aluminum and may want to consult with their physician on the choice of formula for their infant.

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

All people have small amounts of aluminum in their bodies. It can be measured in the blood, feces, or urine, Only the urine measurements can tell you whether you have been exposed to larger-than-normal amounts of aluminum. Your doctor would have to send a sample to a specialized laboratory to do this test. To learn more, see Chapters 2 and 6.

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 s 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 aluminum include the following:

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EPA requires industry to report spills of more than 5,000 pounds of aluminum sulfate. Special regulations are set for aluminum phosphide because it is a pesticide. EPA has recommended a Secondary Maximum Contaminant Level (SMCL) of 0.05 to 0.2 milligrams per liter (mg/L) for aluminum in drinking water. The SMCL is not based on levels that will affect humans or animals. It can be based on taste, smell, or color. OSHA says that the amount of aluminum dusts that workers breathe should be not more than 15 milligrams per cubic meter (mg/m³) of air. FDA has determined that aluminum cooking utensils, aluminum foil, antiperspirants, antacids, and other aluminum products are generally safe. To learn more, see Chapter 7.

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
Fax: (404) 639-6359 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.

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* To order toxicological profiles, contact:

National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161
Phone: (800) 553-6847 or (703) 487-4650