PUBLIC HEALTH STATEMENT
Aluminum
CAS # 7429-90-5

Division of Toxicology and Environmental Medicine **September 2008**

This Public Health Statement is the summary chapter from the Toxicological Profile for Aluminum. 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 1-800-232-4636.

This public health statement tells you about aluminum 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. Aluminum (in some form, e.g., in compounds with other elements such as oxygen, sulfur, or phosphorus) has been found at elevated levels in at least 596 of the 1,699 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 aluminum 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 at high levels may be harmful.

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. However, it should be noted that aluminum is a very abundant and widely distributed element and will be found in most rocks, soils, waters, air, and foods. You will always have some exposure to low levels of aluminum from eating food, drinking water, and breathing air.

If you are exposed to aluminum, 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 ALUMINUM?

Description	Aluminum is the most abundant metal in the earth's crust and it is widely distributed. 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. Aluminum as the metal is obtained from aluminum-containing minerals, primarily bauxite. Aluminum metal is light in weight and silvery-white in appearance.
Uses • **Aluminum metal**	Aluminum is used to make beverage cans, pots and pans, airplanes, siding and roofing, and foil. Powdered aluminum metal is often used in explosives and fireworks.
• **Aluminum compounds**	Aluminum compounds are used in many diverse and important industrial applications such as alums (aluminum sulfate) in water-treatment and alumina in abrasives and furnace linings.
• **Consumer products**	Aluminum is found in consumer products including: • antacids • astringents • buffered aspirin • food additives • antiperspirants • cosmetics

1.2 WHAT HAPPENS TO ALUMINUM WHEN IT ENTERS THE ENVIRONMENT?

Sources	Aluminum occurs naturally in soil, water, and air. High levels in the environment can be caused by the mining and processing of aluminum ores or the production of aluminum metal, alloys, and compounds. Small amounts of aluminum are released into the environment from coal-fired power plants and incinerators.
Break down • **Air** • **Water and soil**	Aluminum cannot be destroyed in the environment. It can only change its form or become attached or separated from particles. Aluminum particles in air settle to the ground or are washed out of the air by rain. However, very small aluminum particles can stay in the air for many days. Most aluminum-containing compounds do not dissolve to a large extent in water unless the water is acidic or very alkaline.

1.3 HOW MIGHT I BE EXPOSED TO ALUMINUM?

Food—primary source of exposure	Unprocessed foods like fresh fruits, vegetables, and meat contain very little aluminum. Aluminum compounds may be added during processing of foods, such as: • flour • baking powder • coloring agents • anticaking agents An average adult in the United States eats about 7–9 mg of aluminum per day in their food.

Air	Most people take in very little aluminum from breathing. Levels of aluminum in the air generally range from 0.005 to 0.18 micrograms per cubic meter (µg/m^3), depending on location, weather conditions, and type and 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 may be higher and can range from 0.4 to 8.0 µg/m^3.
Water and soil	The concentration of aluminum in natural waters (e.g., ponds, lakes, streams) is generally below 0.1 milligrams per liter (mg/L). People generally consume little aluminum from drinking water. Water is sometimes treated with aluminum salts while it is processed to become drinking water. But even then, aluminum levels generally do not exceed 0.1 mg/L. Several cities have reported concentrations as high as 0.4–1 mg/L of aluminum in their drinking water.
Consumer Products	People are exposed to aluminum in some cosmetics, antiperspirants, and pharmaceuticals such as antacids and buffered aspirin. • Antacids have 300–600 mg aluminum hydroxide (approximately 104–208 mg of aluminum) per tablet, capsule, or 5 milliliter (mL) liquid dose. Little of this form of aluminum is taken up into the bloodstream. • Buffered aspirin may contain 10–20 mg of aluminum per tablet • Vaccines may contain small amounts of aluminum compounds, no greater than 0.85 mg/dose.

1.4 HOW CAN ALUMINUM ENTER AND LEAVE MY BODY?

Enter your body **• Inhalation**	A small amount of the aluminum you breathe will enter your body through your lungs.
• Ingestion	A very small amount of the aluminum in food or water will enter your body through the digestive tract. An extremely small amount of the aluminum found in antacids will be absorbed.
• Dermal contact	A very small amount may enter through your skin when you come into contact with aluminum.
Leave your body	Most aluminum in food, water, and medicines leaves your body quickly in the feces. Much of the small amount of aluminum that does enter the bloodstream will quickly leave your body in the urine.

1.5 HOW CAN ALUMINUM AFFECT MY HEALTH?

This section looks at studies concerning potential health effects in animal and human studies.

Workers **• Inhalation**	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 largely eliminated this problem. Some workers who breathe aluminum-containing dusts or aluminum fumes have decreased performance in some tests that measure functions of the nervous system.
Humans **• Oral**	Oral exposure to aluminum is usually not harmful. 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 know for certain that aluminum causes Alzheimer's disease. 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. Although aluminum-containing over the counter oral products are considered safe in healthy individuals at recommended doses, some adverse effects have been observed following long-term use in some individuals.
Laboratory animals **• Inhalation** **• Oral**	Lung effects have been observed in animals exposed to aluminum dust. Scientists do not know if these effects are due to the aluminum or to the animals breathing in a lot of dust. Studies in animals show that the nervous system is a sensitive target of aluminum toxicity. Obvious signs of damage were not seen in animals after high oral doses of aluminum. However, the animals did not perform as well in tests that measured the strength of their grip or how much they moved around.

1.6 HOW CAN ALUMINUM AFFECT CHILDREN?

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

Effects in children	Brain and bone disease caused by high levels of aluminum in the body have been seen in children with kidney disease. Bone disease has also been seen in children taking some medicines containing aluminum. In these children, the bone damage is caused by aluminum in the stomach preventing the absorption of phosphate, a chemical compound required for healthy bones. Aluminum is found in breast milk, but only a small amount of this aluminum will enter the infant's body through breastfeeding. Typical aluminum concentrations in human breast milk range from 0.0092 to 0.049 mg/L. Aluminum is also found in soy-based infant formula (0.46–0.93 mg/L) and milk-based infant formula (0.058–0.15 mg/L).
Birth defects	We do not know if aluminum will cause birth defects in people. Birth defects have not been seen in animals. Very young animals appeared weaker and less active in their cages and some movements appeared less coordinated when their mothers were exposed to large amounts of aluminum during pregnancy and while nursing. In addition, aluminum also affected the animal's memory. These effects are similar to those that have been seen in adults. It does not appear that children are more sensitive than adult animals.

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

Food	You cannot avoid exposure to aluminum because it is so common and widespread in the environment. Exposure to the 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 are not considered to be harmful. Eating large amounts of processed food containing aluminum additives or frequently cooking acidic foods in aluminum pots may expose a person to higher levels of aluminum than a person who generally consumes unprocessed foods and uses pots made of other materials (e.g., stainless steel or glass). However, aluminum levels found in processed foods and foods cooked in aluminum pots are generally considered to be safe.
Consumer products	Limiting your intake of large quantities of aluminum-containing antacids and buffered aspirin and using these medications only as directed is the best way to limit exposure to aluminum from these sources. As a precaution, such products should have child-proof caps or should be kept out of reach of children so that children will not accidentally ingest them.

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

Detecting exposure	All people have small amounts of aluminum in their bodies. It can be measured in the blood, bones, feces, or urine.
Measuring exposure	Urine and blood aluminum measurements can tell you whether you have been exposed to larger-than-normal amounts of aluminum, especially for recent amounts. Measuring bone aluminum can also indicate exposure to high levels of aluminum, but this requires a bone biopsy.

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 aluminum include the following:

Drinking water	The EPA has recommended a Secondary Maximum Contaminant Level (SMCL) of 0.05–0.2 mg/L for aluminum in drinking water. The SMCL is not based on levels that will affect humans or animals. It is based on taste, smell, or color.
Consumer products	The FDA has determined that aluminum used as food additives and medicinals such as antacids are generally safe. FDA set a limit for bottled water of 0.2 mg/L.
Workplace air	OSHA set a legal limit of 15 mg/m^3 (total dust) and 5 mg/m^3 (respirable fraction) aluminum in dusts averaged over an 8-hour work day.

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 1-800-CDC-INFO (1-800-232-4636), by e-mail at cdcinfo@cdc.gov, or by writing to:

Agency for Toxic Substances and Disease Registry
Division of Toxicology and Environmental Medicine
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/