1. PUBLIC HEALTH STATEMENT

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

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. Ammonia has been found in at least 137 of the 1,647 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 ammonia 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 may harm you.

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.

If you are exposed to ammonia, 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 AMMONIA?

Ammonia is a chemical that is made both by humans and by nature. It is made up of one part nitrogen (N) and three parts hydrogen (H_3). The amount of ammonia manufactured every year by humans is almost equal to the amount produced by nature every year. However, when ammonia is found at a level that may cause concern, it was likely produced either directly or indirectly by humans.

1. PUBLIC HEALTH STATEMENT

Ammonia is a colorless gas with a very sharp odor. Ammonia in this form is also known as ammonia gas or anhydrous ("without water") ammonia. Ammonia gas can also be compressed and becomes a liquid under pressure. The odor of ammonia is familiar to most people because ammonia is used in smelling salts, household cleaners, and window cleaning products. Ammonia easily dissolves in water. In this form, it is also known as liquid ammonia, aqueous ammonia, or ammonia solution. In water, most of the ammonia changes to the ionic form of ammonia, known as ammonium ions, which are represented by the formula NH_4^+ (an ion is an atom or a group of atoms that has acquired a net electric charge by gaining or losing one or more electrons). Ammonium ions are not gaseous and have no odor. Ammonia and ammonium ions can change back and forth in water. In wells, rivers, lakes, and wet soils, the ammonium form is the most common. Ammonia can also be combined with other substances to form ammonium compounds, including salts such as ammonium chloride, ammonium sulfate, ammonium nitrate, and others.

Ammonia is very important to plant, animal, and human life. It is found in water, soil, and air, and is a source of much needed nitrogen for plants and animals. Most of the ammonia in the environment comes from the natural breakdown of manure and dead plants and animals.

Eighty percent of all manufactured ammonia is used as fertilizer. A third of this is applied directly to soil as pure ammonia. The rest is used to make other fertilizers that contain ammonium compounds, usually ammonium salts. These fertilizers are used to provide nitrogen to plants. Ammonia is also used to manufacture synthetic fibers, plastics, and explosives. Many cleaning products also contain ammonia in the form of ammonium ions.

For detailed information on the chemical properties of ammonia, see Chapter 4. Details on the production and use of ammonia are in Chapter 5, and more information on the environmental fate of ammonia and sources of human exposure is in Chapter 6.

1.2 WHAT HAPPENS TO AMMONIA WHEN IT ENTERS THE ENVIRONMENT?

Since ammonia occurs naturally in the environment, we are regularly exposed to low levels of ammonia in air, soil, and water. Ammonia exists naturally in the air at levels between 1 and 5 parts in a billion parts of air (ppb). It is commonly found in rainwater. The ammonia levels in rivers and bays are usually less than 6 parts per million (ppm; 6 ppm=6,000 ppb). Soil typically contains about 1–5 ppm of ammonia. The levels of ammonia vary throughout the day, as well as from season to season. Generally, ammonia levels are highest in the summer and spring. Ammonia is essential for mammals and is necessary for making DNA, RNA, and proteins. It also plays a part in maintaining acid-base balance in tissues of mammals.

Ammonia does not last very long in the environment. Because it is recycled naturally, nature has many ways of incorporating and transforming ammonia. In soil or water, plants and microorganisms rapidly take up ammonia. After fertilizer containing ammonia is applied to soil, the amount of ammonia in that soil decreases to low levels in a few days. In the air, ammonia will last about 1 week.

Ammonia has been found in air, soil, and water samples at hazardous waste sites. In the air near hazardous waste sites, ammonia can be found as a gas. Ammonia can also be found dissolved in ponds or other bodies of water at a waste site. Ammonia can be found attached to soil particles at hazardous waste sites. The average concentration of ammonia reported at hazardous waste sites ranges from 1 to 1,000 ppm in soil samples and up to 16 ppm in water samples.

See Chapter 6 for more detailed information on the environmental fate of ammonia, ammonia levels in the environment, and exposure to ammonia.

1.3 HOW MIGHT I BE EXPOSED TO AMMONIA?

Ammonia is naturally produced and used by all mammals in their normal metabolism. Ammonia is produced within a person’s body each day. Most of this ammonia is produced by organs and tissues, but some is produced by bacteria living inside our intestines.

Ammonia is found naturally in the environment. You may be exposed to ammonia by breathing air, eating food, or drinking water that contains it, or through skin contact with ammonia or ammonium compounds. Exposure to ammonia in the environment is most likely to occur by breathing in ammonia that has been released into the air.

Ammonia has a very strong odor that is irritating and that you can smell when it is in the air at a level higher than 5 ppm. Therefore, you will probably smell ammonia before you are exposed to a concentration that may harm you. Levels of ammonia in air that cause serious effects in people are much higher than levels you would normally be exposed to at home or work. However, low levels of ammonia may harm some people with asthma and other sensitive individuals.

You can taste ammonia in water at levels of about 35 ppm. Lower levels than this occur naturally in food and water. Swallowing even small amounts of liquid ammonia in your household cleaner might cause burns in your mouth and throat. A few drops of liquid ammonia on the skin or in the eyes will cause burns and open sores if not washed away quickly. Exposure to larger amounts of liquid ammonia or ammonium ion in the eyes causes severe eye burns and can lead to blindness.

Outdoors, you may be exposed to high levels of ammonia gas in air from leaks and spills at production plants and storage facilities, and from pipelines, tank trucks, railcars, ships, and barges that transport ammonia. Higher levels of ammonia in air may occur when fertilizer with ammonia or ammonium compounds is applied to farm fields. After fertilizer is applied, the concentration of ammonia in soil can be more than 3,000 ppm; however, these levels decrease rapidly over a few days.

Indoors, you may be exposed to ammonia while using household products that contain ammonia. Some of these products are ammonia-cleaning solutions, window cleaners, floor waxes, and smelling salts.

Household and industrial cleaning solutions may contain ammonia, and use of these products at home or work may lead to exposure to ammonia. Both types of ammonia cleaning solutions are made by adding ammonia gas to water to form liquid ammonia. Household ammonia cleaners typically contain lower levels of ammonia (between 5 and 10%) compared to industrial cleaning solutions, which can contain higher levels of ammonia (up to 25%).

Farmers can be exposed to ammonia when they work with or apply fertilizers containing ammonia to fields. Farmers, cattle ranchers, and people who raise other types of livestock and/or poultry can be exposed to ammonia from decaying manure. Some manufacturing processes also use ammonia. Some older refrigeration units used ammonia as the refrigerant.

For more information on levels of exposure associated with effects, see Chapter 3.

1.4 HOW CAN AMMONIA ENTER AND LEAVE MY BODY?

Ammonia can enter your body if you breathe in ammonia gas or if you swallow water or food containing ammonium salts. If you spill a liquid containing ammonia on your skin, a small amount of ammonia might enter your body through your skin; however, more ammonia will probably enter as you breathe ammonia gas from the spilled ammonia. After you breathe in ammonia, you breathe most of it out again. The ammonia that is retained in the body is changed into ammonium compounds and carried throughout the body in seconds. If you swallow ammonia in food or water, it will get into your bloodstream and be carried throughout your body in seconds. Most of the ammonia that enters your body from food or water rapidly changes into other substances that will not harm you. The rest of this ammonia leaves your body in urine within a couple of days. For more information on how ammonia can enter and leave your body, see Chapter 3.

1.5 HOW CAN AMMONIA AFFECT MY HEALTH?

Scientists use many tests to protect the public from harmful effects of toxic chemicals and to find ways for treating persons who have been harmed.

One way to learn whether a chemical will harm people is to determine how the body absorbs, uses, and releases the chemical. For some chemicals, animal testing may be necessary. Animal testing may also help identify health effects such as cancer or birth defects. Without laboratory animals, scientists would lose a basic method for getting information needed to make wise decisions that protect public health. Scientists have the responsibility to treat research animals with care and compassion. Scientists must comply with strict animal care guidelines because laws today protect the welfare of research animals.

Ammonia is a corrosive substance and the main toxic effects are restricted to the sites of direct contact with ammonia (i.e., skin, eyes, respiratory tract, mouth, and digestive tract). For example, if you spilled a bottle of concentrated ammonia on the floor, you would smell a strong ammonia odor; you might cough, and your eyes might water because of irritation. If you were exposed to very high levels of ammonia, you would experience more harmful effects. For example, if you walked into a dense cloud of ammonia or if your skin comes in contact with concentrated ammonia, your skin, eyes, throat, or lungs may be severely burned. These burns might be serious enough to cause permanent blindness, lung disease, or death. Likewise, if you accidentally ate or drank concentrated ammonia, you might experience burns in your mouth, throat, and stomach. There is no evidence that ammonia causes cancer. Ammonia has not been classified for carcinogenic effects by EPA, Department of Health and Human Services (DHHS) (NTP), or the International Agency for Research on Cancer (IARC). Ammonia can also have beneficial effects, such as when it is used as a smelling salt. Certain ammonium salts have long been used in veterinary and human medicine. For more information on how ammonia can affect your health, see Chapter 3.

1.6 HOW CAN AMMONIA 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 are less likely than adults to be exposed to concentrated ammonia because most exposures to concentrated ammonia occur in occupational settings. Children can still be exposed in the same way as adults to ammonia gas from spills or leaks from ammonia tanks or pipelines, especially on farms where it is used as a fertilizer. Children can also be exposed to dilute ammonia solutions from household cleaners containing ammonia.

The effects of ammonia on children are likely to be the same as for adults. Ammonia is an irritant and the solution and gas can cause burns of the skin, eyes, mouth, and lungs. If a spill occurs, children may be exposed to ammonia for a longer time than adults because they may not leave the area as quickly.

There is no evidence that exposure to the levels of ammonia found in the environment causes birth defects or other developmental effects. It is not known whether ammonia can be transferred from a pregnant mother to a developing fetus through the placenta or from a nursing mother to her offspring through breast milk. One study in animals showed that exposure of mothers to very high levels of ammonia during pregnancy caused their newborn offspring to be smaller than normal, but this occurred at levels of ammonia that also affected the mothers.

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

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

You can reduce your risk of exposure to ammonia by carefully using household products and by avoiding areas where ammonia is used or produced. At home, you can reduce your risk of

exposure to ammonia by careful handling of any household products that contain ammonia. For example, some cleaning products contain ammonia; so when you use them, you should be sure that rooms are adequately ventilated during the time you are using them. Avoid ammonia-containing products in glass bottles since breakage could lead to a serious exposure. You should wear proper clothing and eye protection, because ammonia can cause skin burns and damage eyes if it is splashed on them. To lower the risk of your children being exposed to ammonia, you should tell them to stay out of the room when you are using it. While use of ammonia by a child is not recommended, any use by a child should be closely supervised by an adult.

You can also reduce your risk of exposure to ammonia by avoiding areas where it is being used. Ammonia is used to fertilize crops, so you can lower your exposure to ammonia by avoiding these areas when it is being applied. You can also lower your exposure to ammonia by avoiding places where it is produced. Ammonia is found in many animal wastes, and it may be present in high concentrations in the air in livestock buildings. You can lower your exposure to ammonia by avoiding these buildings, especially if large numbers of animals are inside.

If you are a worker who uses or applies ammonia for farming, you can reduce your exposure by using it according to the instructions and wearing proper clothing and protective gear. Be sure to follow all instructions and heed any warning statements.

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

There are tests that measure ammonia/ammonium ion in blood and urine; however, these tests would probably not tell you whether you have been exposed because ammonia is normally found in the body. If you were exposed to harmful amounts of ammonia, you would notice it immediately because of the strong, unpleasant, and irritating smell, the strong taste, and because of skin, eye, nose, or throat irritation. Exposure detection levels and methods for determining ammonia levels in biological materials are discussed in Chapters 3 and 7.

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 ammonia include the following:

EPA regulates the ammonia content in waste water released by several industries. Any discharges or spills of ammonia of 100 pounds or more, or of ammonium salts of 1,000 or 5,000 pounds (depending upon the compound), must be reported to EPA.

Some restrictions have been placed on levels of ammonium salts allowable in processed foods. FDA states that the levels of ammonia and ammonium compounds normally found in food do not pose a health risk. Maximum allowable levels in processed foods are as follows: 0.04–3.2% ammonium bicarbonate in baked goods, grain, snack foods, and reconstituted vegetables; 2.0% ammonium carbonate in baked goods, gelatins, and puddings; 0.001% ammonium chloride in

baked goods and 0.8% in condiments and relishes; 0.6–0.8% ammonium hydroxide in baked goods, cheeses, gelatins, and puddings; 0.01% monobasic ammonium phosphate in baked goods; and 1.1% dibasic ammonium phosphate in baked goods, 0.003% in nonalcoholic beverages, and 0.012% in condiments and relishes.

OSHA has set an 8-hour exposure limit of 25 ppm and a short-term (15-minute) exposure limit of 35 ppm for ammonia in the workplace. NIOSH recommends that the level in workroom air be limited to 50 ppm for 5 minutes of exposure.

Further information on governmental recommendations can be found in Chapter 8.

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 1-888-42ATSDR (1-888-422-8737), by e-mail at atsdric@cdc.gov, or by writing to:

Agency for Toxic Substances and Disease Registry
Division of Toxicology
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/