

1. PUBLIC HEALTH STATEMENT

This Statement was prepared to give you information about silver and to emphasize the human health effects that may result from exposure to it. The Environmental Protection Agency (EPA) has identified 1177 sites on its National Priorities List (NPL). Silver has been found at 27 of these sites. However, we do not know how many of the 1177 NPL sites have been evaluated for silver. As EPA evaluates more sites, the number of sites at which silver is found may change. The information is important for you because silver may cause harmful health effects and because these sites are potential or actual sources of human exposure to silver.

When a chemical 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 as a chemical emission. This emission, which is also called a release, does not always lead to exposure. You can be exposed to a chemical only when you come into contact with the chemical. You may be exposed to it in the environment by breathing, eating, or drinking substances containing the chemical or from skin contact with it.

If you are exposed to a hazardous substance such as silver, several factors will determine whether harmful health effects will occur and what the type and severity of those health effects will be. These factors include the dose (how much), the duration (how long), the route or pathway by which you are exposed (breathing, eating, drinking, or skin contact), the other chemicals to which you are exposed, and your individual characteristics such as age, sex, nutritional status, family traits, life style, and state of health.

1.1 WHAT IS SILVER?

Silver is one of the basic elements that make up our planet. Silver is rare, but occurs naturally in the environment as a soft, "silver" colored metal. Because silver is an element, there are no man-made sources of silver. People make jewelry, silverware, electronic equipment, and dental fillings with silver in its metallic form. It also occurs in powdery white (silver nitrate and silver chloride) or dark-gray to black compounds (silver sulfide and silver oxide). Silver could be found at hazardous waste sites in the form of these compounds mixed with soil and/or water. Therefore, these silver compounds will be the main topic of this profile. Throughout the profile the various silver compounds will at times be referred to simply as silver.

Photographers use silver compounds to make photographs. Photographic materials are the major source of the silver that is released into the environment. Another source is mines that produce silver and other metals.

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The natural wearing down of silver-bearing rocks and soil by the wind and rain also releases large amounts of silver into the environment.

Silver that is released into the environment may be carried long distances in air and water. Rain washes silver compounds out of many soils so that it eventually moves into the groundwater. Silver is stable and remains in the environment in one form or another until it is taken out again by people. Because silver is an element, it does not break down, but it can change its form by combining with other substances. Over time it may change from the form first released, to metallic silver, and then back to the same or other compounds. The form it is found in depends on environmental conditions. More information on the chemical and physical properties of silver compounds can be found in Chapter 3, on its production, use, and disposal in Chapter 4, and on silver in the environment in Chapters 4 and 5.

1.2 HOW MIGHT I BE EXPOSED TO SILVER?

Most people are exposed daily to very low levels of silver mainly in food and drinking water, and less in air. The silver in these sources is at least partially due to naturally occurring silver in water and soil. Skin contact and breathing in air containing silver compounds also occurs in the workplace. Other sources of exposure include the use of silver in medicines, and in activities such as jewelry-making, soldering, and photography. Exposure from everyday use, such as wearing jewelry or eating with silver-coated flatware, is not expected to result in silver being taken into the body.

Silver levels of less than 0.000001 mg silver per cubic meter of air (mg/m^3), 0.2-2.0 parts silver per billion parts water (ppb) in surface waters, such as lakes and rivers, and 0.20-0.30 parts silver per million parts soil (ppm) in soils are found from naturally occurring sources. Silver compounds are also found in groundwater and at hazardous waste sites throughout the United States. Drinking water supplies in the United States have been found to contain silver levels of up to 80 ppb. Surveys show that one-tenth to one-third of samples taken from drinking water supplies (both groundwater and surface water) contain silver at levels greater than 30 ppb. For more information on exposure to silver see Chapter 5.

1.3 HOW CAN SILVER ENTER AND LEAVE MY BODY?

Silver may enter your body through the mouth, throat, or digestive tract after eating food or drinking water that contains silver, or through your lungs after breathing air containing silver. It can also enter your body through your skin when you put your hands into solutions containing silver compounds, such as those used in photography, or when you come in contact with silver-containing powders. Silver is also known to enter the body when medicines containing it are taken or applied to the skin or gums. Generally, much less silver will enter the body through the skin than through the lungs or stomach.

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Because many silver compounds dissolve in water and do not evaporate, the most common way that silver may enter the body of a person near a hazardous waste site is by drinking water that contains silver or eating food grown near the site in soil that contains silver. Silver can also enter the body when soil that has silver in it is eaten. Most of the silver that is eaten or breathed in leaves the body in the feces within about a week. Very little passes through the urine. It is not known how much of the silver that enters the body through the skin leaves the body. Some of the silver that is eaten, inhaled, or passes through the skin may build up in many places in the body. More information on how silver enters and leaves the body can be found in Chapter 2.

1.4 HOW CAN SILVER AFFECT MY HEALTH?

Since at least the early part of this century, doctors have known that silver compounds can cause some areas of the skin and other body tissues to turn gray or blue-gray. Doctors call this condition "argyria." Argyria occurs in people who eat or breathe in silver compounds over a long period (several months to many years). A single exposure to a silver compound may also cause silver to be deposited in the skin and in other parts of the body; however, this is not known to be harmful. It is likely that many exposures to silver are necessary to develop argyria. Once you have argyria it is permanent. However, the condition is thought to be only a "cosmetic" problem. Most doctors and scientists believe that the discoloration of the skin seen in argyria is the most serious health effect of silver.

Exposure to dust containing relatively high levels of silver compounds such as silver nitrate or silver oxide may cause breathing problems, lung and throat irritation and stomach pain. These effects have been seen in workers in chemical manufacturing facilities that make silver nitrate and silver oxide. One man developed severe breathing problems shortly after working with molten silver. Skin contact with silver compounds has been found to cause mild allergic reactions, such as rash, swelling, and inflammation, in some people.

Studies of the health effects of silver in animals commonly use silver nitrate. Doctors and scientists assume that effects seen using silver nitrate in animals will be very similar to effects in humans caused by any silver compound. While this is likely to be true, it is still possible that some silver compounds will be more harmful, or toxic, than silver nitrate.

One animal study suggests that long-term exposure (125 days) to moderately high levels of silver nitrate in drinking water may have a slight effect on the brain because exposed animals were less active than animals drinking water without silver. Another study found that some of the animals that drank water containing moderately high levels of silver for most of their lives (9 months or longer) had hearts that were larger than normal. It is not yet known whether these effects would occur in humans. There have been

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suggestions in some occupational studies in humans that silver can cause kidney problems; however, more people exposed to silver need to be studied to find out if silver causes these effects.

No studies of cancer or birth defects in animals from eating, drinking, or breathing in silver compounds were found. Therefore, it is not known if these effects would occur in humans. One study of animals drinking silver compounds mixed with water for most of their life found no effect on fertility. Another study found that reproductive tissues were damaged in animals after they received injections of silver nitrate. However, the tissues recovered even while the animals received more injections of silver nitrate. Tests in animals show that silver compounds are likely to be life-threatening for humans only when large amounts (that is, grams) are swallowed and that skin contact with silver compounds is very unlikely to be lifethreatening.

Silver does have helpful uses. For example, silver nitrate was used for many years as drops in newborns' eyes to prevent blindness caused by gonorrhoea, and is also used in salves for burn victims. Some water treatment methods (including water filters) also use a form of silver to kill bacteria. More information on the health effects from exposure to silver is presented in Chapter 2. More information on the helpful uses of silver is presented in Chapter 4.

1.5 WHAT LEVELS OF EXPOSURE HAVE RESULTED IN HARMFUL HEALTH EFFECTS?

Reports of cases of argyria suggest that gram amounts of a silver compound taken in medication in small doses over several months may cause argyria in some humans. People who work in factories that manufacture silver compounds can also breathe in the compounds. In the past, some of these workers have become argyric. However, the level of silver in the air and the length of exposure that caused argyria in these workers is not known. It is also not known what level of silver causes breathing problems, lung and throat irritation, or stomach pain in people.

Studies in rats show that drinking water containing very large amounts of silver (2589 parts of silver per million parts of water, or about 2.6 grams per liter) is likely to be life-threatening.

There is very little information about health effects following skin contact with silver compounds. Argyria that covers the entire body is not seen following skin contact with silver compounds, although the skin may change color where it touches the silver. However, many people who have used skin creams containing silver compounds such as silver nitrate and silver sulphadiazine have not reported health problems from the silver in the medicine. In one animal study, a strong solution of silver nitrate (about 41 grams of silver nitrate per liter of water which is equal to 41 parts of

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silver nitrate per thousand parts of water) applied to the skin of guinea pigs for 28 days did not cause the animals to die; however, it did cause the guinea pigs to stop gaining weight normally. It is not known if this would happen to people if they were exposed the same way.

Tables 1-1 through 1-4 present the information that is available concerning specific levels of exposure and health effects. The amount of silver that has caused death in rats, and that has caused mice to be less active are shown in Table 1-4.

1.6 IS THERE A MEDICAL TEST TO DETERMINE WHETHER I HAVE BEEN EXPOSED TO SILVER?

There are reliable and accurate ways of measuring silver in the body. Silver can be measured in the blood, urine, feces, and body tissues of exposed individuals. Because urine and blood samples are easy to get, these fluids are most often used to find out if a person has been exposed to silver in the last week or so. Silver builds up in the body, and the best way to learn if past exposure has occurred is to look for silver in samples of skin. Tests for silver are not commonly done at a doctor's office because they require special equipment. Although doctors can find out if a person has been exposed to silver by having blood or skin samples examined, they can not tell whether any health effects will occur. Information about tests for measuring silver in the body is in Chapters 2' and 6.

1.7 WHAT RECOMMENDATIONS HAS THE FEDERAL GOVERNMENT MADE TO PROTECT HUMAN HEALTH?

The federal government has developed regulations and guidelines to protect people from the possible health effects from long-term exposure to silver in drinking water. The Environmental Protection Agency (EPA) suggests that the level of silver in drinking water not be more than 0.05 milligrams per liter of water (mg/L) (which is equal to 50 parts of silver per billion parts of water or ppb). However, in May, 1989, the EPA announced that this restriction on silver levels in drinking water might be removed. For shortterm exposures (1-10 days), EPA suggests that drinking water levels of silver not be more than 1.142 mg/L (which is equal to 1.142 parts of silver per million parts of water or ppm).

Any release to the environment of more than 1 pound silver nitrate or 1000 pounds of silver alone should be reported to the National Response Center. To limit the amount silver workers are exposed to during an 8-hour shift for a 40-hour work week, the Occupational Safety and Health Administration (OSHA) has set a legal limit (Permissible Exposure Limit or PEL) of 0.01 milligrams of silver per cubic meter of air (mg/m³) in workroom air.

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TABLE 1-1. Human Health Effects from Breathing Silver*

Short-term Exposure (less than or equal to 14 days)		
<u>Levels in Air</u>	<u>Length of Exposure</u>	<u>Description of Effects</u>
		The health effects resulting from short-term exposure of humans to air containing specific levels of silver are not known.
Long-term Exposure (greater than 14 days)		
<u>Levels in Air</u>	<u>Length of Exposure</u>	<u>Description of Effects</u>
		The health effects resulting from long-term exposure of humans to air containing specific levels of silver are not known.

*See Section 1.2 for a discussion of exposures encountered in daily life.

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TABLE 1-2. Animal Health Effects from Breathing Silver

Short-term Exposure (less than or equal to 14 days)		
<u>Levels in Air</u>	<u>Length of Exposure</u>	<u>Description of Effects</u>
		The health effects resulting from short-term exposure of animals to air containing specific levels of silver are not known.
Long-term Exposure (greater than 14 days)		
<u>Levels in Air</u>	<u>Length of Exposure</u>	<u>Description of Effects</u>
		The health effects resulting from long-term exposure of animals to air containing specific levels of silver are not known.

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TABLE 1-3. Human Health Effects from Eating or Drinking Silver*

Short-term Exposure (less than or equal to 14 days)		
<u>Levels in Food</u>	<u>Length of Exposure</u>	<u>Description of Effects</u>
		The health effects resulting from short-term exposure of humans to food containing specific levels of silver are not known.
<u>Levels in Water</u>		The health effects resulting from short-term exposure of humans to water containing specific levels of silver are not known.
Long-term Exposure (greater than 14 days)		
<u>Levels in Food</u>	<u>Length of Exposure</u>	<u>Description of Effects</u>
		The health effects resulting from long-term exposure of humans to food containing specific levels of silver are not known.
<u>Levels in Water</u>		The health effects resulting from long-term exposure of humans to water containing specific levels of silver are not known.

*See Section 1.2 for a discussion of exposures encountered in daily life.

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TABLE 1-4. Animal Health Effects from Eating or Drinking Silver

Short-term Exposure (less than or equal to 14 days)		
<u>Levels in Food</u>	<u>Length of Exposure</u>	<u>Description of Effects*</u>
		The health effects resulting from short-term exposure of animals to food containing specific levels of silver are not known.
<u>Levels in Water (ppm)</u> 2589	2 weeks	Death in rats.
Long-term Exposure (greater than 14 days)		
<u>Levels in Food</u>	<u>Length of Exposure</u>	<u>Description of Effects*</u>
		The health effects resulting from long-term exposure of animals to food containing specific levels of silver are not known.
<u>Levels in Water (ppm)</u> 95 1587	125 days 37 weeks	Sluggish behavior in mice. Decreased weight gain in rats.

*These effects are listed at the level at which they were first observed. They may also be seen at higher levels.

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For more information on criteria and standards for silver exposure, see Chapter 7.

1.8 WHERE CAN I GET MORE INFORMATION?

If you have any more questions or concerns not covered here, please contact your State Health or Environmental Department or:

Agency for Toxic Substances and Disease Registry
Division of Toxicology
1600 Clifton Road, E-29
Atlanta, Georgia 30333

This agency can also give you information on the location of the nearest occupational and environmental health clinics. Such clinics specialize in recognizing, evaluating, and treating illnesses that result from exposure to hazardous substances.