



# **PUBLIC HEALTH STATEMENT**

## **Plutonium**

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**Division of Toxicology and Environmental Medicine**

**November 2010**

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This Public Health Statement is the summary chapter from the Toxicological Profile for Plutonium. 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.

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This public health statement tells you about plutonium 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. Plutonium has been found in at least 16 of the 1,699 current or former NPL sites. Although the total number of NPL sites evaluated for this substance is not known, strict regulations make it unlikely that the number of sites at which plutonium is found would 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 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 normally 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, since plutonium is radioactive, you can also be exposed to its radiation if you are near it.

External exposure to radiation may occur from natural or man-made sources. Naturally occurring sources of radiation are cosmic radiation from space or radioactive materials in soil or

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building materials. Man-made sources of radioactive materials are found in consumer products, industrial equipment, atom bomb fallout, and to a smaller extent from hospital waste and nuclear reactors.

When you are exposed to plutonium, 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 PLUTONIUM?

<b>Radioactive metal</b>	<p>Plutonium is a radioactive element. Pure plutonium is a silvery-white metal.</p> <p>Most plutonium is found combined with other substances, for example, plutonium dioxide (plutonium with oxygen) or plutonium nitrate (plutonium with nitrogen and oxygen).</p> <p>Plutonium is usually measured in terms of its radioactivity (curies or becquerels). Both the curie (Ci) and the becquerel (Bq) tell us how much a radioactive material decays every second.</p>
<b>Exists in various forms called isotopes</b>	<p>The most common plutonium isotope is plutonium-239.</p>
<b>Plutonium is not stable</b>	<p>Each radioactive isotope of an element constantly gives off radiation, which changes it into an isotope of a different element or a different isotope of the same element. This process is called radioactive decay.</p> <p>Plutonium-238 and plutonium-239 give off alpha particles (sometimes referred to as alpha radiation) and transform into uranium-234 and uranium-235, respectively.</p> <p>The half-life is the time it takes for half of the atoms of a radionuclide to undergo radioactive decay and change it into a different isotope. The half-life of plutonium-238 is 87.7 years. The half-life of plutonium-239 is 24,100 years. The half-life of plutonium-240 is 6,560 years.</p>

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<b>Produced in nuclear power plants and used in nuclear weapons and batteries</b>	<p>Very small amounts of plutonium occur naturally. Plutonium-239 and plutonium-240 are formed in nuclear power plants when uranium-238 captures neutrons. Plutonium is used to produce nuclear weapons.</p> <p>Plutonium-238 is used as a heat source in nuclear batteries to produce electricity in devices such as unmanned spacecraft and interplanetary probes.</p>
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### 1.2 WHAT HAPPENS TO PLUTONIUM WHEN IT ENTERS THE ENVIRONMENT?

<b>Released during testing of nuclear weapons</b>	<p>Plutonium released during atmospheric testing of nuclear weapons, which ended in 1980, is the source of most of the plutonium in the environment worldwide. The plutonium released during these tests was deposited on land and water. The small amount that remains in the atmosphere continues to be deposited as it slowly settles out.</p> <p>Plutonium is also released to the environment from research facilities, waste disposal, nuclear fuel reprocessing facilities, nuclear weapons production facilities, and accidents at facilities where plutonium is used.</p>
<b>Deposited in water or soil</b>	<p>Plutonium can be transported in the atmosphere usually when it is attached to particles in the air. It can be deposited on land or water by settling or by rain. Plutonium can stick to particles in soil, sediment, and water.</p> <p>Plutonium isotopes will undergo radioactive decay in the environment.</p>

### 1.3 HOW MIGHT I BE EXPOSED TO PLUTONIUM?

You may be exposed to plutonium by breathing air, drinking water, or eating food containing plutonium; however, the levels of plutonium in air, water, soil, and food are very low.

<b>Soil</b>	<p>Average plutonium levels in surface soil from fallout range from 0.01 to 0.1 picocuries (pCi) per gram of soil (1 picocurie equals one-trillionth [<math>10^{-12}</math>] of a curie).</p>
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<b>Air</b>	Plutonium concentrations in air are generally low. Baseline plutonium-239 concentrations in air ranging from $1.6 \times 10^{-6}$ to $3.8 \times 10^{-6}$ pCi per cubic meter of air ( $\text{pCi}/\text{m}^3$ ) have been reported.
<b>Workplace</b>	Persons who work at nuclear fuel and weapons production facilities have a greater chance of being exposed than individuals in the general population.
<b>Accident</b>	You could be exposed to plutonium if there was an accidental release of plutonium during use. It is very unlikely you would be exposed as the result of a traffic accident or disposal. Plutonium transport containers are virtually indestructible by accident or fire. The disposal site is deep underground and away from the public.

### 1.4 HOW CAN PLUTONIUM ENTER AND LEAVE MY BODY?

<b>Plutonium can enter your body when it is inhaled or swallowed</b>	<p>When you breathe air that contains plutonium, some of it will get trapped in your lungs. Some of the trapped plutonium will move to other parts of your body, mainly your bones and liver. The amount of plutonium that stays in your lungs depends on the solubility of the plutonium that is in the air you breathe.</p> <p>A small amount of the plutonium you swallow (much less than 1%) will enter other parts of your body (mainly your bones and liver).</p> <p>If plutonium gets onto your healthy skin, very little, if any, plutonium will enter your body. More plutonium will enter your body if it gets onto injured skin, such as a cut or burn.</p>
<b>Plutonium in your body will remain there for many years</b>	Plutonium leaves your body very slowly in the urine and feces. If plutonium were to enter your lungs today, much of the plutonium would still be in your body 30–50 years later.

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### 1.5 HOW CAN PLUTONIUM AFFECT MY HEALTH?

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

<b>Lung, liver, and bone cancer</b>	You may develop cancer depending on how much plutonium is in your body and for how long it remains in your body. The types of cancers you would most likely develop are cancers of the lung, bones, and liver. These types of cancers have occurred in workers who were exposed to plutonium in air at much higher levels than is in the air that most people breathe.
<b>Affect ability to fight infections</b>	In laboratory animals, plutonium affected the animal's ability to resist disease (immune system).

### 1.6 HOW CAN PLUTONIUM AFFECT CHILDREN?

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

<b>There are differences between children and adults</b>	<p>Studies in young animals have shown that a larger amount of the plutonium deposited in the lung will move to growing bones. Therefore, it is possible that the bones of children could be more severely affected by plutonium than the bones of adults; however, this has not been shown in humans or tested in laboratory animals.</p> <p>Studies in animals have also shown that a larger amount of plutonium that enters the gut of newborn animals is absorbed into the body.</p>
<b>Effects in unborn children</b>	<p>We do not know if plutonium causes birth defects or affects the ability to have children, although some plutonium that reaches the blood can be found in ovaries and testes.</p> <p>A large portion of the plutonium in the body of adults is in bone. It is possible that plutonium in the bones of a pregnant woman may move to the fetus, when the calcium from the mother's bone is being used to build the bones of the fetus.</p>

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### 1.7 HOW CAN FAMILIES REDUCE THE RISK OF EXPOSURE TO PLUTONIUM?

Exposure of the general population to plutonium will be small. Plutonium levels in water, air, and food are generally low in areas that have not been contaminated by accidents or other releases of radioactive materials.

<b>Risk for working adults</b>	People working at facilities using plutonium that is not highly contained will be more highly exposed to plutonium than the general population.
<b>Risk near the home</b>	People do not generally live near facilities that use plutonium in their operations. Some people may be slightly more exposed to plutonium due to releases of plutonium through filtered stack-emissions or waste water. Any releases are to be within regulatory limits. Disposal sites are deep underground and away from the public.
<b>Risk in the air you breathe</b>	Breathing plutonium-contaminated air is the most dangerous way to be exposed to plutonium. If you know or suspect that plutonium has been released to the air, you should leave the area immediately.

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

<b>Can be measured in urine and feces</b>	Plutonium can be measured in the urine and feces even at very low levels. These measurements can be used to estimate the total amount of plutonium that has entered the body.  The levels of plutonium in the body can be used to predict the kind of health effects that might develop from that exposure.
<b>Plutonium inside the body can be detected from outside the body</b>	Some sensitive equipment can measure the weak gamma rays that travel to the outside of the body after they are released from plutonium and other radioactive materials inside the body. In the United States, this equipment is only available in a few locations.

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### 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), the Food and Drug Administration (FDA), and the U.S. Nuclear Regulatory Commission (USNRC).

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), the National Institute for Occupational Safety and Health (NIOSH), and the FDA.

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, a 24-hour day, or a work-year), 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.

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The U.S. Nuclear Regulatory Commission (USNRC) has recommended the following radiation exposure limits for the general public and for workers:

<b>General public</b>	0.1 rem/year for the general public and 0.5 rem/year for people who work with patients in nuclear medicine. These regulations are for all forms of radiation combined, so they are not only for plutonium.
<b>Workers</b>	5 rem/year for workers in industries where exposure to radiation may occur and 0.5 rem for the pregnancy period following the declaration of pregnancy by a woman in an industry where exposure to radiation may occur.

These recommended radiation exposure limits are for all forms of radiation combined and are not specific to plutonium. The limits are expressed in units called rem (roentgen equivalent man). A rem is a radiation unit that expresses the radiation equivalent dose to a particular organ or tissue. The limits on equivalent dose are used to calculate the limits on the amount of radioactive substances that can be inhaled or ingested.

### 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](http://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

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and technical assistance number at 1-800-CDCINFO (1-800-232-4636), by e-mail at [cdcinfo@cdc.gov](mailto: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-62  
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/>

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