PUBLIC HEALTH STATEMENT
Uranium

Division of Toxicology and Environmental Medicine **September 2011**

This Public Health Statement is the summary chapter from the Toxicological Profile for Uranium. 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 uranium 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. Uranium has been found in at least 67 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 uranium 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 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, since uranium is radioactive, you can also be exposed to its radiation if you are near it.

If you are exposed to uranium, 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.

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1.1 WHAT IS URANIUM?

Description	Uranium is a naturally occurring radioactive element. Natural uranium is a mixture of three isotopes: ^{234}U, ^{235}U, and ^{238}U. The most common isotope is ^{238}U; it makes up about 99% of natural uranium by mass. All three isotopes behave the same chemically, but they have different radioactive properties. The half-lives of uranium isotopes (the amount of time needed for half of the isotope to give off its radiation and change into a different element) are very long. The least radioactive isotope is ^{238}U with a half-life of 4.5 billion years. Depleted uranium is a mixture of the same three uranium isotopes except that it has very little ^{234}U and ^{235}U. It is less radioactive than natural uranium.
Uses	Uranium is almost as hard as steel and much denser than lead. Natural uranium is used to make fuel for nuclear power plants; depleted uranium is the leftover product. Depleted uranium is used as a counterbalance on helicopter rotors and airplane control surfaces, as a shield to protect against ionizing radiation, as a component of munitions to help them penetrate enemy armored vehicles, and as armor in some parts of military vehicles.

1.2 WHAT HAPPENS TO URANIUM WHEN IT ENTERS THE ENVIRONMENT?

Releases to the environment	Uranium is naturally present in nearly all rocks and soils. It can be released into the environment through wind and water erosion and volcanic eruptions. Uranium can be found in drinking water from wells drilled in uranium-rich rock formations. Industries involved in mining, milling, and processing of uranium can also release it into the environment. Inactive uranium industries may continue to release uranium into the environment.
Fate • **Air**	In the air, uranium exists as dust. Very small dust-like particles of uranium in the air settle from the air onto water, plants, and land. Rain washes uranium from the air and increases the amount of uranium that will settle to the ground.
• **Soil**	Uranium deposited on land can be reincorporated into soil, washed into surface water, or adsorbed onto plant roots.
• **Water**	Uranium in surface water can be transported large distances. Some of the uranium in water will adsorb to sediment and other particles in the water.

1.3 HOW MIGHT I BE EXPOSED TO URANIUM?

Food—primary sources of exposure	Food and drinking water are the primary sources of uranium intake for the general public. Root crops such as potatoes, parsnips, turnips, and sweet potatoes contribute the highest amounts of uranium to the diet. Because uranium in soil can stick to these vegetables, the concentrations in these foods are directly related to the concentrations of uranium in the soil where the foods are grown.

Water	In most areas of the United States, low levels of uranium are found in the drinking water. Higher levels may be found in areas with elevated levels of naturally occurring uranium in rocks and soil.
Air	Very low levels of uranium are found in the air.
Occupational exposure	People who work with materials and products that contain uranium may be exposed at work. This includes workers involved in the mining, milling, processing, and/or production of uranium products. People who work with phosphate fertilizers may also be exposed to higher levels of uranium. People may be exposed to higher levels of uranium if they live near uranium mining, processing, and manufacturing facilities. People may also be exposed if they live near areas where depleted uranium weapons are used.

1.4 HOW CAN URANIUM ENTER AND LEAVE MY BODY?

Enter your body	
• Inhalation	About 0.76–5% of the uranium you breathe will enter the bloodstream through the respiratory tract.
• Ingestion	About 0.1–6% of the uranium you ingest will enter the bloodstream through the gastrointestinal tract. Uranium compounds that dissolve in water enter the bloodstream more easily than uranium compounds poorly soluble in water.
• Dermal contact	A very small amount of uranium can be absorbed through the skin; water-soluble uranium compounds are the most easily absorbed.

Leave the body	Uranium is deposited throughout the body; the highest levels are found in bone, liver, and kidney. About half of the uranium in bone leaves in 70-150 days. It takes 2–6 days for half of the uranium in the kidney to leave. Most of the uranium that is absorbed into the body leaves your body in the urine. Most ingested and inhaled uranium is not absorbed into the body and leaves the body in the feces. However, some inhaled uranium which is not absorbed stays in the lungs for a long time.

1.5 HOW CAN URANIUM AFFECT MY HEALTH?

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

General Information	Natural and depleted uranium have the identical chemical effect on your body. The health effects of natural and depleted uranium are due to chemical effects and not to radiation.
Humans	The main target for inhaled, soluble and moderately soluble uranium compounds in humans is the kidneys. Workers who inhaled uranium hexafluoride have experienced respiratory irritation and accumulation of fluid in the lungs. However, these effects were attributed to the irritant hydrofluoric acid rather than the uranium. Oral exposure to large amounts of uranium can damage the kidneys. Evaluations of Gulf War veterans having embedded metal fragments containing depleted uranium did not show consistent changes in renal and liver function, bone function, blood cell levels, sex hormone levels, sperm parameters, neurocognitive function or, damage to genes or chromosomes.

Animals	The kidney is the most sensitive target for uranium toxicity following inhalation, oral, or dermal exposure to soluble and moderately soluble uranium compounds. If inhaled, insoluble uranium compounds can also damage the respiratory tract. Oral exposure studies in animals have shown that water-soluble uranium compounds will produce kidney effects at lower doses than following exposure to insoluble uranium compounds. Prolonged oral administration of uranium to rats has induced neurobehavioral changes as well as changes in the levels of certain chemicals in the brain. Uranium has been shown to decrease fertility in some studies of rats and mice; other studies have not found this effect. Uranium compounds on the skin caused skin irritation and mild skin damage in animals.
Cancer	Neither the National Toxicology Program (NTP), International Agency for Research on Cancer (IARC) nor the EPA have classified natural uranium or depleted uranium with respect to carcinogenicity.

1.6 HOW CAN URANIUM AFFECT CHILDREN?

This section discusses potential health effects in humans from exposures during the period from conception to maturity at 18 years of age. Potential effects on children resulting from exposures of the parents are also considered.

Effects in children	The health effects seen in children from exposure to toxic levels of uranium are expected to be similar to the effects seen in adults.

Birth defects and other effects	We do not know whether uranium can cause birth defects in people. There are some studies that suggest that exposure to depleted uranium increased the frequency of birth defects, but the studies are deficient and cannot be used to determine whether exposure to uranium causes birth defects in humans. Some studies in animals exposed to high levels of uranium during pregnancy, which caused toxicity in the mothers, have described early deaths and birth defects in the young. It is not clear if this can happen in the absence of effects on the mother. Other studies have not found birth defects. In some studies, exposure of rats during pregnancy altered the results of tests of brain function in the offspring. Other similar studies observed changes in the ovaries of the female offspring. One study reported that giving a high amount of uranium to newborn rats altered the formation of teeth.

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

Food	Avoid eating root vegetables grown in soils with high levels of uranium. At least consider washing fruits and vegetables grown in that soil and discard the outside portion of root vegetables.
Water	Consider having your water tested if you suspect that your drinking water might have elevated levels of uranium; if elevated levels are found consider using bottled water.
Soil	If you live near a hazardous waste site where high levels of uranium are not controlled, prevent your children from eating dirt and make sure that they wash their hands frequently, especially before eating.

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

Detecting exposure	Natural uranium is in your normal diet, so there will always be some level of uranium in all parts of your body. If in addition you are exposed to depleted uranium, it adds to the total uranium in your body. Uranium can be measured in blood, urine, hair, and body tissues. Normally, urinary sampling is the preferred method for assessing uranium exposure.
Measuring exposure	Because most uranium leaves the body within a few days, higher than normal amounts in your urine shows that you have been exposed to larger than normal amounts within the last week or so. Most tests are for total uranium; however expensive tests are available to estimate the amounts of both natural and depleted uranium that are present.

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. These are levels of a toxic substance in air, water, soil, or food that do not exceed a critical value. This critical value 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 uranium include the following:

Drinking water	The EPA has established a maximum contaminant level of 0.03 mg/L and set a maximum contaminant level goal of no uranium in drinking water.
Workplace air	OSHA set a legal limit of 0.05 mg U/m^3 for soluble uranium and 0.25 mg U/m^3 for insoluble uranium averaged over an 8-hour work day. NIOSH recommends an exposure limit of 0.05 mg U/m^3 for soluble uranium and 0.2 mg U/m^3 for insoluble uranium averaged for up to a 10-hour work day. It also recommends that exposure to soluble uranium not exceed 0.6 mg U/m^3 for more than 15 minutes.

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-CDCINFO (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-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/