PLUTONIUM HEALTH RISKS

Rocky Flats workers machined or shaped "pits" or triggers for weapons from 1952 through 1989. The pits were then shipped to Texas to be assembled into nuclear weapons.

What is plutonium?

Plutonium is a silvery-gray, radioactive metal named after the planet Pluto. It is essentially a man-made element discovered in 1940 after uranium-238 was bombarded with neutrons in a device called a cyclotron. Plutonium-239, as well as uranium-235 and uranium-233, are among the few materials whose atoms can be split (or "fissioned") to create a nuclear explosion, which releases massive amounts of energy instantly.

How is it used?

Plutonium is used in the manufacture of nuclear weapons. It was first made in significant quantities during the World War II Manhattan Project in the 1940s. Plutonium can also be used as a fuel in certain types of nuclear reactors where the fission process is controlled so that large quantities of energy are released more slowly to make steam and produce electricity. The split plutonium atoms become lighter elements such as cesium-137 and strontium-90, many of which are highly radioactive. These "fission products" are radioactive waste, although some are useful for nuclear medicine and other purposes.

The radioactivity level of an isotope such as plutonium is determined by its half-life, which is the time it takes for half of an original quantity to decay. the half-life of plutonium-239 is about 24,000 years.

What are the problems with handling plutonium?

Plutonium metal is difficult to handle and store safely, because it is radioactive and "pyrophoric" meaning it oxidizes and can become very hot when exposed to air. It can ignite nearby flammable materials, causing fires that can result in plutonium exposure of workers and the public. In addition, workers must avoid storing more than a few pounds in close proximity to prevent runaway fission, an uncontrolled nuclear chain reaction. Such a reaction’s burst of energy, known as a "criticality event," would not become a nuclear explosion, but could release radiation very dangerous to nearby workers. Such an event can also result in uncontrolled releases of both plutonium and fission products to the environment.

How was plutonium used at the former Rocky Flats Nuclear Weapons Plant?

Plutonium was created in nuclear reactors in Hanford, Washington, and the Savannah River Site, South Carolina. It is then shipped to the Rocky Flats Plant northwest of Denver, Colorado for use in the manufacture of nuclear weapons components. Rocky Flats workers machined or shaped "pits" or triggers for weapons from 1952 through 1989. The pits were then shipped to Texas to be assembled into nuclear

weapons. After weapons production ceased, about 14.2 U.S. tons of plutonium were left at Rocky Flats. The site is currently undergoing cleanup and closure.

What caused plutonium releases from Rocky Flats?

Some plutonium particles were released into the environment through roof vents and stacks during routine nuclear weapons production activities. Plutonium was also released during industrial fires in 1957 and 1969, and some was released through wastewater discharges into holding ponds and creeks that flowed off the site. More than 5,000 barrels of contaminated waste oil and solvents stored outdoors at the Rocky Flats 903 Area leaked onto the soil beginning in the late 1950s. The barrels were removed in the late 1960s, exposing the soil to the elements. Windstorms blew the plutonium-contaminated soil particles into the air and off-site. Resuspension of these particles is ongoing. The contaminated 903 Area was covered with asphalt in 1969. Soil sampling around the Rocky Flats Plant has shown that the area east and southeast of the plant has the highest plutonium levels. This contamination is the result of the routine releases, the fires and the 903 Area spill.

Where can plutonium be found in the environment?

Before 1945, plutonium was virtually nonexistent in the human environment. Then in the 1950s and 1960s, plutonium was released into the environment during atmospheric testing of nuclear weapons. Plutonium can now be found in very small amounts in the soil throughout the Northern Hemisphere because of fallout from the atmospheric testing. Plutonium has also been found in soil near nuclear weapons production plants such as Rocky Flats due to accidents and spills.

Why is plutonium a problem in the environment?

Plutonium remains radioactive in the environment for a very long time. Plutonium decays by releasing small amounts of energy through fast-moving alpha particles. The radioactivity level of an isotope such as plutonium is determined by its half-life, which is the time it takes for half of an original quantity to decay. The half-life of plutonium-239 is about 24,000 years.

What happens to plutonium in the environment?

Plutonium particles may be released to the air where people may inhale them, or the particles may deposit on soil, plants and water. The plutonium particles landing on soil either attach to clays or stay near the soil surface where winds can pick them up and redistribute them. Plutonium particles can deposit on plants, but are not readily absorbed by the roots into the plants. Plutonium is usually insoluble in water, so plutonium particles that land on lakes and streams usually settle to the bottom in the sediment.

How are people exposed to plutonium?

Members of the public living or working near nuclear weapons production plants can be exposed when equipment fails, accidents happen or mistakes are made, causing releases that move off the plant site through the air or in water. Plutonium particles in the air can deposit on the soil, where adults or children may work or play, or on water, which may be a source for drinking, irrigation of crops or recreation. Particles can also deposit on vegetables or on grass eaten by cows that may later provide milk and meat for human consumption.

Why is plutonium a human concern?

Plutonium emits alpha radiation and low-energy x-rays, which are easily absorbed by tissue. The alpha radiation travels only about a quarter of an inch in air and cannot penetrate the skin. Therefore, if plutonium remains outside the body, it is generally not harmful. Plutonium is very toxic if it enters into the body because the alpha radiation can damage living tissue. The larger the "dose" in the body, the greater the toxicity.

Human exposure occurs mainly by breathing contaminated air or ingesting contaminated food or drink. Breathing is generally the route of most concern. When plutonium particles are inhaled and lodge in lung

tissue, they continue to give off radiation internally. They can remain in the lungs or enter the gastrointestinal tract and the bloodstream. About 80 percent of the plutonium that enters the bloodstream goes either to the liver, bone or bone marrow, where it is retained for years, damaging tissue nearby. That damage may later develop into cancer. Common forms of plutonium do not dissolve significantly in water or body fluids, so little ingested material is actually absorbed into the blood from the gastrointestinal tract.

How do scientists estimate human health risks from low-level exposure to plutonium?

A great deal of research has been performed on the effects of radiation exposures at higher concentrations. However, little information is available for low doses of plutonium. Relatively few such exposures have been documented, with little solid evidence of effects. New information on exposures of Russian nuclear weapons plant workers has helped in developing better risk estimates for plutonium exposures. To estimate the risks of developing cancer from exposure to plutonium, the researchers conducting the Historical Public Exposures Studies on Rocky Flats used four independent sets of data:

1) Results of studies of Russian workers exposed to plutonium at the Mayak weapons plant, a production facility similar to Rocky Flats;
2) Data from populations exposed to other alpha-emitting radioactive materials such as radium, radon and thorium;
3) Data from Japanese World War II atomic bomb survivors exposed briefly to high levels of the gamma and neutron radiation from the atomic explosions; and
4) Results of controlled experiments on animals exposed to plutonium and other alpha-emitting materials.

Based on this information, the researchers developed revised estimates of the risks associated with plutonium exposure. (See the technical report Assessing Risks of Exposure to Plutonium prepared by Radiological Assessments Corporation for the Historical Public Exposures Studies on Rocky Flats in February 1999.) Because plutonium is retained in the lung, liver, bone and bone marrow, rather than in the reproductive organs, genetic risks are not the primary risks from plutonium.

Can an individual's exposure to plutonium be measured externally or internally?

A person’s plutonium exposure cannot be measured from outside the body, although estimates can sometimes be made by measuring radiation from other materials deposited along with the plutonium. Urine or fecal samples can be analyzed for plutonium, primarily to evaluate the magnitude of known or suspected intakes. These methods are difficult to interpret when multiple intakes have occurred and because very little deposited plutonium leaves the body.

Are there standards for worker and public exposure to plutonium?

The International Commission on Radiological Protection (ICRP) and the National Council on Radiation Protection and Measurement have had standards for public and worker protection from radiation for more than 45 years. The ICRP standards have changed several times over the past 45 years to reflect new data and understanding of hazards from plutonium. In addition, the current philosophy of radiation protection is to keep radiation exposures as low as is reasonably achievable. Efforts are made to protect workers in occupations involving exposure to radioactive materials by limiting that exposure with appropriate methods and equipment. Efforts are made to protect the public by minimizing radioactive releases to the off-site environment.

Where can I get more information about cancer risks from Rocky Flats?

Information about cancer risks from plutonium and other contaminants released from Rocky Flats from 1952 to 1989 is available in the Final Summary Report on the Historical Public Exposures Studies on Rocky Flats.