# Uranium-233 at the Hanford Nuclear Site

December 2002

**Fact Sheet 320-086**

Division of Environmental Health
Office of Radiation Protection

Washington State Department of Health

## INTRODUCTION

Hanford's historical mission was the production of fissile material for nuclear weapons. Most significantly, the fissile material Plutonium-239 was produced by irradiating Uranium-238 in nuclear reactors. In the mid 1960's, and again in the early 1970's, smaller scale efforts were carried out to experiment with producing the fissile material Uranium-233 by irradiating Thorium-232.

## PHYSICAL PROPERTIES?

Uranium has three isotopes that exist naturally. They are Uranium-234, Uranium-235, and Uranium-238. Uranium-233 is man-made. Some properties of these isotopes are listed below.

| Property | U-233 | U-234 | U-235 | U-238 |
|---|---|---|---|---|
| **Natural abundance by weight (%)** | 0 | 0.0055 | 0.7200 | 99.2745 |
| **Natural abundance by radioactivity (%)** | 0 | 49.65 | 2.25 | 48.10 |
| **Half life (years)** | 160,000 | 246,000 | 700 million | 4.5 billion |

## DETECTION AND ANALYSIS

All of these uranium isotopes emit alpha radiation. Typically, uranium is measured in environmental samples by detecting the alpha radiation. Alpha spectroscopy methods are able to detect and differentiate alpha radiation from each of the three natural isotopes, so that concentrations may be reported for each isotope. Alpha radiation emitted from U-233 is detectable by alpha spectroscopic methods, however, it is difficult to differentiate between the alpha radiation emitted from U-233 and U-234.

If U-233 is present in quantities similar to U-234, U-233 can be differentiated and its concentration identified and reported separately. This situation has not been observed in environmental samples analyzed for isotopic uranium at Hanford. These samples include sediment samples along the Columbia River shoreline and groundwater samples from the reactor and separations areas of Hanford. If U-233 is present in quantities that are small relative to U-234, its presence might not be identified. Even if concentrations of U-233 could be not identified the reported concentration for U-234 would include any U-233 that is present.

Mass spectrometry methods can clearly differentiate between U-233 and U-234 and therefore are well suited to specifically measure U-233 concentrations. Using these methods, U-233 has been analyzed for, and detected, in some tank waste sludge samples. However, mass spectrometric methods have not been used to analyze for U-233 in environmental samples.

## HEALTH IMPACTS

Health impacts from radioactive contaminants are measured in terms of radiation dose. Radiation doses are calculated based on radioactivity concentrations measured in environmental samples. For uranium, doses are determined for each of the uranium isotopes, i.e. U-234, U-235, and U-238. As discussed above, environmental sample results for U-234 may contain contributions from the presence of U-233. However, the radiation dose resulting from exposure to U-233 is equal to the dose from exposure to U-234. Therefore, the health impacts from the presence of any U-233 are included when the health impacts from U-234 are tracked.

The U.S. Environmental Protection Agency's drinking water standard for uranium is 30 micrograms (μg) total uranium per liter (total uranium is the sum of all uranium isotopes). The standard is expressed as a mass concentration because uranium is also chemically toxic, and the quantity of mass intake is important. Essentially all of the uranium mass in environmental samples is from U-238 The U-234 mass concentrations are quite small. As discussed above, since U-233 has not been identified in Hanford groundwater, its concentrations must be small compared to those

measured for U-234. Therefore, U-233 mass concentrations in Hanford groundwater must be orders of magnitude smaller than the drinking water standard.

The U.S. Department of Energy has developed screening levels for radioactive contaminants in water and sediment for the protection of aquatic and terrestrial biota. For the uranium isotopes, the screening levels are 200 pCi/L in water and 5,000 pCi/g in sediment. The concentration of uranium in Columbia River sediment and Columbia River water samples are orders of magnitude below the applicable radioactive screening level.

---

## CONCLUSION

In summary, standard alpha spectroscopy methods are capable of identifying and quantifying the presence of U-233 in environmental samples. U-233 has not been identified in environmental samples at the Hanford Site. If U-233 is present in small quantities relative to U-234, the presence of U-233 may not be identified. However, any presence of U-233 would be included in reported U-234 concentrations, and potential impacts from U-233 would be tracked when impacts from U-234 are assessed.

---

## Sources

Office of Radiation Protection, Washington State Department of Health

*Links to external resources are provided as a public service and do not imply endorsement by the Washington State Department of Health.*