



United States
Environmental Protection
Agency

Common Radionuclides



Found at Superfund Sites

Office of Radiation
and Indoor Air
Office of Solid Waste and
Emergency Response
Washington, DC 20460

9200.1-34
PB 2001 963303
EPA 540/R-00-004
March 2002

INTRODUCTION

This booklet contains two page fact sheets on some of the common radionuclides found at hazardous waste sites across the nation. It is meant to help you understand more about the various radionuclides and to assist the public in understanding how the federal government may apply legal requirements in the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA). The CERCLA requirements and regulations described in this document contain legally binding requirements. The information in this booklet is not a substitute for those requirements and regulations, nor is it a regulation itself. Thus, it does not impose legally-binding requirements on any party, including EPA, States, or the regulated community, and may not apply to a particular situation based on the circumstances. EPA and State decisionmakers retain the discretion to adopt approaches on a case-by-case basis that differ from this booklet where appropriate. Any decisions regarding a particular facility will be made based on the applicable statutes and regulations. Therefore, interested parties are free to raise questions and objections about the appropriateness of the application of this booklet to particular situation, and EPA will consider whether or not the recommendations or interpretations in the booklet are appropriate in that situation. EPA may change this booklet in the future.

This booklet answers such questions as: How can a person be exposed to the radionuclide?, How can it affect human health?, How it enters and leaves the body?, What levels of exposure result in harmful effects?, What recommendations has the federal government made to protect human health from the radionuclide?

What recommendations has the Environmental Protection Agency made to protect human health?

Information on recommendations EPA has made to protect human health from exposure to a particular radionuclide are contained in each of the fact sheets. General recommendations EPA has made to protect human health, which cover all radionuclides, are summarized below.

All actions to clean up contamination at CERCLA sites must be protective of human health and the environment and comply with Applicable or Relevant and Appropriate Requirements (ARARs) unless a waiver is justified. ARARs are often the determining factor in establishing cleanup levels at CERCLA sites. However, where ARARs are not available or are not sufficiently protective, EPA generally sets site-specific cleanup levels for carcinogens at a level that represents an excess upper bound lifetime cancer risk of between 10^{-4} to 10^{-6} to an individual under a reasonable maximum exposure (RME) scenario. This can be interpreted to mean that an individual may have a one in 10,000 to one in 1,000,000 increased chance of developing cancer because of exposure to a site-related carcinogen. The site-specific level of cleanup is determined using the nine criteria specified in 40 CFR 300.430(e)(9)(iii) of the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). EPA has developed a standard approach for calculating radionuclide soil concentrations that correspond to a cancer risk level of 1×10^{-6} and that protect against radionuclides moving from the soil into the groundwater. This electronic calculating tool may be found on the internet at <http://epa-prgs.ornl.gov/radionuclides> .

The Environmental Protection Agency OSWER Directive 9200.4-18, [“Establishment of Cleanup Levels for](#)

[CERCLA Sites with Radioactive Contamination](#)”, Attachment A provides a listing of Federal radiation regulations that may be ARARs for Superfund cleanup actions. This list is not a comprehensive list of Federal radiation standards and it does not include State standards which may be ARARs. It must also be cautioned that the selection of ARARs is site-specific and those determinations may differ from those listed in OSWER Directive 9200.4-18, Attachment A. To assess the potential for cumulative noncarcinogenic effects posed by multiple contaminants, EPA has developed a hazard index (HI). The HI is derived by adding the noncancer risks for site chemicals with the same target organ/mechanism of toxicity. When the HI exceeds 1.0, there may be concern for adverse health effects due to exposure to multiple chemicals.

What radionuclides are listed in this booklet?

The radionuclides listed in this booklet are:

- Americium-241
- Cesium-137
- Cobalt-60
- Iodine
- Plutonium
- Radium
- Radon
- Strontium-90
- Technetium-99
- Thorium
- Tritium
- Uranium

If you have more questions about the radionuclides mentioned in this booklet or would like more information on the U.S. Environmental Protection Agency’s Superfund hazardous waste cleanup program, please contact either *EPA’s Superfund Hotline at 1-800-424-9346 or 1-800-535-0202* or *EPA’s Superfund Radiation Webpage <http://www.epa.gov/oerrpage/superfund/resources/radiation/index.htm>*.

GLOSSARY

Activity: See radioactivity.

Aerobic: Able to live or grow only where oxygen is present.

Alpha particle: A positively charged particle released spontaneously from the nuclei of some radioactive elements.

Applicable or Relevant and Appropriate Requirements (ARARs): Any state or federal statute that pertains to protection of human health and the environment in addressing specific conditions or use of a particular cleanup technology at a Superfund site.

Background Concentration: The concentration of a substance in an environmental media (air, water, or soil) that occurs naturally or is not the result of activities from operations at the site.

Becquerel: The international system (SI) units of activity equal to one nuclear transformation (disintegration) per second.

Beta Particle: An electron emitted from the nucleus during radioactive decay.

Curie: The customary unit of radioactivity. A curie is equal to 37 billion disintegrations per second which is approximately the rate of decay of 1 gram of radium.

Decay products: Nuclides produced during radioactive decay of some other nuclide.

Detection limit: The lowest concentration of a chemical that can reliably be distinguished from a zero concentration.

Epidemiology: Study of the distribution of disease, or other health-related states and events in human populations, as related to age, sex, occupation, ethnicity, and economic status in order to identify and alleviate health problems and promote better health.

Fission: Transformation characterized by the splitting of a nucleus into two or more parts and the release of a relatively large amount of energy.

Fission product: Nuclides produced during nuclear fission.

Gamma radiation : Penetrating high-energy, short-wavelength electromagnetic radiation (similar to X-rays) emitted during radioactive decay. Gamma rays are very penetrating and require dense materials, such as lead or steel, for shielding.

Groundwater: The supply of fresh water found beneath the Earth's surface, usually in aquifers, which supply

wells and springs. Because ground water is a major source of drinking water, there is growing concern over contamination from leaching agricultural or industrial pollutants or leaking underground storage tanks.

Half-life: The time in which half the atoms of a particular radioactive substance disintegrate into another nuclear form.

Ingestion: The act or process of putting food, water, or other material into the body for digestion.

Inhalation: To draw air, vapor, etc. into the lungs; to breathe.

Isotope: One of two or more atoms that has the same number of protons but different number of neutrons.

Maximum Contaminant Level (MCL): EPA evaluates the health risks associated with various contaminant levels to ensure that public health is adequately protected. The MCL, as it is commonly known, is the maximum allowable concentration of a specific contaminant in public drinking water. Superfund sites are cleaned up so that the level of contamination in the groundwater does not exceed the MCL for that radionuclide. The MCLs for radionuclides are currently being revised. For further information concerning the MCLs for radionuclides, please refer to the following Internet address:

<http://www.epa.gov/safewater/radionuc.html>

Neutron particle : A particle that is similar in mass to a proton, but carries no charge and is found in the nucleus of every atom heavier than hydrogen.

Nucleus: The small, central, positively charged region of an atom that carries essentially all the mass.

Nuclide: A general term referring to all known isotopes, both stable and unstable, of the chemical elements.

Picocurie (pCi): one-trillionth of a curie. A curie is equal to 37 billion disintegrations per second which is approximately the rate of decay of 1 gram of radium.

Radioactivity: The mean number of nuclear transformations occurring in a given quantity of radioactive material per unit time. The customary unit is the *Curie (Ci)*. The International System unit of radioactivity is the *Becquerel (Bq)*.

Radioactive decay: The spontaneous transformation of an unstable atom into one or more different nuclides accompanied by either the emission of energy and/or particles from the nucleus, nuclear capture or ejection of orbital electrons, or fission.

Radionuclide: An unstable nuclide that undergoes radioactive decay.

“Reasonable maximum exposure” (RME) : The maximum exposure reasonably expected to occur in a population.

Superfund Program: The program operated under the legislative authority of the Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA) that provided broad Federal authority to respond directly to releases or threatened releases of hazardous substances that may endanger public health or the environment.

Toxic: A poisonous or hazardous substance; having poisonous or harmful qualities.

Working Level(WL): Any combination of short-lived radon decay products in one liter of air that will result in the ultimate emission of alpha particles with a total energy of 130 billion electron volts.