

Q: *What is radiation? How do we control our exposure? What are spent nuclear fuel and high-level radioactive waste?*

A: Put quite simply, radiation is energy traveling through space. Radiation can take the form of particles or waves — such as ultraviolet light or x-rays. “Ionizing radiation” is a category of radiation that causes changes to the structure of atoms it comes in contact with — it removes electrons, thereby creating “ions,” which are charged particles. An atom that emits ionizing radiation is described as “radioactive.” As this radiation is released over time, the atom becomes less radioactive, and more stable.

The atoms of most elements in our universe are stable. They don't lose energy on their own, and their atomic structure never changes. But certain elements are naturally radioactive; the atoms of such elements are called “radionuclides.” When radionuclides lose excess energy and decay to a more stable atom with less energy, the energy released in the process is radiation.

The three major, commonly recognized types of ionizing radiation are alpha, beta, and gamma radiation. Alpha and beta radiation are emitted in the form of tiny, electrically charged particles. Gamma radiation is electromagnetic rays, similar to light and X-rays. An alpha particle is identical to the nucleus of a helium atom (i.e., two neutrons and two protons) and is positively charged. Beta particles are usually electrons (and thus negatively charged), but they can be positrons (positively charged particles of the size and weight of an electron).

Everyone is exposed to “natural background” and man-made sources of radiation (e.g., cosmic rays, radon, building materials, food, and medical procedures). The average American receives an annual radiation dose of about 360 millirem from these sources. A millirem is a standard measurement of radiation dose absorbed by the human body.



Radiation is energy, similar to light.

Exposure controlled by time, distance, and shielding.

There are three types of nuclear materials that could be disposed of at Yucca Mountain:

- 1) solidified high-level waste created by past, current, and future national defense activities,**
- 2) surplus plutonium from nuclear weapons, and**
- 3) spent nuclear fuel from defense and civilian reactors.**

How do we control our exposure?

We can manage our exposure to radiation by controlling time, distance, and shielding. The less time we spend near materials emitting radiation, and the farther away we stay, the lower our exposure. Alpha particles are comparatively large and can travel only a short distance in air before being stopped or blocked. Alpha particles can also be stopped or blocked by something as thin as a sheet of paper. Beta particles are smaller than alpha particles and travel a longer distance in air before being stopped, but, again, they can be blocked by something as ordinary as a sheet of aluminum foil. Like X-rays, gamma radiation can be blocked by sufficiently thick pieces of steel, concrete, or lead.

What are spent nuclear fuel, surplus plutonium, and high-level radioactive waste?

“Nuclear fuel” is made of solid ceramic pellets containing both uranium-235 and uranium-238. The more important isotope for the large-scale release of energy through fission is uranium-235, because it more readily releases energy. To make nuclear fuel, the pellets are enriched (made to have a higher concentration of uranium-235 than found in nature) and sealed in corrosion-resistant metal tubes called cladding. These tubes are then bundled together to form a fuel assembly. The energy released from the uranium pellets produces heat, which makes steam for turning turbines that are connected to electrical generators. After the fuel is no longer efficient at generating heat, it is considered “spent” or used.

Natural uranium is an alpha-emitter, and the metal cladding surrounding the pellets is sufficient to stop the alpha particles. When the fuel is used in the reactor, the uranium nuclei are broken apart by neutrons into fragments in a process called “fission.” Some of these fragments

produce gamma radiation, which can penetrate the cladding. Storage and transportation casks containing several inches of steel and lead protect workers and the public from unsafe levels of gamma radiation.

“Surplus plutonium” is plutonium from dismantled nuclear weapons; it is considered surplus because of arms-reduction treaties.

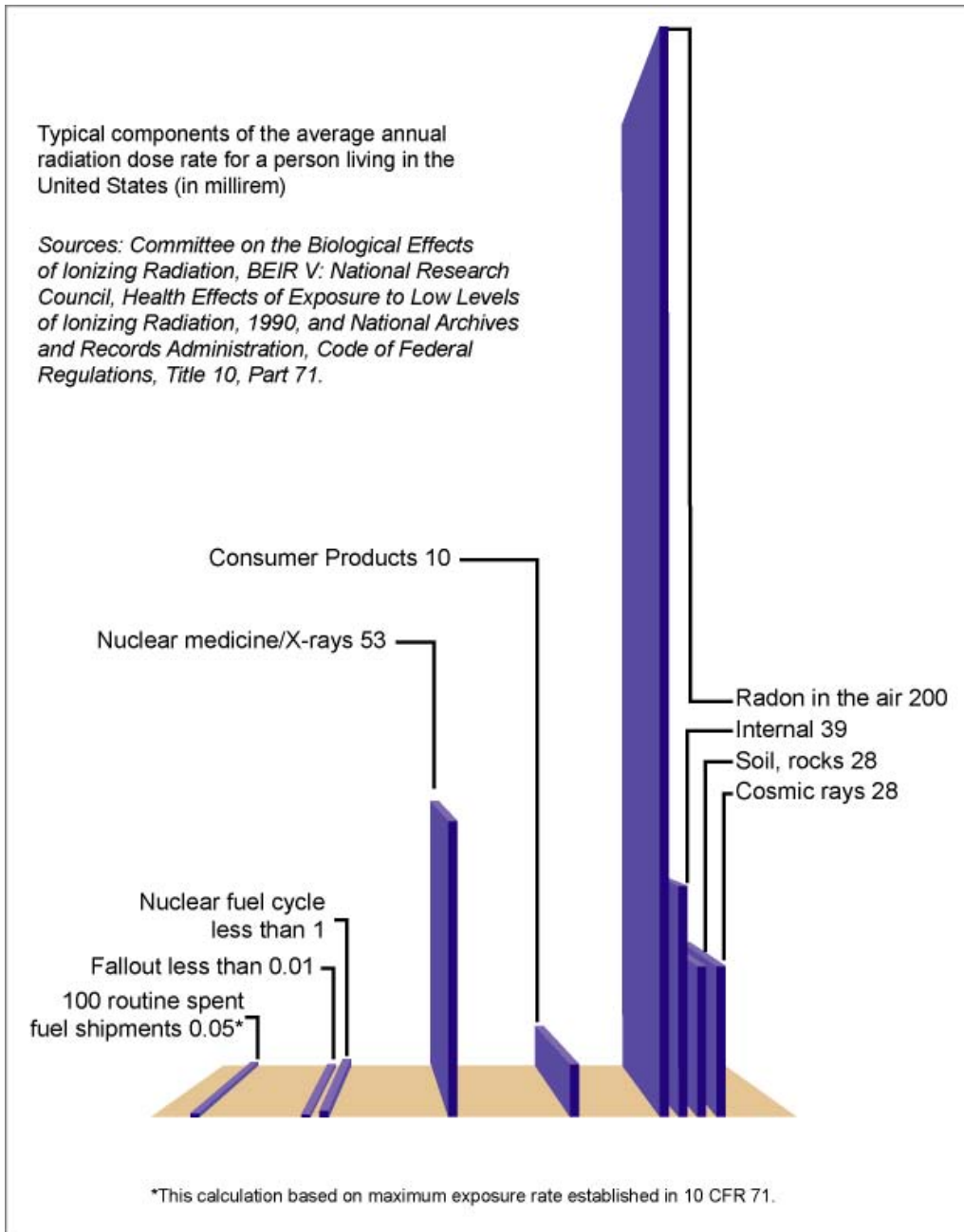
“High-level radioactive waste” that would be disposed of in a repository at Yucca Mountain is 1) solidified high-level waste containing byproducts from past processing of spent fuel to extract plutonium for nuclear weapons for defense needs, and 2) other highly radioactive material that requires permanent isolation, consistent with existing law.

Radioactive materials are routinely managed and handled for medical, industrial, and defense purposes. Safe techniques and procedures for handling these materials are well understood and well established.



Solid ceramic nuclear fuel pellets, each slightly larger than a pencil eraser, containing both uranium-235 and uranium-238.

Comparison of natural and man-made radiation doses



The average American receives about 360 millirem of background (i.e., normal and expected) radiation every year from both natural and man-made sources.