WYOMING LEGISLATIVE SERVICE OFFICE

Research Memo

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Re: Nuclear Waste Storage and Disposal

QUESTIONS

1. **What is nuclear waste?**

2. **What are options for storing and disposing of nuclear waste?**

ANSWERS

1. **The U.S. Nuclear Regulatory Commission's (NRC) "Backgrounder on Radioactive Waste" defines high-level radioactive waste and related terms including fission products, transuranic, and half-life. It also describes some of the issues related to the waste, including hazards to human health. An excerpt from the NRC Backgrounder is included below:**[1]

> High-level radioactive waste is uranium fuel that has been used in a nuclear power reactor and is "spent" or is no longer efficient in generating power to the reactor to produce electricity. Spent fuel is thermally hot as well as being highly radioactive, requiring remote handling and shielding. The basic fuel of a nuclear power reactor contains uranium 235, which is in ceramic pellets inside of metal rods. Before these fuel rods are used, they are only slightly radioactive and may be handled without special shielding. During the nuclear reaction, the fuel "fissions," which means that an atom of uranium is split, releasing two or three neutrons and a small amount of heat. The released neutrons then strike other atoms, causing them to split, and a chain reaction is formed, which releases large amounts of heat. This heat is used to generate electricity at nuclear power plants.
>
> The splitting of relatively heavy uranium atoms during reactor operation creates radioactive isotopes of several lighter elements, such as cesium-137 and strontium-90, called "fission products," that account for most of the heat and penetrating radiation in high-level waste. Some uranium atoms also capture neutrons from fissioning uranium atoms nearby to form heavier elements like plutonium. These heavier-than-uranium, or "transuranic," elements do not produce nearly the amount of heat or penetrating radiation that fission products do, but they take much longer to decay. Transuranic wastes, also called "TRU," therefore account for most of the radioactive hazard remaining in high-level waste after a thousand years.

[1] U.S. Nuclear Regulatory Commission, "Backgrounder on Radioactive Waste." Accessed online at: http://nrc.gov/reading-rm/doc-collections/fact-sheets/radwaste.html

Radioactive isotopes will eventually decay, or disintegrate, to harmless materials. However, while they are decaying, they emit radiation. Some isotopes decay in hours or even minutes, but others decay very slowly. Strontium-90 and cesium-137 have half-lives of about 30 years (that means that half the radioactivity of a given quantity of strontium-90, for example, will decay in 30 years). Plutonium-239 has a half-life of 24,000 years.

High-level wastes are hazardous to humans and other life forms because of their high radiation levels that are capable of producing fatal doses during short periods of direct exposure. For example, ten years after removal from a reactor, the surface dose rate for a typical spent fuel assembly exceeds 10,000 rem/hour, whereas a fatal whole-body dose for humans is about 500 rem (if received all at one time). [Rem is a measurement of radiation in body tissue.] Furthermore, if constituents of these high-level wastes were to get into ground water or rivers, they could enter into food chains. Although the dose produced through this indirect exposure is much smaller than a direct exposure dose, there is a greater potential for a larger population to be exposed.

2. **Nuclear waste *storage* is meant to be temporary. Generally, spent nuclear fuel is stored on-site at nuclear power plants in either underwater pools or in dry caskets. Spent nuclear fuel can be stored for many decades. In contrast to the temporary nature of storage, *disposal* is meant to be permanent. In addition to storing and disposing nuclear waste, another option is to reprocess spent fuel.**

   Storage – Nuclear waste can be either stored at the nuclear power plant or at a remote site for many decades. There are two main ways of storing spent nuclear fuel: wet or dry. Most spent fuel is stored underwater with the water serving a shield from the radiation and as a cooling agent. After its radioactivity has declined, nuclear waste can be moved to above-ground dry storage casks. Stored nuclear waste can be retrieved for either reprocessing or permanent disposal.

   Disposal – While stored nuclear waste can be retrieved, there is no intention of retrieving disposed nuclear waste. As a result, it is a permanent solution. According to a report by the International Atomic Energy Agency (IAEI), "The defining characteristic of disposal, as opposed to storage, is that there is no intention to retrieve the waste material, and there is minimal reliance on long term active controls."[2]

   One option for geological disposal that the U.S. government has long considered is disposal at Yucca Mountain in Nevada; however, that proposal remains contentious. Experts have considered several other methods for disposal, including in the seabed, in deep boreholes, or by shooting the waste into deep space or the sun.

   The U.S. Department of Energy is currently convening a Blue Ribbon Commission on America's Nuclear Future, which is considering issues related to nuclear waste storage, disposal, and transportation. More information about the Commission is available at http://brc.gov.

   Reprocessing – Another option is to reprocess spent fuel. In reprocessing, the remaining uranium and unfissioned plutonium are recovered and separated from the fission productions. This allows the spent fuel to be reused. Generally, nuclear power plants in the U.S. have used new fuel instead of reprocessing fuel. However, reprocessing is used in several other countries including France, England, and Japan. Reprocessing reduces the amount of nuclear waste, but does not completely eliminate all nuclear waste.

If you need anything further, please contact LSO Research at 777-7881.

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[2] International Atomic Energy Agency, "The Long Term Storage of Radioactive Waste: Safety and Sustainability: A Position Paper of International Experts," 2003. Accessed online at: http://www.iaea.org/OurWork/SS/storage.html