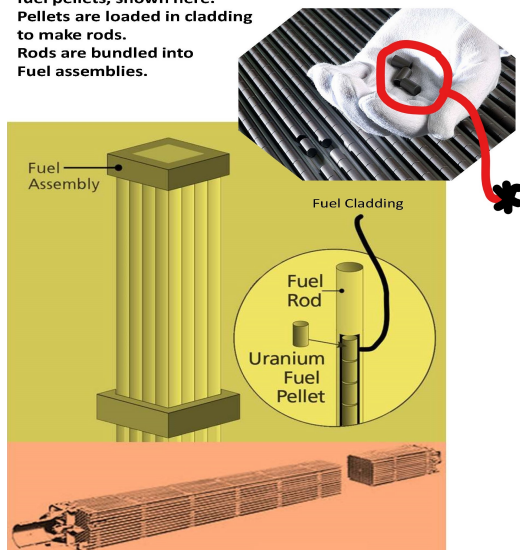


Nuclear Basics: High Level Radioactive Waste

Nuclear power generates electricity using the heat released by splitting atoms (fission). In this process new radioactive atoms are made. Fission in a nuclear reactor and an atomic bomb are the same, though slower in a reactor. Since a power reactor operates “24/7,” over a year it will produce as much heat and radioactivity as 1,000 nuclear detonations of the size that destroyed Hiroshima, Japan in 1945.

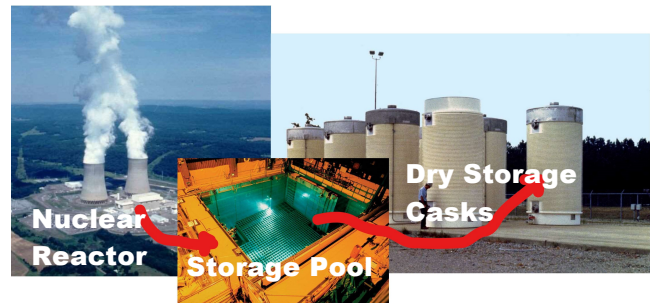
Fuel rods are millions of times more radioactive when they are removed from the reactor than when they go in. This *irradiated* or “spent” nuclear fuel is called **High-Level Radioactive Waste**.

Mined Uranium is intensively processed to produce fuel pellets, shown here. Pellets are loaded in cladding to make rods. Rods are bundled into Fuel assemblies.



Note: Only unused uranium can be held; after use (fissioning) in the reactor, irradiated fuel pellets give off a *lethal* dose of radiation in seconds. This waste must be shielded and handled robotically. Also thermally hot, it is cooled in pools by circulating water for years before it can be stored in dry containers.

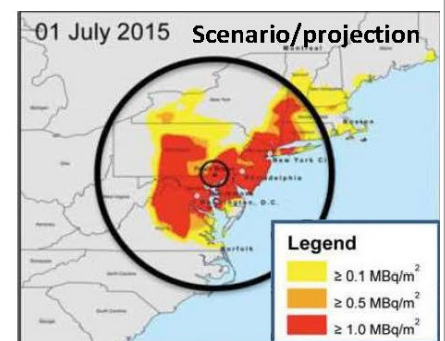
Nuclear Energy creates deadly waste that can harm life on Earth for more than a million years.



For decades High-Level Radioactive Waste has accumulated at reactor sites where it is made. There is no credible plan to permanently isolate it. Continuing to operate reactors makes even more waste (~2,000 tons/year in the US). Storage pools have been re-racked to pack waste tightly, creating new problems.

Unfortunately, the pools have no robust containment. Temperatures rise quickly if cooling pumps stop or water drains out, as happened at Fukushima in Japan. Loss of coolant from boiling or leaks can result in a fuel pool fire. The projected radioactive release from burning fuel is the worst possible nuclear accident scenario and would result in great harm to the immediate community and those downwind and downstream. Consequences depend on the weather.

The accident scenario pictured below uses weather conditions on a day in July 2015 to project impacts from a theoretical fuel fire at nuclear reactors at Peach Bottom, PA. A plume of highly radioactive fuel particles would have caused burns, radiation, sickness, immune



Source:
Von Hippel and
Schoeppner
2016

problems, cancers, heart problems, infertility, miscarriage, birth defects and scores of other health and economic impacts (\$ in the billions) as well as long-term interdiction of land and water.

Reducing the amount of radioactive waste in fuel pools is a top priority. Reactor owners and the federal Nuclear Regulatory Commission have refused to reduce the risks of fuel pools and transfer waste to dry containers. The waste would not be completely safe in dry storage, but independent engineers have testified that it would be *safer*. (2) (See Cask Issues below.)

Hardened On-Site Storage (HOSS) is supported by organizations in all 50 states. It would provide better security at reactor sites with robust dry storage and community oversight, including real-time monitoring of heat and radiation. (3) HOSS is rooted in values of community protection and environmental justice. By contrast, every waste proposal by the federal government and the nuclear industry has targeted communities that are disproportionately low-income, indigenous, or people of color.

High Burn-up Fuel and Waste

The industry's decision to use high burn-up fuel has made nuclear waste dramatically more dangerous. High burn-up fuel has a much higher level of U-235, the main form of uranium that makes the atomic chain reaction and generates nuclear power.

High burn-up waste puts out more heat, more radioactivity and has a higher percentage of plutonium and other dangerous radioisotopes, all more carcinogenic than naturally occurring radioactivity, especially if inhaled or ingested. The fuel cladding, the thin metal tube that forms the fuel rod and holds the uranium fuel pellets, is not tough to begin with, but heat and radioactivity cause it to become brittle. Shaking (in transportation) may cause cladding to break or shatter.

Container / Cask issues

Removing the waste from the pools is an important step. Unfortunately, the US nuclear industry is now almost exclusively using dry casks that are far more vulnerable to failure and more difficult to inspect than those used in other countries. Casks in the U.S. are subject to a number of unacceptable flaws in their design, manufacturing, and usage:

- Thin containers made from weak types of steel are subject to cracking.
- There is no reliable method of inspecting the full surface of the containers.
- Some environmental factors can accelerate cracking, such as salty coastal air.
- There is no easy way to transfer the waste from one container to another.
- There is no on-site emergency protocol for this procedure at reactor sites.

The same casks that are used at reactors are intended to be used at consolidated waste sites, if opened.

Unnecessary Transport

Most of the nearly 70,000 metric tons of commercial nuclear High Level Radioactive Waste is at reactors where it is being made. In a few cases, some (4) has been transported but nowhere near the tens of thousands of shipments, envisioned to move if one or more Consolidated or Centralized "interim" Storage sites are opened.

The waste would move on roads, rails and waterways once, and then again when a permanent site is found, doubling the transport risks. Or the supposedly "interim" site(s) could become de-facto permanent dumps—with waste staying forever at sites never planned or intended for long-term waste isolation.

Transport casks are not required or designed to meet real road, rail and waterway conditions, and the current designs have never been physically tested.

There are a great many problems with nuclear waste that will last far longer than human civilization has existed, or is likely to exist.

Sources:

- (1) Von Hippel and Shoepner, November 2016. Dangers of Spent Nuclear Fuel in Science and Global Security. Posted: <http://scienceandglobalsecurity.org/archive/sqs24vonhippel.pdf>
- (2) Testimony has been written by Dr Marvin Resnikoff (Radioactive Waste Management Associated); Dr Edwin Lyman, Union of Concerned Scientists; Dr Gordon Thompson, Institute for Resource and Security Studies; among others.
- (3) Principles for Safeguarding Nuclear Waste At Reactor Sites, posted: <https://www.nirs.org/wp-content/uploads/radwaste/policy/hossprinciples3232010.pdf>
- (4) Melted fuel from the 1979 Three Mile Island meltdown was moved to a federal facility in Idaho (INL). Nuclear submarine fuel has been stored in Idaho. Irradiated fuel has rarely been moved to other nuclear reactors (transshipped).

See also *NIRS FACT SHEETS on proposals for Consolidated Storage, Yucca Mountain and nuclear waste transport* posted at www.nirs.org--Mary Olson (maryo@nirs.org); Winter, 2017