



**SPENT NUCLEAR FUEL:  
A National Security and Environmental Migraine Headache**

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Of all the professions, accounting is considered the most conservative. After all, credits and debits must line up, and figures must balance. Even in the world of federal budgets, entitlement programs, off the books wars, and partisan politics, there eventually comes a day of reckoning when the bills must be paid. So, too, in the field of nuclear power, things must be made to balance, and a day of reckoning comes. With the Fukushima Daiichi plant in ruins<sup>1</sup>, we are again reminded that atomic energy is neither as cheap nor as clean as the sparkling futuristic films of the Eisenhower era's "Atoms for Peace" made it seem.

The electric power industry in the United States has enjoyed more than fifty years of subsidy from the taxpayers in the form of a sort of willful blindness. The physics of fission power are immutable, even as it mutates Uranium fuel into lighter elements. Each kilowatt-hour of power generated creates waste in the form of spent nuclear fuel (SNF) and reactor equipment that eventually wears out and must be replaced. The spent fuel, usually in the form of the rods withdrawn from the core, is considered "high level" waste, "hot" enough in remaining radiation to be deadly to humans for a very long time (though no longer hot enough to generate power); such waste contains Tc-99 (half-life 220,000 years), I-129 (half-life 17 million years), Np-237 (half-life two million years), and Pu-239 (half life 24,000 years). (Remember that a half-life is just the time that it takes one half of the material to lose its radioactivity; thus, for a relatively short-lived material like Pu-239 it requires more than 159,000 years to become 99 percent "cold," and even then, the remaining 1 percent is still very radioactive and dangerous.) According to the United States Nuclear Regulatory Commission, "Because of their highly radioactive fission products, high-level waste and spent fuel must be handled and stored with care. Since the only way radioactive waste finally becomes harmless is through decay, which for high-level wastes can take hundreds of thousands of years, the wastes must be stored and finally disposed of in a way that provides adequate protection of the public for a very long time."

The experience of the past 50 years, and of the past 6 weeks in Japan, is that SNF waste from power generation is accumulated in large water-filled pools, where it glows an eerie blue from the Cerenkov Effect (high speed electrons emitted from the waste slam into water molecules and give off light in the blue part of the spectrum.) The SNF "cools" in such pools for ten or more years before it has decayed sufficiently to be placed in large steel and concrete "casks" where it must remain for, in effect, eternity. Since the oldest known human-made items are about 2 million years old (stone tools, simply chipped rocks) and the oldest extant (but ruined) human structures are about 10,000 years old (a Neolithic-age tower in Jericho) it seems odd to think that anyone, anywhere knows how to build a container that will hold this poison for the next several hundred thousand years, let alone millions.

The US Department of Energy has collected billions of dollars from electric utility ratepayers for the Nuclear Waste Fund, and it long believed that the solution was storage of both military and civilian high level waste deep underground at Yucca Mountain, Nevada. After spending over \$10 billion on studies and construction, with great political and technical opposition, Congress voted to completely and finally defund the project on April 14, 2011. As of now, the United States has no plan for long-term storage of SNF high level waste, and continues to allow it to accumulate in cooling pools at each nuclear facility where it is generated. The Nuclear Waste Fund balance is clearly insufficient to pay for long-term safe SNF storage. Dr. Steven Chu, Secretary of Energy has promised to convene a "Blue Ribbon" panel to study the issue again.

<sup>1</sup> <http://www.iaea.org/newscenter/news/tsunamiupdate01.html>

In addition, many more tons of low level waste, such as worn out plant equipment, worker uniforms, medical waste, construction debris, and the like are stockpiled and stored around the US and the world, with no consistent plans for “disposal” and safety. Much of this waste is dangerous to human health, and some of it could possibly be used by terrorists in “dirty” bombs. (Disposal, of course, is impossible, since as anyone who has studied ecology can tell you, the central lesson of that science is that there is no “away” anywhere on earth -- we cannot just throw things “away” pretending that out of sight and out of mind is somehow, magically, safe and nontoxic as well.)

As the failure of the spent fuel pools at Fukushima Daiichi teaches us, the short-term risks are at least as large as the longer-term ones. If we cannot keep the pool full of water and the fuel rods cooled sufficiently, the fuel heats the water, boiling it away. Once the water level falls, the rods continue to heat, and either melt or catch fire. Melted fuel presents a difficult recovery problem that in the case of Fukushima will take more than a decade to solve. Burning fuel allows radioactive particles to escape into the air, and to contaminate land, water, crops, and the food chain. Many sites in the US have already detected radioactive fallout from Fukushima, and contaminated water is being dumped into the ocean, as well. In either case, we have a mess that will take billions of dollars and decades to clean up, and even then, eons to become safe in any meaningful way.

And yet, the total eventual and inescapable costs of final nuclear waste storage have never been imposed on either the shareholders or ratepayers of electric utility companies. Those costs have been “externalized” to future taxpayers, but are carried “off the books.” Were we to impose the true costs on utility customers, it is likely that nuclear generated electricity would cost at least three to four times the present price. Today’s utility company profits and low electric energy costs will mean little to our descendants, to whom the job of nuclear cleanup will fall.

Finally, we should add to all of this known risk the unknowable risk of intentional acts of war and terrorism. By now, the accountant in you should see red. Regardless of advances in technology, efficiency, and operational safety, the nuclear energy books still haven’t been made to balance, except on the backs of future generations of taxpayers.

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