Insight

Nuclear Waste 101: Addressing the Problems Surrounding Nuclear Waste Policy

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Summary

- The U.S. has close to 70,000 metric tons of spent nuclear fuel. This fuel represents the most likely source of a radiation release from nuclear power, and should be relocated from cities' power plants to better equipped facilities in remote locations.
- Now may be the best opportunity in nearly a decade for the incoming administration to uphold the law and resume the licensing process for the Yucca Mountain Nuclear Waste Repository. This would cut back on government nuclear waste liabilities, which will be between $29 billion and $97 billion.
- Yucca Mountain is not a complete solution to nuclear waste disposal. Both Congress and the administration need to work towards bipartisan, politically durable solutions that are consent-based and improve public safety.

Introduction

The United States has a growing stockpile of nuclear waste with nowhere to go, and domestic policy has remained frozen over the past eight years with no solution. Despite the inaction, there are clear policy initiatives that can be taken to minimize risk, improve U.S. security, and bolster clean energy. However, political contention has been a constant roadblock. This paper will address the basic problems with nuclear waste disposal, and some solutions that the next administration should implement to address this growing issue.

The Origins of Nuclear Weapons, Nuclear Power, and Nuclear Waste

In the 1940s, scientists researched a pathway to building a powerful bomb that would use the energy released from splitting atoms—a process known as nuclear fission. The avenue to this was the discovery that a naturally occurring element, uranium, was fissionable. However, only 0.7 percent of naturally occurring uranium ore has the proper atomic structure for fission (an isotope known as U-235), which made natural uranium insufficient for building a bomb. Through a process known as enrichment, engineers took large amounts of uranium and separated the non-fissionable part, increasing the concentration of fissionable uranium in what remained. Through enrichment, engineers increased the composition of fissionable material from 0.7 percent, to a "weapons grade" 90 percent. Thus, nuclear weapons were born.

It was then discovered that if the enrichment process was done only enough to enrich uranium to 3-5 percent, the resulting material would be insufficient for a bomb, but would still be able to sustain a weak fission reaction for some time. This reaction would release heat, which could then be used to boil water and produce steam, which could spin a conventional electric turbine. Thus, nuclear power was born.

The 3-5 percent enriched uranium, known as “low-enriched uranium” (LEU) was used to fabricate uranium pellets that are shaped into fuel rods and inserted into a nuclear reactor. After being used to sustain nuclear fission for months at a time, the fuel rods, which were already radioactive, become highly radioactive and have an altered chemical composition. The fuel rods still contain a great amount of energy in the form of uranium, and may even contain plutonium (another fissionable element). These spent fuel rods were classified with other nuclear-related radioactive materials, and considered “waste” despite their opportunities for further use.

Spent fuel rods comprise the bulk of the country’s “nuclear waste,” and they currently have no home. They remain at the nuclear power plants (NPP) in perpetuity, typically kept in “cooling pools” (water shields radiation far better than lead or any other solid material) while they wait to be relocated. These fuel rods, even after losing much of their radiation in cooling pools for 4-8 years, are destined to be dangerously radioactive for centuries, and even millennia.

Why Care about Nuclear Waste?

There are currently 61 NPPs across the country. All the NPPs are situated in locations that are ideal for electricity production, which is near energy hungry cities, and bodies of water to use for cooling. Nuclear waste represents a greater risk than nuclear electricity production, since after being used for fission, spent fuel rods contain an easily dispersed radioactive isotope (caesium-137) that is highly soluble in water. During the 2011 Fukushima NPP accident, most of the radiation released came from exposed nuclear fuel rods after power failures caused the water in cooling pools to boil and evaporate. Simply put, the best place to put a nuclear power plant is the worst place to have a nuclear accident. Since spent nuclear fuel is the most likely and greatest source of a radiation release in the event of a nuclear accident, the best way to minimize risk from nuclear power is to relocate the waste.

Aside from the reduced radiation risk that comes from removing waste, there are some other reasons for Americans to be concerned:

- The Nuclear Waste Policy Act requires the federal government to take possession of nuclear waste, and the government’s services are funded by utilities that pass the costs on to nuclear electricity consumers. The government violated this contract, and the courts have now ordered the government to repay the money they accepted from utilities, resulting in $29 billion in liability costs. The GAO estimates that the total long term liabilities could reach as much as $97 billion.
- The U.S. is a leader in nuclear power, but other nations are reticent to pursue it if solutions for nuclear waste are unproven. The Nuclear Non-Proliferation Treaty stipulates that nuclear weapon states (like the U.S.) help other nations develop peaceful nuclear power in exchange for them not pursuing weaponizable nuclear research. If the U.S. cannot lead on nuclear power, it will forego its influence as other states, like China, fill the vacuum.
- Nuclear power provides electricity 24/7, fulfilling a demand for reliable “baseload” electricity. Even though there are only 61 nuclear power plants, they provide 20 percent of the nation’s total electricity, and more than half of the nation’s clean energy. Improving energy security and cutting pollution is most easily achieved by expanding nuclear power, but the lack of progress on spent nuclear fuel makes it a risky market to enter.
- Spent fuel in cooling pools is more vulnerable to accidents or terrorist attack than other methods of nuclear waste storage. If the government continues to do nothing, there will simply be mounting liability costs to the government while the risk of incident increases.

What Can be Done About Nuclear Waste?

From an engineering perspective, nuclear waste is an easy problem to manage. There are clear low-risk solutions, but the challenge lies in political opposition. Yucca Mountain, a remote site in the Nevadan desert, is a prime example of this. Nearly $15 billion and decades of time has been spent on researching Yucca Mountain and determining its suitability for storing large quantities of nuclear waste underground, but Nevadans are opposed to accepting nuclear waste. Nevadans do not use any nuclear electricity, and to them it seems unjust that other states can reap the benefits of nuclear power, but put the risk on them.

However, nuclear waste is a national problem, the risk of any radiological exposure from Yucca Mountain is exceedingly low, and there are only a few geologic locations across the country that could be suitable for nuclear waste storage on the necessary scale. There is no guarantee that if the government began researching alternative sites for long-term storage that they would be found suitable. The challenges are largely political in nature, and given the long-term nature of nuclear waste management issues, the solutions need to be politically durable to ensure continuity and enforcement. Furthermore, Yucca Mountain is not large enough to store all the nation's 70,000 metric tons of nuclear waste. The new Congress and administration should be focused on:

- Upholding the law and moving forward with the licensing process for Yucca Mountain to relieve nuclear utilities from nuclear waste management risks.
- Expediting the transferring spent fuel rods from cooling pools to "dry cask" Spent fuel casks do not rely on powered cooling to be safe, are less vulnerable to accidents than cooling pools, and are ready for future transport for permanent storage.
- Finding consent-based solutions by identifying communities that are experienced with high risk professions (such as chemical waste management) that are well suited to capitalize on the economic opportunities of nuclear waste management.
- Create political durability for solutions by collaborating with local groups that will be responsible for the management of spent fuel so that opportunities align with the risk.
- Improve education efforts from the Department of Energy to highlight that perceptions of risk associated with nuclear power may not be in line with actual risk levels. By orders of magnitude, fewer people have died producing nuclear power than any other energy source.
- Explore opportunities for reprocessing spent nuclear fuel for further energy use, as well as converting nuclear waste into alternative materials that emit less radiation.

Conclusion

Spent nuclear fuel is a problem that will not go away. The past administration was apathetic to pursuing solutions to a growing problem that cannot be forestalled indefinitely. The new administration represents the best opportunity in almost a decade to finally make real progress on this issue. Without long-term solutions for nuclear waste, Americans will be forced to deal with less reliable, costlier, and dirtier energy sources. Given that existing NPPs are nearing the end of their permits, addressing the nuclear waste issue is critical to encouraging the construction of replacement plants and applying newer, safer, and more efficient technology to nuclear power.