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Yucca Mountain Remains Critical to Spent Nuclear Fuel Management

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The recent push to build new nuclear power plants in the United States is forcing some to consider alternatives to the Yucca Mountain geologic repository, located in Nevada, for spent nuclear fuel. These options include recycling nuclear fuel and opening interim storage facilities. Both options could play critical roles in any American nuclear power renaissance, but they simply cannot eliminate the need to open the Yucca Mountain repository.

The United States generates about 20 percent of its electricity from 104 nuclear power reactors, and these reactors in turn have generated over 56,000 tons of spent nuclear fuel. Commonly referred to as waste, this spent fuel is in fact a potentially valuable resource.

Although politicians and the public have begun to accept that nuclear power is a clean and affordable source of energy, questions remain about how to manage spent fuel. There are at least three solutions to this problem.

First, the spent fuel could be put directly into Yucca Mountain for permanent storage. While politics has made this impossible to date, no scientific, safety, or technological reason prevents it. Volumes of data attest to the repository's safety.[1] These data have been generated by numerous sources, including both private and public entities, and more studies are being conducted.

Second, the U.S. could recycle (reprocess) spent nuclear fuel, which still contains usable fuel that could be recovered and "used again" for future power generation. This could be achieved through numerous

Talking Points

- Yucca Mountain is critical to the long-term success of nuclear power in the United States. Regardless of the number of reactors or what is done with spent nuclear fuel, the U.S. will still need long-term geologic storage.
- Yucca Mountain alone is not enough to support America's spent fuel management needs. Other technologies, such as recycling (reprocessing) and interim storage, would extend Yucca's useful life, perhaps indefinitely.
- Recycling and interim storage of spent nuclear fuel are important elements of any modern spent fuel management system. They provide additional flexibility that will allow more efficient management of spent fuel.
- While recycling and interim storage should be pursued, they are not substitutes for Yucca Mountain.
- Other countries have successfully integrated interim storage and recycling into their spent fuel management regimes.

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methods. Some technologies have already been commercialized abroad, and others are being researched and developed. These technologies will enable more efficient use of uranium resources and could drastically reduce the amount of high-level nuclear waste. In the end, however, some byproduct will still need to be placed in permanent geologic storage.

Finally, the spent fuel could be stored on an interim basis at shorter-term storage facilities. This option also has advantages. Simply allowing the spent fuel to decay over time decreases its heat load, making it easier to store for the long term. Shorter-term storage would also provide time to develop new technologies that would improve long-term management of spent fuel.

Both recycling and interim storage would provide flexibility, but geologic storage in Yucca Mountain will still be necessary.

A Comprehensive Approach

The United States is on the verge of a nuclear renaissance. U.S. demand for electricity is expected to increase by 40 percent over the next 25 years.

However, recent pushes to limit carbon dioxide (CO_2) emissions will make it especially difficult to meet this demand with traditional energy sources, such as fossil fuel, which releases CO_2 when burned. Despite the alleged promise of renewable energy sources like wind and solar, the current reality is that only nuclear power can provide large amounts of emissions-free electricity. If the nation is serious about reducing CO_2, it must significantly expand nuclear power.

The extent of that expansion will determine the best mix of spent fuel management options. However, two constants will be common to any workable approach: It will be fundamentally different from the current strategy to manage spent nuclear fuel, and it must include the Yucca Mountain repository.

The Role of Yucca Mountain

In every scenario, the Yucca Mountain repository is critical to the long-term success of nuclear power in the United States. The reality is that some of the byproducts of nuclear fission will last a long time. Therefore, the U.S. needs a place where it can be safely stored and remain under the control of an enduring institution like the U.S. government after the facility is closed. If properly managed, Yucca Mountain should be adequate for that purpose.

While the current direct deposit scenario—in which spent fuel will be taken directly from the reactor and placed into storage—dictates that numerous Yucca-like repositories be developed, other scenarios that include processing and recycling spent fuel could ensure that Yucca alone would be adequate to store America's nuclear waste indefinitely. Either way, the Yucca Mountain repository must remain the final destination for America's nuclear waste. Maximizing Yucca Mountain's potential requires that any new spent fuel management regime focus on minimizing waste volume and heat content.

Regrettably, the Yucca Mountain repository is already over a decade behind schedule and probably will not open until about 2020. The primary reason is politics. Opposition, especially from anti-nuclear activists and the Nevada congressional delegation, has slowed progress at Yucca. While the U.S. was not building new reactors, the need to open Yucca was not as pressing, but it is still critical in the long term, and the emerging recognition that nuclear energy is critical to meeting U.S. energy and environmental objectives has made the need seem even more urgent.

The next step toward opening Yucca is for the U.S. Department of Energy to submit a license application to the Nuclear Regulatory Commission as soon as possible. While this may seem arcane, it is critical. NRC commissioners serve five-year terms and are appointed by the President and confirmed by the Senate. Submitting the application by

1. U.S. Department of Energy, *Draft Supplemental Environmental Impact Statement for a Geologic Repository for the Disposal of Spent Nuclear Fuel and High-Level Radioactive Waste at Yucca Mountain, Nye County, Nevada*, October 2007, at *http://www.ocrwm.doe.gov/ym_repository/seis/docs/001_summary.pdf* (April 14, 2008), and U.S. Department of the Interior, U.S. Geologic Survey, *Yucca Mountain as a Radioactive Waste Repository*, 1999, at *http://geopubs.wr.usgs.gov/circular/c1184/C1184.pdf* (April 14, 2008).

mid-2008 will allow the current NRC commissioners to place the application on the NRC docket for consideration.

This ensures that, at a minimum, the NRC will have the opportunity to consider the Yucca Mountain construction application. Waiting to submit the application would give the next President and Congress the opportunity to seed the commission with anti-Yucca appointees who could choose to leave the application off the docket, thus avoiding its consideration and leaving the U.S. with no set policy for dealing with spent fuel.

Yucca Is Not Enough

The United States has approximately 56,000 tons of high-level nuclear waste stored at over 100 sites in 39 states.[2] Furthermore, America's 104 commercial nuclear reactors are producing approximately 2,000 tons of spent fuel annually.

The first problem with Yucca Mountain is that the applicable statute artificially constrains Yucca's capacity to 70,000 tons of waste. This was decided nearly three decades ago when most believed that nuclear power had little future in the U.S., but with nuclear power likely to expand in coming years—perhaps dramatically—the current program for managing America's nuclear waste is infeasible.

The actual capacity of Yucca Mountain is much larger. Numerous bills have been offered in recent years to repeal the artificial 70,000-ton capacity restraint and replace it with a more scientifically calculated cap.[3] The Department of Energy believes that the Yucca repository could safely hold 120,000 tons of waste.[4] Some believe the capacity is even greater. According to the Department of Energy, the expanded capacity of Yucca Mountain would likely be adequate to hold all of the spent nuclear fuel produced by currently operating reactors.[5]

Yet even with the expanded capacity, Yucca Mountain could not hold all of America's spent fuel if the U.S. adds nuclear capacity. According to one analysis, assuming 1.8 percent growth in America's nuclear capacity after 2010, the U.S. would fill a 120,000-ton Yucca by 2030. At this growth rate, the U.S. would need nine Yucca Mountains by the end of the 21st century.[6]

The possibility of carbon constraints and other anti–fossil fuel restrictions raises the prospects of much more nuclear power in the United States. While Yucca Mountain will play an extremely important role in America's spent fuel management system, a more practical approach would use recycling, interim storage, and other tools to manage spent fuel.

Interim Storage

Spent fuel is highly radioactive when it is removed from the reactor. All radioactive materials decay, but while some lose their radioactivity within fractions of a second, others take billions of years. However, most stabilize within an intermediate period. The radioactivity of spent nuclear fuel falls to about 1 percent of its original levels within a year and to 0.1 percent within 40 years.[7] This characteristic makes interim storage an important element of spent fuel management.

Although the United States has a *de facto* interim storage system because the federal government has not fulfilled its legal obligation to take possession of and dispose of America's spent fuel, it does not fully integrate interim storage into its spent fuel regime.

2. Samuel W. Bodman, U.S. Secretary of Energy, letter to Speaker of the House Nancy Pelosi, March 6, 2007, at *http://www.energy.gov/media/BodmanLetterToPelosi.pdf* (April 24, 2008).
3. Two recent examples are the Nuclear Waste Policy Amendments Act of 2008 (S. 2551) and the Nuclear Fuel Management and Disposal Act (S. 2589, 109th Congress).
4. Bodman, letter to Speaker of the House Nancy Pelosi.
5. *Ibid.*
6. Phillip J. Finck, Deputy Associate Laboratory Director, Applied Science and Technology and National Security, Argonne National Laboratory, statement before the Subcommittee on Energy, Committee on Science, U.S. House of Representatives, June 16, 2005, at *http://gop.science.house.gov/hearings/energy05/june15/finck.pdf* (January 17, 2008).
7. Posiva Oy, "Spent Nuclear Fuel," at *http://www.posiva.fi/englanti/ydinjate_kaytetty.html* (February 25, 2008).

Interim storage could be integrated in a number of capacities. It could be done on-site. Under this system, the fuel would be removed from a nuclear reactor's cooling pools and placed in an on-site facility before it is moved to another location for permanent storage for further processing, as is done in some other countries, such as Finland.

Spent fuel could also be collected and stored at one or multiple off-site locations. These locations could be co-located with other spent fuel processing facilities. Yucca Mountain could be an optimal location for an interim storage facility. Either way, interim storage has some advantages that spent fuel managers may find attractive.

First, permanent geologic storage is a scarce resource. Although a geologic storage facility's capacity is often expressed in terms of volume, the primary limiting factor is heat load. Radioactive material gives off heat as it decays. The more it has decayed, the less heat it will give off, allowing more to be stored in any one place. Thus, allowing the fuel to decay for a few decades at an interim storage facility would ultimately allow storage of more spent fuel in a long-term geologic storage facility, even without further processing.

Introducing interim storage would allow far more flexible use of Yucca Mountain. However, adding interim storage to the U.S. spent fuel management regime cannot eliminate the vital role of the Yucca Mountain repository. Opening Yucca must remain a top U.S. priority.

Second, interim storage frees cooling pool capacity. When spent fuel rods are removed from the reactors, they are placed in cooling pools. After a reactor's pools are full, it would essentially be forced to shut down because there is nowhere else to put spent fuel rods.

This is a problem in the United States, where plants were built with spent fuel pools under the assumption that the spent fuel rods would be removed and stored off-site. However, the politics of Yucca Mountain has prevented the U.S. from executing its spent fuel management strategy as planned. U.S. plants are facing the real possibility of filling their cooling pools. Interim storage should be an option in the U.S. as part of a comprehensive spent fuel management regime along with permanent geologic storage and recycling.

Many types of interim storage regimes are used in other parts of the world. For instance, Germany operates multiple interim storage facilities that are independent of the German reactor sites, whereas Finland has on-site interim storage operations. In the U.S., interim storage would likely be applied in multiple ways due to the diversity of U.S. nuclear power plants.

Recycling

The current U.S. policy is to dispose of all spent fuel permanently. This is a monumental waste of resources. To create power, reactor fuel must contain 3 percent to 5 percent enriched fissionable uranium (U-235). Once the enriched fuel falls below that level, the fuel must be replaced. Yet this "spent" fuel generally retains about 95 percent of its original content, and that uranium, along with other byproducts in the spent fuel, can be recovered and "recycled."

Many technologies exist to recover and recycle different parts of the spent fuel. The French have been successful in commercializing a process. They remove the uranium and plutonium and fabricate new fuel. Using this method, America's 56,000 tons of spent fuel contains roughly enough fuel to power every U.S. household for 12 years.

Other technologies show even more promise. Indeed, most of them, including the process used in France, were developed in the United States. Some recycling technologies would leave almost no high-level waste at all and would lead to the recovery of an almost endless source of fuel. However, none of these processes has been successfully commercialized in the United States, and they will take time to develop. Until the future of nuclear power in the U.S. becomes clearer, it will be impossible to know which technologies will be most appropriate to pursue in this market.

Ultimately, the private sector should make these decisions in consultation with government regulators. Valuing spent nuclear fuel against the costs of permanent burial is a calculation best done by the companies that provide fuel management services.

What the U.S. Should Do

To meet the growing demand for electricity and to satisfy public desires for clean, safe, and affordable energy, the U.S. government should establish a practical, comprehensive, and sensible regime to manage spent nuclear fuel. Specifically:

- **The U.S. Department of Energy** should submit a license application for the Yucca Mountain spent fuel repository to the Nuclear Regulatory Commission by mid-2008.
- **Congress** should replace the artificial 70,000-ton cap on Yucca Mountain with a more scientifically calculated cap.
- **Congress** should acknowledge that the current regime for managing spent nuclear fuel is broken and engage in a process to develop a new rational, market-based approach to managing spent nuclear fuel that can support a broad expansion of nuclear power in the United States.

Conclusion

The public desires energy that is clean, safe, and affordable, and nuclear energy can meet all three of these criteria. Managing spent nuclear fuel has been a political sticking point for the advancement of nuclear energy in the United States. Yucca Mountain is crucial to resolving the issue of spent nuclear fuel, but a more practical and comprehensive approach would include a combination of interim storage, recycling, and geological storage.

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