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Cliff Hamal: The coming costs of spent fuel storage

As the current U.S. fleet of power reactors retires, the cost of on-site storage and management of spent fuel is expected to increase dramatically.

Cliff Hamal is managing director and principal at Navigant Economics, which earlier this year released a report titled *Spent Nuclear Fuel Management: How Centralized Interim Storage Can Expand Options and Reduce Costs* (*NN,* July 2011, p. 17). The report contains the findings of a study Navigant conducted for the Blue Ribbon Commission on America's Nuclear Future, which on July 29 issued its draft report on the future management of spent nuclear fuel and high-level waste (see page 43, this issue). Among the seven recommendations included in the report are the development of one or more interim storage facilities and one or more geologic disposal facilities.

Hamal: "If this were easy, we could wait until the last minute."

The Navigant report recognizes that with a permanent repository for the United States already decades behind schedule, taxpayers will be liable for billions of dollars in spent fuel management costs through legal claims filed with the Department of Energy. As the current U.S. fleet of commercial reactors retires in the coming decades, the cost of storing and managing spent fuel at existing reactor sites will increase dramatically. To lower those costs, actions are needed now to create options for spent fuel storage.

Hamal has worked as an economic consultant for the electricity industry for 22 years and has testified in a number of cases involving spent fuel, nuclear power plant operations, and valuation issues. In the 1980s, he worked for General Electric at Knolls Atomic Power Laboratory in the U.S. Navy's nuclear program as an engineering officer of the watch. He later was a senior reactor operator for Westinghouse, where he also taught courses in accident analysis and operations to power plant personnel and served in project management. Hamal has a bachelor's degree in marine engineering from the U.S. Merchant Marine Academy and a master's degree in business and economics from Carnegie Mellon University.

Hamal talked about the Navigant report, which is available on the Blue Ribbon Commission's Web site at <http://brc.gov/sites/default/files/documents/centralized_interim_storage_of_snf.pdf>, with Rick Michal, *NN* senior editor.

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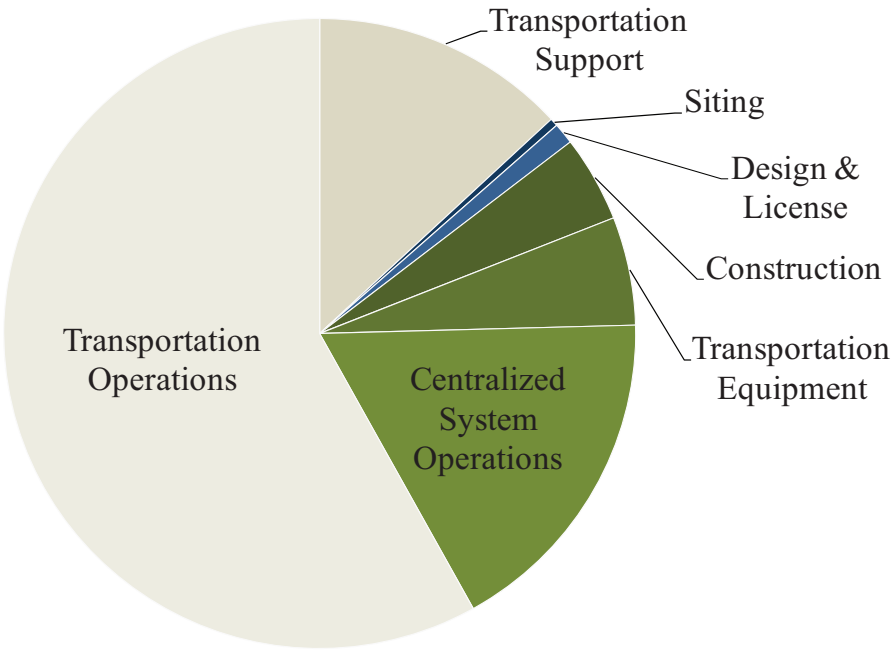


The Navigant study found that transportation accounts for the largest share by far of the total cost of centralized interim storage. (Graphics: Navigant Economics)

How does your report help answer the question of how the United States got to the current state of not having a clear path forward on spent fuel management?

Our analysis is forward-looking, and in particular addresses the problem of developing a strategy when there are enormous financial, technological, and political uncertainties. While we did not go back to study in detail how we got to the current situation, it is pretty clear that strategies were adopted with the best of intentions but not nearly enough attention was given to contingencies and dealing with the unexpected. There are challenges in dealing with all of the uncertainties, but history demonstrates what happens if those uncertainties are ignored.

What did you use as a baseline for your analysis of interim storage?

There are five studies—we've listed them in the report—that were done in the past two years by credible organizations such as the Massachusetts Institute of Technology, the Government Accountability Office (GAO), and the Department of Energy. A careful review of these studies points out the tremendous uncertainties in spent fuel planning. In those studies, the time estimates for building a centralized interim storage facility ranged from four years to 34 years. Also, shipping the waste is the most expensive part of the disposal process, and there are huge differences of opinion over the expected cost, which is a reflection of never having shipped fuel at the scale required.

When did you start working on this report?

We started working with the Blue Ribbon Commission in late December 2010. It was a fascinating assignment that evolved over time. We thought we would come in and say, "Here are the costs of going to centralized interim storage, and here are the costs if you don't. Compare the two and make your decision." But as we dug into the assignment and evaluated the enormous uncertainties, our approach changed. When you recognize the implications of the GAO study's assumption that a decision regarding a permanent repository might be put off for 500 years, you appreciate that a different approach is needed.

What approach did you end up taking in conducting your analysis?

In dealing with planning horizons spanning decades, and in particular when there are such big unknowns, you need to realize that people will continue to study the issues and make changes to strategies in the future. The real question today is not how the United States will manage the entire spent fuel program, but rather whether to take the first step in creating an option for going to interim storage. To do that, we would need to spend $30 million to $70 million to find a site, design a facility, license and permit that site, and then make a decision about whether or not to build it sometime in the future.

In the grand scheme of things, $30 million to $70 million is a small amount to spend to create an option that will be available five to 10 years down the road if we need it and at a time when we will have a better understanding of all the uncertainties. What we've shown in our report is that the decision for today is really about whether or not to commit to going forward with this planning and licensing phase, and that the cost of going forward is modest considering the scale of what we're talking about here. If the United States follows this option and we're successful at it, we will have created something that will be very valuable 10 years from now.

Does your report consider the lawsuits that are sure to be filed by parties who are against siting a facility in a particular region or who don't want spent fuel being transported through their lands?

Yes, it does. We expect there to be lawsuits of that nature regarding siting and permitting of the facility. That's why the time necessary for taking the site into operations can range from four years to 34 years. If this were easy, we could wait until the last minute. It is these kinds of challenges that make going forward so important.

How did you perform your analysis?

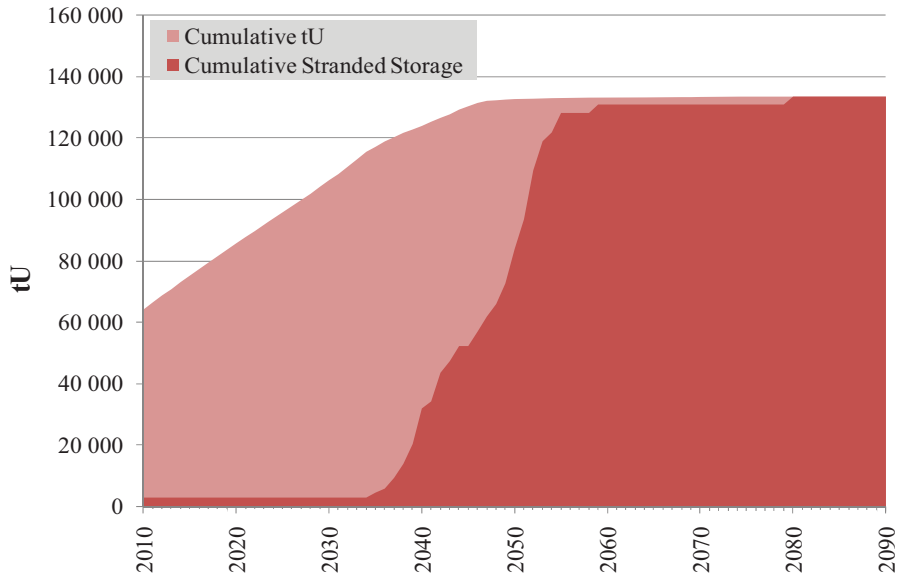
We took an options approach, considering the wide-ranging uncertainties and evaluating whether or not a commitment to develop the facility would produce savings. In some cases, the initial investment might be relatively small, resulting in the loss of a few tens of millions of dollars. But there are also cases in which hundreds of millions of dollars or more could be saved. From an options perspective, it is pretty clear that we should be moving forward.

What were some of the factors that drove this finding?

SPENT FUEL CURRENTLY IN STRANDED STORAGE AT SHUTDOWN REACTOR SITES

Reactor Name	State	Year of Shutdown	SNF (tU)	On-Site Dry Storage Status
Humboldt Bay	California	1976	29	In Transition
LaCrosse	Wisconsin	1987	38	Planned
Rancho Seco	California	1989	228	In Storage
Yankee Rowe	Massachusetts	1991	127	In Storage
Trojan	Oregon	1992	359	In Storage
Haddam Neck	Connecticut	1996	412	In Storage
Maine Yankee	Maine	1997	542	In Storage
Big Rock Point	Michigan	1997	58	In Storage
Zion 1 & 2	Illinois	1998	1019	Planned
Total			**2813**	

(Source: DOE)



About 130 000 metric tons of uranium (tU) in spent fuel could be stored at plant sites soon after 2050.

By around 2035, there will be about 120 000 metric tons of spent fuel at reactor sites in the United States. Around this time, the cost of storing the spent fuel will soar because the plants will be undergoing decommissioning. The fuel just sits there, but the incremental cost of protecting it and monitoring it skyrockets. It is a given that as long as the plant is operating, there is a need for a perimeter fence, security, health physics personnel, engineers, and management. The incremental cost for the spent fuel storage is modest while the plant is operating—about $100 000 to $200 000 a year. After the plant is shut down, however, the only reason to incur security at the site, along with the health physicists and the management, is to guard the spent fuel. The incremental cost of that task is now somewhere between $4.5 million to $8 million per reactor site. What used to be trivial—if $100 000 can be considered trivial—is now millions of dollars per site. We refer to this as "stranded" spent fuel, because all other operations at the site have ended.

There are 70 sites in the United States where spent fuel is stored. These costs are going to start escalating dramatically around 2035 as a result of all of the reactors that will be shutting down. By 2050, 70 of the currently operating plants will be shut down. Multiply $8 million times 70, and the result is $560 million per year in 2011 dollars that the industry is going to have to find to store spent fuel at decommissioned plant sites. That is why we need to start now if centralized storage facilities are going to be built.

With the highest costs not hitting until after 2030, can't we just wait?

You might think so, but the fact is that there will be so many plants shutting down that we can't avoid having spent fuel sitting for years at the plant sites. The wave of decommissioned plants will be so strong that we'll still be incurring billions of dollars of stranded fuel storage costs at reactor sites. We can't get ahead of it. Even if we were to open a repository in 2030, which is very optimistic, the amount of spent fuel would swamp our ability to accept it. The numbers are the same for a centralized storage facility opening in 2030. Obviously, it's all about the rate at which we remove the spent fuel from reactor sites.

"The real question today is not how the United States will manage the entire spent fuel program, but rather whether to take the first step in creating an option for going to interim storage."

How long will it take to remove the spent fuel from the reactor sites?

Under the shipment assumptions currently being used even in optimistic planning studies, it will take 45 years to move the spent fuel away from the reactor sites. By 2050, almost all of the spent fuel will be in the stranded storage condition, which means that all of our current reactors will be nearly ready for decommissioning. If we start moving the fuel in 2050, it will be almost 2100 before all of it is removed from existing plant sites. The problem exists even for higher shipment rates.

What costs are involved in centralized storage?

These costs are not small, and as I have already discussed, the uncertainty regarding each cost item is substantial. We relied on the GAO report for much of our analysis, with consideration given to a range of opinions from other sources. Each centralized facility costs a couple hundred million dollars, and the hardware for transportation equipment costs even more. The cost of actually shipping the waste is a few billion dollars. The overall spent fuel program, including the permanent repository, is much higher. The GAO report conducted Monte Carlo analyses of the overall cost of the program and arrived at a total of around $50 billion. It is easy to get lost in the scale of what is needed to ultimately solve this problem.

How could a commitment to centralized storage save the United States money in this process?

Our analysis points out that the multibillion-dollar cost for an overall spent fuel management program—or interim storage and repository—is not what the decision-makers should be looking at. Instead, they need to consider spending only $30 million to $70 million to fully license a storage alternative. The final decision to build the facility and commit substantial dollars for construction will only be made once it is licensed and much more is known about the status of the rest of the spent fuel program. We will pursue this option only if we're saving money. This will be a money saver if the cost of storage at individual sites escalates as expected and we don't achieve a breakthrough on the permanent repository. Savings of hundreds of millions, if not billions, is possible under many scenarios.

In many ways, that analysis misses the greatest benefits. There are all kinds of other developments where having a centralized facility will prove invaluable. One lesson of the Fukushima Daiichi accident is the importance of being able to deal with the unexpected. Currently, there is no backup plan for at-reactor storage. If we need to cut into dry storage facilities for some reason, or if safety issues require moving spent fuel away from some reactor sites, the benefits of having a centralized storage facility will prove substantial. And at the very least, accepting the fuel at a centralized facility will allow the DOE to meet its commitments and cut down on litigation costs. NN