Private Fuel Storage, L.L.C.

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EIS COMMITMENT RESOLUTION LETTER #4
DOCKET NO. 72-22 / TAC NO. L22462
PRIVATE FUEL STORAGE FACILITY
PRIVATE FUEL STORAGE L.L.C.

References:
1. PFS letter, Parkyn to Director Office of Nuclear Material Safety and Safeguards, Responses To EIS Request For Additional Information, dated February 18, 1999
2. PFS letter, Parkyn to U.S. NRC, Responses To Second Round EIS Request For Additional Information, dated October 19, 1999
3. PFS letter, Donnell to U.S. NRC, EIS Commitment Resolution Letter #2, dated November 19, 1999
4. PFS letter, Donnell to U.S. NRC, EIS Commitment Resolution Letter #3-Proprietary, dated November 19, 1999

During the January 19, 2000 phone call, between the NRC/ORNL, Private Fuel Storage (PFS), and Stone and Webster (S&W), the NRC requested clarification/additional information regarding the PFS cost benefit analysis. The NRC requests/questions are documented below along with the PFS response.

NRC Requests/Questions

1. Explain the difference in the generic $/MTU estimates ($91,000 to $162,000) used in the February 1999 RAI response (Reference 1) for spent fuel storage at reactor sites compared to the costs used in the October/November 1999 ERI analysis (References 2, 3, and 4). Provide an explanation regarding why the October/November analysis was redone to reflect the appropriate analysis of storage costs on a site by site basis instead of using the generic cost estimates which can result in underestimating at-reactor costs.

NMSS01 Public

RESPONSE - The $91,000 to $162,000 per metric ton uranium (MTU) unit costs, used in the February 1999 RAI response, were based on a generic cost estimate for a 1,000 MTU Independent Spent Fuel Storage Installation (ISFSI) prepared by Eileen Supko, Energy Resources International, Inc. and presented at a January 1999 INFOCAST Conference, *"Nuclear Power Plants, Coming to Grips with Your License Expiration Options – Sell, Decommission, or Renew Your License"* (1999 Supko), included as Attachment A. Application of these generic costs for a 1,000 MTU ISFSI should not have been applied to the considerably smaller ISFSIs analyzed for the cost benefit analysis. This is because costs for a larger facility would underestimate the costs for the smaller ISFSIs analyzed for most reactor sites, as observed by NRC staff and consultants. The proper way to analyze site specific costs is on a reactor by reactor basis as done in the 1997 ERI Report (ERI-2025-9701), *"Utility At Reactor Spent Fuel Storage Costs for the Private Fuel Storage Facility Cost Benefit Analysis"*, and in the October RAI response and subsequent November 1999 ERI Report (ERI-2025-9901), *"Utility At Reactor Spent Fuel Storage Costs for the Private Fuel Storage Facility Cost Benefit Analysis, Revision 1."* The cost benefit analysis for at-reactor storage costs provided in the November 1999 ERI Report should be considered to supercede any information supplied to NRC in the 1997 ERI Report and the February 1999 RAI response.

To demonstrate how the facility size will affect unit costs expressed on a $/MTU basis, which results in costs being higher than the $91,000 to $162,000 per MTU cited in the February 1999 RAI response, it is useful to examine the fixed upfront costs of approximately $9 million per site assumed in the November 1999 ERI Report. For example,

- For a 1000 MTU facility this equates to $9,000 /MTU
- For a 200 MTU facility this equates to $45,0000 /MTU
- For a 100 MTU facility this equates to $90,000 /MTU

Thus, just the difference in upfront costs divided by the MTU stored in a projected ISFSI can significantly affect the cost on a $/MTU basis. It should also be noted that those sites classified as truck sites will have dry transfer facility costs added to the upfront costs which will result in higher $/MTU costs for those facilities. ERI's analysis of costs on a reactor by reactor basis as contained in the December 1997 report and the November 1999 report is the correct way to estimate site specific costs.

2. Provide an explanation of the current market for dry storage components compared to the costs from the TRW Report escalated to 1999 dollars to demonstrate that the unit costs from the TRW Report provide a conservative estimate of costs compared to the current market. Tie this to October/November ERI analysis, showing that the numbers used for the PFS cost benefit analysis are conservative compared to costs that a utility might actually pay for storage at reactor sites.

RESPONSE - The unit costs that make up the $91,000 to $162,000 /MTU cited from *1999 Supko* are in the same range as those used in the November 1999 ERI Report. A comparison is provided in Table 1. As presented in Table 1, the costs used in the November 1999 ERI Report are comparable to the unit costs that make up the $91,000 to $162,000 per MTU cited in *1999 Supko*.

The unit costs for spent fuel storage components that form the basis of the cost estimate provided in *1999 Supko* were developed by ERI based on Ms. Supko's knowledge of the dry storage market through discussions with utilities, dry storage cask designers, and others.

TABLE 1: COMPARISON OF UNIT STORAGE COSTS FOR NOVEMBER 1999 ERI REPORT AND 1999 SUPKO PAPER

Cost Component	November 1999 ERI Report	1999 Supko Paper
Upfront Costs • **Upfront Costs** • **Incremental Storage Pad** **TOTAL (60 to 90 casks)**	 $9.2 Million $4.2 to 5.8 Million (60 to 90 casks) $13.4 to 15.0 Million	 $9 to $14 million
Storage System and Loading • **Canister** • **Overpack** • **Loading** • **Consumables** • **Unloading** **Total per cask loaded:**	 • $396,480 • $196,000 • $36,176 • $33,600 • $7,280 • $669,536	$70 to $130 million (if above is divided by 60 to 90 casks needed to storage 1000 MTU, the resulting unit costs are: $800,000 to $1.4 million
ISFSI Operating Costs During Reactor Operation	$600,000 per year	$10 to $14 million for 20 Years) equivalent to: $500,000 to 700,000 per year
ISFSI Decommissioning Costs	$52,192 per storage unit	$2 to $4 million (60 to 90 casks) $22,000 to $66,000 per storage unit

The basis for the costs in the both the 1997 ERI Report and the November 1999 ERI Report are the costs components contained in a Department of Energy (DOE) contractor report, *At-Reactor Dry Storage Issues,* Revision, 1, TRW Environmental Safety Systems, Inc., December 10, 1993 (TRW 1993), included as Attachment B. The 1997 ERI Report used these costs (in 1993 dollars) without escalating the costs to then-current dollars. As explained in the November 1999 ERI Report, dry storage costs have increased since the 1997 ERI Study was completed. However, since there are no recent publicly available references that ERI could cite as a source for new unit costs, ERI escalated the unit costs contained in TRW 1993 to constant 1999 dollars in order to more accurately reflect current market costs seen at reactor sites for dry storage. As shown in Table 1, the escalated TRW 1993 costs are generally conservative compared to what ERI believes are current market costs for spent fuel storage components. The unit costs summarized in *1999 Supko* are based on "typical" costs and it should be noted that actual costs seen at individual reactor sites could be significantly higher depending upon various factors at those sites as discussed in 3., below.

3. Provide an explanation of the range of costs provided in *1999 Supko.*

<u>RESPONSE</u> - The cost components presented in Table 1 will vary over a range of costs due to a number of factors. Upfront costs include design, engineering, licensing, equipment, startup testing, construction, etc. Engineering and design costs would depend on the licensing status of the storage technology being used. Licensing costs will depend upon the regulatory status of the storage technology and whether spent fuel will be stored under a general or site specific license. ISFSI construction costs would be dependent upon the storage site terrain, proximity to local populations and the need for additional shielding, and the size of the facility. Additional construction costs for the metal cask monitoring system, duct banks for monitor system electrical hookup, and an alarm system would be included. Equipment costs will vary depending upon the storage technology selected. It should be noted that sites that require crane upgrades or other cask handling upgrades or that require a significant amount of construction for the storage pad area could have upfront costs in excess of $20 million.

Storage system and loading costs include the cost of the storage cask or canister, concrete overpacks, consumables used during loading, loading costs, etc. These incremental costs will vary depending upon the storage system used (storage only canister systems, dual-purpose canister systems, metal storage casks, dual-purpose metal casks, etc.). Cask costs can range from $650,000 per storage unit to $1.5 million per storage unit and loading costs will vary depending upon whether the casks have welded or bolted closures.

Decommissioning costs will vary depending on the type of system used. Attachment C cites dry storage decommissioning costs of $240,000 per canister (Page 3) – more than 4 times the amount assumed in the November 1999 ERI Report. The November 1999 ERI Report assumes that dual-purpose canisters are transferred to DOE for waste acceptance of the spent fuel and the utility is not responsible for decontamination and disposal.

4. Provide the basis for the $8 million per year post shutdown pool storage number including more than one data point to support this estimate. Explain that the $8 million estimate is typical of the estimates developed by utilities to assess post-shutdown spent fuel pool storage costs.

RESPONSE - Annual post-shutdown spent fuel pool operating costs typically assumed by utilities range from approximately $6 million to $24 million per site, depending upon the type of reactor, configuration of the spent fuel storage pool equipment, etc. Thus, average post-shutdown pool operating costs are $15 million per year per site. There are several references available to support the conservative assumption of $8 million per year used in the November 1999 ERI report for post-shutdown spent fuel pool operating costs. The $8 million estimate is typical of the estimates used by utilities and other industry consultants to assess the post-shutdown spent fuel pool storage costs, as identified below.

- Attachment C, "*James P. Malone Expert Witness Report*", Yankee Atomic Electric Company v. United States of America in the U.S. Court of Federal Claims, No. 98-126C, June 30, 1999. Post-shutdown spent fuel pool operations and maintenance costs are cited as $8 million per year per site.
- Attachment D, "*Utility On-Site Spent Fuel Storage Issues*", Kenneth Miller, Sacramento Municipal Utility District, presented at the March 1996 NEI Fuel Cycle Conference, states that post-shutdown spent fuel storage costs for Rancho Seco were estimated to be approximately $15.1 million per year. It should be noted that while SMUD plans to transfer spent fuel to dry storage, it has still not received a license for its dry storage facility and has not yet transferred any fuel to dry storage.
- Attachment E, *NES/Boston Edison, Decommissioning Workshop, Innovative Approaches Towards Reducing Post-Shutdown Decommissioning Costs*", February 1993, presented two estimates for post-shutdown spent fuel storage pool operating costs. The first estimate was for $24 million per year and included major cost elements for wet storage with existing plant systems. The second estimate was for $8.6 million per year and included major cost elements for wet storage with modified plant systems.
- Attachment F, *Spent Fuel and Decommissioning,* a presentation by William Cloutier, Jr., TLG Services, Inc., December 1997, indicates that post-decommissioning operating costs are typically $6 million to $10 million per year.

5. Explain the difference in the February 1999 RAI response of $3 to $8 million compared to the use of $8 million in the October/November submittal. Explain that the $3 million estimate is not for pool storage but dry storage and is speculative at this time as no reactor has yet unloaded the spent fuel pool to dry storage and decommissioned the pool.

RESPONSE - Regarding the $8 million per year per site used for post-shutdown spent fuel pool storage, this number has been used consistently as the estimate of post-shutdown pool operating costs by ERI in all of its analyses – the 1997 ERI Report, the February 1999 RAI response, and the November 1999 ERI Report. While the February 1999 RAI response discusses a range of post-shutdown spent fuel management costs of $3 million to $8 million per year, the reference cited in the February RAI response, *1999 Supko*, makes it clear that pool storage costs are $8 million per year per site (page 4). The lower cost of $3 million per year is associated with post-shutdown dry storage, assuming an on-site ISFSI has already been constructed.

As discussed in the November 1999 ERI Report (Section 2.3.2), it has been projected that spent fuel could be unloaded from storage pools to dry storage systems at reactor sites following shutdown for decommissioning. The annual operating and maintenance costs to store spent fuel at shutdown reactors using more recent information are projected to be approximately $4 million per year per site (increased from the previously estimated $3 million number) if dry storage were utilized instead of pool storage. However, this has not yet been achieved and it would be speculative to assume these costs for a system-wide analysis at this time. No shutdown reactors have yet emptied their spent fuel storage pools into dry storage and decommissioned their spent fuel pools. Several shutdown reactors are considering this alternative. It should also be noted that while the annual operating and maintenance costs would be lower if spent fuel were transferred to dry storage, there would be a subsequent large increase in the capital costs associated with the purchase and loading of dry storage systems to house the entire inventory of the spent fuel storage pool. Most of the reactors that are currently shutdown have done so prior to reaching the end of their 40-year operating licenses; thus, spent fuel inventories are relatively small. A typical 1,000 MW reactor is expected to produce 1,000 MTU of spent fuel over its 40-year license. This would require a significant capital expenditure to transfer all spent fuel to dry storage. The November 1999 ERI Report assumed that spent fuel pools would remain operational until all spent fuel has been removed from individual reactor sites.

6. Review PNL report referenced by NRC and explain why the estimate in this report for post shutdown pool storage is not valid and the $8 million is a more reasonable assumption.

<u>RESPONSE</u> - Pacific Northwest National Laboratory (PNL) published a report entitled, *"Cost Estimates of Operating Onsite Spent Fuel Pools after Final Reactor Shutdown"*, PNL-7778, dated August 1991 (PNL Report). Shortly after publication of the PNL Report, ERI reviewed the report on behalf of the Edison Electric Institute's Utility Nuclear Waste and Transportation Program (EEI/UWASTE). In two letters from Michael Schwartz, ERI, to Julie Jordan, EEI/UWASTE, (December 18, 1991 and February 24, 1992) ERI explains that the PNL Report estimates of post-shutdown spent fuel pool operating costs appear to be low by a factor of 2 to 6 compared to information obtained from utilities. ERI found that the annual cost of operating a spent fuel storage pool following final reactor shutdown could be $8 to $25 million per year, instead of the approximately $4 million reported by PNL. A substantial part of the difference between the PNL estimate and the utility estimates appeared to be due to the fact that PNL based its estimate on a dedicated spent fuel storage facility (General Electric's Morris facility) and attempted to adjust these costs for the nuclear power plant environment. Whereas the utility estimates began with an operating nuclear power plant and adjusted for the change due to cessation of power production. The two letters and associated attachments discussing ERI's findings following release of the PNL report are included as Attachments G and H.

7. Provide an explanation regarding how the 51 reactors used in the "best estimate" case were selected.

<u>RESPONSE</u> - As discussed in Section 2.5.1 of the November 1999 ERI Report, the 51 reactors were selected for this scenario based on their projected need for additional storage capacity during operation and their requirements for post-shutdown spent fuel storage. The selection of reactors included PFS members, shutdown reactors, reactors with near-term license expiration, and those projected to require additional on-site storage capacity.

8. Provide a further explanation regarding non-quantitative reasons that a utility might chose to use PFS even if it might appear not to be the most economical reason.

<u>RESPONSE</u>

Conservative Cost Assumptions

The analysis of at-reactor storage costs contained in the November 1999 ERI Report is conservative as described in items 1, 2, and 3 above. Utility costs may indeed be higher than those assumed by the PFS cost-benefit analysis.

- As presented in Table 1, storage system and loading costs could be 20% to 100% higher than the costs assumed in the November 1999 ERI Report.

- As discussed in the response to 3., above, Upfront Costs could be more than $20 million per site if sites require crane upgrades or other cask handling upgrades or require a significant amount of construction for the storage pad.
- As discussed in the response to 4., above, post-shutdown spent fuel pool operating costs typically assumed by utilities range from approximately $6 million to $24 million per site, depending upon the type of reactor, configuration of the spent fuel storage pool equipment, etc.

Risk Management Issues

Risk management issues should be considered in evaluating whether an individual utility might choose to store spent fuel at PFS rather than in an at-reactor dry storage facility. For example, shutdown reactors might view the near-term schedule for operation of the PFSF as a benefit for removal of spent fuel from the reactor site to allow near-term decommissioning of the site. As discussed in the November 1999 ERI Report, (section 2.4.3), while DOE has not announced a repository delay beyond its current expected operational date of 2010, delays are expected due to future limits in Congressional appropriations for the project, political delays (both National and State related), and licensing and technical issues. Since the operating and maintenance costs for one large central storage facility will be less than the separate operating and maintenance costs for many small at-reactor ISFSIs, the risk management benefits associated with the uncertain DOE schedule and long-term operating expenses may result in shutdown reactors choosing to store spent fuel at the PFSF.

It should also be noted that just because a reactor (operating or shutdown) has constructed an at-reactor ISFSI does not preclude that reactor from making a decision to use the PFSF. It is possible that any dual-purpose casks/canisters could be shipped to PFS and offset the cost of PFS' purchase of similar equipment. It might also be possible that concrete overpacks used in at-reactor storage could be shipped to the PFSF for subsequent reuse. While these potential cost savings are not evaluated in the November 1999 ERI Report, they should be considered qualitatively for sites that might not appear to have an economic benefit for using the PFSF.

Other economic benefits of the PFSF exist for some utilities that are not easily quantified, but are nonetheless real. Some states, such as Minnesota and Wisconsin, have limited the amount of on-site dry cask storage available at some plant sites. Utilities in these states that have limitations would likely choose to use the PFSF in order to accommodate continued economic operation of the units, including life extension beyond the current operating license term. Currently, under state limitations and without the option of offsite storage, the NSP Prairie Island units in Minnesota would be forced to close in 2007, even though the two units are licensed by the NRC to operate until 2013 and 2014 respectively. Extending the operation of these NSP units beyond 2007 is not possible without the PFS option, and no consideration for continued operation beyond the license expiration can be given until an off-site storage option is available. Other utilities either currently have such planning limitations, or may have in the future. While no quantifiable benefits associated with continued operation and life extension were presented in the PFS Environmental Report (ER) and subsequent submittals, the availability of the PFSF storage option represents an important qualitative benefit for these utilities.

Other qualitative benefits that the PFSF option provides include the availability of reuse and commercial development potential of the sites of permanently shutdown commercial nuclear power plants. By completing the decommissioning phase for these plants, including shipment of the spent fuel to the PFSF, the sites can be reused for non-nuclear applications. The utilities are allowed to choose real estate and industrial development options that would not be possible if the fuel were to remain on-site, providing significant economic benefits, which could not otherwise be realized. Having an off-site storage option also allows the utilities to plan and implement decommissioning activities on a predictable schedule, consistent with other utility manpower and capital requirements, providing resource loading options that otherwise would not be available, resulting in cost savings. In addition, decommissioning activities can be completed consistent with the availability of economical Low Level Radioactive Waste (LLW) storage options. As outlined in Chapter 7 of the PFSF ER (Section 7.2.1), costs for LLW disposal are increasing much faster than inflation, and the availability of LLW disposal is continuing to change. While no quantifiable credit for these decommissioning benefits were presented in the PFS Environmental Report and subsequent submittals, the availability of the PFSF option represents an important benefit for those utilities considering decommissioning.

If you have any questions regarding this response, please contact me at 303-741-7009.

Sincerely

John L. Donnell
Project Director
Private Fuel Storage L.L.C.

Enclosure

Copy to (with enclosure):

- Mark Delligatti
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- John Paul Kennedy
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EIS COMMITMENT RESOLUTION LETTER #4

LIST OF ATTACHMENTS

Attachment A	"Nuclear Power Plants, Coming to Grips with Your License Expiration Options – Sell, Decommission, or Renew Your License" (1999 Supko)
Attachment B	At-Reactor Dry Storage Issues, Revision, 1, TRW Environmental Safety Systems, Inc., December 10, 1993 (TRW 1993)
Attachment C	"James P. Malone Expert Witness Report", Yankee Atomic Electric Company v. United States of America in the U.S. Court of Federal Claims, No. 98-126C, June 30, 1999
Attachment D	"Utility On-Site Spent Fuel Storage Issues", Kenneth Miller, Sacramento Municipal Utility District, presented at the March 1996 NEI Fuel Cycle Conference
Attachment E	NES/Boston Edison, Decommissioning Workshop, "Innovative Approaches Towards Reducing Post-Shutdown Decommissioning Costs", February 1993
Attachment F	"Spent Fuel and Decommissioning", a presentation by William Cloutier, Jr., TLG Services, Inc., December 1997
Attachment G	Letter of December 18, 1991, Michael Schwartz of ERI to Julie Jordan of EEI/UWASTE
Attachment H	Letter of February 24, 1992, Michael Schwartz of ERI to Julie Jordan of EEI/UWASTE

EIS COMMITMENT RESOLUTION LETTER #4

ATTACHMENT A

(7 pages)

How Spent Nuclear Fuel and Low- and High-Level Waste Will Be Disposed and At What Price

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Presented at: INFOCAST Conference, *Nuclear Power Plants, Coming to Grips with Your License Expiration Options – Sell, Decommission, or Renew Your License*, January 25-27, 1999, Washington, DC

The costs and risks associated with the long-term management and disposal of spent nuclear fuel, and low- and high-level radioactive waste play a role in decisions regarding whether to continue to operate, purchase/sell, or decommission nuclear power plants in a competitive electricity market. This presentation will address: the impact that long-term spent nuclear fuel management costs have at reactor sites; the status of the Department of Energy's (DOE) civilian radioactive waste management program; potential changes in the one mill per kilowatt hour Nuclear Waste Fee paid to the Federal government for disposal of spent nuclear fuel; and the impact of low-level radioactive waste disposal costs and capacity on decommissioning costs.

1. IMPACT OF LONG-TERM SPENT FUEL MANAGEMENT AT REACTOR SITES

Because DOE is not expected to begin spent fuel acceptance for disposal in an operating repository until 2010, at the earliest, it is necessary for utilities to plan for the long-term management of spent nuclear fuel at reactor sites.

1.1 On-Site Spent Fuel Storage Background

During the early 1980s, it was evident that a number of reactor sites would have insufficient spent fuel storage capacity in spent fuel storage pools at reactor sites to support continued reactor operation through license expiration. These reactors had already reracked spent fuel storage pools to the maximum extent possible and another storage alternative was necessary as an interim measure until DOE was to begin spent fuel acceptance in 1998. The Nuclear Waste Policy Act (NWPA) required the Secretary of Energy to establish a demonstration program, in cooperation with the private sector, for dry storage of spent fuel at reactor sites. In 1982, Virginia Power initiated a research program to provide additional spent fuel storage at its Surry station using metal cask storage technology. DOE and the Electric Power Research Institute signed cooperative agreements with Virginia Power to demonstrate the metal storage technology. The Surry facility received the first site-specific license for an Independent Spent Fuel Storage Installation (ISFSI) from the U.S. Nuclear Regulatory Commission (NRC) in 1986.

Utility experience with the dry storage of spent nuclear fuel has increased dramatically since 1986 and will continue to grow given that the earliest date that the DOE projects it will have a repository available to begin accepting spent nuclear fuel will be 2010. Figure 1 presents a projection of the number of operating reactors that lose the ability to discharge a full core of spent nuclear fuel into the storage pool by date. In addition to the need for additional storage capacity at operating reactors, many shutdown reactors are planning to offload spent fuel storage pools to on-site dry storage facilities in order to facilitate decommissioning activities and to potentially reduce post-shutdown storage costs. The post-shutdown storage of spent nuclear fuel will play a significant role in the costs that must be set aside for decommissioning and related activities.

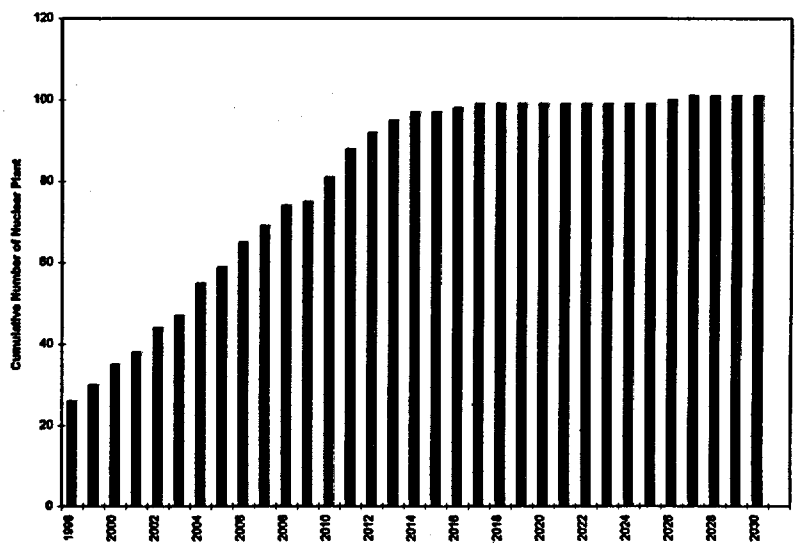

Figure 1 **Cumulative Number of Reactors Losing Full Core Discharge Capability**

1.2 Storage Costs At Operating Reactors

Costs for on-site storage will vary depending on the type of storage technology selected, its licensing status, nuclear power plant site topography, and the projected capacity of the dry storage facility. Table 1 presents a range of representative projected life cycle costs for a 1,000 metric ton of uranium (MTU) on-site dry storage facility, assuming that a transportable canister-based storage system or metal dual purpose cask is used. This is equivalent to the projected lifetime spent fuel arisings from one large 1,000 MW nuclear power plant. The costs include capital costs, operations and maintenance (O&M) costs, and ISFSI decommissioning costs.

Upfront costs include the costs for design, engineering, licensing, equipment, construction of storage pads and security systems, and startup testing for the facility. Upfront costs are estimated to be approximately $9 million to $14 million depending on the technology's licensing status, facility size, the type of equipment required, and the site's topography.

Storage system and loading costs are the costs associated with loading fuel into the ISFSI, including the costs for transportable metal storage canisters and concrete overpacks, metal casks, storage system loading, and consumables. For a 1000 MTU on-site storage facility, storage system and loading costs are estimated to total $70 million to $130 million, depending on the storage technology selected.

Annual operating costs are the costs required to operate the facility that are not associated with loading fuel into dry storage. This would include NRC annual license fees, fabrication surveillance, monitoring costs, personnel costs, utilities, etc. these costs will be vary depending upon whether the ISFSI is located at an operating reactor site or a shutdown reactor site. During reactor operation, operating costs for a 20-year period will range from $10 million to $14 million.

Decommissioning costs are the costs associated with dismantling, decontaminating, and disposing of the material in the dry storage facility. Decommissioning costs are estimated to be approximately $2 million to $4 million.

Total life cycle costs to build and operate a 1,000 MTU ISFSI for a 20 year period during reactor operation are estimated to total between $91 million and $162 million. Actual costs for any individual reactor site may be higher or lower depending upon the storage technology selected, the amount of fuel requiring dry storage, site conditions, etc.

Table 1 REPRESENTATIVE LIFE-CYCLE COSTS FOR A 1,000 MTU ISFSI AT AN OPERATING REACTOR SITE

COST COMPONENT	DESCRIPTION	ESTIMATED COST (MILLIONS $1999)
Upfront Costs	Design, engineering, licensing, equipment, startup testing, etc.	$9 – $14
Storage System and Loading	Storage system, loading costs, consumables, etc.	$70 – $130
ISFSI Operating Costs During Reactor Operation	20 years of dry storage during reactor operation: NRC fees, operating and maintenance costs, etc. 500-700.	$10 – $14
ISFSI Decommissioning	Assumes metal canisters or dual purpose casks transferred to DOE	$2 – $4
TOTAL COSTS		$91 – $162

1.3 Storage Costs At Shutdown Reactors

In addition to the costs identified above to place 1,000 MTU of spent fuel into dry storage during reactor operation, reactor sites will experience significant costs associated with the long-term storage of spent fuel following reactor shutdown for decommissioning. These long-term post-shutdown storage costs are a result of DOE's delay in beginning spent fuel acceptance. Table 2 presents an estimate of the operating costs for post-shutdown spent fuel storage in an ISFSI and in a spent fuel storage pool. Costs at individual reactor sites will differ depending upon site conditions, number of reactors, etc.

ISFSI operating costs at a shutdown reactor site will be much higher than those for an operating reactor since the costs for security, insurance, utilities, etc., will be attributed entirely to the storage of spent fuel. If DOE does not begin spent fuel acceptance until 2010 or later, spent fuel could be stored at reactor sites for 20 to 30 years following reactor shutdown at a cost of $60 million to $120 million for storage in an ISFSI.

Spent fuel pool operating costs at a shutdown reactor site are estimated to be approximately $8 million per year, depending upon the degree to which the spent fuel pool can be isolated from the reactor systems. If DOE does not begin spent fuel acceptance until 2010 or later, spent fuel could be stored at reactor sites for 20 to 30 years following reactor shutdown at a cost of $160 million to $240 million for storage in spent fuel pools.

Table 2 REPRESENTATIVE POST-SHUTDOWN SPENT FUEL STORAGE COSTS FOR DRY STORAGE AND POOL STORAGE

COST COMPONENT	DESCRIPTION	ESTIMATED COST (MILLIONS $1999)
ISFSI Operating Costs Post Reactor Shutdown	20 to 30 years of dry SNF storage until DOE acceptance begins: NRC fees, operating and maintenance costs, etc.	$60 – $120
Pool Operating Costs Post Reactor Shutdown	20 to 30 years of pool storage until DOE acceptance begins: NRC fees, operating and maintenance costs, etc.	$160 – $240

The largest impact associated with spent fuel management is the unknown length of time that fuel must be stored at reactor sites which could cost tens to hundreds of millions of dollars per site. NRC regulations for the calculation of the minimum funding levels required for decommissioning do not include the cost of long-term storage, removal or disposal of spent nuclear fuel. Therefore, these costs must be accounted for in order to ensure adequate funding is available for ISFSI construction and loading activities, and long term O&M costs for either dry storage or pool storage.

According to an NRC document responding to frequently asked questions regarding decommissioning (NUREG-1628)[1], currently shutdown reactors have provided estimates for long-term spent fuel management. These estimates include:

- Portland General Electric, Trojan, $110 million for an ISFSI and related fuel management (1993 dollars)
- Connecticut Yankee Atomic Power Company, Haddam Neck, $82.3 million for spent fuel storage (1996 dollars)
- Maine Yankee Atomic Power, Maine Yankee, $53.4 million for spent fuel management (1997 dollars)

2. STATUS OF DOE CIVILIAN RADIOACTIVE WASTE MANAGEMENT SYSTEM

Over the past several years, the DOE's Office of Civilian Radioactive Waste Management (OCRWM) has focused on addressing major unresolved technical issues in the characterization of Yucca Mountain, Nevada, as a potential repository site for spent nuclear fuel and high-level radioactive waste. OCRWM completed a viability assessment (VA) of the Yucca Mountain project in September 1998 and it was transmitted to the President and Congress in December 1998. While the VA is not one of the decision points defined in the Nuclear Waste Policy Act of 1982, as amended, it will give policy makers important information regarding the prospects for geologic disposal at Yucca Mountain. No show-stoppers were identified in the VA; thus, DOE will continue site characterization activities at Yucca Mountain continuing to focus on uncertainties in the scientific and technical information needed to support a site recommendation and preparation of a license application.

The VA components included: (1) a design for the critical elements of a repository and waste package; (2) an evaluation of the predicted performance of the repository system, the way in which natural and manmade systems work together to contain waste and to protect people and the environment; (3) a schedule and cost estimate for remaining work required to complete a license application; and (4) a cost estimate for construction and operation of a repository.

Relevant future milestones for the OCRWM program include:

- Publication of a Draft Environmental Impact Statement (EIS) during 1999
- Publication of a Final EIS during 2000
- Submittal of Site Recommendation to the President in 2001
- Submittal of License Application for construction authorization to the NRC in 2002

3. POSSIBLE CHANGES TO NUCLEAR WASTE FEE

Along with the publication of the VA in December 1998, DOE also released *"Analysis of the Total System Life Cycle Cost of the Civilian Radioactive Waste Management Program"*,(TSLCC) DOE/RW-0510, and *"Nuclear Waste Fund Fee Adequacy: An Assessment"*, DOE/RW-0509. An annual assessment of the adequacy of the Nuclear Waste Fund (NWF) fee is required by the NWPA to evaluate whether *"collection of the fee will provide sufficient revenue to offset the costs"* of the OCRWM program. The TSLCC analysis is used as the baseline cost profile to determine the adequacy of the fee. In the Fee Adequacy Assessment, DOE recommends that the fee not be changed. DOE bases this recommendation *"on examination and analysis of the revenue forecasts and estimated costs for the Program's current approach to a waste management system, and on consideration of the uncertainties associated with the economic assumptions, program revenues, program scope, and cost estimates."*

Based on DOE's analysis of the adequacy of the NWF fee, it is unlikely that there will be a need to increase the one mill per kilowatt-hour electric fee in the near future. In addition, it would be politically difficult for DOE to recommend an increase in the NWF fee given that it has missed the January 31, 1998 deadline to begin spent fuel acceptance and has not set a firm schedule regarding when spent fuel acceptance will begin under a repository-only system.

4. LOW-LEVEL RADIOACTIVE WASTE DISPOSAL COSTS AND CAPACITY

The costs associated with the disposal of low-level radioactive wastes from nuclear power plants comprise one of the largest components of decommisioning costs and thus play a role in the selection of the method of decommissioning to be used. Current LLW disposal costs range from less than $100 per cubic foot to $400 per cubic foot depending on the type of waste (Class A, B, or C) and the disposal facility being used. LLW disposal costs have increased by 12% per year over the past ten years.[2] Further cost increases for LLW disposal are projected, particularly if any of the regional LLW disposal facilities begin operation. Many recently shutdown nuclear power plants are choosing immediate dismantlement because it offers lower LLW disposal costs in the near-term than the projected costs for LLW disposal under a delayed decommissioning option.

Another risk associated with disposal of LLW waste from decommissioning is the future availability of LLW disposal facilities. Delays in the development of new LLW disposal facilities have been widespread. Only two LLW disposal facilities accept all classes of LLW; they are facilities in Barnwell, South Carolina and Richland, Washington. The Washington LLW facility is restricted to waste generators in the 10 states in the Northwest and Rocky Mountain LLW Compacts. Access to the Barnwell facility is open to generators in every state except North Carolina. The Envirocare of Utah facility also accepts certain types of low-activity wastes.

Annual waste disposal volumes at the Barnwell facility have fallen dramatically during the past ten years despite the fact that Barnwell is the only facility open to all generators (except North Carolina generators) that accepts all classes of LLW. Waste volumes have fallen due to rising prices and increased use of volume reduction techniques or on-site storage of LLW. The state of South Carolina established a $235 tax on each cubic foot of LLW received at the Barnwell facility. In 1997, the legislature passed a law holding Chem Nuclear liable for a $23 million minimum in tax for the scholarship portion of the education funds for fiscal year 1997/1998. In subsequent years the tax in $24 million. The future availability of the Barnwell facility to out-of-state generators is at risk since it is expected that the new Governor of South Carolina will recommend that the Barnwell facility be closed to out-of-state generators.[3]

An average nuclear power plant will need to dispose of 250,000 to 500,000 cubic feet of decommissioning LLW. A recent estimate by Maine Yankee Atomic Power Station included in its *Post Shutdown Decommissioning Activities Report*, filed with the U.S. NRC on August 27, 1997, estimates that the LLW burial volume associated with immediate dismantlement of the Maine Yankee nuclear power plant will be approximately 209,000 cubic feet with costs of $83.7 million for LLW burial and $13.7 million for LLW packaging and shipping as part of an overall decommissioning cost of $274 million in 1997 dollars.. An August 1997 estimate by Connecticut Yankee Atomic Power Company filed with the NRC estimates the total decommissioning costs for the Haddam Neck reactor to be $427 million in 1996 dollars. LLW burial and shipping charges are estimated to be $71.9 million.[4]

It is expected that as long as LLW disposal capacity is available at prices that utilities are willing to pay, utilities will dispose of LLW as part of the decommissioning process rather than storing the waste on-site in a safe-storage mode. However, should LLW disposal capacity be unavailable (particularly for Class B and C wastes) or should the prices for disposal become prohibitively expensive, utilities do have the alternative of leaving the radioactive components at reactor sites – particularly since spent fuel will likely require on-site storage for several decades. In addition to disposal of LLW and spent fuel, there will also be wastes classified as Greater-Than-Class-C LLW (GTCC) that will require disposal. DOE has been given the statutory responsibility for disposal of this material and it is expected that the waste will be disposed of in a geologic repository. However, there has not been a decision on the part of the Federal government regarding the ultimate disposition of GTCC waste and the costs for such disposal have not yet been identified. Most utilities are planning to store GTCC waste in canisters along with the spent nuclear fuel until it is accepted by DOE.

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[1] U.S. NRC, *Staff Responses to Frequently Asked Questions Concerning Decommissioning of Nuclear Power Reactors,* NUREG-1628, April 1998

[2] Schmalz, Gregory, Transco Products; *The Cost of Delay*, Nuclear Engineering International, March 1996

[3] LLW Forum, *"SC Governor -Elect Considers Future of Barnwell,"* LLW Notes, Volume 13, Number 8, 1998

[4] T.C. Feigenbaum, Connecticut Yankee Atomic Power Company, to the U.S. NRC, "Haddam Neck Plant Post Shutdown Decommissioning Activities Report, Docket 50-213, August 22, 1997