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Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management

Westinghouse
Hanford Company Richland, Washington

Management and Operations Contractor for the
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PROGRESS ON THE HANFORD K BASINS SPENT NUCLEAR FUEL PROJECT

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ABSTRACT

This paper highlights progress made during the last year toward removing the Department of Energy's (DOE) approximately 2,100 metric tons of metallic spent nuclear fuel from the two outdated K Basins at the Hanford Site and placing it in safe, economical interim dry storage. In the past year, the Spent Nuclear Fuel (SNF) Project has engaged in an evolutionary process involving the customer, regulatory bodies, and the public that has resulted in a quicker, cheaper, and safer strategy for accomplishing that goal. Development and implementation of the Integrated Process Strategy for K Basins Fuel is as much a case study of modern project and business management within the regulatory system as it is a technical achievement.

A year ago, the SNF Project developed the K Basins Path Forward that, beginning in December 1998, would move the spent nuclear fuel currently stored in the K Basins to a new Staging and Storage Facility by December 2000. The second stage of this $960 million two-stage plan would complete the project by conditioning the metallic fuel and placing it in interim dry storage by 2006. In accepting this plan, the DOE established goals that the fuel removal schedule be accelerated by a year, that fuel conditioning be closely coupled with fuel removal, and that the cost be reduced by at least $300 million.

The SNF Project conducted coordinated engineering and technology studies over a three-month period that established the technical framework needed to design and construct facilities, and implement processes compatible with these goals. The result was the Integrated Process Strategy for K Basins Fuel. This strategy accomplishes the goals set forth by the DOE by beginning fuel removal a year earlier in December 1997, completing it by December 1999, beginning conditioning within six months of starting fuel removal, and accomplishes it for $340 million less than the previous Path Forward plan.

DOE approval of the Integrated Process Strategy was received in late July 1995 and its implementation is well underway. Because this is a strategy as compared to a fully engineered solution, technical challenges must be overcome and continually adjusted while accelerated engineering, procurement, construction, and startup activities are proceeding in parallel. A comprehensive technical integration process including the requirements baseline, process flow diagrams, interface control, issues management, technical data management, and configuration control has been implemented to manage and communicate these adjustments throughout the Project. These modern business practices are central to the success of the Integrated Process Strategy for K Basins Fuel.

INTRODUCTION

At last year's WM '95 Conference, the K Basins Path Forward was described. This was a strategy for the early removal of fuel and sludge from the K Basins to quickly mitigate environmental concerns and public and worker health and safety issues. In the year since then, many changes to those plans have occurred through working with the customer, regulatory bodies and the public and incorporating changing and improved requirements. The result of this evolutionary process is the Integrated Process Strategy for K Basins Fuel. This new strategy and how it effectively meets the challenges is the subject of this paper.

Development of the Integrated Process Strategy for K Basins Fuel is as much a case study of project and business management within the regulatory system as it is a technical achievement. The paradigms of DOE's production past are no longer operative in today's complex political, regulatory, and public involvement environment. Previously, a technical problem would be thoroughly studied and evaluated before any plans were made. A technically elegant solution would be developed without public or regulatory input. A budget and schedule would then be adopted that supported this solution, a Congressional funding appropriation obtained, and the project executed.

The SNF Project at Hanford has shown that modern business practices can be applied within the DOE system, albeit, dramatic shifts away from the old cost-plus processes are required. The business practices being applied by the SNF Project are not new or different from those used in private industry. In today's environment many factors drive the technical solution which must often be adjusted before it is fully implemented as those factors change. The SNF Project has successfully combined the practical "can do, get the job done" attitude of the past with the political, regulatory, and public realities of the present.

SPENT NUCLEAR FUEL PROJECT AND THE K BASINS PATH FORWARD

The inventory of spent nuclear fuel at the Hanford Site covers a wide variety of fuel types (production reactor to space reactor) in many facilities (reactor fuel basins to hot cells) at locations all over the Site. The 2,129 metric tons of spent nuclear fuel at Hanford accounts for over 80% of the total U.S. DOE inventory. Most (98%) of the Hanford spent nuclear fuel is 2,103 metric tons of metallic uranium production reactor fuel currently stored in the K Basins located near the Columbia River at the northern end of the Hanford Site.

These two basins each contain about 3,800 cubic meters (one million gallons) of water and were part of the K East and K West production reactor complex constructed in the 1950s. They were used to cool discharged fuel prior to chemical processing at the PUREX facility. After the K Reactors production mission ended in the 1970s, the basins were used as temporary storage capacity for N Reactor fuel while the PUREX processing facility was being refurbished and restarted. When the defense production mission ended in 1990 and PUREX operations were terminated in December 1992, part of the N Reactor fuel inventory remained in the basins with no means for near-term removal and processing. The K East

Basin contains 1,146.2 metric tons of spent fuel and the K West Basin contains 956.8 metric tons of spent fuel. (This includes the 2.9 metric tons of spent fuel recently transferred from PUREX to the K West Basin.) The fuel in the K West Basin has been stored in water filled, lidded canisters containing a corrosion inhibitor and the basin environment is relatively clean and free of corrosion products. The fuel in the K East Basin, however, was stored in open canisters and some of the fuel has corroded extensively. The deteriorating fuel with no viable "path forward," and worker health and safety issues, coupled with aging facilities with seismic vulnerabilities, has been identified by several groups, including regulators, stakeholders, and the DOE, as being one of the most urgent safety and environmental concerns at the Hanford Site.

To meet these challenges, the Spent Nuclear Fuel Project was formed in February 1994. The mission accepted by the SNF Project is to "Provide safe, economic, and environmentally sound management of Hanford spent nuclear fuel in a manner which stages it to final disposition." A year ago, the SNF Project developed the K Basins Path Forward, a two-phase strategy to allow early removal of fuel and sludge from the K Basins followed by its stabilization and interim storage. In the expedited response phase, fuel and sludge from the K East and K West Basins would be packaged in large multi-canister overpacks (MCO). The fuel would remain in the original canisters while the sludge would be placed in containers resembling the fuel canisters. The canisters would be loaded into the MCOs under water and the MCOs would remain water filled during shipping to temporary storage at a new Staging and Storage Facility. During the second phase, MCOs would be transferred from the Staging and Storage Facility to a newly constructed Fuel Stabilization Facility which would be co-located with the Staging and Storage Facility. Here the fuel and unseparated sludge would be dried and passivated in the MCO to reduce the potential hazards associated with metal fuel storage. Following this stabilization process, the MCOs would be returned to the Staging and Storage Facility for interim dry storage. This strategy would begin removal of the spent fuel and sludge from the basins in December 1998 and place it in a new Staging and Storage Facility located in the 200 Area at the Hanford Site by December 2000. The K Basins Path Forward would complete placing the fuel and sludge in interim dry storage by the year 2006 for an estimated cost of $960 million.

K BASINS PATH FORWARD APPROVAL AND REFINEMENT PROCESS

In February of 1995, the DOE formally approved the K Basins Path Forward and provided the following goals for its refinement:

- Accelerate the Path Forward schedules by one year to commence fuel removal by December 1997, and to complete fuel removal in approximately two years, i.e. by December 1999.
- Accelerate the schedules for fuel conditioning activities so that fuel stabilization is closely coupled with fuel removal from the K Basins.
- Achieve significant cost reductions, with every attempt to complete implementation of the accelerated schedules including close coupled fuel stabilization within the fiscal year (FY)

1995 through FY 1997 budget projections.

- Revise the process to avoid reopening the MCOs once fuel is loaded so that the MCOs can be welded at the K Basins.
- Utilize the partially constructed Canister Storage Building (CSB) located in the 200 East Area as the Staging and Storage Facility recommended in the Path Forward strategy.

In response to the DOE's goals, the SNF Project conducted coordinated engineering and technology studies over a three-month period to establish the technical framework needed to design and construct facilities, and implement processes compatible with these goals. To achieve a timely and optimum evaluation and solution, Westinghouse Hanford Company, in conjunction with Pacific Northwest National Laboratory (PNNL), DOE staff, and several subcontractors, formed an integrated team to coordinate the studies and arrive at decisions. The overall process and timeline for developing the Integrated Process Strategy was aggressive. Beginning in April 1995, the technical options and criteria were developed, cost, schedule, and safety input provided, and the evaluations were performed. The resulting integrated process strategy was reviewed by an external advisory panel of experts between July 11-14, 1995, and their advice incorporated. The recommended strategy was finalized and provided to the DOE on July 18, 1995, for their consideration.

The decision process built upon the foundation established by the K Basins Path Forward and incorporated the schedule acceleration and compression, and cost reduction goals. The team identified the following key technical issues which afforded flexibility for improvements:

- Selection of the process for drying and conditioning the fuel.
- Wet (flooded) versus dry shipment of fuel.
- Wet (flooded) versus dry staging of fuel.
- Canister preparation and desludging requirements.
- MCO venting and hydrogen management requirements.
- Definition of an acceptable (defensible) safety basis.

Technical and engineering trade-off studies to resolve these issues were performed and a systems engineering process then resulted in process alternatives as shown in the summary block diagram in Figure 1. Eight integrated process options were developed from these alternatives for evaluation. These options, the evaluation results, and cost comparisons are summarized in Table 1. A comparison with the initial Path Forward of the same project scope is also included. The evaluation of these alternatives included the use of systematic multi-attribute decision analysis techniques to assure a comprehensive, balanced treatment. The evaluations included assessments of technical viability, health, safety and environmental risk, and cost, schedule, and programmatic risk.

Place Figure 1 and Table 1 here.

Cost was a major factor in evaluating process alternatives. The guidelines provided by DOE required that about $300 million be cut from the total $960 million project cost of the Path Forward and that the near-term budget profile be met. Major cost savings are realized by accelerating fuel removal from the basins through an early significant reduction in K Basins operating costs. Options that increase the packing density of fuel and a corresponding reduction in the number of MCOs can also have a significant impact on cost. Simplified fuel conditioning processes using commercially available equipment that treats the fuel within the MCO can also reduce costs. Because cost is not the only evaluation concern, higher cost alternatives were still considered in selection of the preferred alternative.

Another major evaluation criteria focuses on achieving initiation of fuel transfer away from the Columbia River at the earliest possible date, while maintaining worker safety and minimizing life-cycle costs. Those options with high or very high schedule risk are, therefore, eliminated from further consideration. Option 6, which features shipping fuel as-is in water-filled MCOs and wet staging, has the lowest schedule risk. However, this scenario has safety concerns and high costs. Option 1 is the lowest cost, but has a number of technical and safety uncertainties. Option 7, the recommended option, has moderate schedule risk, good technical viability, and acceptable safety/risk features. Option 7 will also produce a cost savings of approximately $340 million over the original Path Forward estimate and is consistent with the DOE budget goals.

INTEGRATED PROCESS STRATEGY

Option 7 was named the Integrated Process Strategy for K Basin Fuel and recommended to the DOE as the best method of achieving the cost and schedule goals. The DOE accepted the recommendation in late July 1995 and the SNF Project began implementing the strategy. The major elements of the strategy and the schedule for their acquisition are shown in Figure 2. Each of the individual process steps are closely interelated. For example, the fuel retrieval operation is designed to prepare the fuel for the drying operations that follow. The features of each process step are as follows:

- Fuel Retrieval During fuel retrieval the fuel canisters will be moved to a centralized work location within pool, the fuel removed, separated from the sludge, and loaded into tier baskets. After the tier baskets are filled with fuel, five or six baskets (depending on fuel length) will be loaded into a multi-canister overpack (MCO) and the closure welded in place. The MCO will be placed in a cask, removed from the basin, and transported to the Cold Vacuum Drying Facility.

- Cold Vacuum Drying At the Cold Vacuum Drying Facility, the water will be removed from the MCO before shipping it to the Canister Storage Building (CSB) by a combination of draining and cold vacuum drying. Vacuum drying will require only 24 to 48 hours to remove all of the free water. Removal of the free water greatly reduces the hydrogen generation rate and allows the MCO to be shipped to the CSB with the process valves closed, greatly enhancing safety during shipping.

- Staging in the CSB Upon arrival at the CSB, the MCOs will be staged in the storage tubes until they are prepared for interim storage with the conditioning process. Venting of hydrogen generated during staging will be through a high efficiency particulate air (HEPA) filter into inerted storage tubes.

- Hot Vacuum Conditioning The MCOs will be removed from staging and placed in the Hot Vacuum Conditioning Facility within the CSB where the metallic uranium fuel in the MCOs will be prepared for long-term interim dry storage in the CSB. The hot vacuum conditioning process will be designed to eliminate most of the chemisorbed water and mitigate further fuel corrosion and hydrogen generation. The MCO will be used as the process vessel and operated at approximately 300°C. The process, pending validation by the testing program, will consist of heating, vacuum drying, surface oxidation, cooling, and monitoring phases. The total cycle time for hot vacuum conditioning is estimated to require approximately six to eight days. Following conditioning, the MCOs will be sealed and returned to the storage tubes where they will remain until their ultimate disposition is determined.

Place Figure 2 here.

TECHNICAL INTEGRATION

Because the Integrated Process Strategy for K Basin Fuel is a strategy as compared to a fully engineered solution, there are many technical issues to be resolved as implementation proceeds. Effective technical integration is crucial to the success of the strategy because many accelerated engineering, procurement, construction, and startup activities are proceeding in parallel. Maintaining a traceable record of how issues are resolved and how key decisions are reached is even more challenging. The SNF Project has developed a technical integration process to effectively communicate the large volume of rapidly changing technical information.

The cornerstone of this technical integration process is the Technical Baseline Description. The Technical Baseline Description is a systems engineering based body of technical information that documents the project-level functions and requirements along with enabling assumptions, issues, trade studies, external interfaces, and products. A key feature of the Technical Baseline Description is the process flow diagrams (PFD). The PFDs have been developed to provide an integrated picture of the overall Integrated Process Strategy. They document and illustrate the material flows and interfaces among the subprojects and external interfaces. Management of the interfaces identified through the PFDs is performed by an interface control procedure. A centralized database has been developed to aid in the management of the interfaces and document agreements to maintain interface control. A technical issues management system has been implemented within the SNF Project to aid in the tracking, documentation, and timely resolution of issues. A two-tier system is used to maintain a traceable record of how issues are resolved and how key decision are made. The final element of the technical integration process is configuration management. The SNF

Project has developed and implemented a configuration control procedure that keeps Project documentation, design requirements, and physical configuration of equipment and facilities consistent with each other.

SUMMARY

The SNF Project at Hanford has employed modern business practices to develop and implement a strategy, consistent with DOE budget and schedule goals, for accelerated removal of the spent nuclear fuel stored in the two K Basins. An Integrated Process Strategy for K Basins Fuel was developed through trade studies and evaluation of alternatives to select a process strategy that minimizes schedule risk and provides opportunities for cost savings. Compared to the previous Path Forward plan, the Integrated Process Strategy will accelerate the schedule for fuel removal by a year, compress the schedule for fuel conditioning and its placement in interim dry storage by more than five years and reduce the life cycle costs by more than $340 million. Implementation of this strategy is underway with engineering, procurement, construction and startup activities occurring in parallel. The evolving technical solutions supporting the strategy are continually being adjusted to accommodate changing requirements as the Integrated Process Strategy is being implemented. A comprehensive technical integration process has been established to manage changes to the technical baseline and communicate them throughout the Project.

Table 1. Integrated Process Options Evaluation

Process Option Number	Key Process Decisions						Evaluation Criteria			
	Canister Prepration	Processing	Transport	Staging	Conditioning	Interim Storage	Schedule Risk	Technical Viability	Safety and Risk	Cost ($M)
Original Path Forward	As-Is	None	Wet (Flooded)	Wet (Flooded)	Passivation	Dry	Low	Acceptable	Acceptable	960
1	Perforate, Desludge and Selective Rerack	Vacuum Dry at K Basins	Dry (Sealed)	Dry (Vented)	Hot Vacuum	Sealed	Moderate	Good	Acceptable	670
2	Total Rerack	None	Wet (Flooded)	None	Hot Vacuum	Sealed	Very High	Marginal	Marginal	610
3	Total Rerack	None	Dry (Sealed)	None	Hot Vacuum	Sealed	Very High	Good	Acceptable	620
4	Perforate and Desludge - No Reracking	Vacuum Dry at K Basins	Dry (Sealed)	Dry (Vented)	Hot Vacuum	Sealed	Moderate	Marginal	Acceptable	660
5	Perforate and Desludge - No Reracking	Vacuum Dry at K Basins	Wet (Flooded)	Dry (Vented)	Hot Vacuum	Sealed	Moderate	Marginal	Acceptable	650
6	As-Is With Lids Removed	None	Wet (Vented)	Dry (Vented)	Hot Vacuum	Sealed	Low	Poor	Marginal	660
7	Total Rerack	Vacuum Dry at Annexes to the K Basins	Dry (Sealed)	Dry (Vented)	Hot Vacuum	Sealed	Moderate	Very Good	Acceptable	620
8	Total Rerack	Vacuum Dry at Annexes to the K Basins	Dry (Sealed)	None	Self-Heating	Vented	Moderate	Good (Additional Evaluation Required)	Marginal (Additional Evaluation Required)	590

Figure 1
Process Options for K Basins Fuel

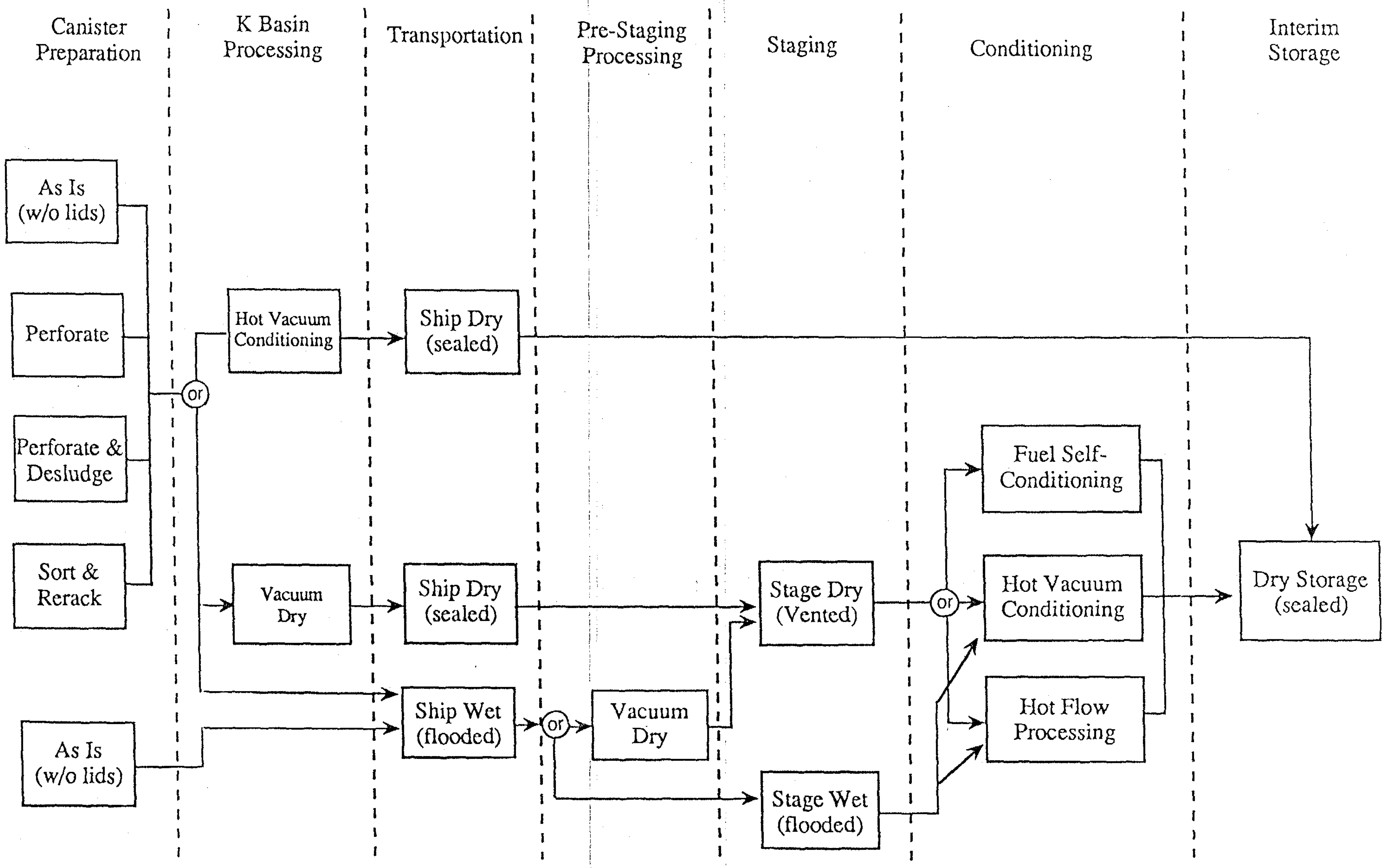

Figure 2
Integrated Process Strategy for K Basins Fuel Schedule