Hanford's Progress Toward Dry Interim Storage of K Basins Spent Fuel

G. E. Culley
E. W. Gerber
J. C. Fulton
Westinghouse Hanford Company

C. A. Hansen
U.S. Department of Energy, Richland Operations Office

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Abstract

This paper highlights the progress made toward removing the U.S. Department of Energy's (DOE) approximately 2,100 metric tons of metallic spent nuclear fuel from two outdated K Basins on the banks of the Columbia River and placing it in safe, economic interim dry storage beginning in December 1997. A new way of doing business at the Hanford Site and within DOE is being used to achieve the fast-track schedule, cost savings, and public cooperation needed for success.

In February 1994, the Spent Nuclear Fuel (SNF) Project was formed to solve serious safety and environmental problems associated with corroding metallic spent fuel stored in 1950's vintage, leak-prone, water-filled concrete basins located within 365 meters (400 yards) of the last remaining unspoiled section of the Columbia River. Working together, the integrated project team focused on quickly getting the fuel out of the basins and into safe, dry storage. The team involved the public, government, regulators, and other stakeholders and forged a common understanding. The DOE transferred authority to the field to shorten approval times, and Site contractors reengineered processes to improve efficiency. Within nine months of creating the project, a plan was recommended to the DOE. It was approved on February 14, 1995. Further refinement, during the following six months, shortened the schedule even more and reduced costs by $350 million.

The SNF Project is on a fast track. The K Basins Environmental Impact Statement was completed in only 11 months for only $1.3 million. Fuel and sludge samples were obtained from both basins and were sent to the laboratory for characterization and testing. The partially constructed Canister Storage Building (CSB), selected as the fuel storage facility, was redesigned, and construction was restarted saving over $17 million and cutting a year off the project schedule. With fuel removal beginning in December 1997, the SNF Project will have the fuel out of the K Basins and into economic safe storage four years ahead of the Tri-Party Agreement schedule, and it will save $100,000 a day in operating costs.

Introduction

Managing spent nuclear fuel safely is a top priority of the DOE. The 2,129 metric tons of SNF at the Hanford Site accounts for over 80% of the total nationwide inventory of DOE SNF. The SNF, located at Hanford, covers a wide variety of fuel types from plutonium production reactor fuel to exotic space reactor fuel. Ninety-eight percent of Hanford's SNF is the 2,103 metric tons of metallic uranium production reactor fuel currently stored in the K Basins located in the 100 Area near the Columbia River at the northern end of the Hanford Site.

Most SNF in the K Basins was previously used in the N Reactor, a dual purpose material and power production reactor that operated at the Hanford Site until 1991. This fuel was made of uranium metal coextruded with a protective cladding of zirconium metal. Inner and outer annular fuel rods were assembled into elements, about 60 centimeters (two feet) long and 6.3 centimeters
of the fuel
in the K East Basin is stored in open canisters, and some
fission products to the basin water and producing
handling resulted in exposed uranium metal surfaces
been stored in water-filled, covered canisters containing
a corrosion inhibitor; therefore, the basin environment is
relatively clean and free of fuel corrosion products. The
K East Basin has a history of
leaking. Between 1974 and 1979, an estimated 57 million
liters (15 million gallons) of contaminated water leaked
into the soil beneath the basin through a construction joint
where the basin and reactor structures are joined.
Although this joint was repaired in 1980, another leak of
about 357,200 liters (94,000 gallons) occurred in 1993.
These conditions and the close proximity of the basins to
the Columbia River raise significant environmental,
worker safety, and public health concerns.

Because there are no adequate plans to deal with SNF
disposition and with health and safety issues and because
the facilities are aging and vulnerable to seismic events,
the deteriorating fuel has been identified as one of the
most urgent safety and environmental concerns at the
Hanford Site.

THE PATH FORWARD

To meet these concerns, the Spent Nuclear Fuel
Project was formed in February 1994. The mission is to
"provide safe, economic, and environmentally sound
management of Hanford spent nuclear fuel in a manner
which stages it to final disposition." The DOE and the
Westinghouse Hanford Company committed to a new way
of doing business at Hanford: open communication,
cooperation, fast-track scheduling, and cost savings.
From the beginning, the public and regulators were
involved in developing solutions. The Hanford Advisory
Board; Indian tribes; state, county, and city government
leaders; and special-interest groups such as the Hanford
Education Action League, took part in the discussions.
Their goal was to get the fuel into safe storage as quickly
and as safely as possible.

With this input, four alternatives were developed and
evaluated, then the best features of several alternatives
were combined into the K Basins Path Forward. This
was a two-phase strategy that allowed early removal of
fuel and sludge from the K Basins followed by its
stabilization and interim storage. In the first phase, the
expedited response phase, fuel from the K East and
K West Basins would be placed in large multi-canister
overpacks (MCO). The fuel would remain in the original
canisters, and 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 to be located on the

(2.5 inches) in diameter, that weigh about 23 kilograms
(50 pounds) each. Following irradiation in the reactor,
the elements were discharged from the rear face, dropping
from distances up to 10 meters (35 feet) to the surface of
the water-filled discharge chute where they fell into a steel
cart at the bottom. These high velocity impacts with
structural surfaces and each other frequently damaged
many elements and exposed bare uranium to the water.
The irradiated elements were placed into double-barreled
canisters (seven elements per barrel) and cooled in the
basin for a few months while the short lived, highly active
fission products decayed away. The canisters were loaded
into casks on rail cars and shipped to the Plutonium
Uranium Extraction (PUREX) plant for separation and
recovery of the plutonium and uranium. Because this was
normally a close-coupled process, the fuel elements and
handling procedures were designed for throughput and not
for long-term storage. From 1972 to 1983, the PUREX
plant was shutdown for refurbishing. During this time,
the N Reactor continued to operate, and the discharged
fuel was stored in the N Reactor basin until its capacity
was exceeded. At that time, additional storage capacity
at the K Reactor basins was placed in service.

The two K Basins were part of the K East and
K West production reactor complex constructed in the
1950s. Each basin contains about 3,800 cubic meters
(one million gallons) of water. After the production
mission ended in 1970 and 1971, the basins were outfitted
with racks and used as temporary storage capacity for
N Reactor fuel. The K East Basin was used as it was,
with bare concrete walls. The K West Basin, however,
was drained, cleaned, and coated with epoxy paint before
going into service. Most of the operating systems
(cranes, fuel handling, basin water circulation, etc.) and
support systems (water, fire, electrical etc.) received
minimal maintenance and were never upgraded to modern
standards. After the Cold War ended, defense production
ceased in 1991 and PUREX operations were terminated in
December 1992. The N Reactor fuel inventory remained
in the K Basins with no means for near-term removal and
processing. Currently, the K East Basin contains 1,146.2
metric tons of SNF, and the K West Basin contains 956.8
metric tons.

Prior fuel damage caused by discharge operations and
handling resulted in exposed uranium metal surfaces
susceptible to corrosion. Fuel in the K West Basin has
been stored in water-filled, covered canisters containing
a corrosion inhibitor; therefore, the basin environment is
relatively clean and free of fuel corrosion products. Fuel
in the K East Basin is stored in open canisters, and some
of the fuel has corroded extensively releasing radioactive
fission products to the basin water and producing a thick
layer of sludge on the basin floor. This has created a
contaminated radiation environment for workers causing
health concerns. The 43-year-old basins are well past
their design life, and they lack modern earthquake-
resistant features. The K East Basin has a history of
leaking. Between 1974 and 1979, an estimated 57 million
liters (15 million gallons) of contaminated water leaked
into the soil beneath the basin through a construction joint
where the basin and reactor structures are joined.
Although this joint was repaired in 1980, another leak of
about 357,200 liters (94,000 gallons) occurred in 1993.
These conditions and the close proximity of the basins to
the Columbia River raise significant environmental,
worker safety, and public health concerns.
200 Area plateau about 20 kilometers (12 miles) from the Columbia River. In the second phase, the MCOs would be transferred from the Staging and Storage Facility to a newly constructed Fuel Stabilization Facility, co-located with the Staging and Storage Facility. Here, the fuel and unseparated sludge would be dried and rendered passive 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 by December 2000. The second phase of the strategy would stabilize the fuel and sludge and place it in interim dry storage by the year 2006. The estimated total cost would be $960 million. To meet this aggressive schedule, the strategy required that DOE streamline the way it conducts business and become more responsive. The strategy included recommendations for transferring authority for acquisition authorizations and approving National Environmental Policy Act (NEPA) documentation from DOE Headquarters to the local Field Office.

The Westinghouse Hanford Company recommended the Path Forward strategy to the DOE in October 1994. In February, 1995, the DOE formally approved the K Basins Path Forward and provided the following goals:

- Accelerate the Path Forward schedules by one year to commence fuel removal by December 1997 and to complete fuel removal in approximately two years (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 by attempting to complete implementation of the accelerated schedules, including close coupled fuel stabilization, within the fiscal year 1995 through 1997 budget projections.

- Revise the process to avoid reopening the MCOs after fuel is loaded so that MCOs can be welded closed at the K Basins.

- Use the partially constructed Canister Storage Building in the 100 East Area as the Staging and Storage Facility recommended in the Path Forward Strategy.

In response to DOE 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 to implement processes compatible with these goals. To achieve a timely and optimum evaluation and solution, the Westinghouse Hanford Company in conjunction with Pacific Northwest National Laboratory, DOE staff, and several subcontractors, formed an integrated team to coordinate the studies and make decisions. The overall process and timeline were aggressive. The technical options and criteria were developed; the cost, schedule, and safety input were provided; and the evaluations were begun in April 1995.

INTEGRATED PROCESS STRATEGY FOR K BASIN FUEL

The evaluation resulted in selecting an option to achieve the schedule goals and produce a cost savings of approximately $340 million over the original Path Forward estimate. This option was named the Integrated Process Strategy for KBasin Fuel, and it was recommended to the DOE on July 18, 1995. The DOE accepted the recommendation in late July, and the strategy began to be implemented. The major elements of the Integrated Process Strategy for K Basin Fuel are shown in Figure 1. 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 the basin. The fuel will be removed, cleaned, 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 MCO. The MCO will be placed in a cask, removed from the basin, and transported to the nearby Cold Vacuum Drying Facility.

- **Cold Vacuum Drying.** At the Cold Vacuum Drying Facility, the MCO shield plug will be welded in place, sealing the MCO except for the process penetrations. Water will be removed from the MCO by draining and cold vacuum drying. Vacuum drying for 24 to 48 hours will remove all free water, halting further corrosion of the metallic fuel and minimizing safety concerns.
**Staging in the CSB.** Upon arrival at the CSB, the MCOs will be staged in 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 filter into inert 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 use the MCO as the process vessel and will eliminate most of the chemisorbed water and mitigate further fuel corrosion and hydrogen generation. 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 be six to eight days. Following conditioning, the MCOs will be sealed and returned to the storage tubes where they will remain in dry storage safely until the fuel’s ultimate disposition is determined.

**Sludge and Debris Removal.** Sludge and debris will be removed from the basins in separate streams. Sludge, liberated as a result of fuel removal, will be collected by the water treatment system and stored within the basin. Floor sludge also will be collected, and the sludges will be transferred to a double-shell tank at Hanford for disposition. The debris, which includes discarded tools and other miscellaneous items as well as fuel canisters, will be cleaned with high-pressure water jets, sampled, compacted, loaded into burial boxes and managed as solid waste.

The Integrated Process Strategy for K Basin Fuel is a strategy rather than a fully engineered solution. There are many technical issues to be resolved during implementation. Effective technical integration is crucial to the success of the strategy because many accelerated engineering, procurement, construction, and startup activities are proceeding in parallel. The SNF Project has developed a technical integration process to effectively communicate and manage the large volume of rapidly changing technical information.

**PROGRESS TOWARD INTERIM DRY STORAGE OF K BASIN FUEL**

Much progress in a very short time has been made toward achieving the goal of safe, interim storage of the metal fuel stored in the K Basins at Hanford. This progress was enabled by the early decisions to manage the task as a project, with a beginning and an end; to involve stakeholders, tribes, and regulators; and to transfer full authority from DOE Headquarters to the field. Managing the task as a project allowed the scope to be fixed and realistic budgets and schedules to be established. Close cooperation among interested parties has built consistent support for this project. Transferring authority to the field has allowed the SNF Project to be conducted like a commercial venture. Progress toward the goal of starting fuel removal in December 1997 is shown in the summary schedule in Figure 2. Major events marking this progress since project approval in February 1995 are as follows:

- Developed the Integrated Process Strategy that accelerated the K Basins fuel removal schedule and reduced project costs by $350 million.
- Issued the K Basins Environmental Impact Statement Record of Decision in a record 49 weeks for only $1.3 million.
- Developed a Memorandum of Understanding for transferring sludge to a Hanford Site double-shell tank for disposition.
- Completed the design and started construction of new dry fuel storage facility (CSB).
- Completed preliminary design of the cask/transportation system.
- Began design of the Cold Vacuum Drying system.
- Collected fuel and sludge samples from both basins and transferred samples to laboratories for analysis and testing.
- Reduced radiation levels in K East Basin by 20 percent and began preparations to raise the water level to further reduce the radiation levels.
- Began removal of debris from K East Basin.
- The SNF Project workforce achieved one year without a lost workday.
The new way of doing business at Hanford with fast-track schedules, cost savings, and public cooperation has been successful. Construction of the dry fuel storage facility is underway, and other needed systems are proceeding on schedule to begin fuel removal from the K Basins in December 1997. When fuel removal is completed in December 1999, a major threat to the environment, and public and worker health and safety will have been eliminated.

Figure 1. Spent Nuclear Fuel Project Process.